Stay in Touch with Factory Automation Technology Webinars

www.siemens.com/tia

FA Webinar Scheduling Format

Week 18

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Session Times

Morning Session

- NZ: 11:30am
- NSW/VIC/QLD 09:30am
- SA: 09:00am
- WA: 07:30am

Afternoon Session

- NZ: 6:00pm
- NSW/VIC/QLD 4:00pm
- SA: 3:30pm
- WA: 2:00pm

This week's webinars

Tuesday 28th Morning

Industrial Internet of Things in Action

Callum McIntosh

Tuesday 28th Afternoon

Condition Monitoring

Chris Mears

Thursday 30th Morning

Condition Monitoring

Chris Mears

Thursday 30th Afternoon

Industrial Internet of Things in Action

Callum McIntosh

Next week's webinars

Tuesday 5th Morning

TIA Portal Multiuser Engineering

Heath Stranger

Tuesday 5th Afternoon

Machine Level Visualisation

Mark Karalapillai

Thursday 7th Morning

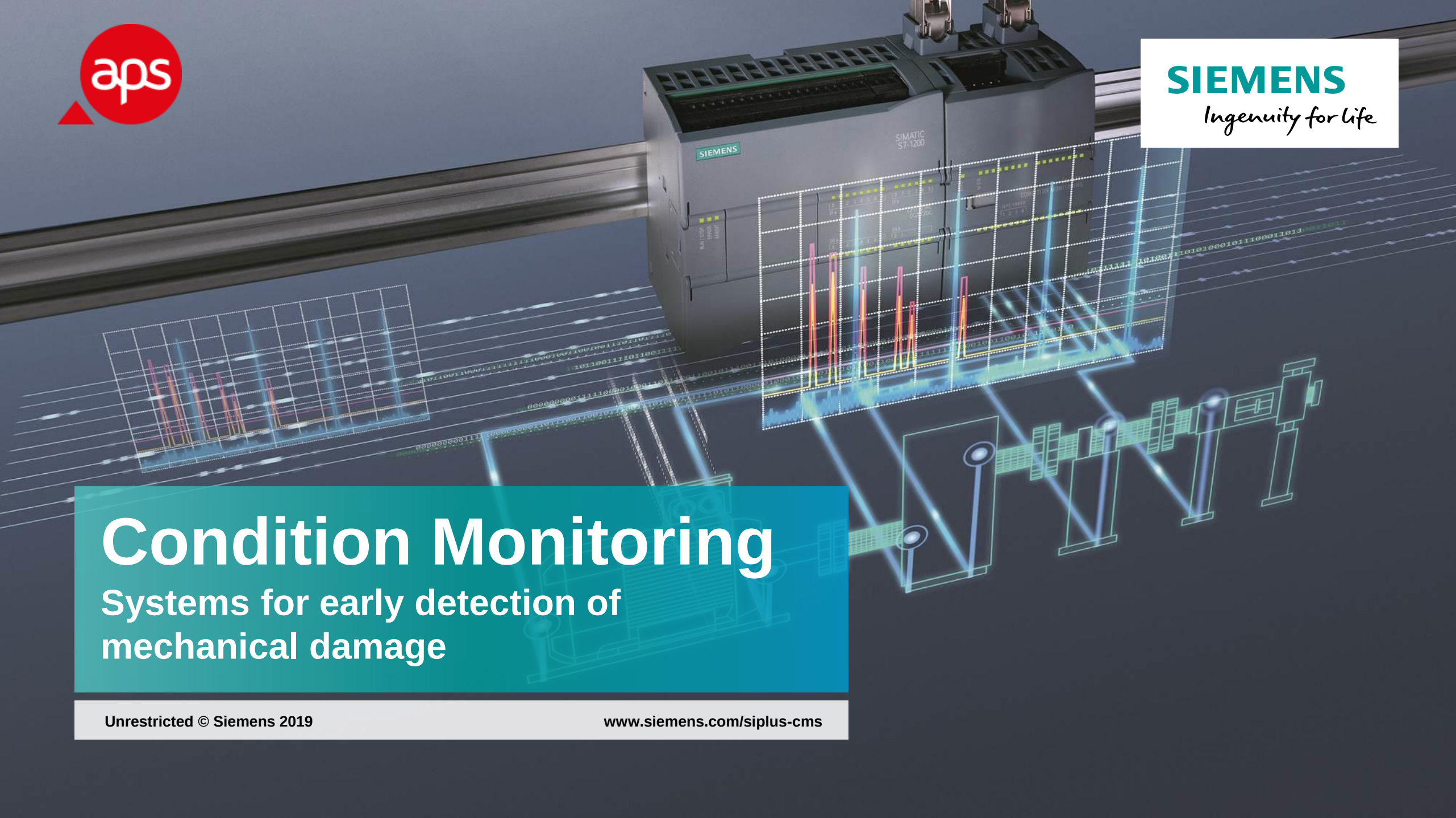
Machine Level Visualisation

Mark Karalapillai

Thursday 7th Afternoon

TIA Portal Multiuser Engineering

Heath Stranger

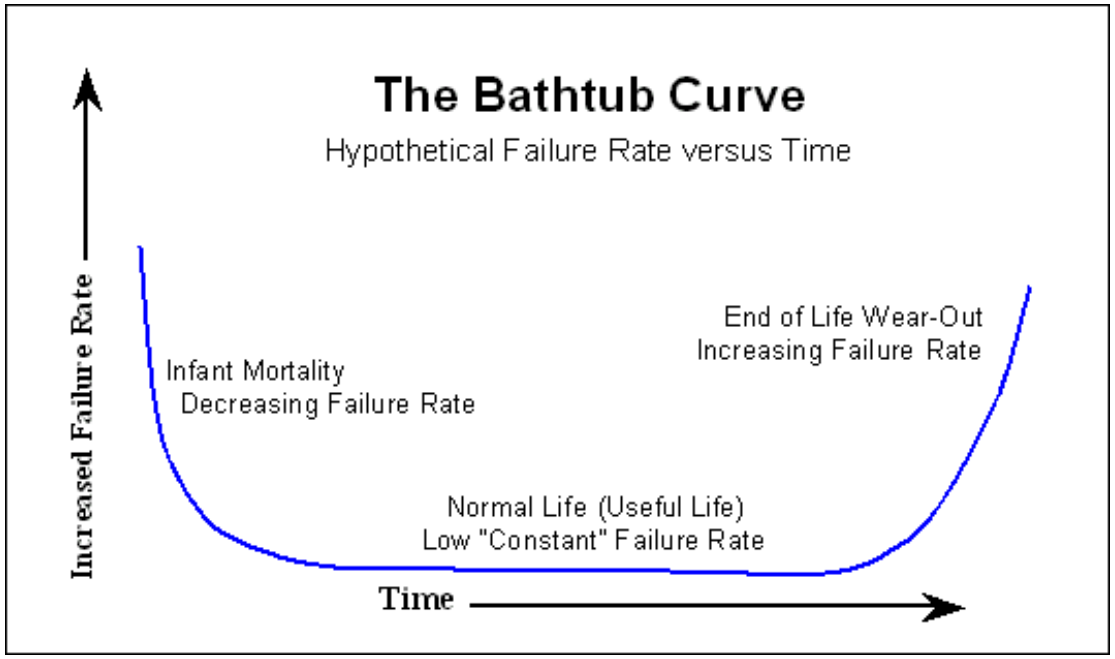


Condition Monitoring

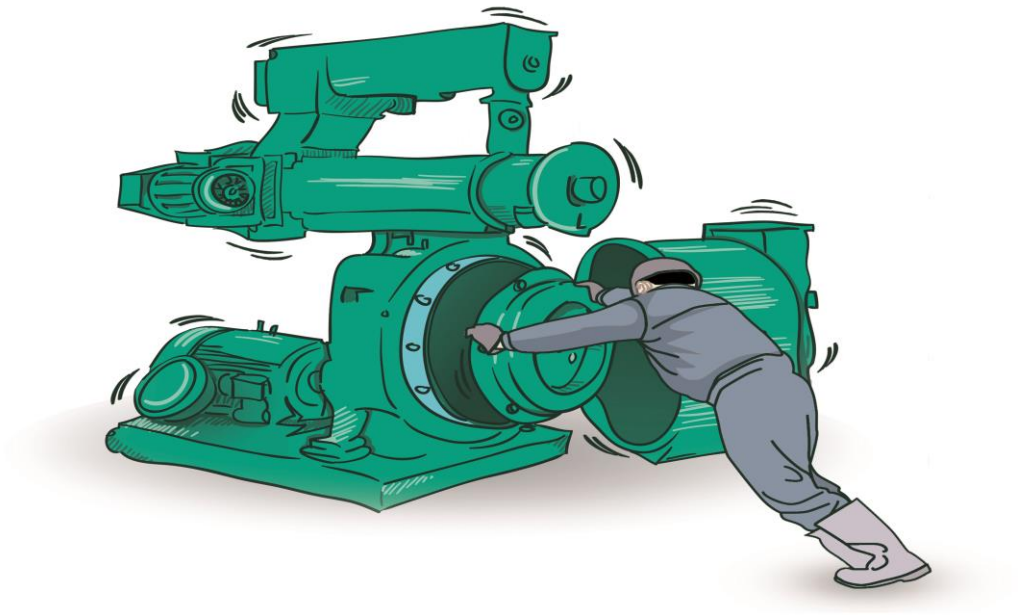
Systems for early detection of mechanical damage

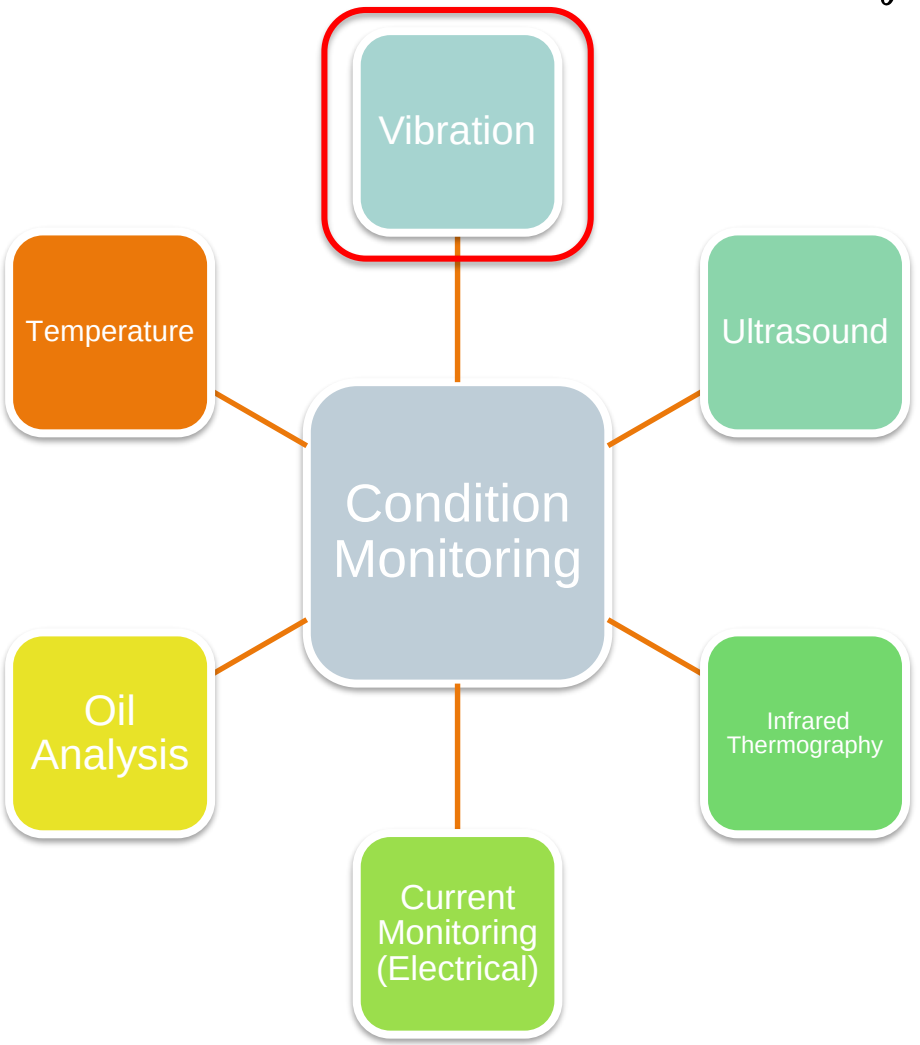
www.siemens.com/siplus-cms

Why do we want to Monitor our machines?



Types of Condition Monitoring





Why Vibration?

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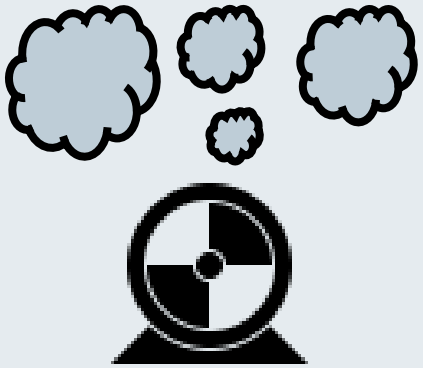
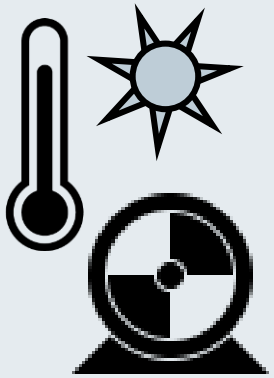
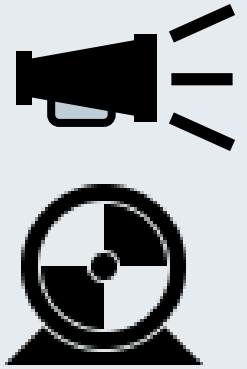
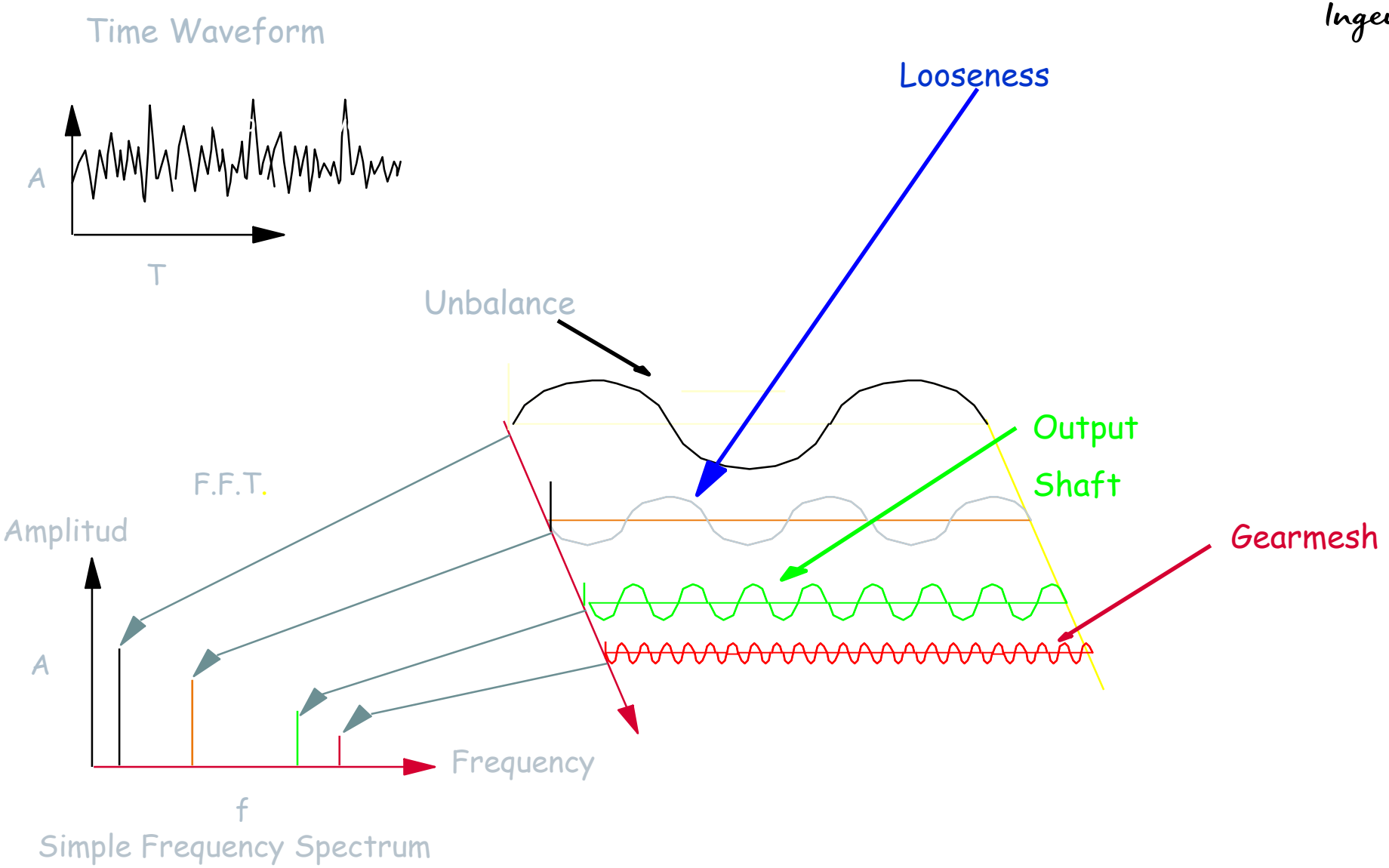
Watch	Feel	Hear	SIPLUS CMS
			
Smoke	**Heat**	**Noise**	**Early detection**
			
Minutes	**Days**	**Weeks**	**Months**

Reaction time until breakdown

How does it work?



What sort of damage can be detected?

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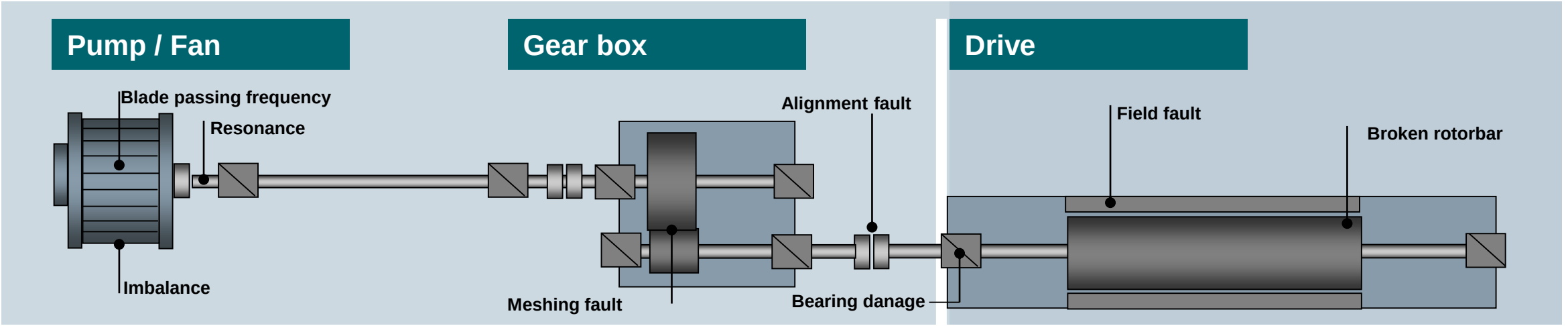


Condition Monitoring with SIPLUS CMS – more than just Motor Condition Monitoring

Mechanical damages

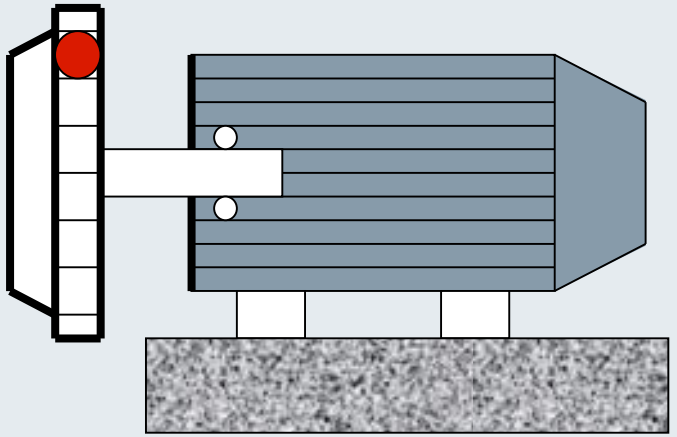
Resonance	Imbalance
Bearing damage	Meshing fault
Alignment fault	Blade passing frequency

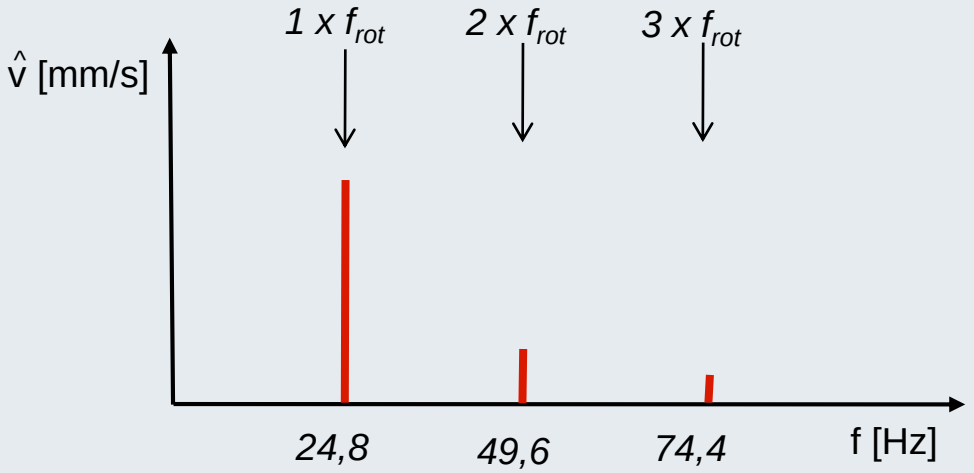
Electrical faults

Field fault stator
Broken rotorbar

SIPLUS CMS – Analysis methods
Examples of typical spectra - Unbalance

Machine speed	*n = 1488rpm*
Number of pole pairs	*p = 2*
Rotation frequency	*f_{rot} = 24.8Hz*





Amplitude of frequency of rotation is clear in horizontal and vertical measuring directions

SIPLUS CMS – Analysis methods

Examples of typical spectra - Alignment faults

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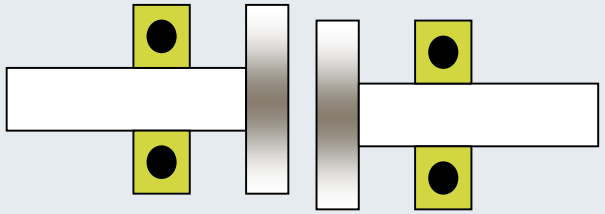
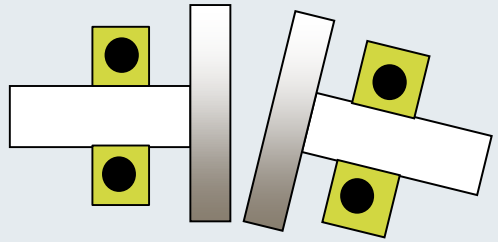
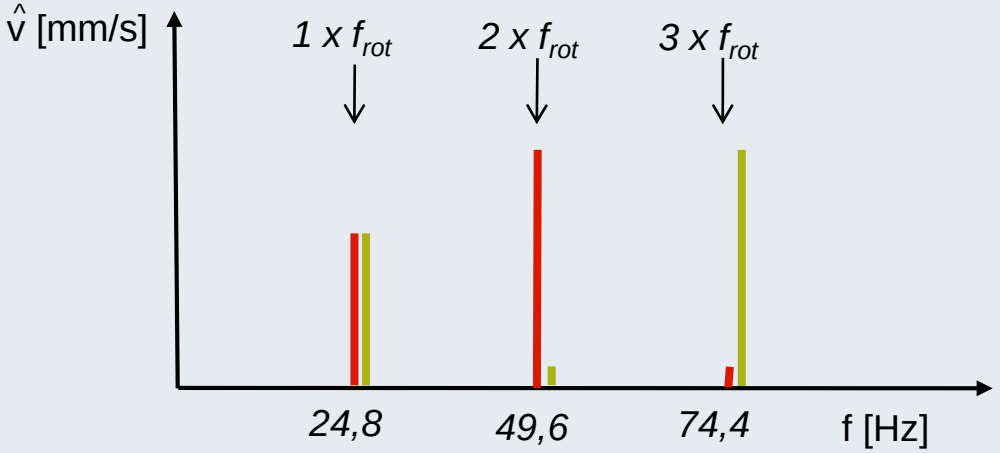




Machine speed *n = 1488rpm*
Rotation frequency f_{rot} *= 24.8Hz*



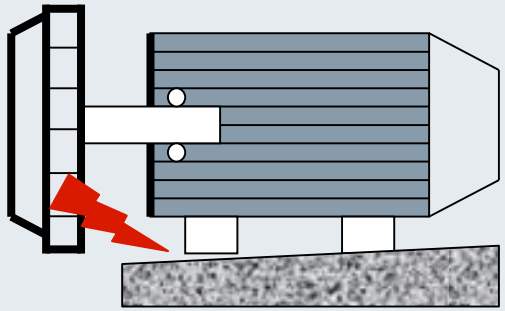
First and second frequency of rotation are considerably increased. The rise depends on the measurement direction, in accordance with the direction of the alignment fault.

For fixed coupling:
First and second frequency of rotation increased

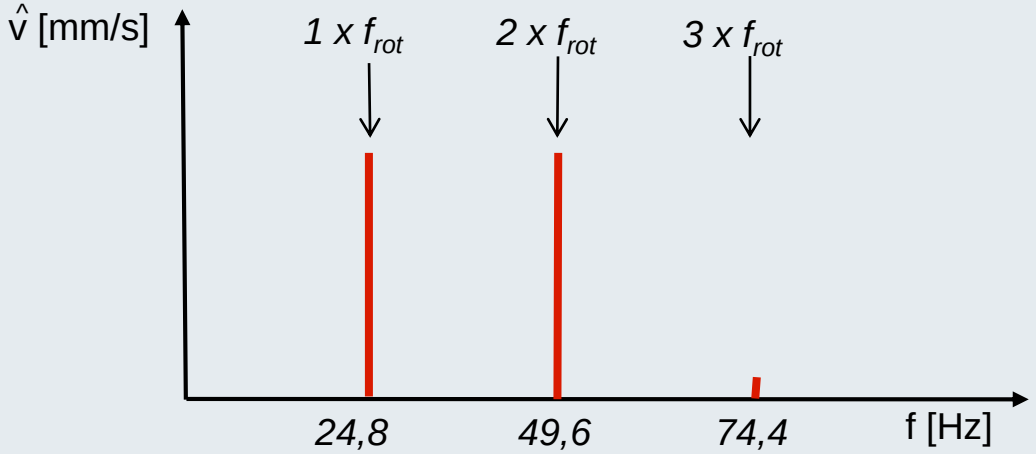
For elastic coupling:
First and third frequency of rotation increased

SIPLUS CMS – Analysis methods

Examples of typical spectra - Housing mounted with displacement



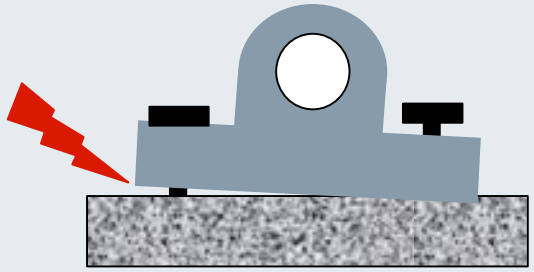
Machine speed $n = 1488rpm$
Rotation frequency $f_{rot} = 24.8Hz$



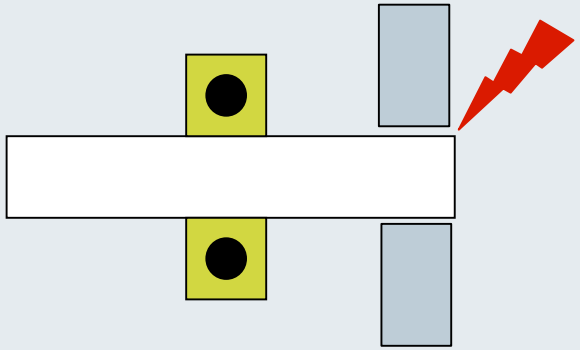
First and second frequency of rotation are considerably increased, usually in every direction of measurement (horizontal, vertical, axial).

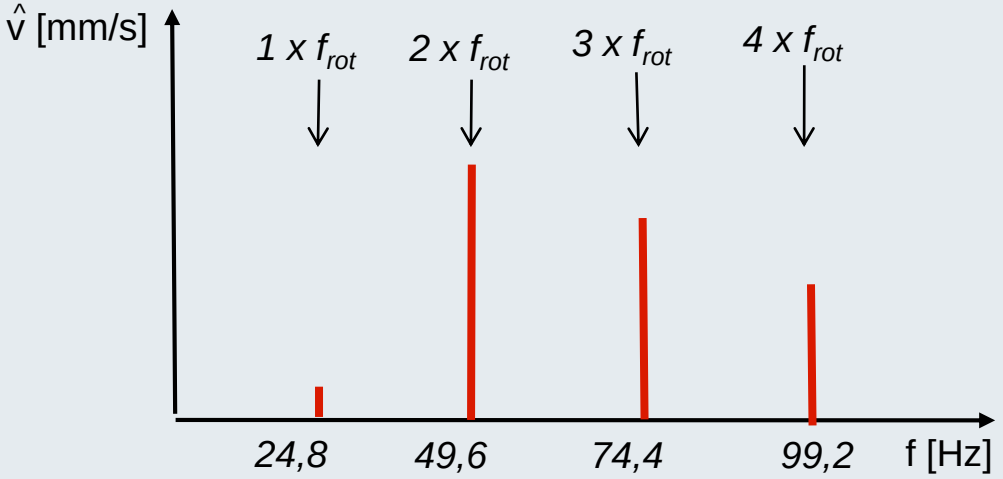
SIPLUS CMS – Analysis methods

Examples of typical spectra - Mechanical loosening



Machine speed $n = 1488rpm$
Rotation frequency $f_{rot} = 24.8Hz$

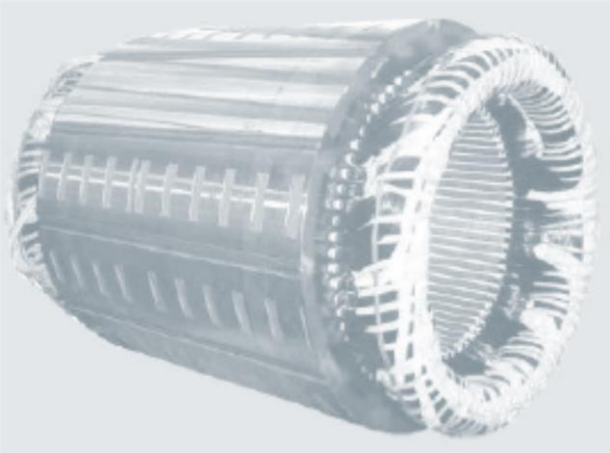




First frequency of rotation is practically non-existent, multiples (especially twice the frequency of rotation) are clearly visible.

SIPLUS CMS – Analysis methods

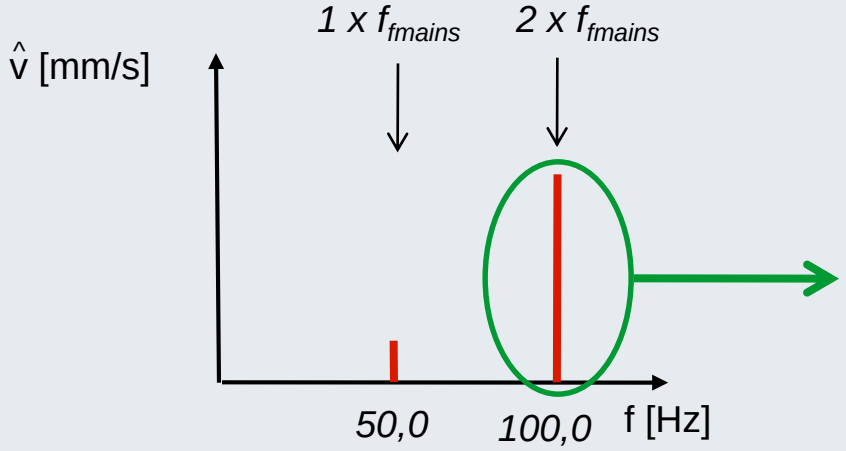
Examples of typical spectra - Field faults in stators

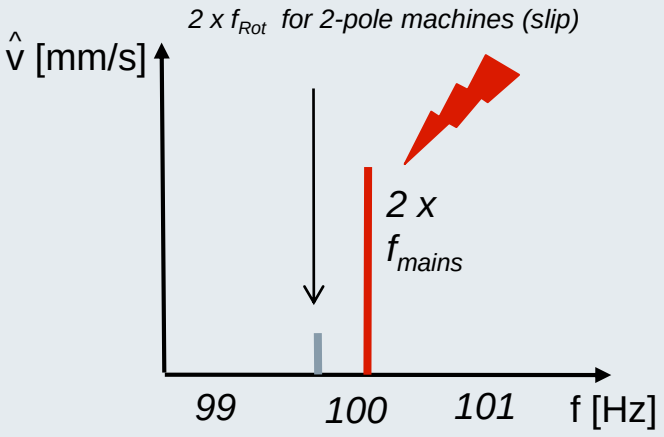


Possible causes:

- Eccentric rotor alignment
- Short circuit in the winding
- Asymmetric supply
- Switching fault in the winding

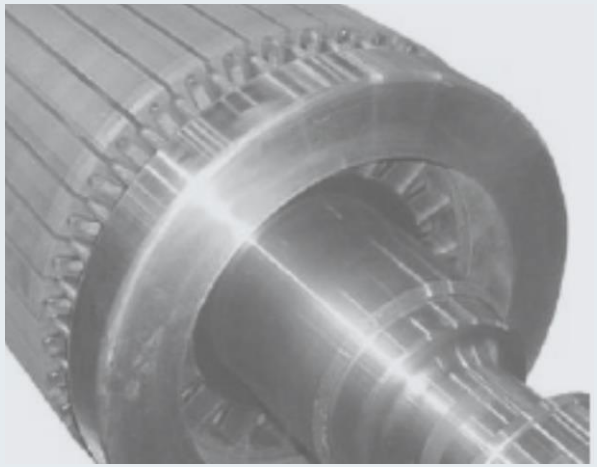
Increased level of twice the mains frequency. Mains frequency is 50/60Hz for direct drives. This varies in the case of converter operation.



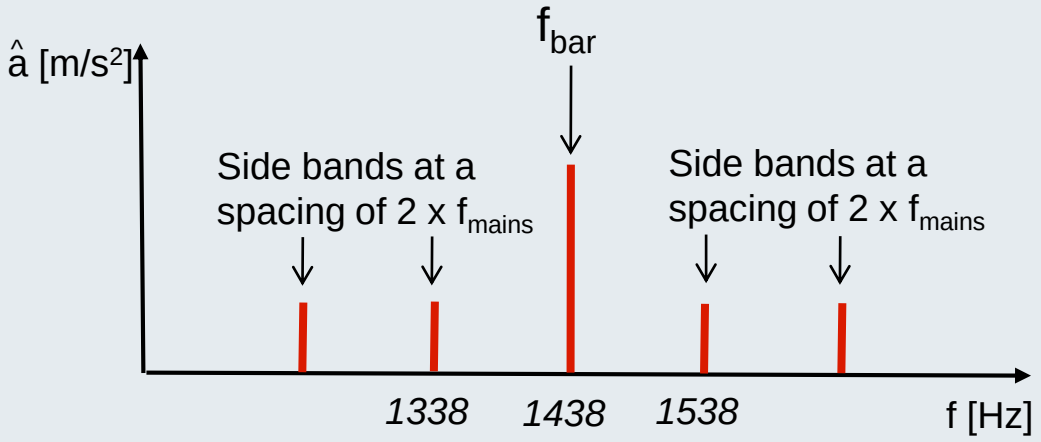


SIPLUS CMS – Analysis methods

Examples of typical spectra - Field faults in rotors



Number of bars	*58*
Machine speed	*1488rpm*
Rotation frequency	*f_{rot} = 24,8Hz*
Bar frequency	*f_{bar} = 58 x f_{Rot} = 1438Hz*



Possible causes:

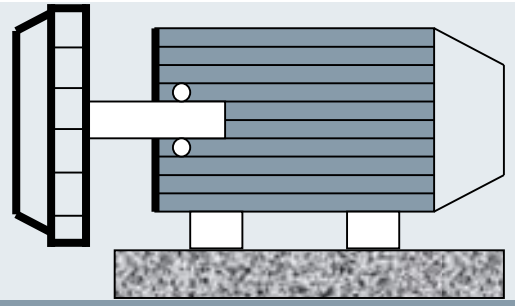
- Bar break
- Loose bar
- Broken connection between bar and short-circuit ring

These faults can be detected by:

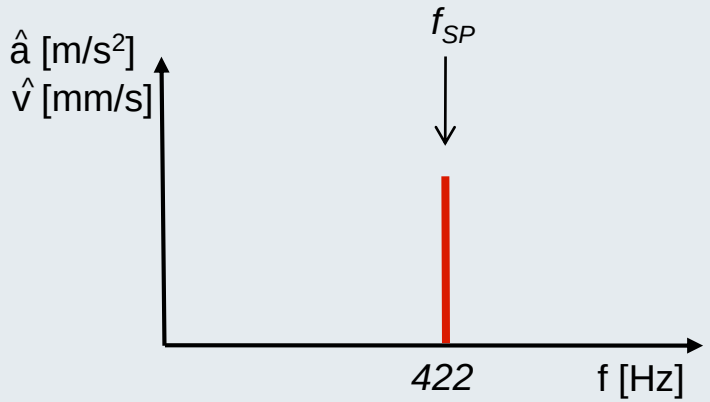
- Bar passing frequency with side bands of twice the mains frequency
- Twice the mains frequency with side bands of the slip frequency

SIPLUS CMS – Analysis methods

Examples of typical spectra - Blade passing frequency



Machine speed	*n = 1488rpm*
Rotation frequency	*f_{rot} = 24.8Hz*
Number of blades	*17*
Blade passing frequency	*f_{SP} = 17 x f_{rot} = 422Hz*



The blade passing frequency is a product of the number of impeller blades and the rotation frequency.

The impurity is on the housing.

In case of an increase of the blade passing frequency‘s amplitude

Every impeller blade generates a vibration peak, e.g. when the impeller blade runs past an impurity on the housing and by a short pressure vibration it experiences a shock impetus.

Caution:
Not to confuse with imbalance! Imbalance is usually caused by a part of a rotating component generating a vibration at rotational frequency, e.g. when material deposit at a impeller blade causes a asymmetric mass distribution towards the center.

Possible causes:

- Turbulence
- Suction pressure incorrectly dimensioned
- Adjustable blades have not been accurately set

The amplitude of the blade passing frequency has increased

SIPLUS CMS – Analysis methods

Examples of typical spectra - Meshing frequency

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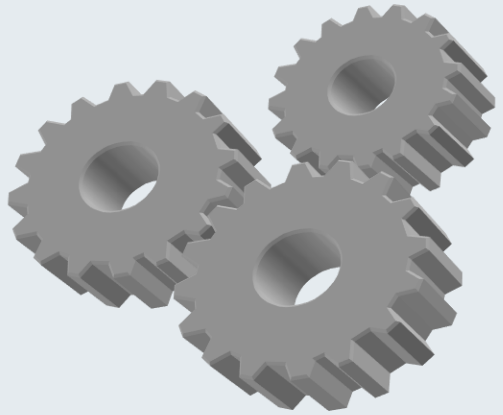
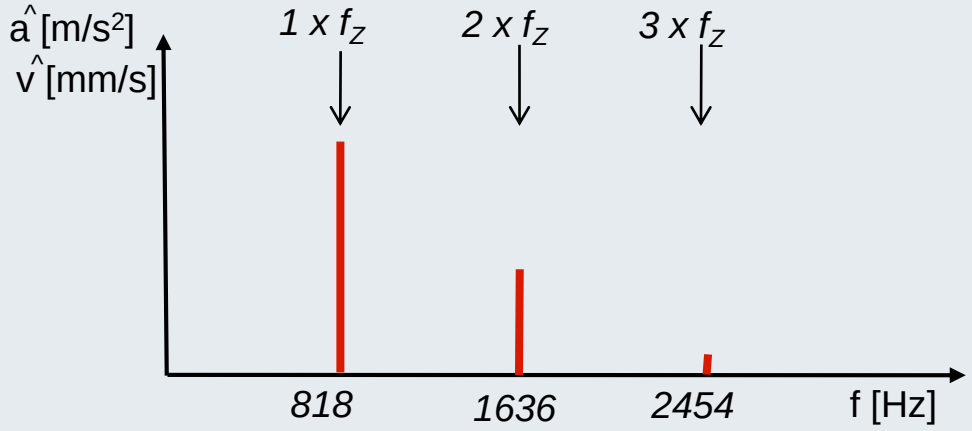


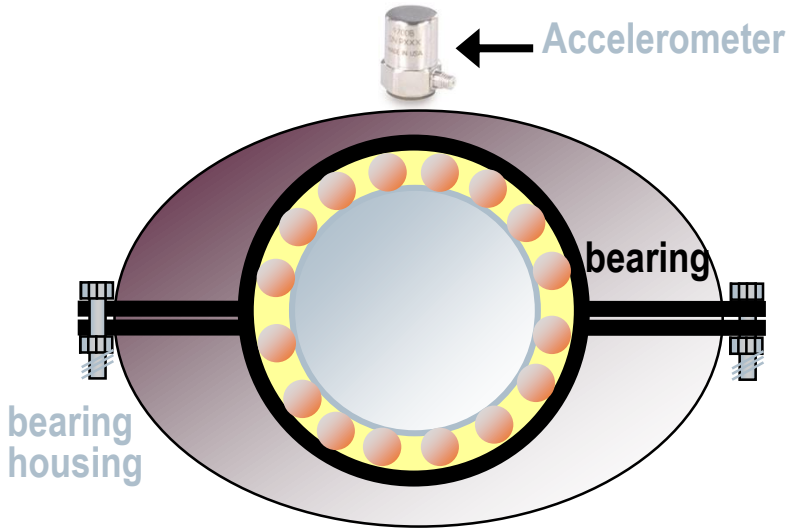
Machine speed *n = 1488rpm*
Rotation frequency f_{rot} *= 24.8Hz*
Number of teeth *33*
Meshing frequency $f_Z = f_{Rot}$ *x number of teeth = 818Hz*

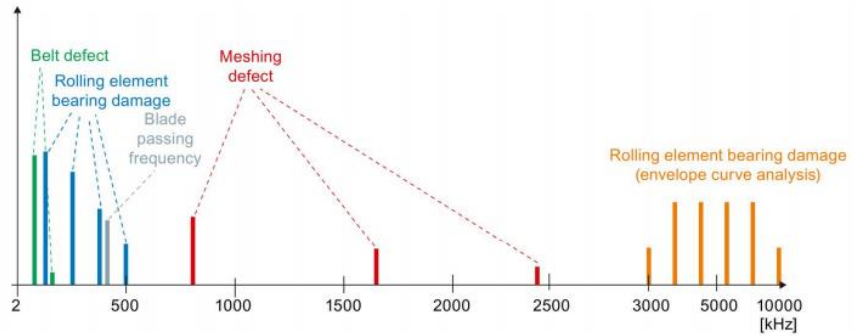


Gear unit spectra comprise numerous meshing frequencies and their harmonics, as well as side bands.

The frequencies depends on the geometry of the teeth.

Rolling Element Bearings





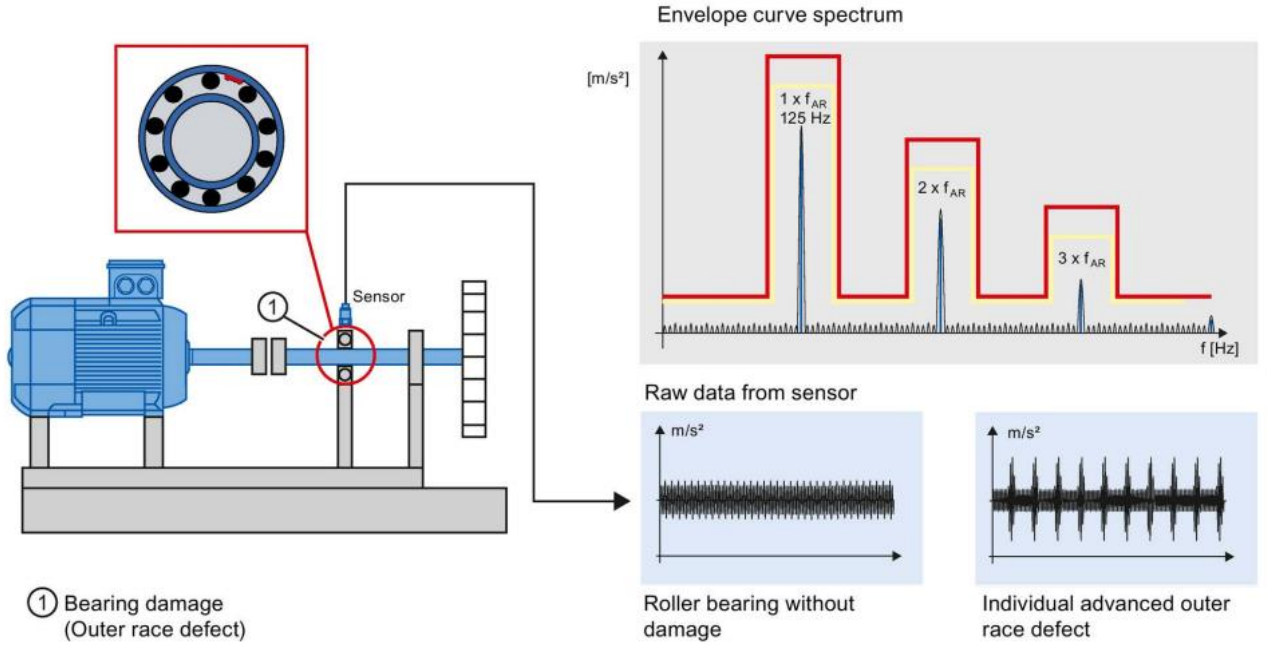
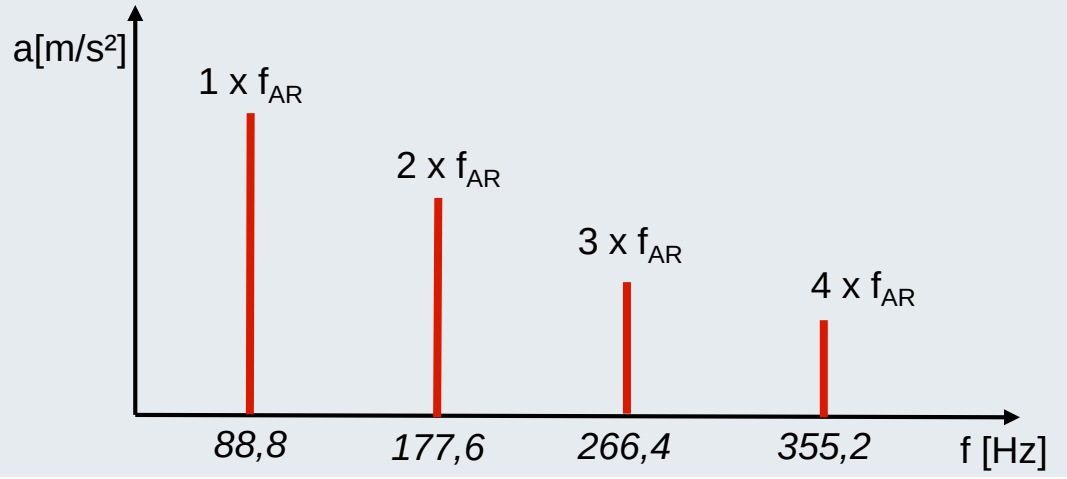


Image 4-7 Example of envelope curve analysis

SIPLUS CMS – Analysis methods

Examples of typical spectra - Roller bearing damage

Envelope curve spectrum of vibration acceleration, damage frequency of the outer ring 88,8Hz at a motor speed of 1488rpm = 24,8Hz



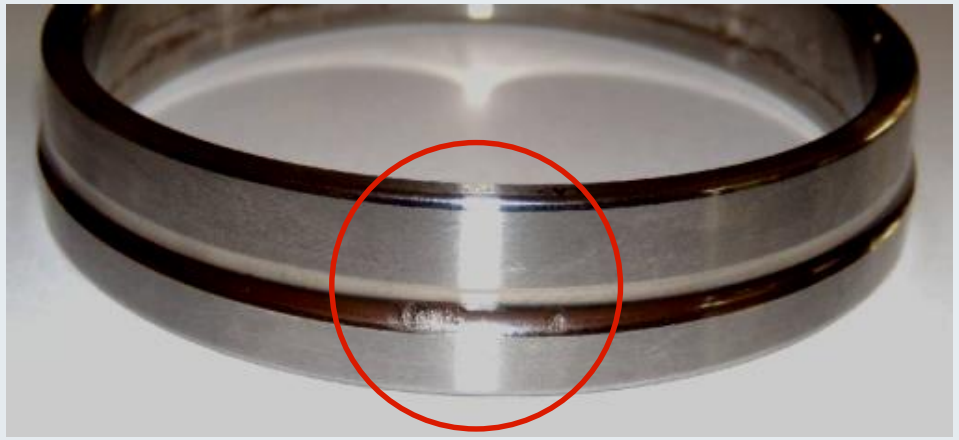
Outer ring damage

Damage frequently develops first in the raceway of the outer ring. These faults can normally be detected several months before a critical condition develops by using envelope curve analysis.

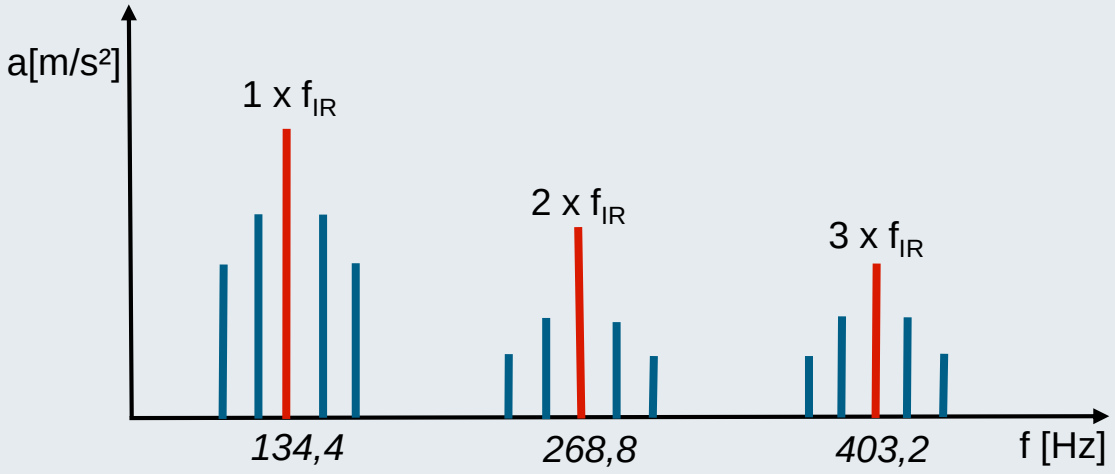
The damage frequency is presented in the envelope curve spectrum without modulation.

SIPLUS CMS – Analysis methods

Examples of typical spectra - Roller bearing damage



Envelope curve spectrum vibration acceleration, inner ring damage frequency 134,4Hz
At a motor speed of 1488rpm = 24,8Hz
Sidebands with distance of the mechanic rotation frequency (24,8Hz)

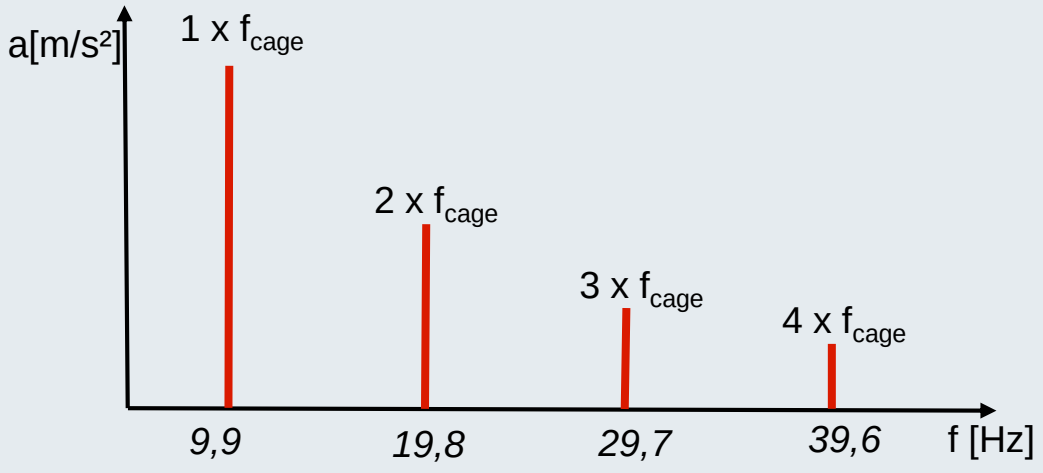


Inner ring damage

These faults can normally be detected several weeks before a critical condition develops by using envelope curve analysis.
Inner ring damage runs through the load zone periodically. In the envelope curve spectrum, the damage frequency therefore presents with side bands at a distance equal to the frequency of rotation f_{Rot}.

SIPLUS CMS – Analysis methods

Examples of typical spectra - Roller bearing damage



Envelope curve spectrum of vibration acceleration, damage frequency of the cage 9.9Hz
At a motor speed of 1488rpm = 24,8Hz

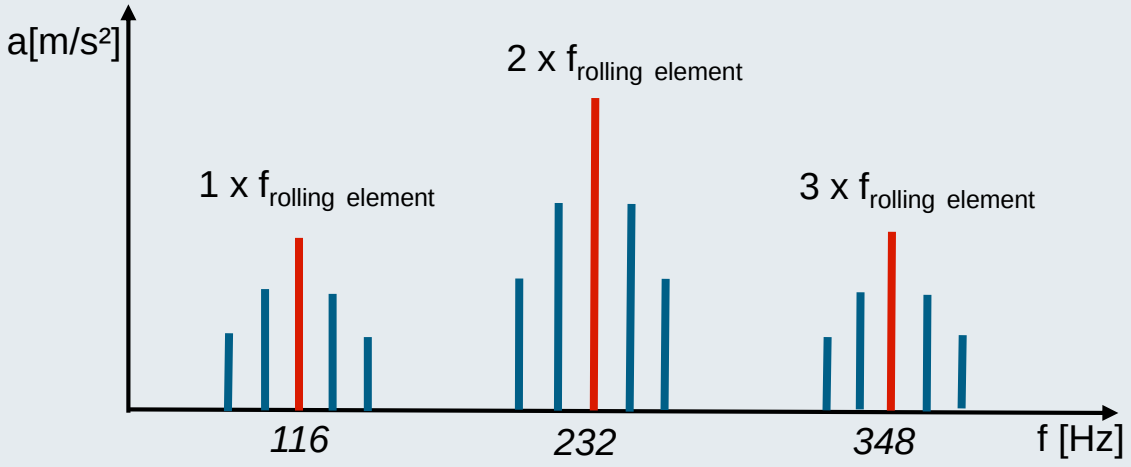
Cage damage

Cage damage results in failure of the bearing within a very short period of time.

The damage frequency is presented in the envelope curve spectrum without modulation.

SIPLUS CMS – Analysis methods

Examples of typical spectra - Roller bearing damage



Envelope curve spectrum vibration acceleration, damage frequency of rolling element 116Hz
at a motor speed of 1488rpm = 24,8Hz,
Siede bands with the distance of cage frequency 9.9Hz

Rolling element damage

Rolling element damage results in failure of the bearing within a very short space of time.

In the envelope curve spectrum, the damage frequency is presented with side bands at a distance equal to the cage rotation frequency. In praxis the peaks of the 2., 4., 6…. order are more visually in the envelope curve spectrum.

What can we do with all this?

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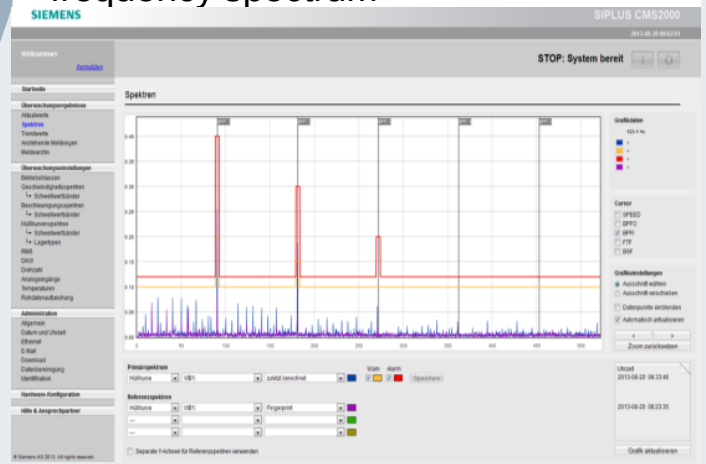
Significance of the analysis

Parameter-based analysis

- Is damage imminent?
- Trend history of characteristic values

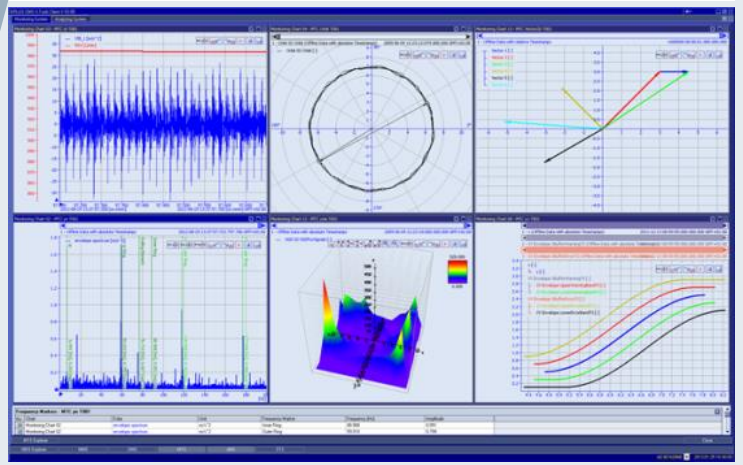
Frequency-selective analysis

- What damage is imminent?
- Every type of damage has its own frequency spectrum



Expert analysis

- Freely configurable analysis with diagnostics software CMS X-tools, e.g. orbit, histogram, vector/waterfall diagram



SIPLUS CMS1200: Condition Monitoring with SIMATIC S7-1200

SM1281 - Overview

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SM 1281 Condition Monitoring Model

Features

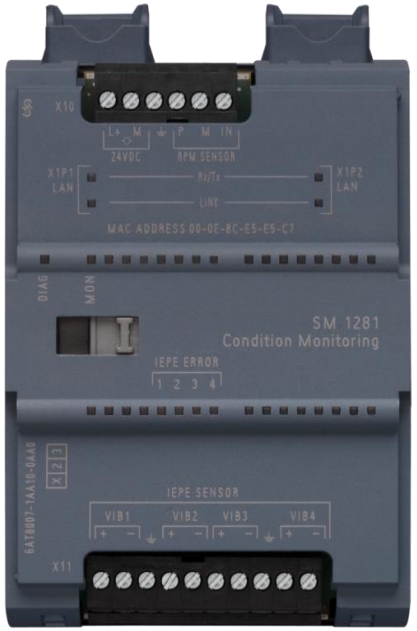
- Characteristic-based diagnostics
- Frequency-selective diagnostics
- Export of raw data
- SIMATIC and web-based

Connections

- Up to 4 vibration sensors (IEPE-sensors)
- 1 optional speed input (Bero)
- Ethernet (2 ports)
- Power supply 24VDC

Expansion option

Up to 7 modules can be connected; depending on the S7-1200 CPU used



BERO

IEPE-sensors

Operating principle

- Calculations are performed continuously
- The 4 IEPE channels and the speed sensor are read in and processed simultaneously

Diagnosis

- Characteristic values via SIMATIC S7-1200 and TIA Portal
- Frequency selective via integrated Web Server

Advantages and Costumer benefits

No additional software for diagnosis and visualizing needed

SIPLUS CMS1200: Condition Monitoring with SIMATIC S7-1200

SM1281 – What is required?

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Hardware requirements

S7-1200 CPU	Max. connectable SM1281
CPU 1211C	None
CPU 1212C	2
CPU1214C / 1214FC	7
CPU 1215C / 1215FC	7
CPU 1217C	7

Important:

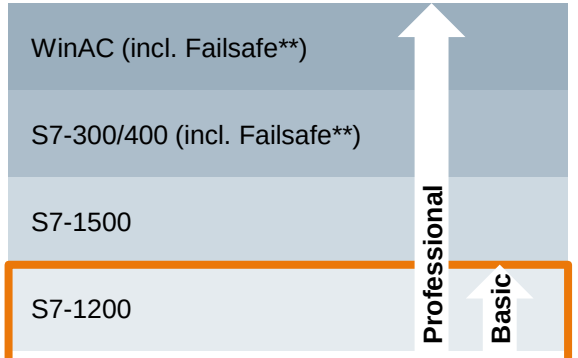
SM 1281 is supported as of FW version V4.1 for S7-1200 CPU

Software requirements

SIMATIC STEP 7

Programming languages
KOP, FUP, SCL, AWL*, S7-GRAPH*

STEP 7 Safety option package



- **TIA Portal is required to configure the module**
- **The lowest license, SIMATIC STEP 7 Basic, is sufficient for S7-1200**

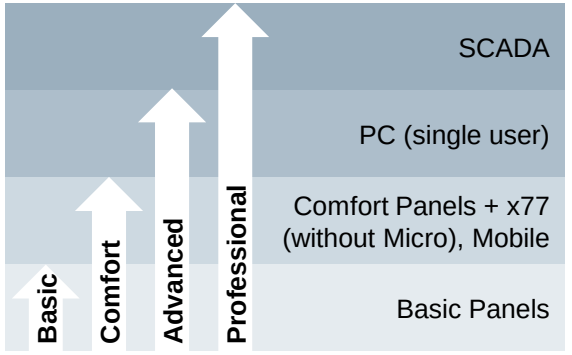
***) Not available for S7-1200**

Optional software

SIMATIC WinCC

Machine-level operating and monitoring

SCADA applikations



- **If panels are used, optional use of the corresponding WinCC version is possible**

→ Browser functionality for panels is NOT supported by SM1281

SIPLUS CMS1200: Analysis methods
SM1281 – Overview

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Parameter-based analysis

Monitoring of machine vibration based on characteristic values

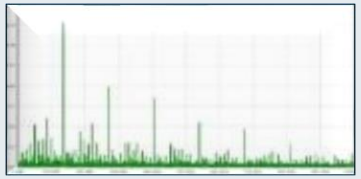
- Simple representation, e.g. via traffic light
- Trend analysis

Engineering in TIA Portal + analysis via integrated software

Frequency-selective analysis

Frequency-selective diagnostics of machine vibration and bearing

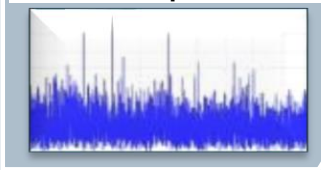
- Spectrum view via browser
- Integrated message system



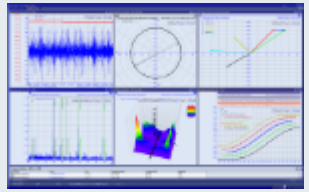
Engineering in TIA Portal / SM 1281 web-interface + analysis via integrated software

Expert analysis

Online Datastreaming / Raw Data Export



e.g. CMS X-Tools



Freely configurable analysis models, e.g. for

- Detail analysis
- Gearbox diagnostics
- …

Engineering via separated analysis-software e. g. CMS X-Tools

Monitoring online in SM1281

Raw data analysis: on- or offline

System setup, engineering, parameter for parameter-based analysis

Engineering with TIA Portal		
Module parameters	Channel parameters	Parameters for characteristic-value-based analysis

Evaluation of limits for characteristic values

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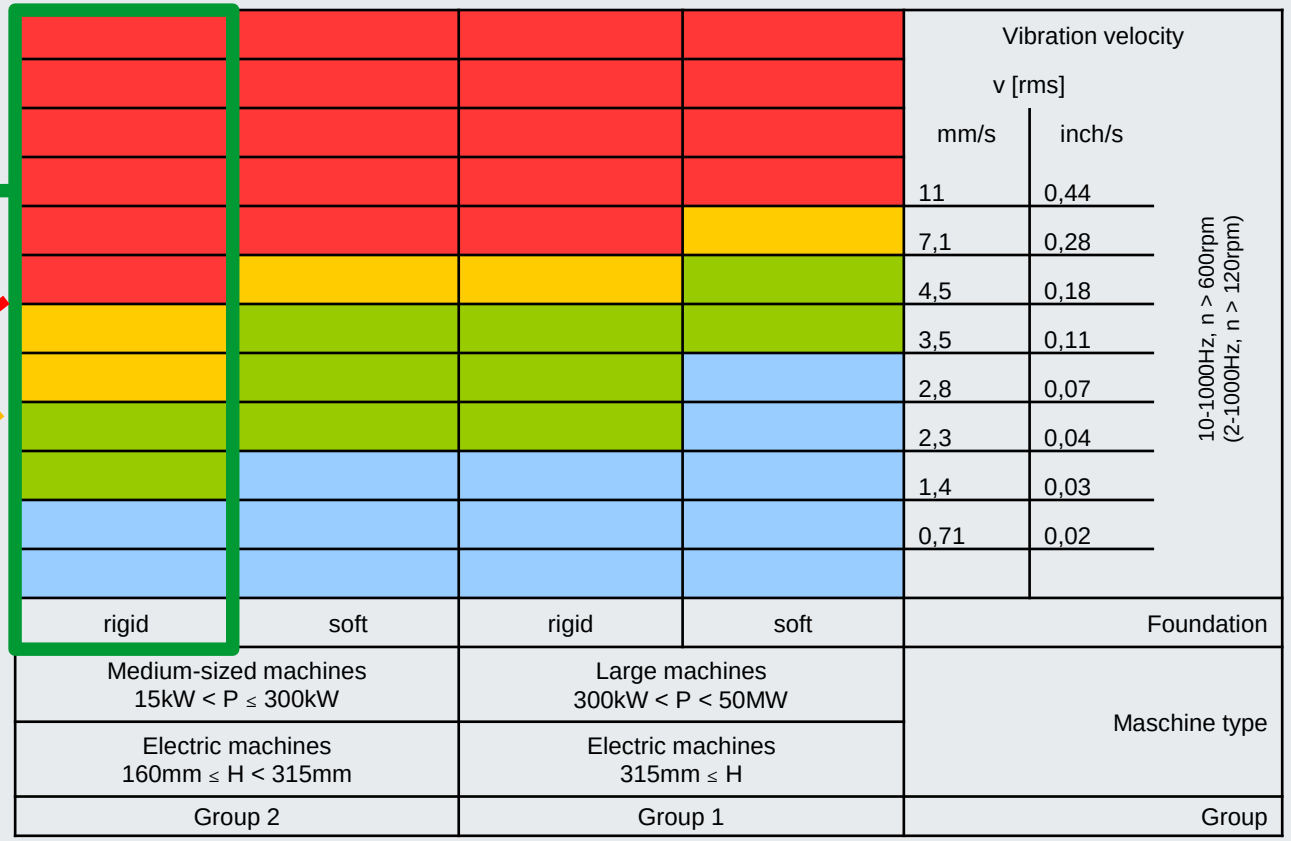
Basic data for determining the limits according to ISO10816-3

Motor nominal power: 20kW
Shaft height: 100mm
Foundation: rigid
The fan was newly commissioned.

Limit values

Alarm limit: 4,5 mm/s

Warning limit: 2,8 mm/s



Vibration velocity v [rms] mm/s	inch/s	10-1000Hz, n > 600rpm (2-1000Hz, n > 120rpm)
11	0,44	
7,1	0,28	
4,5	0,18	
3,5	0,11	
2,8	0,07	
2,3	0,04	
1,4	0,03	
0,71	0,02	

rigid	soft	rigid	soft	Foundation
Medium-sized machines 15kW < P ≤ 300kW		Large machines 300kW < P < 50MW		Maschine type
Electric machines 160mm ≤ H < 315mm		Electric machines 315mm ≤ H		
Group 2		Group 1		Group

System setup, engineering, parameter for parameter-based analysis

FB SM1281_Module

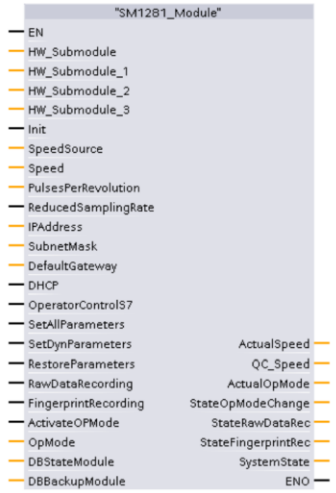


Image 11-1 FB SM1281_Module

FC SM1281_Channel

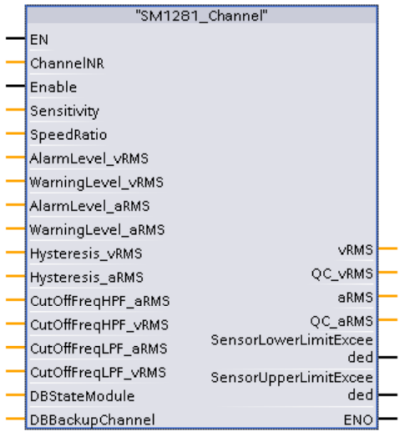
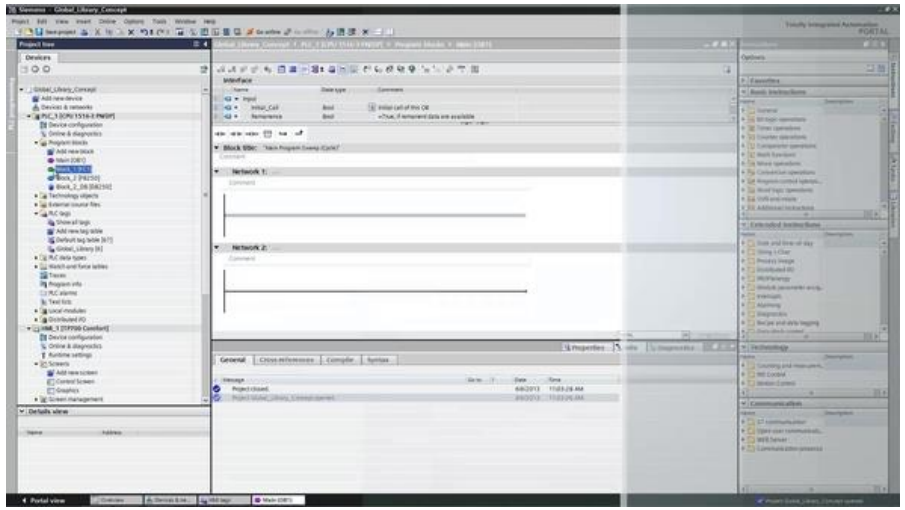


Image 11-2 FC SM1281_Channel



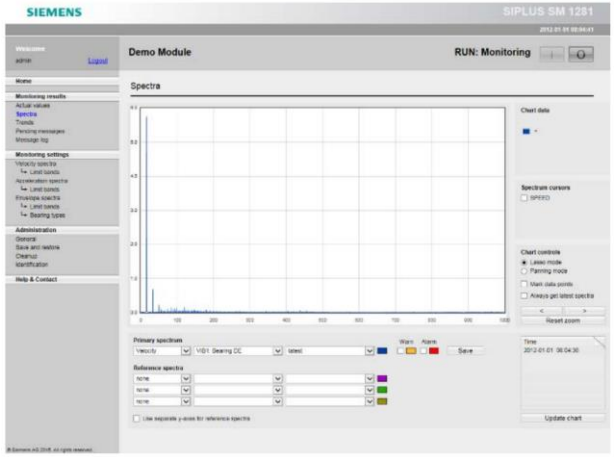
System setup, engineering, parameter for frequency-selective analysis

Engineering with TIA Portal			Engineering via Web-Interface SM 1281
Module parameters	Channel parameters	Parameters for characteristic-value-based analysis	Parameter for frequency-selective analysis
No additional software needed ➔ SM 1281 has everything on board			

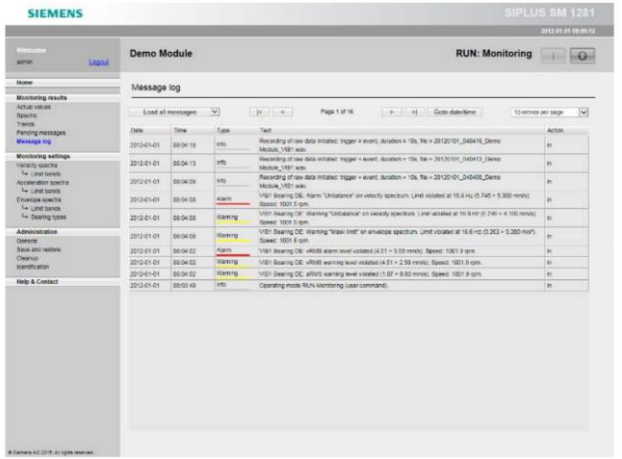
System setup, engineering, parameter for frequency-selective analysis

Trends

Spectra



Alarm Logs



Realizing the practical example with SM1281
Optional operation

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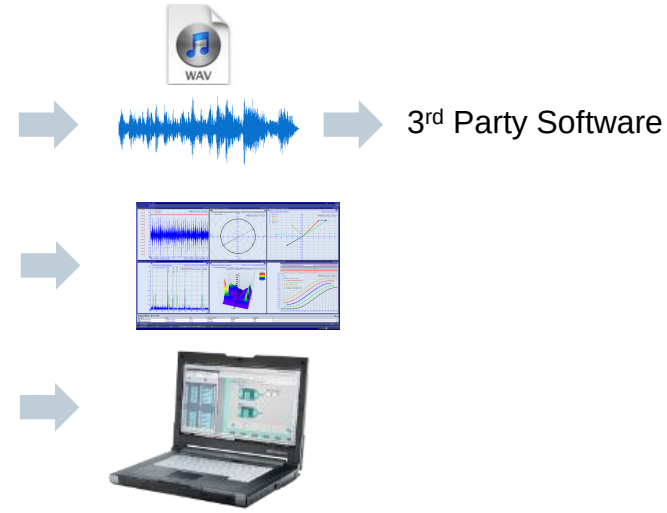
Own SM1281 Ethernet network

- Networks for maintenance and production can be separated

→ Detailed diagnostics WITHOUT load on the production network



Planning, analysing, diagnosing
with CMS X-Tools

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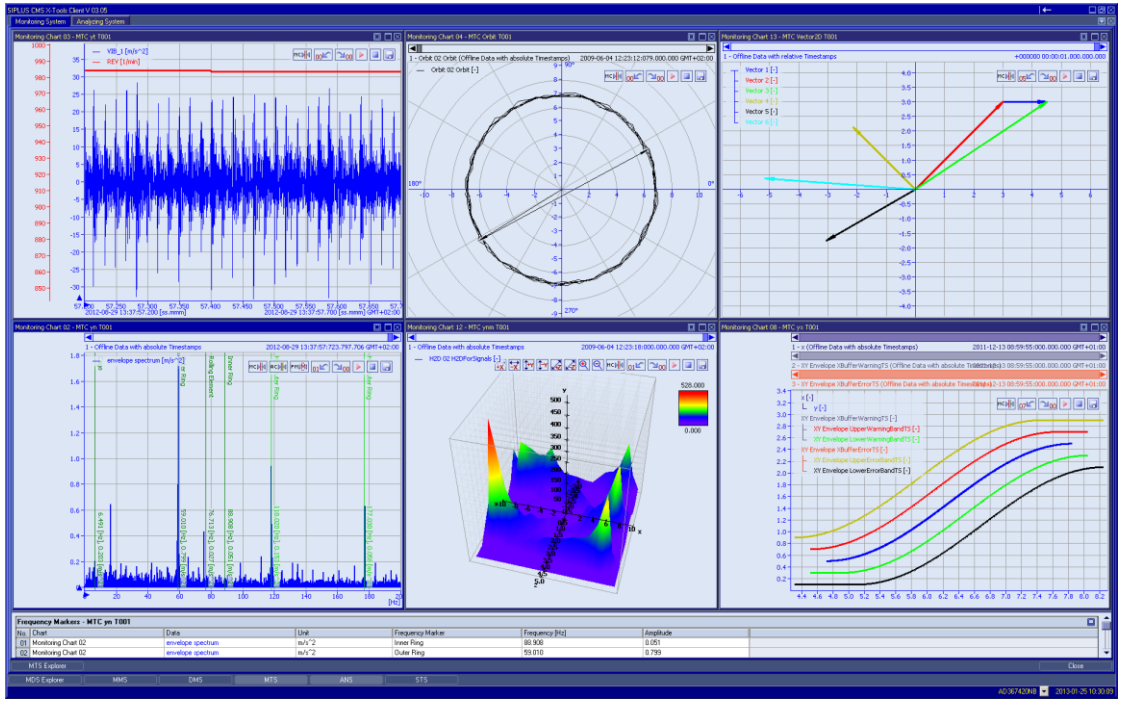
Analysis software CMS X-Tools

- Huge library of graphically interconnectable analyis components
- Display of measurement and analysis data
- Fast and easy archiving
- Multi-user operation (client-server architecture)
- Open SW-interface for scada-systems and further programs via OPC UA
- Supporting Remote Service (e.g. cRSP)
- Process plattform on the standard PC with Windows operating system



SIPLUS CMS1200
SM1281 - Order Information

SIEMENS
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Pos.	Product	MLFB	Additional Information
1	SIPLUS CMS1200 SM 1281 Condition Monitoring	6AT8007-1AA10-0AA0	SM 1281
2	SIPLUS CMS1200 SM 1281 shield clamp set	6AT8007-1AA20-0AA0	For EMC-compliant connection of signal
4	SIPLUS CMS2000 VIB-SENSOR*		Sensor for SM 1281
5	SIPLUS CMS2000, CABLE-MIL-300*	6AT8002-4AC03	Cable length 3m
6	SIPLUS CMS2000, CABLE-MIL-1000*	6AT8002-4AC10	Cable length 10m

* VIB-Sensors and cable can be used for CMS1200, CMS2000 and CMS4000.

SIPLUS CMS
The three Condition Monitoring Systems

SIEMENS
Ingenuity for life

CMS1200
Integrated and flexibly expandable

- Monitoring with SIMATIC for 1-7 drive trains per station
- Analysis software on board

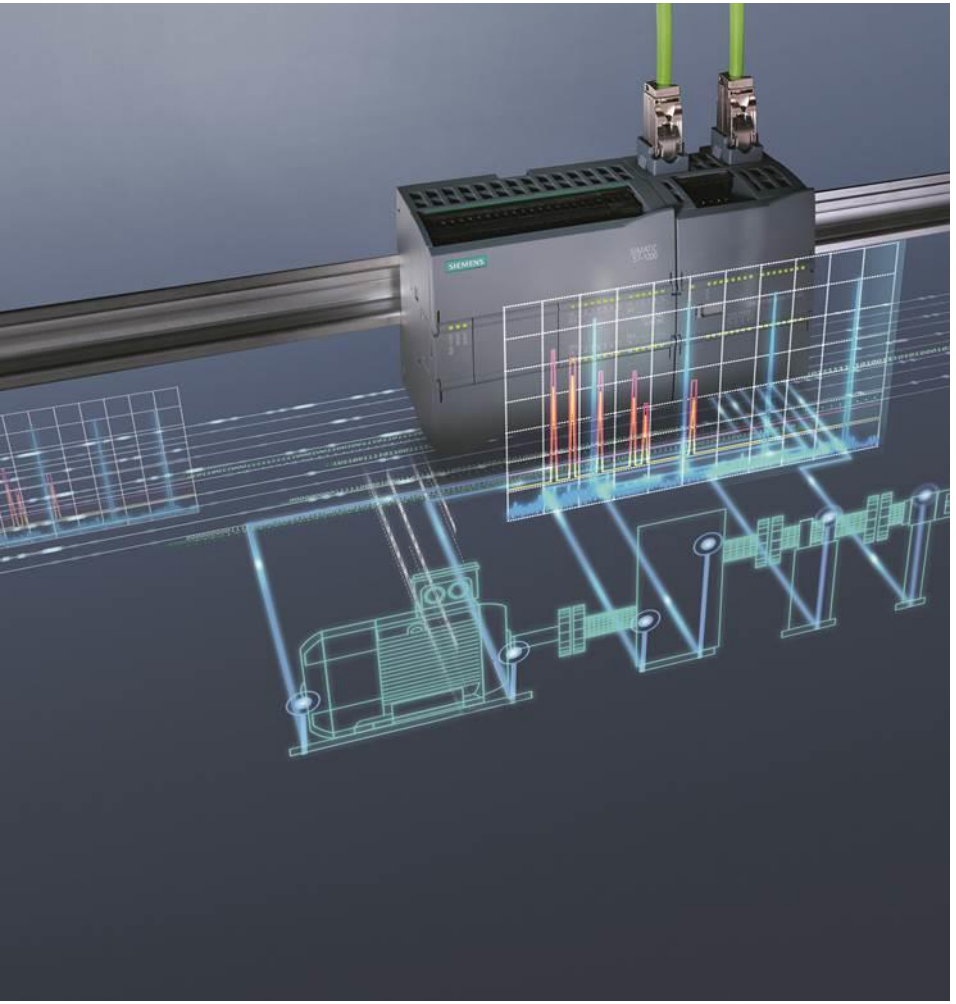
CMS2000
Modular and autonomous

- SIMATIC-independent monitoring for 1-4 drive trains per station
- Analysis software on board

CMS4000
Powerful and freely configurable

- Autonomous monitoring of the drive trains of complete plants
- Monitoring of slide bearings
- CMS X-Tools as analysis software

Thank you for your attention



siemens.com/siplus-cms