



SHIP PERFORMANCE

Maihak Shaft Power Meter • Fuel Consumption Measurement
Dynamic Draught, Trim and Motion Measurement • Performance Monitoring
Fleet Data Quality • Analysis Catalog



SHIP PERFORMANCE

Performance is the completion of a task with the application of knowledge, skills and abilities¹. The task of a merchant vessel is to carry various kinds of cargo. However, how to measure how well the completion of the task was done?

Interviewing ten stakeholders in the shipping industry about their philosophy for a Ship Performance system will result in ten different answers. Experience, job position and perspective determine the focus. It results in different approaches including key performance indicators (KPI), visualization and analytics.

Only a reliable, unified input can satisfy the demand of all stakeholders towards ship performance. While the broker needs sound figures for the cargo intake, the chief engineer focuses on fuel quality and SFOC, whereas the agent needs a real-time ETA.

Hoppe Marine's ship performance approach originates back to our expertise as a sensor manufacturer for over 60 years.

Our solution is based on high quality measurements, especially for shaft power, fuel consumption and dynamic draught and trim. Moreover, our systems are self-monitoring for validity of measurements.

We strive to provide you with "qualified sensors and data" as a solid foundation for every decision you make – within seconds – on whichever platform you prefer.

¹ John Shields; Michelle Brown; et al. (2015)

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ABOUT HOPPE

Hoppe is a family owned group of companies with global presence and activities focused and dedicated to the maritime market. It's passion for Technology has been the company's key of success in more than six decades with the permanent motivation to deliver customer-oriented products and services.

Starting with the business idea to deliver precise instruments and measuring equipment for seagoing vessels (ship speed and power), Hoppe Bordmesstechnik was founded in 1949 by the German engineer Dipl.-Ing. Hans Hugo Karl Hoppe. The work life of Hans Hoppe was characterized by many technical inventions and patents for on-board measuring systems. After 35 years of successful work life Hans Hoppe passed away and his colleague Jürgen Haas took over the company and put things on the right track for the future of Hoppe. Four years later (1990) Helmut Rohde joined Hoppe as partner before finally taking over all shares of the company in 1997. The Hoppe era of the Rohde family business started.

Besides many years of organic growth the Rohde family established business in further maritime markets to follow the globalization of the shipbuilding business. In 1997 Hoppe Korea was established, followed by Hoppe China in 2010 and Hoppe Singapore in 2017. In parallel, strategic investments were made with the acquisitions of Meramont Automatyka (Poland), MAIHAK Marine (Germany), Flume Stabilization (USA) and INTERING ship stabilization systems (Germany). Combined with many new inventions and patents Hoppe has established a leading position in several maritime business areas.

The passion for technology is still unbroken and all Hoppe products are fully designed in Germany by our skilled engineers. This means that Hoppe has the full technical control over its portfolio and remains dedicated to quality, accuracy and reliability. With this approach Hoppe has maintained a very good market reputation ever since.

Being a fully independent family-owned company Hoppe is well known in the market as a reliable long-term partner. Hoppe combines decades of engineering know-how, sustainable on-board experiences with the continuous development of new technologies and innovations. Based on the strategic product- and service-focus approach Hoppe is a key player also in the digitalization process of the marine industry.



MAIHAK SHAFT POWER METER

The Maihak shaft power meter is designed to measure the shaft speed and shaft torsion of sea-going vessels with highest accuracy and repeatability.

The PLC display unit HOMIP processes these measurements and calculates the resulting shaft power. Those and other key performance indicators (KPI) values are shown on the PLC touchscreen and are also logged on the PLC memory card.

Its purpose is to monitor and control shaft torsion, rotation and power, in order to avoid heavy load conditions, allowing the crew's manual optimization,

monitor specific cylinder oil and fuel consumption and evaluate hull and propeller efficiency.

Today, and since the beginning of the shaft power measurement the ship industry, Maihak was and is a market reference leader.

With more than 900 installed systems Maihak has become a synonym for shaft power measurement. This in combination with high quality production (Made in Germany) has made Maihak what it is now – a highest quality product that we are all proud of.

KEY FEATURES

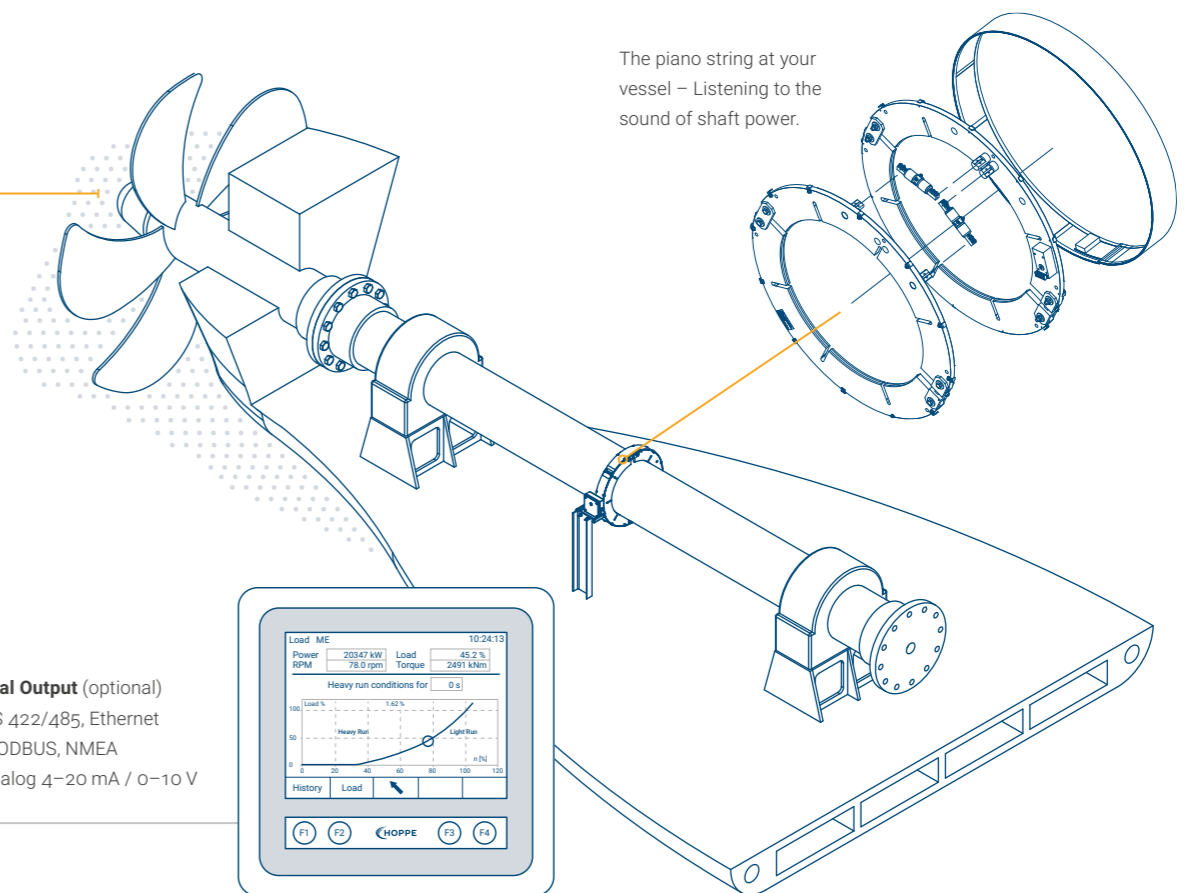
- Type approved (DNV-GL & LR) highly accurate and reliable measurement
- System accuracy: < 0,5 % at all load levels
- Calculates averages per hour, per day, and for a user-defined period
- Generates "heavy run alarm" or "torque alarm" with respect to the customer's settings
- Calibrated sensors with self-validation by software in operation
- Protected from external influences (temperature, shaft bending, etc.)
- Maintenance free and easy calibration by crew
- Can be safely dismantled from shaft for vessel maintenance
- For solid and hollow shaft sizes > 150 mm \varnothing and speed up to 800 rpm
- Single / twin shaft installation integrated in single PLC unit
- Installation for other possible purposes (cutter, dredger)

MEASURING PRINCIPLE

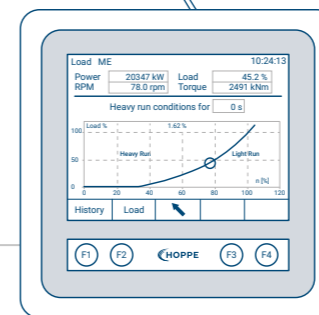
The measuring principle of the Maihak shaft power meter is based on two acoustic vibrating string sensors. They operate at a natural frequency of 600 Hz. These sensors are installed on the shaft ring. Due to their alignment one sensor will be stretched and the other will be compressed when the shaft is twisted by the torque. The stretched string will create a higher tone (increase its frequency) and the compressed sensor will create a lower tone (decrease its frequency).

By determination of the frequency-dependent behavior of every single sensor a fully calibrated system is supplied from the factory. With this information, the differential frequency between both sensors can be translated to the mechanical twist of the shaft.

Additionally, the shaft speed is measured with a gyroscope, an accelerometer and a hall sensor. The product of the mechanical twist and the shaft speed is the shaft power.



- Signal Output (optional)**
- RS 422/485, Ethernet
 - MODBUS, NMEA
 - analog 4–20 mA / 0–10 V



FUEL CONSUMPTION MEASUREMENT

Measuring fuel consumption offers economical and ecological opportunities to improve the operational fuel efficiency of ships. Therefore, ship owners are focused on fuel consumption management and seeking optimum ways of using the ship's fuel bunker.

Since decades, Hoppe Marine has been engaged in the development, installation and upgrading of fuel consumption measurement systems by offering harmonized hardware and in-house developed software.

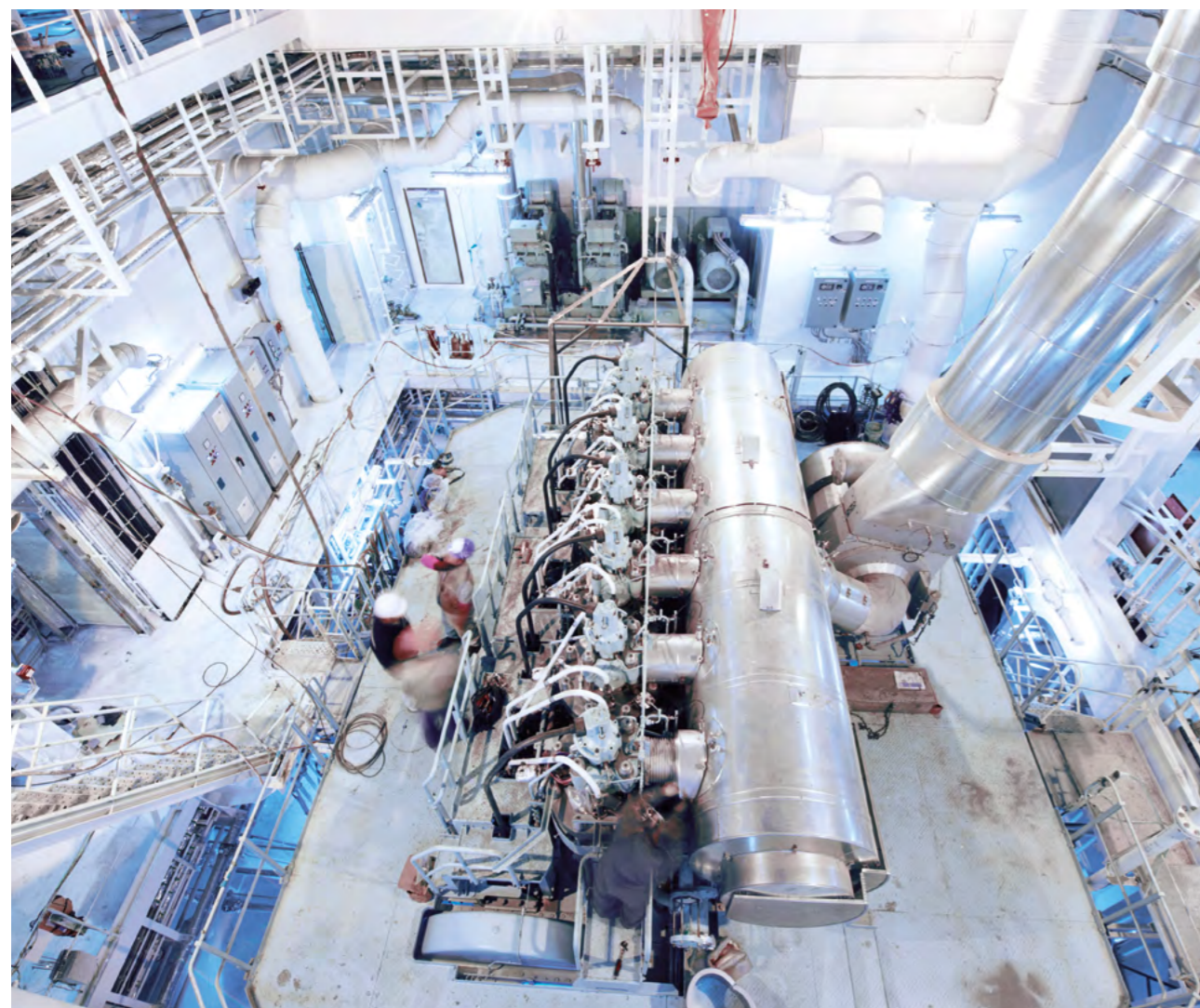
From small supply vessels to ultra large container ships, our fuel consumption monitoring system is fully adjustable for any type of fuel scheme and is designed to meet all customers' requirements.

Our partnership with specialists in the field of instrumentation and process automation allow us to make use of high-level performing components and to deliver more complex requirements when needed.

The fuel consumption measurement system primary consists of our Control Unit (HOMIP) and mass flow meters operating on the "Coriolis principle".

Additionally and depending on the customers' application, further fuel consumption optimization modules such as Navigation can be connected to the system to provide all features necessary for precise long term consumption.

Nearly all existing flow meters can be intergraded to become compatible with our system.



KEY FEATURES

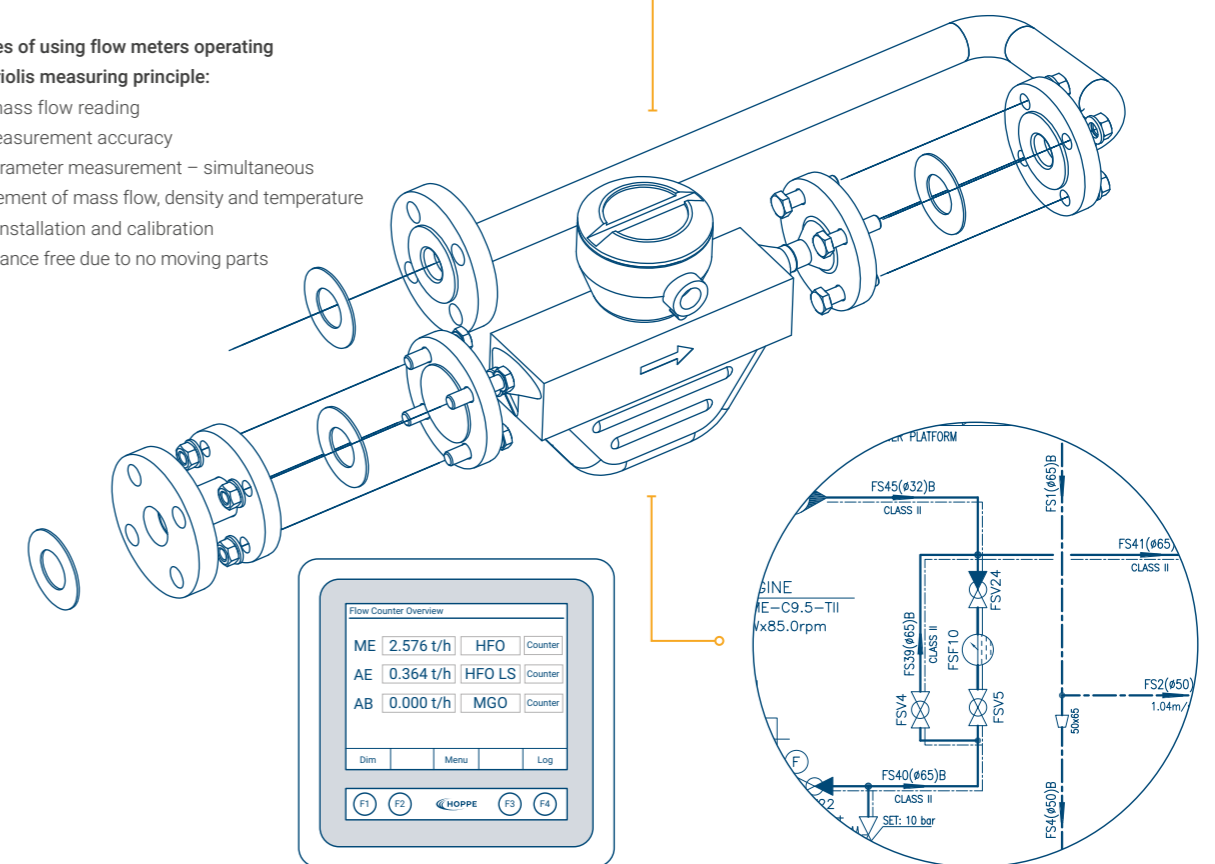
- Accurate mass flow, density and temperature measurement
- Compatible with existing equipment
- Overview of important performance and fuel consumption relevant data of the main/auxiliary engines and boiler at different time intervals and for various parameters
- Overview of consumption of all fuel grades at a glance (HFO, HLS, MGO, MDO, MLS)
- Overview of lower heating value and rate of sulphur for each fuel grade
- Overview of propulsion specific data such as vessel speed over ground and through water, slip and efficiency per nautical mile (if connected to nautical data)
- Possibility to display all fuel consumption measurements on data display in engine control room
- Convenient zero flow calibration through control unit
- Automatic fuel grade switch by temperature detection
- Individual piping design

MEASURING PRINCIPLE

The Coriolis principle allows the flow of mass to be directly measured. A pair of tubes is located inside each Coriolis flow meter. An exciter causes these tubes to oscillate constantly. If there's no flow, the measuring tubes are oscillating uniformly. Sensors are located at the inlet and outlet and register this oscillation precisely. As soon as the fluid starts to flow in the measuring tubes, additional twisting is imposed on the oscillation as a result of the liquid's inertia. Due to the Coriolis effect, the inlet and outlet sections of the tubes oscillate in different directions at the same time. The sensitive sensors pick up this change in the tube oscillation in terms of time and space. This is known as the "phase shift" and is a direct measure of how much mass is currently flowing through the pipe.

Advantages of using flow meters operating on the Coriolis measuring principle:

- Direct mass flow reading
- High measurement accuracy
- Multi-parameter measurement – simultaneous measurement of mass flow, density and temperature
- Simple installation and calibration
- Maintenance free due to no moving parts



DYNAMIC DRAUGHT, TRIM AND MOTION MEASUREMENT

Our **Dynamic Draught Measurement** Solution (DDM) continuously monitors the ship's draught by combining draught and motion sensors. Pressure transmitters measure the hydrostatic draught, one each located at bow, stern, mid ship port and mid ship starboard. With our inertial measuring system (HOSIM2) we compensate any dynamic influence during sailing. This makes the draught measuring system independent of wave effects or wave hammering. It determines the draught values precisely at perpendiculars and draught marks in any sailing condition.

HOPPE Marine's **Dynamic Trim Measurement** (TRIMCON) is a satellite-based measuring system for real time monitoring of a ship's dynamic trim, heading and speed in longitudinal and athwart directions. Two GPS-receivers located on the fore and aft mast are using carrier phase measurements. The significant advantage of TRIMCON is the continuous and precise determination of the dynamic trim in almost every sailing condition.

The system assists the Nautical Officers with precise information on actual pitch angle and dynamic trim and monitors the ship's fore and aft relative motion with high precision during manoeuvring. The dynamic trim varies under sea conditions with the ship's speed, bottom clearance and tank contents and needs to be corrected for a fuel-optimised ship operation.

HOPPE Marine **Dynamic Motion Measurement** is an inertial measuring system with two sensor boxes (HOSIM2), one at the bow and one at the stern, that continuously monitor the ship's motion and hull stress. It is the highly accurate solution for the roll angle, pitch angle, angular rate, angular acceleration, orbital acceleration, roll and pitch period, ship's torsion, as well as trim and list. The provided information can be used by subsequent systems or by nautical staff to better evaluate questions regarding cargo safety, ship performance and general ship safety.

KEY FEATURES

Dynamic Draught Measurement

- Precise determination of real draughts
- Basis of trim optimization
- Possibility of draught, trim and speed modeling

Dynamic Trim Measurement

- True dynamic trim
- Conning information
- Shallow water pilotage

Dynamic Motion Measurement

- Precise vessel motions
- Rolling, pitch and acceleration forces
- Hogging and sagging
- Sea state modeling

COMPONENTS

Dynamic Draught Measurement

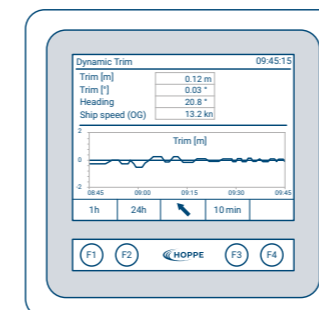
- 4 draught sensors (optionally only 2)
- 2 HOSIM2 IMU Sensors¹
- HOMIP PLC unit

Dynamic Trim Measurement

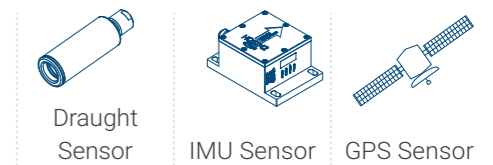
- 2 GPS antennas with signal amplifiers²
- HOMIP PLC unit

Dynamic Motion Measurement

- 2 HOSIM2 IMU sensors
- HOMIP PLC unit



- Draught Sensor** A
- IMU Sensor** B
- GPS Sensor** C



	Draught Sensor	IMU Sensor ²	GPS Sensor
Dynamic Draught Measurement	•	○ ¹	○ ¹
Dynamic Trim Measurement		○ ²	○
Dynamic Motion Measurement		•	

PERFORMANCE MONITORING

"A house can only be as good as the foundation, it is built on". In a digital world, more than ever the saying "Garbage in, Garbage out" has proven to be true. Important decisions are made on the basis of numbers provided by performance monitoring systems. Merely connecting existing systems and sensors will not result in precise figures, and thus well-founded decisions. A proper and permanent assessment is therefore essential. Hoppe Marine's Performance Monitoring System combines highly

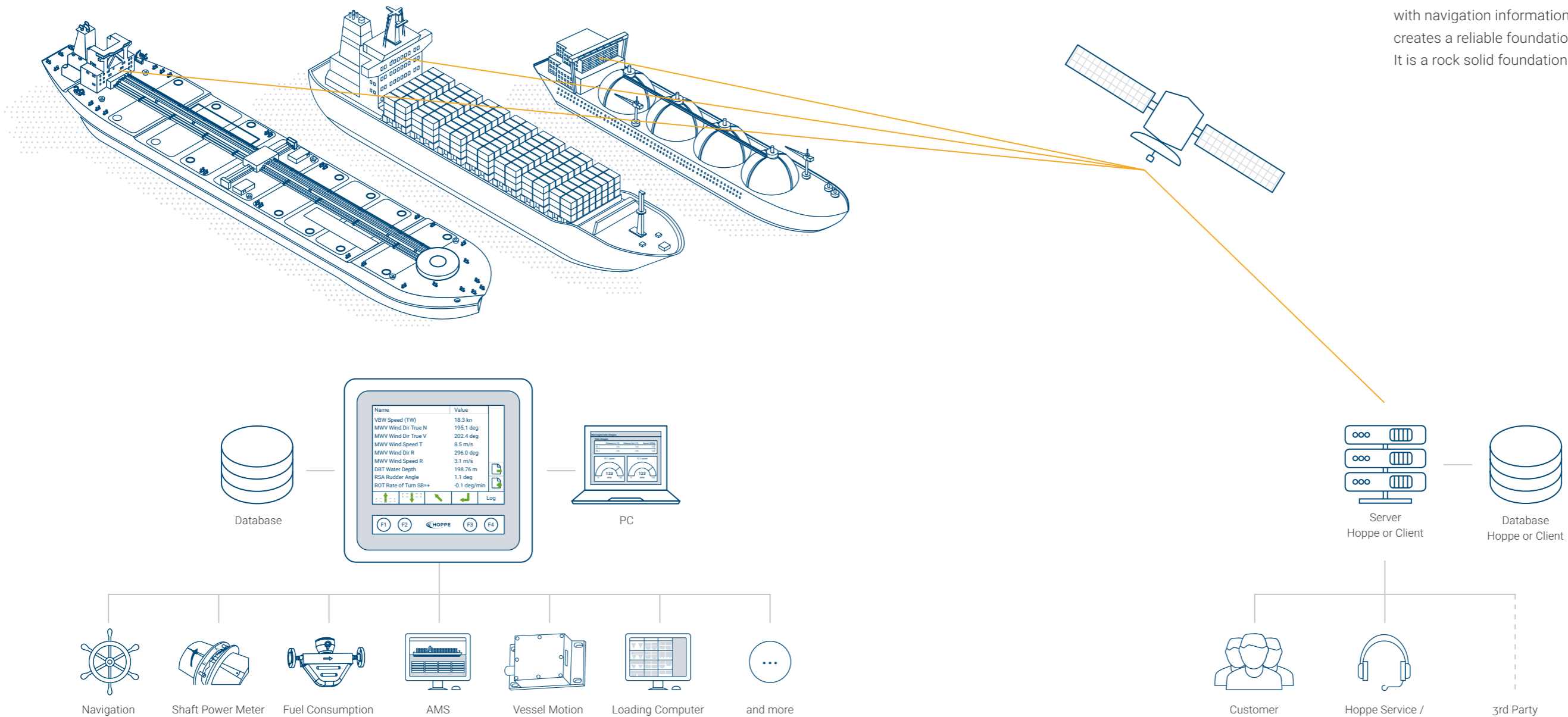
sophisticated measurement equipment with the experience of interfacing third party systems on board of vessels for more than 60 years. Our Performance Monitoring systems are already monitoring their own health to create the rock-solid foundation for all your decision support processes and tools. In collaboration with our data quality service you can ensure correct decision making. It is a unique approach to enable shipping companies to bring their own visualization, BI or analytics tool.

KEY FEATURES

- Several hundred retrofits
- High quality sensors
- Class approved PLC unit
- High performance SQL database
- Interfacing experience with more than 100 different makers
- Data quality service to ensure high availability of reliable information

DESIGNS

The heart of every Hoppe Performance Monitoring system is our class approved PLC unit HOMIP. It is a state-of-the-art PLC including sufficient processing power, supports all common interfaces (analogue, digital, serial, Ethernet) and a 6" operational display. A SQL database server is processing all signals. The HOMIP ensures proper data handling and is tailorable to fit every demand. The Maihak Shaft Power Meter, along with our Fuel Consumption Measurement, Dynamic Draught and various 3rd party interfaces, will provide the engine signal data set. The combination of the engine signal data set with navigation information like GPS, Speed Log, Wind etc. creates a reliable foundation for performance monitoring. It is a rock solid foundation for all our client decisions.



FLEET DATA QUALITY

Validation of a large number of the ship's operational and nautical measurement data on-shore – this is the key demand of today's maritime data acquisition.

The major challenge for vessel owners and operators to verify and validate the large amount of data after receiving them on shore still increases. Unclean data can significantly lower the potential for optimization and might even lead to disadvantages in vessel operation.

KEY INFORMATION

- The procedures provide a wealth of opportunities to create a clean data base and to continuously improve quality.
- The evaluation of indicators as an early warning system as well as the fulfillment of the required maintenance activities with regular reporting form the basis for further work. The comprehensive amount of data can be systematically examined and the overall quality of the data gets improved.



ANALYSIS CATALOG


Hoppe Marine is a system provider which offers a wide range of products for validation, monitoring and optimization of ship operation.

In order to meet the requirements of a full vessel operation rating, the Analysis Catalog was developed.

The Analysis Catalog allows an individual catalog configuration – with a selection of over 100 visualizations and evaluation features as well as the integration of charter and shop test curves in order to compare the target and actual condition.

CORE FUNCTIONALITIES

- Detects and excludes severe measuring errors by long term data analysis and thereby offers the full package from measurement, validation and monitoring to evaluation.
- Enables to pin down the most favorable operation state by processing dynamic measurement data and early on detection of deficiencies by trend analysis.
- Allows consistent and reliable performance improvements by analysis of real-world energetic data and KPIs.



Fact Sheet	Data Analysis Catalog	Issue Date 25.07.2018
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HOPPE MARINE DATA SOLUTIONS – ANALYSIS CATALOG

The ability to reduce emissions and operational costs is a major factor of success in the increasingly competitive shipping market. Hoppe Marine is a system provider who offers a wide range of products for validation, monitoring and optimization of ship operation.

The Hoppe Data Analysis Catalog features

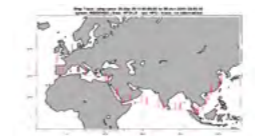
- individual catalogue configuration – choose from over 60 visualisations,
- integration of charter and shop test curves,
- with its ship-specific visualizations the catalogue is suitable for superintendents, ship owners and the crew on board alike,
- detects and excludes severe measuring errors by long term data analysis and thereby offers the full package from measurement, validation and monitoring to evaluation,
- enables to pin down the most favourable operation state by processing dynamic measurement data and early on detection of deficiencies by trend analysis,
- allows consistent and reliable performance improvements by analysis of real-world energetic data and KPIs.

"Offers an in-depth look into all areas of ship operations with target-oriented visualizations."

CATALOG CONTENT

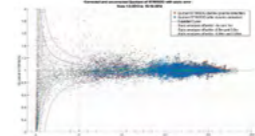
CHOOSE FROM OVER 60 VISUALIZATIONS IN HIGH-RESOLUTION

- 1. General Trends**
 - Lists all ship-specific data
 - Automated ECA and port detection with travel distances and fuel consumption as well as ship track visualization on chart
 - Trend analysis and visualization of common parameters of ship operation for a quick overview of ship performance and data quality
 - Optional: Extensive evaluation of data quality, operational abnormalities and optimization potential by an expert




Ship track with ECA zones

- 2. Validation of Sensors and Systems**
 - The validation chapter provides information about the functionality of the used measuring equipment
 - Dynamic error and static offset detection of the speed log by evaluation of representative ship-specific data sets
 - Validation of flow meters and shaft power meter for direct monitoring of offsets and drifts and evaluation of leakages in the fuel oil service system with calibration advice
 - Lists all signal parameters including logging rate, averages, validity and plausibility in tabular form



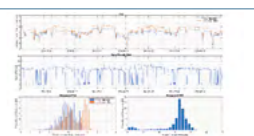
Validation of speedlog with dynamic correction

Doc. No.	Sales Documentation	Revision
F-08064-02150-FS	1/2	1.0



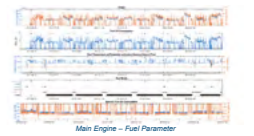
Fact Sheet	Data Analysis Catalog	Issue Date 25.07.2018
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- 3. Nautical Trends**
 - Visualization of general nautical trends such as trim, STW, SOG, current, draught and rudder angle with histograms
 - Identification of the influence of true on-ship performance and fuel consumption
 - Visualization of the rudder behaviour and its influence on fuel consumption




Draft and trim behavior

- 4. Engine Trends**
 - Treats main engine, auxiliary engines and boiler
 - Clear visualization of trends for common operational parameters such as power, torque, RPM and ship speed
 - Clear visualization of fuel-related trends including FOC, SFOC, SFOC TW, fuel grades and fuel temperature
 - Direct detection of deviation of exhaust gas temperature and charge air parameters



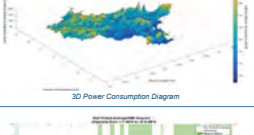
Main Engine - Fuel Parameter

- 5. Performance Monitoring and Validation**
 - SFOC / SFOC ISO - graph with additional load histogram for evaluation of the energetic condition of the engines
 - Specific and daily fuel consumption of the main engine correlating with propeller curve data
 - Monitoring of auxiliary engines with focus on efficient operation and load distribution




Daily FOC / STW Diagram with Histogram

- 6. Ship Performance Optimization**
 - ISO 19030 speed loss diagram with the lowest speed loss and power consumption for every mean draft and trim
 - Propeller slip grid for the determination of the most favourable draught-trim combinations



3D Power-Consumption Diagram

- 7. Ship Motion Analysis Features (HOSIM)**
 - HOSIM (Hoppe Ships Inertial Measuring System) roll period analysis including estimated GM and with trends and histograms
 - HOSIM pitch period analysis with trends and histograms
 - Visualizations of events with maximum roll angle
 - Evaluation of roll angles during critical periods conditions



Roll period with port detection and GM est. value

Doc. No.	Sales Documentation	Revision
F-08064-02150-FS	2/2	1.0

HOPPE SYSTEMS AND COMPONENTS

	Electronic Devices		Valve-Actuator-Combinations				Motion Sensors				Heel Control and Trim units		Level Sensors			Power and Performance Meter	
	PLC unit HOMIP	I/O Modules	HOPAC (pneumatic)	HOHAC (hydraulic)	HOHEA (electro hydraulic)	electric	Inclination Sensor	Electronic Inclinomometer	Inertial Measuring unit HOSIM 2	GPS Sensor	Reversible propeller pump	Blower unit	HCG2011 (electric)	HCG 4011 (electric BUS)	HOBUB (pneumatic)	Shaft Power Meter	Fuel Counter
Fluid Management	Valve Remote Control	•	•	•	•	•											
	Tank Content Measurement	•	•				•						•	•	•		
	Ballast Management	•	•	•	•	•	•						•	•	•		
	Bunker Management	•	•				•		•				•	•	•		
	Draught Measurement	•	•				•						•	•	•		
Dynamic Draught Measurement	•	•				•		•	•			•	•	•			
Motion Control	Heel Control	•	•	•	•	•	•		•		•	•	•	•			
	Trim Control	•	•	•	•	•	•		•		•	•	•	•			
	FLUME® Roll Damping	•	•	•	•	•			•				•	•			
	U-Tank Roll Damping	•	•	•	•	•			•				•	•			
	Load Moment Control	•	•	•	•	•	•		•		•	•	•	•			
	Dock Control	•	•	•	•	•	•		•	•	•	•	•	•	•		
Ship Performance	Maihak Shaft Power Meter	•	•													•	
	Fuel Consumption Measurement	•	•													•	•
	Trim and Motion Measurement	•	•							•							
	Performance Monitoring	•	•						•				•	•	•	•	•

COMPACT OVERVIEW

Fluid Management

- Valve Remote Control
- Tank Content Measurement
- Bunker Management
- Ballast Water Management
- Draught Measurement
- Dynamic Draught Measurement
- Sensor Toolbox HOSET



Motion Control

Motion Control

- Heel Control
- Trim Control
- Roll Damping
- Load Moment Control
- Dock Control
- Tailored Control Systems
- Monitoring
- Engineering Service



Ship Performance

- Main Shaft Power Meter
- Fuel Consumption Measurement
- Dynamic Draught, Trim and Motion Measurement
- Performance Monitoring
- Fleet Data Quality
- Analysis Catalog



SHIP SERVICES

Ship Services

- Technical Support
- Spare Parts
- On Board Service
- Retrofit
- Service 4.0
- Predictive Maintenance and Self-Validation
- Fleet Data Quality
- Analysis Catalog
- Hoppe Global Service Points



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