# **SCHALLER AUTOMATION**

**Group Presentation** 



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## A proven 60 years experience in Engine Monitoring









## **Our Vision**



## Schaller Automation strives to create a future in which:



- The customers recognize us as a leading manufacturer and business partner
- The employees enjoy a high degree of satisfaction and good development opportunities
- The customers recognize Schaller Automation because we fulfill our goals and commitments



## **Our Mission**



## Schaller is and remain the world's leading OMD manufacturer and is to:



- Develop, produce and distribute highquality safety
- Actively contribute to a better global environment sennsor systems
- Make people's lives EASIER and SAFER







## A proven partner...

Engine Maker (Licensor)	Engine Maker (License)	Ship-owners
<ul> <li>Caterpillar</li> <li>Hyundai Heavy Industries</li> <li>MAN Energy Solutions</li> <li>Rolls-Royce Power System</li> <li>Wärtsilä</li> <li>WIN GD</li> </ul>	<ul> <li>CMD</li> <li>CMP</li> <li>Doosan</li> <li>HHM</li> <li>Hyundai Heavy Industries</li> <li>STX Engine</li> <li>STX Heavy Industries</li> <li>WHEC</li> <li></li> </ul>	<ul> <li>AIDA</li> <li>Carnival Cruise Line</li> <li>CMA-CGM</li> <li>Maersk</li> <li>MSC</li> <li>NYK</li> <li></li> </ul>

... and many others .



## **German Quality**

### "Made in Germany" worldwide dimension



**Production -** All products are assembled and tested in Blieskastel by qualified personnel. We work very closely with our suppliers to ensure that our high quality standards are met.



Validation - The product validation process guarantees that products are designed and manufactured so that our equipment meet the high standards.



**Traceability -** Individual traceability is ensured by specific serial numbers. Each product is reviewed separately and data are recorded for a complete traceability.





## **Project Management**





# **SAFETY SYSTEMS FOR** VN301<sup>plus</sup> LARGE DIESEL, GAS AND **DUAL FUEL ENGINES** VN87<sup>plus</sup> IN THE PROPERTY OF THE PROPERT OFFSHORE ON BOARD POWERPLANT







## Own testing for environmental influences

## Validation

### Test and laboratory equipment

- Test Vessel
  - According IACS UR M67 Rev2.2015
- Power supply tests, low voltage, high voltage
  - IEC 60092-x
  - GL 2003 VI Part 7, ...
- EMC, Imission, Emission
  - IEC 61000-x
- Climate test (Cold, Dry Heat, Damp Heat)
  - IEC 60068-x
- Vibration
  - IEC 60068-x
  - Class rules DNV-GL
- Engine laboratory
  - Simulation conditioning monitoring
  - 2x Hatz single cylinder engines







## **Close Co-operation with IACS class societies**

## Validation

### Classification validation process

- Schaller proposed latest revision of IACS UR M67 rev. 2
- Test vessel for VISATRON OMD-Systems.
- Simulation of ship movement of 22.5° in any direction
- Splash Oil test
- Oil mist wash out effect
- Evaluation system immunity against false alarm (oil ingress, water condensation...)





## **OMDEA (Oil Mist Detection Efficiency Approval)**

### In accordance with IACS UR M10 Rev4 2013

M10.9 The oil mist detection system and arrangements are to be installed in accordance with the engine designer's and oil mist manufacturer's instructions/recommendations. The following particulars are to be included in the instructions:

• Schematic layout of engine oil mist detection and alarm system showing location of engine crankcase sample points and piping or cable arrangements together with pipe dimensions to detector.

• Evidence of study to justify the selected location of sample points and sample extraction rate (if applicable) in consideration of the crankcase arrangements and geometry and the predicted crankcase atmosphere where oil mist can accumulate.

• The manufacturer's maintenance and test manual.

• Information relating to type or in-service testing of the engine with engine protection system test arrangements having approved types of oil mist detection equipment.

M10.10 A copy of the oil mist detection equipment maintenance and test manual required by UR M10.9 is to be provided on board ship.









## Oil mist detection today

## Current OMD designs

### Basic approaches with and without damage localization

- Active atmosphere sampling
- Integral vs. compartment-wise crankcase monitoring
- Standard vs. ATEX with zone separation
- Software strategies to avoid false alarms and unnecessary engine shut-downs (OMD does not "ask" anyone!)





## **New Product Program**





# Visatron VN301<sup>plus</sup> Multisensor OMD system





## **Product** overview

### **Central Unit**

- Provide power and air supply up to 10 sensors
- Single or Master Slave configuration
- Two types of interfaces with three types of protocols: RS485, ModBUS, CAN Bus
- System overview/status/set up

### Sensor

- Each sensor is analyzing 1 compartment
- Engine wall connection to fix sensor on engine crankcase
- Hybrid cable to connect sensor to central unit



Single Version

Master/Slave Version







## Sensor function

# Layout of IR-measuring path



### CFD-flow lines







### **Sensor Units**

• 3 versions with vertical and horizontal (2) connection





## **Dimensions - Sensor**





## Engine Wall and Hybrid Cable

Engine wall connection (EWC)

- Sensor with G3/4" connection or M27x1,5, respectively
- No installation from inside (as compared to the piping system)

Hybrid cable and plug design

Only one plug connection per sensor









## Sensor function

### System properties

- Closed-Loop system: immune to unsteady pressure states within the crankcase
- Pressure sensors in the air supply ensure proper functionality of the Venturi principle
- Fresh air calibration ensures re-calibration of the measuring path and indicates pollution of the optical elements
- **Easy cleaning** of the optical elements if necessary due to unnatural high pollution during operation or faulty storage during maintenance of the engine









### **Product overview**

### Central unit /CU

- 10 sensors per CU
- Max. 20 sensors in Master/Slave configuration
- CU display shows
  - Operational state
  - Oil mist concentration
  - sensitivity
  - Air supply pressure
  - Prealarm
  - Alarm
- Anti-vibration design
- IP 65
- Water-/Oil-separator for supply air available as option





## **Product overview**

### System Features

- Robust and reliable
  - Designed to withstand the harsh conditions found in the engine room and easy to install
- Maximum false alarm immunity (proven Software Know-How)
  - The combination new sensor design and new software allow us to have maximum false alarm immunity and to avoid engine downtime.
- Prealarm / Alarm relay with very short reaction time
  - With the updated software and the close installation of the sensor at the crankcase, we have the fastest system on the market.
- Wear-free active atmosphere extraction with Venturi-principle without moving parts
  - ✓ Maintenance free, no rotating parts like fans. Maintenance activity reduced at maximum





## Product overview

### System Features

- Fresh air curtain to protect the optics
  - ✓ Avoid any false alarm due to pollution detection. System constantly knows the operational crankcase opacity
- Very low fresh air consumption: 100 l/h per sensor
  - ✓ With the newest system design, we have reduced our air consumption which minimizes the operating costs
- Compact hybrid cable with power supply, data transmission and air supply
  - ✓ Each engine can be equipped easily with the VN301<sup>plus</sup> system

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- **Optional Remote Monitoring** 
  - Displays opacity per compartment, status,...in ECR
- Optional integration via RS485 / ModBus / CAN Bus
  - ✓ Integration of signal in the engine / ship automation system.





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### Product overview

### **Installation Features**

- Time- and cost efficient installation
  - ✓ Independent on engine design, plug & measure concept
- Flexible installation of the anti-vibration mounted CU
  - ✓ CU can be mounted ON the engine or beside. Designed to withstand the extreme condition in engine room
- Complete installation from outside of the crankcase possible
  - ✓ The new sensor design allows to reduce the installation time of the system
- Sensor installation via <sup>3</sup>/<sub>4</sub>" or M27x1,5 engine wall connection
  - ✓ Fits to already existing drill holes, no need to redesign the complete engine CNC program







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# Product overview

### **Installation Features**

• Easy and robust plug connection of the sensors

VN301<sup>plus</sup> Multisensor System

- The locking system guarantees a good connection of the system and facilitates assembly work
- Max. of 30 m hybrid cable length
- Easy implementation at different suction points
- (Compartment / Supply-, HP-Unit / Gear, Chain Drive, Thrust Bearing, Camshaft,...)
  - Flexible connection / integration of all relevant detection points
- Easy exchange of single components
- No interference of the whole system when single sensor failure occurs
  - ✓ Intrinsic system which guarantees the operation of the other sensors





## Central Unit (CU)

- Customer specific software-options via USB-interface programmable
- System Setup (Single /xxx Slave)
- Sensor
- Sensitivity



VISATRON® VN301<sup>plus</sup>/VN301<sup>plus</sup>EX Connection Unit

Service Laptop/Netbook

Engine Name / Type	0 to 64 characters
No. of VN301 <sup>plus</sup> Central Units	1 or 2
No. of Sensors for Central Unit 1	1 to 10
No. of Sensors for Central Unit 2	1 to 10
Oil Mist Alarm limit Value sensitivity setting 1 sensitivity setting 2 sensitivity setting 3 sensitivity setting 4 sensitivity setting 5 sensitivity setting 6 sensitivity setting 7	0.75 mg/l Oil Mist concentration 0.9 mg/l Oil Mist concentration 1.1 mg/l Oil Mist concentration 1.2 mg/l Oil Mist concentration 1.3 mg/l Oil Mist concentration 1.5 mg/l Oil Mist concentration 2.0 mg/l Oil Mist concentration
Date	jijj.mm.dd
Time	hh.mm.ss



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### Sensor function

Software Know-How

- Suction point-wise sensitivity adjustment, always within IACS rules (< 2.5 mg/l oil mist concentration)</li>
- Wire check  $\rightarrow$  after installation to check if connection is working









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### Service Software



### Software Know-How

 Damage localization / Compartment identification



## Comparison to competitor brands

FEATURES	SCHALLER	Competitors
Active atmosphere extraction	<b></b>	$\otimes$
Wear-free Venturi principle		$\otimes$
No rotating wear parts (e.g. fans)	<b>Ø</b>	8
Fresh air calibration		$\bigotimes$
Bi-directional communication system	<b>Ø</b>	$\bigotimes$
Floating zero algorithm		$\bigotimes$
Robust and flexible hybrid cable connection	<b></b>	$\bigotimes$
Maintenance friendly		$\bigotimes$
Designed for engine lifetime	<b>Ø</b>	$\bigotimes$
Reliable worldwide service network	<b>Ø</b>	$\bigotimes$



## **OMD Retrofit Business**

	VN2020	VN301plus
2 Stroke engine		++
4 Stroke engine	+	++
4 Stroke DF	+	++ (Standard* /Ex Version**)
2 Stroke DF		++ (Ex Version**)

- \*: Localization
- \*\* : Depending customer requests and engine type



## **OMD Retrofit Business**

- 2 type of retrofit business
  - Horizontal : replace an old Visatron by **newest generation** 
    - VN115/XX  $\rightarrow$  VN2020
    - VN116/XX  $\rightarrow$  VN301<sup>plus</sup>
    - VN215/XX  $\rightarrow$  VN301<sup>plus</sup>
  - Vertical : replace a competitor by a Schaller Visatron
    - Dr Horn  $\rightarrow$  VN2020 or VN301<sup>plus</sup>
    - Daihatsu/SPECS/Graviner → VN301<sup>plus</sup>



## Retrofit installation VN301<sup>plus</sup>

Bulk Carrier	"Yeoman Bank" / IMO Number 7422881
U.K.	Aggregate Industries Ltd
Poland	SMT Shipmanagement & Transport
unknown	
Liberia	
Spare parts obsolete	from Kidde Graviner MK5 to VN301 <sup>plus</sup>
January, 2019	
RSS_2019_01_03	
Sulzer 6RD90	2-stroke 6-cyl. 900mm x 1.550mm 10.444 kW at 122 rpm
	Bulk Carrier U.K. Poland unknown Liberia Spare parts obsolete January, 2019 RSS_2019_01_03 Sulzer 6RD90





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## Retrofit installation VN301<sup>plus</sup>











## Retrofit installation VN301<sup>plus</sup>













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## VN301<sup>plus</sup> Promotion



### The new Generation of Oil Mist Detectors: VISATRON® VN 301<sup>plus</sup>





## Recent installation VN301<sup>plus</sup> on 6X72DF





# **Condition monitoring**

## prevention against damages



## Oil mist detection today



### Today's appearance of severe damages

Damages to main and aux engines (Source: The Swedish Club main & aux engine report 2018)

- Main engine claims account for 28% of all machinery claims and 34% of the costs, with an average <u>claims cost close to USD 650,000</u>
- Aux engine claims account for 13% of the total machinery claim costs and 16% of the volume, with an average <u>claim cost of USD 345,000</u>
  - The most expensive type of main engine damage is on crank shaft/bearings with an average cost of USD 1.2 million per claim
  - Lubrication oil related failure is the most common cause of damage for main engines
  - Incorrect maintenance and wrongful repair are the most common causes of damage for aux engines; poor lubrication oil management is also a major contributing factor

Oil mist related crankcase explosions: Significance and development

- Key components of the engines face increasing challenges, e.g.:
  - Conflict of oil consumption vs. friction losses for liner and piston bore interface
  - High bearing loads and the conflict of stiffness vs. weight
- Experience shows the importance of safety systems to avoid crankcase explosions is more present than ever before





## **Condition monitoring approach**

### Development of mechanical failures over time

Increasing prevention corridor with additional condition monitoring

- Detection of mixed lubrication in journal bearings
- Detection of vibration anomalies





## ACCOMOS sensor



### Motivation

- 3-axis acceleration sensor monitors mechanical vibrations at non-rotating parts in accordance with **DIN ISO 10816-6**
- Monitors permissible limit values of internal combustion engines having more than 100 kW but also other engine components, generators...
- Mounting with extra-strong magnets allows installation within minutes
- Tested in accordance to DNVGL-CG-0339, CE conformity, IATA certificate, risk assessment in accordance to DIN EN ISO 12100







**Motivation** 

Principle

•



operating conditions in an early stage of occurrence

Effective solution for condition monitoring of vibration to detect critical

• Monitor your engine according DIN ISO 10816-6

COMOS



















## **ACCOMOS Version 2 Software**

### Software features/options

- Software has following features/options :
  - Life signal visualization
  - Teach In function
  - Data viewer (to analyze recorded data)



Life signal screen





Teach In screen

Data viewer





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### Software

With the software you have following possibilities :

- System indicator (2) : R/Y/G ٠
- Upper screen : Live signal of vibration and the limits (3)
- Lower screen : FFT Frequency spectrum of the • sensor signal as square average (5)
  - To identify source of vibration •
- Possibility to record the signal (7)





YOU AND YOUR ENGINE

### Benefits

- Live-Monitoring of Deviation in normal vibration of the machine/engine
- One sensor for 3 Axes
- Permanent Installation within minutes via ultrastrong magnets
- Suitable to monitor your engine according **DIN ISO 10816-6**
- RS 485 or CAN Bus







### Multiple application

- On engines test cell for validation purpose
- Validation vibration profile during FAT, according DIN ISO 10816-6 or classification society
- Monitor the engine during sea trial
- Monitor engine vibration profile during service visit
  - Control profile in accordance to FAT results
  - Define if potential failure
- For end-user monitor engine after important engine work
- For fleet owner and engine maker remote engines  $\rightarrow$  4.0 industries





### Multiple source of vibration

Monitor your engine/machine to identify a vibration deviation before severe damage

- Cracks in engine frame
- Coupling damage
- Misalignment e.g. between engine and machine
- Engine/Machine Baseplate cracks
- Breaking Base dampers
- Many more failures linked to oscillating forces









### Installation rule

The installation of ACCOMOS is based on DIN ISO 10816-6

1 sensor per engine at critical place. Defined based DIN ISO.





NOTE - See figure 1 for key.



Source: DIN ISO 10816-6



### Maximum values of overall vibration Machine vibration classification numb Vibratio red on the machine s severity 1 2 3 4 5 6 7 Velocity Acceleration grade mm/s (r.m.s.) m/s2 (r.m.s.) Evaluation zones um (r.m.s.) 17.8 1.12 1.76 1,8 A/B A/B 2.8 44.8 2.82 4.42 A/B 4.5 A/B A/B 4.46 7.01 7,1 С A/B 113 7.07 11.1 A/B 11 С 17,6 18 С 283 17.8 27.9 28 С 28.2 44.2 45 D С 446 70.1 D 71 D С D 112 D С 176 D 180 D Key to zones

### Table A.1 — Vibration classification numbers and guide values for reciprocating machine

The vibration of newly commissioned machines would normally fall within this zone.

A: B: Machines with vibration within this zone are normally considered acceptable for long-term operation.

Machines with vibration within this zone are normally considered unsatisfactory for long-term continuous operation. Generally, the machine may be operated for a limited period in this condition until a suitable opportunity arises for remedial action.

Vibration values within this zone are normally considered to be of sufficient severity to cause damage to the machine

NOTE -- Vibration values for reciprocating machines may tend to be more constant over the life of the machine than for rotating machines Therefore zones A and B are combined in this table. In future, when more experience is accumulated, guide values to differentiate bety and B may be provided.



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Figure 1 — Example of a vertical in-line machine

Coupling end

Mid-machine

Free end of machine

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.1

.2

.3

Measurement points

related to machine

length

### Technical data

Power supply	9-36 VDC
Consumption	Max. 110 mA
Temperature range	-25°C to +85°C
Measure range	+/- 16 000 mG
Frequency range	0-750 Hz (1500Hz for CAN BUS possible)
Sensitivity	4 mG
Data transfer	Digital via RS485 or CAN
Weight	400g
Diameter	89,5 mm





Scope of delivery





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- Customer : City of Saarbrücken (D)
- Engine type : CAT G3520C
- Fuel type : Gas (coal gas)
- Application : Powergen for load
- Installation since : 12/2017
- Working hours : 8300 hours w/o issues



CAT G3520C













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### Installation example

Monitoring of vibration profile on 4-stroke engine test bench.









### Installation example

Monitoring of 4 engines (4-stroke) on a ferry in Europe









### Installation example

Monitoring of vibration profile on 4-stroke engine, power plants.



Power plant Bliestal (D)



Power plant Saarbrücken (D)



Marine college Flensburg (D)







### Seebeck effect (thermoelectric voltage)

Motivation

 Effective solution for the transient condition monitoring of journal bearings to detect critical operating conditions in an early stage of occurrence

### Principle

 Detection of thermoelectric voltage as consequence of frictional contact

### Applications

- Monitoring system of main bearing on :
  - Engines
  - Gearbox
  - Windmill
  - Equipment (eg. Pumps)







### Source: M. Limmer, RWTH Aachen University, presented at GfT-Tagung in Göttingen, Germany, 2009.







### Key sensors: BEAROMOS 2020

Validation: Public funded project with RWTH Aachen, iMSE:

• Detection of friction transitions on journal bearing test bench





### Technical data BEAROMOS 2020

Supply Voltage: Current drain: Temperature range: RPM range (standard): Data transfer: Diameter: Length: Weight: Mounting:

Degree of protection:

Monitoring Diode:

9 - 32Vdc (nominal 24Vdc) max. 400 mA -20°C bis +70°C up to 1,500 1/min RS485: 230,400 Bit/s 140 mm 125 mm 4.5 kg shaft-hub-joint by expansion cone / custom-designed adaption IP56 (IP5x: dust protected,

IPx6: protected against powerful water jets) monitors the condition of the slip ring connectors









### Mechanical adaption





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### Scaled single cylinder test bench

Challenge: Generation of bearing damage

 Reliable algorithms for anomalies detection require selective introduction of damages in order to assign damage mechanisms → impossible with field test experiments





### Scaled single cylinder test bench

Challenge: Generation of bearing damage

 Reliable algorithms for anomalies detection require selective introduction of damages in order to assign damage mechanisms → impossible with field test experiments





### Field test experience

Marine application

- HiMSEN 8H32/40 and 7H32/40
- Installation on free end of crankshaft
- RPM: 715
- Installation period: 07/2018









### Field test experience

Marine application

- Installation on 4-stroke M/E Caterpillar MaK 8M32C
- RPM: 600
- Installation period: 07/2013 until 04/2019
- Total evaluated operating hours: 32,762
- Total evaluated RPM: 1,180,000.000
- Continuous operation without failure







### Field test experience

Power plant application

- Installation on 4-stroke MWM 632
- RPM: 1,000
- Installation period: Since 08/2017
- Total evaluated operating hours: 9,239
- Total evaluated RPM: 554,360,000
- Continuous operation without failure





AND YOUR ENGINE

## **Technical Information**



Power supply	18 – 32 VDC (nominal 24VDC)
Current	max. 400 mA
Temperature range	-25°C to +70°C
Data transmission to central unit	RS485 : 1 kBit/s CANopen : 500 kBit/s
Diameter	140mm
Lenght	125mm
Weight	4,5kg
Adaptation engine	Engine specific
IP	IP54



## Summary and conclusion

### Strategies to avoid crankcase explosions and oil mist formation

### Crankcase explosions

- ... are still a serious threat to man and machine as the demands to the engine components increase
- ...can be avoided if the knowledge about formation and propagation of oil mist within the crankcase is considered in OMD design

### Oil mist formation

• ...should be avoided with modern condition monitoring approaches including an early damage detection in journal bearings or the anomaly detection with vibration sensors

	Avoidance of crankcase explosions	Avoidance of oil mist formation
Gas-Fueled Engines	OMD with ATEX	Condition Monitoring, e.g. journal bearings
Oil-Fueled Engines	OMD Standard	Condition Monitoring, e.g. journal bearings



## **THANK YOU**





