

# MACHINE CONDITION MONITORING FOR HYDRO



VIBRATION EXPERT SYSTEMS  
CONSULTING  
SYSTEM DESIGN

The logo for CoDiS, featuring the word 'CoDiS' in a bold, black, sans-serif font with a small white dot above the 'i'.





### Benefits of condition monitoring

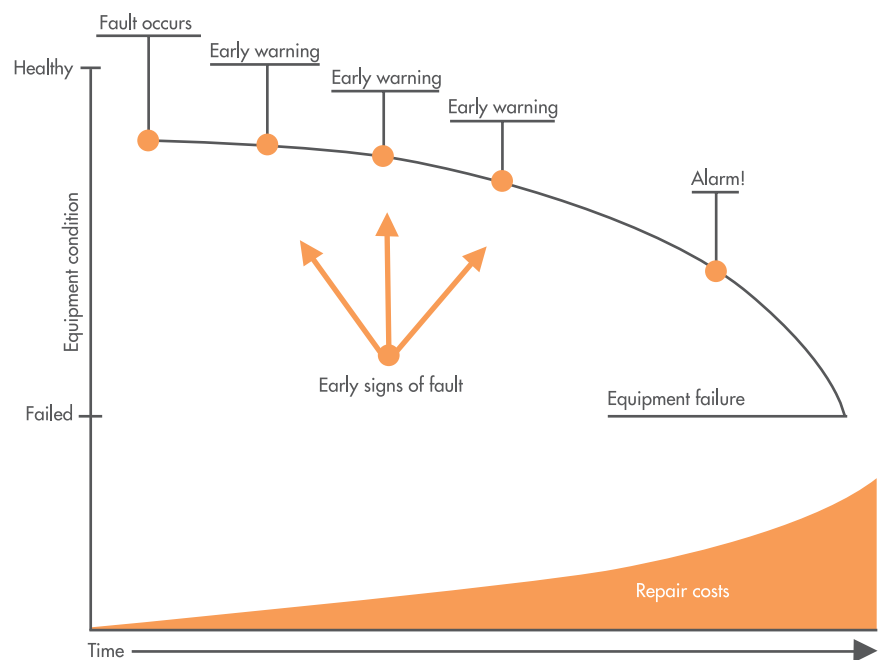
- Efficient repairs
- Better maintenance planning
- Condition change detection
- Damage prediction
- Damage prevention
- Fault diagnosis and detection

## Predictive maintenance

On-line monitoring system installed in power production plants ensures continuous monitoring of exploitation and is a critical step toward predicting machine behaviour. The real benefit is the predictive capability and root cause identification, which can significantly improve repair planning and scheduling and can also prevent additional damage from occurring.

CoDiS all in one monitoring system includes vibration monitoring, air gap and flux monitoring, hydraulic quantities, seamlessly integrated with electrical parameters and process parameters (temperatures, pressures, flow etc.).

System includes continuous measurement, trending and database creation for all calculated parameters. Substantial and well structured database ensures organized and cost effective maintenance planning. CoDiS has proven to help reduce the maintenance cost, up to 50 %.



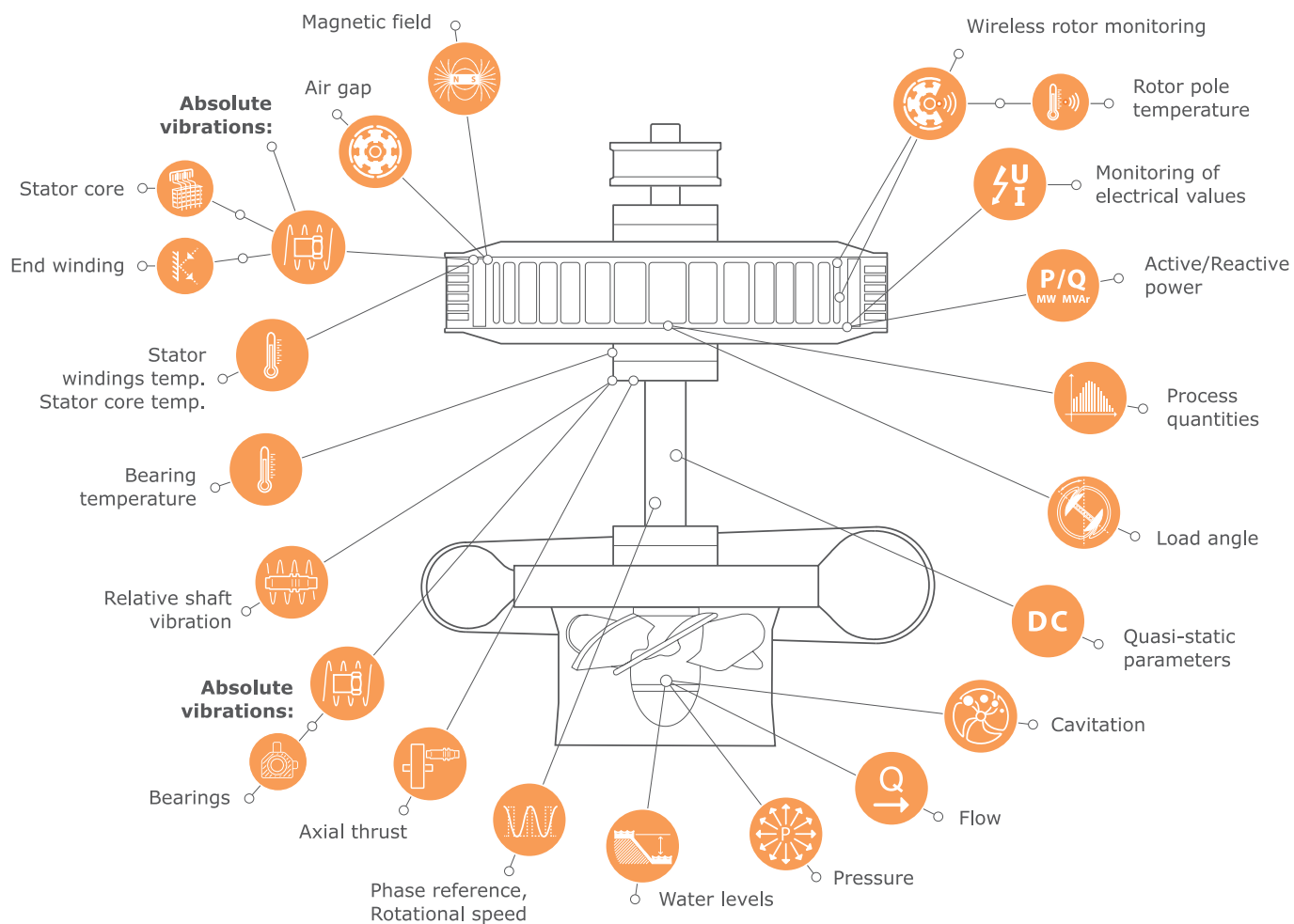
## CoDiS Machine Condition Monitoring system

The system is used for early warning and predictive maintenance of rotating machines in power plants and processing industry. **CoDiS** architecture includes front end components (sensors and terminal boxes), real time protection controller (CoDiS RT hardware inside industrial cabinet) and diagnostic software (CoDiS DM running on server PC).

The key advantage is based on open software architecture which enables flexible configuration of the system, easy customization for end user and easy future upgrades.

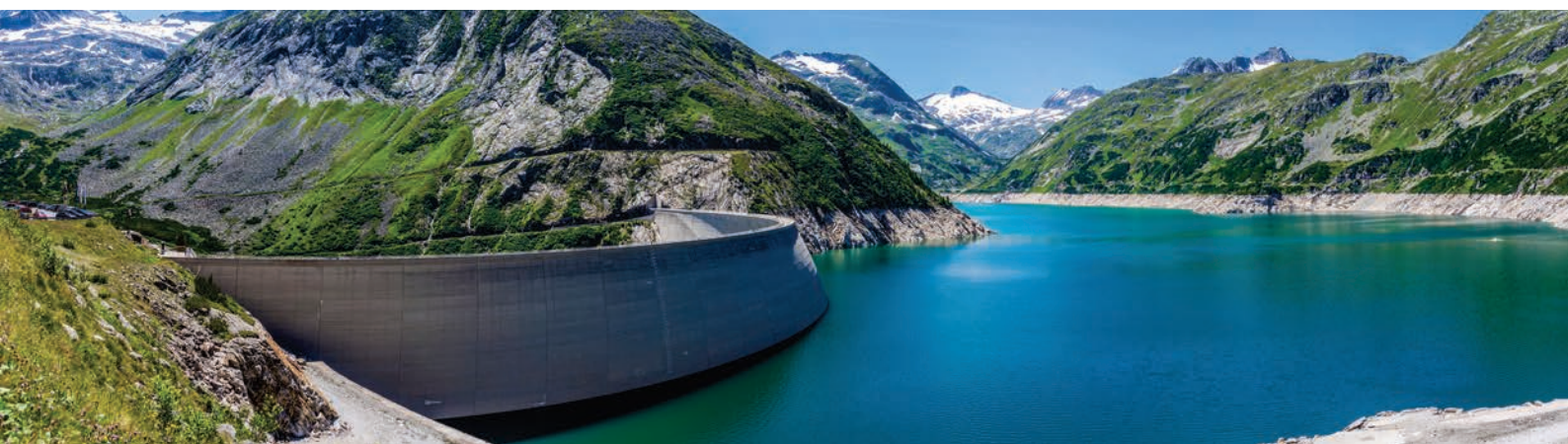
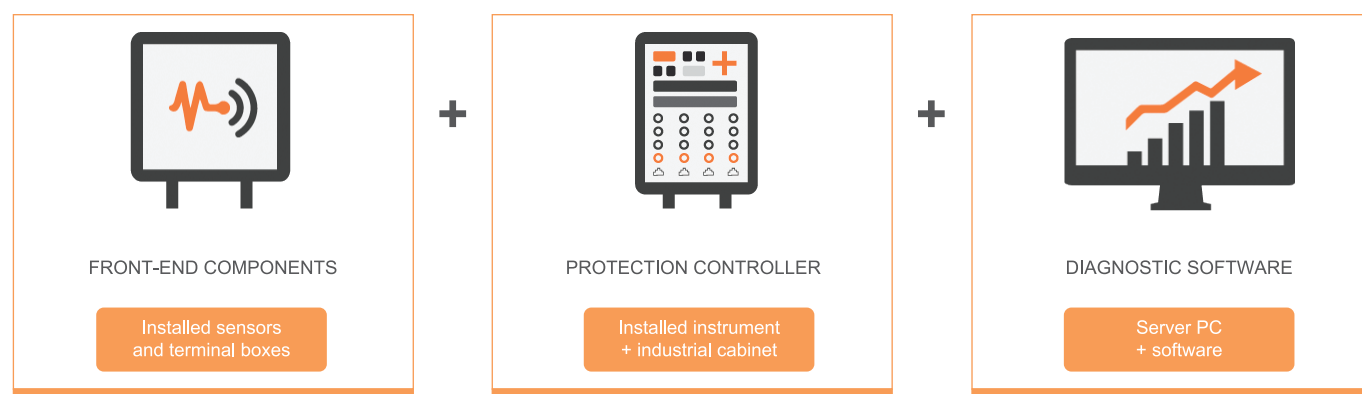
# Solutions only

## CoDiS All in One Hydro Generator Monitoring



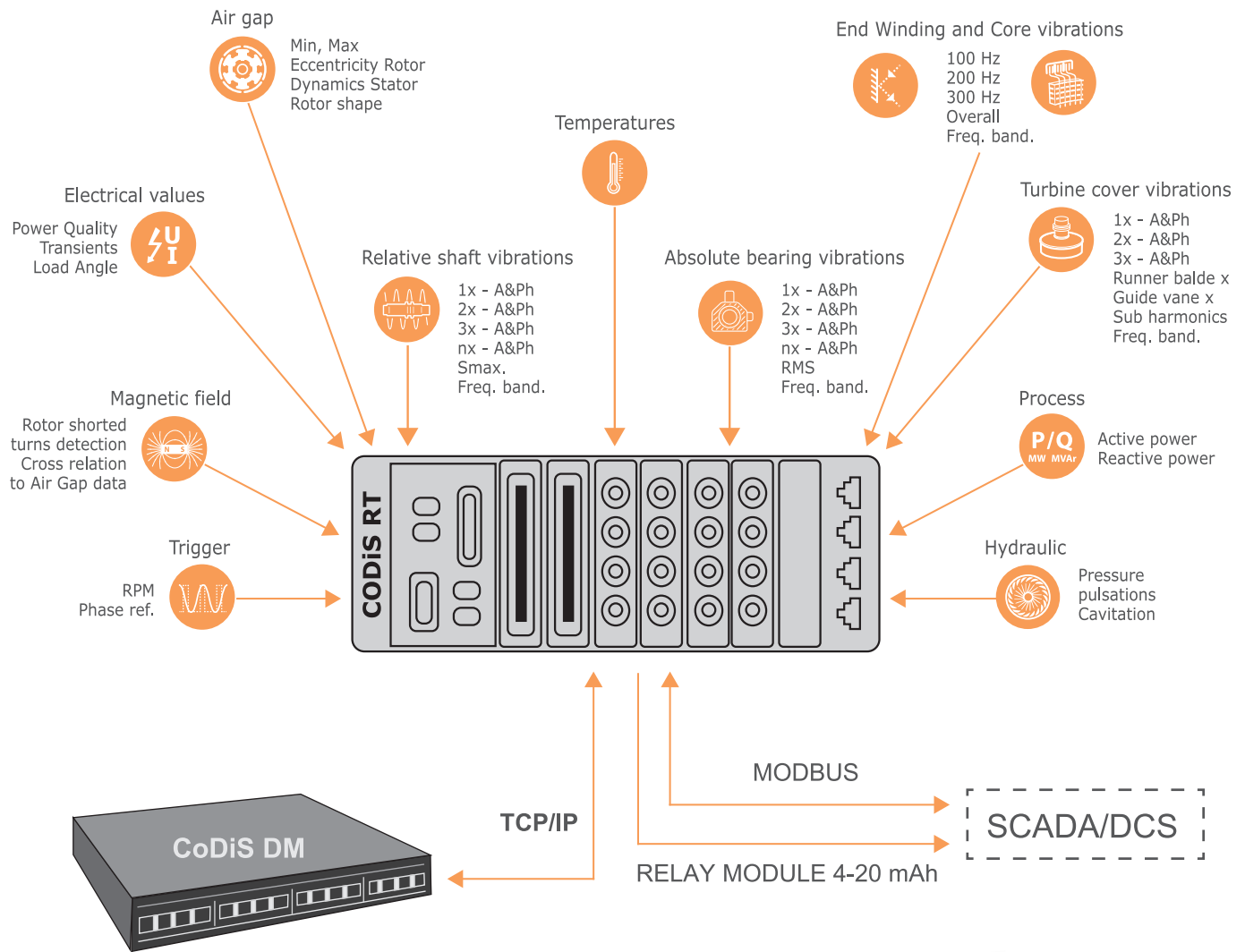
## CoDiS System Architecture

„CoDiS” – Real Time data acquisition, protection and condition analysis





# CoDiS Real Time Protection Unit Real Time analysis and Processing Capabilities



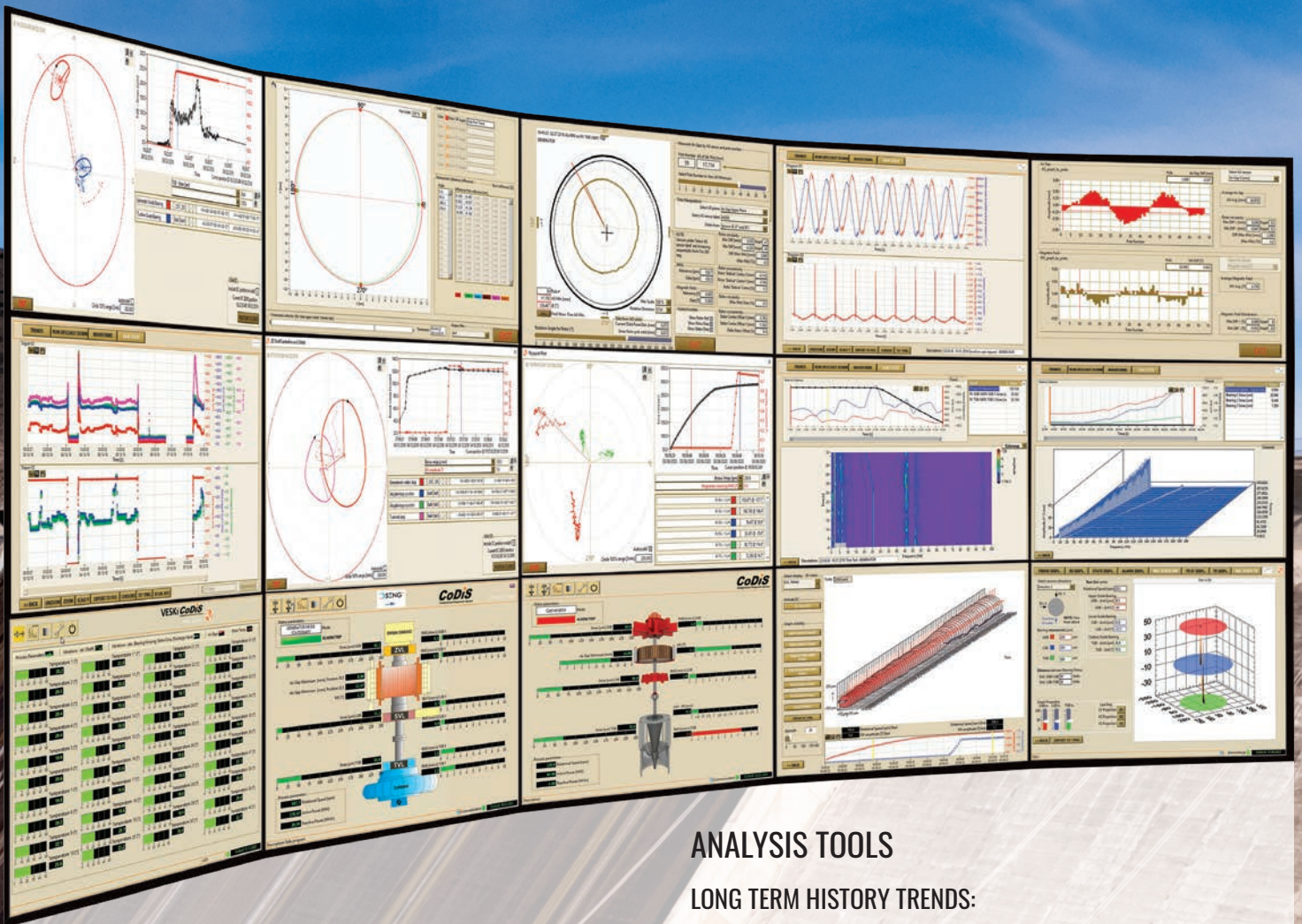
## CoDiS RT ensures the following functionality:

1. Real time data processing and analysis
2. Recognition of different operating conditions (i.e. Stop, Run Up, Normal operation, User defined condition)
3. Relay triggering and alarm notifications
4. Condition vector (calculated values) streaming to the server
5. Raw waveform data stream to the server
6. Communication with SCADA or DCS
7. Time synchronization

CoDiS RT is based on NI CompactRIO technology



# CoDiS Software Feature List



## PLANT or FLEET VIEW

- Machine mimic overview (suitable for operators)
  - Vibrations
  - Process quantities
  - Air gap
  - Magnetic field
  - Electrical quantities
- Alarm indication
- Alarm management

## MACHINE REAL TIME DATA

- Vibrations (Relative shaft vibrations, Absolute bearing housing vibrations)
- Process quantities (Active power, Reactive power, Head, Flow, Pressures)
- Temperatures
- Air gap/Magnetic field (pole profile, eccentricity)

Each signal is trended in 10/20/30 minute real time trends for quick overview (suitable for operators).

## ANALYSIS TOOLS

### LONG TERM HISTORY TRENDS:

- Data recorded with highest resolution of one minute
- Daily data storage organization (selectable from one day to multiple days/months/years)
- Operating condition filter display (steady state, run up, coast down...)
- Data export to ASCII

### TRANSIENT CONDITION ANALYSIS:

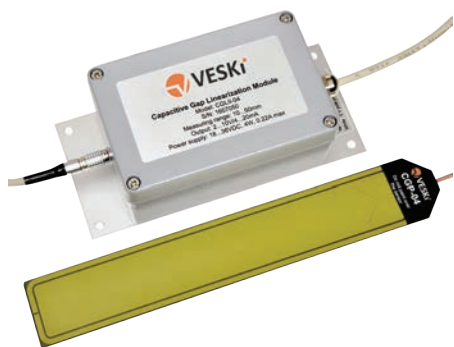
- Trend data recorded with highest resolution (0.5s, 1s, 2s selectable)
- Post processing analysis available:
  - Shaft centerline 2D and 3D, Nyquist and Bode, 2D and 3D orbits, RunOut compensation, 3D shaft centerline

### EVENT ANALYSIS (ALARM OR USER CREATED)

- Waveform raw data display (with pre-trigger)
- Spectrum analysis (CPB, Waterfall, Intensity)
- Orbits and shaft centerline
- Air Gap analysis (Stator geometry, Rotor geometry, eccentricity, and circularity)
- Magnetic field (Pole profile, pole winding short circuit detection)



# Sensors



Air gap

Air Gap Sensors features:

- Capacitive Sensor Technology
- Output directly proportional to the air gap distance (pole profile)
- Easy to install and no special calibration is needed
- Low profile
- High Temperature Stability (-15 to 125 C)
- Immune to magnetic fields, dust, oil, EMI and RFI

Capacitive Gap Sensor\* models:

- **CGS020110** with measuring range 2 to 10mm
- **CGS020210** with measuring range 3 to 15mm
- **CGS020310** with measuring range 5 to 25mm
- **CGS020410** with measuring range 10 to 50mm

\* Air gap sensors are also available with magnetic base, perfect for periodic measurements with CoDiS PMU.



Magnetic Field

Magnetic Field sensors features:

- Output directly proportional to field in Tesla (T)
- Easy to install and no special calibration is needed
- Low profile, used for air gaps up to 50mm
- High Temperature Stability (-15 to 125 C)
- Immune to dust, oil, EMI and RFI

**MFS25** Magnetic field sensor

- Output signal from the conditioner;  $\pm 5V$
- Non integrated and integrated signal available



Proximity probes

Proximity probe sensors features:

- Output directly proportional displacement
- Used for different applications;
- Shaft displacement, axial rotor displacement, stator frame displacement, phase reference

Proximity probe models:

- **Phase reference** – measuring range 1 to 4mm
- **Axial displacement** – measuring range 2-10mm
- **Shaft displacement** – measuring range 0.3 to 2.3mm



Absolute vibrations

Absolute vibration sensor features:

- Output directly proportional acceleration
- Output directly proportional velocity
- Used for different applications;
- Bearing vibrations, turbine cover and draft tube vibrations, stator core or frame vibrations

Absolute vibration sensor models:

- **Low frequency accelerometer** – measuring range 0.1 to 8000Hz, 500mV/g sensitivity
- **Low frequency velocity meter** – measuring range 1 to 7000Hz, 20mV/mm/s sensitivity

# CoDiS Monitoring Systems



**CoDiS MCA01**

Monitoring Cabinet MCA01 features:

- Standalone monitoring cabinet 800x2000x800
- Used for 32+ ch systems
- Robust steel frame construction
- 17" Touch screen interface (or larger)
- Custom machines health on-screen dashboard
- Real-time OS with instant processing power
- Records and monitors machines health
- Front and back door construction
- Designed for the most demanding environments
- Operational at temp -40 to +70°C / -40 to +158°F



**CoDiS MCA02**

Monitoring Cabinet MCA02 features:

- Wall mounted monitoring cabinet 800x1000x300
- Used for <32 ch systems
- Robust steel frame construction
- 15" Touch screen interface
- Custom machines health on-screen dashboard
- Compact design
- Designed for the most demanding environments
- Operational at temp -40 to +70°C / -40 to +158 °F



**CoDiS PMU**

Portable monitoring unit PMU18 / PMU24 features:

- 18 or 24 channel unit configuration
- Collecting real-time machines data
- Best suited for periodic machine analysis
- Easy connectivity to PC via standard LAN interface
- Limitless channel configuration system available via synchronised PMUs
- Direct Power supply to connected sensors
- Designed for the most demanding environments



**CoDiS WRM**

Wireless monitoring unit WRM features:

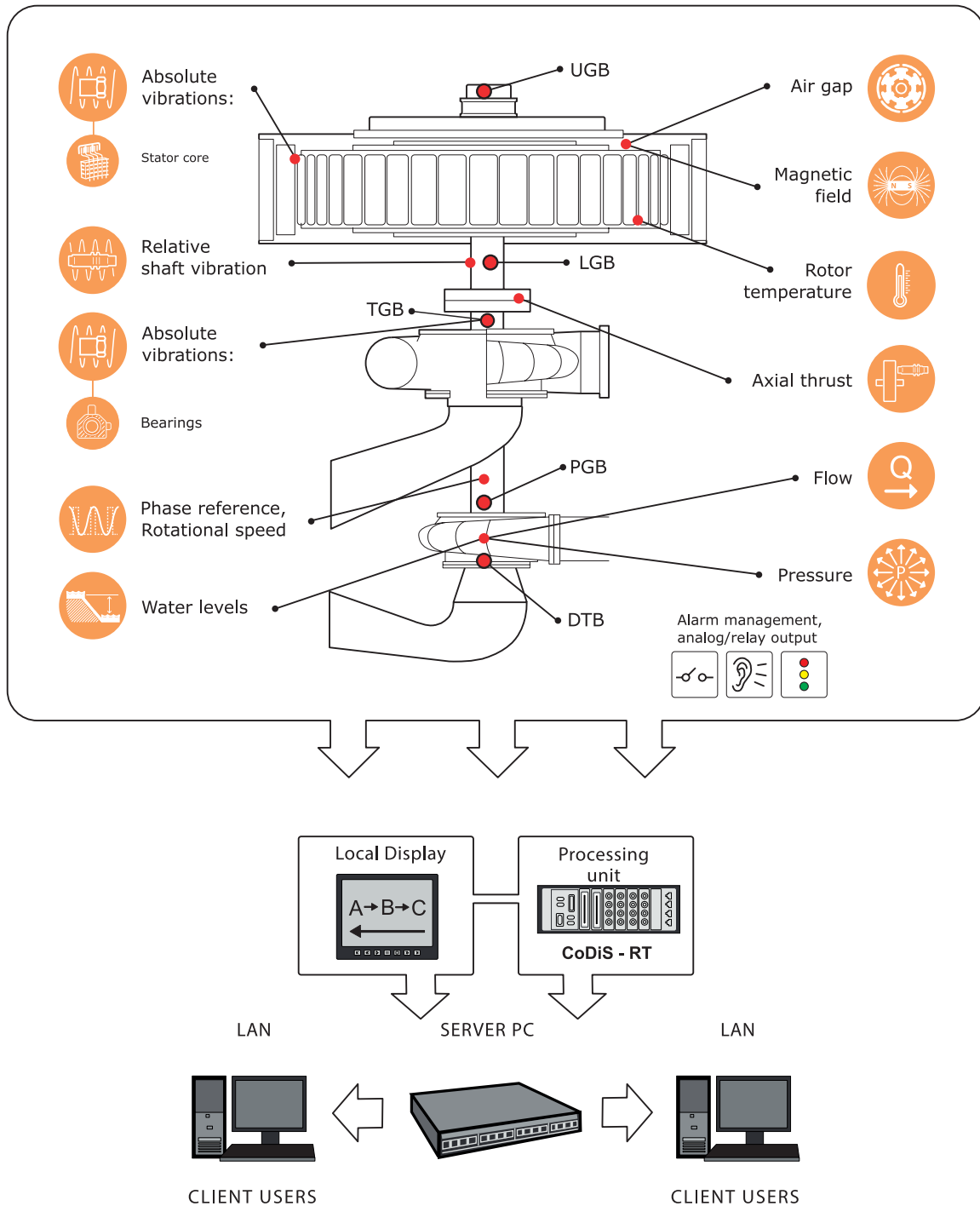
- Online Wireless Rotor Monitoring (8 analog and 100 digital inputs)
- Real time data streaming over Wi-Fi to stationary server PC
- WRM continuously monitors: temperature of rotor pole windings, excitation current and voltage, magnetic field and air gap, rotor insulation resistance, rectifier diode failure
- Powered by rotor excitation voltage







# PSPS Wivenhoe, Queensland Australia, 2x250MW | Safety and Diagnostic | SCADA communication



## Vibrations

- Relative shaft vibrations
- Absolute bearing vibrations
- Stator vibrations
- Stator blades

## Axial displacement

## Air gap

## Magnetic field

## Partial Discharge

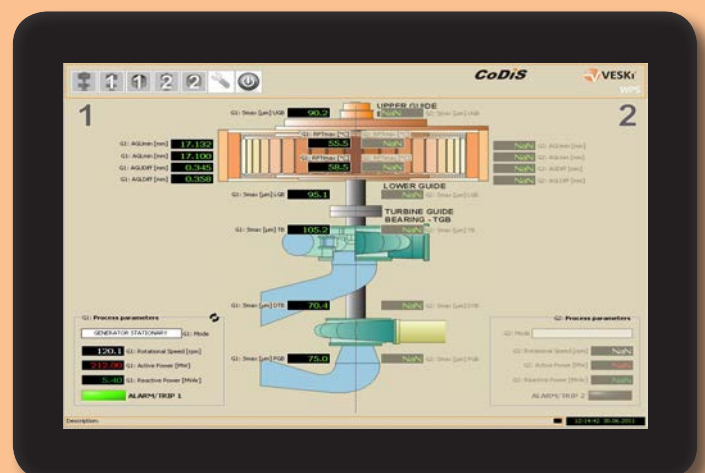
## Temperatures

## Process quantities

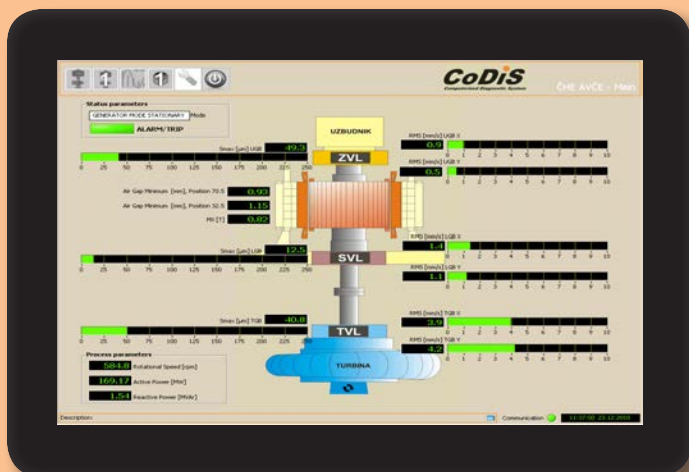
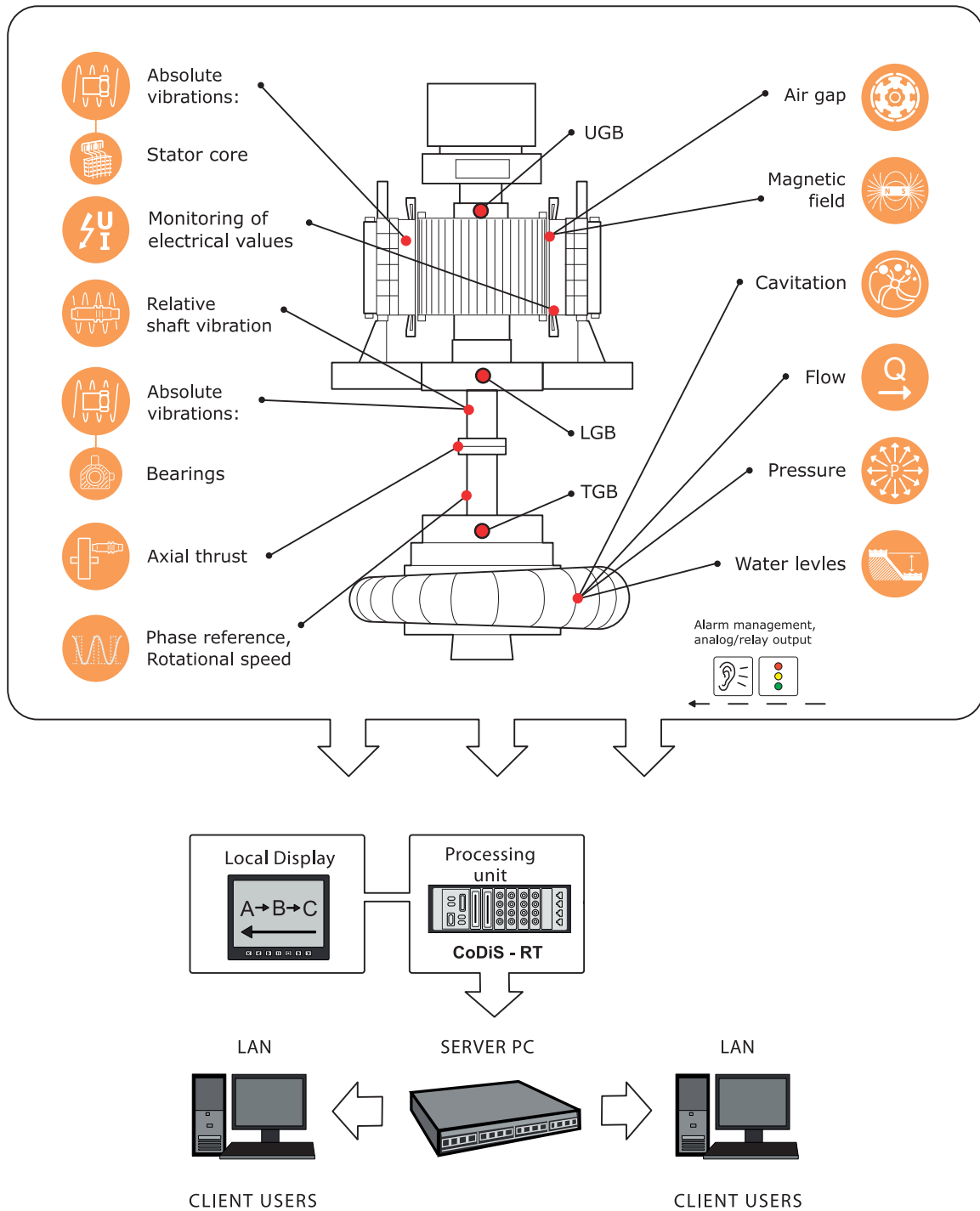
- Active power
- Reactive power
- Pressures
- Water head

## Rotor pole temperatures

- temperature sensors on 50 poles
- temperature sensors on 49 pole interconnections



## PSP Avce, Slovenia, 1x 185 MW | Variable speed | Safety and Diagnostic | SCADA communication



### Vibrations

- Relative shaft vibrations
- Absolute bearing vibrations
- Stator vibrations
- Stator blades

### Axial displacement

### Bearing clearance

### Air gap

### Magnetic field

### Partial Discharge

### Cavitation

### Hydraulic quantities on pipeline

### Electrical quantities

- Transient recording
- Power quality monitoring

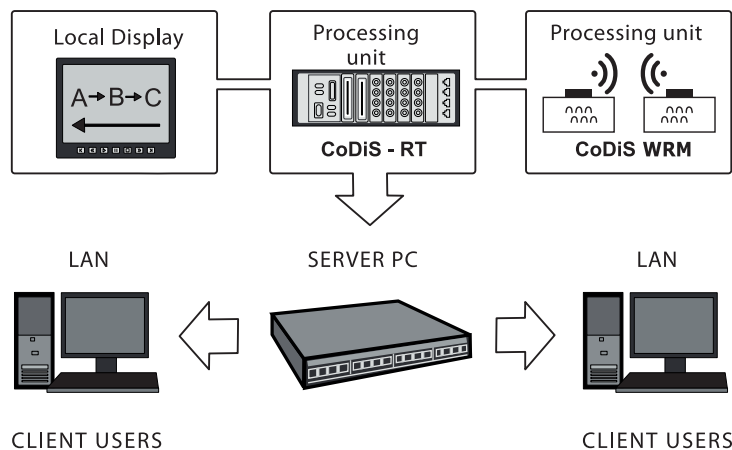
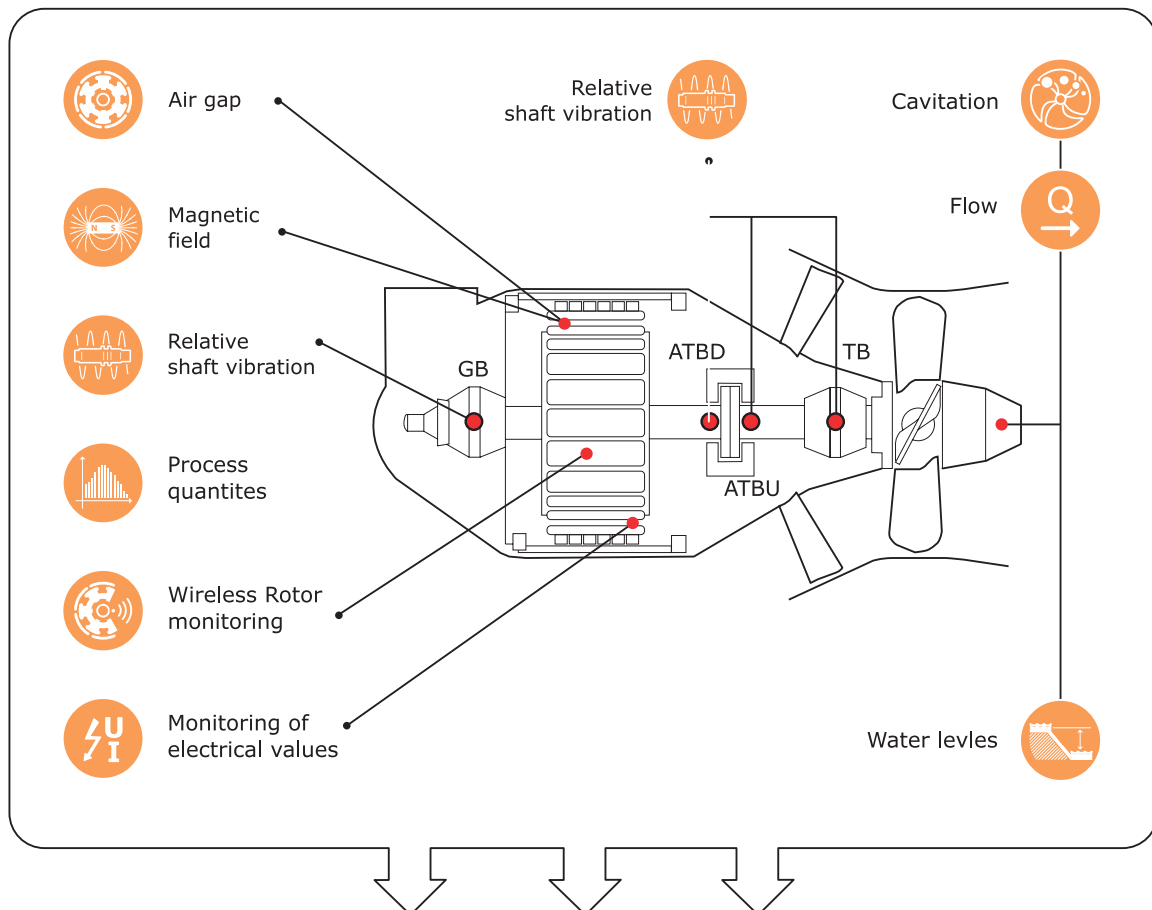
### Temperatures

### Process quantities

- Active power
- Reactive power
- Pressures
- Water head



## HPP Dubrava, Croatia, 2x39MW, 1x 1.2MW | Safety and Diagnostic



### Vibrations

- Relative shaft vibrations

### Axial displacement

### Air gap

### Magnetic field

### Electrical quantities

- Power quality monitoring

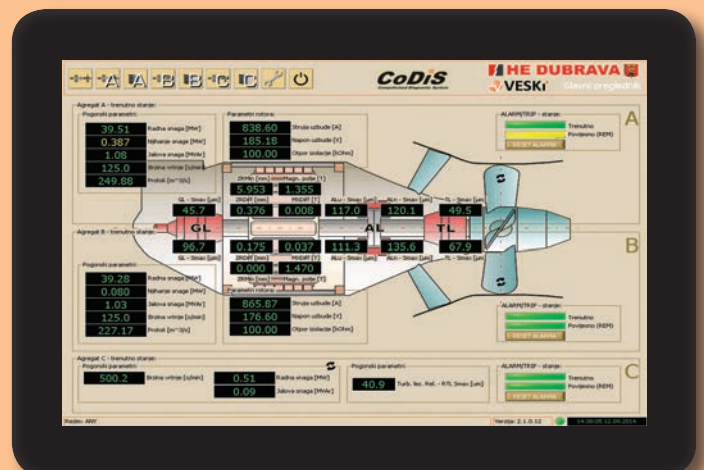
### Rotor monitoring

- Rotor pole temperatures
- Excitation current and voltage
- Insulation resistance

- Air Gap on rotor pole
- Magnetic field on rotor pole

### Process quantities

- Active power
- Reactive power
- Pressures
- Water head





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