Crank-Case Protection System (CPS)

The Crank-Case Protection System (CPS) is designed for monitoring of bearings of 4-stroke Diesel engines. A thermoelectric measurement between the rotating shaft (e.g. via brushes) and the engine block is transformed into a signal (CPS signal) designated for engine condition monitoring.

The basic principle of the system is to measure the thermos-voltage produced by a steel crankshaft when it slides on the metal surface of its bearing shells.

The CPS signal provides information, at an early stage, about upcoming damages caused by friction, especially of bearings. Operators get informed through the display about the condition. Thus, it helps to diagnose failures in those moving parts at early stages, preventing the engine from serious damages.

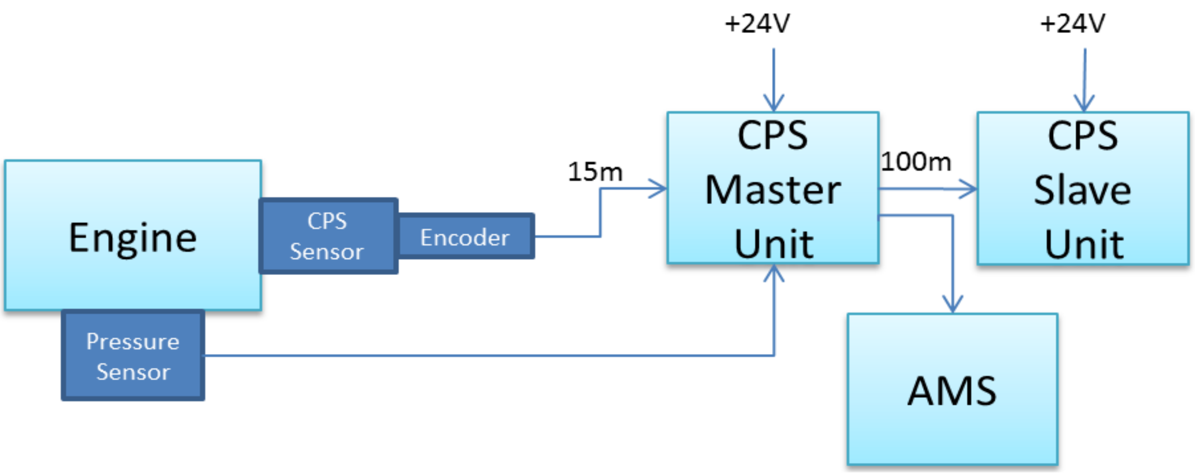
The system is, in parallel, connected to the AMS system - by pre-alarm and main-alarm relay outputs.

The CPS, its *position encoder (optional) and the pressure sensor (optional),* is connected to the CPS Master unit that calculates and monitors the measured values. Depending on engine specific settings and parameters, limits for alarm levels are set.

The CPS Master Unit is directly connected to the AMS.

The CPS Slave Unit is used for displaying live-data at the ECR where the measured values are displayed and the signal evaluation is performed.

CPS Sensor is installed on the housing on a free end of the crankshaft.



Main Characteristics

- Thermoelectric measurement
- Engine speed measurement (optional)
- Engine load measurement (under preparation)
- Crankcase pressure measurement (optional)
- Oil temperature measurement (under preparation)
- Oil pressure measurement (under preparation)
- Monitoring of bearing condition

CPS Advantages

- Simple and easy assembly
- Assembly by crew possible
- Easy maintenance
- Early initialisation of an alarm if bearing anomalies occur
- Two independent external supply voltages, one from the 24V net and one from the safety battery (under preparation)

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Technical Data

Power supply:	24VDC +30%/-25%
Power consumption:	approx.125W
Over current protection:	by fuse
Operating temperature:	0°C ... +90°C for sensor 0°C - +85°C for computing unit
Storage temperature:	-10°C ... +100°C for sensor -10 – +90°C for computing unit
Relative humidity:	< 90%, not condensing
Current Consumption:	< 500mA
Protection acc. to DIN 40050:	for sensor IP68 for computing unit IP67 from front panel and IP 20 for rear side
Connection terminals:	plug in multiple cage tensions spring terminal connection screw able
Connection cross section:	0,14 -1,5 mm² acc. IEC947-7-1
Data Interface	Under preparation

CPS mounted on engine / in engine room

Test measurements

During the last years, the following application tests have been carried out:

1. 9 Cylinder Engine

Field evaluation test on a power plant using a 4-stroke diesel engine

- Test duration on a live engine: approximately 1 year
- Long term tests of the measuring principle under live conditions
- Mechanical tests on a live engine
- Gathering information about systems (mechanic/electronic) stability
- Long term data recording to evaluate system stability
  →Improvement of the crankcases' oil sealing and concentricity of rotating parts.

2. 16 Cylinder Engine

- Data on different engines during engine start & stop
- Data on different oil temperatures
- Preliminary setup of alarm levels (pre and main alarm)
- Tests with different foreign materials to simulate impure lubrication oil
- Tests with squeezed main bearings to simulate bearing wear / malfunction by increased bearing temperature
- Alarm speed comparisons between Oil Mist Detector and CPS

  → Improved mechanics to allow a bigger crankshaft clearance.

3. 12 Cylinder Engine

3.1 Field evaluation test on a cruise ship's main generator engine

- Test duration on a live engine: approximately 1 year
- Test with improved mechanics
- Improved electronical connection to reduce application and system noise
- Long term data recording to evaluate alarm levels & system stability
  → Alarm level optimization.

3.2 Field evaluation test on a second main generator engine

- Test duration: approximately 6 months
- Test to experience engine tolerance impact on system
- Alternative electronical connection to reduce system costs without interfering with system accuracy
- Long term data recording to evaluate (engine specific) alarm levels & system stability

  → Alarm level optimization.

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Results of measurements

During the above field tests the data processing and as a result the signal-to-noise ratio has been vastly improved (Figure 1, 2, 3). By that, alarm levels had been defined more accurate, so that “functional distance” between normal operation and alarm limits exists. Therefore, false alarms had not occurred and had been highly avoided.

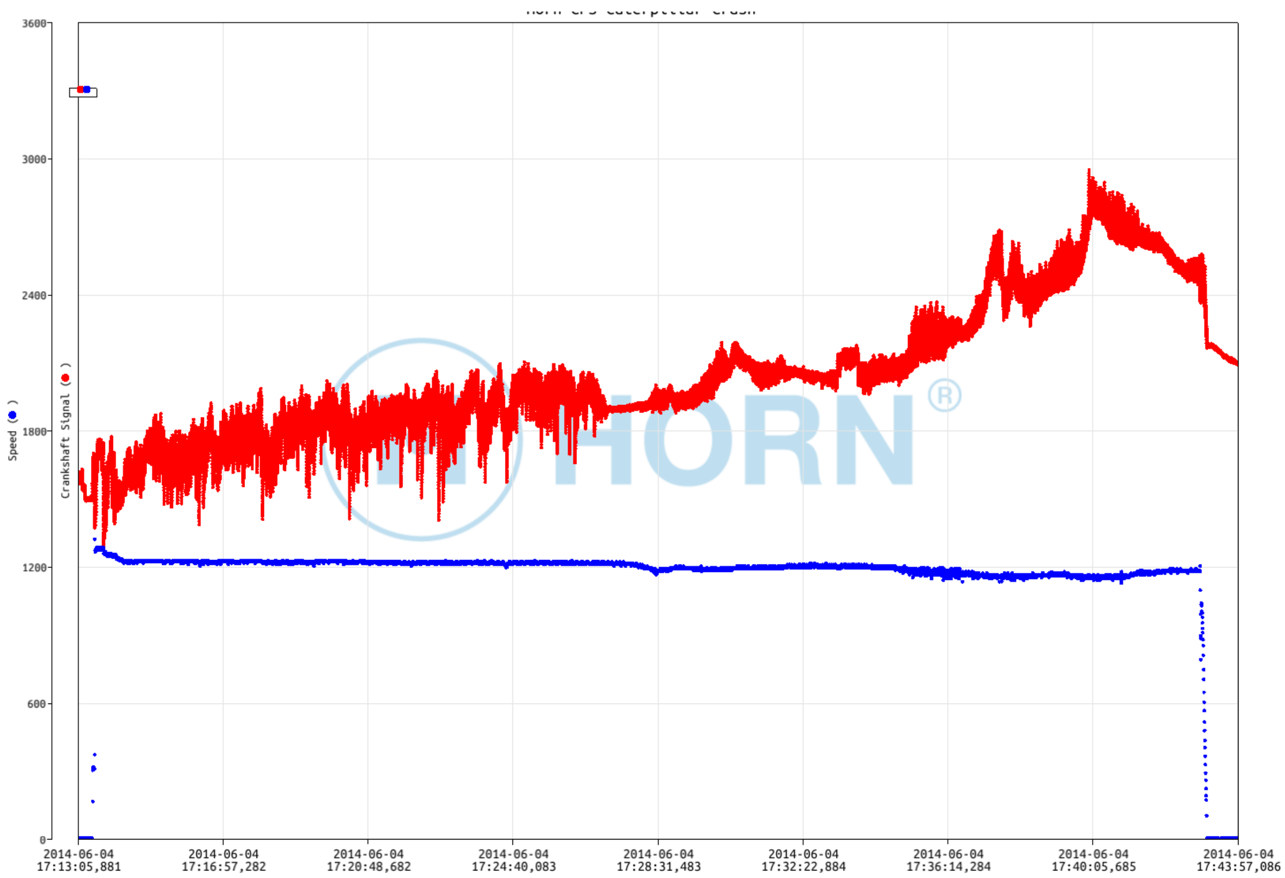

Figure 1: Alarming signal on engine during crash tests

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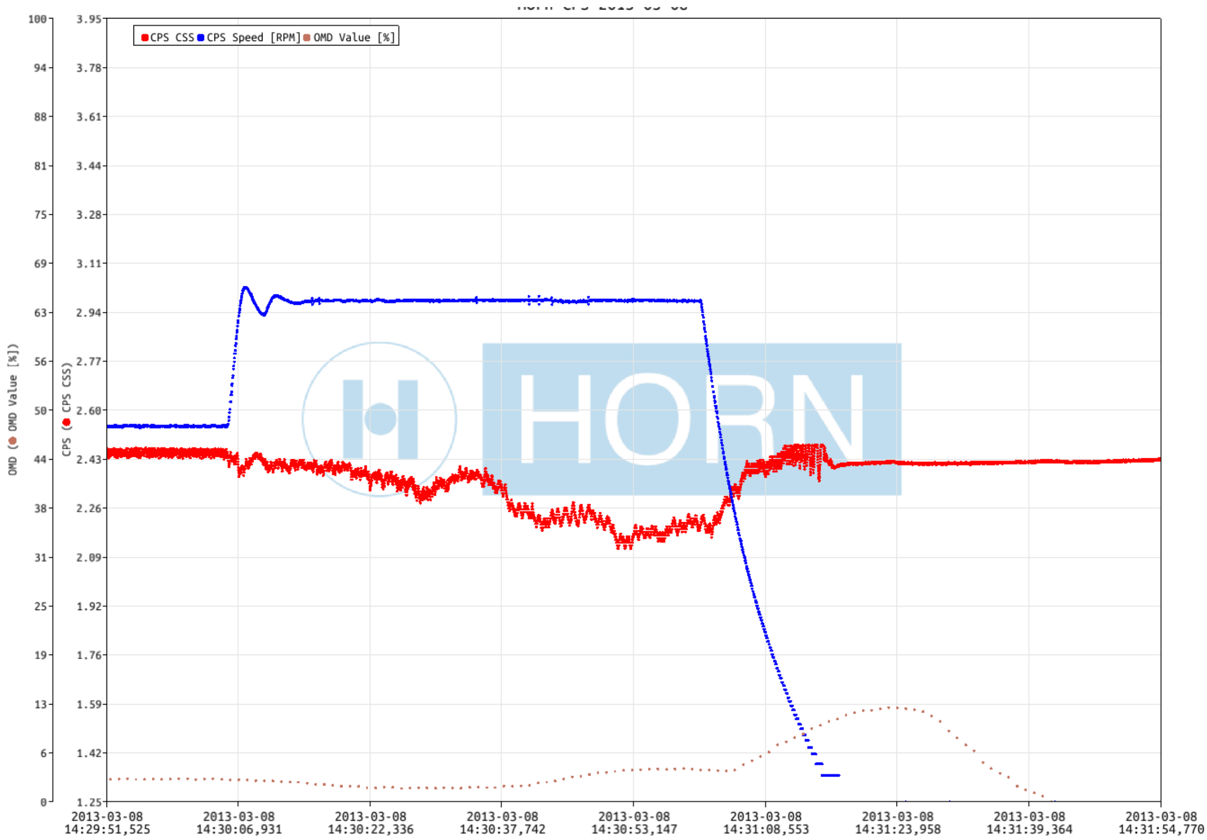

Figure 2: Comparing Response Time of CPS (red) versus OMD (brown) Graph is showing a main bearing damage

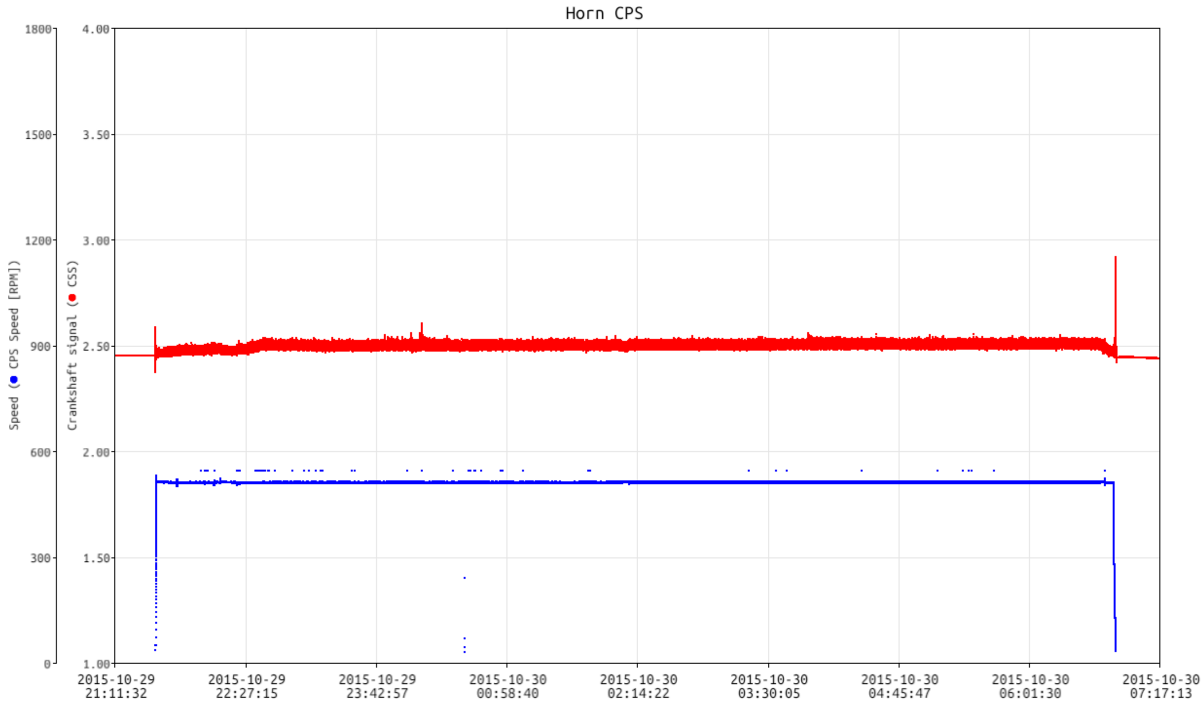

Figure 3: Signal at normal operation (Cruise vessel DG4) with engine start and stop.

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Out view for further developments for CPS

Additionally to the actual development additional features can be added by using an added encoder detecting the engine speed, position information and speed changes over one revolution.
Information like cylinder balancing and engine performance may be calculated out of such sensor data.
Crankcase pressure sensors connected to the system are available and supply further information for example about blow-by of the engine.

Conclusion

On the basis of the above tests and field evaluations the following conclusions can be made:

1. The mechanics is stable on continuous and long-term operation. All rotation parts are suitable for long time of operation without maintenance.

2. The electronics is fail safe. It does not interrupt normal operation due to false alarms.

3. Enough memory for data recording of all input signals.