Blade Intelligence

Phoenix Contact – Solutions for Wind Energy

PHOENIX CONTACT

Phoenix Contact GmbH & Co.KG , Stammsitz in Blomberg

We world market leader and highly innovative in electrics and electronics

We create progress with inspring and innovative solutions

Corporate history

1923 Founding in Essen

1928 First “RWE” ceramic terminal block
A modulare system for every connection
World market leader

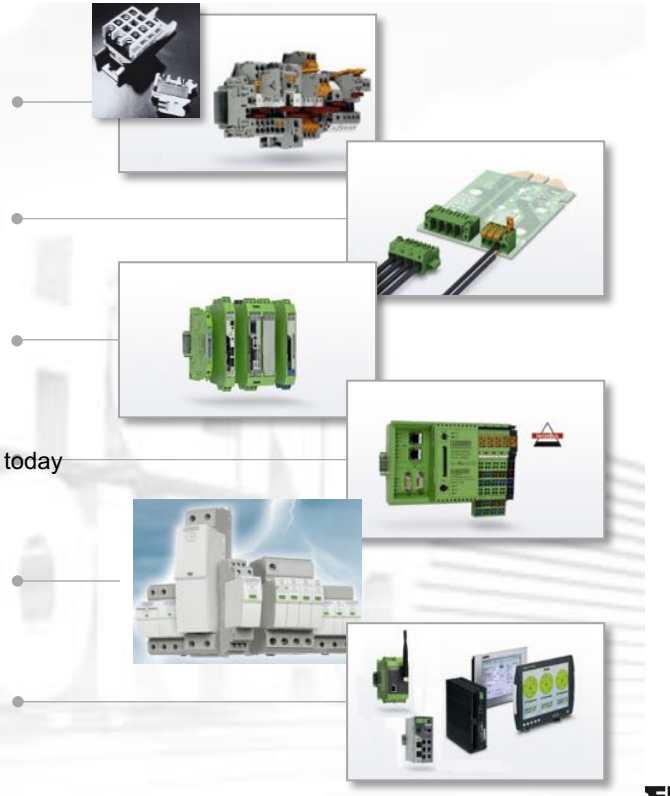
1975 Printed circuit board connectors
Connection technology for industrial electronics
World market leader

1980 Interface
Instrument transformers and signal converters
Technology leader

1984 Fieldbus technology
INTERBUS - the first industrial fieldbus, IEC standard today
Technology leader

1985 Surge- and Lightning protection
and signal quality products for systems and devices
Technology leader

2000 Automation technology
Industrial Ethernet, Industrial Wireless technology,
Control systems and Software
Technology leader



PHOENIX CONTACT Group

PHOENIX CONTACT Electronics GmbH
Bad Pyrmont

PHOENIX CONTACT Feinbau GmbH & CoKG
Lüdenscheid

Phoenix Contact Connection Technology GmbH
Herrenberg

Phoenix Contact-Software GmbH
Lemgo

PHOENIX CONTACT HMI-IPC
Technology GmbH
Filderstadt

PHOENIX CONTACT Cyber Security AG
Berlin

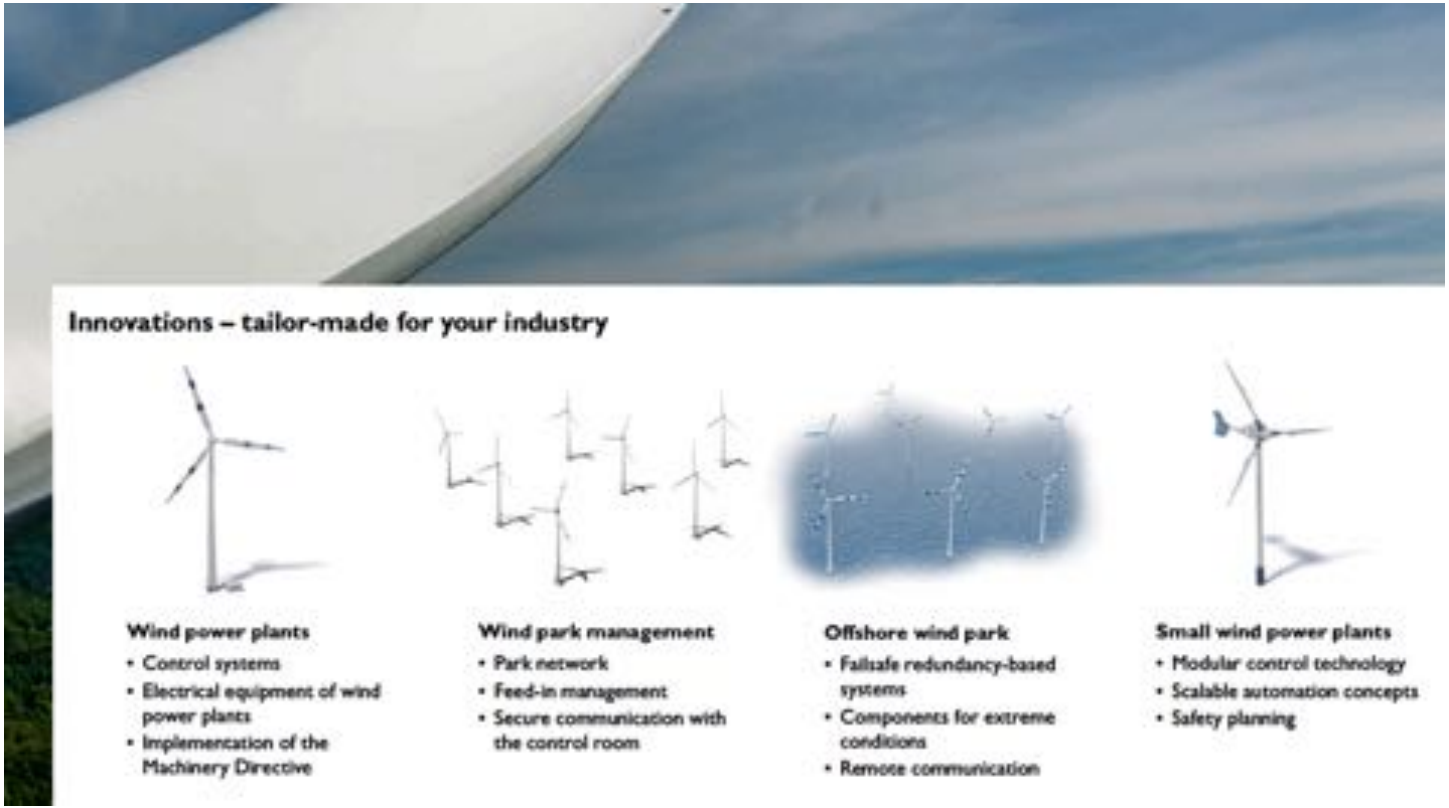
Phoenix Contact Power Supplies
Paderborn

PHOENIX CONTACT US Headquarters
Harrisburg, PA

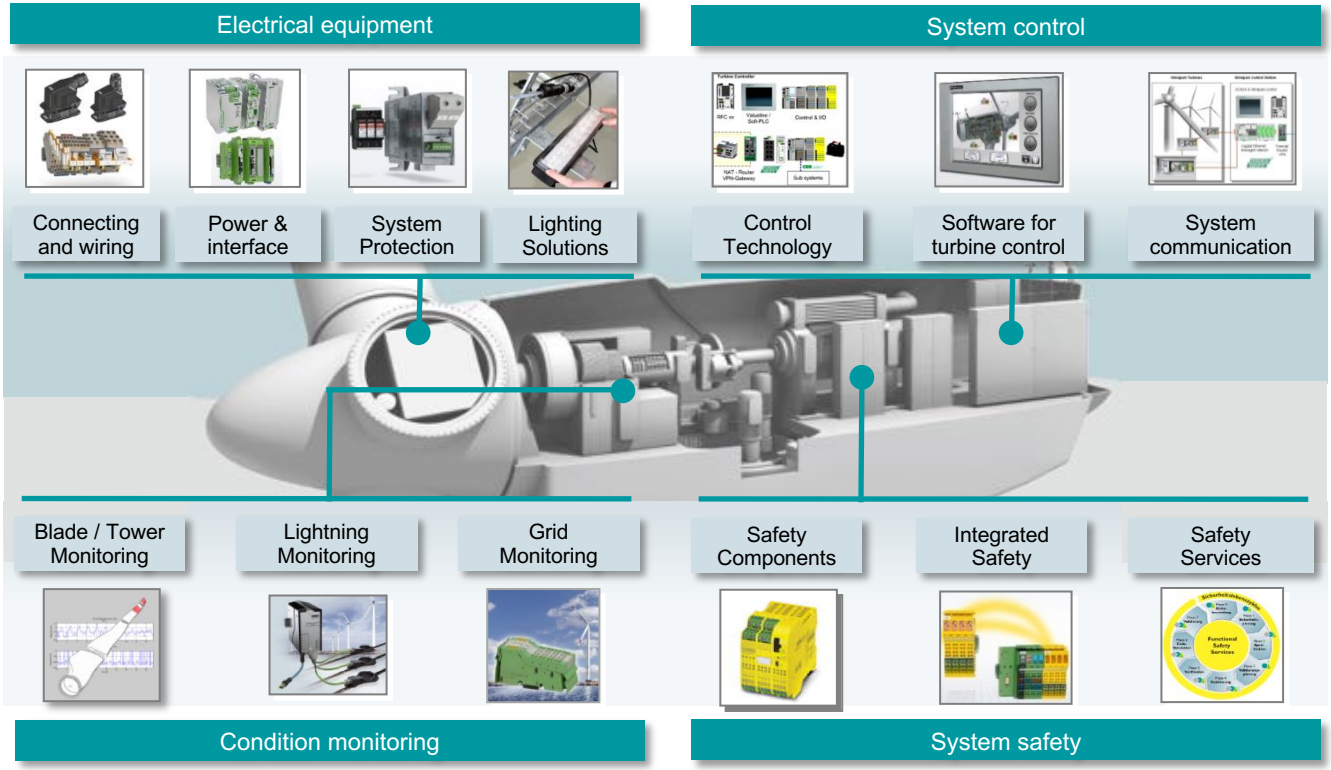
PHOENIX CONTACT China Headquarters
Nanjing

- >16,000 employees worldwide
- turnover 2019 ~ Euro 2.3 bn.
- 14 Production sites worldwide
- 52 subsidiaries
- over 60.000 active products
- appx. 1.500 new product launches p.a.

Our offer to the wind power industry



Solution portfolio for Wind Energy



Wind turbine control in worldwide operation

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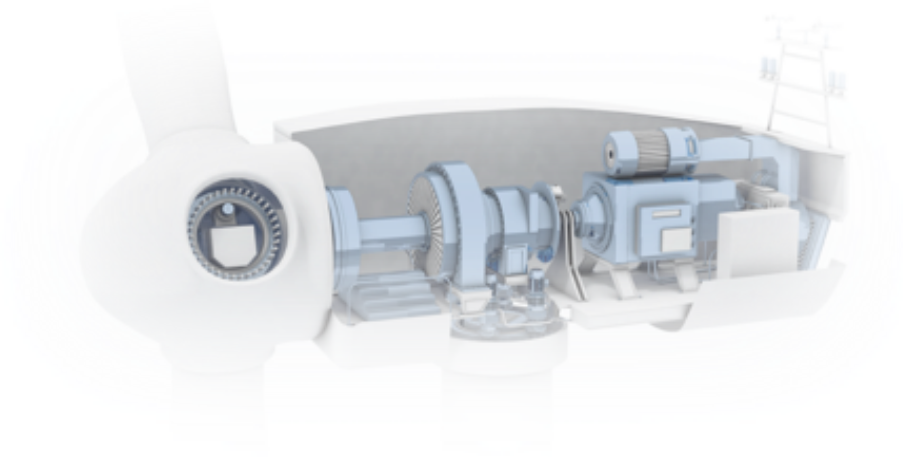
Agenda

- Global Scope
- Sensor Systems
  - LM-S
  - ID-S
  - RM-S
- Conclusion



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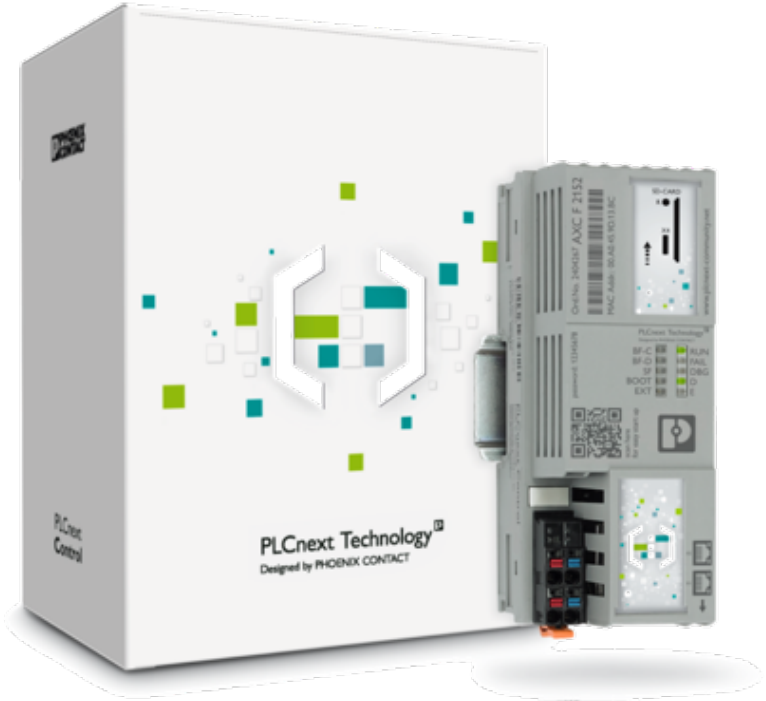
Hardware - AXC F 2152



- Cyclone 5 ARM Cortex-A9 CPU 2 x 800 MHz
- 512 Mbytes RAM
- SD Flash card slot up to 8 GB
- 1 x ETH-MAC interface switched
- Micro-USB type C
- Axio field bus for up to 63 modules
- Left side extension capability, e.g. 2nd ETH
- Trusted platform module (TPM) for security
- Temperature range: -25°C up to +60°C

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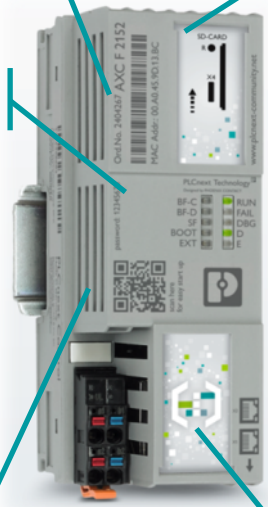
Open Edge Computing Platform

Lean engineering

Flexible IOs

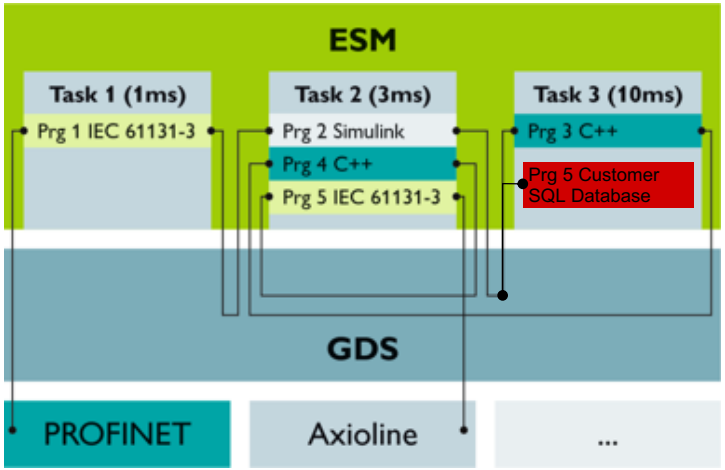
Security



Open platform

A priori consistent data

PLCnext Technology



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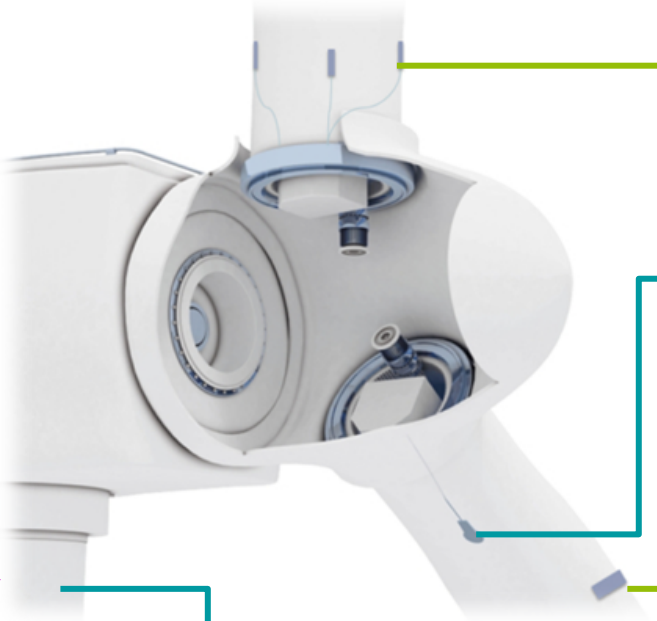
Sensor Systems



- RM-S

- LM-S

- ID-S

- …

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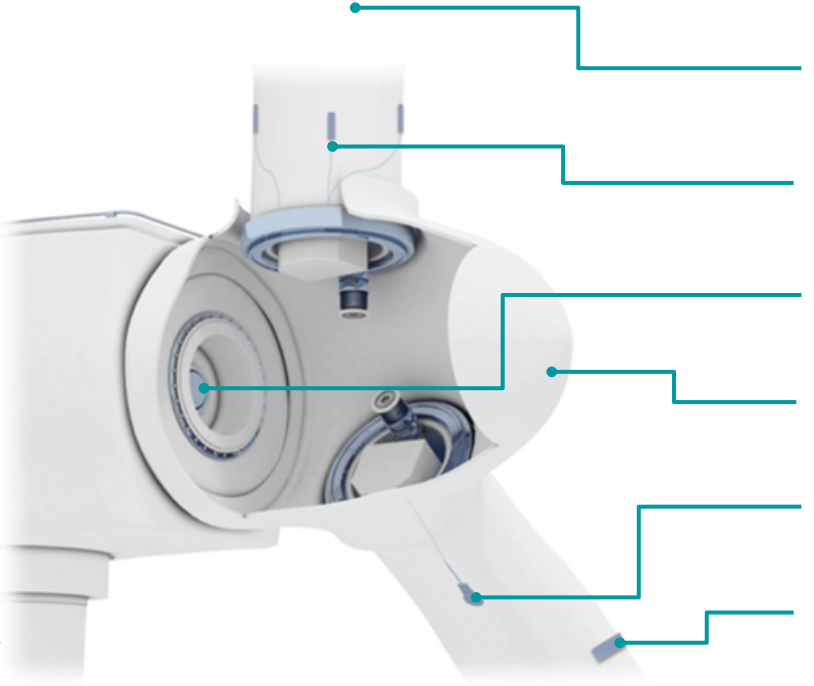
Measurements



- Blade acceleration sensor
- RM-S-SGI strain gauge sensors
- Shaft acceleration/ inertial sensor
- Several temperature sensors
- LM-S Lightening sensors
- ID-S Ice sensors

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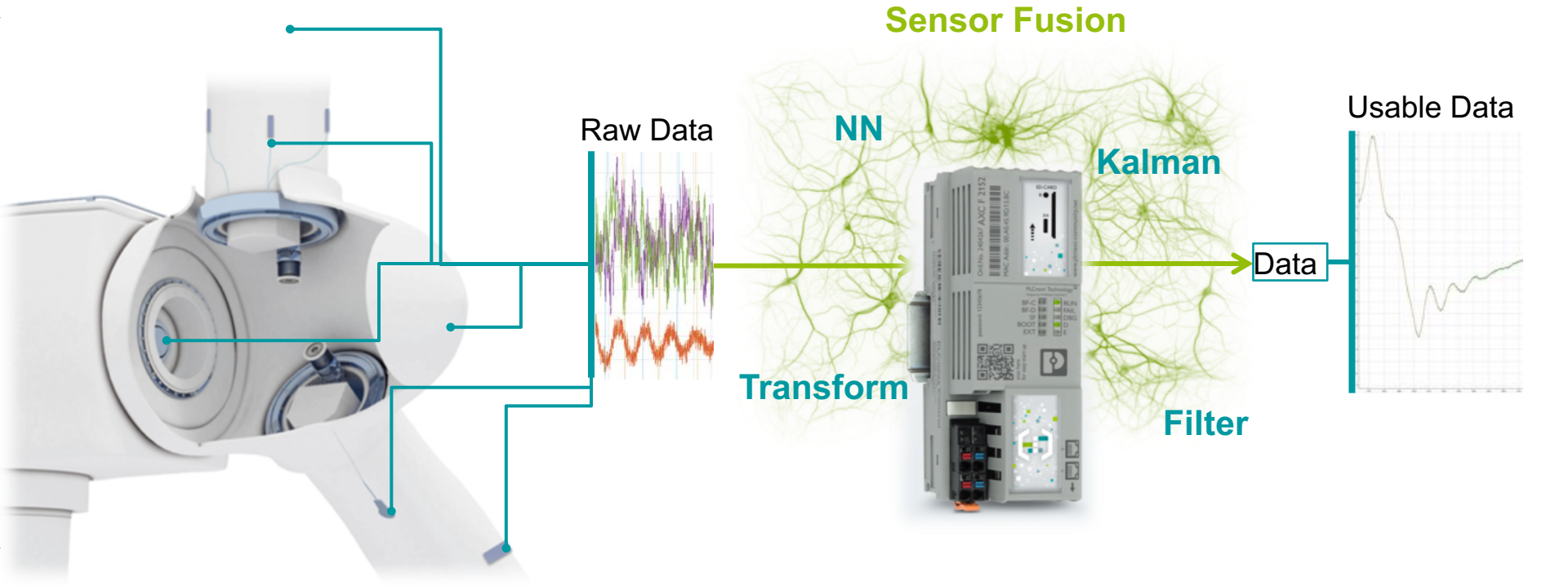
Calculation



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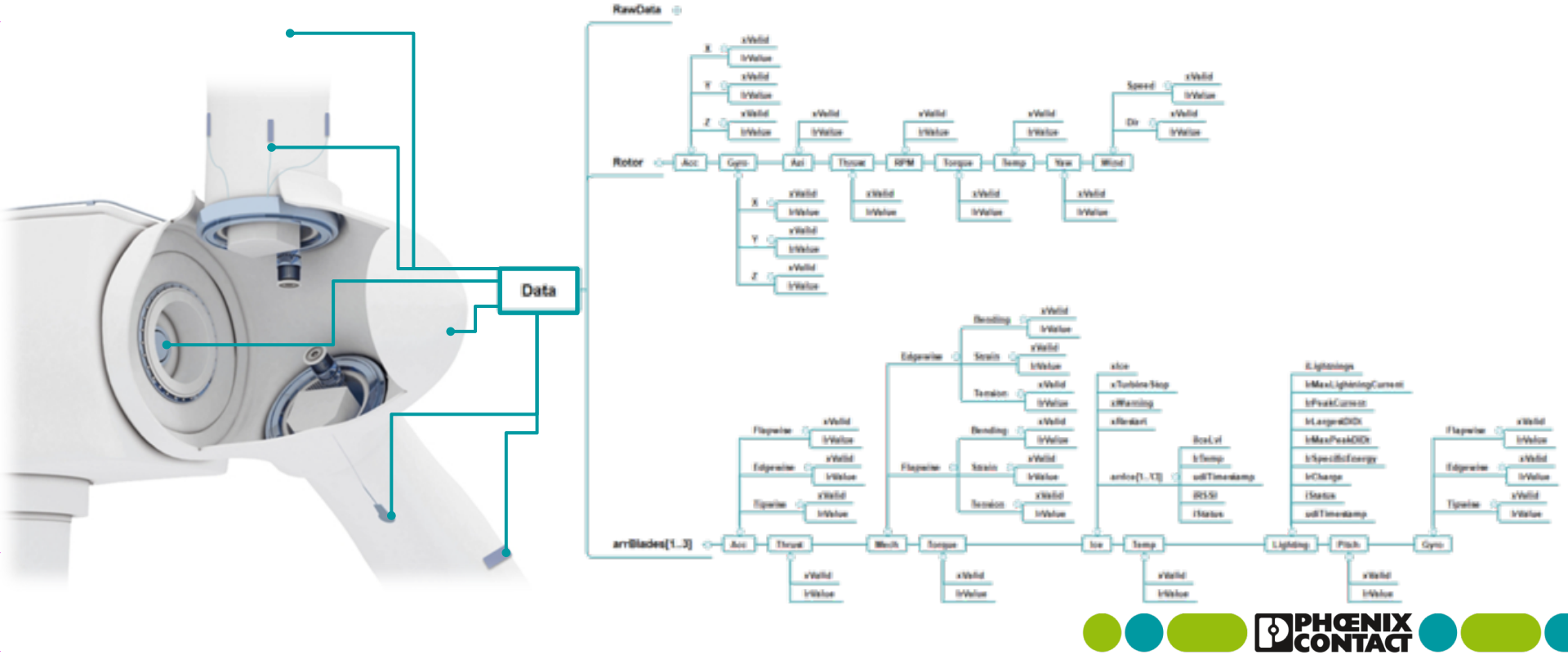
Data



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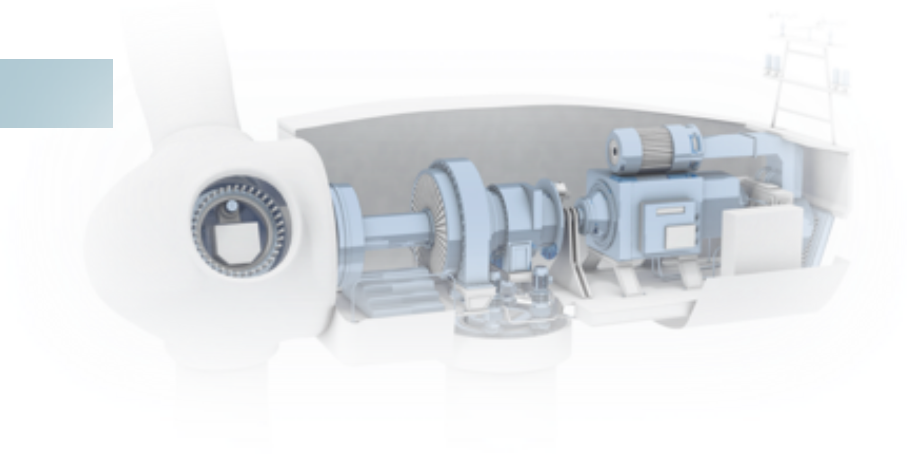

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Subsysteme – LM-S

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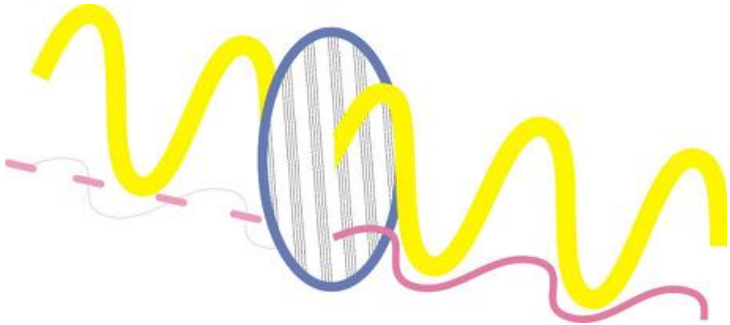
Subsysteme– LM-S



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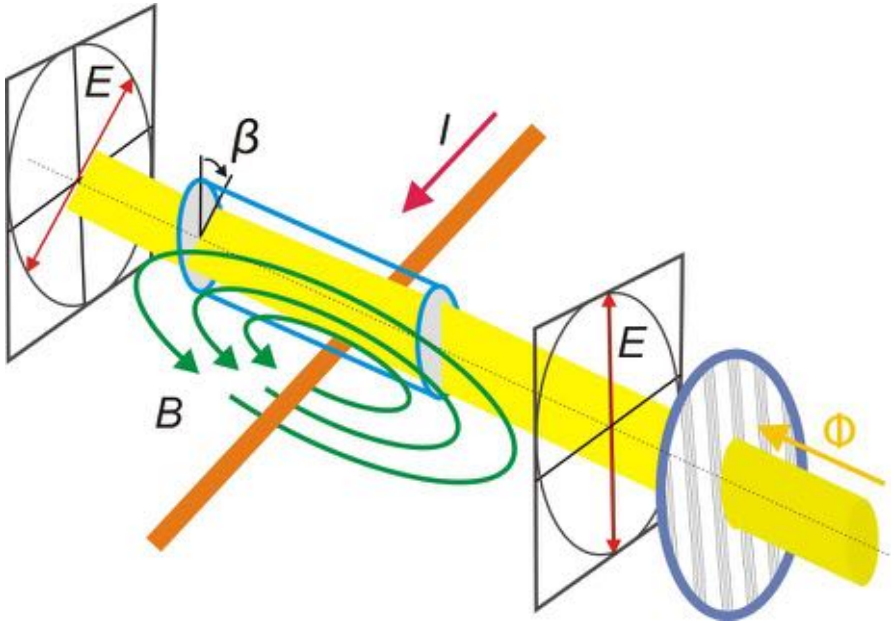
Subsysteme – LM-S



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Sensor

- Robust sensor (IP67)
- Easy installation directly on the down conductor
- Push-Pull-Connector for easy and safe connection of fiber optical cable

+ Purely optical measuring and signal transmission
+ No disturbances caused by the electrical field
+ No galvanic connection between sensor and electronics

LM-S-LS-H
2800616

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Main features

- Live monitoring system for permanent recording and analysis of lightning strikes
- Detailed analysis of lightning currents
  I_{max} ,di/dt, Charge and Specific Energy
- Surge current measuring range:
  +/- 5 kA to 400 kA
- Exact determination of past lightning events
- Network access via Ethernet

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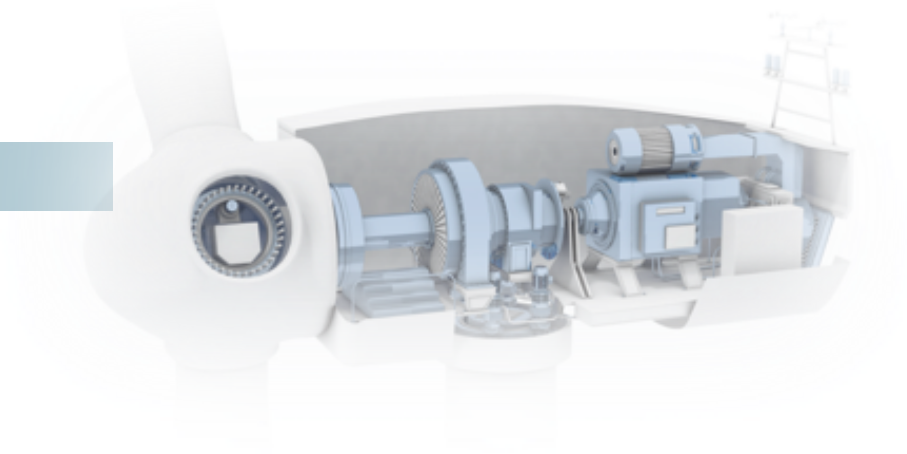

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Subsysteme – ID-S

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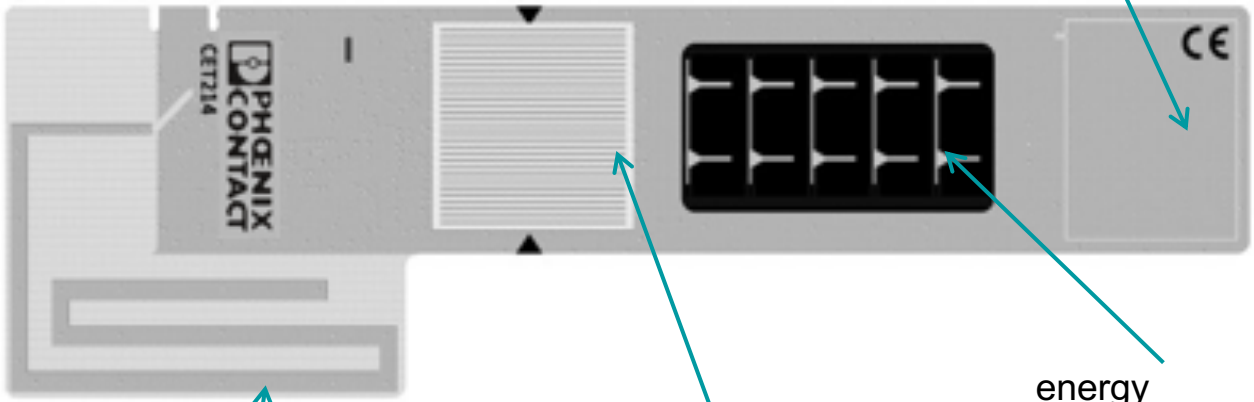
Subsysteme – ID-S



Energy buffer

energy harvesting

ice and temperatur measurement

wireless data transfer

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Subsysteme – ID-S

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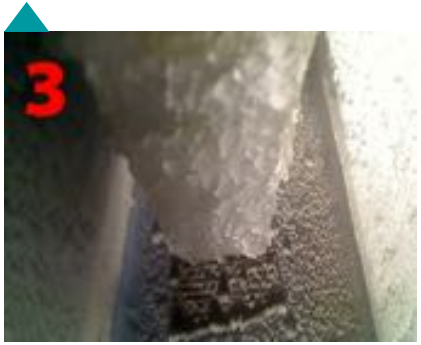
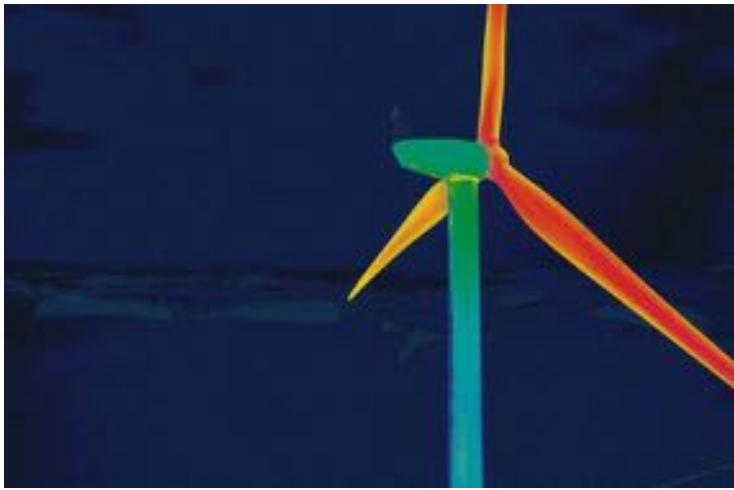
Icing Wind Tunnel Test



Blade Intelligence

Rotorblade heating

- Temperature measurement directly on the blade
- Feedback for the blade heating
- Build up reliable control loop to improve heating system



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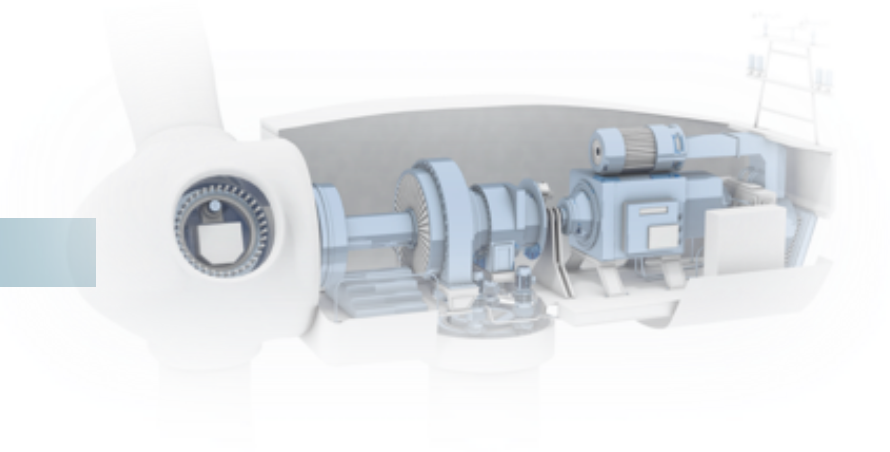

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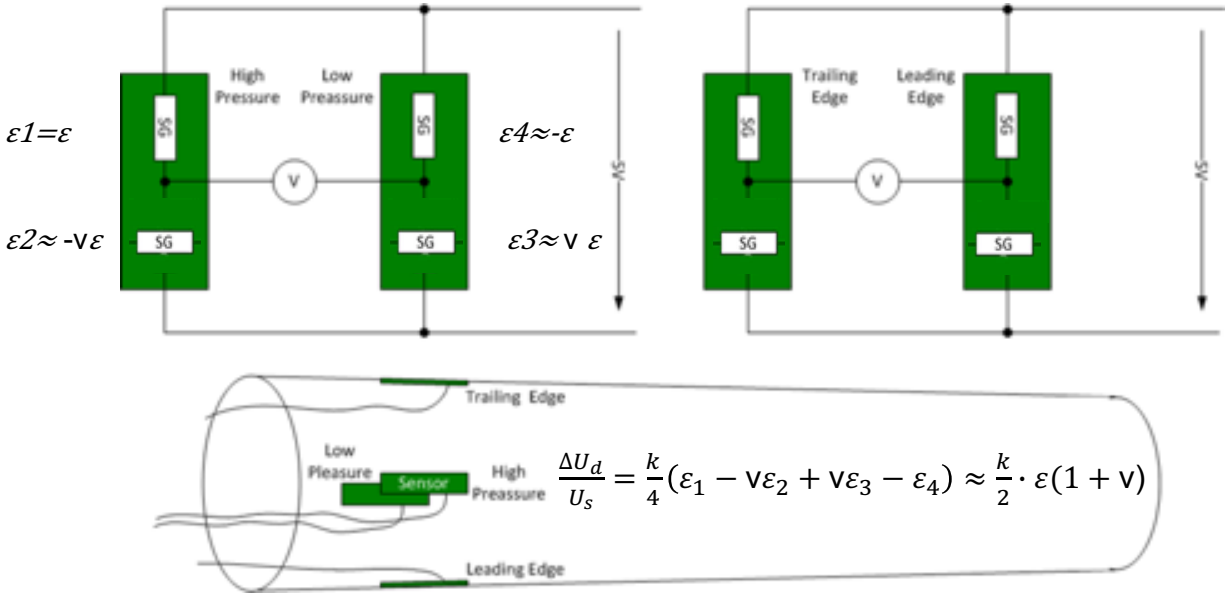
Subsystem – RM-S – E.g. bending moment



Part of Blade Intelligence Solution

Blade Intelligence

Subsystem – RM-S – Standard Sensor

- M12 standard connector and standard cables
- “Walk on” and environmental protection
- Surge protection by TRABTECH® modules
- Easy to install inexpensive solution with well known technology
- Insensitive to humidity and temperature variations

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Subsystem – RM-S Advanced data

Half bridge HBM staple T Sensor

Maximum strain 5 ‰ (once)

Normal strain ± 0.8 ‰ (for 20 years lifetime at 12 rpm)

Resolution > 0.01 ‰

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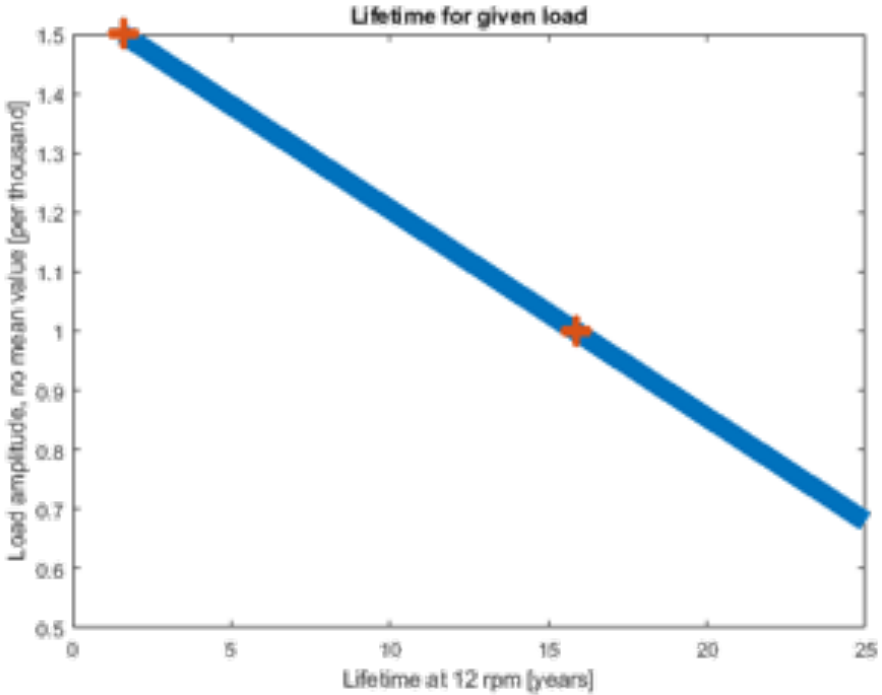
Subsystem – RM-S – Lifetimegraph



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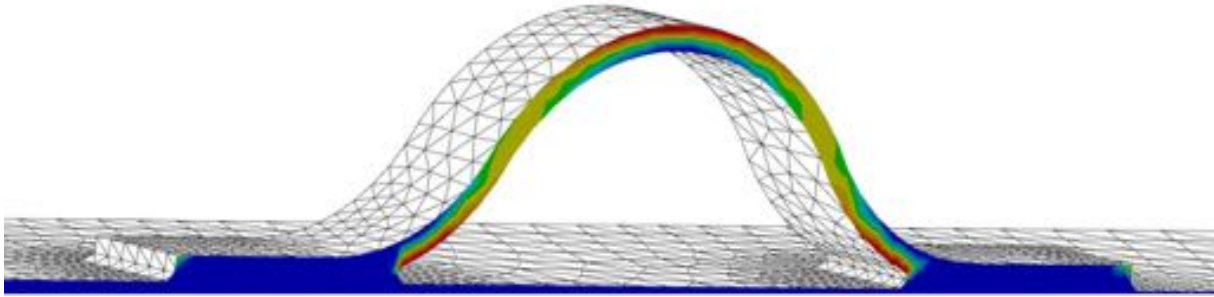
Subsystem – RM-S – High Load



Blade Intelligence

Subsystem – RM-S – High load

Sensor woven into robust GRP[1)]

M12 standard connector and standard cable

“Walk on” and environmental protection

Full bridge

± 5 ‰ strain

Easy installation

Temperature sensor

Inexpensive

Surge protection by TRABTECH® modules

Two 4..20 mA outputs

Insensitive to local imperfections of laminate

1) GRP = glass-fiber reinforced plastic

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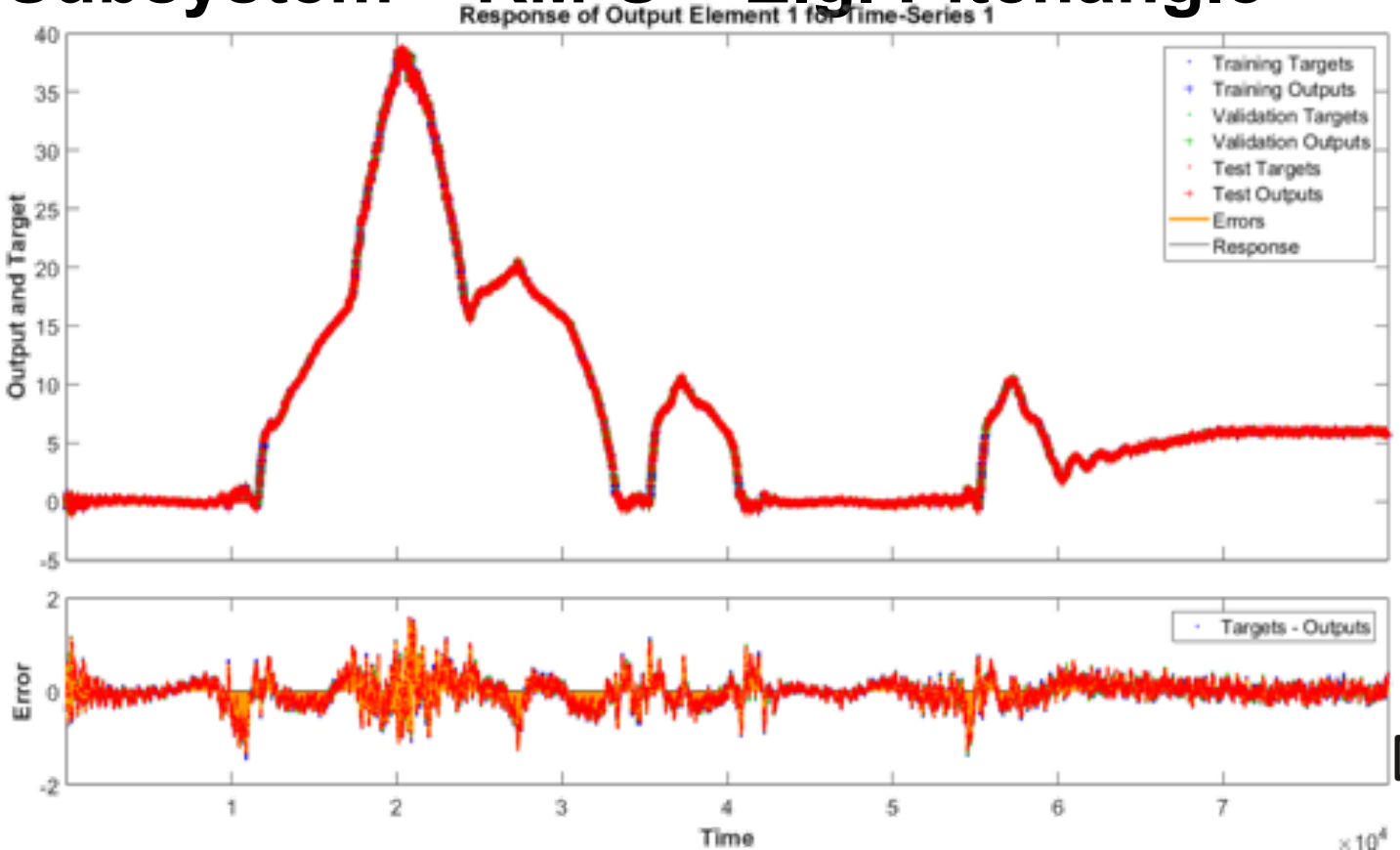
Subsystem – RM-S – E.g. Pitchangle



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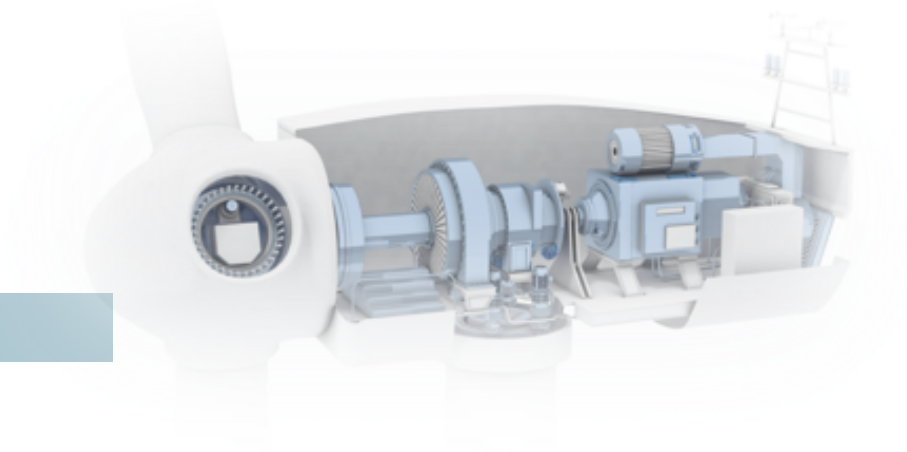

Digital Solutions for Wind Power

Blade Intelligence