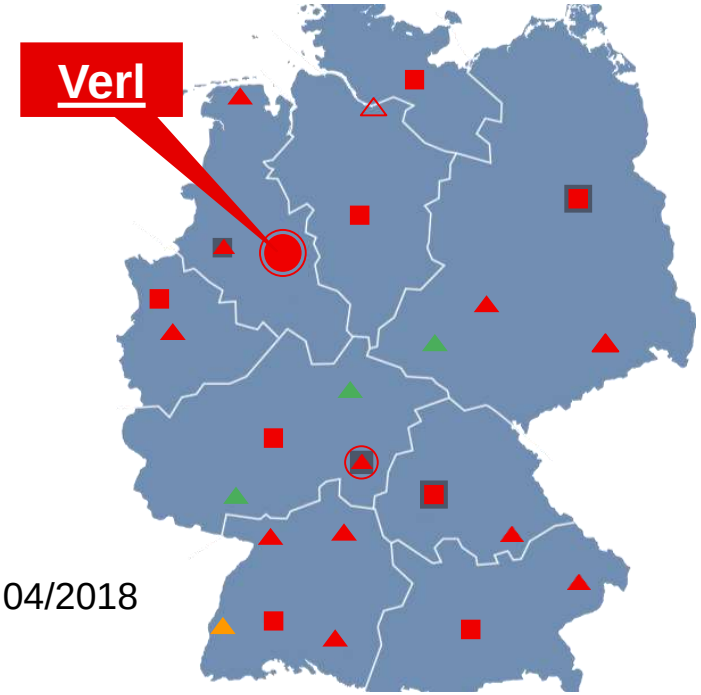
New Automation Technology
PC-based control for Wind Turbines

BECKHOFF

Facts and figures

BECKHOFF

Headquarters:	Verl, Germany
Employees worldwide:	3,900
Number of engineers:	1,400
Sales/technical offices in Germany:	22
Beckhoff companies worldwide:	37 countries
Subsidiaries and distributors:	75 countries
Sales worldwide 2016	679 million € (+9.5 %)
Sales worldwide 2017	810 million € (+19 %)



as of: 04/2018

Components for Industrial Automation

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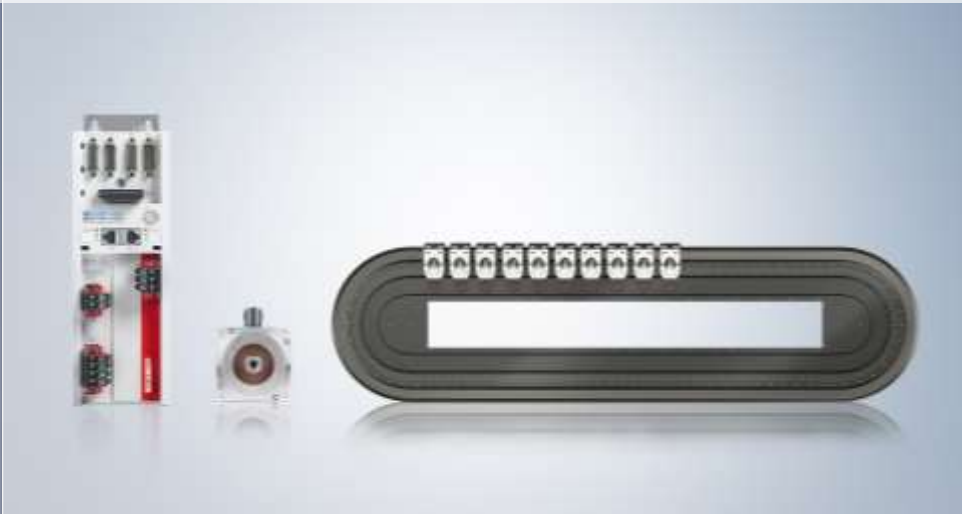
The IPC Company

The Automation Company

The I/O Company

The Motion Company



Germany

BECKHOFF

- Headquarters
- Office
- Development Center
- Sales Office
- New Offices 2017
- New Offices 2018
- Technical Office
- Production

Production in Verl

BECKHOFF

Worldwide

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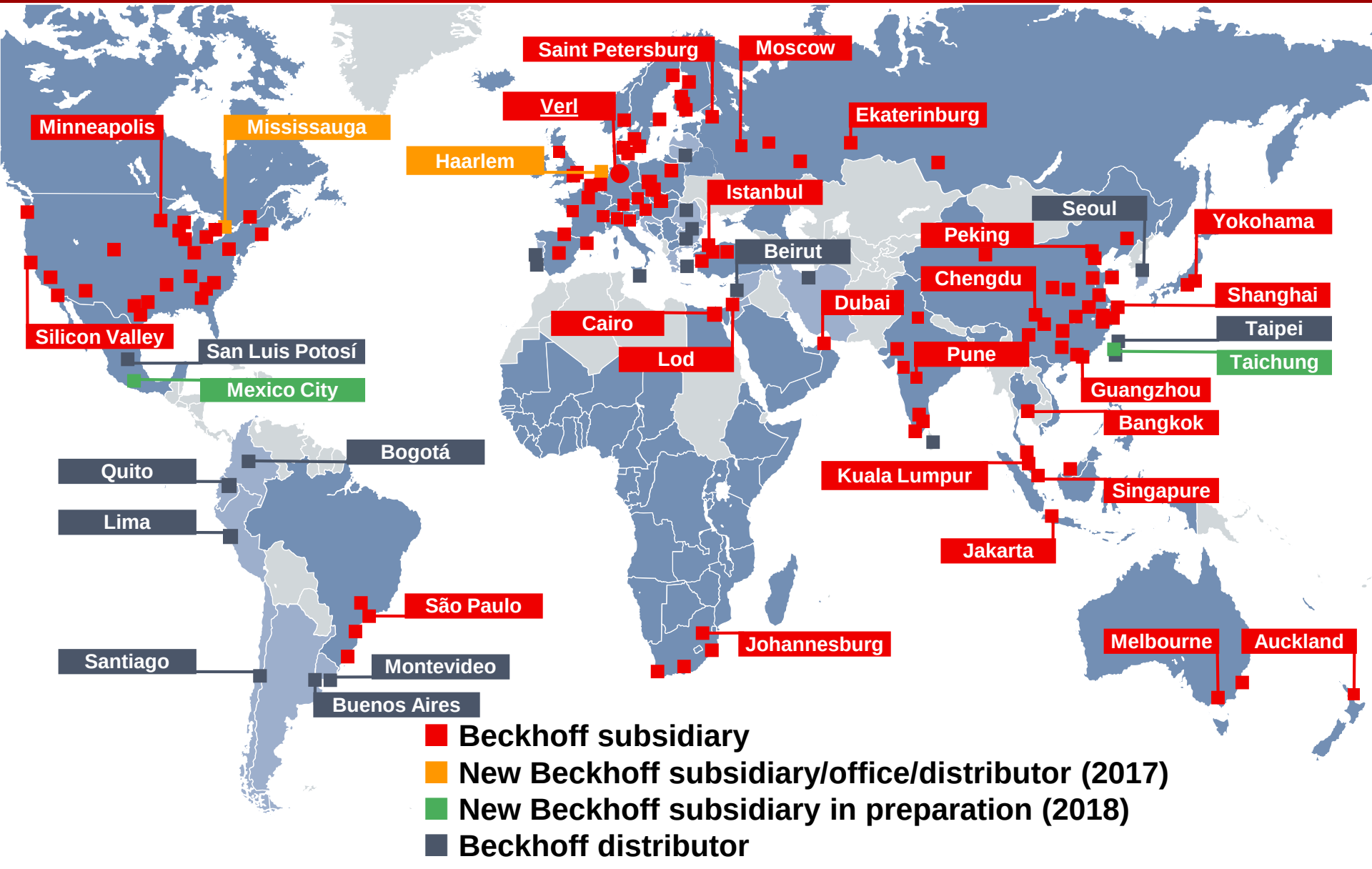


Applications and solutions

BECKHOFF

Semiconductor Manufacturing

Medical Engineering

Energy Industry

Wire | Cable | Pipe

End User

Food Industry

Transport | Logistics

Textile Industry

Machine Building

Applications and solutions

BECKHOFF

Water Treatment

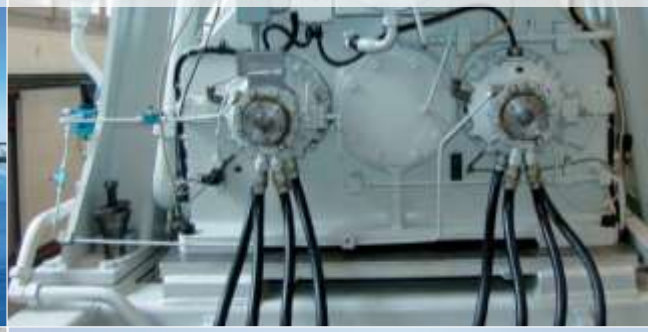
Photovoltaic

Automotive

Building Automation

Process Industry

Test Facilities



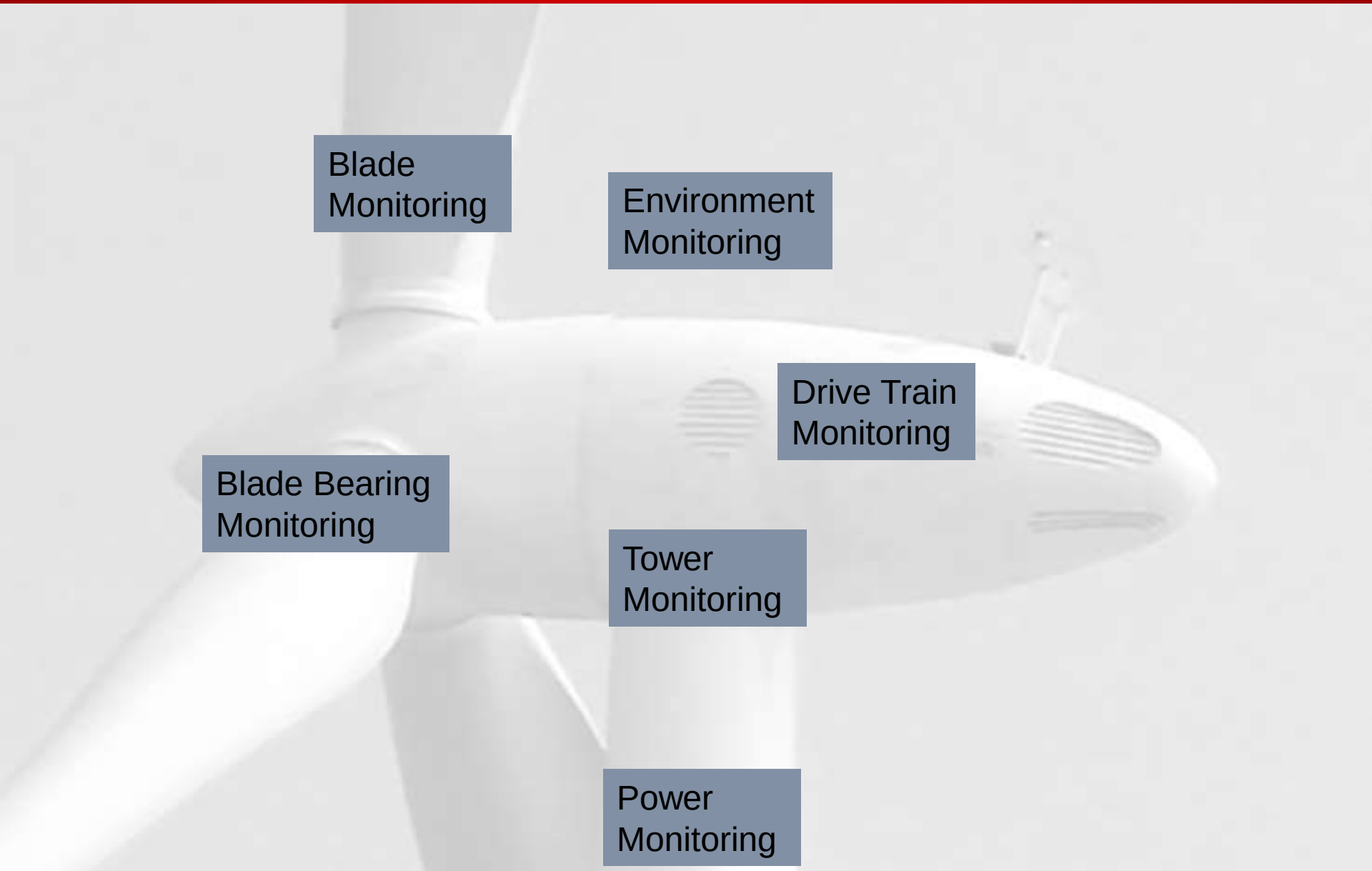
Shipbuilding

Stage Technology

Wind Turbines

Condition Monitoring | Current Situation

BECKHOFF



Condition Monitoring | Current Situation

BECKHOFF

- Black Boxes for each Monitoring Task
- Interface work for each device
- Each device contains own CPU and infrastructure components
- Each device needs additional Data like power, speed, windspeed etc.
- Measured values are not time synchronized
- Different data formats
- Data concentration (loss of data) in many devices
- Many different hardware suppliers
- High cost level

Condition Monitoring | Beckhoff Approach
1 Hardware, 1 Database, 1 Infrastructure

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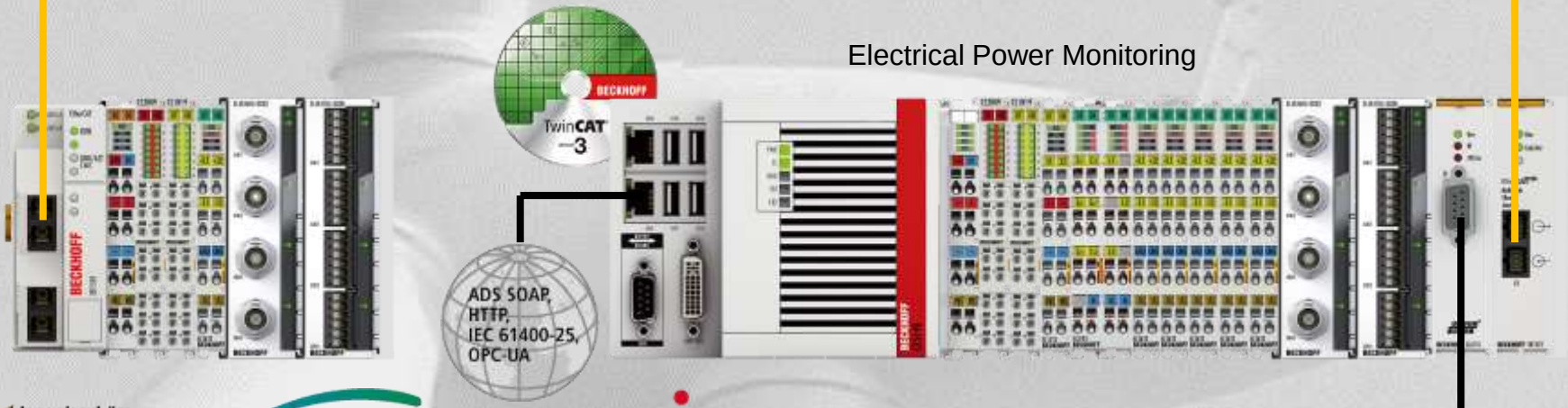
EtherCAT

Slipring



Electrical Power Monitoring

Ingenieurbüro Frey
Blade Monitoring

Wölfel
Blade Monitoring
Tower Monitoring

GfM
Drive Train Monitoring
Blade Bearing Monitoring

Interface to the WTC

Weidmüller
Blade Monitoring

8.2
Drive Train Monitoring

cms@wind
Drive Train Monitoring

Condition Monitoring | The Beckhoff Approach
1 Hardware, 1 Database, 1 Timebase, 1 Infrastructure

BECKHOFF

- One Hardware, one interface, one solution for all tasks
- Collection of all raw data
- All measured values are time synchronized << 1 µs
- All data could be stored in one data base
- Terminals for all relevant sensors are available
- Interfaces to the WTC are all available
- Power, speed, windspeed etc. are available for all tasks
- 3rd party software suppliers offer software for all monitoring tasks on a turbine
- Licensing for 3rd party software based on TwinCAT3 licensing
- Ability to integrate own measurement campaigns into the system

Condition Monitoring Integrated

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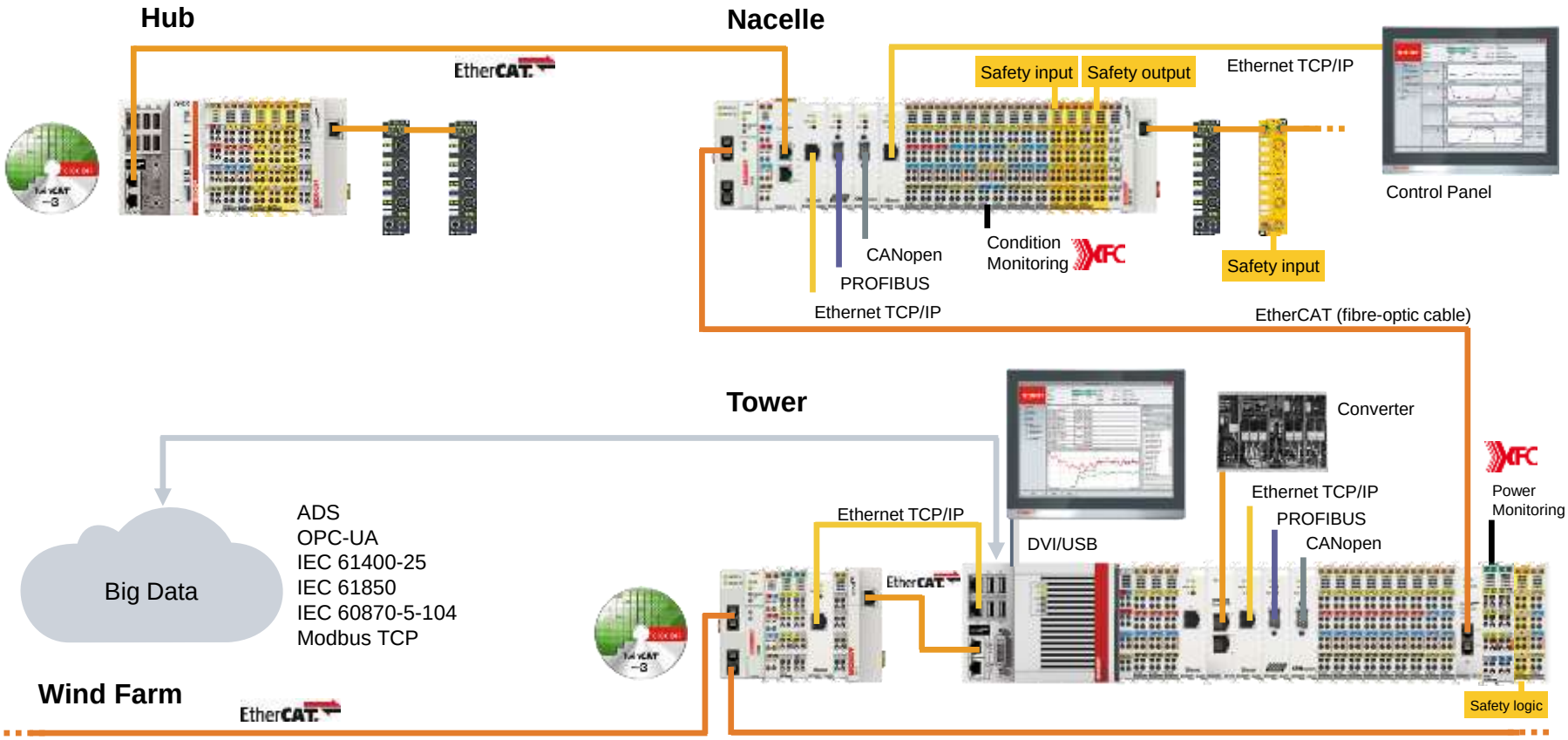
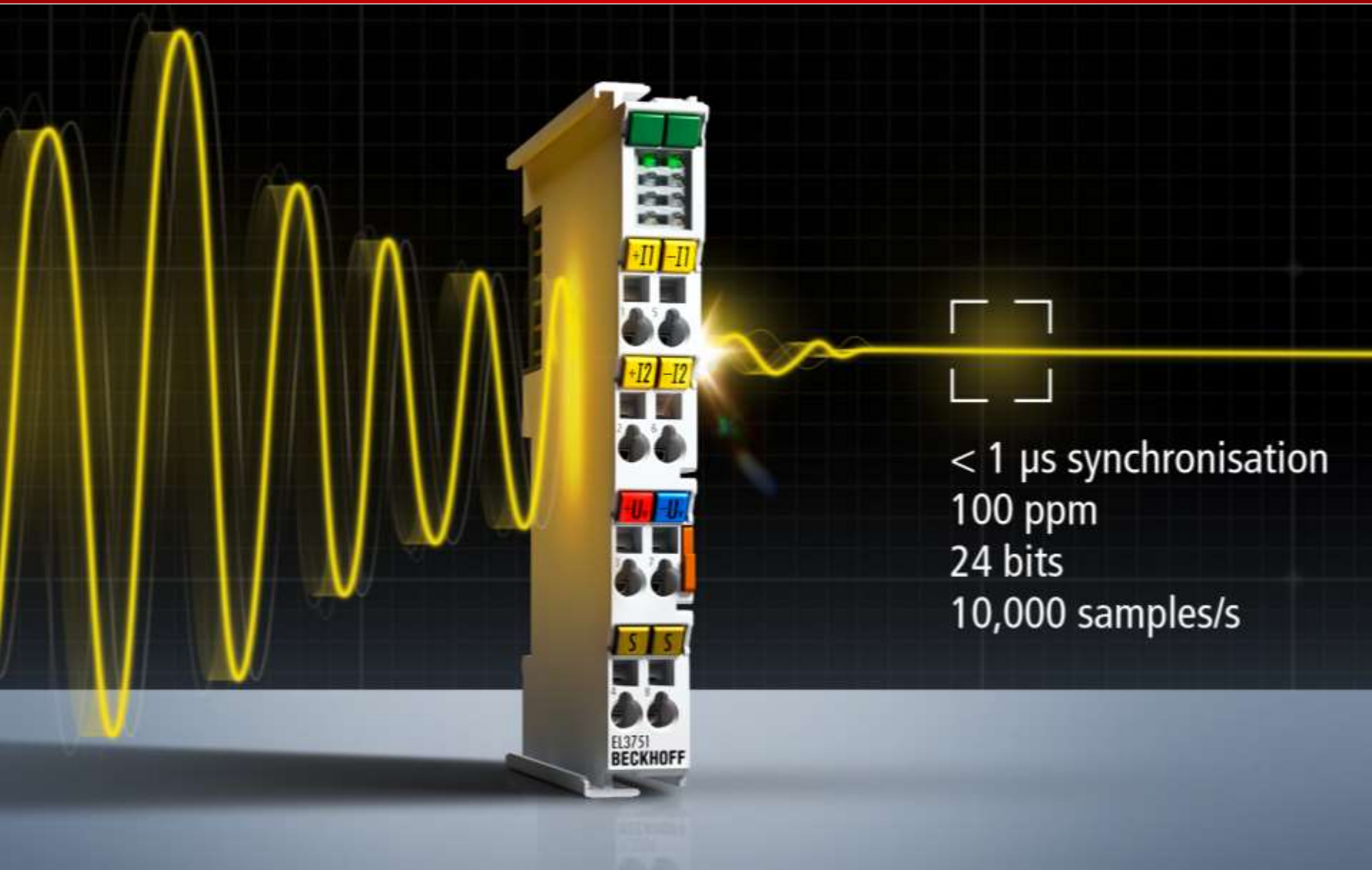


Measurement technology

BECKHOFF



EtherCAT Terminals
EL3751 | Analog multi-functional input, 24 bit

BECKHOFF

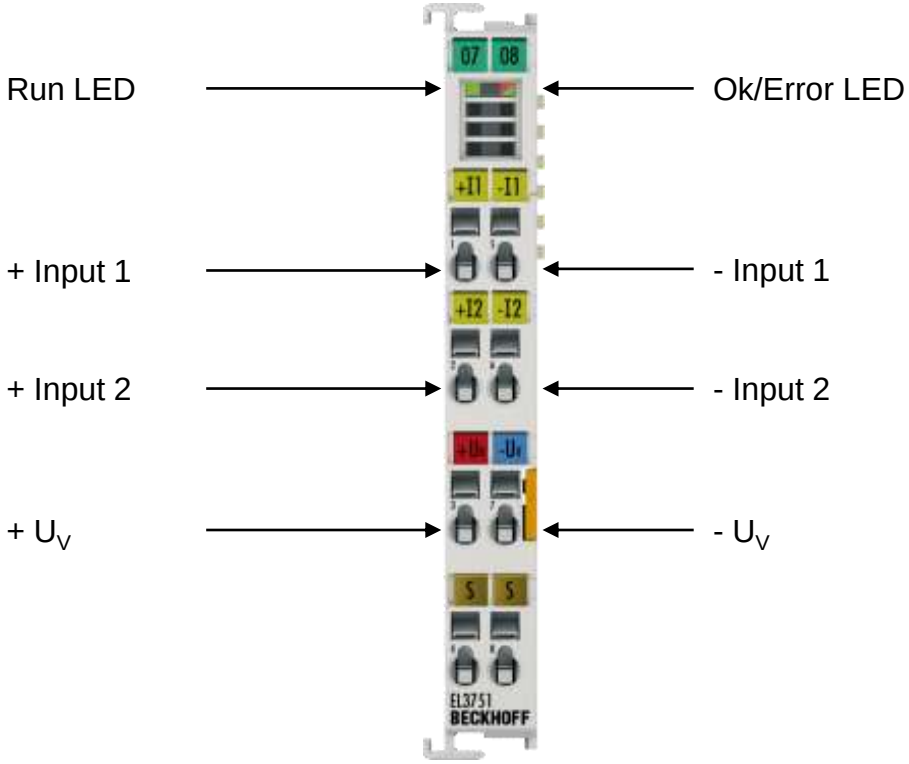
- 1-channel measurement terminal, parameterisable
  - voltage measurement
  - current measurement
  - resistance measurement
  - electrical resistance R in 2-/3-/4-wire connection
  - RTD measurement in 2-/3-/4-wire connection
  - strain gauge/load cell
    - ¼-bridge, ½-bridge or full bridge
  - potentiometer

EtherCAT Terminals
EL3751 | Analog multi-functional input, 24 bit

BECKHOFF

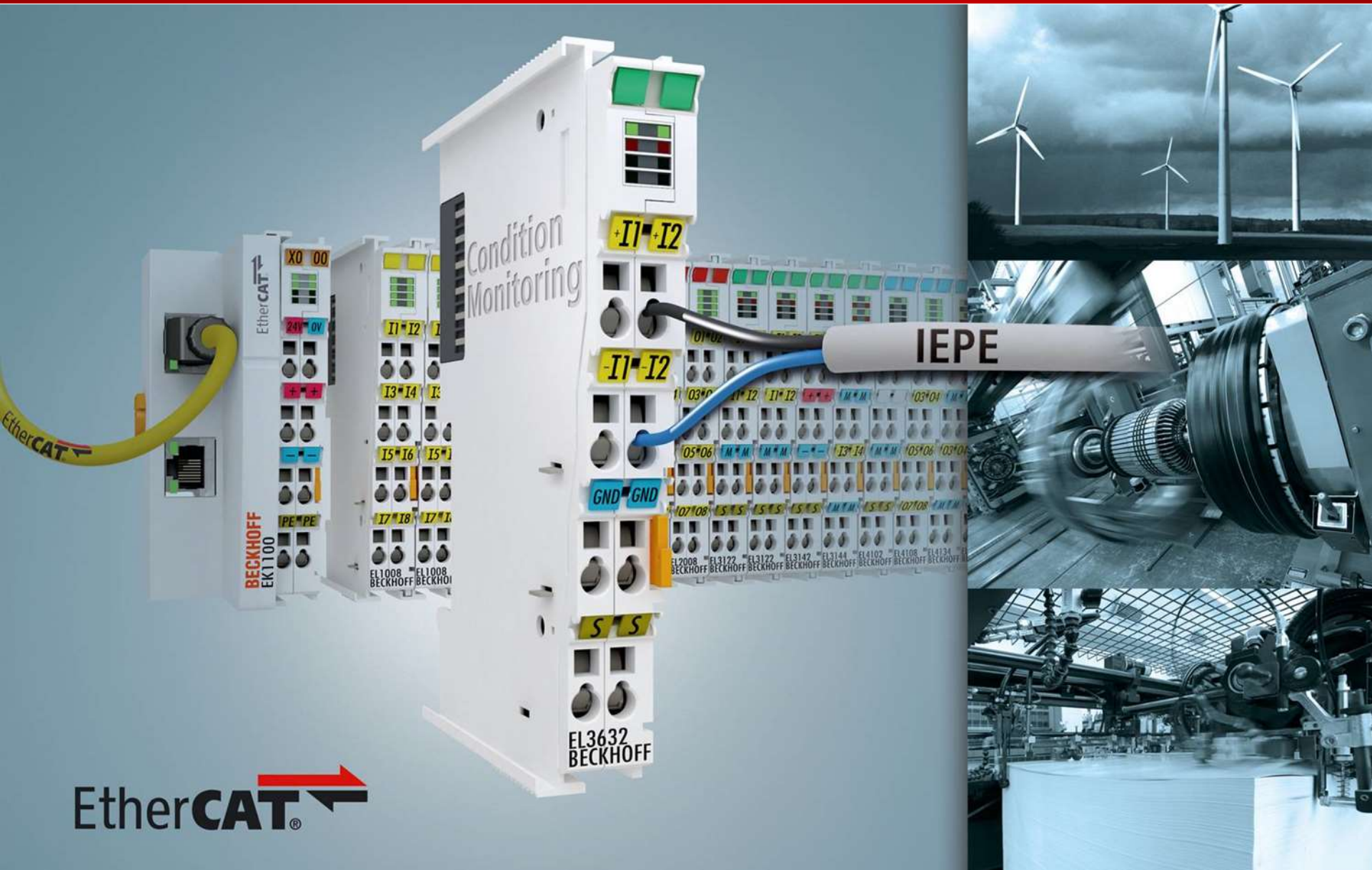
NEW

- differential input, 2-/3-/4-/5-/6-wire connection
- distributed clocks
- 10 ksps → oversampling possible
- free downsampling to 1 sps
- ExtendedRange 107 %
- measuring error in general ±0.01 % at 23 °C (±5 °C)
- 500 V electrical isolation



Vibration Monitoring with EL3632

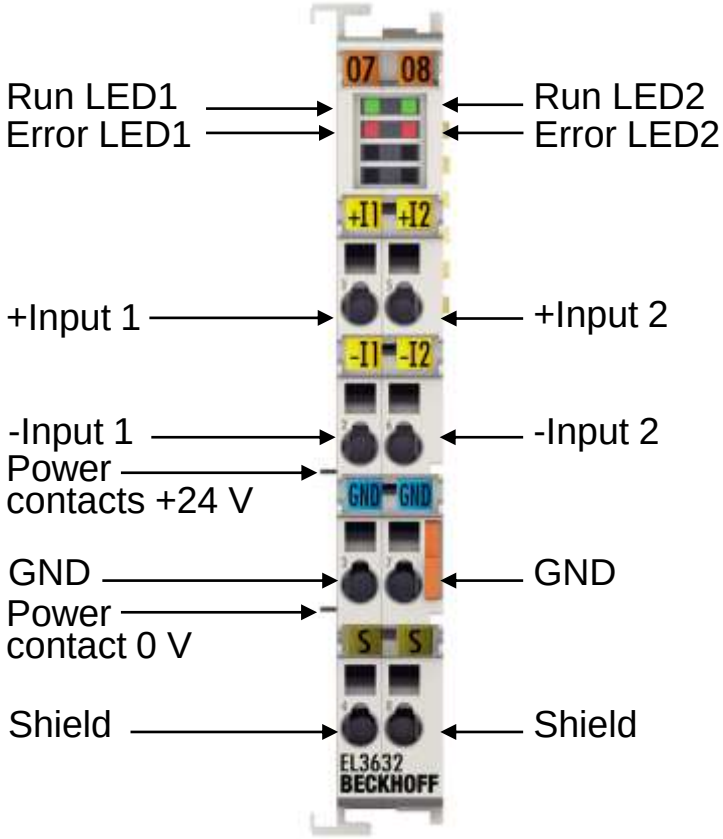
BECKHOFF



EtherCAT Terminals
EL3632 | 2-channel-analog-input terminal for CMS

BECKHOFF

- acceleration sensors with ICP / IEPE interfaces can be directly connected
- flexible and low-priced solution
- TwinCAT Lib is required for analysis or own analysis through the customer
- Max. sampling rate 40 kSamples/s
- Resolution 16 bit



Power Monitoring with EL3783

BECKHOFF

EL3783 | Very fast and precise Power Monitoring

BECKHOFF

- Power monitoring oversampling terminal for 690 V AC
- Measuring range: Nominal * ExtendedRange
  - 690 V (AC) * 130 %
  - 5 A (AC) * 130 %
  - 1 A (AC) * 650 % for detailed error case analysis
- Current and voltage measurement of each 3 channels with 20,000 samples per second and measuring error <0.2 %

Measurement technology

BECKHOFF

The new EtherCAT-Measurement-Modules: Very precise. Very fast. Very robust.

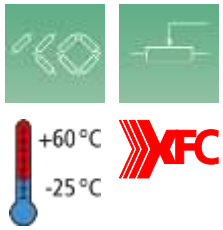
BECKHOFF

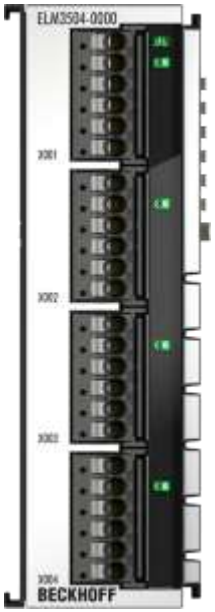
Fast:	Up to 50.000 samples/sec with 24 bit resolution
Precise in time:	exact Synchronisation < 1 µs by EtherCAT-Distributed-Clocks, systemintern and external to reference clock
Precise in value:	Accuracy of 100 ppm and better with high temperature stability
Proactive:	Integrated wire- and function diagnosis to have a long-lasting high operation reliability

ELM3504, ELM3502 | Measuring bridge analysis

BECKHOFF

- evaluation of measuring bridges in full-bridge, half-bridge, quarter-bridge configuration
- internally switchable supplementary resistors, integrated feed
- adjustment of supply voltage and other values in the CoE
- 6-pin push-in plug removable for maintenance purposes
- **ELM3504:** 4-channel, max. 100 µs/10 ksps
- **ELM3502:** 2-channel, max. 50 µs/20 kSps

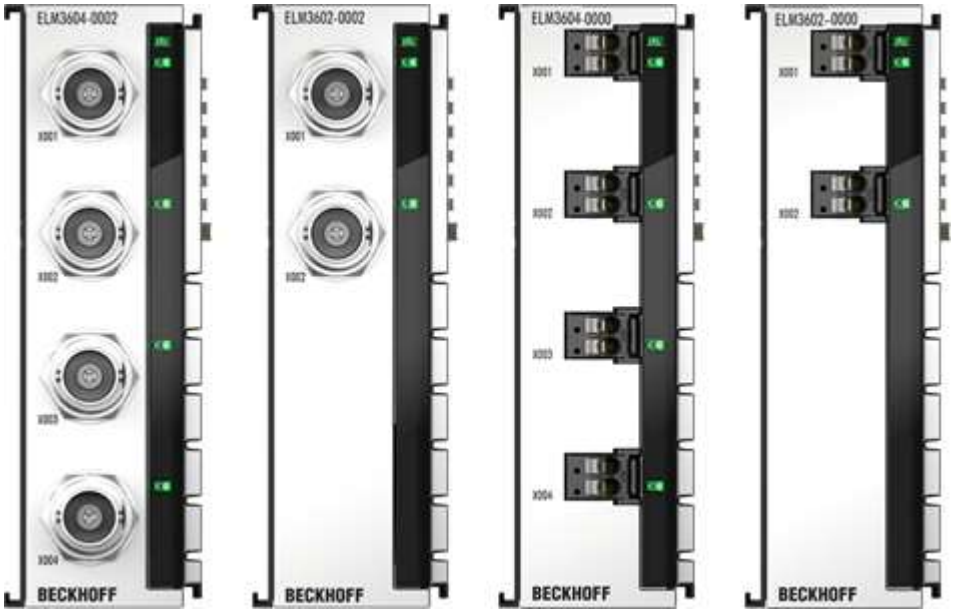


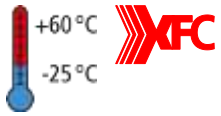


ELM3604, ELM3602 | IEPE analysis

BECKHOFF

- Measuring of
  - IEPE sensors (vibration diagnostics, acoustics)
  - Voltage AC/DC single ended (0..20V, ±10V …±20mV)
- 0/2/4 mA constant current feed and flexibly adjustable input characteristics from DC to 10 Hz
- internal scaler function: transform [V] → [m/s²] directly
- Connectors:
  - 0000: PushIn
  - 0002: BNC connector
- **ELM3604-000x:** 4-channel, max. 50 µs/20 ksps
- **ELM3602-000x:** 2-channel, max. 20 µs/50 ksps

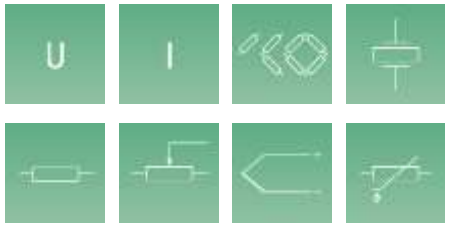


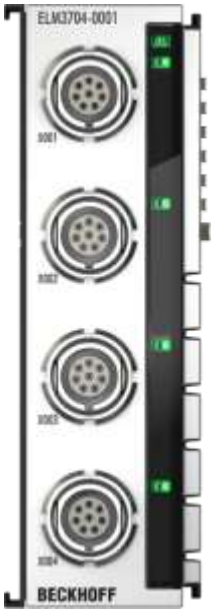


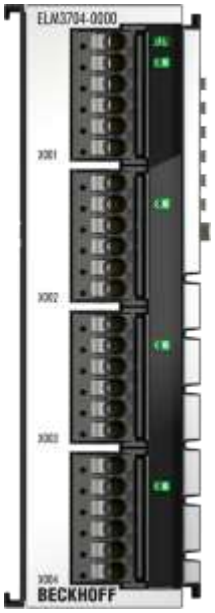
ELM3704, ELM3702 | Multi-functional input

BECKHOFF

- over 30 different types of electrical connections possible: ±30 V to ±20 mV, ±20 mA, full/ half/quarter bridge strain gauge, IEPE, thermocouple, RTD, all with a 2- to 6-wire connection, depending on the type
- **ELM3704-0001:** LEMO connector, for changing sensor configurations on a daily basis (e.g. laboratory use)
- **ELM3704/ELM3702:** 6-pin with push-in, fast wiring and less frequent unplugging for maintenance (for industrial use)







Measurement applications

BECKHOFF

- Where are EL3xxx, ELM3xxx in use?

GfM Gesellschaft für Maschinendiagnose mbH, Germany | Vibration diagnostics solution

BECKHOFF

Automation

- TwinCAT PLC

IPC

- CX5020 Embedded PC

I/O

- EtherCAT
- EL3632 Condition Monitoring terminals
- Further EtherCAT Terminals, e.g.: EL5151 incremental encoder interface, EL3202-0010 PT100 input terminal and EL3702, EL3742, EL3356-0010 XFC terminals

8.2 Monitoring GmbH, Germany
Condition Monitoring system

BECKHOFF

IPC

- Embedded PC CX5000

I/O

- XFC Terminals
- EtherCAT Condition Monitoring terminal EL3632

Automation

- TwinCAT PLC

Fraunhofer IWES Northwest, Germany
Test bench system for wind turbines

BECKHOFF

Automation

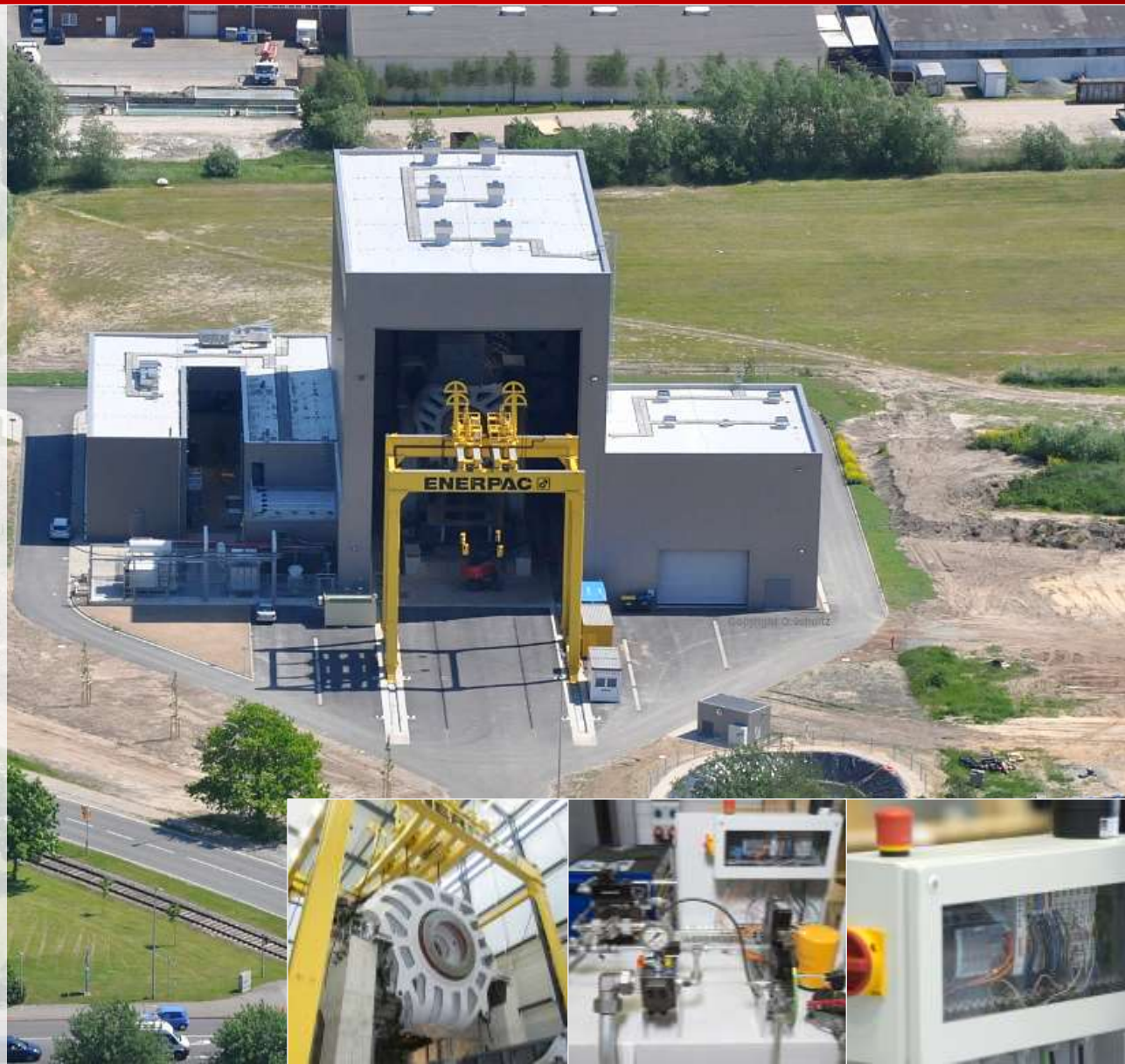
- TwinCAT 3 PLC, Scope View Professional, Scope Server, XML Server, Database Server, TC3 Interface for MATLAB®/Simulink® a. o.

IPC

- Two 19-inch C5102 slide-in IPCs
- CX5010 Embedded PC

I/O

- EtherCAT
- EtherCAT and TwinSAFE terminals



Measuring in the Beckhoff universe

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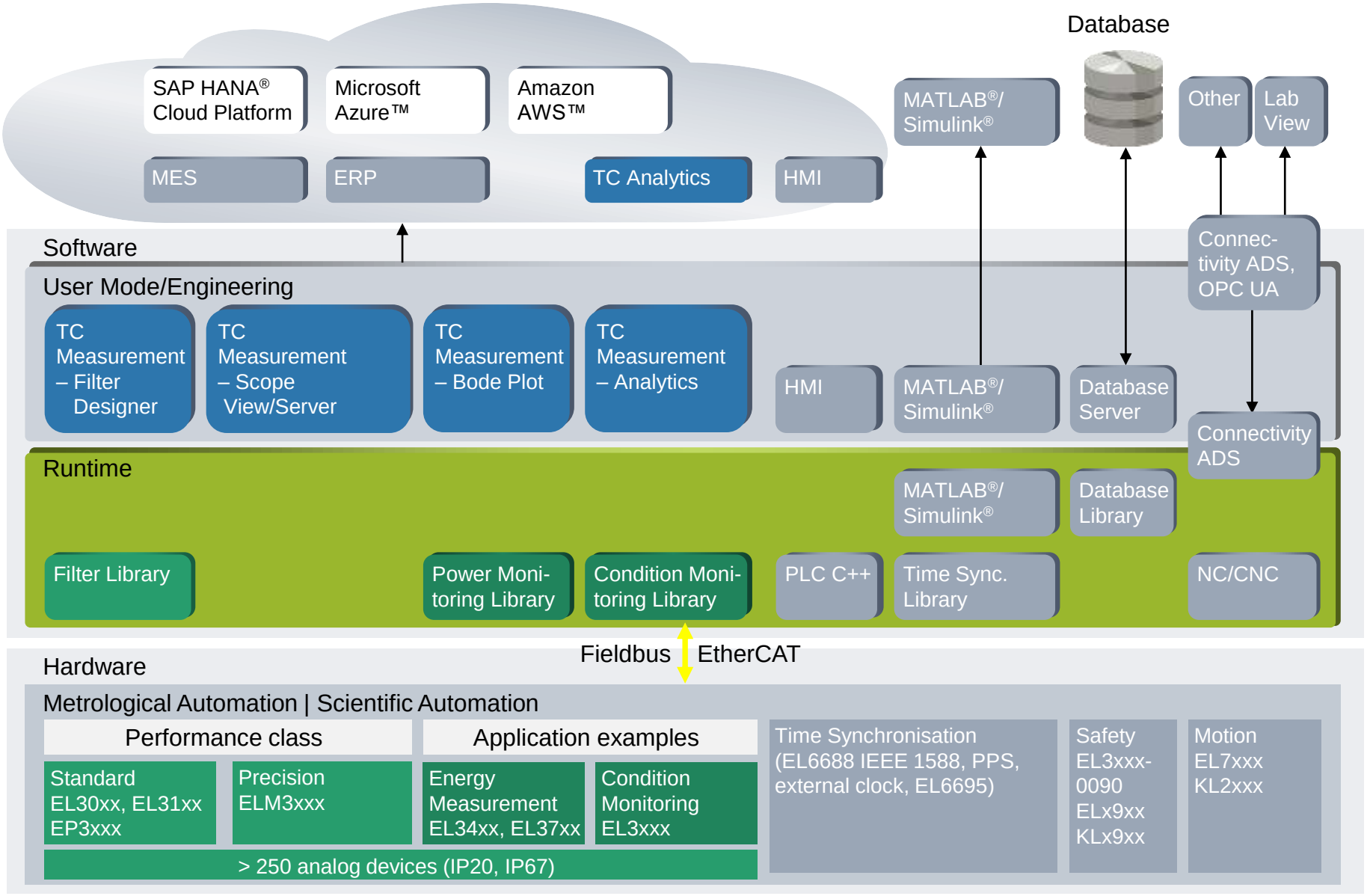


Scenario: new business models with data analytics

BECKHOFF

Service technician (location-independent)

Machine builder (location-independent)

IPC/VM

Dashboard

MQTT

MQTT

TwinCAT Analytics Storage Provider

Storage

Message Broker

MQTT

MQTT

MQTT

Machine Control Customer 1

Machine Control Customer 2

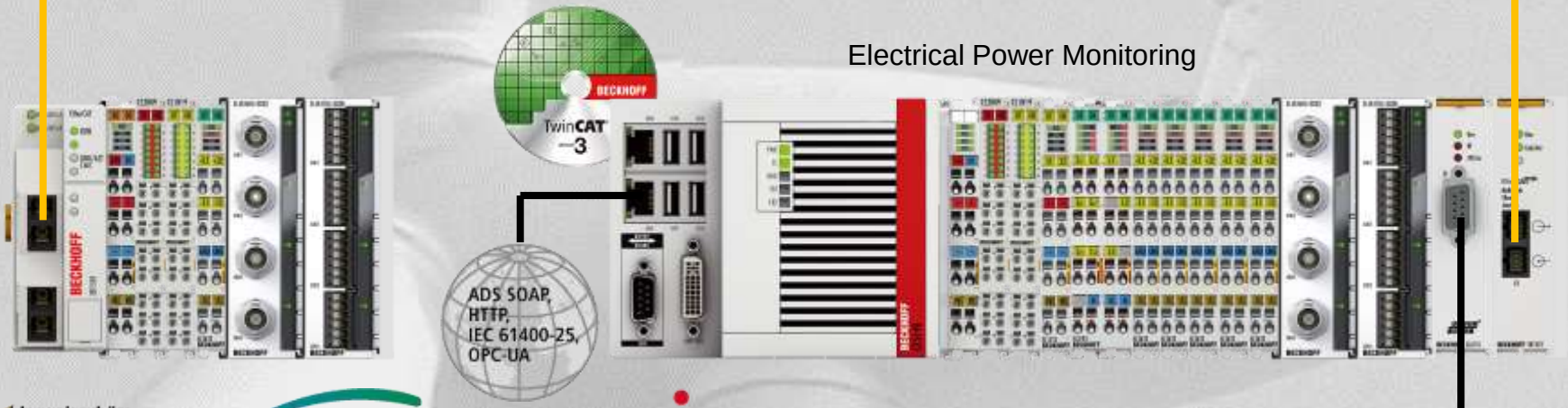
Machine Control Customer n

Condition Monitoring | The Beckhoff Approach
1 Hardware, 1 Database, 1 Timebase, 1 Infrastructure

BECKHOFF

EtherCAT

Slipring



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Thanks!

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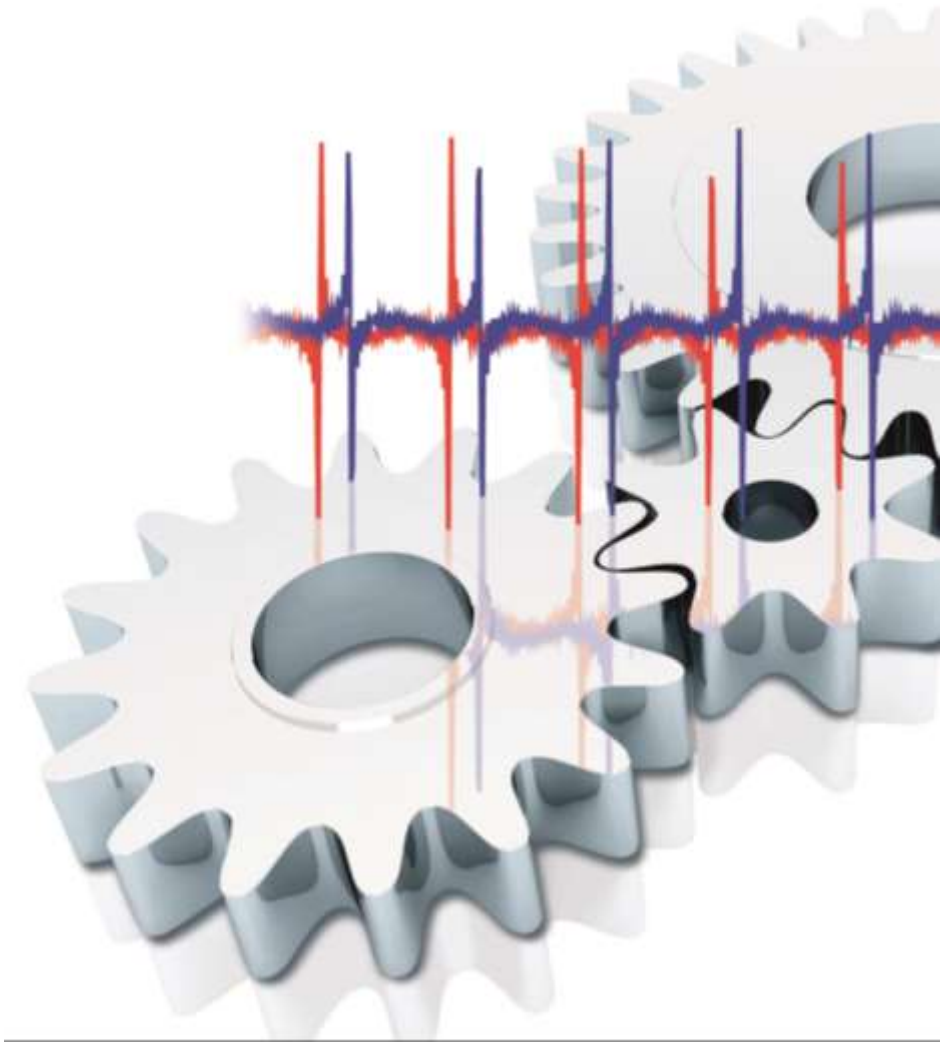

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