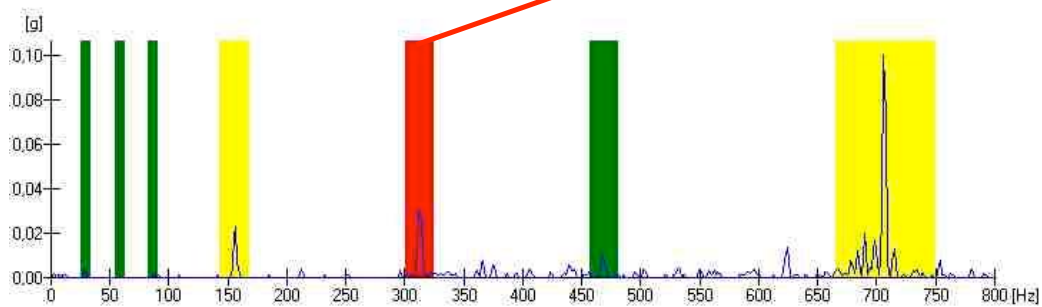


**E-GOMS II** Gearbox Online Monitoring System

Application Note Wind Energy



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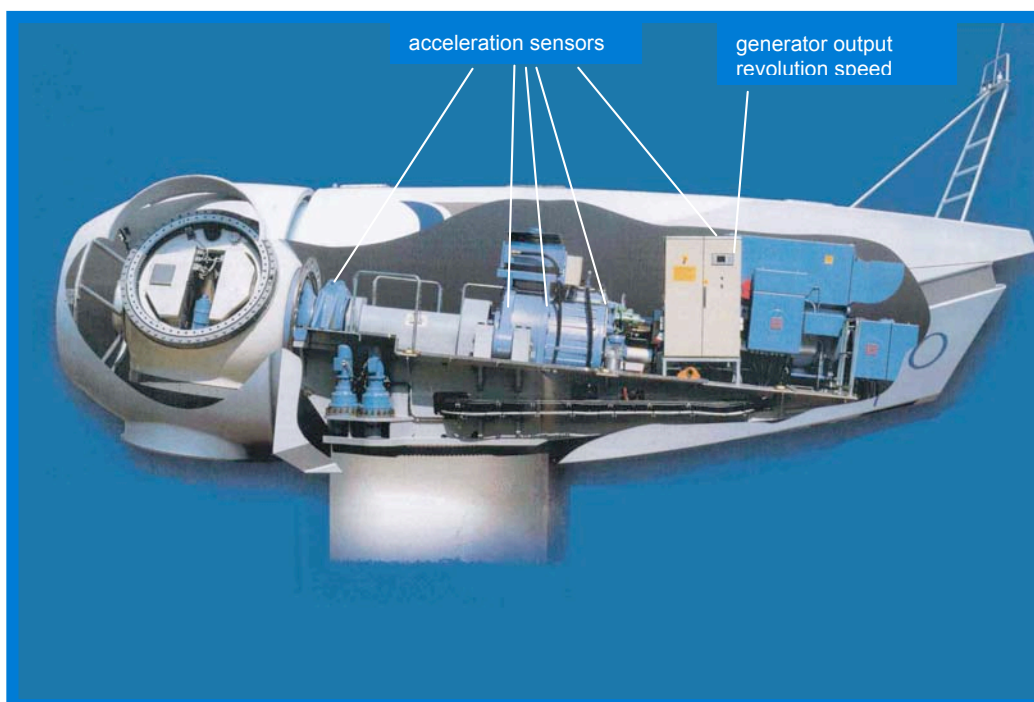
## 1 System Description EGOMS II – Wind

E-GOMS, certified by the "AZT - Allianz Zentrum für Technik", is a condition monitoring system for the remote monitoring of drivetrains, e.g. wind turbine drivetrains.

The solid born sound of the gearbox bearings, the gear tooth system and the gearbox shafts as well as the solid born sound of the generator bearings and the rotor bearing is recorded by vibration sensors. The intelligent measuring unit of the new vibration analyser generation is able to assess the recorded data frequency-selective. The measured data is stored on a flash disc data memory of the E-GOMS II. Afterwards all recorded data can be send to a remote computer by serial communication via the RS232 port, by mobile communication via modem-interface or by internet communication via an ethernet port.

If any predefined alarm level is exceeded, the measured data relating to this event is saved by the E-GOMS II and a message can be sent to the control station via relay switching output, e-mail or SMS. The Configuration Manager module as part of the modular designed administration software allows the root cause analysis of the alarm level overstepping and to evaluate the condition of the drivetrain components.

The monitored alarm levels and the frequency bands can be routed as a function of the revolution speed. To realise the alarm level and frequency band entrainment one of the eight additional input ports of the E-GOMS II can be configured to record the revolution speed. Depending on the revolution speed, the torque or another load- dependent measurand a validation of measurements is also possible. The minimization or exclusion of incorrect results of measurements due to variable operating conditions during the data recording is feasible in this way. Hence E-GOMS II is applicable for drivetrains with fixed or variable revolution speed.

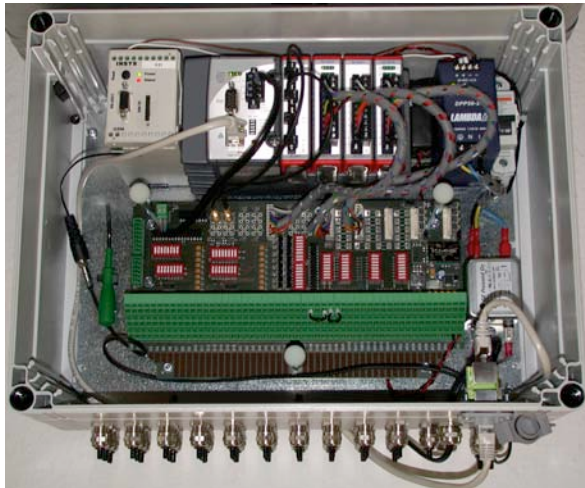


## 1.1 System for Online Vibration Measurement

### Hardware

The basic system comprises of the controller, as the central control and processing unit, the back-plane with integrated FPGAs and the plugged on in- and output modules, the connection board with an integrated multiplexer, a communication module as well as a power supply unit.

The mentioned components are implemented in a control cabinet. The E-GOMS II - Wind provides 16 acceleration input ports for solid born sound recording. Depending on the sensor type an ICP constant current supply can be activated for each single port. The monitoring of any measurand is possible if it can be displayed as a DC current or volatage signal.



E-GOMS II - Basic System



E-GOMS II - Controller (left hand) and the in- and output modules



E-GOMS II - modules & communication module (here: GSM-Modem)

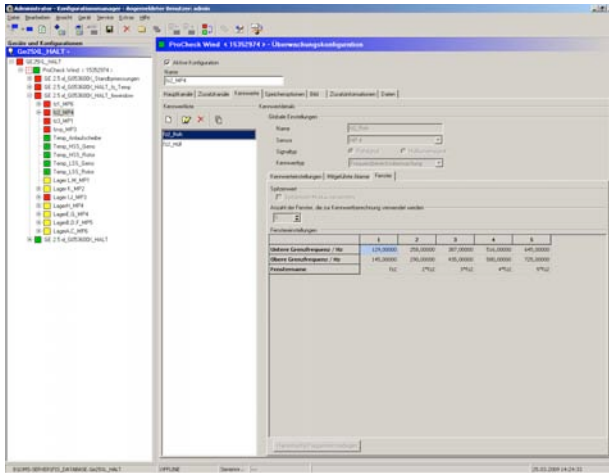


IEPE - Acceleration Sensor

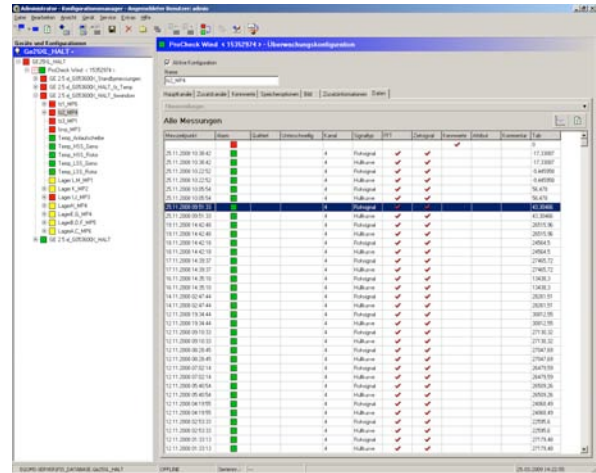
**Software**

The modular designed administration software of the E-GOMS II is used to communicate with the condition monitoring system, to configure the measurement system as well as to display and analyse the measured data.

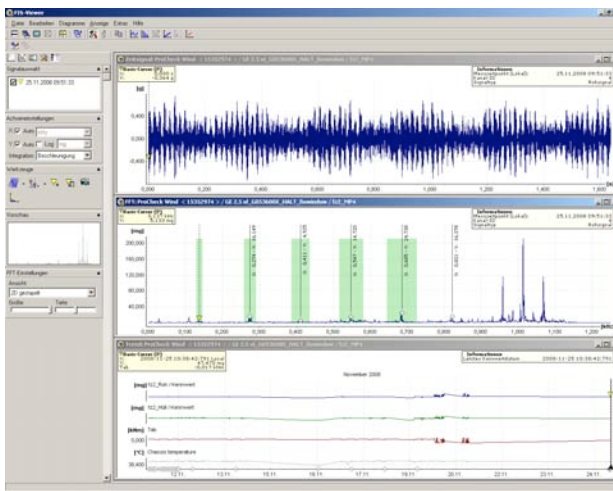
The use of approved analytical methods allows detailed investigation of the monitored drivetrain components. E-GOMS II uses a SQL data base (Microsoft SQL Server) which allows easy and well-arranged data management and also ensures a high data reliability. Automatically creation of short status reports is possible by the use of the report generator module which is also provided by the administration software.



Configuration



Data base



Analysis

**2 Status**

Die folgenden Tabellen geben einen ersten Überblick über den Status der Lager und Verzahnungen. Die Farbenzeichnungen sind folgendermaßen zu interpretieren:

- Grün: Integrität
- Gelb: Warnung
- Rot: Schaden
- Blau: Inaktiv

**2.1 Übersicht Lagerzustand**

| Lager | Status | Bemerkungen |
|-------|--------|-------------|
| A     | Grün   |             |
| B     | Grün   |             |
| C     | Grün   |             |
| D     | Grün   |             |
| E     | Grün   |             |
| F     | Grün   |             |
| G     | Grün   |             |
| H     | Grün   |             |
| I     | Grün   |             |
| J     | Grün   |             |
| K     | Grün   |             |
| L     | Grün   |             |
| M     | Grün   |             |
| N     | Grün   |             |
| O     | Grün   |             |
| P     | Grün   |             |
| Q     | Grün   |             |
| R     | Grün   |             |
| S     | Grün   |             |
| T     | Grün   |             |
| U     | Grün   |             |
| V     | Grün   |             |
| W     | Grün   |             |
| X     | Grün   |             |
| Y     | Grün   |             |
| Z     | Grün   |             |

**2.2 Übersicht Verzahnungszustand**

| Verzahnung | Status | Bemerkungen  |
|------------|--------|--|
| A          | Grün   |  |
| B          | Grün   |  |
| C          | Grün   |  |
| D          | Grün   |  |
| E          | Grün   |  |
| F          | Grün   |  |
| G          | Rot    | Die Verzahnung ist übermäßig verschliffen. Bitte überprüfen Sie die Zahnprofile. |
| H          | Grün   |  |
| I          | Grün   |  |
| J          | Grün   |  |
| K          | Grün   |  |
| L          | Grün   |  |
| M          | Grün   |  |
| N          | Grün   |  |
| O          | Grün   |  |
| P          | Grün   |  |
| Q          | Grün   |  |
| R          | Grün   |  |
| S          | Grün   |  |
| T          | Grün   |  |
| U          | Grün   |  |
| V          | Grün   |  |
| W          | Grün   |  |
| X          | Grün   |  |
| Y          | Grün   |  |
| Z          | Grün   |  |

**3 Messergebnisse**

Die folgenden Tabellen geben einen ersten Überblick über den Status der Lager und Verzahnungen. Die Farbenzeichnungen sind folgendermaßen zu interpretieren:

- Grün: Integrität
- Gelb: Warnung
- Rot: Schaden
- Blau: Inaktiv

Report

## 1.2 Technical Details of the EGOMS II – Wind

### System:

- measurement system (with multiplexer) with 16 channels for the vibration monitoring of wind turbines.
- parallel measurement of 2 channels (raw and envelope signal of one channel or 2 channels at the same time with a raw or envelope signal).
- 8 additional input channels (e.g. revolution speed or torque signal for validation of the measurements as well as to realise the alarm level and frequency band entrainment).
- 64 monitoring configurations
- 12 frequency bands per monitoring configuration to carry out a selective monitoring of the gearbox bearings (the inner ring, the outer ring, the roller and the cage), the gear tooth system and the gearbox shafts.
- the measurand of the sensors (acceleration) can be converted into speed and displacement within the frequency range.

### Additional input ports:

- max. 8 ports (optionally analogue or digital): e.g. revolution speed, torque or generator output, temperature, oil pressure, load, oil condition/ oil quality, etc.
- +/- 10 V input voltage range
- 12 Bit signal resolution
- 50 Hz to 10 kHz sample rate for analogue signals / 50 kHz sample rate for digital signals

### Sensor Technology:

- IEPE- (ICP-) acceleration sensors
- power supply: 2 mA (direct) / 4 mA (multiplexer) at 24 V

### Measurement functions:

- time signal
- frequency spectrum
- envelope spectrum
- vibration acceleration (RMS)
- vibration speed (peak, RMS)
- vibration displacement (RMS)

### Characteristic Values in the frequency domain:

- ISO 10816
- broadband or selective LDZ value (envelope analysis for the monitoring of bearings)
- broadband or selective RMS value (effective value) of the vibration acceleration, speed or displacement
- calculation of the variables RMS respectively LDZ under exclusive consideration of the frequency components which are contained in the defined frequency bands

**Characteristic Values in the time domain:**

- RMS
- constant component
- peak
- peak to peak
- crestfactor

**Filters:**

- low-pass filter with adaptable cut-off-frequency  
(5, 10, 20, 50, 100, 200, 500 Hz / 1, 2, 5, 10, 20 kHz)
- high-pass filter with adaptable cut-off-frequency  
(250, 750, 2000 Hz)

**Memory:**

- 64 MB RAM
- 512 MB data memory (flash disc)

**Outputs:**

- max. 8 relay switching outputs, drain/source, 60 V DC/ 250 V AC, 750 mA
- max. 16 switching outputs, 6 - 30 V, source, 100  $\mu$ s, 750 mA (24 V)
- max. 8 current output, 16 Bit, 0 - 20 or 4 - 20 mA

**Communication Interfaces:**

- RS232 (max. data rate 115 kBit/s)
- Ethernet 10/100 MBit/s (IEEE 802.3)

**Software:**

- Modular designed administration software (Configuration Manager, Data Manager, Remote Server, Data Link und E-Mail Link) for configuration, visualization, diagnosis, documentation, data management and communication.

**Validation:**

- Determination of the maximal respectively minimal signal amplitude which is acceptable during the data recording (Definition of the wind turbine working point) and/ or Determination of the maximal respectively minimal value variation which is acceptable during the data recording.

**Alarms:**

- predefinition of main- and pre-alarm levels in the frequency range (for each frequency band)
- alarm level entrainment according to the revolution speed (for each monitoring configuration)
- message posting via e-mail or SMS in case of the occurrence of an alarm  
(Feasibility to send the measured data and variables to the control station automatically at the same time.)

### 1.3 Optional Add-Ons

#### Option 1: Speed measurement

Use of a revolution speed sensor which is connected to an additional input port of the E-GOMS II. An additional connection of a revolution speed sensor can be considered, if no analogue signal ( $\pm 10$  V) can be used which is linked to the revolution speed of the generator and provided by the control unit of the wind turbine.

#### Option 2: Differential measurement of the revolution speed

Use of a second revolution speed signal, e.g. to monitor the slip of a hydrodynamic coupling. The differential revolution speed will be calculated from the two speed signals and monitored.

#### Option 3: Data Interface in the Tower Base

A data interface can be considered at the tower base, when data transfer is requested between the E-GOMS II in the wind turbine housing and the tower base by means of fibre optic cables. If there is no ISDN or network connection available in the nacelle and if the use of mobile phones/GSM modems isn't possible due to an electromagnetic susceptibility of the wind turbine control unit or due to a poor signal quality in the nacelle, the data transfer to the tower base will be realised by the already mentioned fibre optic cables. Any available telephone connection at the tower base or a GSM modem can be used in this case.

#### Option 4: Torque Measurement

For the online monitoring of torque and revolution speed of the drivetrain the E-GOMS-Torque monitoring system can be added to the vibration monitoring system. By means of E-GOMS-Torque a permanent monitoring of the time signals and the signal gradients as well as the permanent storage of time signals and the calculation of 4 types of load collectives is feasible.

The installation of a torque monitoring system includes the application of strain gauges (measurement of shaft-torsion) as well as the assembly of a one-channel telemetry system with a contactless signal transmission and an inductive power supply on the high speed shaft of the gearbox.



Strain gauges on the high speed shaft.



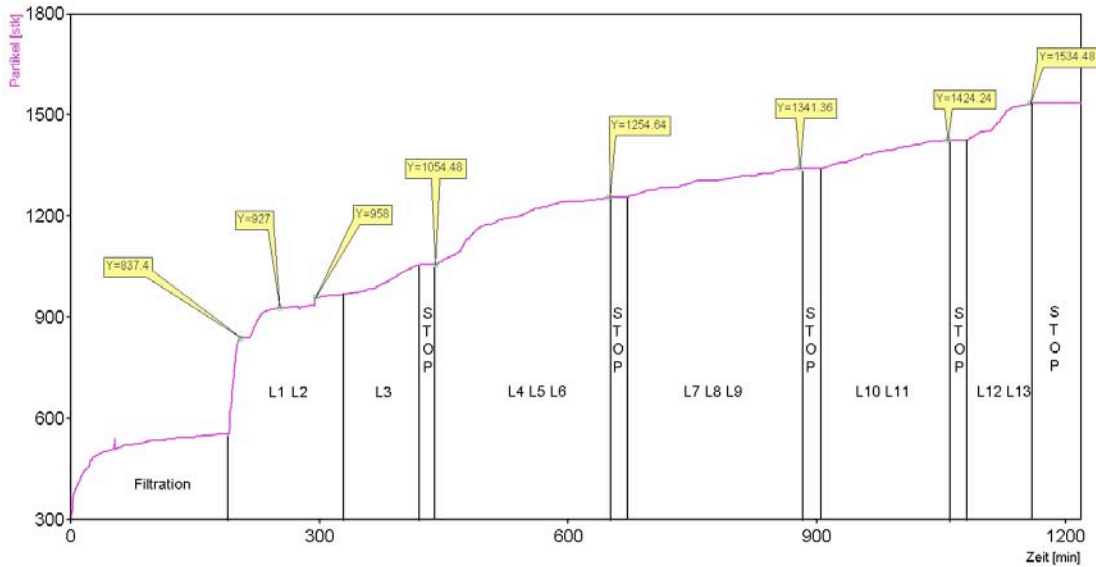
Rotor und stator (antenna) on the high speed shaft of the gearbox.



Option 5: Particle Counter

A particle counter which is integrated in the gearbox lubrication circuit can be added to the monitoring system. Each particle passing by the sensors tube makes the sensor to create an rectangular Impulse. This impuls is transmitted to an evaluation unit within the measurement system which creates a proportional voltage signal according to the sum of impulses.



An additional input port of the E-GOMS II is used to monitor this analogue signal. The amount of the recorded particles respectively the amount of particles per unit of time gives information about the gearbox condition. Similar to the trend chart of the vibration monitoring, the sum of recorded particles can be plotted versus time and a limit value monitoring can be done.



Result of a particle counting which were done during a gearbox test run.

## 2 -GOMS Services

### 2.1 Installation


- pre-delivery installation of the -GOMS II within the Eickhoff facilities or subsequent on-site installation within the wind turbine housing
- installation of the -GOMS II including the torque monitoring system and other systems which are optionally requested to monitor the temperature, the slip, the oil condition (by particle counting), etc.

### 2.2 Configuration and Start- Up



- on the gearbox test bench within Eickhoff facilities
- on-site after installation

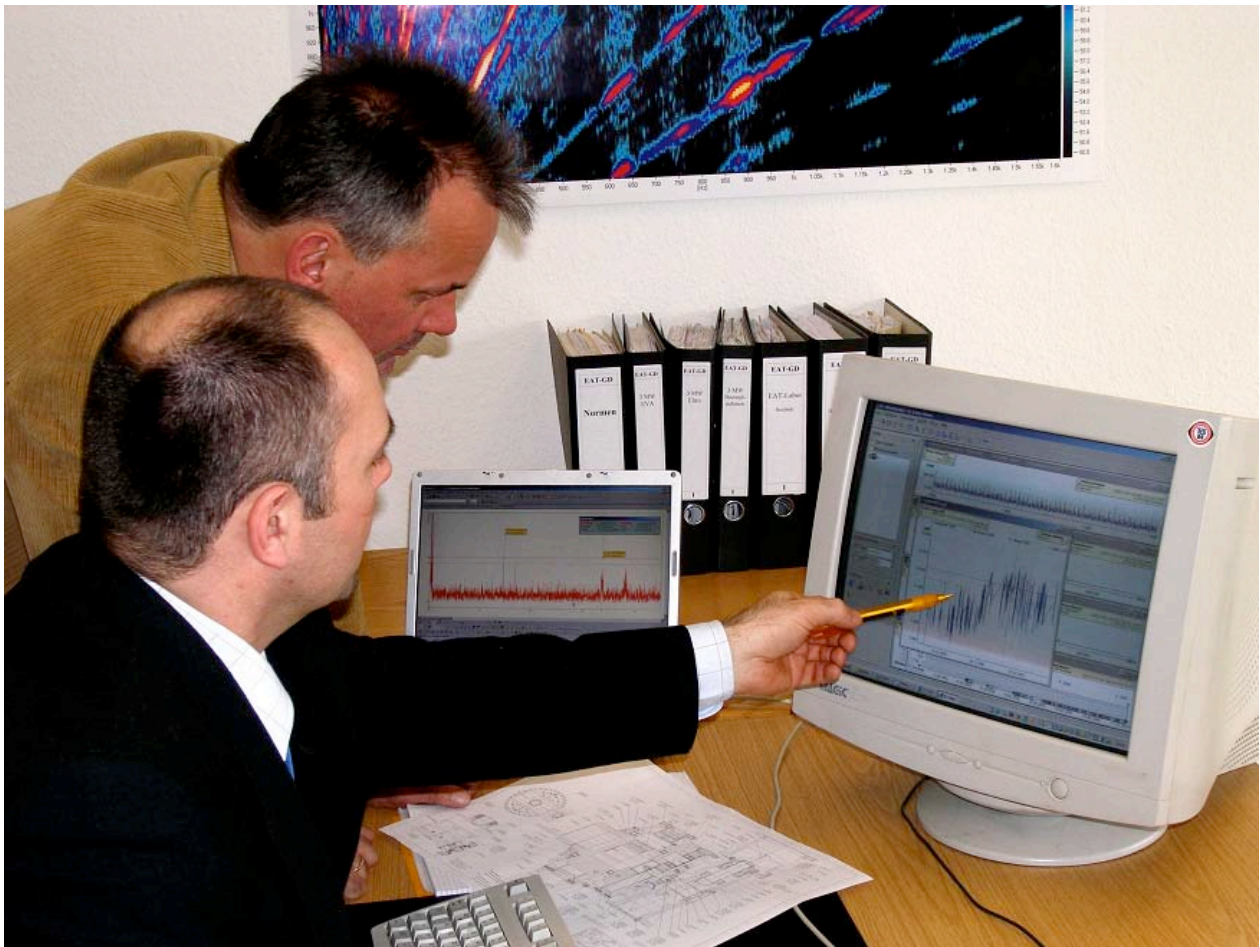
### 2.3 Monitoring Services

#### Single measurements

- for individual measurements our portable monitoring system (-GOMS-Portable) is generally used
- single measurements are often done including an video-endoscopic inspection

#### Permanent monitoring

- For long-term monitoring periods (>14 days) a permanent installation of the -GOMS II is recommended. In this case a consistently trend of the measured data is ascertainable. The vibration monitoring and diagnosis is done in our remote control station which means via remote control of the -GOMS II.



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