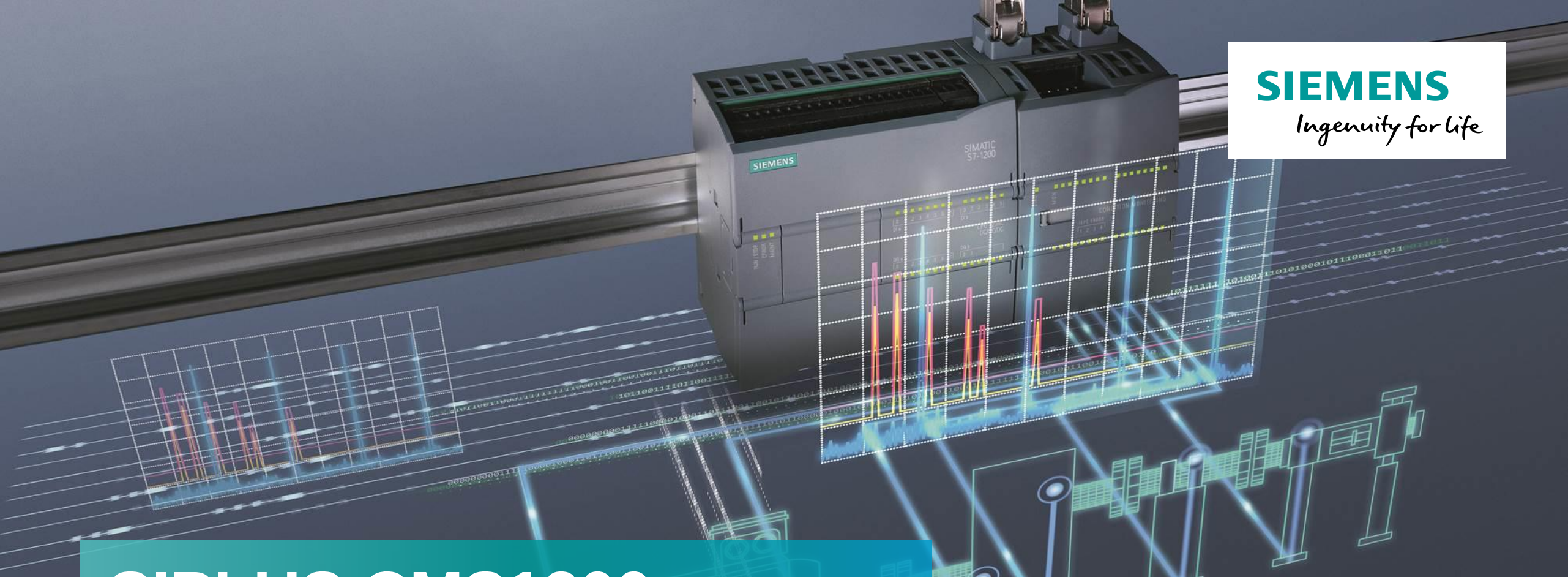

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Ingenuity for life

SIPLUS CMS1200 – SM 1281 Technical Slides

Agenda

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SIPLUS CMS1200: Condition Monitoring with SIMATIC S7-1200

SM 1281 – Early detection of mechanical damage

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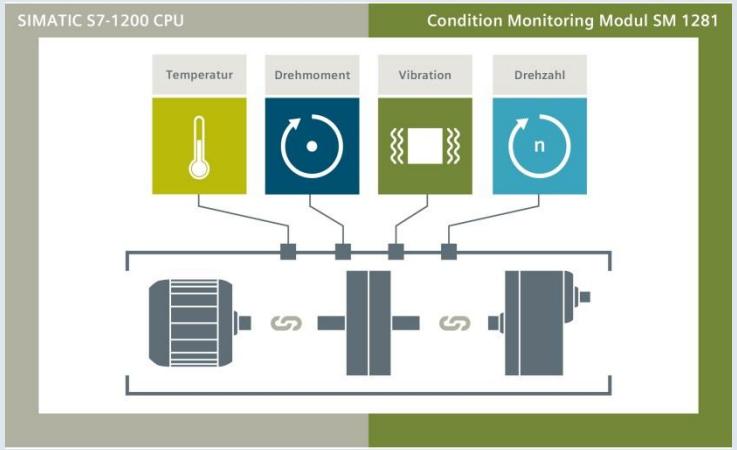
SIPLUS CMS1200: Extensive on-site diagnostics



Feature / Function	Benefits
• SIMATIC S7-1200 based Condition Monitoring via TIA Portal, V13 SP1 or higher	• Easy integration of Condition Monitoring of mechanical components in SIMATIC S7-1200
• Continuous Condition Monitoring (CM) of motors, generators, pumps, fans, … via as many as 28 IEPE vibration sensors per S7-1200	• Early detection of mechanical damage • Scheduled maintenance instead of spontaneous repair
• Analysis algorithms in the SM 1281 CM module • Visualization via web browser	• No additional software required for diagnostics and visualization
• Long-term storage of raw data/ trend (800 MB) in the SM 1281	• Simple data archiving • Further analysis via raw data

SIPLUS CMS1200: Condition Monitoring with SIMATIC S7-1200

SM 1281 – What sort of damage can be detected?

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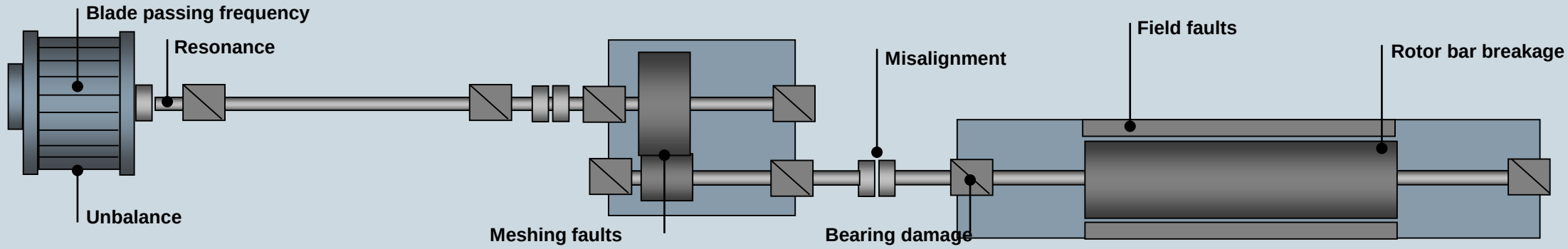

Mechanical damage	
Resonance	Unbalance
Bearing damage	Meshing faults
Misalignment	Blade passing frequency

Electrical faults
Stator field faults
Rotor bar breakage

SIPLUS CMS1200: Condition Monitoring with SIMATIC S7-1200

SM 1281 - Overview of customer benefits

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SIPLUS CMS – Effectiveness right from the start

- Effective spare parts stocking
- Decision-making aids
- Enhanced availability
- Prolonged lifecycle time
- Prolonged maintenance intervals
- Investment protection

Benefits

- Simple system design
- Open standards
- Easy expandability

Reduced costs

- Selective repair
- Shorter commissioning times
- Plannable maintenance

Increased efficiency

- Reference states
- Gapless knowledge
- Simple troubleshooting

SM 1281 Condition Monitoring Module

Features

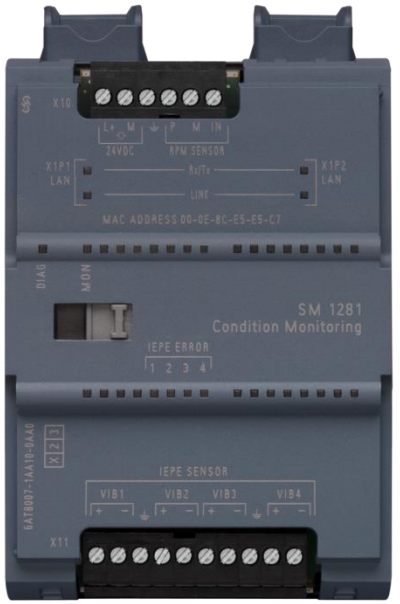
- Characteristic-based diagnostics
- Frequency-selective diagnostics
- Export of raw data
- SIMATIC AND web-based

Connections

- Up to 4 vibration sensors
- 1 speed input
- Ethernet
- Power supply 24VDC
  (supply to sensors)

Expansion option

Up to 7 modules can bei connected
(depending on the S7-1200 CPU used)



BERO
Speed measurement

IEPE-Sensoren
Vibration measurement

Operating principle

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

SIPLUS CMS1200: Condition Monitoring with SIMATIC S7-1200

SM 1281 – Connections and indicator elements

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Ethernet (RJ45)

DC 24V connection

LEDs: Link / Rx / Tx

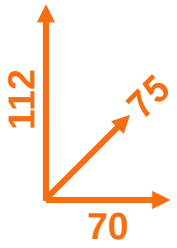
Module status LEDs

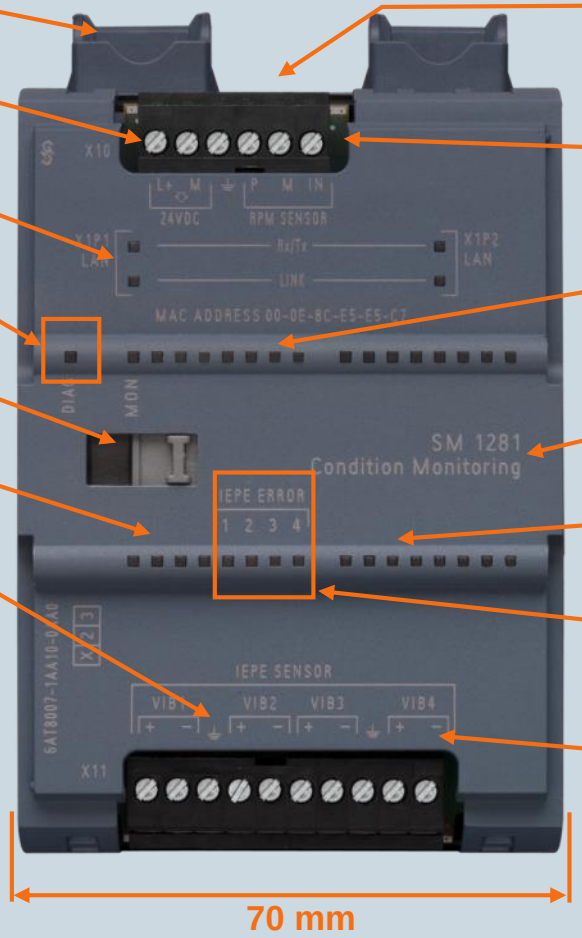
Backplane bus connection

Unassigned LEDs

Functional grounding connection

Dimensions W x H x D (mm)





Unlatching of DIN rail requires no tools

Connection for speed sensor

Unassigned LEDs

Inscription

Status LEDs for IEPE inputs

Unassigned LEDs

IEPE sensor connection

SIPLUS CMS1200: Condition Monitoring with SIMATIC S7-1200
SM 1281 – What is required?

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Hardware requirements

S7-1200 CPU	Max. connectable SM 1281
CPU 1211C	None
CPU 1212C	2
CPU1214C / 1214FC	7
CPU 1215C / 1215FC	7
CPU 1217C	7

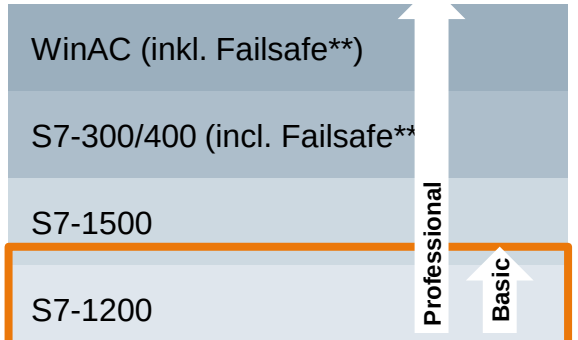
Important:
SM 1281 is supported as of FW version V4.1 for S7-1200 CPU

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

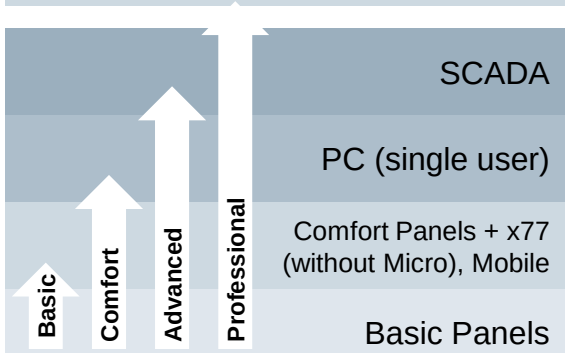
*) Noit available for S7-1200

Optional software

SIMATIC WinCC

Machine-level operating and monitoring

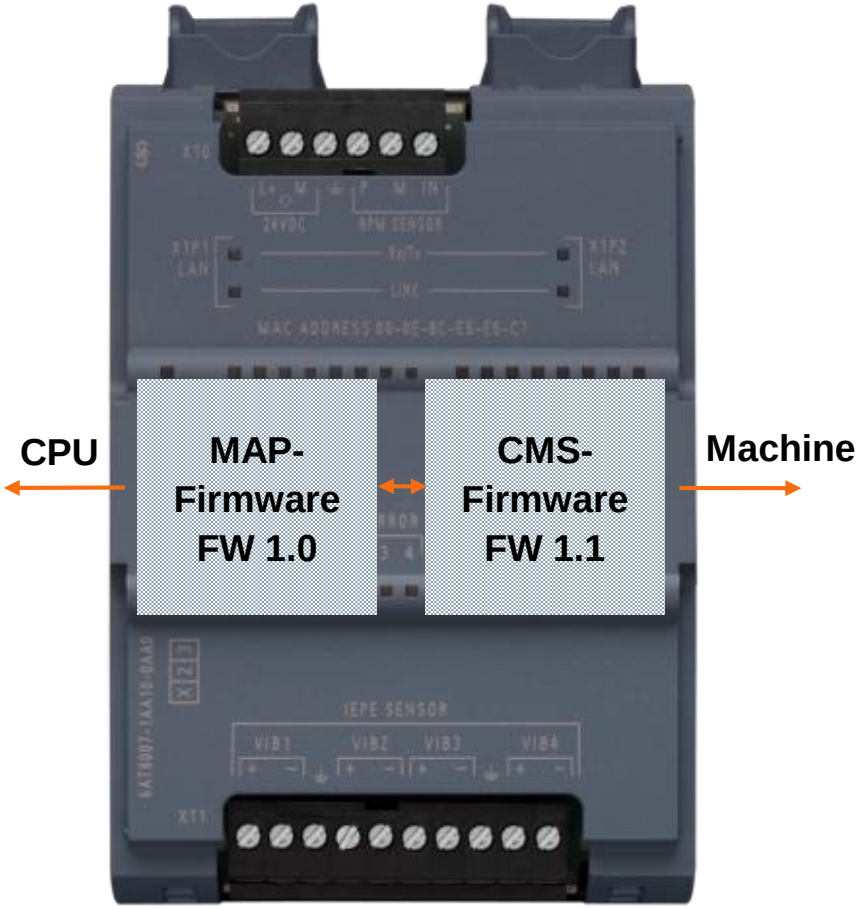
SCADA applikations



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

➔ Browser functionality for panels is NOT supported by SM 1281

SIPLUS CMS1200
SM 1281 – Firmware design



Firmware SM1281	
MAP-Firmware (FW)	**CMS-Firmware**
Interface to S7-1200 CPU	CM functionality
Version correspondents to HSP (Hardware Support Package)	Version follows the functional extension
Independent of the CMS-Firmware	Independent of the MAP-Firmware
Automatic update: TIA Portal (HSP)	Manual update: User
Current version: 1.0 printed on SM shown in library	Current version: 1.1 shown in WEB Interface

Important: Only the version of MAP-FW is printed on SM1281, the version of CMS-FW is shown in WEB-Interface

Agenda

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SIPLUS CMS1200: Engineering
SM 1281 - Efficiency engineering in the TIA Portal

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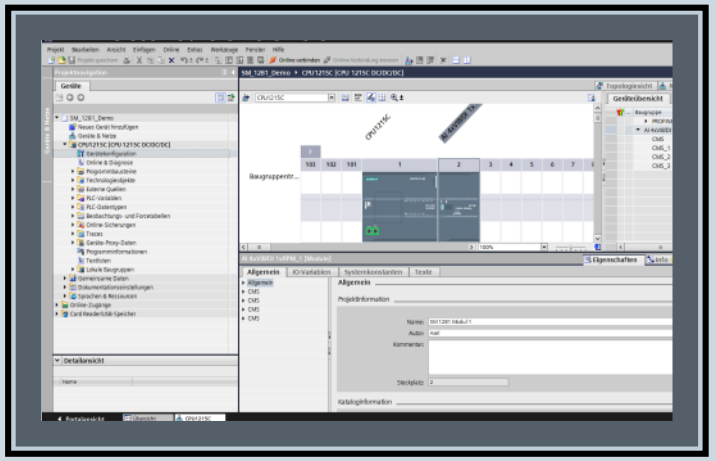


TIA Portal

- SIPLUS CMS1200 (SM 1281) in the TIA hardware catalog under the category S7-1200 technology module
- Efficient engineering in the TIA Portal thanks to extensive SM 1281-Library
- Application example as an introduction

1 TIA Portal V13 SP1,update 7 (STEP7 basic V13 update 3): Create project

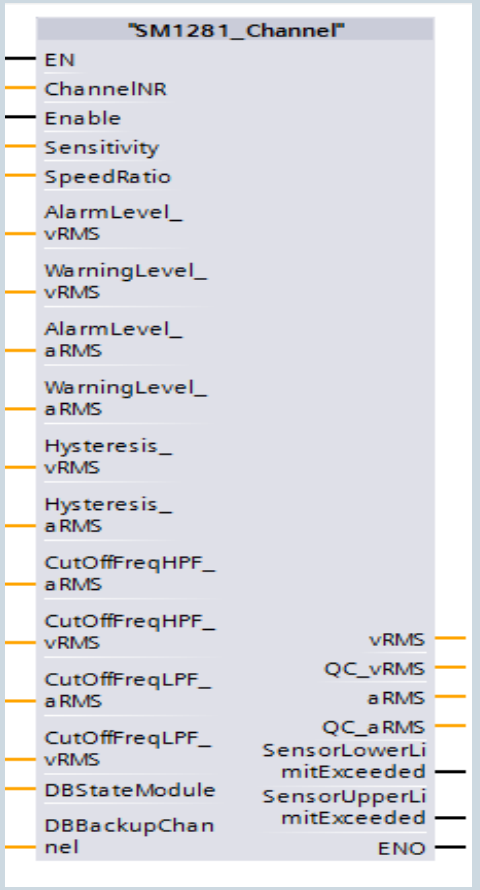
2 Transferring the project data of CPU to SM 1281 (CMS1200)

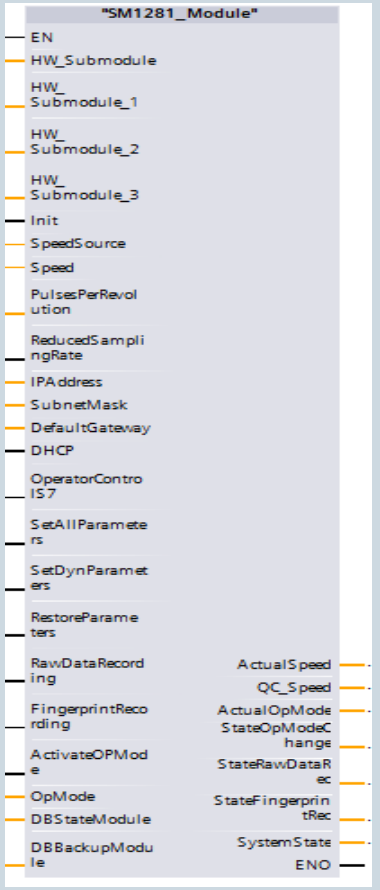
3 Determine visualization – e.g. WinCC. For monitoring: Select SM 1281 directly

SM1281-Library

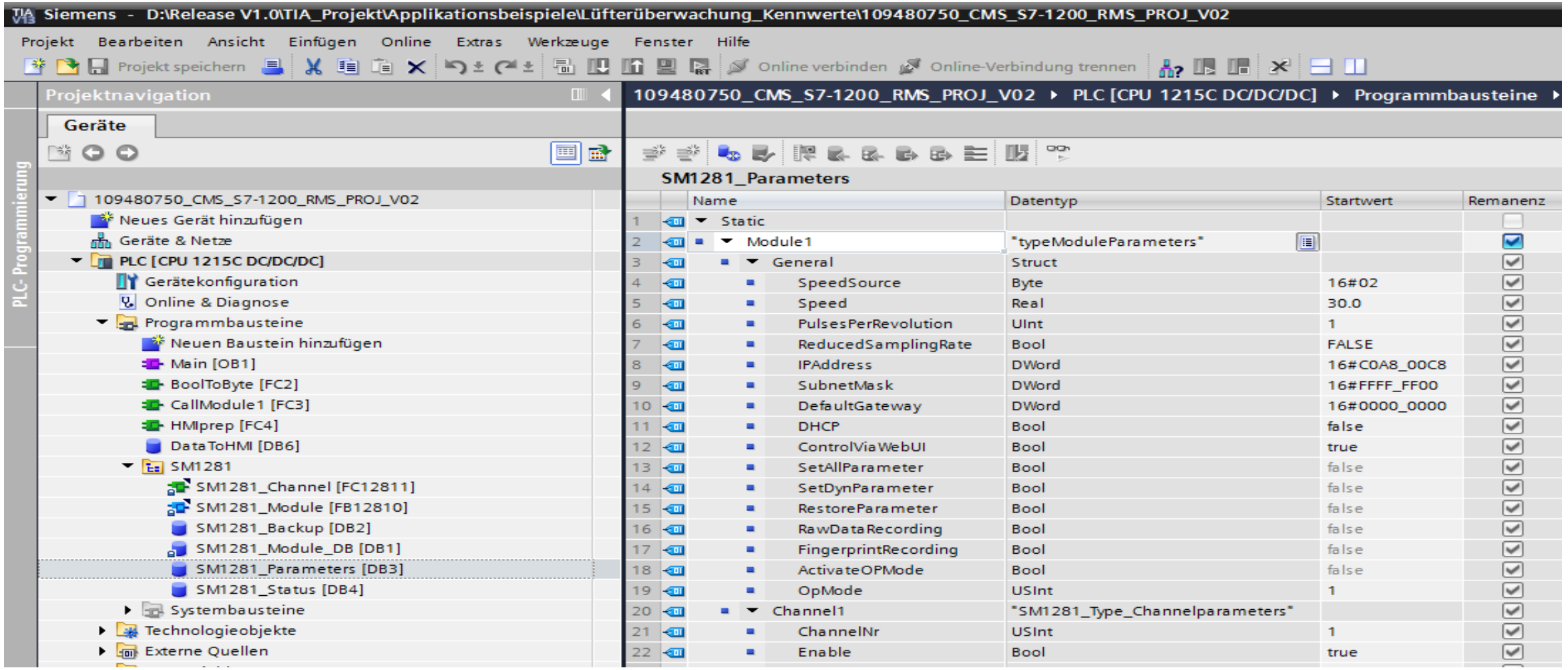
- Simple integration of the SM 1281-functions into the S7-1200-programm e. g. for
  - parametrization of the SM 1281
  - output of status- und traffic lights signals
  - automatic backup of parameter sets

- One project with a SM 1281 and 4 channels would require
  1 x the function block „SM1281_Module“ and
  4 x the function „SM1281_Channel“

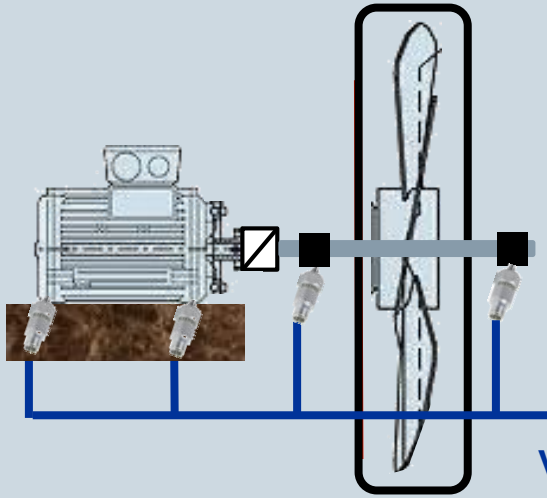




SIPLUS CMS1200: Engineering
SM 1281 - Extensive Library in the TIA Portal (2)



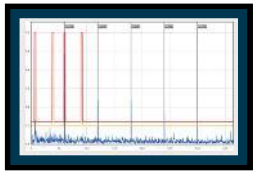
SIPLUS CMS1200: Engineering
SM 1281 - Use case Fans



Vibration signals

SM 1281

TIA Portal: System integration



TIA Portal: Diagnostics

TIA Portal Engineering

Use case: Fans

- Monitoring of a fan with 4 channels
- TIA Portal "uniform software" for:
  - System integration
  - Diagnostics
  - Engineering
- No other analysis software required

SIPLUS CMS1200: Engineering
SM 1281 – System setup and engineering

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TIA Portal engineering system

Module parameters	Channel parameters	Parameters for characteristic-value-based diagnostics
▪ Speed source ▪ Constant speed ▪ Pulses per revolution ▪ Low-frequency RMS monitoring ▪ IP configuration	▪ Channel active/inactive ▪ Sensitivity of sensor ▪ Transformation ratio	▪ Alarm and warning limits for vRMS and aRMS ▪ Hysteresis for vRMS and aRMS ▪ Limit frequency filter for vRMS and aRMS

Note the restriction:
- The SM 1281 module uses the entire IO address range provided for the SM module by the S7-1200 CPU
- Since the CPU has onboard IO for which an address range also has to be made available, the maximum number of SM 1281 units that can be operated is reduced from 8 to 7 per CPU

SIPLUS CMS1200: Engineering
SM 1281 – Principle of operation

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TIA Portal / CPU / backplane bus / SM 1281			SM 1281
Operation and visualization	**Data storage**	**Backplane bus**	**Web interface / module**
Display of: ▪ Characteristic values ▪ Trend curves of characteristic values ▪ Parameters ▪ Messages Entering or changing of: ▪ Parameters ▪ Operating mode (e.g. Run, Stop, etc.) Automatic backup of module parameters Triggering of fingerprint of the three spectra Triggering of raw data recording	Saving of: ▪ Characteristic values ▪ Trend curves of characteristic values ▪ Messages ▪ Module parameters ▪ Channel parameters	*For initialization (changing the configuration)* → Global settings (IP configuration) → Hardware configuration (IEPE channels) → Configuration of diagnostics procedures *Event-triggered* ← Diagnostics messages (e.g. warning/alarm) ← System messages (e.g. cable break) *Cyclic* Time synchronization CPU→SM 1281 Speed Operating mode (monitoring, measuring) Commands for recording raw data / fingerprints Current characteristic values of all active channels	▪ Modification of spectra parameters ▪ View and diagnostics of: • Actual values • Spectra • Trend curve of characteristic values • Plain text messages ▪ Download of raw data files

SIPLUS CMS1200: Engineering
SM 1281 – Ethernet network

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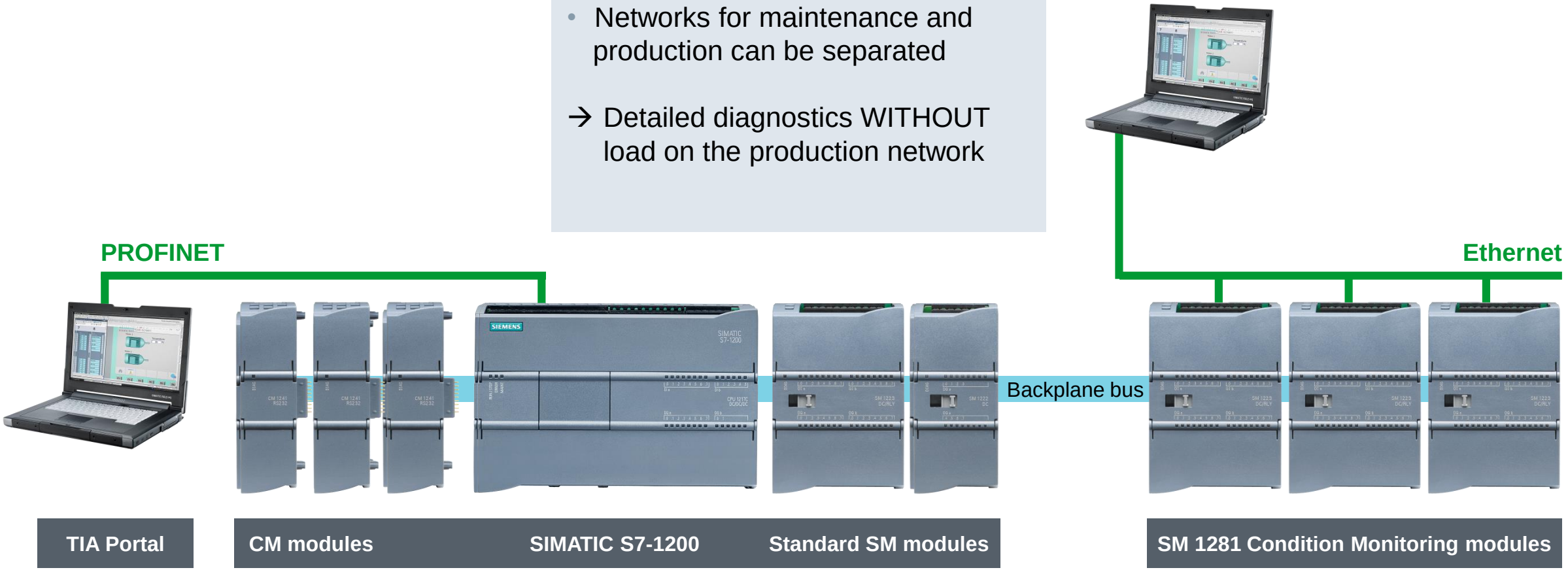
Own SM 1281
Ethernet network

- Networks for maintenance and production can be separated

→ Detailed diagnostics WITHOUT load on the production network



Agenda

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SIPLUS CMS1200: Analysis methods
SM 1281 – Overview

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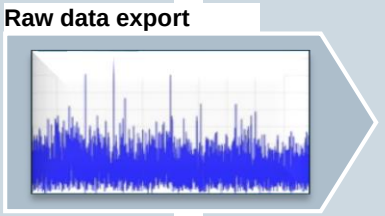
Analysis based on characteristic values

Monitoring of machine vibration based on characteristic values

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

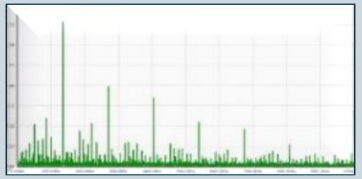
Engineering in TIA Portal + analysis via integrated software

Frequency-selective analysis



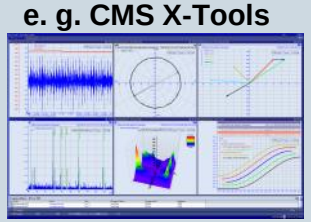
Frequency-selective diagnostics of machine vibration and bearing

- Spectrum view via browser
- Integrated signaling system



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

Expert analysis



Freely configurable analysis models, e. g. for

- Detail analysis
- Gearbox diagnostics
- Know-how protection

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

Monitoring always online in SM 1281

Offline diagnostics

SIPLUS CMS1200: Analysis methods
SM 1281 – Vibration analysis

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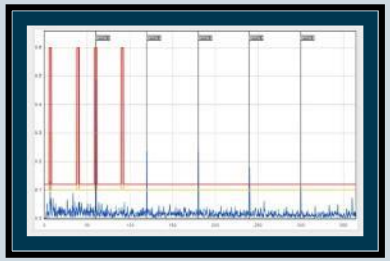
Analysis based on characteristic values

Any signs of damage?

- Analysis of machine / bearing vibrations:
  RMS value of vibration velocity vRMS / vibration acceleration aRMS
- Simple representation, e.g. signal light tower
- Trend charts of vRMS and aRMS

Frequency-selective analysis

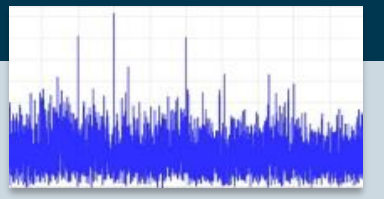


What precise damage is imminent?

- Analysis of machine vibrations, such as resonance; unbalance, alignment/coupling faults
- Analysis of roller bearing damage, such as damage to outer or inner ring, cage, roller damage
- Limit value monitoring of frequency bands

Expert analysis via raw data export

Freely configurable analysis models, e.g. for detailed analyses, gear unit diagnoses



SIPLUS CMS1200: Analysis methods
SM 1281 – Analysis based on characteristic values

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Engineering und configuration via SIMATIC S7-1200 CPU

Characteristic values	Monitoring for
vRMS acc. to ISO 10816-3	vRMS: machine vibration
vRMS freely configurable	aRMS e.g. bearing damage
aRMS freely configurable	

Signal

- Alarm
- Warning
- OK

Mode of operation

- All monitoring parameters can be set via the S7-1200 CPU
- Monitoring in the SM 1281
- Cyclic transfer to S7-1200-CPU of:
  - RMS value of vibration velocity
  - RMS value of vibration acceleration
  - Status messages
- Display on IPC, panel, etc.

Advantages:
Quick and easy to implement
No Condition Monitoring expertise required

Disadvantage:
Type of looming damage not discernable
➔ Troubleshooting required

SIPLUS CMS1200: Analysis methods

SM 1281 – How do frequency-selective diagnostics work?

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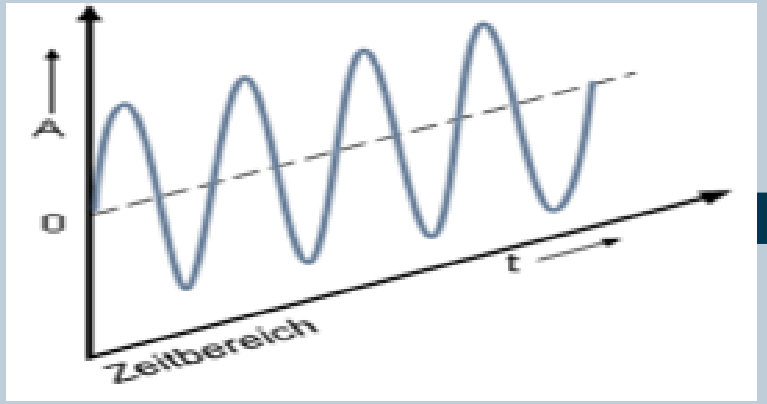
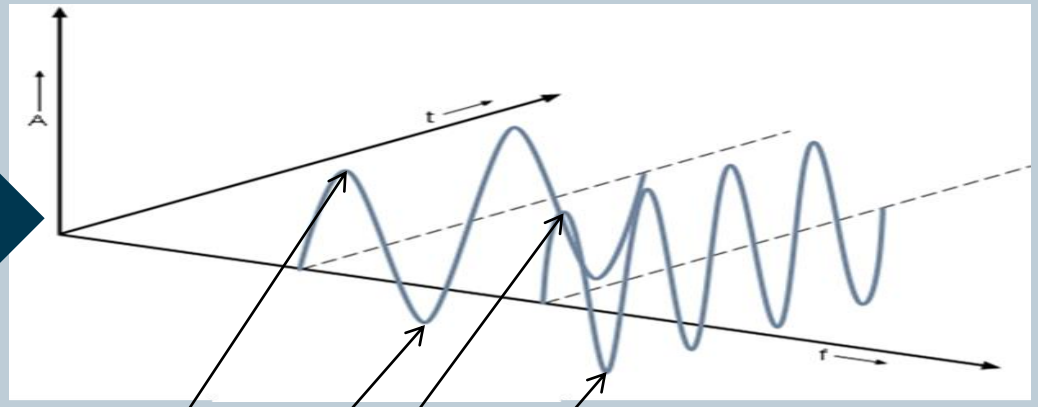
Machine vibration



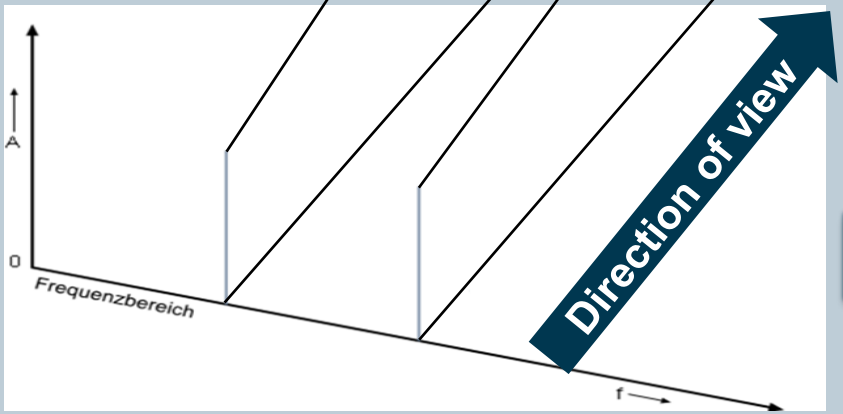
Fragment

Basic vibration and its multiples



Benefits of frequency-selective diagnostics:

- Each type of mechanical damage has its own unique frequency spectrum
- One glance at the frequency spectrum is sufficient to determine the cause of damage to within a high degree of accuracy
- The search for the actual cause of the damage is reduced to a minimum
- The amplitude is a measure for the extent of damage, which allows conclusions to be drawn about the remaining lifespan. The experience of the operator plays a decisive role here



Frequency spectrum

SIPLUS CMS1200: Analysis methods
SM 1281 – Which spectra can be calculated?

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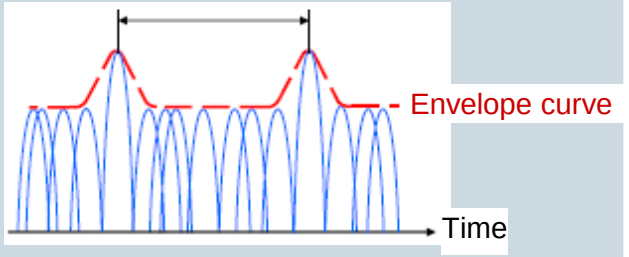
Term	Spectrum	Use
v(f)	Vibration velocity spectrum	Locating rotation-frequency damage up to 1kHz, for example: ▪ Unbalance ▪ Misalignment ▪ Mechanical loosening
a(f)	Vibration acceleration spectrum	Locating rotation-frequency damage greater than 1kHz, for example: ▪ Blade passing frequency ▪ Rotor bar breakage
e(f)	Envelope spectrum	Locating roller bearing damage: ▪ Outer race defect ▪ Inner race defect ▪ Ball damage ▪ Cage damage 
Advantage	The signal of a single sensor, e.g. at the drive end of a motor, is used to calculate all three spectra. By calculating the three spectra, different types of damage in different frequency ranges can be located simultaneously.	

SIPLUS CMS1200: Analysis methods
SM 1281 – Frequency-selective analysis (1)

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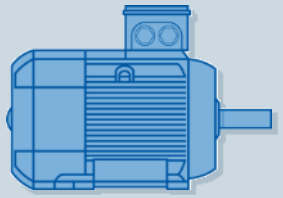
Engineering and configuration via SIMATIC S7-1200 CPU and SM 1281 Web interface

Monitoring for machine vibration



Examples of detectable mechanical damage

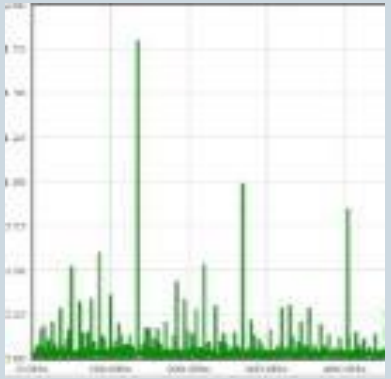
Resonance	Misalignment
Unbalance	Coupling fault

Monitoring for roller bearing damage

Detectable mechanical damage

Outer race defect	Rolling element damage
Inner race defect	Cage damage

Signal



Frequency-selective analysis with SM 1281

How it works

- Settings for monitoring the spectra are made in the SM 1281
- Monitoring in the SM 1281
- Cyclic transmission of
  - Characteristic values
  - Status messages

  for S7-1200 CPU
- Display on PC, panel, etc.
- Access to Web interface SM 1281 shows
  - Spectra
  - Trend analyses

Advantages:
Quick and easy to implement
Type of damage identifiable→ less troubleshooting
Electrical faults detectable → Rotor bar breakage and field faults

SIPLUS CMS1200: Analysis methods
SM 1281 – Frequency-selective analysis (2)

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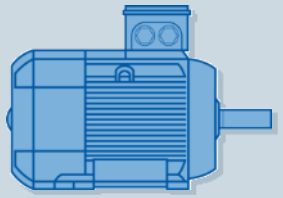
Engineering and configuration via SIMATIC S7-1200 CPU and SM 1281 Web interface

Monitoring for machine vibration

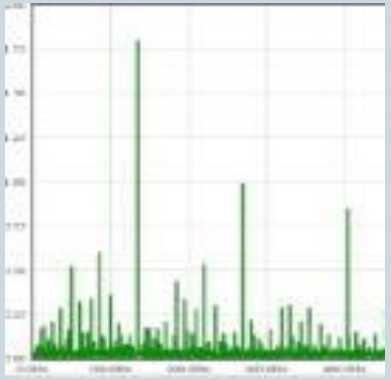


Examples of detectable electrical faults

- **Rotor bar breakage**
- **Field fault stator**

Electrical faults are also visible in the frequency spectrum

Signal



Frequency-selective analysis with SM 1281

How it works

- Settings for monitoring the spectra are made in the SM 1281
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- Display on PC, panel, etc.
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  - Spectra
  - Trend analyses

Advantages:

Quick and easy to implement

Type of damage identifiable→ less troubleshooting

SIPLUS CMS1200: Analysis methods
SM 1281 – Expert analysis via raw data export

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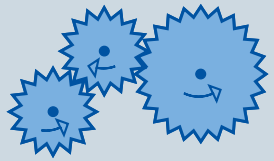
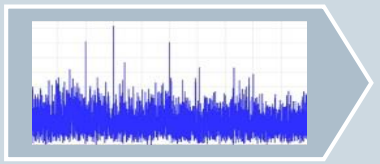
Engineering and configuration of analyses, e.g. via CMS X-Tools

Monitoring for gear unit wear	Detectable mechanical damage
	Meshing faults

Signal

Raw data export



How it works

- A message signals that a meshing fault was detected
- The raw data of the sensor channel is recorded and saved
- Exporting of the raw data via FTP

Analysis of exported raw data is always OFFLINE analysis

<u>Advantage:</u>
Raw data used for analysis models that are exactly tuned to the gear unit

Agenda

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SIPLUS CMS1200
SM 1281 – Technical specifications (1)

Basic information	SM 1281
Mechanical monitoring of	Motors, fans, pumps, etc.
Memory	800 MByte for data recording of: ▪ Raw data (max. 30 recordings of 90 sec. each) ▪ Trend curve (10 years) ▪ Fingerprints (spectra: max. 100)
Raw data export	WAV file for further diagnoses (CMS X-Tools), Can be downloaded via browser or FTP
Max. number/type of connectable sensors	4 vibration acceleration sensors (IEPE), 1 speed sensor
Communication	PROFINET (controller), Ethernet (SM 1281), S7-1200 backplane bus, Web server HTTP, E-mail via S7-1200, File transfer via FTP or WebDAV
System	**SM 1281**
Parametrization **Engineering** **Visualization**	TIA Portal / user program: ▪ Hardware config. (module- , channel-specific), Characteristic values Web browser SM1281: ▪ Spectra, Down- / uploading of configuration- /data files
Power supply	24 V DC
Power loss	Typ. 6 W

SIPLUS CMS1200
SM 1281 – Technical specifications (2)

System	SM 1281
Self-monitoring	Sensor inputs, firmware, electronics
Status display	DIAG-LED Green → Red, Channel LED Red for fault, MON-LED Green for monitoring
Design	Modular
Expandability	▪ Up to 7 SM 1281 modules ▪ Modules from the S7-1200 range
Measuring inputs	**SM 1281**
Vibration acceleration	
Number of measurement channels	4 per module
Input signal	IEPE standard
Frequency band	0.05 Hz – 10 kHz
Scanning frequency, max.	46 kHz
Operating principle	Synchronous processing of all 4 channels per module
Max. cable length	30 m

SIPLUS CMS1200
SM 1281 – Technical specifications (3)

Measuring inputs	SM 1281
Temperature	
Temperature inputs	IO modules of S7-1200
Speed	
Number of measurement channels	1 digital input per module, alternatively via backplane bus from CPU
Input signal	• 24 V DC digital pulses • Number of pulses per revolution can be adjusted via TIA Portal / user program Max. 16 000 pulses per min. • Minimum pulse width 50 us
Scanning frequency, max.	46 kHz
Analog inputs	
Number of measurement channels	IO modules of the S7-1200
Onboard IO	**SM 1281**
Digital inputs	IO modules of the S7-1200
Digital outputs	IO modules of the S7-1200
Analog outputs	IO modules of the S7-1200

SIPLUS CMS1200
SM 1281 – Technical specifications (4)

Characteristic value analysis	SM 1281
Monitoring in accordance with ISO 10816	RMS vibration velocity vRMS: 2 Hz/10 Hz to 1 kHz
Bearing monitoring	RMS vibration acceleration aRMS: 2 Hz/10 Hz to 10 kHz
Parameterizable limits	Lower limits: 2 Hz / 10 Hz, 1 kHz Upper limits: 1 kHz, 3 kHz, 10 kHz
Frequency-selective analysis	**SM 1281**
Parameterizable	FFT, envelope curve, fingerprint comparison, trend analysis
Vibration velocity spectrum v(f)	Evaluation: 2 Hz … 1 kHz, Resolution: 0.3 Hz
Vibration acceleration spectrum a(f)	Evaluation: 2 Hz … 10 kHz, Resolution: 3 Hz
Envelope spectrum env(f)	Evaluation: 2 Hz … 1 kHz, Resolution: 0.3 Hz
Recording function	Raw data recording: manual / event-triggered Snapshot of FFT/fingerprint, characteristic values, long-term trend recording
Monitoring enabled at	3 to 16,000 rpm

SIPLUS CMS1200
SM 1281 – Technical specifications (5)

Unit design	SM 1281
Enclosure	Plastic
Dimensions (H x W x D) mm	112 x 70 x 75
Mounting	DIN rail
Weight	Approximately 260 g
Environmental conditions / standards	
Ambient temperature during operation	-20° to +55 °C
Storage temperature	-25° to +85 °C
Relative humidity	5 ... 95 %, no condensation
Degree of protection	IP20
Certifications	CE, UL, CSA, RCM, EAC; Shipbuilding: LR, DNV-GL, ABS, PRS, KR Available soon: KC; Shipbuilding: BV, NK, CCS

SIPLUS CMS1200
SM 1281 – Ordering information

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Item	Product	MLFB	L price (€)	Remarks
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*	6AT8002-4AB00		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-Sensor and cabels can be used for SM 1281, CMS2000 and CMS4000

SIPLUS CMS1200
SM 1281 – What is provided?

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Component	For what purpose?	From what source?
Hardware Support Package (HSP)	The Hardware Support Package enables configuring of the SM 1281 in the TIA Portal	Download DE: https://support.industry.siemens.com/cs/document/72341852/support-packages-f%C3%BCr-den-hardware-katalog-im-tia-portal-(hsp)?dti=0&lc=de-DE Download EN: https://support.industry.siemens.com/cs/document/72341852/support-packages-for-the-hardware-catalog-in-the-tia-portal-(hsp)?dti=0&lc=en-DE
Library SM1281_ Library	Library for simple integration of the SM 1281 functions into the control program; required for operating the SM 1281. With the STEP 7 blocks from the "SM1281_Library", you can parameterize, control, and diagnose the SM 1281 configured in the device configuration in the TIA Portal.	Download DE: https://support.industry.siemens.com/cs/document/109482016/bibliothek-siplus-cms1200?dti=0&lc=de-DE Download EN: https://support.industry.siemens.com/cs/document/109482016/library-siplus-cms1200?dti=0&lc=en-DE
SM 1281 Application example	Application example: “Monitoring Motor Vibration Variables using a Condition Monitoring System with a SIMATIC S7-1200”. The monitoring of mechanical components is executed by the Condition Monitoring System SIPLUS CMS1200 with the module SM 1281. Specifically designed for the use with a SIMATIC S7-1200, the monitoring can thus be integrated seamlessly into the automation process.	Download DE/EN: https://support.industry.siemens.com/cs/ww/de/view/109480750

Agenda

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SIPLUS CMS1200
SM 1281 – Explanation of terms

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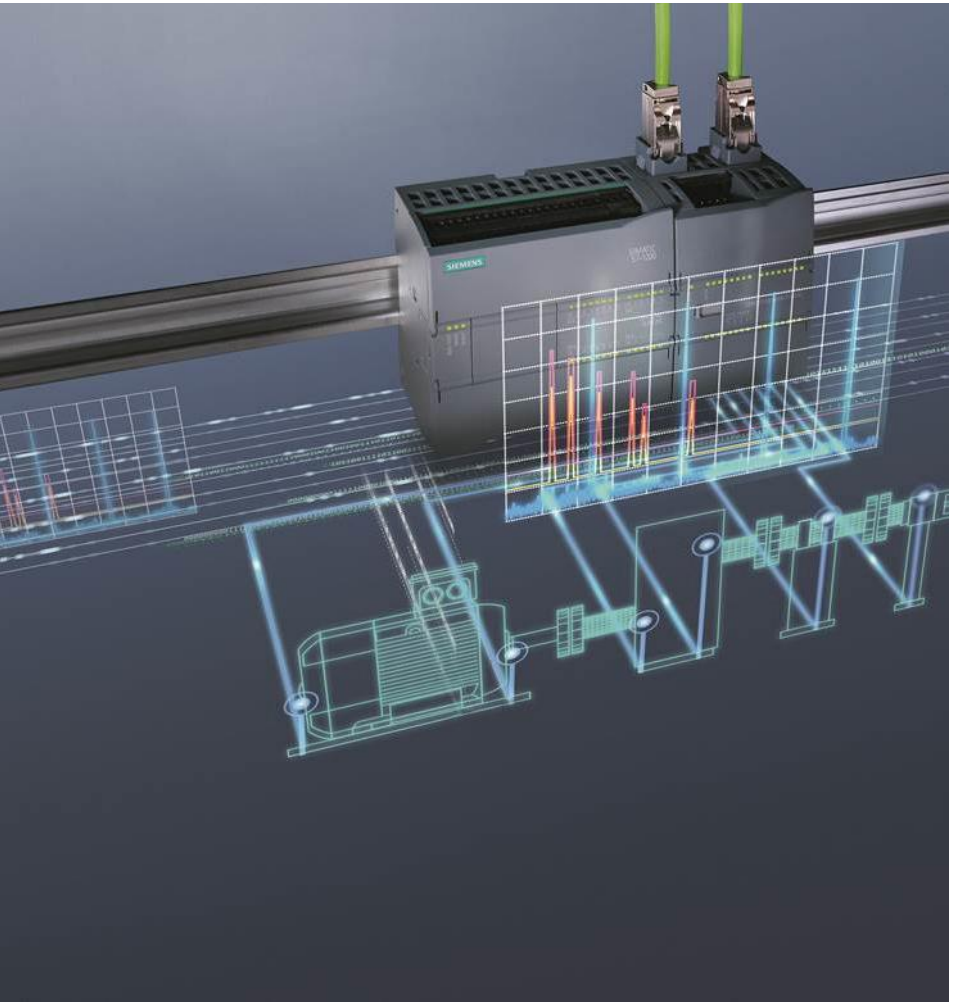
Term	Meaning	Use
vRMS	RMS value of vibration velocity	Characteristic value for evaluating general machine vibration in accordance with ISO 10816-3
aRMS	RMS value of vibration acceleration	Characteristic value for evaluating bearing damage, for example
Low-frequency frequency band	RMS value of vibration velocity	Characteristic value for evaluating tower vibration in wind turbines or machine vibration on slow running machines, for example
Analysis based on characteristic values	Numeric value for evaluating machine vibration	Evaluation of general machine vibration on the basis of characteristic values
Frequency-selective analysis	Frequency range for evaluating machine vibration and locating faults	Evaluation of machine vibration on the basis of calculated spectra
IEPE	Electrical interface of suitable vibration acceleration sensors	Industrial standard for piezo-electric sensors (Integrated Electronics PiezoElectric)
Spectrum	Result of Fourier transformation of recorded vibration signals	The spectra of the vibration acceleration, vibration velocity, and envelope curve are calculated
Limit band	Limits for spectrum monitoring	
Envelope curve	Envelope end of bearing vibration	Detailed determination of roller bearing damage (outer -, inner race, cage, or ball)
ISO 10816-3	Standard for evaluating machine vibration	Evaluation of machine vibration by measurements on non-rotating parts Part 3: Industrial machines with rated outputs above 15 kW and rated speeds between 120 1/min and 15 000 1/min; in situ (ISO 10816-3:2009)



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