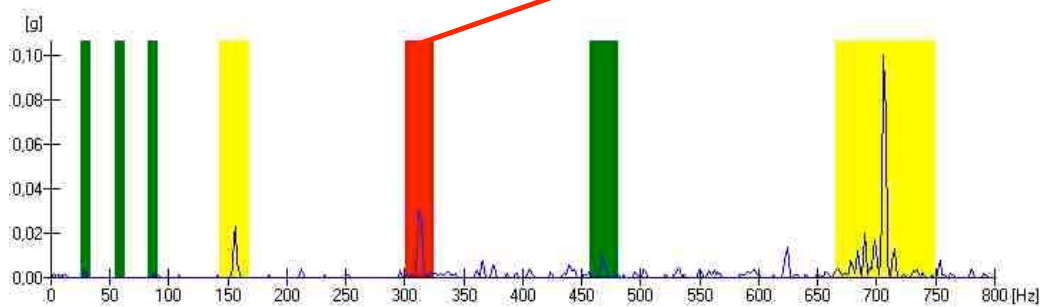


E-GOMS I Gearbox Online Monitoring System

Application Note Wind Energy



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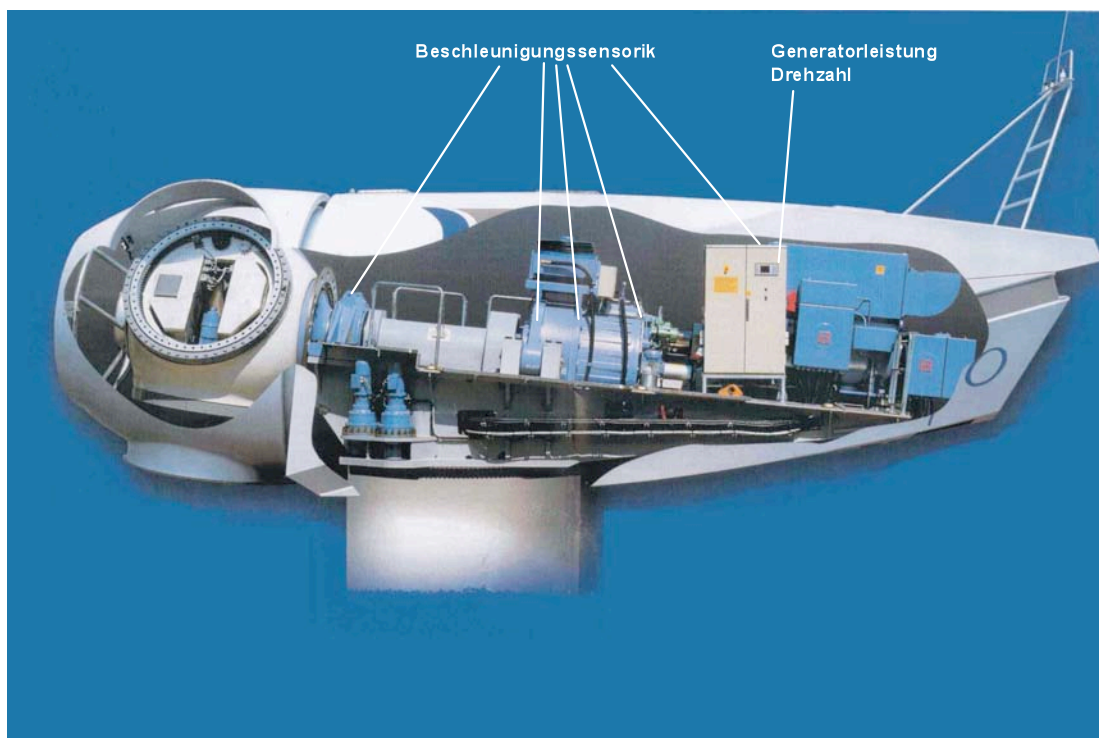
1 System Description

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

The conditions of the gearbox, generator and rotorbearing are monitored by several acceleration sensors and frequency-selective assessed by the intelligent measuring unit on site. Every recording is stored on the ring memory and is retrievable via the interface RS232, modem or COM-server.

If any alarm level is exceeded, the history relating to this event is saved and a message will be sent to the main station (relay, mail, SMS). The administrator software helps to identify the cause of the exceeded alarm level and gives indications of the state of the individual components.

Two additional measuring channels detect speed and torque or, alternatively, the generator power. The monitored frequency bands and the alarm levels are routed as a function of speed. The recordings are validated by speed, torque or, alternatively, the generator power parameters. In this way incorrect measuring results caused by variations in the operating conditions during measurement can be excluded. **E-GOMS** is thus suited for both variable speed and constant speed applications.



1.1 System for Online Vibration Measurement

Hardware

The basic system comprises the vibration monitor, one 8-channel multiplexer and one communication module which are housed inside a control cabinet. Up to 8 ICP acceleration sensors detect the structure-borne sound signals around the gear housing, generator and rotorbearing. For validation of the readings, the system needs the output speed and output torque of the gearbox or, alternatively to the torque, the generator power as a reference.



E-GOMS I vibration monitor



8-channel multiplexer



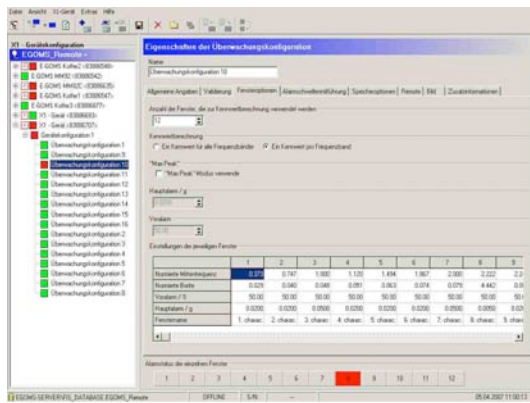
communication module



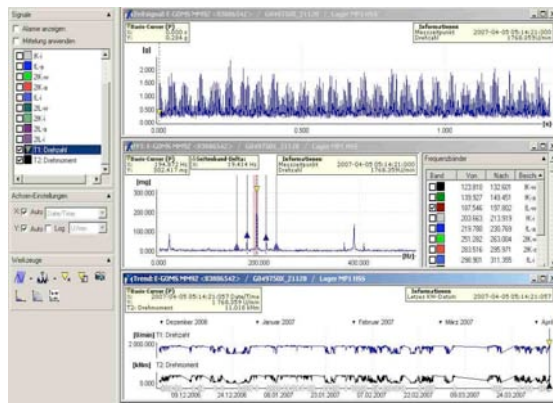
acceleration sensor

Software

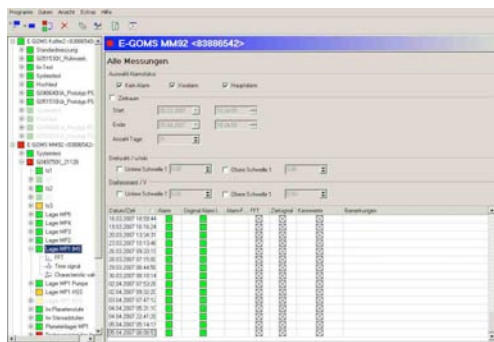
The administrator software helps to communicate with the monitoring system and to configure it. Analysing tools show the gearbox condition and enable a closer look on the measured time signals, FFT-spectra and trends of the characteristic values. Data base functions make the organisation of the stored data easy. With the report generator short reports of the gearbox conditions are printed automatically.



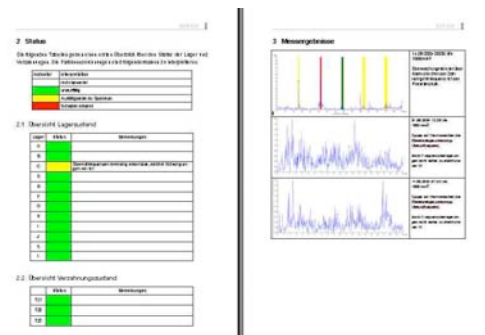
configuration



analysis



data base



report

1.2 Technical Details

System:

- Individual configured 8-channel measurement system for continuous monitoring of the gearbox, generator and rotor bearing of wind turbines.
- FFT and envelope analysis
- 16 configurations
- 12 frequency-bands in each configuration
- frequency-bands and alarm-levels defined as function of speed
- characteristic values RMS und LDZ
- input channels for additional signals (e.g. speed and torque).

Inputs:

8 ICP-input-channels for ICP acceleration sensors 24V/4mA (4 channels for the gearbox-monitoring, 4 channels for the monitoring of rotorbearing, generatorbearings and tower).

amplifier 1- to 1024-fach, autoranging, overvoltage-detection,

2 additional channels 4...20mA (optional 0...10V)

channel 1: speed signal

channel 2: torque or generator power.

Sensor Technology:

- ICP acceleration sensors for the monitoring of all bearings, gearing and shafts.
- measure: acceleration, convertible into speed in the frequency domain

Characteristic Values in the frequency domain:

- RMS of the acceleration, speed or distance
- LDZ-value (envelope analysis for the monitoring of the bearings)

Characteristic Values in the time domain:

- RMS
- mean value
- Peak
- Peak to Peak
- Crestfaktor

Filters:

- analog antialiasing filter Butterworth 24 dB/Oct., cut-off frequencies 5, 10, 20, 50, 100, 200, 500 Hz und 1, 2, 5, 10, 20 kHz.
- analog highpass filter for the envelope analysis, Butterworth 12 dB/Oct., cut-off frequencies variable.

Memory:

- for the configurations, timesignal, frequency-spectrum, "alarm-spectrum",
- ring-memory: 264 to 3837 data-sets each configuration (depends on the configuration)

Configurations:

- 16 configurations, which are executed in rotation:
- 12 optimized configurations for the gearbox,
- 4 configurations for the monitoring of the rotorbearing, generatorbearings and the tower vibration.

Configurations in the frequency domain:

- definition of the frequency range (low pass filter)
- RMS of acceleration, speed or distance or LdZ (envelope analysis)
- validation of the measurement by speed and torque
- if required definition of frequency bands as function of speed
- if required definition of alarm levels as function of speed or torque

Frequency Bands:

- In the frequency domain maximum 12 frequency bands are available for each configuration for the frequency selective monitoring of the bearings (inner race, outer race, roller and cage), gearing and shafts. In the calculation of the characteristic values RMS or LdZ, only the lines of the frequency bands are included.

Validation:

- Speed and a 2nd additional signal (torque or generator power) for the validation of the measurement: Definition of maximum and minimum values (operating condition of the turbine) and of acceptable variation during the measurement.

Alarms:

- Main- and pre-alarm levels in the frequency domain for each frequency band predefined. Readjustment of the alarm levels after a while of operation of the turbine, if required as a function of speed. In the case of an alarm, message per e-mail or SMS possible.

Outputs:

- output relays for the main- and prealarms, 30V/5A
- analog outputs 4...20 mA
- 8 ICP-signals on BNC-output on the front cover

Communication Interfaces:

- RS232
- modem (analog, ISDN, GSM) or
- COM-server for Ethernet (TCP/IP)

Software:

- Administrator-software for the configuration, visualization, diagnosis, documentation and data management for Windows (at least Version 95), remote monitoring via telephone, GSM or Ethernet, data export in ASCII-files.

1.3 Optional Add-Ons

Option 1: Speed measurement

Speed sensor for connection to the 1st additional channel. If there is no analog signal (0...10 V) proportional to the number of revolutions of the generator, this equipment has to be installed.

Option 2: Continuous Power Supply

In the case of power failure, the monitoring service of the system is maintained at least for another 30 minutes by an integrated rechargeable buffer battery (220 VAC - 24 VDC or 110 VAC - 24 VDC or 24 VDC - 24 VDC)


Option 3: Data Interface in the Tower Base

Data transfer from the monitoring system in the top of the tower to the tower base via optical fibers, data interface located in the tower foot.

In case, that there is no telephone- or network connection in the top of the tower and a data transfer via mobile phone is not possible, the data will be transferred to the tower base.

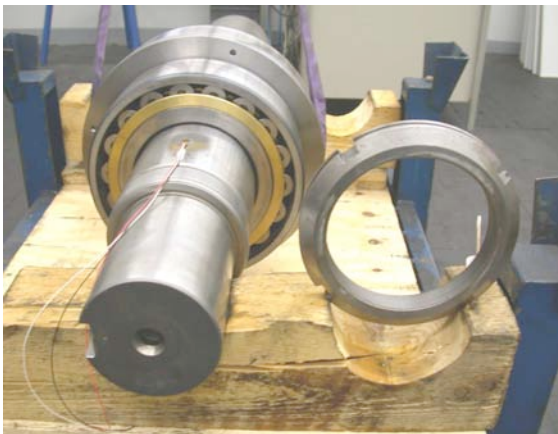
Option 4: -GOMS_{Torque} Torque Measurement

Monitoring System:

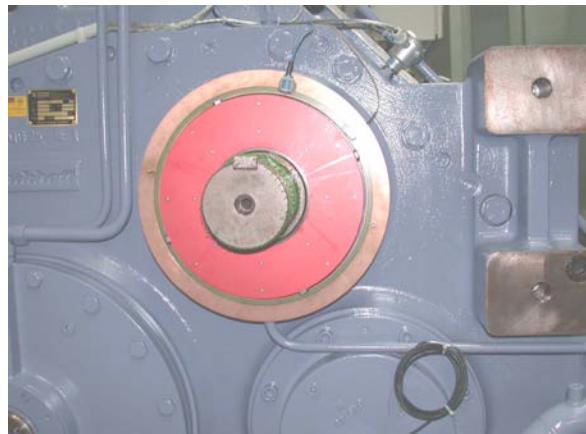
-GOMS_{Torque} torque monitor for online monitoring of the torque, rotational speed and power. Limit value monitoring of the time signal, signal gradient and signal extrapolation. Storage of signal histories, trend data and load collectives.

Measuring System for Continuous Industrial Use:

Consisting of wire strain gauges for detecting the output shaft torsion, one single-channel telemetry system with non-contact signal transmission and inductive power supply and one system carrier and protective ring, including the ready-for-use installation and commissioning. The construction of the system depends on the gearbox type.



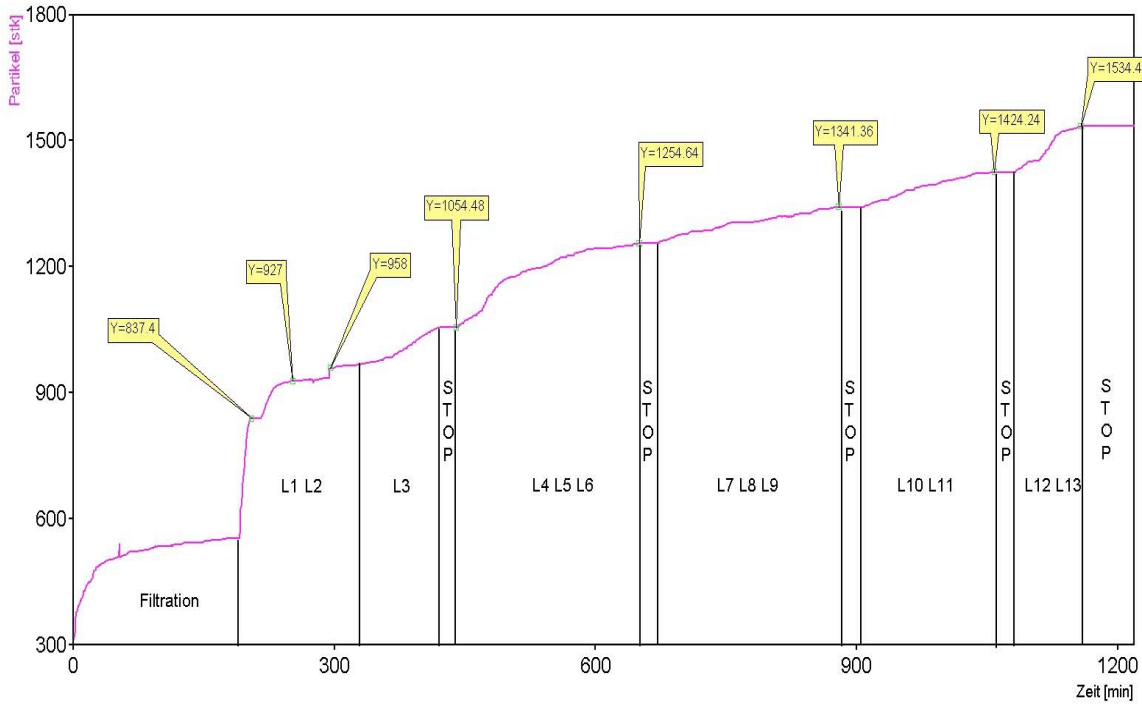
strain gauges on the high speed shaft



rotor und stator antenna

Option 5: E-GOMS Particle Counter

A particle counter can be integrated in the oil circuit of the gearbox. This device is capable of detecting particles of the size of 200µm. Particles will be counted and the trend stored as an additional signal in E-GOMS.



particle count during test bench run

2 E-GOMS I Portable



The portable version of E-GOMS I is particularly advisable in cases that several gearboxes shall be monitored at regular intervals with no need for continuous vibration monitoring of the plants. The system housed in a service case allows taking measurements during the regular inspections of the gearboxes. For this purpose every gearbox only needs to be equipped with the acceleration sensors. Their connections are combined in one compact connection box. After connection of the portable system in this box, the data will be transferred to a database just like described for the on-line system (GSM modem or direct PC connection). Thus data is available for analysis and, following several measurements, for trend assessment. The system, however, can also be operated temporarily online at any time if and when required.




E-GOMS I Portable

3 -GOMS Services

3.1 Installation

- installation of the vibration measurement system -GOMS either on site or at Eickhoff facilities
- installation of the torque measurement system -GOMS_{Torque} torque either on site or at Eickhoff facilities

3.2 Configuration and Start- Up



- configuration of -GOMS based on kinematic frequencies of the drive train
- start up phase either beginning during test bench run at Eickhoff facilities or during regular operation

3.3 Monitoring Services


Single Measurement

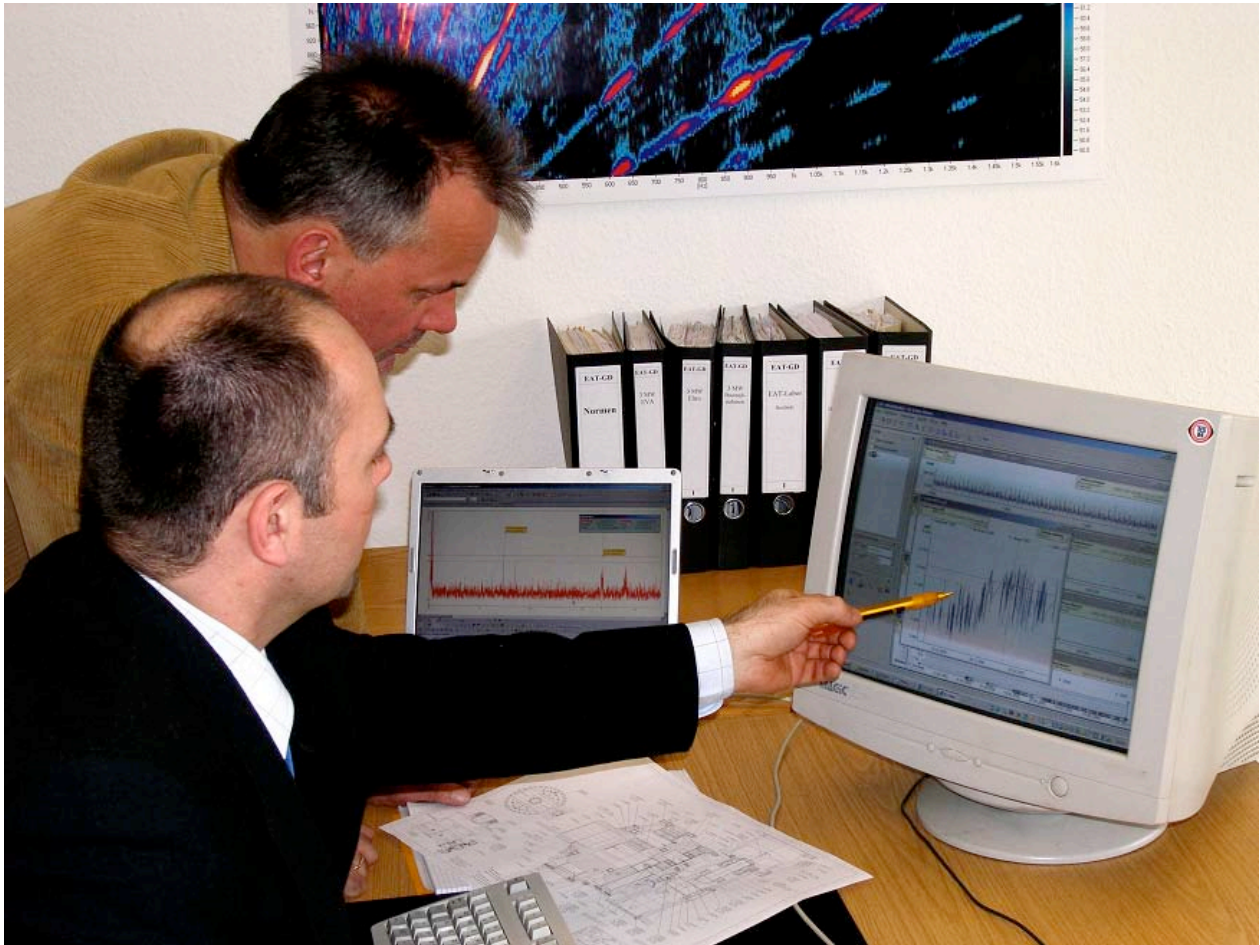
- system installed by Eickhoff Service
- app. 30 min test run followed by automated data transfer to Eickhoff diagnosis center
- immediate data analysis by Eickhoff expert and information of people on site

Repeated Single Measurements

- by means of -GOMS I Portable
- sensors fixed installed on the drive train, connection to -GOMS I Portable by means of a junction box and one single cable for all signals (very easy and quick to install)
- single measurements will be done in regular intervals. Hence trend monitoring is possible.
- condition monitoring reports in regular intervals
- several drive trains can be monitored with only one vibration measurement system

Permanent Online Monitoring

- by means of a fixed installed -GOMS
- data transfer every 24 hours or according to specific agreement
- data analysis and storage at Eickhoff diagnosis center
- condition monitoring reports in regular intervals



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