Welcome to the webinar
“From Sensor to Industrial Automation in the Digitalized World”

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Michael Guckes

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Topics:

- Tasks of modern control technology
- What benefits does high-quality measurement technology provide?
- How do Smart Functions help in testing and production technology?
- Modern automation concepts, efficient diagnosis & application examples
- Future development – “Smart factory”

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Use cases and range of applications

- Manufacturing Monitoring, Test Rigs, Functional Test Stands, Condition Monitoring
- Absolute cost control through integrated systems and functionality according to IOT – Internet of things

Assembly

Metal working

Machine control

Functionality testing

Energy production

Medical production

Functional test stands

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Industrial environments include three factors:
quality, time and cost

What users need:

- Simple integration into the system components
- Precise and electrical robust operation
- Easy handling
- Comprehensive, preventive diagnostics, easy maintenance
- High system availability

Megatrends:

- Shorter and shorter product life cycles
- Increasing IT networking
- Demographic change

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Performance in required application areas

Metal working

Production monitoring applications

- Production monitoring
- Condition monitoring
- “Effective” Installation
- High precision 0.1% to 0.05%; 24bit resolution, 38.4kHz sample rate, 3kHz bandwidth/channel,
- 32 virtual channels
- 4 to 16 meas- I/O-channels
- Fieldbus-integration
- Analog, digital I/O-signals

End-of-line testing applications

- Production-related functional tests
- Testing of 4 up to 500 channels via additional integrated CAN-Field-modules

Industrial test-rig applications

- Fix installed, but modular test rigs for product development
- With definite flexibility PLC controlled or via internal Soft-PLC

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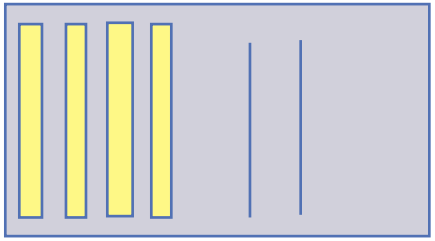
Amplifier- evaluation platform- and automation concepts

Automation solutions

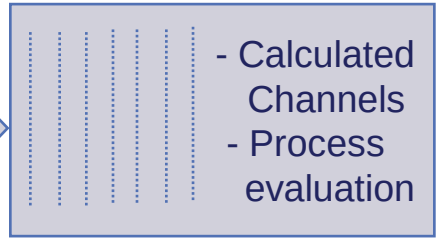
User-specific software
a.) **Soft PLC** as standard product
b.) As service by HBM
c.) By the customer
(know-how protection)

Digital analog interface

Advanced front-end evaluation criteria



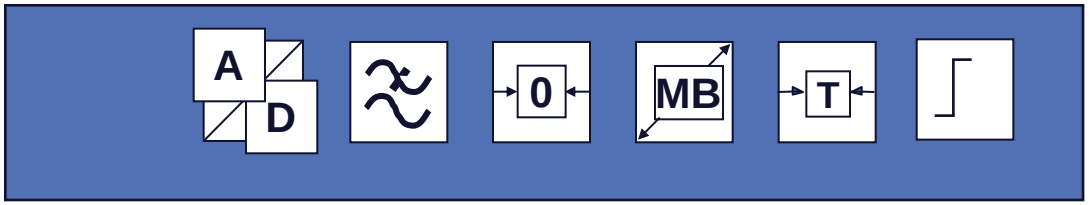
Math. calc



- Calculated Channels
- Process evaluation

Digital analog interface

Front-end (measuring channels)



Digital analog interface

Standard channels

Option: type upon request

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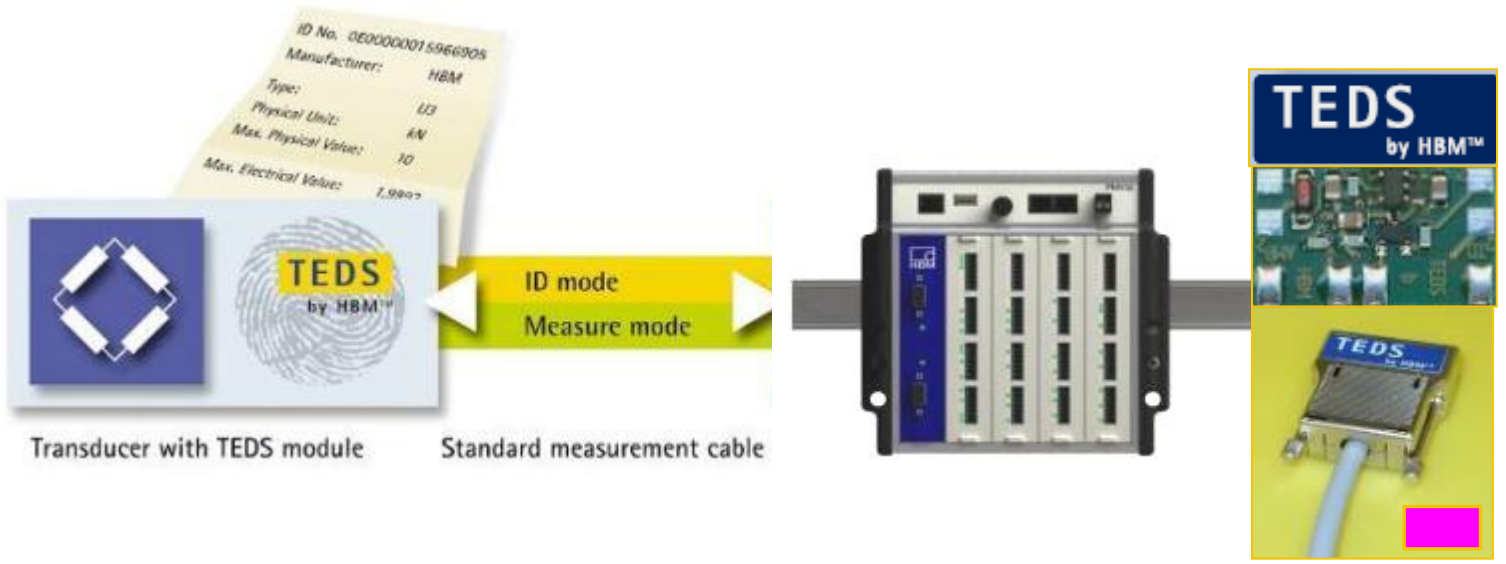
TEDS – Immediate usage of the measuring sensors (plug&measure)



- TEDS = Transducer Electronic Data Sheet (IEEE1451.4)
- No manual adjustments of the sensor data and amplifier data necessary !!!
- Readout of TEDS-data via existing sensor cables
  (no additional cables necessary) (0-Wire / 1-Wire)
  - ➔ Cable and plugs can be used as usual

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Documented quality

Calibration certificate for each measuring channel / board

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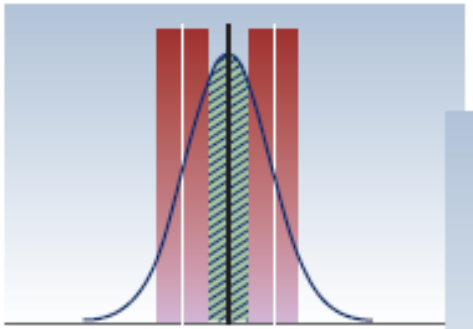
High system availability

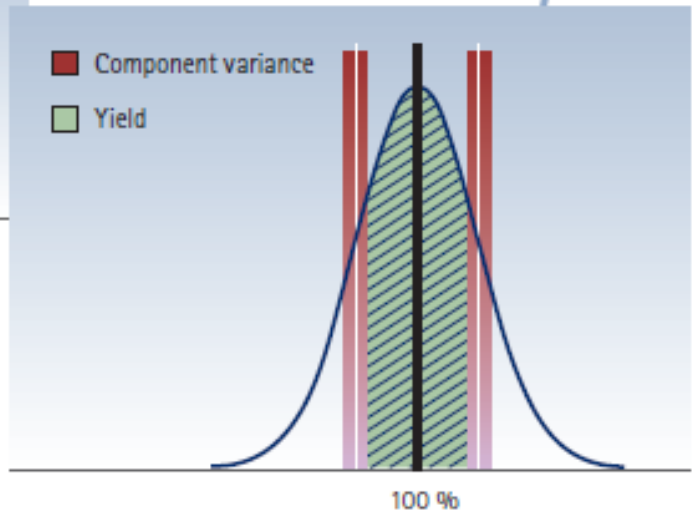
- Greater accuracy makes it possible to record manufacturing tolerances more precisely.
- Components are precisely tested and manufactured with the necessary tolerance.
- Reduces rejects and conserves resources while maximizing output.

...without



Process monitoring with conventional measuring amplifiers, high rejection rate due to measuring inaccuracies

... with



Increased efficiency with PMX, optimum yield with precise measurement results

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Design concept – Flexibility for the application

Hardware

- Flexible slots for sensor, analog output, digital I/O and interface modules
- Slot for communication & bus interfaces
- Housing with Ethernet, USB host, Synchronization, CAN master/ slave (opt.)
- The slots are equipped as specified by the customer
- Cards can be removed for service
- Card are calibrated, no recalibration in the field necessary

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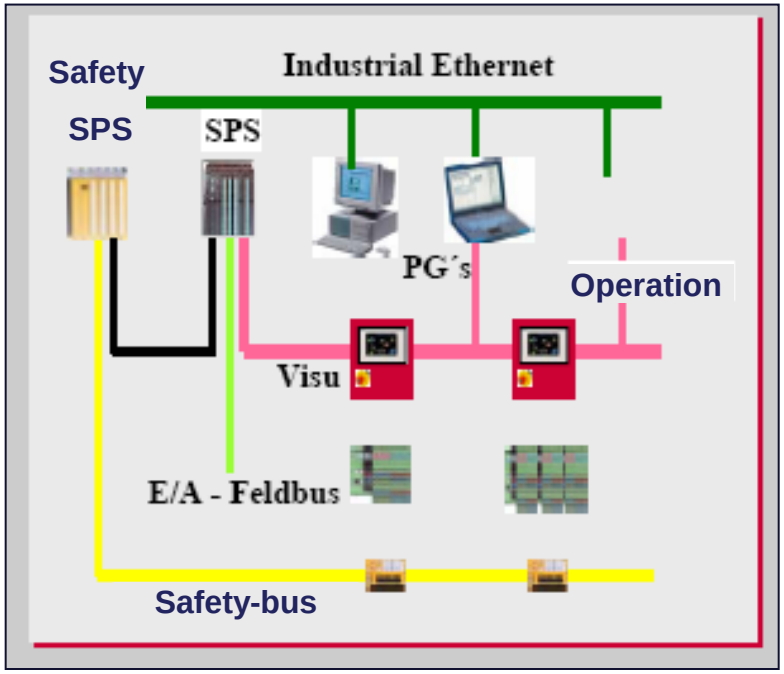
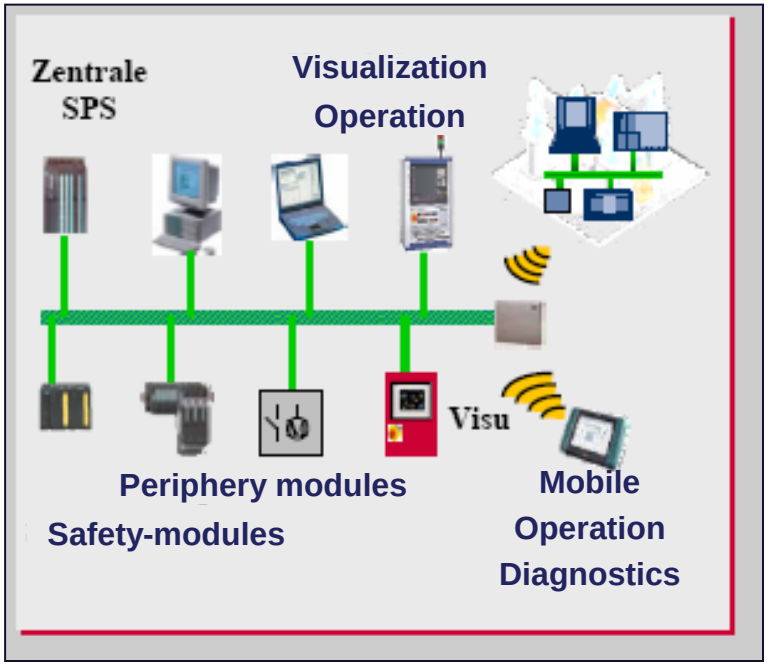
Network integration

Old structure



New structure



Standardization through consistent network structure

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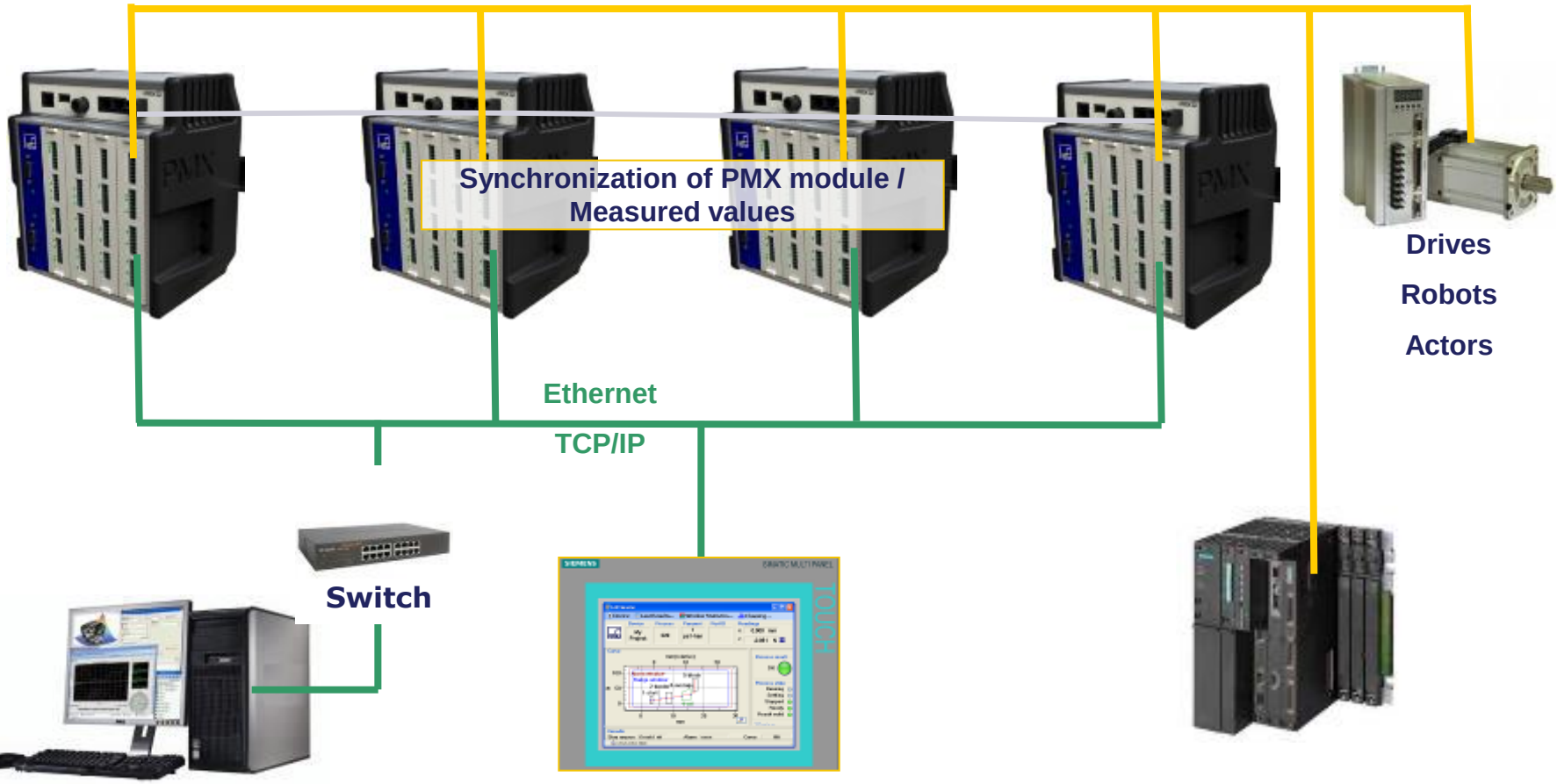
Automation in industrial test-rig applications



Important multi-client capabilities

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Innovative Web Technologies

Flexible and cost-saving

Whether you are a machine operator or installer, configurable, three-level user administration (operator, service, administrator) always gives you access to all relevant device and diagnostic data. This cuts down on the number of software tools you need and reduces complexity and system faults.

Easy integration with the control system

HBM measurement technology can be easily integrated with the control system and test bench environment using various software drivers, the PMX command set, LabVIEW and the .NET/API programming interface. That makes it easy to implement individual solutions and safeguard application know-how.

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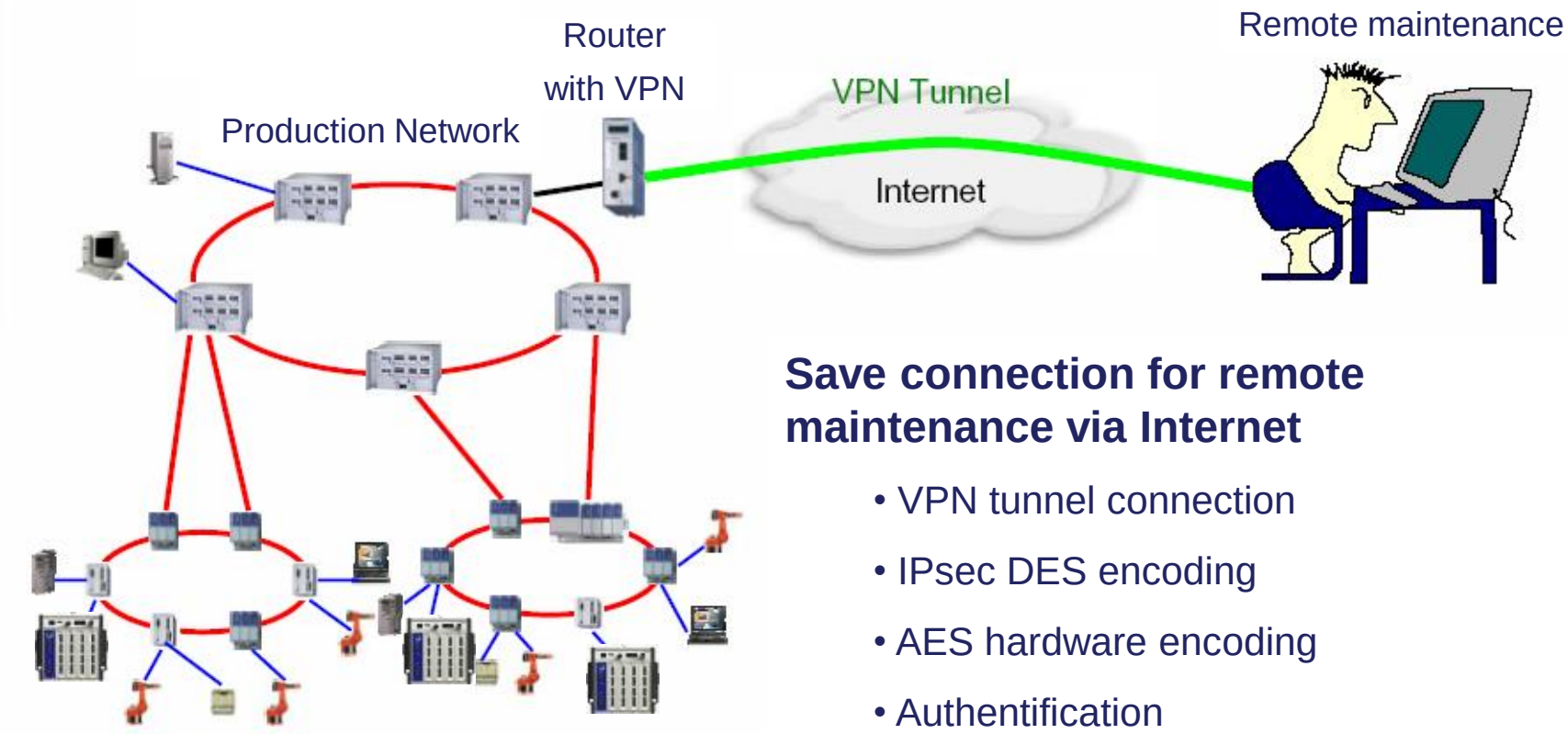
Remote maintenance and diagnostics



Save connection for remote maintenance via Internet

- VPN tunnel connection
- IPsec DES encoding
- AES hardware encoding
- Authentification

- Support of local service
- Saves time and money (reduces travelling times)
- Enables additional benefit with predicted maintenance

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Remote maintenance and diagnostics

Live-Demo available around the world

PMX live in the internet:
http://pmxdemo.hbm.com

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Diagnostics and preventive maintenance

- Display on the device locally: per channel and device
  - Supply voltage measurements, digital I / O, fieldbus
  - Synchronization, reading buffer
- Defined states of the signal outputs when powering on
- Defined states of the signal outputs in the event of an error (for example, cable breakage)
- Selection of static and test signals (Setup & Service)
- Signal generators and dynamic test signals (component tests)
- User levels with configurable user rights
- Easy visualization of fault conditions and device utilization
- Transmission error of all available interfaces:
  - Digital I / O, fieldbus, API software
- Device internal error memory (log file)
- Device internal line recorder

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Measure, evaluate and automate (Smart functions)

Modern automation systems offer: precise & robust measurement, control- & evaluation functions in real-time and easy-to-use setup and operation without software knowledge

Measurement

PMX detects your transducers automatically via TEDS for the most important measurement variables.

This saves time and prevents errors. The high resolution of 24 bits allows for accurate partial load measurements and high measuring bandwidths. A sampling rate of 19.2 kHz or 38.6 kHz for frequency measurements for every channel ensures high measuring bandwidths.

- SG full bridges
- SG half bridges
- Inductive full bridges
- Inductive half bridges
- Active sensors for current and voltage
- LVDTs
- Potentiometric sensors
- Piezoresistive sensors
- Current-fed piezoelectric sensors (IEPE)
- Frequency signals
- Angular/incremental encoders
- SSI sensors
- PWM sensors
- Magnetic transducers
- Pulse counters

Evaluation

PMX analyzes and processes your data in real time (< 1 millisecond).

The measuring amplifier system has integrated algorithms to support the actual measurement and pre-process data. 32 computing channels are available. That replaces small and mid-size machine control units and saves a tidy sum of money.

Scaling

- Two-point scaling
- Characteristic curve table
- Polynomials
- Taring
- 3x3 matrix
- Cartesian to polar coordinates
- SG stress analysis
- Dead time

Technology functions

- Two-point controllers
- PID controllers
- Signal generators (square, triangle and sine wave)
- Logic blocks (AND, OR, etc.)
- Edge detectors
- Timers
- CODESYS channel

Mathematical functions

- Adder
- Multiplier
- Divider
- Multiplexer 2:1
- Pulse width measurement
- Counter
- Integrator
- Differentiator
- Modulo function
- Constant signal

Evaluation functions

- Angle-synchronous filter
- Peak values
- Hold function (triggerable)
- Mean values (arithmetic, RMS)
- Trigger function (range, pulse)

Automation

PMX transfers data to your automation system.

Ethernet-based fieldbuses and Soft-PLC as well as digital inputs/outputs and monitoring outputs ensure fast machine control and automation.

- EtherCAT
- ProfiNET
- Ethernet/IP
- CODESYS
- CANopen (1 Mbit/s)
- Fast Ethernet (100 MBit/s)
- Digital inputs
- Digital outputs
- Analog output: voltage

Machine control test bench

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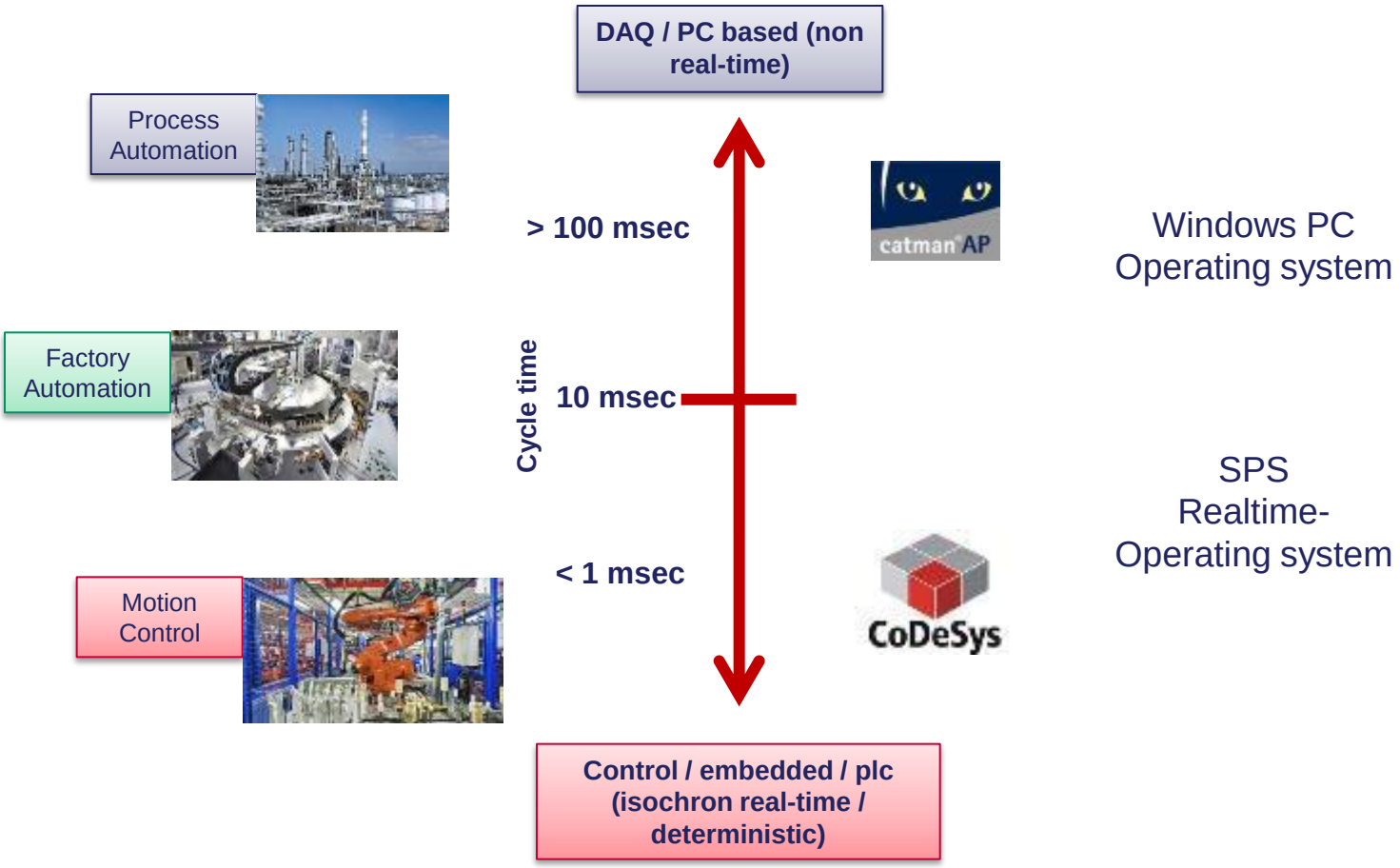
Segmentation Software vs Control functions

- PC-application for DAQ (easy and ready to measure)
- .NET/ LabVIEW: PC-application for Non-Real-Time applications
- LabView Real-Time: Runs in NI-hardware for Real-Time applications
- PLC/ Codesys: Runs in hardware for Real-Time and Control applications



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User interface and software solutions

User interface / Software modules

Web Server

Catman®Easy

dotNET-API

LabView® DIAdem

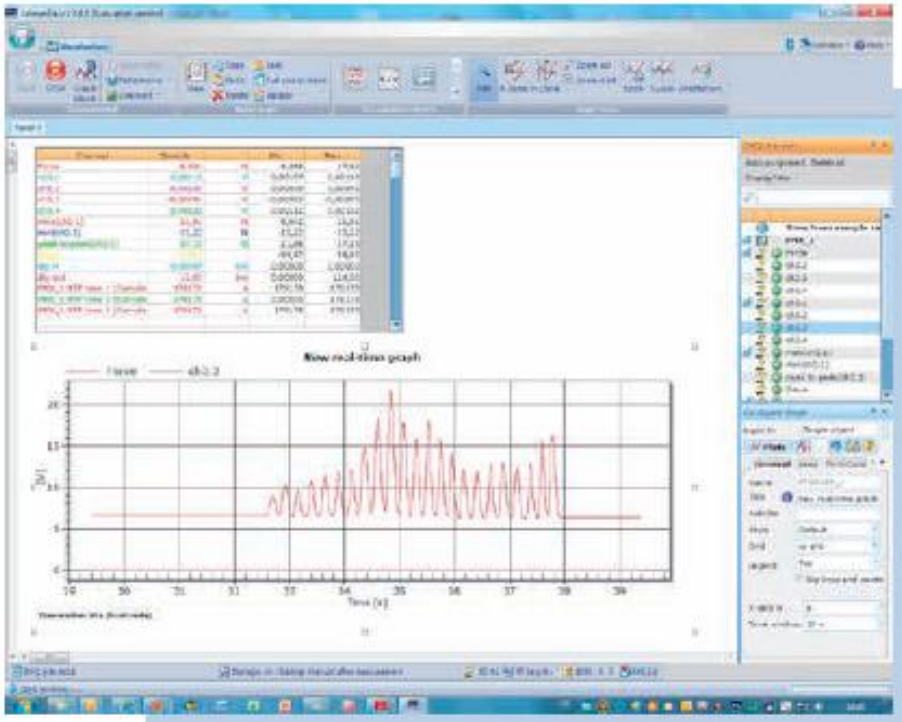
Soft-plc CoDeSys

Control/WebVisu PC/Win Driver .NET / LV Control/WebVisual

PMX

Operating System + Applications

PC based data analysis (also setup, service and documentation)



- Professional software for visualization, storage and analysis of PMX measurement data, internal PMX computing channels and digital inputs/outputs
- Easy PMX system and channel configuration (sensor database, TEDS editor, sampling rate, filter, etc.)
- Start recording measured values via PMX digital inputs (pre/post trigger, cyclic storage, long duration measurement, etc.)
- Powerful data analysis (signal-to-signal, zoom, magnifying glass, ruler, min/max, cut to size, eliminate outliers, etc.)
- Create reports and export measurement data and displays automatically (to Microsoft Word, Excel)

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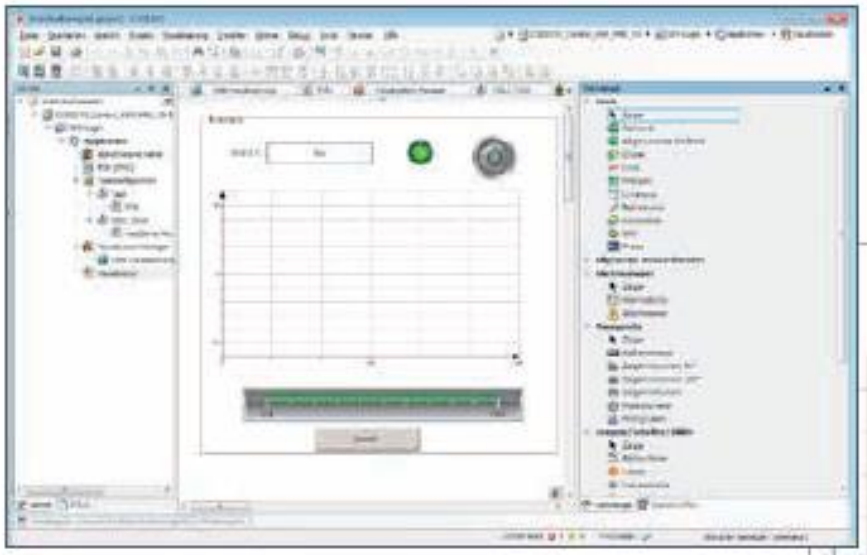
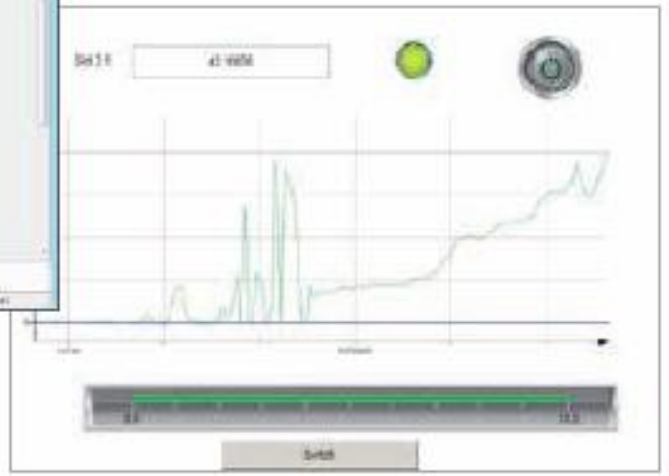
Customized automation solutions designed acc. IEC61131



CODESYS programming environment



CODESYS web visualization

CODESYS engineering

Professional engineering from IEC 61131-3 applications for specialists and software engineers – from ladder diagram to UML in one expandable platform.

CODESYS visualization

Creation of professional visualization interfaces, fully integrated into the PLC programming system. Display on the target device, on a PC or in the web browser.

CODESYS fieldbus

Integrated fieldbus support in the IEC 61131-3 tool (i.e. the CANopen interface is supported in PMX). You can receive CAN data (CAN master) or send CAN data (SDO/PDO mode).

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Customized web-based machine visualisation and operation

CODESYS web and target visualization via Ethernet

Process control through on-site web visualization

PMX, the modular CODESYS PLC controller with integrated visualization

Wi Fi

Simple remote maintenance with smart phone and micro or HTML5 browser

Transparent monitoring from plant control room or machine PC

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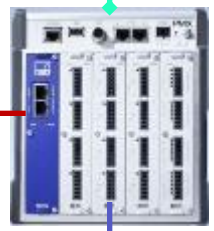
Functional testing – automated workpiece control

Ethernet (TCP/IP)

PLC control

Industrial Ethernet I/O´s

Analog out



OPC-server

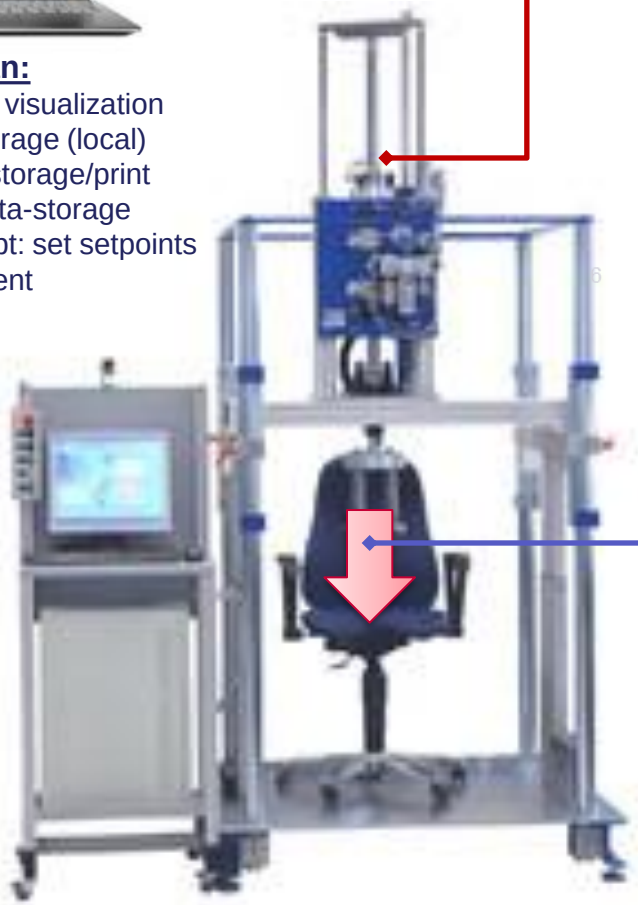
CoDeSys

PC / Catman:

- Process visualization
- Data storage (local)
- Report storage/print
- SQL/ data-storage
- Cat-script: set setpoints
- OPC-client

Control/ Real-time:

- Start/ Stop
- Speed
- Run Test curves
- Error controls:
  - Machine
  - PMX
  - User handling
- Start/stop store meas. curves



Sensors: force, displacement,torque…

PMX:

- Real-time meas.each channel
- Peak-meas.(50µs)
- Limit-evaluation (50µs)
- Tolerance-band evaluation
- Mechanical-work calculation
- OK / NOK-Counters
- Self-control functions
- Signalization

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From component testing to production monitoring

- Real-time data and control results
- Measurement and process data storage for quality assurance
- Diagnostic functions for safe operation and effective service

Test stand for gear boxes

- Power measurement and quality control of gear boxes
- Measured values: Torque, Rotational speed, angle of rotation, pressure, temperature
- Real-time condition-monitoring in a test cell and real-time automation via industrial Ethernet
- PC Data logging of row-measurement-data, real-time calculations on site for evaluation
- Customer benefits: end-of-line test with improved Quality control, modern interfaces, easy-to-use PMX WebBrowser

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Why Calculated Channels ?

- In industrial settings, different types of **automation provide benefits** to companies including decreased part-cycle times, higher quality products, and increased worker safety.

- A lot of **applications require additional signals/ information and calculations** coming from the measuring signal .e.g.: Peak, Mean, RMS, filters, math. logic functions, sample-hold, timer, counter, PID regulator,..

- **PMX** generates this signals/ information in **Real-Time. Calculated channels** run as fast as measuring channels. They are **sampled with 19.2kHz.**

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general use – not public

PMX Calculated channels (Smart functions)

Browser dialog – all 32 calculated channels in one view

PMX LIVE on Internet : pmxdemo.hbm.com

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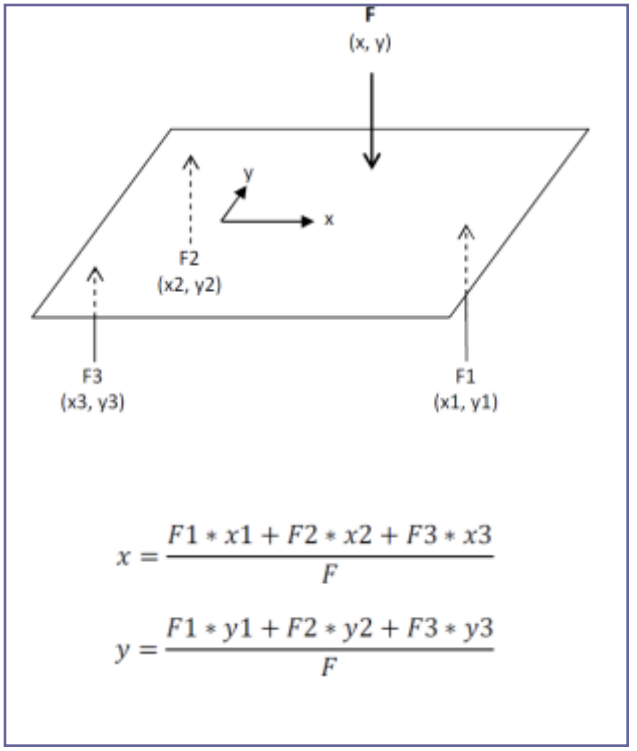
HBM: public

Application – Pressload monitoring – Inline measurement

- Controlling Press Capacity



$$x = \frac{F1 * x1 + F2 * x2 + F3 * x3}{F}$$

$$y = \frac{F1 * y1 + F2 * y2 + F3 * y3}{F}$$

Industry compliant measurement technology:

- SLB700 Strain sensors measuring bending on each column
- 2 sensors per column:
  - mounted in opposite position, allow bending compensation of column
  - force measurement on 2 or 4 columns allow load-distribution

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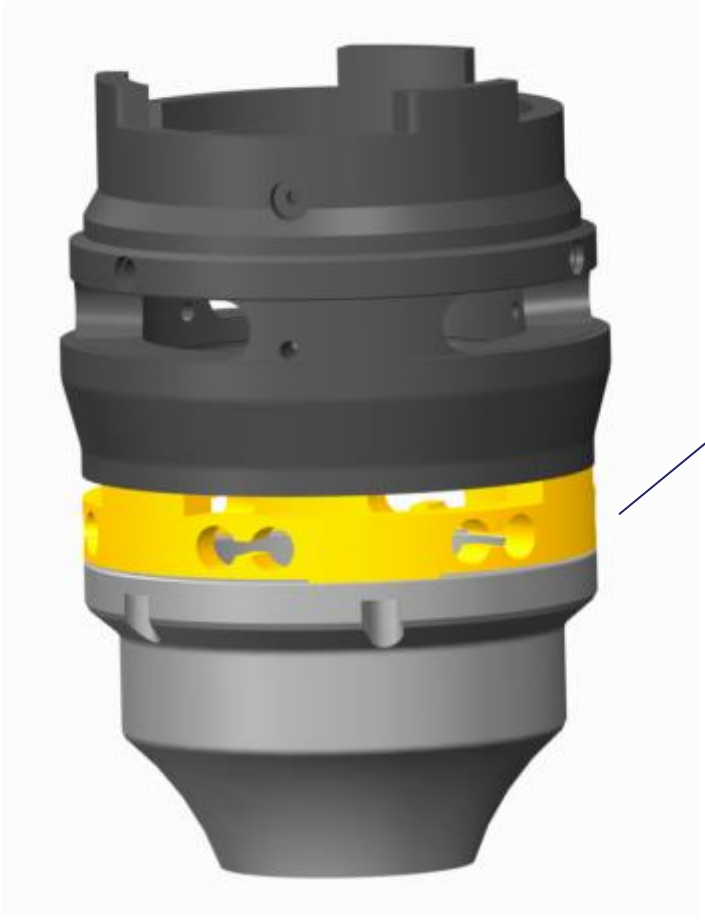
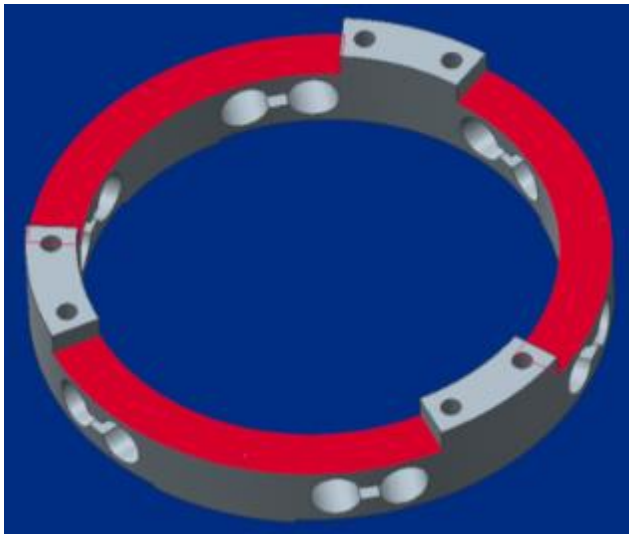
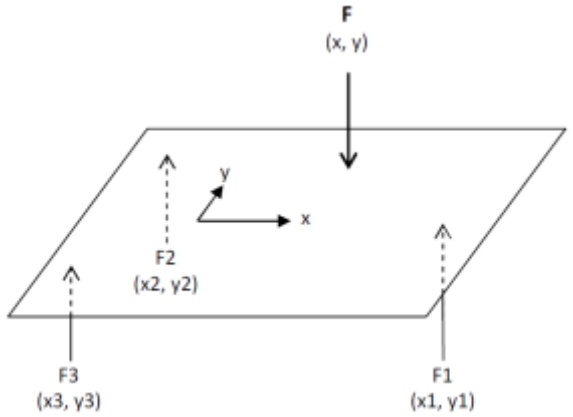
Application in medical machine control

Medical Eye-Laser treatment



Sensor





$$x = \frac{F1 * x1 + F2 * x2 + F3 * x3}{F}$$

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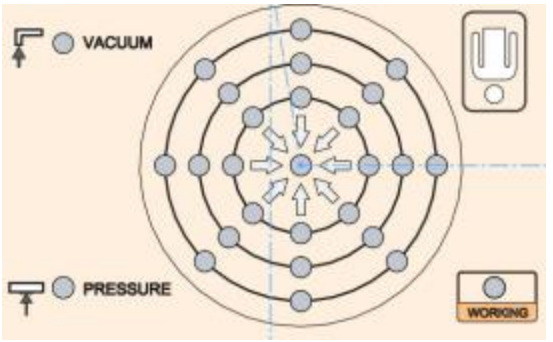
Application in medical machine control



Laser cutting machines for eye lens correction

- Precise and robust force (SG multicomponent) measurements for adjusting the laser optic
- Calculated channels provide polar coordinates of the resulting force as digital and analog output, and can be equipped for redundancy measurements
- Customer gets rid of old and unprecise SG-measurement and increases efficiency of the operation

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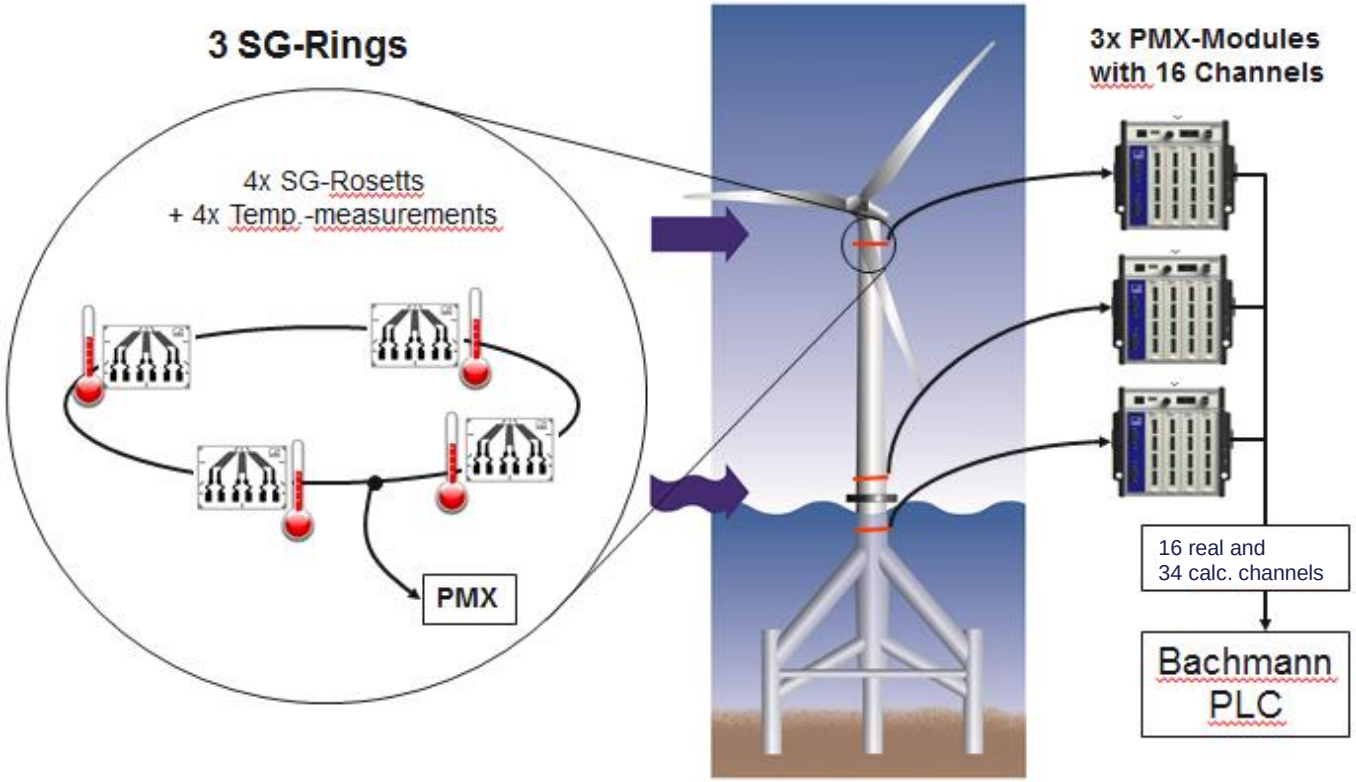
Structural monitoring of energy plants



Inputs:
3x strain, 1x Temp-compensation SG

Outputs:
sigma1, sigma2 phi, tau(max.)

4x PX455 (4 rosette-calculation) / 8 peak-values)

Sum:
16 real + 34 calculated channels

Condition monitoring on wind turbines 16 real + 34 calculated channels

- Realization of several SG sensor technologies
- Real-time condition-monitoring due to rosette and sheer-stress calculations (with temperature compensation)
- Data logging on site for service or via Web-Server on remote stations
- Option for Industrial Ethernet integration into the machine control

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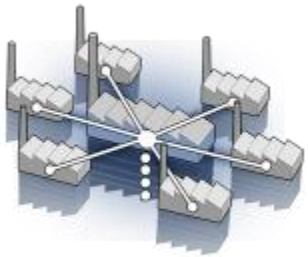
“Internet Of Things": What does that mean?

- **Sensors** that allow for easy and fast integration with complex production systems - for example through availability of “electronic data sheets”
- **Measuring amplifiers** that can communicate in real time with sensors and today’s Industrial Internet systems
- **Test and measurement software** that bridges the gap between easiest possible handling and increasingly complex functionality
- **Individual information** stored directly in the object
- **Network** of Internet-connected **objects**
- **Individual** decision making based on information evaluated locally
  Individual on-demand **services** for event-driven, real-time process control



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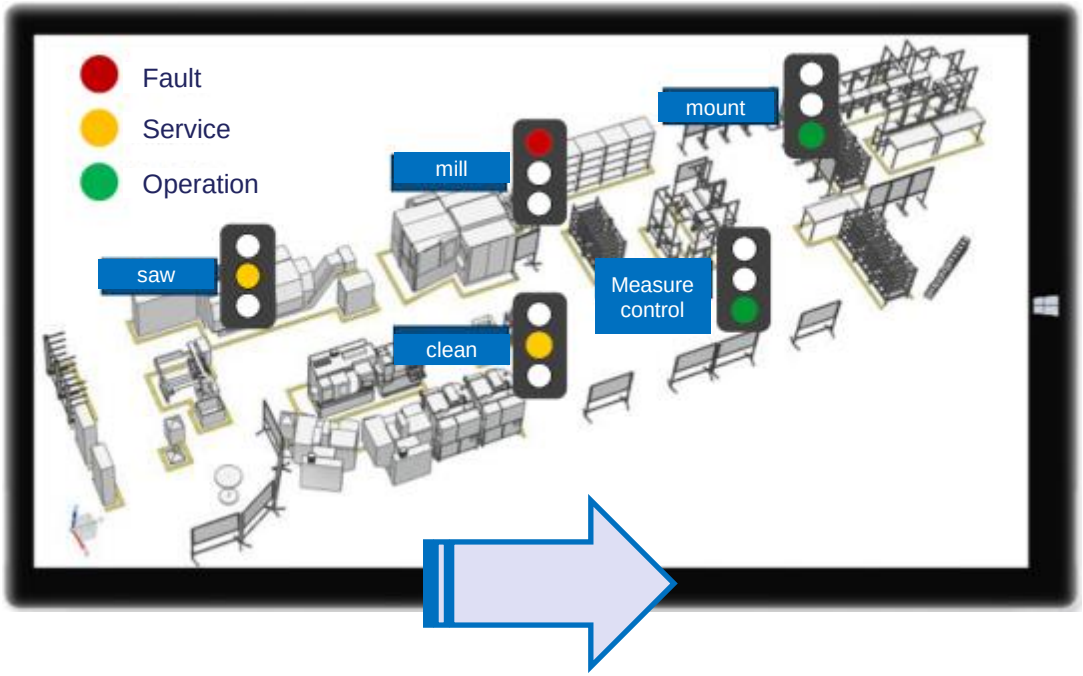
Networked production – “Smart factory”

Model Factory I4.0 Darmstadt University of Technology: manufacturing pneumatic cylinders



Horizontal integration and flexible worker assistance systems:

- Component as an information carrier by means of RFID chip
- Component and assembly information, employee information
- Linking the data along the value stream
- Energy consumption, quality assessment (pass / fail)

Infolink: http://www.effiziente-fabrik.tu-darmstadt.de/menue/index.de.jsp

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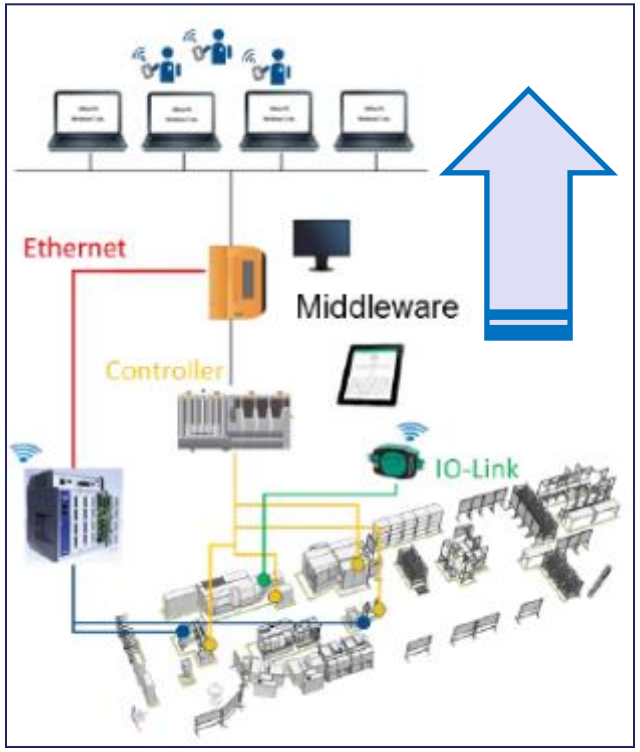
Networked production – “Smart factory”

Model Factory I4.0 Darmstadt University of Technology: manufacturing pneumatic cylinders



Vertical integration and quality of the machining process

- "Dashboards": product state, process state and machines condition
- Visualization for different users
- Unified data management
- Integration of data from the shop floor through the process tiers

Infolink: http://www.effiziente-fabrik.tu-darmstadt.de/menue/index.de.jsp

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Additional information

More information on PMX can be found on our website:

- **www.hbm.com/pmx**

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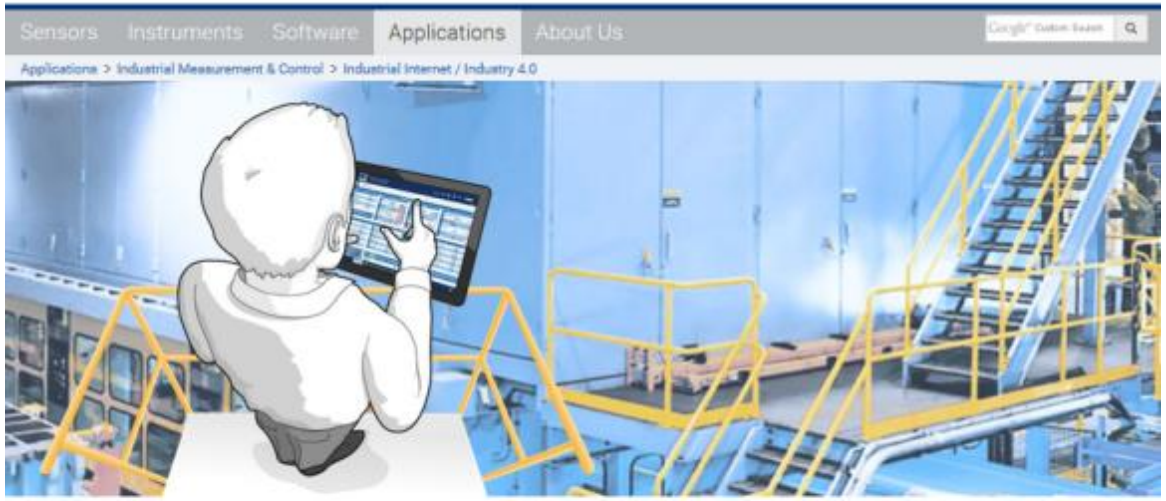
Additional information

More information on IOT can be found on our website:

- **https://www.hbm.com/en/4547/industrial-internet-industry-40/**



Test and measurement technology meets Industry 4.0

Enhanced flexibility, higher speed and increased efficiency in the production process are the objectives pursued by forward-thinking companies. The vision of networking man and machine with other objects is the central pillar in this context and is quickly becoming a reality. 'Industry 4.0' is the name the vision is known by.

Only through the use of cutting-edge "Test and measurement technology 4.0" can this vision of a networked production of the future become reality. Since the more complex and dynamic the processes in the manufacturing companies throughout the world, the more important becomes the availability of real-time data on critical parameters.

"Test and Measurement Technology 4.0": What Does That Actually Mean?

- **Sensors** that allow for easy and fast integration with complex production systems - for example through availability of "electronic data sheets"
- **Measuring amplifiers** that can communicate in real time with sensors and today's Industrial Internet systems
- **Test and measurement software** that bridges the gap between easiest possible handling and increasingly complex functionality

"We Learn About Industry 4.0 and What it Means for Test and Measurement Technology"

"HBM, as a test and measurement partner in the industry, is proud to be able to contribute to the success of Industry 4.0. In joint projects with universities we learn what Industry 4.0 means in practice for test and measurement technology. Our innovative products for use in manufacturing are proof that we have many ideas for making Industry 4.0 a reality."

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