Monitoring system MSENSE® VAM

Operating instructions

8459861/03 EN

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The product may have been altered since this document was published.

We reserve the right to change the technical data, design and scope of supply.

Generally the information provided and agreements made when processing the individual quotations and orders are binding.

The original operating instructions were written in German.

Table of contents

1 Introduction

This technical file contains detailed descriptions on the safe and proper installation, connection, commissioning and monitoring of the product.

It also includes safety instructions and general information about the product.

This technical file is intended solely for specially trained and authorized personnel.

1.1 Manufacturer

Maschinenfabrik Reinhausen GmbH
Falkensteinstraße 8
93059 Regensburg
Deutschland
+49 941 4090-0
sales@reinhausen.com
reinhausen.com

MR Reinhausen customer portal: https://portal.reinhausen.com.

Further information on the product and copies of this technical file are available from this address if required.

1.2 Completeness

This technical file is incomplete without the supporting documents.

The following documents are considered supporting documents:

- Operating instructions
- Connection diagrams

1.3 Safekeeping

Keep this technical file and all supporting documents ready at hand and accessible for future use at all times.

1.4 Notation conventions

1.4.1 Hazard communication system

Warnings in this technical file are displayed as follows.

1.4.1.1 Warning relating to section

Warnings relating to sections refer to entire chapters or sections, sub-sections or several paragraphs within this technical file. Warnings relating to sections use the following format:

⚠ WARNING

Type of danger!

Source of the danger and outcome.

► Action

► Action

1.4.1.2 Embedded warning information

Embedded warnings refer to a particular part within a section. These warnings apply to smaller units of information than the warnings relating to sections. Embedded warnings use the following format:

⚠ DANGER! Instruction for avoiding a dangerous situation.

1.4.1.3 Signal words in warning notices

Signal word	Meaning
DANGER	Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates measures to be taken to prevent damage to property.

Table 1: Signal words in warning notices

1.4.2 Information system

Information is designed to simplify and improve understanding of particular procedures. In this technical file it is laid out as follows:

Important information.

1.4.3 Instruction system

This technical file contains single-step and multi-step instructions.

Single-step instructions

Instructions which consist of only a single process step are structured as follows:

Aim of action
✓ Requirements (optional).
► Step 1 of 1.
⇨ Result of step (optional).
⇨ Result of action (optional).

Multi-step instructions

Instructions which consist of several process steps are structured as follows:

Aim of action
✓ Requirements (optional).
1. Step 1.
⇨ Result of step (optional).
2. Step 2.
⇨ Result of step (optional).
⇨ Result of action (optional).

1.4.4 Typographic conventions

Typographic convention	Purpose	Example
UPPERCASE	Operating controls, switches	ON/OFF
[Brackets]	PC keyboard	[Ctrl] + [Alt]
Bold	Software operating controls	Press **Continue** button
…>…>…	Menu paths	Parameter > Control parameter
Italics	System messages, error messages, signals	*Function monitoring* alarm triggered
[► Number of pages]	Cross reference	[► Page 41].
Dotted underscore	Glossary entry, abbreviations, definitions, etc.	Glossary entry

Table 2: Typographic conventions used in this technical file

2 Safety

- Read this technical file through to familiarize yourself with the product.
- This technical file is a part of the product.
- Read and observe the safety instructions provided in this chapter.
- Read and observe the warnings in this technical file in order to avoid function-related dangers.
- The product is manufactured on the basis of state-of-the-art technology. Nevertheless, risks to life and limb for the user or impairment of the product and other material assets due to the function may arise in the event of improper use.

2.1 Appropriate use

The product is a monitoring system for monitoring on-load tap-changers on power transformers/reactors. You can use the product to detect time and amplitude anomalies in the progression of the vibro-acoustic signal sent by the on-load tap-changer and receive event messages when anomalies are detected.

The product is designed solely for use in electrical energy systems and facilities. It may only be used in compliance with the requirements and conditions listed in this technical file as well as the warnings in this technical file and the warnings posted on the product. This applies throughout the service life of the product, from delivery, installation and operation to removal and disposal.

The following is considered appropriate use:

- Only use the product with the on-load tap-changer and the motor-drive unit specified in the order.
- Only use the product for on-load tap-changers that have not already been damaged.
- Operate the product in accordance with this technical file, the agreed-upon delivery conditions and the technical data.
- Ensure that all necessary work is performed by qualified personnel only.
- Only use the equipment and special tools included in the scope of delivery for the intended purpose and in accordance with the specifications of this technical file.
- Only use the product on transformers with insulated add-on parts after approval by Maschinenfabrik Reinhausen GmbH (special version required).
- Only operate the product in industrial areas. Observe the notices in this technical file regarding electromagnetic compatibility and the technical data.

2.2 Inappropriate use

- The product is not suitable for extending the permitted service life of the on-load tap-changer specified by the on-load tap-changer manufacturer.
- The product is not a protective device. Do not use it to handle safety-related functions.
- Risk of explosion and fire from highly flammable or explosive gases, vapors, or dusts. Do not operate the product in areas at risk of explosion.
- The product is not intended for use in environments subject to strong corrosion effects.
- Unauthorized or inappropriate changes to the product may lead to personal injury, material damage and operational faults. Only modify the product after consultation with Maschinenfabrik Reinhausen GmbH.

2.3 Fundamental safety instructions

To prevent accidents, malfunctions and damage as well as unacceptable adverse effects on the environment, those responsible for transport, installation, operation, maintenance and disposal of the product or parts of the product must ensure the following:

Personal protective equipment

Loosely worn or unsuitable clothing increases the danger of becoming trapped or caught up in rotating parts and the danger of getting caught on protruding parts. This poses a danger to life and limb.

- Wear appropriate personal protective equipment such as a helmet, work gloves, etc. for the respective activity.
- Never wear damaged personal protective equipment.
- Never wear rings, necklaces, or other jewelry.
- If you have long hair, wear a hairnet.

Work area

Untidy and poorly lit work areas can lead to accidents.

- Keep the work area clean and tidy.
- Make sure that the work area is well lit.
- Observe the applicable laws for accident prevention in the relevant country.

Working during operation

The product may only be operated in a sound, operational condition. Otherwise it poses a danger to life and limb.

- Regularly check the operational reliability of safety equipment.
- Comply with the inspection work, maintenance work and maintenance intervals described in this technical file.

Securing the motor-drive unit

If you open the motor-drive unit during operation, there is a danger of electric shock due to live components behind the swing frame.

- Secure the motor-drive unit against unauthorized opening during operation by using a padlock.
- The motor-drive unit may only be opened by an electrically skilled person.

Safety markings

Warning signs and safety information plates are safety markings on the product. They are an important aspect of the safety concept.

- Observe all safety markings on the product.
- Make sure all safety markings on the product remain intact and legible.
- Replace safety markings that are damaged or missing.

Ambient conditions

To ensure reliable and safe operation, the product must only be operated under the ambient conditions specified in the technical data.

- Observe the specified operating conditions and requirements for the installation location.

Modifications and conversions

Unauthorized or inappropriate changes to the product may lead to personal injury, material damage and operational faults.

- Only modify the product after consultation with Maschinenfabrik Reinhausen GmbH.

Spare parts

Spare parts not approved by Maschinenfabrik Reinhausen GmbH may lead to physical injury, damage to the product and malfunctions.

- Only use spare parts that have been approved by Maschinenfabrik Reinhausen GmbH.
- Contact Maschinenfabrik Reinhausen GmbH.

2.4 Personnel qualification

The person responsible for assembly, commissioning, operation, maintenance and inspection must ensure that the personnel are sufficiently qualified.

Electrically skilled person

The electrically skilled person has a technical qualification and therefore has the required knowledge and experience, and is also conversant with the applicable standards and regulations. The electrically skilled person is also proficient in the following:

- Can identify potential dangers independently and is able to avoid them.
- Is able to perform work on electrical systems.
- Is specially trained for the working environment in which (s)he works.
- Must satisfy the requirements of the applicable statutory regulations for accident prevention.

Electrically trained persons

An electrically trained person receives instruction and guidance from an electrically skilled person in relation to the tasks undertaken and the potential dangers in the event of inappropriate handling as well as the protective devices and safety measures. The electrically trained person works exclusively under the guidance and supervision of an electrically skilled person.

Operator

The operator uses and operates the product in line with this technical file. The operating company provides the operator with instruction and training on the specific tasks and the associated potential dangers arising from improper handling.

Technical Service

We strongly recommend having maintenance, repairs and retrofitting carried out by our Technical Service department. This ensures that all work is performed correctly. If maintenance is not carried out by our Technical Service department, please ensure that the personnel who carry out the maintenance are trained and authorized by Maschinenfabrik Reinhausen GmbH to carry out the work.

Authorized personnel

Authorized personnel are trained by Maschinenfabrik Reinhausen GmbH to carry out special maintenance.

2.5 Personal protective equipment

Personal protective equipment must be worn during work to minimize risks to health.

- Always wear the personal protective equipment required for the job at hand.
- Never wear damaged personal protective equipment.
- Observe information about personal protective equipment provided in the work area.

Protective clothing	Close-fitting work clothing with a low tearing strength, with tight sleeves and with no protruding parts. It mainly serves to protect the wearer against being caught by moving machine parts.
Safety shoes	To protect against falling heavy objects and slipping on slippery surfaces.
Safety glasses	To protect the eyes from flying parts and splashing liquids.
Visor	To protect the face from flying parts and splashing liquids or other dangerous substances.
Hard hat	To protect against falling and flying parts and materials.
Hearing protection	To protect against hearing damage.
Protective gloves	To protect against mechanical, thermal, and electrical hazards.

Table 3: Personal protective equipment

3 IT security

Observe the following recommendations to operate the product safely.

3.1 General

- Ensure that only authorized personnel have access to the device.
- Only use the device within an ESP (electronic security perimeter). Do not connect the device to the Internet in an unprotected state. Use mechanisms for vertical and horizontal network segmentation and security gateways (firewalls) at the transition points.
- Ensure that the device is only operated by trained personnel who are familiar with IT security.
- Check regularly whether software updates are available for the device and perform the updates.

3.2 Commissioning

Observe the following recommendations for device commissioning:

- User IDs must be unique and assignable. Do not use a "Group account" function or the "Auto login" function.
- Activate the "Auto logout [►Section 8.1.1.2, Page 78]" function.
- Restrict the rights of the individual user groups as much as is feasible; this helps avoid errors during operations. A user with the "Operator" role, for example, should only perform operations and should not be able to change any device settings.
- Delete or disable the default "admin" user ID. This requires first creating a new user account with the "Administrator" role. You can then use it to delete or disable the default "admin" account.
- Deactivate service user access.
- Enable SSL/TLS encryption [►Section 8.1.1, Page 77]; access to the device is then only possible using the SSL/TLS protocol. In addition to encrypting communication, this protocol also checks the authenticity of the server.
- Use TLS version 1.2 or higher wherever possible.
- Integrate the device into a public key infrastructure. Create your own SSL certificates for this if necessary and then import them.
- Connect the device to a central log server by using the syslog interface [►Section 8.1.4, Page 83].
- Only use the [►Section 8.1.1.3, Page 79]SNMP function if you can ensure that the communication is protected by external security equipment.
- Media converter with managed switch (assembly SW 3-3):
  - Change user account and password.
  - Disable unnecessary services.

Also refer to

Setting SNMP [▶ 79]

3.3 Operation

Observe the following recommendations during device operation:

- Change the password at regular intervals.
- Export the security log [▶ Section 8.1.15.2, Page 121] at regular intervals.
- Check the log files regularly for unauthorized system access and other security-related events.
- Media converter with managed switch (assembly SW 3-3): Check at regular intervals whether the manufacturer Belden/Hirschmann has released an update for the product “EES 25” and, where necessary, perform a firmware update.

3.4 Interfaces

The device uses the following interfaces for communication:

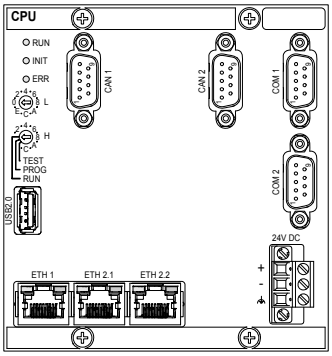


Figure 1: CPU assembly interfaces

Interface	Protocol	Port	Description
CAN 1	-	-	DIO assembly connection
CAN 2	-	-	Communication with other ISM® devices (e.g. parallel operation)
COM 1	-	-	Internal system interface
COM 2	-	-	Serial interface (SCADA)
USB	-	-	Import or export of data
ETH 1	TCP	80	HTTP for web-based visualization[1), 2)]
ETH 1	TCP	443	HTTPS for web-based visualization[2)]
ETH 1	TCP	102	IEC 61850
ETH 1	TCP	502	Modbus[3)]

Interface	Protocol	Port	Description
ETH 1	TCP	20000	DNP3[3)]
ETH 1	UDP	161	SNMP[4)]
ETH 2.x	TCP	21	FTP[1)] (only for MR service)
ETH 2.x	TCP	80	HTTP for web-based visualization[1)]
ETH 2.x	TCP	443	HTTPS for web-based visualization
ETH 2.x	TCP	990	FTPS (only for MR service)
ETH 2.x	TCP	8080	HTTP for web-based visualization[1)]
ETH 2.x	TCP	8081	HTTPS for web-based visualization
ETH 2.x	UDP	161	SNMP[4)]

Table 4: Interfaces and open ports of the CPU assembly

[1)] Port is closed if you activate the device's SSL encryption.

[2)] Depending on the setting of the parameter Visualization release.

[3)] Default setting; if you have modified the port for the control system protocol, only the set port is open.

[4)] Depending on the setting of the SNMP agent [►Page 79] parameter.

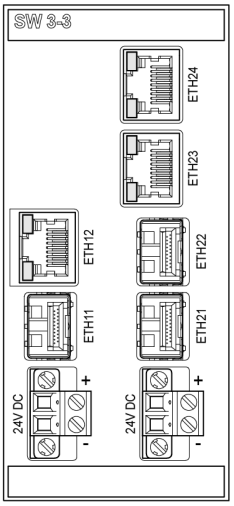


Figure 2: Assembly SW 3-3 interfaces

Interface	Protocol	Port	Description
ETH 2.3, ETH 2.4	TCP	22	SSH[1)]
		23	Telnet[1)]
		80	HTTP for web-based visualization[1)]
		443	HTTPS for web-based visualization[1)]
	UDP	161	SNMP[1)]

Table 5: Interfaces and open ports of the SW 3-3 assembly

[1] Port is closed if the corresponding service is disabled.

3.5 Encryption standards

The device supports the following TLS versions:

- TLS 1.0
- TLS 1.1
- TLS 1.2
- TLS 1.3

The device uses the following cipher suites for a TLS-secured connection:

Cipher suite	TLS version [▶ Page 81]			
	>=1.0	>=1.1	>=1.2	>=1.3
TLS_AKE_WITH_AES_128_GCM_SHA256	●	●	●	●
TLS_AKE_WITH_AES_256_GCM_SHA384	●	●	●	●
TLS_DHE_RSA_WITH_AES_128_CBC_SHA	●	●	-	-
TLS_DHE_RSA_WITH_AES_128_CBC_SHA256	●	●	●	-
TLS_DHE_RSA_WITH_AES_128_CCM	●	●	-	-
TLS_DHE_RSA_WITH_AES_128_CCM_8	●	●	-	-
TLS_DHE_RSA_WITH_AES_128_GCM_SHA256	●	●	●	-
TLS_DHE_RSA_WITH_AES_256_CBC_SHA	●	●	-	-
TLS_DHE_RSA_WITH_AES_256_CBC_SHA256	●	●	●	-
TLS_DHE_RSA_WITH_AES_256_CCM	●	●	-	-
TLS_DHE_RSA_WITH_AES_256_CCM_8	●	●	-	-
TLS_DHE_RSA_WITH_AES_256_GCM_SHA384	●	●	●	-
TLS_DHE_RSA_WITH_ARIA_128_GCM_SHA256	●	●	-	-
TLS_DHE_RSA_WITH_ARIA_128_GCM_SHA256	●	●	-	-
TLS_DHE_RSA_WITH_CHACHA20_POLY1305_SHA256	●	●	-	-
TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA	●	●	-	-
TLS_ECDHE_ECDSA_WITH_AES_128_CBC_SHA256	●	●	●	-
TLS_ECDHE_ECDSA_WITH_AES_128_CCM	●	●	-	-
TLS_ECDHE_ECDSA_WITH_AES_128_CCM_8	●	●	-	-
TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256	●	●	-	-
TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA	●	●	-	-
TLS_ECDHE_ECDSA_WITH_AES_256_CBC_SHA384	●	●	●	-
TLS_ECDHE_ECDSA_WITH_AES_256_CCM	●	●	-	-
TLS_ECDHE_ECDSA_WITH_AES_256_CCM_8	●	●	-	-
TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384	●	●	●	-
TLS_ECDHE_ECDSA_WITH_ARIA_128_GCM_SHA256	●	●	-	-

Cipher suite	TLS version [▶ Page 81]			
	>=1.0	>=1.1	>=1.2	>=1.3
TLS_ECDHE_ECDSA_WITH_ARIA_256_GCM_SHA384	●	●	-	-
TLS_ECDHE_ECDSA_WITH_CHACHA20_POLY1305_SHA256	●	●	-	-
TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA	●	●	-	-
TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256	●	●	●	-
TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256	●	●	●	-
TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA	●	●	-	-
TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384	●	-	-	-
TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384	●	●	●	-
TLS_ECDHE_RSA_WITH_ARIA_128_GCM_SHA256	●	-	-	-
TLS_ECDHE_RSA_WITH_ARIA_256_GCM_SHA384	●	-	-	-
TLS_RSA_WITH_AES_128_CBC_SHA	●	●	-	-
TLS_RSA_WITH_AES_128_CBC_SHA256	●	●	-	-
TLS_RSA_WITH_AES_128_CCM	●	●	-	-
TLS_RSA_WITH_AES_128_CCM_8	●	●	-	-
TLS_RSA_WITH_AES_128_GCM_SHA256	●	●	-	-
TLS_RSA_WITH_AES_256_CBC_SHA	●	●	-	-
TLS_RSA_WITH_AES_256_CBC_SHA256	●	●	-	-
TLS_RSA_WITH_AES_256_CCM	●	●	-	-
TLS_RSA_WITH_AES_256_CCM_8	●	●	-	-
TLS_RSA_WITH_AES_256_GCM_SHA384	●	●	-	-
TLS_RSA_WITH_ARIA_128_GCM_SHA256	●	●	-	-
TLS_RSA_WITH_ARIA_256_GCM_SHA384	●	●	-	-
TLS_RSA_WITH_IDEA_CBC_SHA	●	-	-	-
TLS_RSA_WITH_IDEA_CBC_SHA	●	-	-	-

Table 6: Cipher suite (● = available, - = not available)

The device uses the SHA256 hash function to save passwords.

The SW 3-3 assembly supports the following TLS version:

- TLS 1.2

The assembly uses the following cipher suites for a TLS-secured connection:

	Key exchange	Authentication		Encryption	Key length	Operating mode	Hash function
TLS	ECDHE	RSA	WITH	AES	128	GCM	SHA265
	DHE					CBC	SHA

Table 7: Cipher suite

The device uses the following encryption standards in accordance with technical directive TR-02102-4 from Germany's Federal Office for Information Security:

- Key agreement:
  - diffie-hellman-group1-sha1
  - diffie-hellman-group14-sha1
  - diffie-hellman-group16-sha512
  - diffie-hellman-group18-sha512
  - diffie-hellman-group-exchange-sha256
  - ecdh-sha2-nistp256
- Server authentication:
  - ssh-rsa
  - rsa-sha2-512
  - rsa-sha2-256
- Encryption algorithms:
  - aes128-ctr
  - aes128-gcm@openssh.com
  - chacha20-poly1305@openssh.com
- MAC protection:
  - hmac-sha1
  - hmac-sha2-256
  - hmac-sha1-etm@openssh.com
  - hmac-sha2-256-etm@openssh.com
- Compression:
  - None
  - zlib@openssh.com
  - Zlib

Also refer to

TLS version [► 81]

4 Product description

4.1 Variants

The device is available in the following versions:

- MSENSE® VAM:
  - Standalone version in the control cabinet
- ETOS® ED/TD with MSENSE® VAM function:
  - Integration solution in the motor-drive unit
- ETOS® IM with MSENSE® VAM function:
  - Integration solution in the customer control cabinet (pluggable modules)
- MSENSE® BM with MSENSE® VAM function

4.2 Scope of delivery

Please note the following:

- Check the shipment for completeness using the shipping documents.
- Store the parts in a dry place until installation.

Depending on the product version, the following MSENSE® VAM monitoring system assemblies are included in the scope of supply. Depending on the order, additional ETOS® modules that are not listed in these instructions may also be used. Also observe the corresponding operating instructions.

MSENSE® VAM: Standalone version in the control cabinet

- VI 4 vibration sensor input module
- VAM sensor assembly (including VS 1 vibration sensor, adapter screw and kick guard)
- Sensor cable for VS 1 vibration sensor
- Analog AIO 2 or AIO 4 inputs/outputs
- G1 PULS DIMENSION QS3.241 power supply
- Digital DIO 28-15 or DIO 42-20 inputs/outputs
- CPU II (central processing unit)
- Control cabinet
- Optional: MC 2-2 media converter
- Optional: SW 3-3 media converter with managed switch
- Optional: Display
- Optional: PT100 for OLTC oil temperature (temperature pocket must be available in the on-load tap-changer head cover)[1)]

ETOS® ED/TD with MSENSE® VAM option: Integration solution in the motor-drive unit

- VI 4 vibration sensor input module
- VAM sensor assembly (including VS 1 vibration sensor, adapter screw and kick guard)
- Sensor cable for VS 1 vibration sensor
- Optional: MC 2-2 media converter
- Optional: SW 3-3 media converter with managed switch
- Optional: Display
- Optional: PT100 for OLTC oil temperature (temperature pocket must be available in the on-load tap-changer head cover)[1)]

ETOS® IM with MSENSE® VAM option: Integration solution in the customer control cabinet (pluggable modules)

- VI 4 vibration sensor input module
- VAM sensor assembly (including VS 1 vibration sensor, adapter screw and kick guard)
- Sensor cable for VS 1 vibration sensor
- Analog AIO 2 or AIO 4 inputs/outputs
- G1 PULS DIMENSION QS3.241 power supply
- Digital DIO 28-15 or DIO 42-20 inputs/outputs
- CPU II (central processing unit)
- Optional: MC 2-2 media converter
- Optional: SW 3-3 media converter with managed switch
- Optional: Display
- Optional: PT100 for OLTC oil temperature (temperature pocket must be available in the on-load tap-changer head cover)[1)]

[1)] Oil temperature recording is a prerequisite for the self-learning of the yellow limit value curve. As an alternative to recording the OLTC oil temperature, the top-oil temperature can be used.

4.3 Function description

The product is a monitoring system for monitoring vibro-acoustic signals from on-load tap-changers. You can use the product to detect time and amplitude anomalies in the vibro-acoustic signal progression and receive event messages when anomalies are detected.

The on-load tap-changer is equipped with measuring equipment that records the vibro-acoustic signal in the system throughout the entire tap change sequence and analyses it immediately upon completion. In addition, the system determines the changed tap position and the oil temperature in the on-load tap-changer.

Using the implemented algorithms, the monitoring system can reliably detect any potential anomalies that occur in the vibro-acoustic signal progression, taking the temperature variations of the on-load tap-changer oil into account.

Status message

The MSENSE® VAM monitoring system produces a 3-stage status message:

Status	Device/visualization display	SCADA/digital output remote signaling
Normal	OK message through blue status message	No remote signaling
Warning	The first and the second anomalies in an evaluation cluster are indicated via a yellow status message in the VAM analysis (Information menu).	No remote signaling
Alarm	A third anomaly arising in an evaluation cluster or the third successive anomaly triggers an additional event message (Events menu).	This event message is transmitted to a connected SCADA system. In addition, it can also be sent to a digital output.

4.4 Performance features

The MSENSE® VAM monitoring system monitors the vibro-acoustic signals from on-load tap-changers and has the following :

- Monitoring on-load tap-changers/reactors in accordance with the technical specification in the order confirmation
- Suitable for on-load tap-changers with oil-switch and vacuum-switch technology
- Recording of the vibro-acoustic signals during on-load tap-changer operation via automatic triggering
- Evaluation of the vibro-acoustic signal progression with regard to time and amplitude anomalies
- Self-learning limit value at an oil temperature above 15 °C, which moves towards the signal progression with increasing tap-change frequency Approximately 5 tap-change operations per evaluation cluster (e.g. 5x from step 1 to step 2 in reverse tap-change operation) are necessary before the first limit value curve is displayed.
  The signals are also evaluated below 15 °C, but the limit value is not adjusted.
- Display and recording of the measured and calculated values
- Status messages via digital outputs
- Web-based visualization

- SCADA
  - IEC 60870-5-101
  - IEC 60870-5-103
  - IEC 60870-5-104
  - IEC 61850 (edition 1 and edition 2)
  - Modbus (RTU, TCP, ASCII)
  - DNP3

4.5 Design

This chapter contains an overview of the design of the monitoring system:

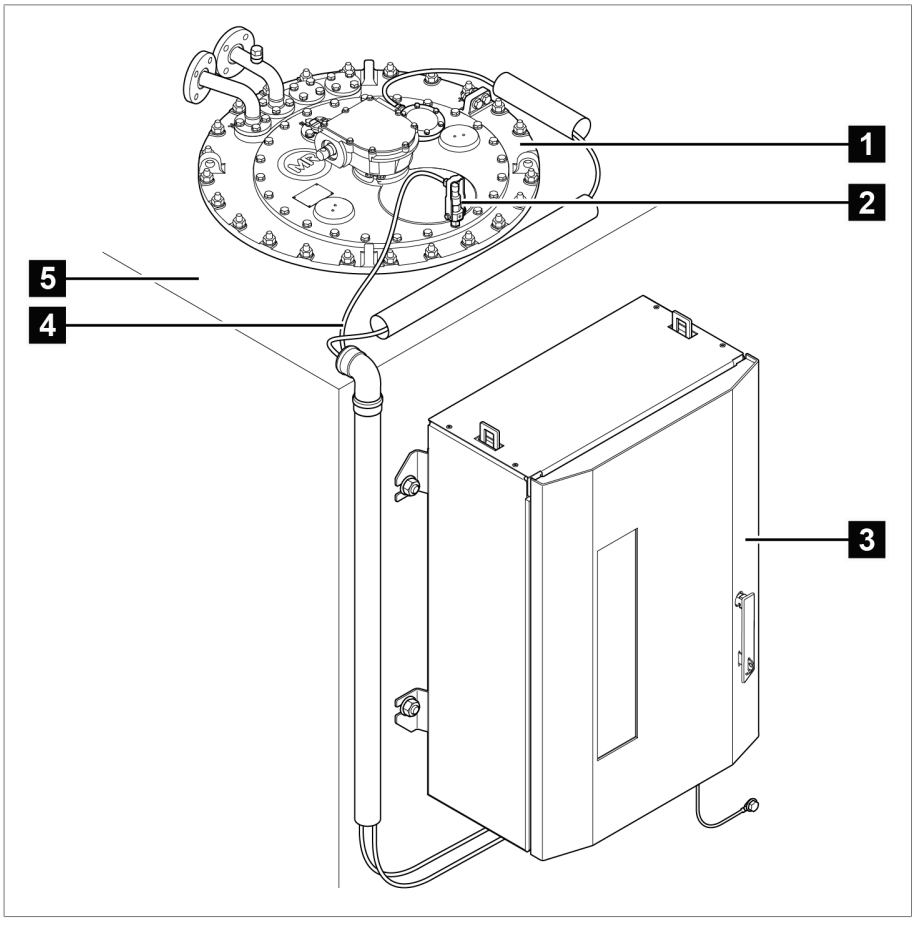


Figure 3: Design, example of single-column application

1	On-load tap-changer head cover	2	Vibration sensor with kick guard
3	Control cabinet	4	Sensor cable
5	Transformer		

4.5.1 VS 1 sensor assembly

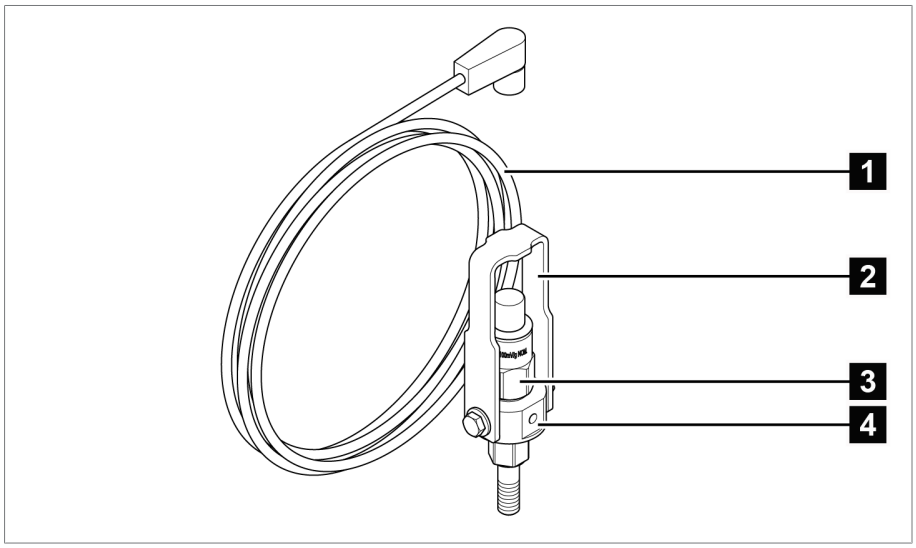


Figure 4: VAM sensor assembly

1 Sensor cable	2 Kick guard
3 Vibration sensor	4 Adapter

4.5.2 Control cabinet

Depending on the order, the electronic assemblies are either already installed in a control cabinet or are supplied as individual components for mounting on a cap rail. The following two figures show a design example for the standalone version.

4.5.2.1 Display elements and operating controls

The control cabinet contains the following display elements and operating controls:

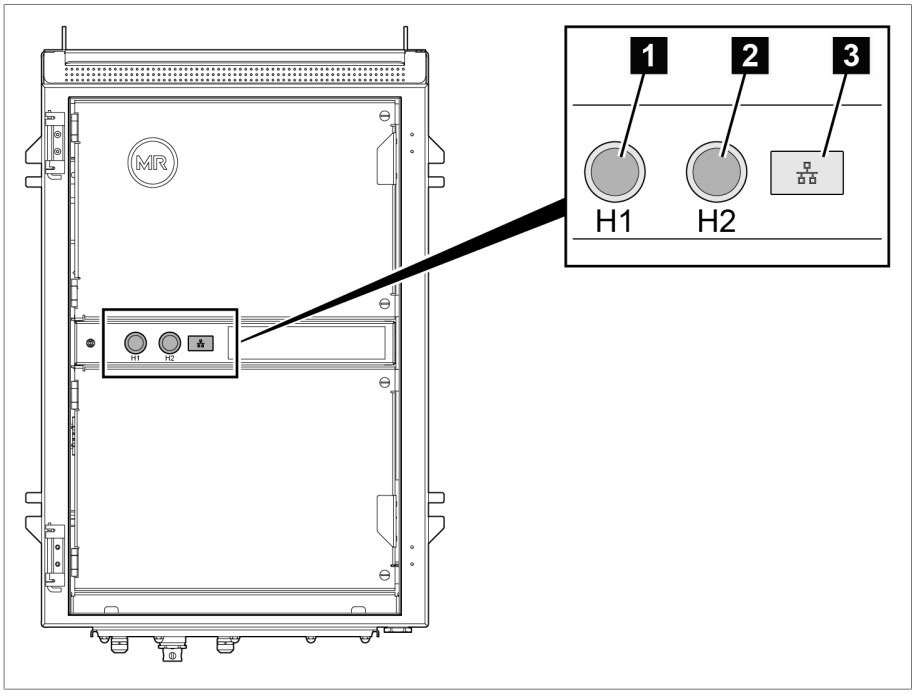


Figure 5: Display elements and operating controls (example)

1	Indicator lamp H1: yellow = "Anomaly detected"	2	Indicator lamp H2: green = "No anomalies"
3	Service interface		

4.5.2.2 Control cabinet layout

The following figure shows an example layout in the control cabinet with the most important electronic assemblies for the MSENSE® VAM. The order-specific details can be found in the connection diagram provided.

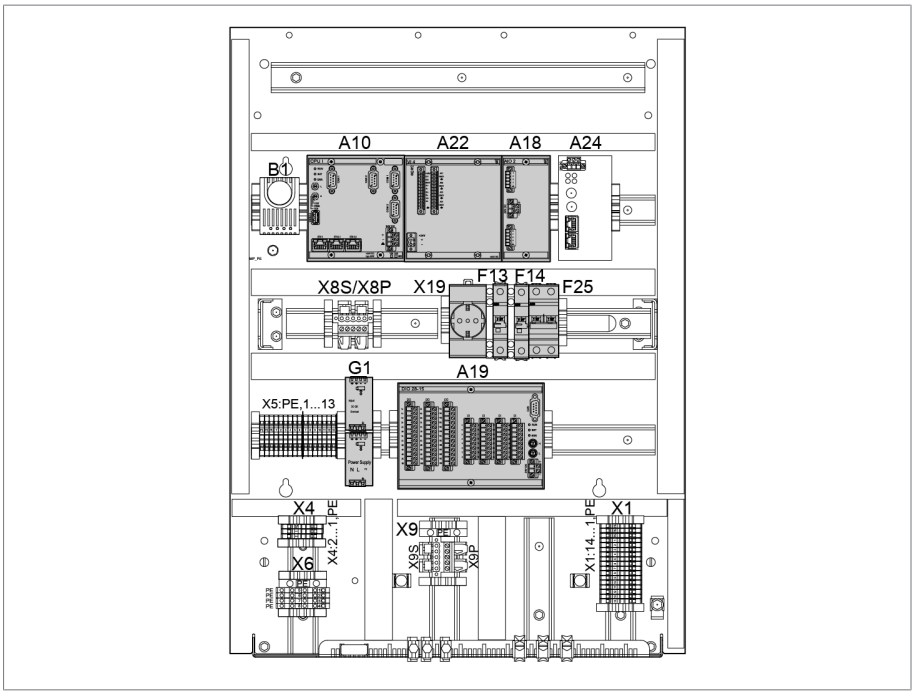


Figure 6: Control cabinet layout (example)

A10	CPU II (central processing unit)	A22	VI 4 vibration sensor input module
A18	Analog AIO 2 or AIO 4 inputs/outputs	G1	Voltage supply
X19	Plug socket	F13	Miniature circuit breaker for heating
F14	Miniature circuit breaker for control system	F25	Residual current circuit breaker plug
A19	Digital inputs/outputs DIO 28-15		

The functions of the device's individual assemblies are described in the following section. You can find more information about these assemblies in the Technical data [►Section 13, Page 157] section.

4.5.2.2.1 Power supply QS3.241

The PULS DIMENSION QS3.241 assembly supplies power to the ISM® assemblies.

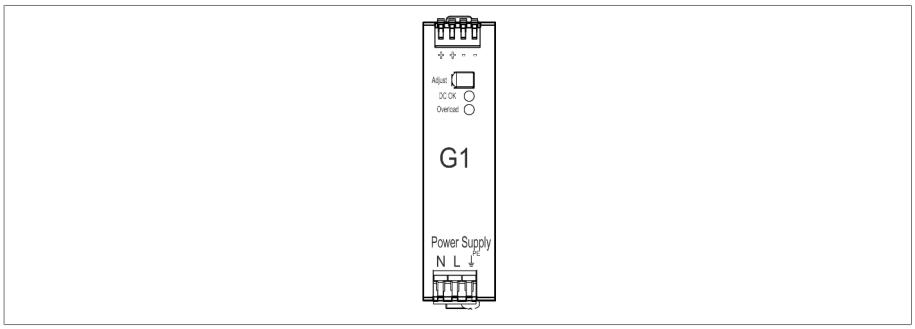


Figure 7: PULS DIMENSION QS3.241 assembly

4.5.2.2.2 CPU II

The CPU II assembly is the central computing unit for the device. It contains the following interfaces:

- Internal system interface RS232 (COM1)
- Serial interface RS232/485 (COM2)
- 3x Ethernet (ETH 1, ETH 2.1, ETH 2.2)
- USB (USB 2.0)
- 2x CAN bus (CAN 1, CAN 2)

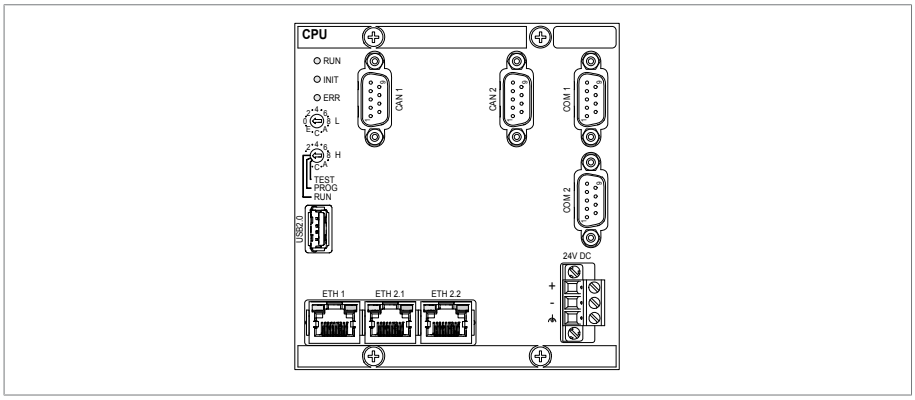


Figure 8: CPU assembly

4.5.2.2.3 DIO 28-15 digital inputs and outputs

The DIO 28-15 assembly makes 28 inputs and 15 outputs (6 N/O contacts, 9 change-over contacts) available.

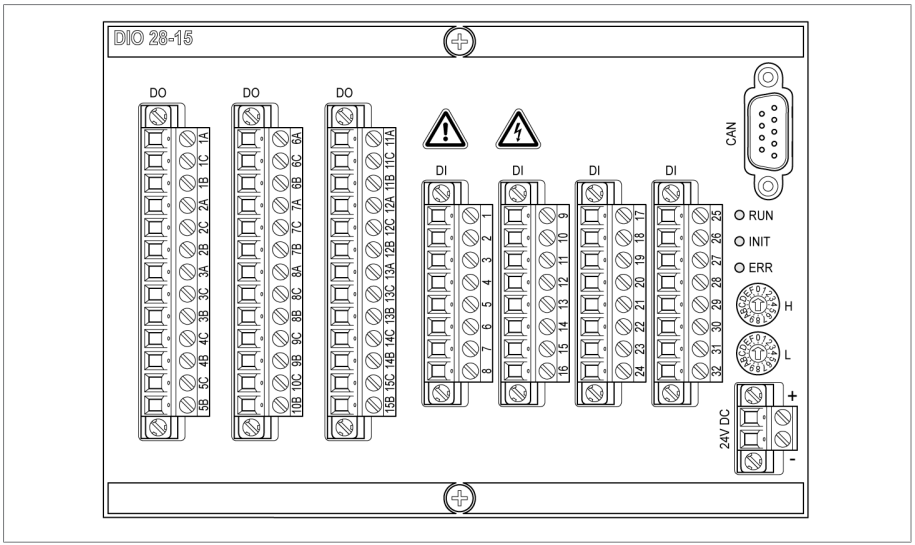


Figure 9: DIO 28-15 assembly

⚠	Warning of a danger point. Read the information given in the product operating instructions.
⚠	Warning of dangerous electrical voltage.

Table 8: Safety-relevant symbols on the assembly

4.5.2.2.4 Analog inputs and outputs (AIO 2)

The AIO 2 assembly provides 2 channels for analog inputs and outputs. In accordance with the device configuration, the AIO assembly supports one of the following signal types:

Input		Output	
Voltage	**Current**	**Voltage**	**Current**
0 to 10 V	0...20 mA	0 to 10 V	0...20 mA
	4...20 mA		4...20 mA
Resistance measurement (e.g. PT100, resistor contact series)			

Table 9: Signal types supported by the AIO assembly

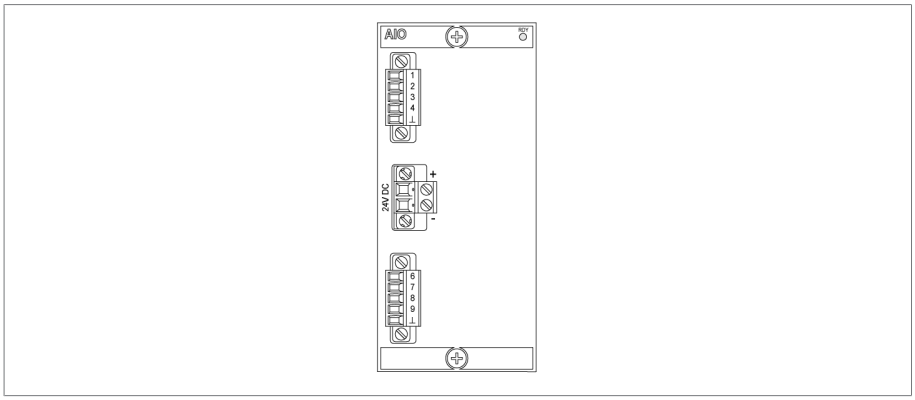


Figure 10: AIO 2 assembly

4.5.2.2.5 Vibroacoustics VI 4

The VI 4 assembly records the vibration sensor signals via an IEPE interface. The abbreviation IEPE refers to an industry standard for piezo-electrical sensors (IEPE = Integrated Electronics Piezo Electric).

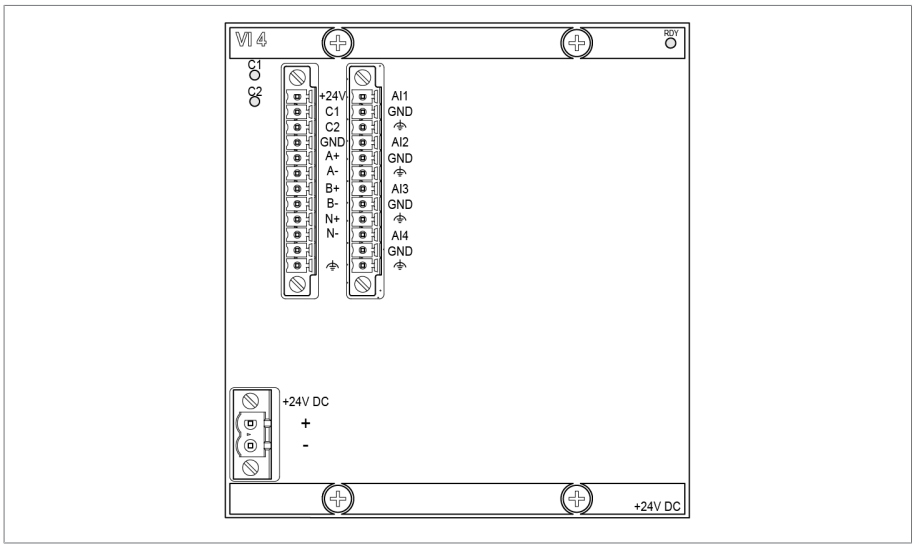


Figure 11: Assembly VI 4

The measured signals are processed with evaluation algorithms.

4.5.2.2.6 System networking MC 2-2

The MC 2-2 assembly is a media converter, which converts 2 electrical connections (RJ45) to one fiber-optic cable connection each. Each is converted independently of the other. The following interfaces are available:

- 2x RJ45 (ETH12, ETH22)
- 2x Duplex-LC (SFP module) (ETH11, ETH21)

The media converter is designed to be transparent for the network and does not have its own IP address.

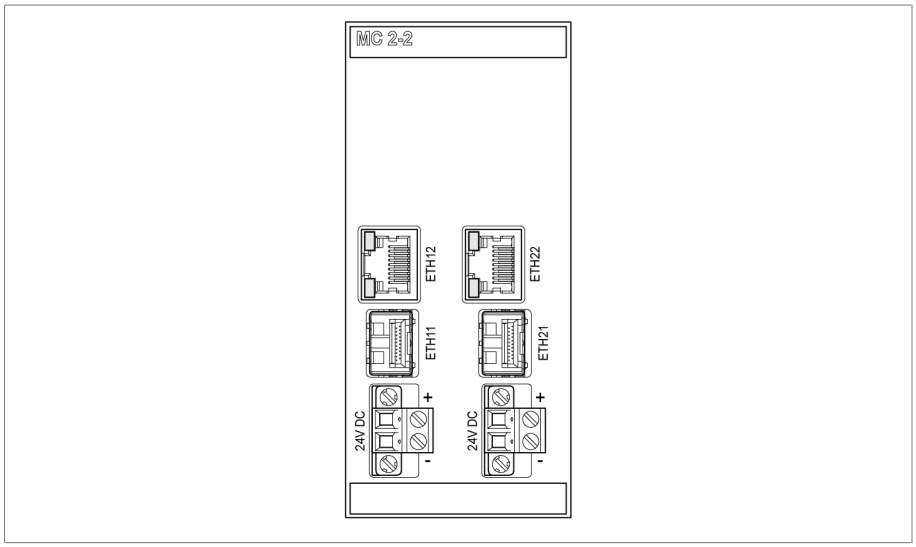


Figure 12: MC 2-2 assembly

4.5.2.2.7 System networking SW 3-3

The assembly SW 3-3 is a media converter with managed switch. It combines two independent functions and provides you with the following interfaces:

- A media converter converts an electric connection (RJ45) into a fiber-optic cable connection
  - RJ45 (ETH12)
  - Duplex-LC (SFP module) (ETH11)
- Managed switch with redundancy function (PRP or RSTP)
  - 2x RJ45 (ETH23, ETH24), device-internal connection
  - 2x Duplex-LC (SFP module) (ETH21, ETH22), redundancy connection

The following redundancy functions are available to you according to your order:

- PRP (standard setting)
- RSTP

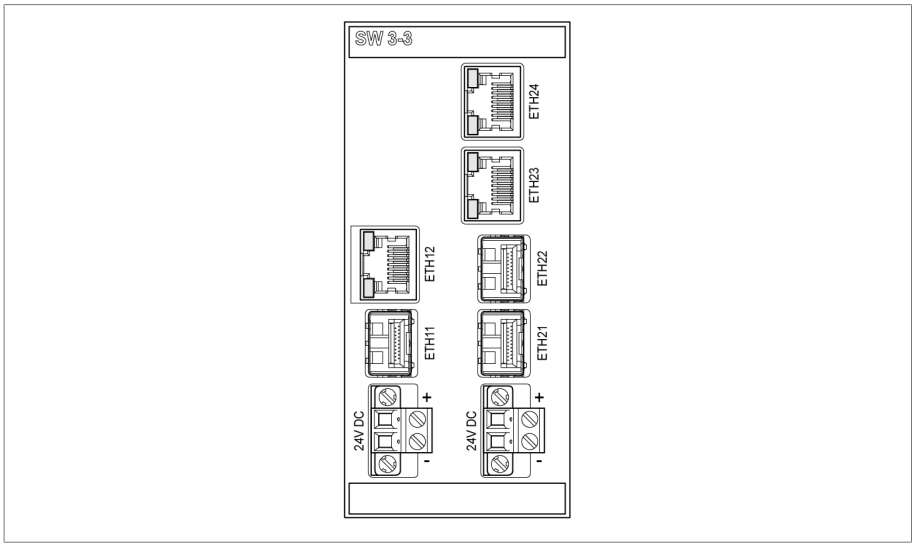


Figure 13: SW 3-3 assembly

4.6 Main screen

The visualization start screen of the MSENSE® VAM monitoring system varies depending on the product version. Their is a difference between the following product versions:

4.6.1 Standalone version

On the start screen of the standalone version, the vibro-acoustic signal progression of the last recorded and evaluated on-load tap-changer operation is shown in blue. Clicking on the **Home** button always returns you to this screen.

Once the recording of a tap-change operation is complete, the calculation and evaluation is performed. With complex switching sequences and a high switching frequency, it may take a few minutes before the latest tap-change operation is displayed.

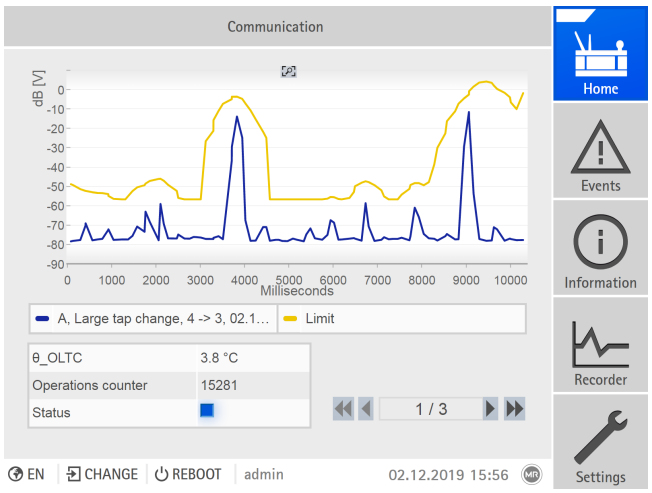


Figure 14: Start screen

The upper curve in yellow indicates the self-learned limit value. In addition, the corresponding properties of the tap-change operation are shown:

- Type of OLTC tap-change operation (e.g. reverse tap-change operation)
- Start and end position of the tap-change
- Date and time of the tap-change operation
- Oil temperature of the on-load tap-changer
- Number of OLTC tap-change operations registered until now
- Status display with the following color code:

Color code	Meaning
Blue	No anomalies: Plausibility criteria met and limit values not exceeded
Yellow	Limit value was exceeded
Gray	The evaluation could not be carried out

4.6.2 Integration solution

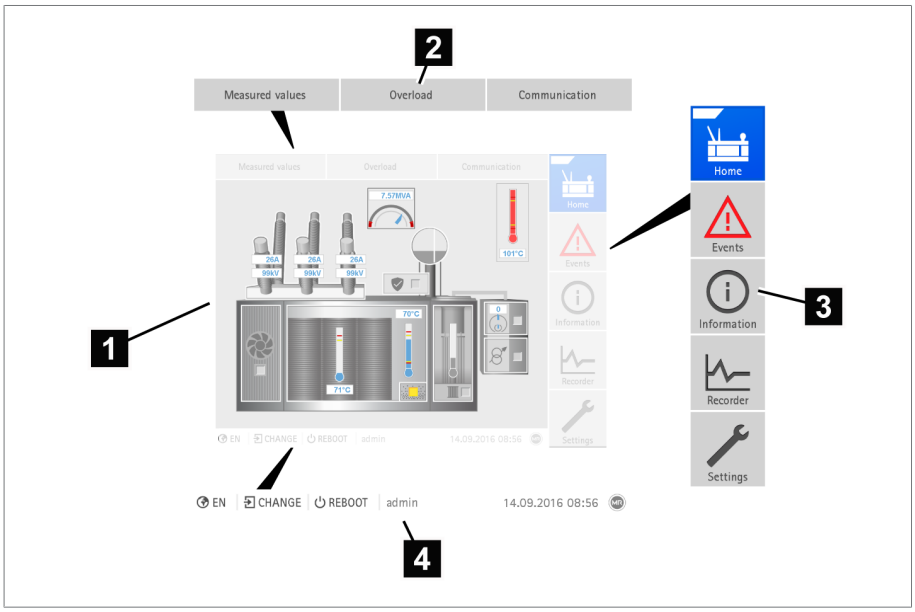


Figure 15: Main screen

1	Display area	2	Secondary navigation
3	Primary navigation	4	Status bar

Click on the on-load tap-changer in the graphic to enter the overview screen for the vibro-acoustically measured tap-change operations of the on-load tap-changer (OLTC).

Primary navigation

The primary navigation on the right edge of the screen is always structured the same way, regardless of the product version. The buttons of the primary navigation have the following functions:

Button	Function
Home	Switch to the start screen
Events	Switch to the display of events detected
Information	Switch to the display of information on: ▪ Installed hardware ▪ OLTC ▪ Tap-change operation statistics ▪ OLTC oil temperature curve ▪ VAM analysis
Recorder	Switch to the display of statistics for tap position and oil temperature

4.7 Operating concept

You can operate the device using the controls on the front panel or using the web-based ISM™ Intuitive Control Interface visualization on a PC. The scope of function and structure of both options is virtually identical.

User rights and user roles

The device is equipped with a rights system and a roles system. The display and access rights to device settings or events can therefore be controlled at the user level.

You can configure the rights system and roles system to meet your requirements. You will find more information on user rights in the User administration [►Section 8.1.12, Page 111] section.

You can only modify the device settings or parameters if you have the necessary user rights.

Logging on, logging off and changing users

The control of access rights to device settings and parameters is user-based. Various users can log in at the same time (e.g. via the visualization) and access the device.

If you want to operate the device via the controls and visualization at the same time, you have to log in on the device and via the visualization.

1. Select the **LOGIN** or **CHANGE** button in the status line.
2. Enter your user name and password and select the **OK** button.

⇨ The name of the logged-in user appears in the status line.

To log out as a user, proceed as follows:

► Press the **LOGOUT** button in the status line.

Navigation

If you are operating the device using the controls on the front panel, you can use the rotary knob to navigate through the entire menu. The menu currently selected has a blue border. To open the highlighted menu, you have to press the ENTER key. Pressing the BACK key returns you to the previous menu level.

If you are operating the device using the web-based visualization, you can navigate by clicking on the appropriate buttons.

Example

1. Go to **Settings**.
2. Go to **Parameters**.
3. Go to **System**.

4. Go to **Time synchronization**.
5. Select **Time**.

In these operating instructions, the path for navigating to a parameter is always shown in an abridged form: Go to **Settings > Parameters > System > Time synchronization**.

Setting parameters

There are various ways to configure the settings, depending on the parameter.

Selecting from a list

To select a list entry, proceed as follows:

1. Use the rotary knob to navigate to the list and press the ENTER key.

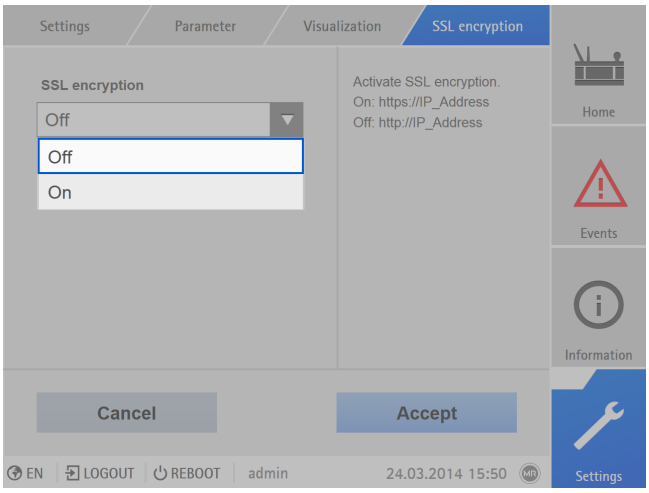


Figure 16: Select an entry from a list

2. Use the rotary knob to highlight the list entry and press the ENTER key.
3. Press the **Accept** button to save the modified parameter.

Entering a value

To enter a value, proceed as follows:

1. Use the rotary knob to select the value field and press the ENTER key.
   ⇨ If operating via the front panel, the numerical keypad appears.

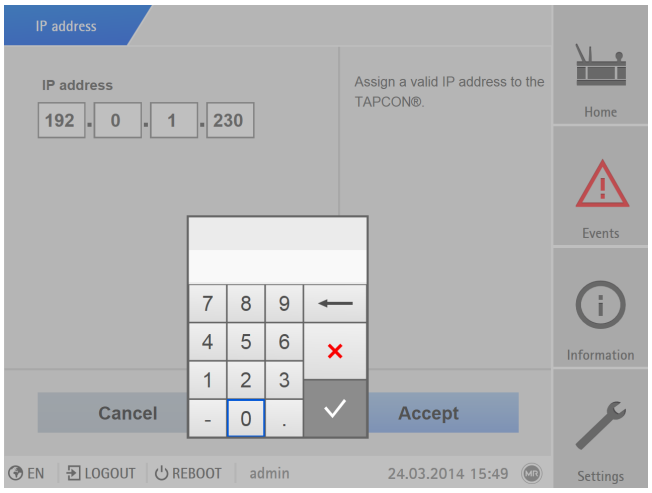


Figure 17: Entering a value

2. Enter the desired value and confirm with ✓.
3. Press the **Accept** button to save the modified parameter.

Entering text

1. Use the rotary knob to select the text box and press the ENTER key.
   ⇨ If operating via the front panel, the keyboard appears.

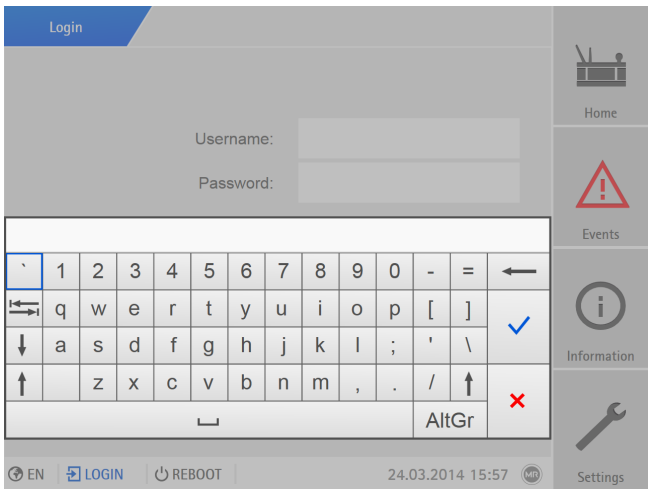


Figure 18: Entering text

2. Enter the desired text and confirm with ✓.
3. Press the **Accept** button to save the modified parameter.

Parameter search

You can use the quick search function in the parameter menu to search for a parameter. Enter the name of the desired parameter in the **Search** entry field.

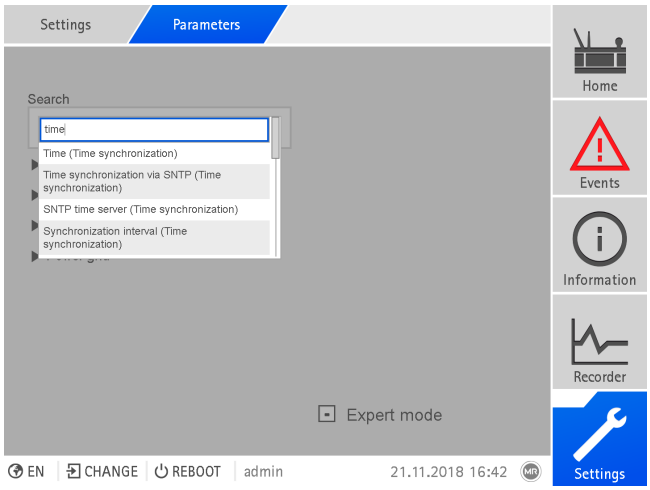


Figure 19: Quick search

Expert mode

The device has an expert mode for entering the parameters. You can enter the parameters directly on the overview screen of the respective menu in this mode.

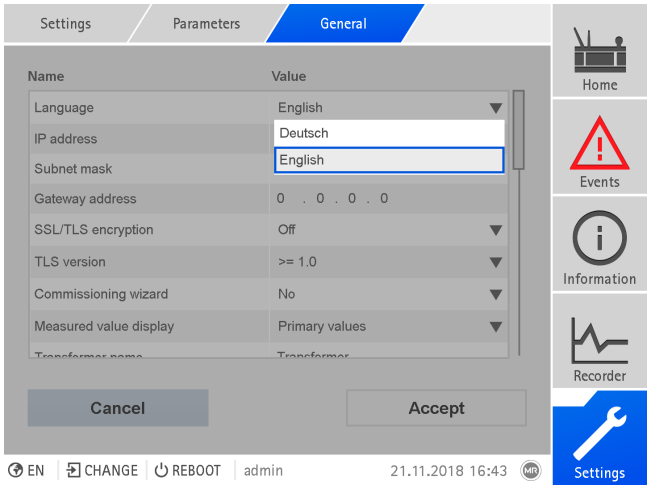


Figure 20: Expert mode

1. Go to **Settings > Parameters**.
2. Select the **Expert mode** checkbox.

⇨ Expert mode is active.

Hiding/showing parameters

Depending on how you set the parameters, the device will hide or show additional parameters related to this function.

5 Packaging, transport and storage

5.1 Suitability

NOTICE

Property damage due to incorrectly stacked crates!

Stacking the crates incorrectly can lead to damage to the packaged goods.

- ► The outer marking on the packaging states if, for example, the on-load tap-changer or selector has been packed upright. Never stack these crates.
- ► General rule: Do not stack crates above a height of 1.5 m.
- ► For other crates: Only stack up to 2 equally sized crates on top of one another.

The packaging is suitable to ensure undamaged and fully functional means of transportation in compliance with local transportation laws and regulations.

The packaged goods are packed in a sturdy crate. This crate ensures that, when in the intended transportation position, the packaged goods are stabilized to prevent impermissible changes in position, and that none of the parts touch the loading surface of the means of transport or touch the ground after unloading.

Sealed packaging surrounds the packaged goods with plastic foil on all sides. The packaged goods are protected from humidity using a desiccant. The plastic foil was bonded after the desiccant is added.

5.2 Markings

The packaging bears a signature with instructions for safe transport and correct storage. The following symbols apply to the shipment of non-hazardous goods. Adherence to these symbols is mandatory.

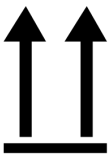
				
Protect against moisture	Top	Fragile	Attach lifting gear here	Center of mass

Table 10: Shipping pictograms

5.3 Transportation, receipt and handling of shipments

⚠ WARNING **Danger of death or severe injury!**

Danger of death or serious injuries due to tipping or falling load.

- ► Only transport the crate when closed.
- ► Do not remove the securing material used in the crate during transport.
- ► If the product is delivered on a pallet, secure it sufficiently.
- ► Only trained and authorized persons may select the sling gear and secure the load.
- ► Do not walk under the suspended load.
- ► Use means of transport and lifting gear with a sufficient carrying capacity in accordance with the weight stated on the delivery slip.

In addition to oscillation stress, jolts must also be expected during transportation. In order to prevent possible damage, avoid dropping, tipping, knocking over and colliding with the product.

If a crate tips over, falls from a certain height (e.g. when slings tear) or experiences an unbroken fall, damage must be expected regardless of the weight.

Every delivered shipment must be checked for the following by the recipient before acceptance (acknowledgment of receipt):

- Completeness based on the delivery slip
- External damage of any type

The checks must take place after unloading when the crate or transport container can be accessed from all sides.

Visible damage

If external transport damage is found upon receipt of the shipment, proceed as follows:

- Immediately record the identified transport damage in the shipping documents and have this countersigned by the carrier.
- In the event of severe damage, total loss or high damage costs, immediately notify the manufacturer and the relevant insurance company.
- After identifying damage, do not modify the condition of the shipment further and retain the packaging material until an inspection decision has been made by the transport company or the insurance company.
- Record the details of the damage immediately on site together with the carrier involved. This is essential for any claim for damages.
- Photograph damage to packaging and packaged goods. This also applies to signs of corrosion on the packaged goods due to moisture inside the packaging (rain, snow, condensation).

- **NOTICE!** Damage to packaged goods due to damaged sealed packaging. If the product is delivered in sealed packaging, check the sealed packaging immediately. If the sealed packaging is damaged, do not under any circumstances install or commission the packaged goods. Either re-dry the dried packaged goods as per the operating instructions, or contact the manufacturer to agree on how to proceed.
- Identify the damaged parts.

Hidden damage

When damages are not determined until unpacking after receipt of the shipment (hidden damage), proceed as follows:

- Make the party responsible for the damage liable as soon as possible by telephone and in writing, and prepare a damage report.
- Observe the time periods applicable to such actions in the respective country. Inquire about these in good time.

With hidden damage, it is very hard to make the transportation company (or other responsible party) liable. Any insurance claims for such damages can only be successful if relevant provisions are expressly included in the insurance terms and conditions.

5.4 Storage of shipments

Packaged goods dried by Maschinenfabrik Reinhausen

Upon receipt of the shipment, immediately remove the packaged goods dried by Maschinenfabrik Reinhausen from the sealed packaging and store air-tight in dry insulating fluid until used if the packaged goods were not supplied in insulating fluid.

Non-dried packaged goods

Non-dried packaged goods but with a functional sealed packaging can be stored outdoors when the following conditions are complied with.

When selecting and setting up the storage location, ensure the following:

- Protect stored goods against moisture (flooding, water from melting snow and ice), dirt, pests such as rats, mice, termites and so on, and against unauthorized access.
- Store the crates on timber beams and planks as a protection against rising damp and for better ventilation.
- Ensure sufficient carrying capacity of the ground.
- Keep entrance paths free.
- Check stored goods at regular intervals. Also take appropriate action after storms, heavy rain or snow and so on.

Protect the packaging foil from direct sunlight so that it does not disintegrate under the influence of UV rays, which would cause the packaging to lose its sealing function.

If the product is installed more than 6 months after delivery, suitable measures must be taken without delay. The following measures can be used:

- Correctly regenerate the drying agent and restore the sealed packaging.
- Unpack the packed goods and store in a suitable storage space (well ventilated, as dust-free as possible, humidity < 50% where possible).

5.5 Unpacking shipments and checking for transportation damages

- ***NOTICE!*** Transport the packaged crate to the place where the packaged goods are to be installed. Do not open the sealed packaging until just before installation. Otherwise, damage to the packaged goods may occur due to ineffectively sealed packaging.
- **⚠ WARNING!** When unpacking, check the condition of the packaged goods. Place the packaged goods in an upright crate and protect it from tipping out. Otherwise, the packaged goods may become damaged and serious injuries may result.
- Check the completeness of the accessories kit using the delivery slip.

Attachment points for lifting gear

⚠ WARNING

Danger of death and damage to property!

Danger of death and damage to property due to tipping or falling load!

► Only trained and authorized persons may select the sling gear and secure the load.

► Do not walk under the suspended load.

► Use means of transport and lifting gear with a sufficient carrying capacity in accordance with the weight stated in the Technical data [► Section 13, Page 157] section.

- **⚠ WARNING!** Serious injuries and damage to the control cabinet due to falling load. Attach the lifting gear such that the cable angle is always less than 45° in relation to the vertical.

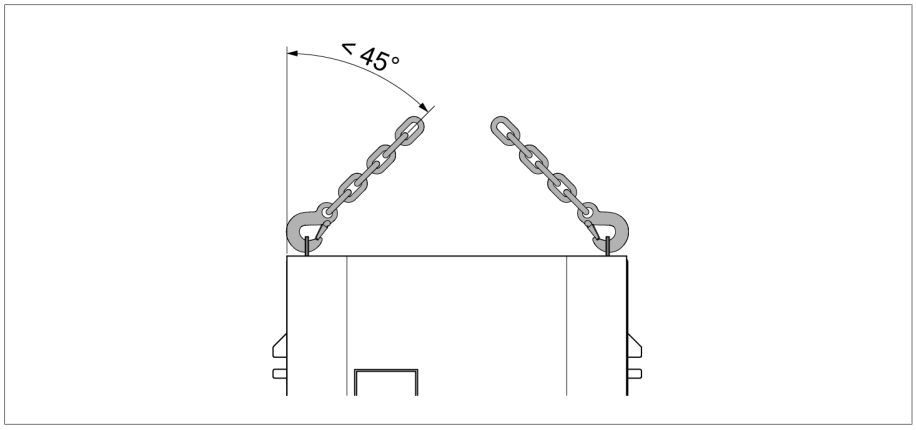


Figure 21: Maximum permissible cable angle for the lifting-gear limit stop of the control cabinet

- **⚠ WARNING!** Serious injuries due to the control cabinet tipping and damage to the cable gland if the control cabinet is set down, transported or stored upright. Only set down, transport and store the control cabinet on its back.
- Only remove the control cabinet from the crane once it has been fully connected to the transformer.

6 Mounting

This chapter describes how to correctly mount and connect the device. Note the connection diagrams provided.

⚠ DANGER

Electric shock!

Risk of fatal injury due to electrical voltage. Always observe the following safety regulations when working in or on electrical equipment.

- ► Disconnect the equipment.
- ► Lock the equipment to prevent an unintentional restart.
- ► Make sure all poles are de-energized.
- ► Ground and short-circuit.
- ► Cover or cordon off adjacent energized parts.

NOTICE

Damage to the device!

Electrostatic discharge may cause damage to the device.

- ► Take precautionary measures to prevent the build-up of electrostatic charges on work surfaces and personnel.

6.1 Installing the Cap rail modules / control cabinet

6.1.1 Installing the cap rail modules

With the MSENSE® VAM product version as an integration solution in the customer control cabinet, the cap rail modules must be installed in a suitable control cabinet, taking the EMC standards into consideration. This section does not apply for other product versions.

6.1.1.1 Minimum distances

NOTICE

Damage to the device!

Insufficient circulation of ambient air can result in damage to the device due to overheating.

- ► Keep the ventilation slots clear.
- ► Ensure sufficient distance to neighboring components.
- ► Only mount device in horizontal position (ventilation slots are at the top and bottom).

Reliable operation of the device in the permitted temperature range requires that you maintain the following minimum distances to the control cabinet and to neighboring components:

	Minimum distance
To the floor of the control cabinet	88.9 mm (3.5 in)
To the roof of the control cabinet	Corresponds to 2 RU
Between assemblies on the bus bar and assemblies on the remote cap rail	

Table 11: Minimum distances in the control cabinet

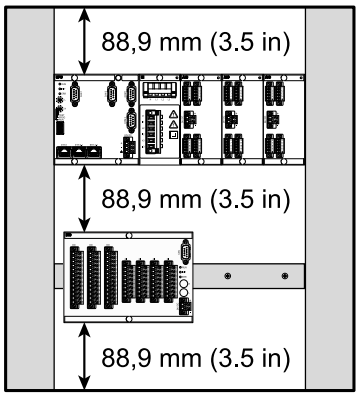


Figure 22: Example depiction of the minimum distances in a control cabinet

For other installation types, contact Maschinenfabrik Reinhausen GmbH.

6.1.1.2 Fastening the cap rail

The cap rail is required to mount a bus bar or a device's remote assemblies in a control cabinet. Only use the following types of cap rails in accordance with EN 60715:

- TH 35-7.5
- TH 35-15

The cap rail may not be painted or lacquered.

⚠ WARNING

Electric shock!

Risk of fatal injury due to electrical voltage if the cap rail is not connected to the protective ground.

► Connect the cap rail to the protective ground securely (e.g. with a protective conductor line-up terminal).

► Ensure that the cap rail is connected securely to the protective ground via a ground test after installation.

► Fasten the cap rail to the rear panel of the switch cabinet using screws and contact washers or lock washers. The distance between the screws may be no more than 10 cm (3.94 in).

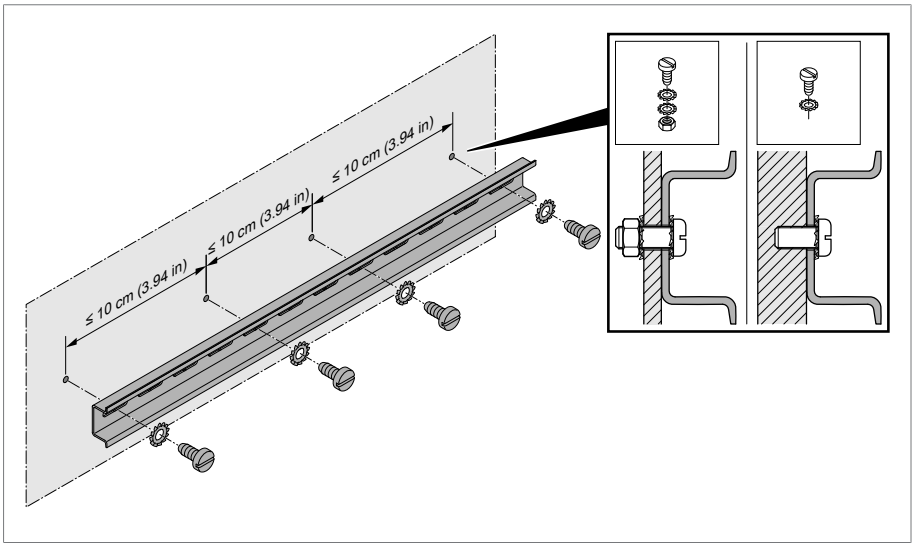


Figure 23: Fastening the cap rail

6.1.1.3 Installing the bus rail on the cap rail

The bus rail connects assemblies, such as the CPU, UI and AIO, to each other mechanically and electrically. The bus bar can contain different assemblies according to your order.

► **⚠ WARNING!** Mount the bus rail on the cap rail, ensuring that the bus rail engages correctly. Otherwise, it can result in electric shock due to a faulty connection to the protective ground.

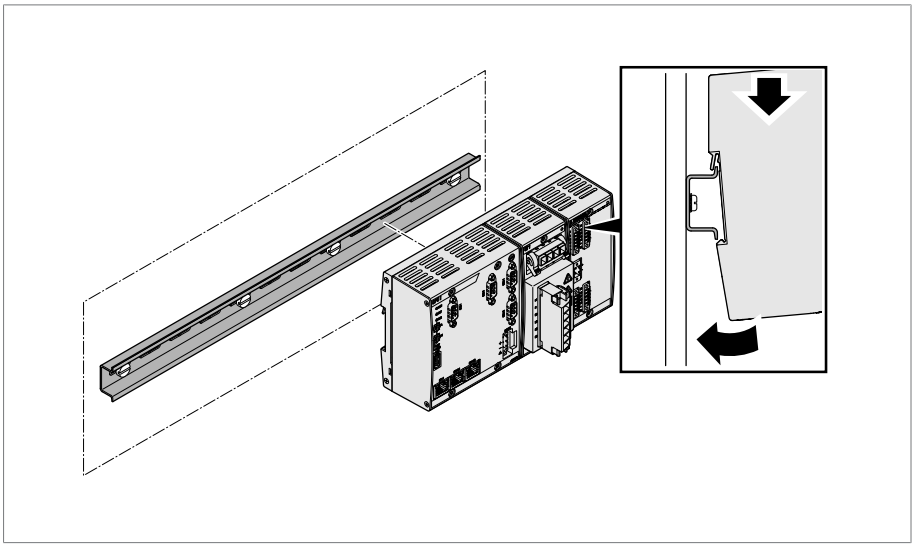


Figure 24: Hooking the bus rail into position

6.1.1.4 Installing the assembly at a distance on the cap rail

The assemblies VI 4, CPU II and AIO 2/AIO 4 are delivered pre-mounted on the bus rail. The following optional assemblies must be mounted with an offset on a cap rail:

- DIO 28-15 or DIO 42-20
- MC 2-2
- SW 3-3
- G1 (PULS)

✓ Cap rail fastened to the rear panel of the cabinet [►Section 6.1.1.2, Page 46].

► **⚠ WARNING!** A faulty connection to the protective ground can lead to an electric shock in the event of faults. Hook the assembly onto the cap rail at the specified location, ensuring that the assembly engages correctly.

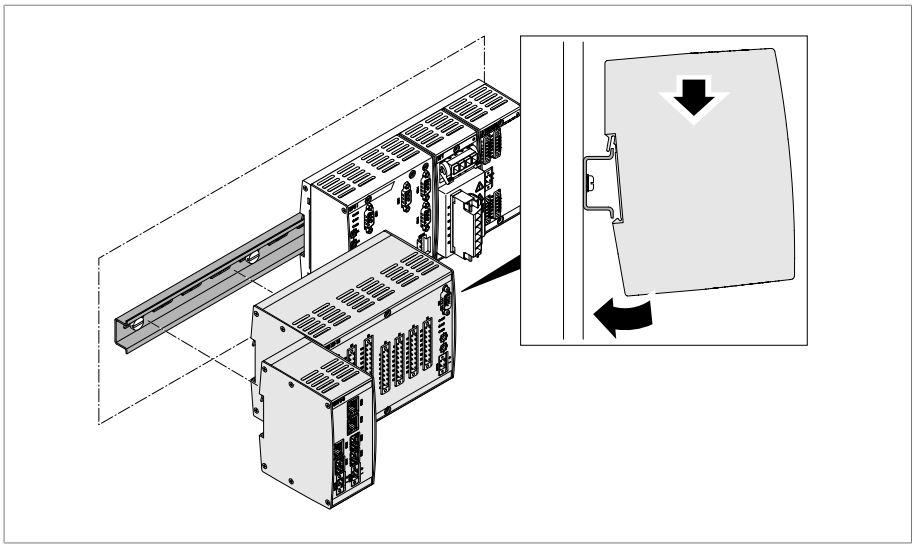


Figure 25: Example: Hooking on DIO and SW assemblies

6.1.2 Integration solution in the ETOS® ED motor-drive unit

With this product version, proceed in accordance with the ETOS® ED operating instructions and follow the safety information and warnings they contain when mounting the control cabinet on the transformer. Once mounted, continue in accordance with the section "Mounting the vibration sensor" [►Section 6.2, Page 51] in these instructions.

6.1.3 Fitting the control cabinet to the transformer

This section describes how to mount the control cabinet of the stand-alone version to the transformer.

The special design with vibration dampers must be used on transformers where the control cabinet is subject to vibration.

The control cabinet has four fixing attachments on the rear to secure it. To mount the control cabinet on the transformer, proceed as follows:

1. Attach four stud bolts (not supplied by MR) to the transformer tank.

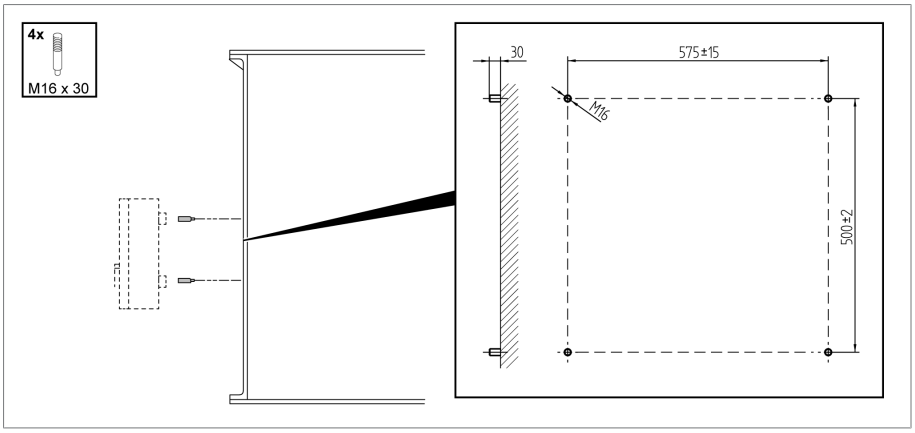


Figure 26: Fastening the stud bolts

2. Use the fixing attachments to attach the control cabinet to the stud bolts and align it vertically on the transformer tank.

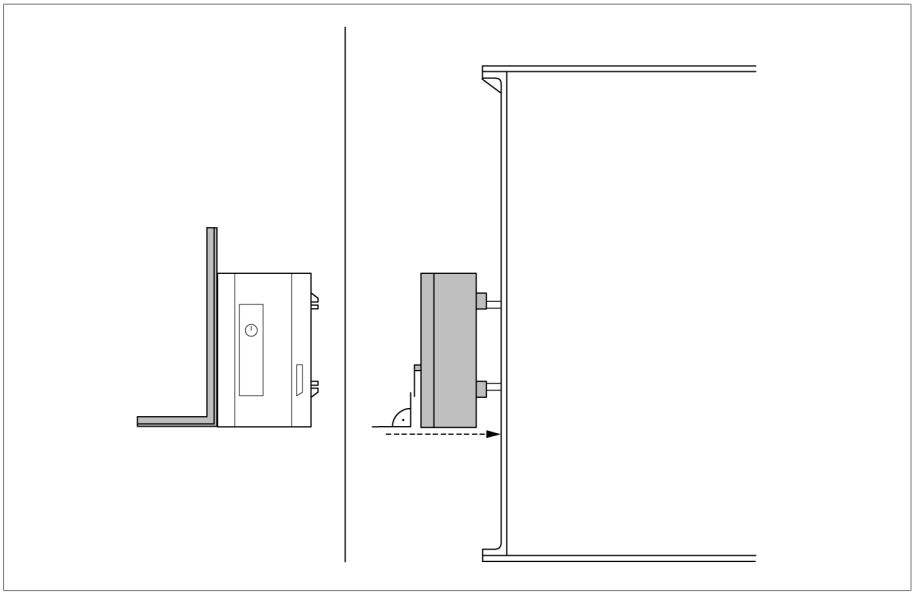


Figure 27: Attaching the control cabinet

3. **NOTICE!** Secure the control cabinet without subjecting it to mechanical tension. Otherwise, the control cabinet may be damaged.

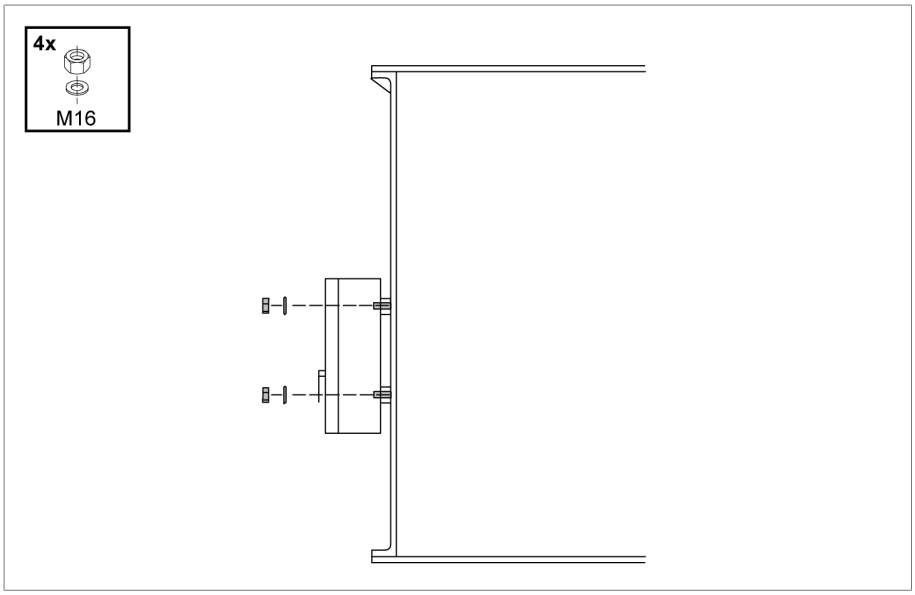


Figure 28: Fastening the control cabinet

4. Connect the grounding cable to the control cabinet and transformer tank, holding it against the control cabinet using a wrench of size 36.

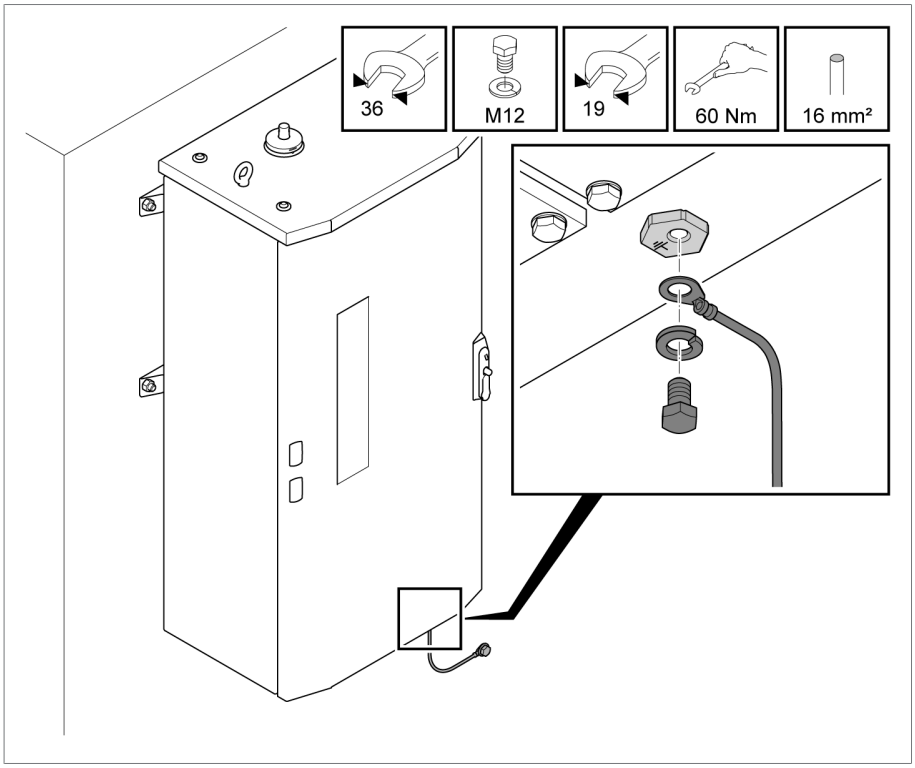


Figure 29: Connecting the grounding cable to the control cabinet

6.2 Mounting the vibration sensor

When selecting the mounting position, ensure that there is the greatest possible clearance to the drive motor, drive shafts and pipelines to reduce the disruptive effect on the vibro-acoustic recording to a minimum.

To mount the VAM sensor, proceed as follows:

1. Remove one bolt from the on-load tap-changer cover. Reuse the washer that is present.

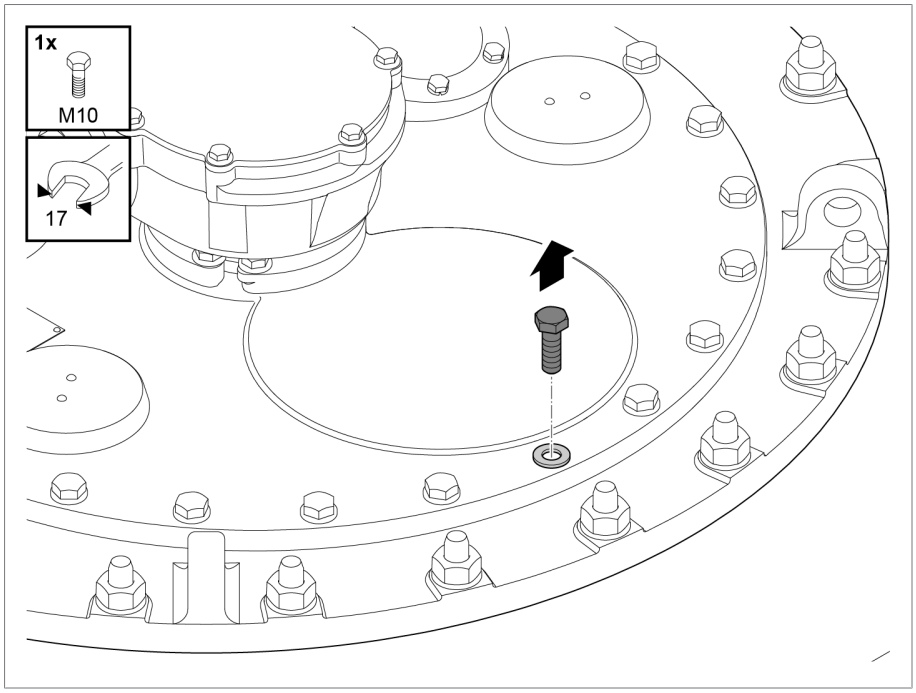


Figure 30: Removing bolt

2. ***NOTICE!*** Incorrect mounting can destroy the vibration sensor. Only apply a tool with wrench size 17 to the lower hexagon of the adapter to attach the sensor assembly. Place the washer over the open tapped hole and screw in the sensor assembly (vibration sensor with adapter and kick guard) with a torque of 34 Nm.

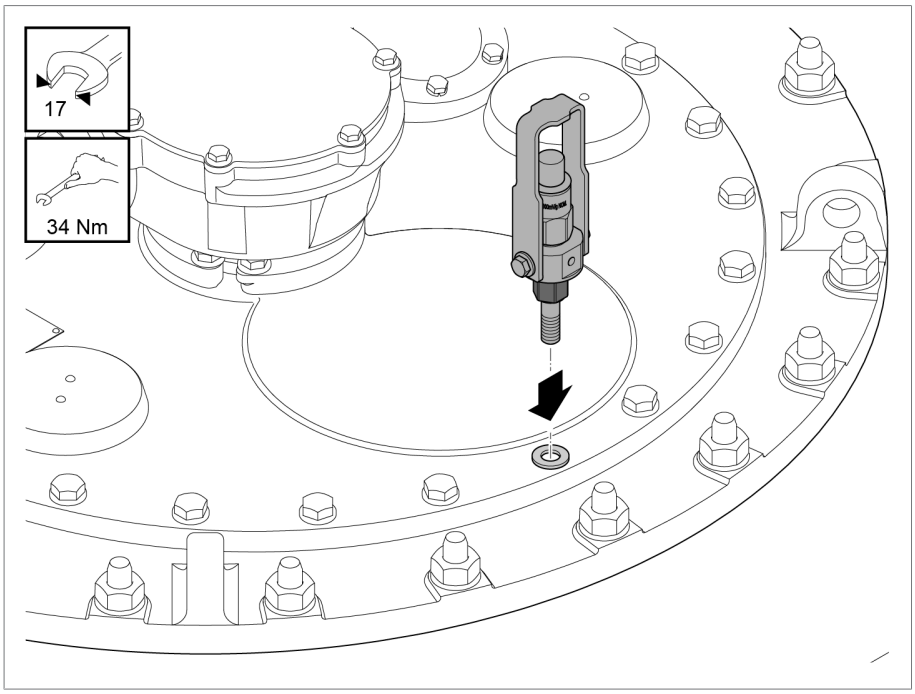


Figure 31: Mounting the vibration sensor

6.3 Connecting the ISM® assemblies

⚠ WARNING

Electric shock!

Risk of fatal injury due to connection errors.

► Ground the device using the grounding screw on the housing.

6.3.1 Cable recommendation

Please note the following Maschinenfabrik Reinhausen recommendation when wiring the device.

Excessive line capacitance can prevent the relay contacts from interrupting the contact current. In control circuits operated with alternating current, take into account the effect of the line capacitance of long control cables on the function of the relay contacts.

If you want to route Ethernet connections from a control cabinet or building, we recommend the use of fiber-optic cables (in accordance with the IEC 61850-90-4 recommendation).

The sensor cable is included in the scope of delivery and is oil-resistant and UV-resistant.

Use oil-resistant versions for all connection cables outside of control cabinets and versions also with additional UV resistance for those outside of buildings.

Cable	Assembly	Cable type	Conductor cross-section	Max. length
Signal inputs	DIO 28-15, DIO 42-20	Shielded	1.5 mm^2	400 m (<25 Ω/km)
Signal outputs*	DIO 28-15, DIO 42-20	Shielded	1.5 mm^2	-
Signal inputs	AIO 2, AIO 4, AIO 8	Shielded	1 mm^2	400 m (<25 Ω/km)
Signal outputs	AIO 2, AIO 4, AIO 8	Shielded	1 mm^2	-
RS232, SUB-D	CPU I, CPU II	Shielded	0.25 mm^2	25 m
RS485; SUB-D	CPU I, CPU II	Shielded	0.25 mm^2	140 m
Ethernet RJ45	CPU I	Min. CAT5, shielded S/FTP	-	100 m
Ethernet FO	MC 2-2, SW 3-3	Duplex LC Multimode, OM3, 1310 nm	-	2000 m

Table 12: Recommendation for connection cables

*) Observe line capacitance, see note above.

6.3.2 Notes on the screw terminal tightening torque

NOTICE

Damage to screw terminals

Tightening the screws too tightly can damage the screw terminals.

► When fastening the screw terminals, make sure that the tightening torque is 0.5 Nm.

6.3.3 Information about connecting serial interfaces RS232 and RS485 (with 9-pin data cable)

NOTICE

Damage to the device!

Using the wrong data cable may damage the device.

► Only use data cables which comply with the description below.

RS232 (D-SUB 9-pin)

To connect the device via the RS232 interface (COM2), use a data cable with the following structure:

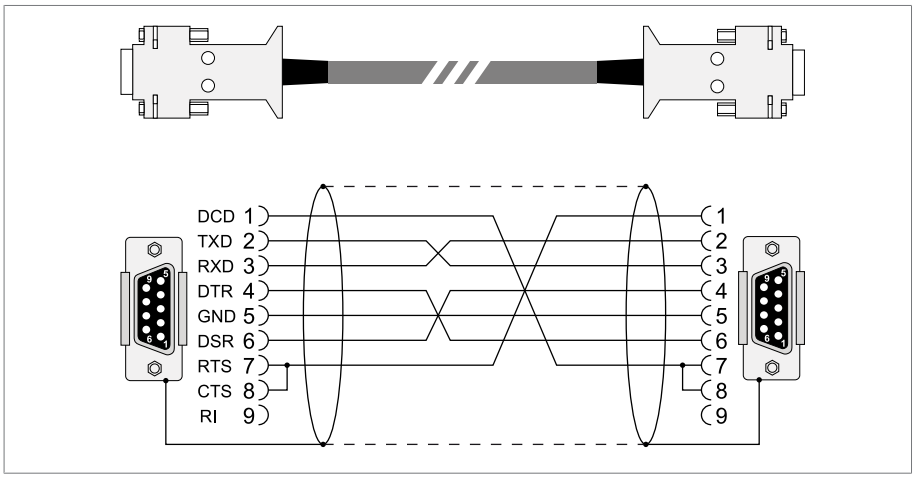


Figure 32: RS232 data cable (9-pin)

RS485 (D-SUB 9-pin)

To connect the device via the RS485 interface (COM2), use a data cable with the following structure:

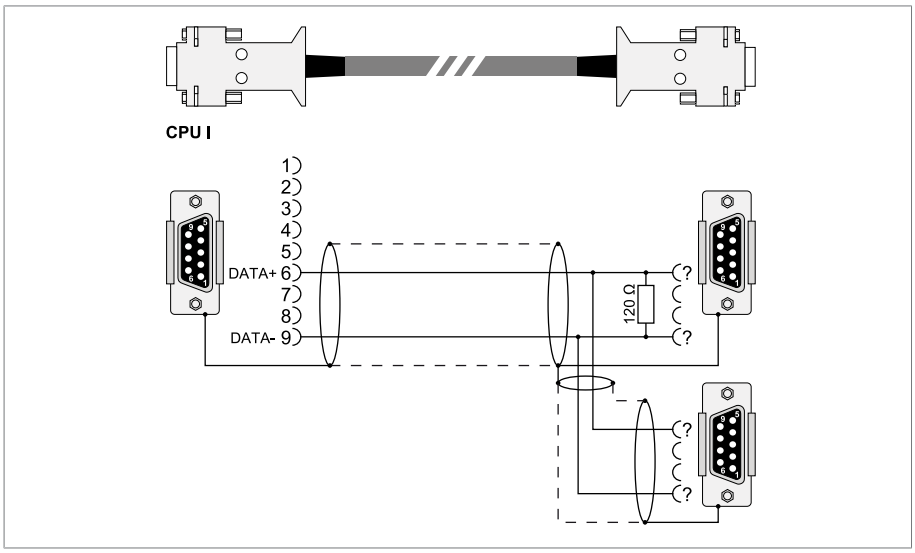


Figure 33: RS485 data cable

D-SUB 9-pin plug connection

Only use 9-pin D-SUB plugs with the following characteristics:

- Plug housing is metallic or metal-plated
- Cable shielding is connected with the plug using one of the following two variants:
  - Shielding is screwed down with traction relief.
  - Shielding is soldered to the plug housing.

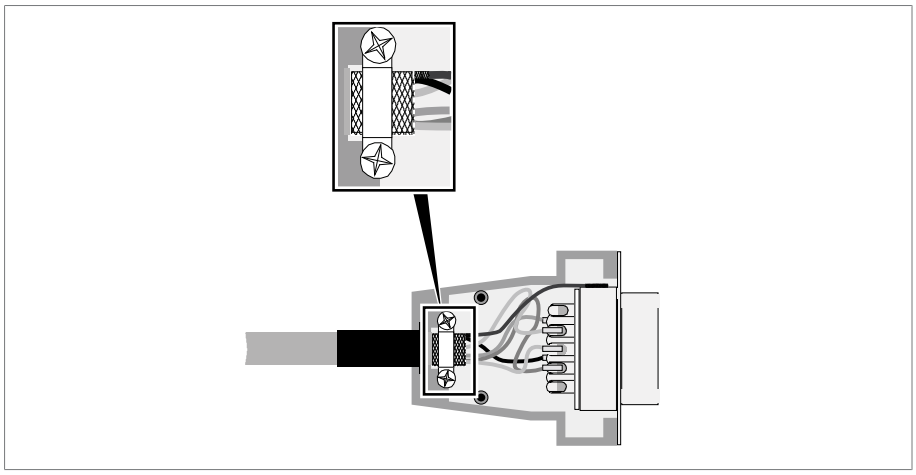


Figure 34: Example of a soldered shielding on a plug housing

6.3.4 Information about connecting analog sensors

NOTICE

Damage to the device and sensors!

Incorrectly connected and configured analog inputs/outputs may result in damage to the device and sensor.

► Follow information about connecting analog sensors [► Section 6.3.4, Page 55].

► Configure analog inputs and outputs according to the connected sensors.

6.3.5 Electromagnetic compatibility

The device has been developed in accordance with applicable EMC standards. The following points must be noted in order to maintain the EMC standards.

6.3.5.1 Wiring requirement of installation site

Note the following when selecting the installation site:

- The system's overvoltage protection must be effective.
- The system's ground connection must comply with all technical regulations.

- Separate system parts must be joined by a potential equalization.
- The device and its wiring must be at least 10 m away from circuit-breakers, load disconnectors and busbars.

6.3.5.2 Wiring requirement of operating site

Note the following when wiring the operating site:

- Route the connecting leads in grounded metal cable ducts.
- Do not route lines which cause interference (e.g. power lines) and lines susceptible to interference (e.g. signal lines) in the same cable duct.
- Maintain a distance of more than 100 mm between lines which cause interference and those which are susceptible to interference.

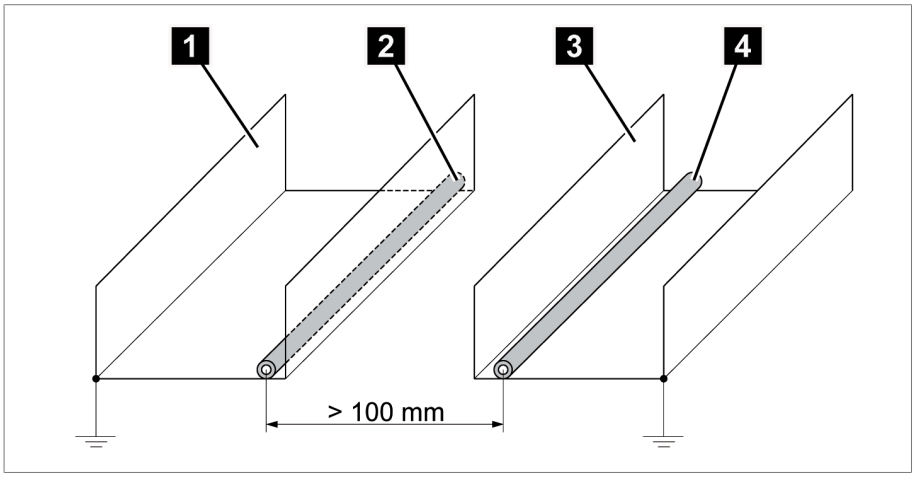


Figure 35: Recommended wiring

1	Cable duct for lines causing interference	3	Cable duct for lines susceptible to interference
2	Line causing interference (e.g. power line)	4	Line susceptible to interference (e.g. signal line)

- Short-circuit and ground reserve lines.
- Never connect the device with a multi-wire collective pipe.
- For signal transmission, use shielded lines with individual conductors (outgoing conductor / return conductor) twisted in pairs.
- Connect full surface of shielding (360º) to device or to a nearby grounding bar.

Using single conductors may limit the effectiveness of the shielding. Connect close-fitting shielding to cover all areas.

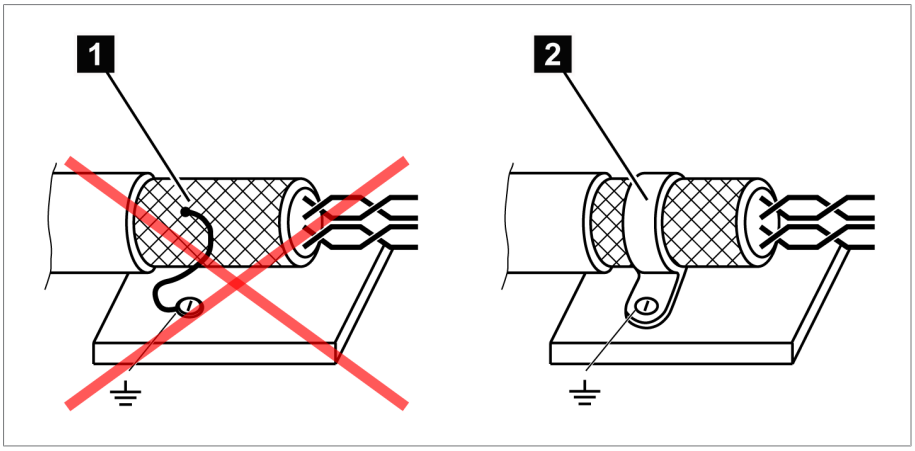


Figure 36: Recommended connection of the shielding

1	Connection of the shielding via a single conductor	2	Full-surface connection of the shielding

6.3.5.3 Wiring requirement in control cabinet

Note the following when wiring in the control cabinet:

- The control cabinet where the device will be installed must be prepared in accordance with EMC requirements:
  - Functional division of the control cabinet (physical separation)
  - Constant potential equalization (all metal parts are joined)
  - Line routing in accordance with EMC requirements (separation of lines which cause interference and those susceptible to interference)
  - Optimum shielding (metal housing)
  - Overvoltage protection (lightning protection)
  - Collective grounding (main grounding rail)
  - Cable bushings in accordance with EMC requirements
  - Any contactor coils present must be interconnected
- The device's connection cables must be laid in close contact with the grounded metal housing or in metallic cable ducts with a ground connection.
- Signal lines and supply lines / switching lines must be laid in separate cable ducts.

6.3.5.4 Information about shielding the cables for analog signals

In order to correctly record the analog signals, you must place the cable shielding on the grounding bar in the control cabinet. The cable shielding should only be removed just prior to connecting to ensure that the section with unshielded cables is kept as short as possible. Observe the notes in the connection diagram.

Direct connection to ISM assemblies

If you connect the analog signals directly to the ISM assembly, you must place the cable shield on the grounding bar in the control cabinet using a clamping bracket.

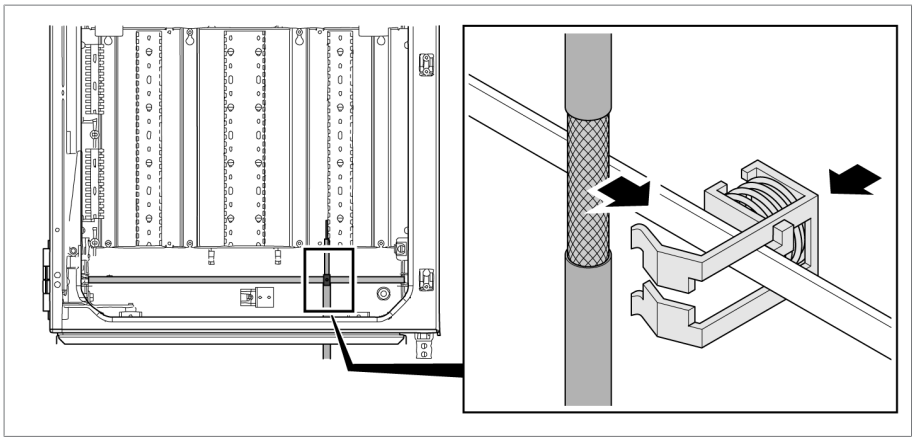


Figure 37: Placing the cable shield with clamping bracket on the grounding bar

Connection to transfer module

If you connect the analog signals to the transfer module, you must place the cable shield on the transfer module using a shielding terminal.

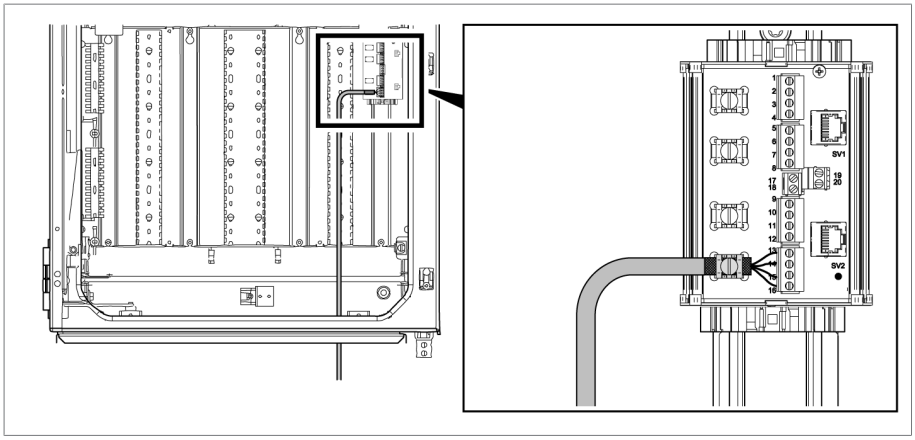


Figure 38: Placing cable shield on transfer module

6.3.6 Information about laying fiber-optic cable

To ensure the smooth transfer of data via the fiber-optic cable, you must ensure that mechanical loads are avoided when laying the fiber-optic cable and later on during operation. Also observe the information from the manufacturer of the fiber-optic cable and the following instructions:

- Radii must not fall below the minimum permissible bend radii (do not bend fiber-optic cable).
- The fiber-optic cables must not be over-stretched or crushed. Observe the permissible load values.

- The fiber-optic cables must not be twisted.
- Be aware of sharp edges because they can damage the fiber-optic cable's coating during laying or can place mechanical loads on the coating later on.
- Provide a sufficient cable reserve near distributor cabinets. Lay the reserve such that the fiber-optic cable is neither bent nor twisted when tightened.

6.3.7 Connecting the vibration sensor to the control cabinet

Depending on the application, one or more vibration sensors are included in the scope of delivery. Repeat the following steps for a multi-column application.

You must connect the vibration sensor to the control cabinet using the sensor cable provided. Note the following information when routing the sensor cable:

- Route the sensor cable with as much shielding as possible on the transformer (e.g. in the tube or cable duct) and along a conductive grounded surface that runs without interruption.
- Route sensor cables separately from supply lines and do not create any unnecessary loops.
- The vibration sensor cable can also be routed together with the temperature sensor cable in a protective tube.
- On the control cabinet, it is advantageous to have routing parallel to the earthing cable that connects the transformer and the control cabinet together.

To route the sensor cable, proceed as follows:

1. Remove the vibration sensor cover cap.

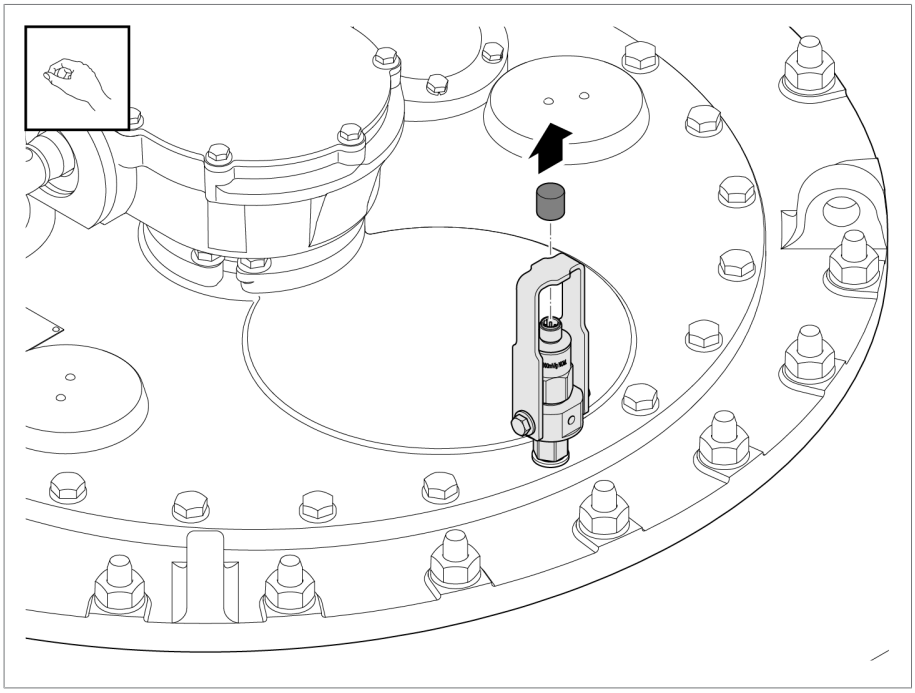


Figure 39: Vibration sensor cover cap

2. Ensure that the sensor cable plug and the socket on the sensor are dry and free of dirt. If this is not the case, clean and dry them with a cloth.

3. Plug in the sensor cable plug and screw it in by hand.

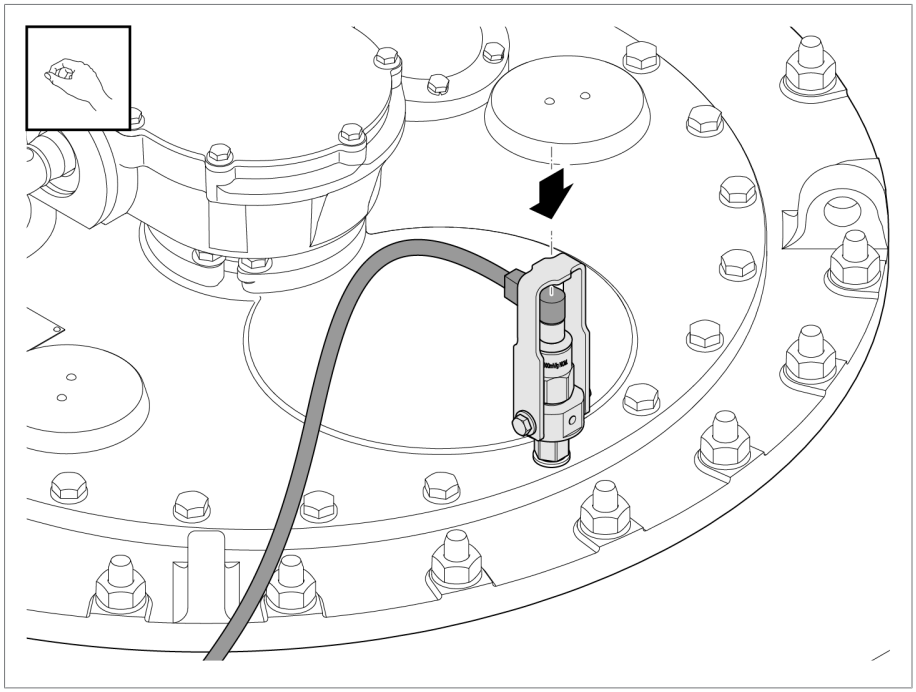


Figure 40: Plugging in the sensor cable

4. Route the sensor cable on the transformer to the control cabinet with shielding to prevent mechanical damage and interference.

5. Shorten the sensor cable to the desired length. Loops or coil windings of an excessive length are not permitted when routing the cable.

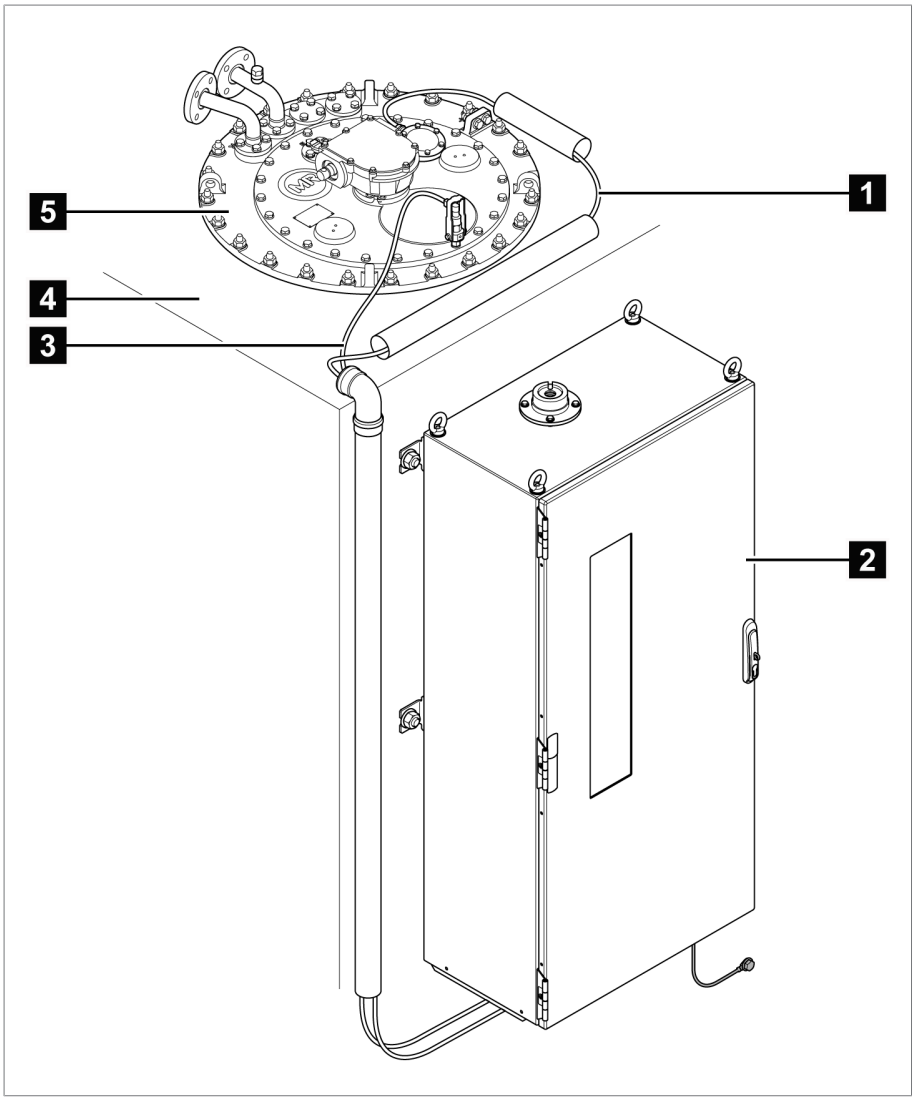


Figure 41: Sensor cable routing

1	Temperature sensor cable	2	Control cabinet
3	Vibration sensor cable	4	Transformer
5	On-load tap-changer head cover		

If the control cabinet is farther away, extend the sensor cable with a shielded cable in the motor drive cabinet or in a metal intermediate terminal box.
Follow the information in the Cable recommendation [►Section 6.3.1, Page 52] section and implement continuous shielding.

For the control cabinet connection, proceed as follows:

1. Place the cable shield on the earthing bar of the control cabinet using the clamping bracket.

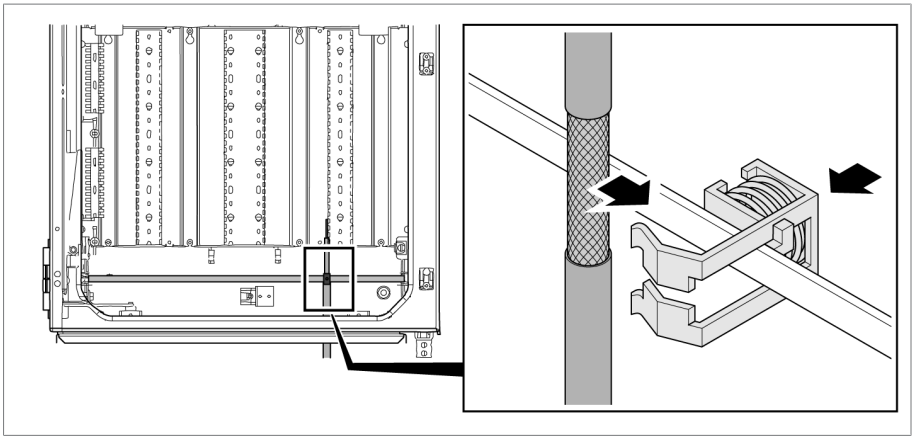


Figure 42: Placing the cable shield with clamping bracket on the earthing bar

2. Connect the sensor cable in accordance with the connection diagram provided (blue = signal, brown = signal ground, black = ground in control cabinet).

6.3.8 Connecting the motor-drive unit controller to the monitoring system

To synchronize the vibro-acoustic signals with the tap position change, it is necessary to measure the diverter switch operation in the motor-drive controller. With the integration solution in the motor-drive unit, this connection is already made at the factory.

With the "standalone" and "integration solution in the customer control cabinet" versions, you must make this connection yourself. To do so, connect the position transmitter module of the motor-drive unit to the DIO assembly of the vibro-acoustic monitoring system in accordance with the connection diagram provided.

6.3.9 Connecting the temperature sensor

Depending on the application, one or more temperature sensors are included in the scope of delivery. When making the connection, follow the connection diagram on the associated dimensional drawing. Make the connection to the control cabinet in accordance with the connection diagram provided for the monitoring system.

6.3.10 Connecting additional leads (optional)

Connect additional leads as necessary in accordance with the connection diagram:

- Digital inputs and outputs
- Control system
- Visualization

Routing information for connecting the control system or visualization

When connecting the device to a control system or to your network for accessing the visualization, observe the following recommendation on the cable routing in the control cabinet:

► Route the cable along the outer edge of the control cabinet.

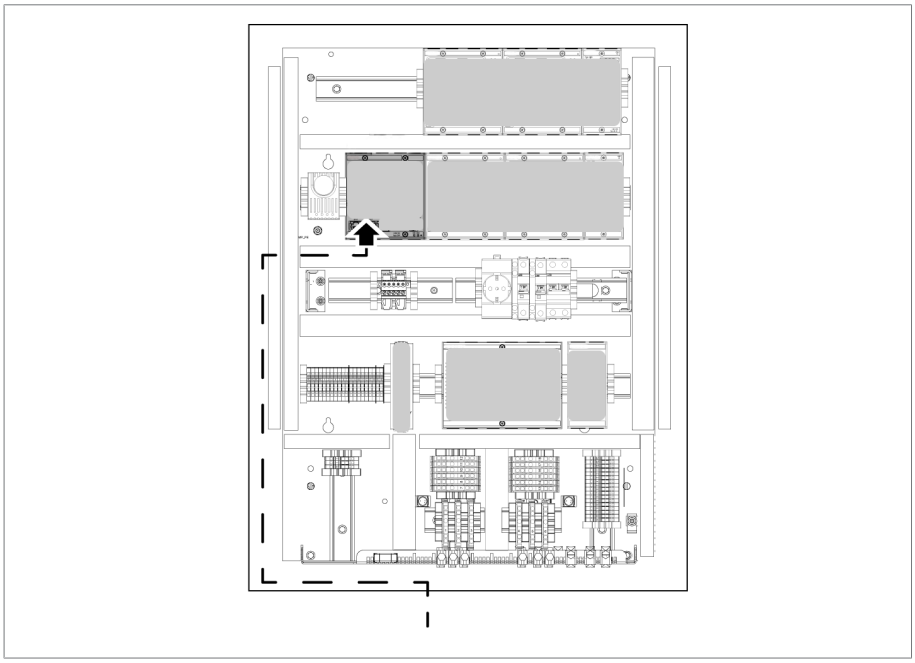


Figure 43: Example of the cable routing in the control cabinet for the connection of the control system or visualization

6.3.11 Connecting the power supply

You may only connect the control cabinet to circuits with an external overcurrent protection device and an isolating device with all poles disconnected so the equipment can be fully de-energized if required (service, maintenance etc.).

Suitable equipment includes isolating devices in accordance with IEC 60947-1 and IEC 60947-3 (e.g. circuit breaker). Note the properties of the relevant circuits (voltage, maximum currents) when selecting the circuit breaker type. In addition, observe the following:

- It must be easy for the operator to access the isolating device
- The isolating device must be labeled for the device and circuits to be isolated
- The isolating device may not be a part of the power line
- The isolating device may not interrupt the main protective conductor

You must connect the power supply circuit with a conductor cross-section of at least 2.5 mm^2 (AWG 13) and protect it with a C6A or B6A type miniature circuit breaker.

To connect the voltage supply, proceed as follows:

► Connect the power supply of the control cabinet to terminal X1 in accordance with the connection diagram provided.

6.4 Checking functional reliability

To ensure that the device is wired correctly, check its functionality.

NOTICE

Damage to device and system periphery!

An incorrectly connected device can cause damage to the device and system periphery.

► Check the entire configuration before commissioning.

► Apply voltage to the control cabinet.

⇨ The device's control system boots up. After a brief period, the relay switches the make contact *STATUS OK* (DIO 28-15:1B).

The device is fully mounted and can be configured. The actions required for this are described in the following chapter.

NOTICE

Damage to the device!

Damage to the device due to condensate in the control cabinet.

► Always keep the control cabinet tightly closed.

► In the event of downtimes of more than 8 weeks prior to initial commissioning or an operational interruption of more than 2 weeks, connect and operate the anti-condensation heater in the control cabinet. If this is not possible, place a sufficient amount of desiccant (silicon-free) in the control cabinet.

7 Commissioning

7.1 Establishing connection to visualization

The MSENSE® VAM monitoring system is equipped with web-based visualization. This enables you to configure the device with a computer and to display measured values.

Overview of Ethernet interfaces:

MSENSE® VAM product version	ETH 1.1	ETH 2.1	ETH 2.2
Standalone version in the control cabinet	Yes	No	Optional
Integration solution in the ETOS® TD motor-drive unit	Yes	No	Optional
Integration solution in the ETOS® ED motor-drive unit without display	No	Yes	Optional
Integration solution in the ETOS® ED motor-drive unit with display	Yes	No	Optional
Integration solution in the customer control cabinet (ETOS® IM, pluggable modules)	No	Yes	Optional

Establishing a connection for visualization via the ETH 1.1 front interface

1. Connect the PC and device using an Ethernet cable (RJ45 plug) via the ETH 1.1 interface. This interface is directly accessible after opening the control cabinet door. Depending on the product version, there are two options:

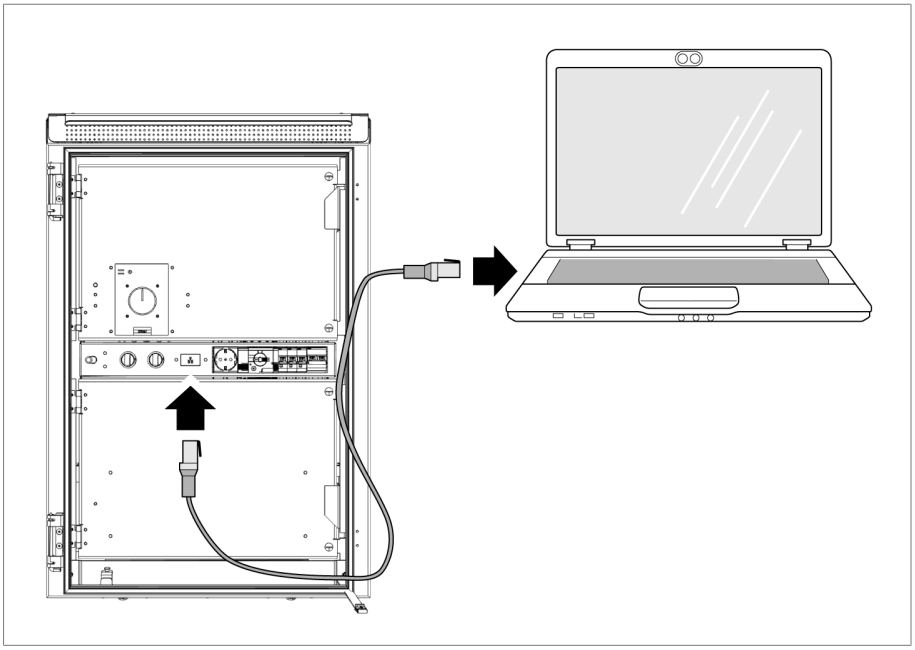


Figure 44: MSENSE® VAM standalone front interface

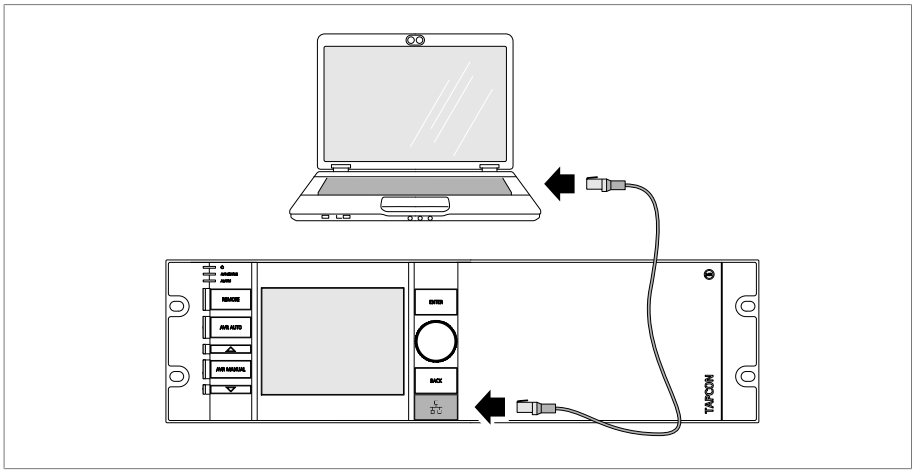


Figure 45: ETOS® ED front interface

2. Assign a unique IP address to the PC in the same subnet as the device (e.g. `192.168.165.100`).
3. Enter the visualization's IP address `http://192.168.165.1`, or if SSL encryption is active enter `https://192.168.165.1`, in the browser on the PC.

⇨ The visualization is accessed.

Establishing a connection for visualization via the ETH 2.1 or ETH 2.2 interface

You can use the ETH 2.1 interface or the optional ETH 2.2 interface of the CPU assembly to establish the connection to the visualization. The interfaces do not use a DHCP server. Therefore, you must assign a static IP address to your PC. To do this, observe the following configuration example:

Interface		Configuration
Standard	ETH 2.1	IP address: 192.168.165.1 (not adjustable)
	PC	IP address: 192.168.165.100 Subnet mask: 255.255.255.0
Optional	ETH 2.2	IP address: 192.0.1.230 (factory setting) [▶ Section 8.1.2, Page 79] Subnet mask: 255.255.255.0
	PC	IP address: 192.0.1.100 Subnet mask: 255.255.255.0

Table 13: Interface configuration example

1. Connect the PC and device using an Ethernet cable (RJ45 plug) via the ETH 2.1 or ETH 2.2 interface.

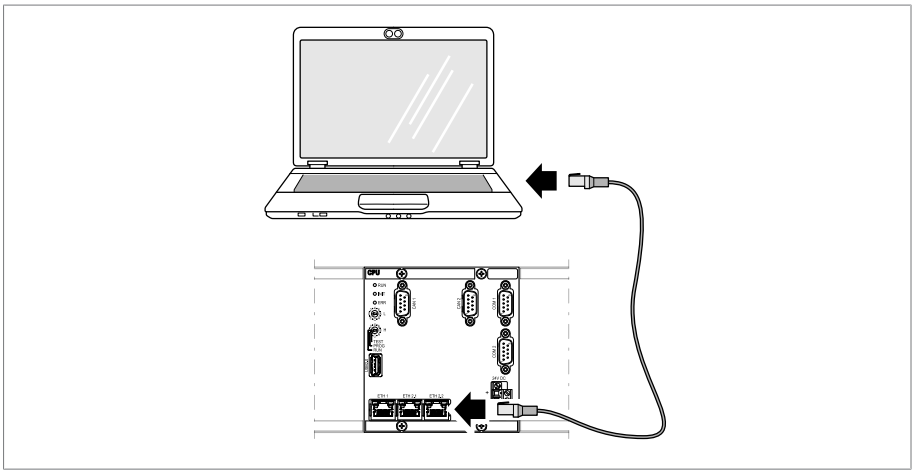


Figure 46: CPU interface ETH 2.1 or ETH 2.2

2. Assign a unique IP address to the PC in the same subnet as the device (e.g. ETH 2.1: `192.168.165.100`).
3. Enter the IP address of the visualization (e.g. ETH 2.1: `http://192.168.165.1`; if SSL encryption is active, enter `https://192.168.165.1`) in the browser on the PC.

⇨ The visualization is accessed.

7.2 Setting the language

You can use this parameter to set the display language for the device. The device comes with a maximum of four languages.

English	Italian*
German	Portuguese*
French*	Russian*
Spanish*	Chinese*
Korean*	Polish*

Table 14: Available display languages

*) Language is available as an option

1. Select the **Language** button in the status bar, or as an alternative go to **Settings** > **System** > **General** > **Language**.

Figure 47: Setting the language

2. Select the desired language from the list field.
3. Press the **Accept** button to save the modified parameter.

⇨ The "Restart device" dialog appears.

4. Restart the device to apply the changed language setting.

7.3 Downloading the operating instructions

Download the operating instructions from the device to start device commissioning and parameterization.

► Select in the status line.

⇨ The operating instructions will be downloaded.

The document is also available for download in the MR Customer Portal and on our website www.reinhausen.com.

7.4 Setting date and time

You can set the date and time in the following ways:

- Manually
- Time synchronization via control system (SCADA)
- Time synchronization via SNTP time server

If you are using a control system, the device automatically synchronizes the date and time with the control system. If you would like to use an SNTP time server, you must set the required parameters.

For more information, refer to the information in the section Setting the device time [►Section 8.1.3, Page 81].

7.5 Commissioning wizard

If you want the device to help when setting the relevant parameters, you can use the commissioning wizard. The commissioning wizard provides a selection of parameters that you can configure in order.

A detailed description of each of the parameters can be found in the Operation [►Section 8, Page 77] chapter.

To call up the commissioning wizard, you will need the necessary access rights [►Section 8.1.12, Page 111].

When in delivery status, you can log in as the administrator as follows:

- User name: `admin`
- Password: `admin`

To set the parameters with the help of the commissioning wizard, proceed as follows:

1. Log in as a user with the necessary access rights.
2. Go to **Settings** > **Commissioning wizard**.

Figure 48: Calling up the commissioning wizard

3. Press the **Accept** button to launch the commissioning wizard.
4. Follow the on-screen instructions.

Once you have entered all of the parameters relevant to commissioning, continue with the function test.

7.6 Name plate

You can enter the data of the nameplates from the transformer, on-load tap-changer and motor-drive unit and display it later.

When operating ETOS® with the MSENSE® VAM option, you must enter the correct serial number for every on-load tap-changer. This entry is necessary to ensure the correct assignment of the vibro-acoustic records in the external database.

7.6.1 Enter the name plate data

You can enter the name plate data for the transformer, the on-load tap-changer and the motor-drive unit.

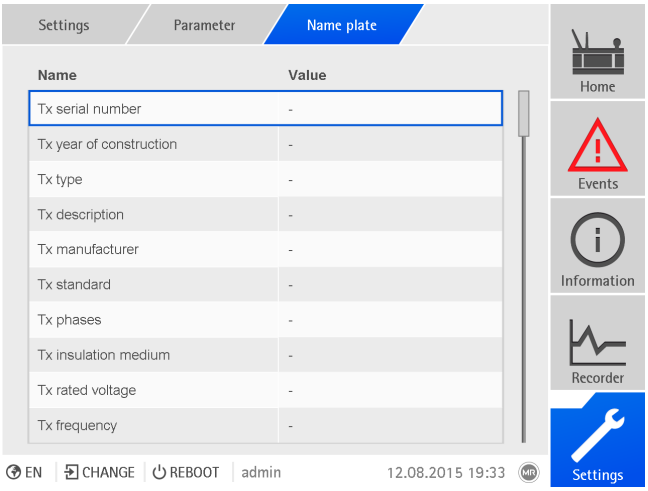


Figure 49: Nameplate

► Go to **Settings** > **Parameter** > **System** > **Name plate**.

7.6.2 Displaying the name plate

You can display the nameplate data for the transformer, on-load tap-changer, and motor-drive unit.

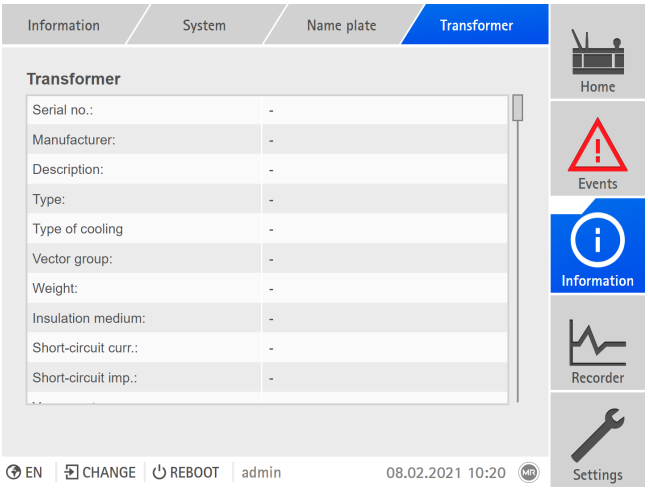


Figure 50: Transformer nameplate

► Go to **Information** > **System** > **Name plate** > **On-load tap-changer/Motor**.

7.7 Setting the control system protocol (optional)

If you need a control system protocol, you must set the parameters required for this. More information on this (e.g. data points) is to be found in the provided supplement for the control system protocol.

You do not need to set additional parameters for commissioning.

7.8 Performing tests

Please contact Maschinenfabrik Reinhausen GmbH (MR) if any aspect of the tests is not clear.

7.8.1 Checking measured values and status of digital inputs and outputs

Upon commissioning the device, check whether the measured values and status of digital inputs and outputs are plausible. To do so, use an additional measuring device if necessary in order to check the individual measured values.

To display the status of the digital inputs and outputs, proceed as follows:

1. Go to **Information > Hardware**.
2. Select the individual **assemblies** one after another and check the individual measured values or the status of digital inputs and outputs.
3. If errors arise, check the measurement path and the wiring.

7.8.2 Performing function tests

To ensure that the monitoring system functions seamlessly, you have to check the communication with the sensor and the automatic triggering function after each installation or maintenance action as follows:

1. Check that the wiring of the sensor and the signal feedback is in accordance with the supplied circuit diagram.
2. Perform a few on-load tap-changes for all positions and in both directions and check the plausibility of the signal progression including the envelope curve in the monitoring system.
3. Check that the signals are being recorded and saved correctly.
4. Optional: Check the control system.

⇨ The monitoring system is ready to function.

7.8.3 Electrical high-voltage tests on the transformer

It is essential that you ensure only trained, instructed expert personnel who are familiar with and comply with the pertinent safety and technical regulations, who are aware of the potential risks, and who consistently use the occupational safety equipment provided to prevent injury and property damage are assigned to perform such a transformer test.

Note the following points **before** performing high voltage tests on the transformer:

- Check that the ground connections on the control cabinet and the control cabinet fixings are free of paint.
- Only perform a high voltage test with the control cabinet door closed.
- Disconnect the sensor cable and other external connections to electronic components in the control cabinet to prevent damage through overvoltage.
- When connecting the control cabinet's supply voltage, only use the bushings in the protective housing base intended for lead insertion.
- Guide all ground connecting leads to one central connection point (establishment of suitable reference earth).
- Disconnect all electronic components before the high voltage test. Before a dielectric test of the wiring, remove all devices with a withstand voltage of < 1000 V.
- Remove leads used for testing before the high voltage test, because these function as antennas.
- Wherever possible, route the measurement leads and data leads separately to the energy cables.

7.8.4 Ground test

For commissioning, carry out a ground test (check of the impedance of the protective bonding) in accordance with IEC 61010-1. Note the following information:

- Test current: 2 times the measurement current of the overcurrent protection device of the supply line.
- Test duration: 1 minute for each measurement point.
- The measured voltage between the measurement point and the protective conductor must be smaller than 10 V.

Proceed as follows to carry out the ground test:

1. Feed the test current at the fixing screw of assembly DIO 28-15 or DIO 42-20 using a constant current source and measure the voltage between the measurement point and the protective conductor.

   ⇨ The measured voltage must remain less than 10 V over a duration of 1 minute.

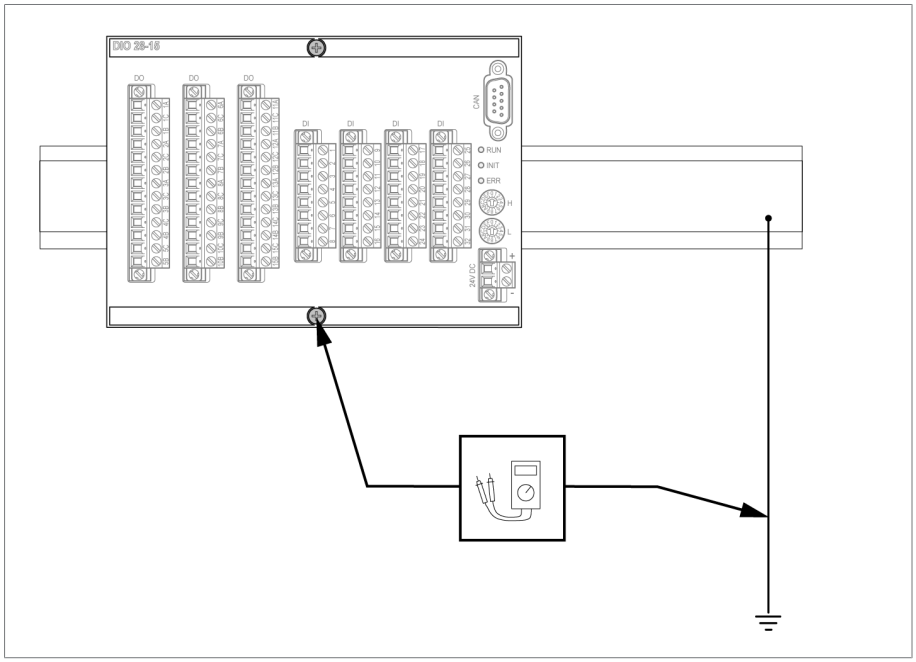


Figure 51: Perform a ground test on the DIO assembly (sample representation of the DIO 28-15 assembly).

2. Feed the test current at the grounding terminal of the G1 PULS DIMENSION QS3.241 assembly using a constant current source and measure the voltage between the measurement point and the protective conductor.

⇨ The measured voltage must remain less than 10 V over a duration of 1 minute.

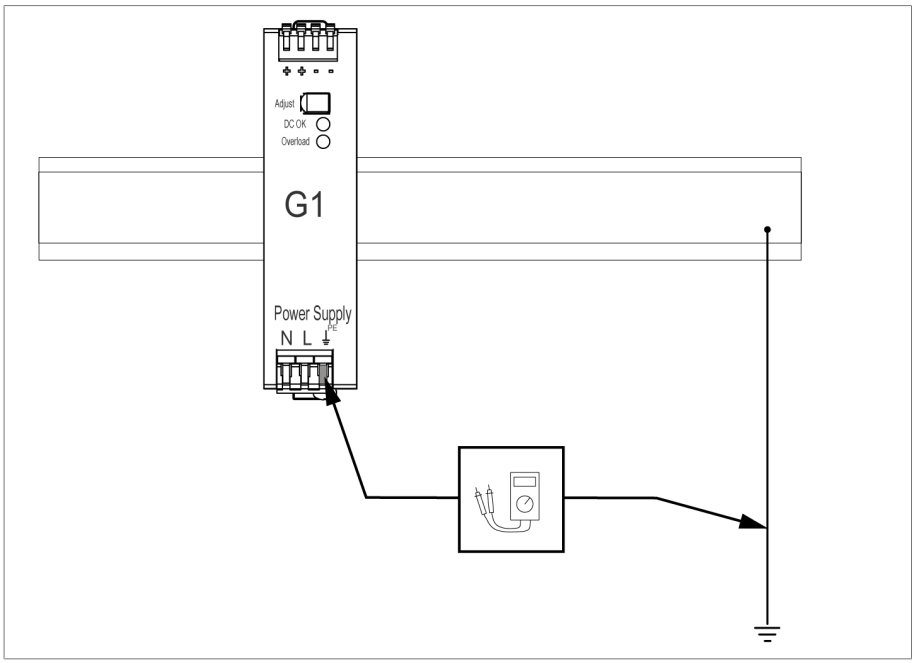


Figure 52: Perform a ground test on the G1 PULS DIMENSION QS3.241 assembly

7.8.5 Dielectric tests on transformer wiring

Note the following points for dielectric testson the transformer wiring:

The monitoring system has been put through dielectric tests before delivery.

► Before the dielectric test for the transformer wiring, disconnect the monitoring system from the section to be tested to rule out increased component loading for those components fitted in the control cabinet.

8 Operation

8.1 System

8.1.1 General

You can set general parameters in this menu item.

8.1.1.1 Setting general device functions

You can set general device functions with the following parameters.

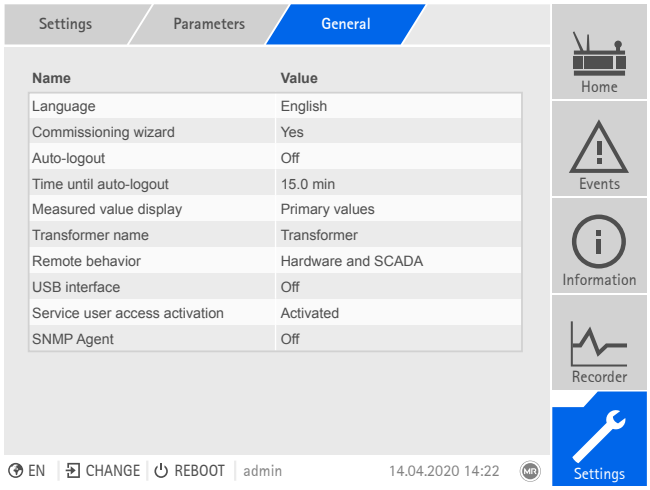


Figure 53: General

► Go to **Settings** > **Parameters** > **System** > **General**.

Commissioning wizard

You can use this parameter to set whether the commissioning wizard [►Section 7.5, Page 70] is to launch automatically when the device is restarted.

Transformer name

You can use this parameter to enter a transformer name for identification purposes. The transformer name will be displayed on the main screen in the visualization.

Remote behavior

You can use this parameter to select the behavior of the device in remote operating mode. Depending on the device configuration, you can set the remote behavior as follows:

- Through the visualization (optional)
- By setting the digital inputs (optional)

You can select the following settings:

Setting	Description
Hardware only	The device accepts commands through digital inputs.
SCADA only	The device accepts commands via SCADA.
Hardware and SCADA	The device accepts commands via digital inputs and SCADA.

Table 15: Selecting remote behavior

USB interface

You can use this parameter to deactivate the USB interface. You can select the following options:

- On: USB interface is activated
- Off: USB interface is deactivated

8.1.1.2 Set up automatic logout

You can change the settings so that the device of a logged-in user automatically logs the user out after a certain period of inactivity.

These settings apply to all users. If you have activated the Auto login [▶Section 8.1.12.3, Page 113] function for a user, then this user will not be automatically logged out.

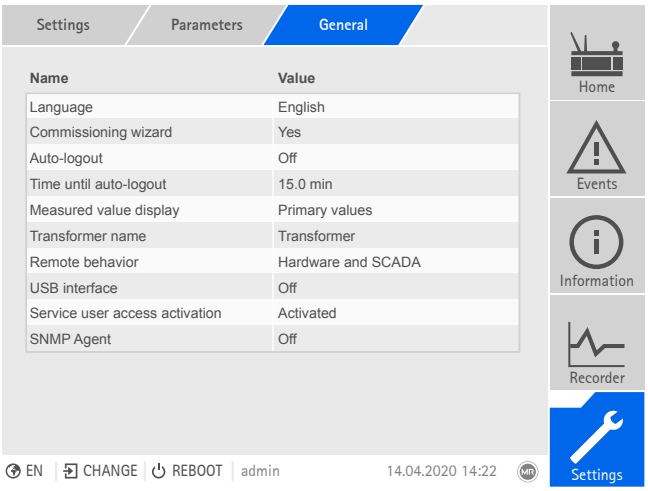


Figure 54: General

► Go to **Settings** > **Parameters** > **System** > **General**.

8.1.1.3 Setting SNMP

The device supports the SNMP network management protocol (SNMPv1 and SNMPv2c). The protocol uses the port 161/UDP. To use SNMP, you must activate the SNMP agent.

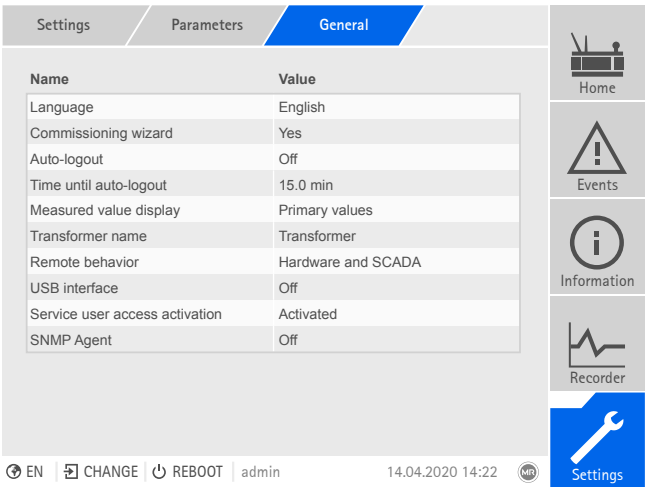


Figure 55: General

1. Go to **Settings > Parameters > System > General**.
2. Select the desired parameter.
3. Set the parameter.
4. Press the **Accept** button to save the modified parameter.

SNMP agent

You can use this parameter to activate or deactivate the SNMP agent. If you change the setting, you must then restart the device.

8.1.2 Configuring the network

You can use this menu item to configure the network interfaces of the CPU assembly.

You can only set the parameters for ETH 1 if the device is equipped with the optional control system connection via Ethernet (TCP/IP):

- IEC 61850
- IEC 60870-5-104
- Modbus (Modbus type TCP active)
- DNP3 (DNP3 transmission type TCP active)
- MQTT

You can only set the parameters for ETH 2.2 if the device is equipped with the optional interface for visualization.

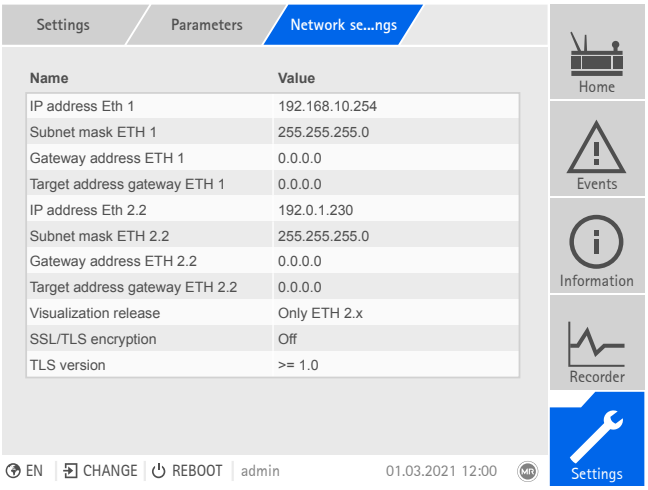


Figure 56: Network settings

► Go to **Settings** > **Parameters** > **System** > **Network settings**.

IP address ETH 1/ETH 2.2

You can use this parameter to assign an IP address to the device.

Assign IP addresses to both web-based visualization and SCADA (optional) in different subnets. Otherwise you will not be able to establish a connection.

Subnet mask ETH 1/ETH 2.2

You can use this parameter to set the subnet mask.

Be sure to enter a valid network mask that is not 0.0.0.0, otherwise it will not be possible to connect to the device.

Gateway address ETH 1/ETH 2.2

You can use this parameter to set the gateway's IP address.

If you set the value to 0.0.0.0, no gateway is used.

SSL/TLS encryption

You can use this parameter to set whether the process for accessing the visualization should be carried out over an SSL/TLS-encrypted connection.

TLS version

You can use this parameter to set the accepted TLS versions. If you would like to establish an encrypted connection to the visualization, you must use an accepted TLS version. You can select the following options:

Option	Accepted TLS versions
>= 1.0	▪ 1.0 ▪ 1.1 ▪ 1.2 ▪ 1.3
>= 1.1	▪ 1.1 ▪ 1.2 ▪ 1.3
>= 1.2[1]	▪ 1.2 ▪ 1.3
>= 1.3[1]	▪ 1.3

Table 16: TLS version

8.1.3 Setting the device time

You can set the device time manually or automatically via a time server. The device must be connected to a time server via Ethernet for this purpose.

You can operate SNTP and PTP at the same time. In this case, the PTP time is queried in slave operation.

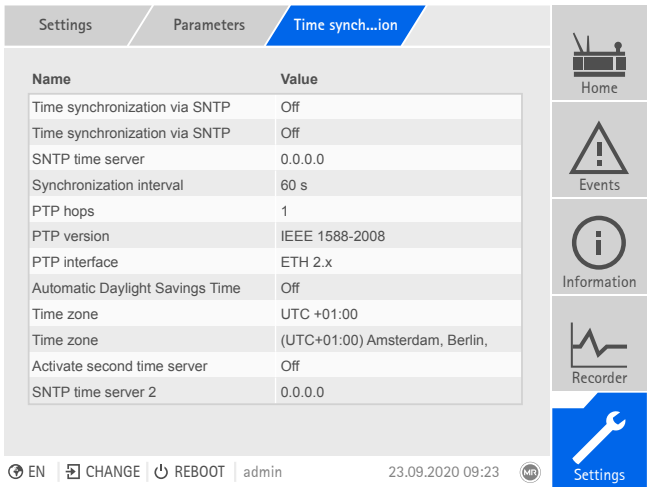


Figure 57: Time synchronization

► Go to **Settings** > **Parameters** > **System** > **Time synchronization**.

1 This option can be selected only if the TLS version is supported by the connected peripheral equipment.

Time synchronization via SNTP

You can use this parameter to activate time synchronization using an SNTP time server.

SNTP time server

You can use this parameter to enter the IP address of a SNTP time server. If you are using a time server, the device uses the time of the time server as the system time.

Be sure to enter a valid time server address that is not 0.0.0.0, otherwise it will not be possible to connect to the device.

Time zone

If the time information is transmitted to the device by a network service (SNTP or SCADA), this time is transferred depending on the set reference time. To adjust the device time to your local time, you can use the time shift parameter to set the time shift to UTC.

Example:

Region	Time shift to UTC
Mumbai, India	UTC +5:30 h
Beijing, China	UTC +8:00 h
Brasilia, Brazil	UTC -3:00 h

Table 17: Time shift to UTC (Coordinated Universal Time)

Synchronization interval

You can use this parameter to set the interval at which the device is to call up the time from the time server.

Time

You can use this parameter to set the date and time manually.

8.1.4 Configuring syslog

The device supports the transmission of log messages via the syslog protocol in accordance with the standards RFC 5424 and RFC 3164.

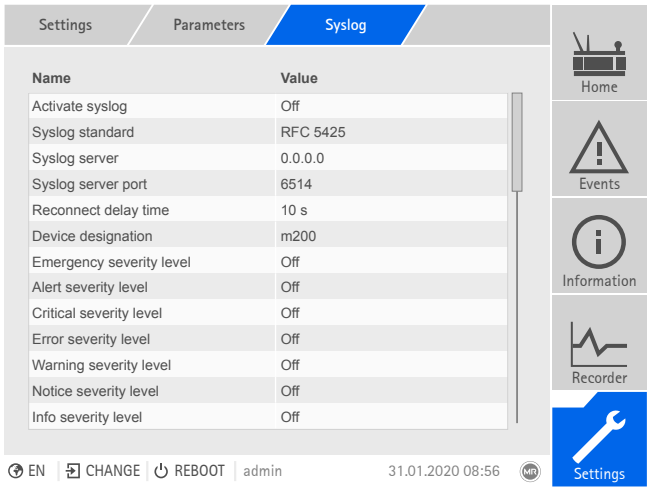


Figure 58: Syslog

► Go to **Settings** > **Parameters** > **System** > **Syslog**.

Activate syslog

You can use this parameter to activate transmission of syslog messages via the device.

Syslog standard

You can use this parameter to adjust the transmission process and the format for the syslog messages. You can select the following options:

Standard	Transport	Message format
RFC 5425 (recommended)	TLS	RFC 5424
RFC 5426	UDP	
RFC 6587	TCP	RFC 3164
RFC 3164	UDP	

Table 18: Syslog standard

If you use the standard RFC 5245 (TLS), you have to import the root certificate and the client certificate with the corresponding key to the syslog server. For more information, refer to the section titled Importing data [► Section 8.1.15.1, Page 119].

Syslog server

You can use this parameter to set the IP address of the syslog server.

Syslog server port

You can use this parameter to set the port of the syslog server.

Reconnect delay time

You can use this parameter to determine how long the device will wait before it attempts to reconnect after the connection has been interrupted earlier or a syslog message could not be transmitted (only for TCP or TLS).

Device designation

You can use this parameter to set the device designation that the device will be identified with on the syslog server.

Severity level

You can set which syslog messages the device will send. You can also activate or deactivate messages for each severity level.

Severity level	Description
`Emergency`	The system is unusable.
`Alert`	Immediate intervention required.
`Critical`	Critical state
`Error`	Error state
`Warning`	Warning state
`Notice`	Notice state
`Info`	Information state
`Debug`	Debug state

Table 19: Severity levels

8.1.5 SCADA

The following section describes how you can configure the device to connect to a control system (SCADA). You can download the data points with the help of the export manager [►Section 8.1.15, Page 118].

8.1.5.1 Configuring IEC 61850 (optional)

If you want to use the IEC 61850 control system protocol, you must set the following parameters. Also refer to the section Configuring the network [▶ Section 8.1.2, Page 79].

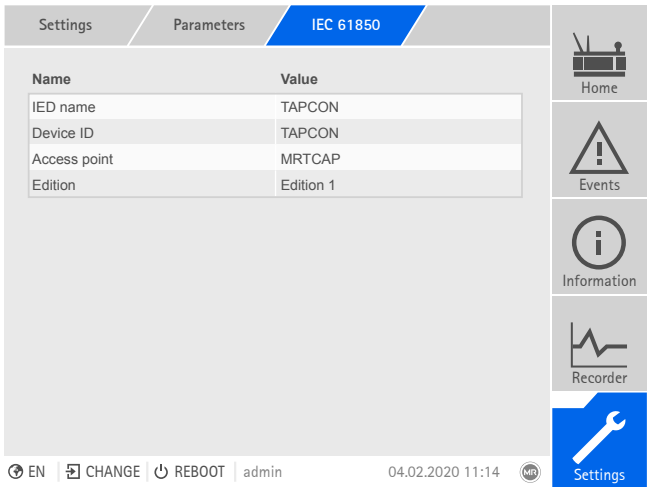


Figure 59: IEC 61850

► Go to **Settings** > **Parameters** > **System** > **IEC 61850**.

8.1.5.2 Configuring IEC 60870-5-101 (optional)

If you want to use the IEC 60870-5-101 control system protocol, you must set the following parameters.

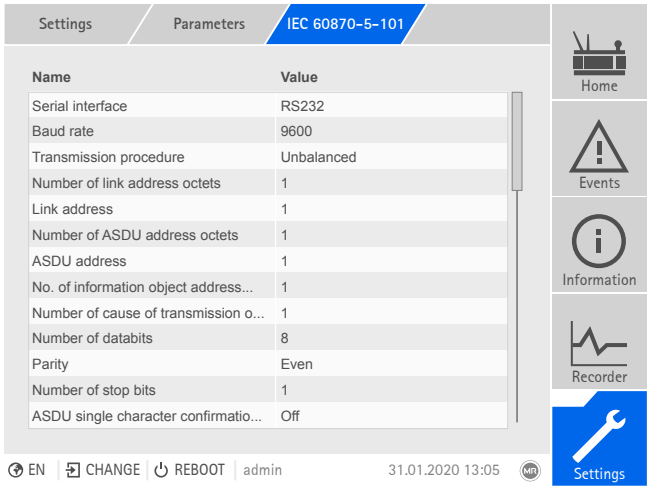


Figure 60: IEC 60870-5-101

1. Go to **Settings > Parameters > System > IEC 60870-5-101**.
2. Select the desired parameter.
3. Set the parameter.
4. Press the **Accept** button to save the modified parameter.

8.1.5.3 Configuring IEC 60870-5-103 (optional)

If you want to use the IEC 60870-5-103 control system protocol, you must set the following parameters.

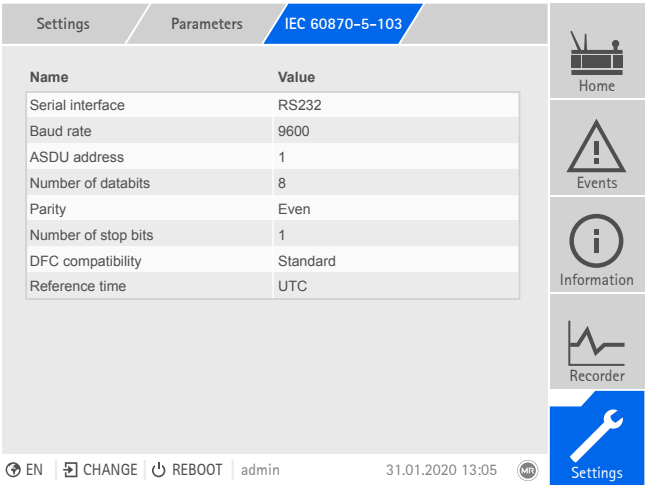


Figure 61: IEC 60870-5-103

1. Go to **Settings > Parameters > System > IEC 60870-5-103**.
2. Select the desired parameter.
3. Set the parameter.
4. Press the **Accept** button to save the modified parameter.

8.1.5.4 Configuring IEC 60870-5-104 (optional)

If you want to use the IEC 60870-5-104 control system protocol, you must set the following parameters. Also refer to the section Configuring the network [▶Section 8.1.2, Page 79].

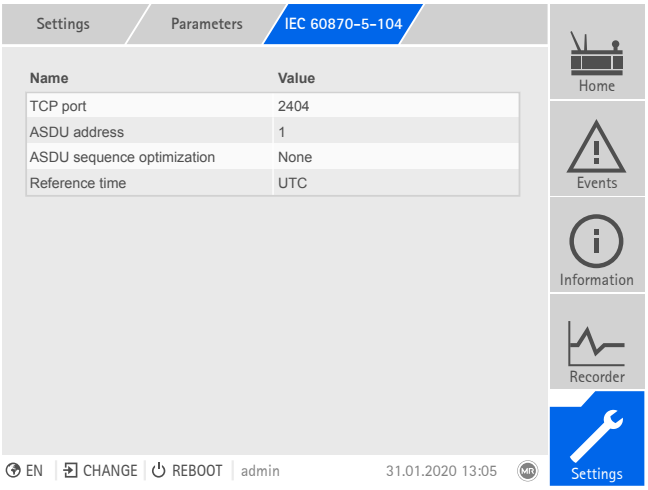


Figure 62: IEC 60870-5-104

► Go to **Settings** > **Parameters** > **System** > **IEC 60870-5-104**.

8.1.5.5 Configuring Modbus (optional)

If you want to use the Modbus control system protocol, you must set the corresponding parameters depending on the Modbus type selected. Also refer to the section Configuring the network [▶Section 8.1.2, Page 79] if you want to use Modbus TCP.

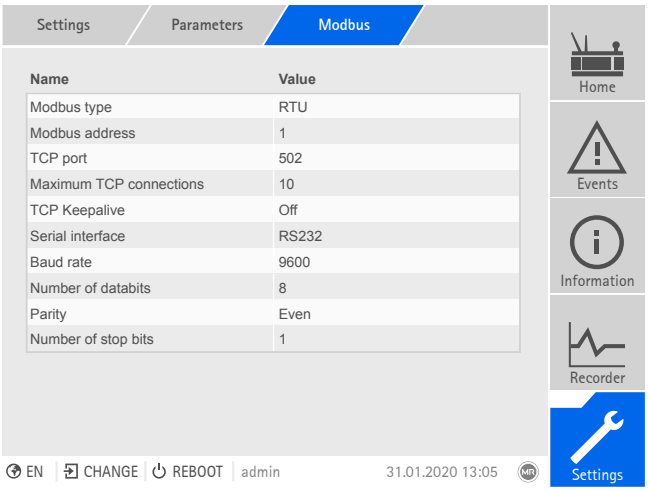


Figure 63: Modbus

▶ Go to **Settings** > **Parameters** > **System** > **Modbus**.

8.1.5.6 Configuring DNP3 (optional)

If you would like to use the DNP3 control system protocol, you must set the parameters listed below. Also refer to the section Configuring the network [▶Section 8.1.2, Page 79] if you want to use the DNP3 via TCP.

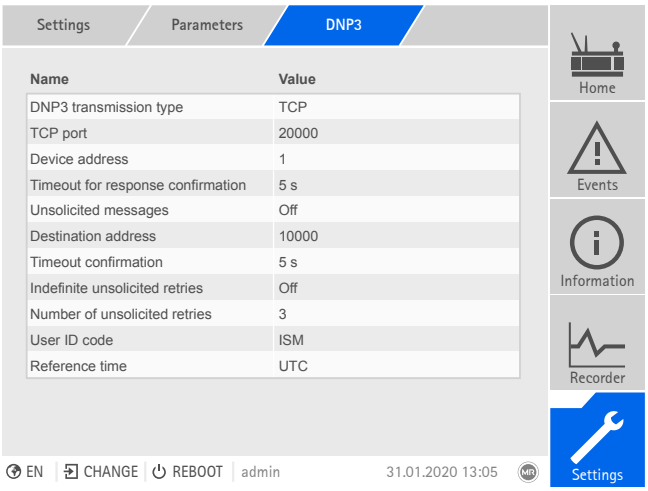


Figure 64: DNP3

▶ Go to **Settings** > **Parameters** > **System** > **DNP3**.

8.1.5.7 Configure data points (optional)

You can use the optional "Configure data points" function to adjust the control system data points of the device. You can only configure the data points on a PC using the web-based visualization.

8.1.5.7.1 Configuring IEC 60870-5-101 data points

You can adjust the following data point properties for the IEC 60870-5-101 control system protocol:

Column	Description	Modifiable	Setting range
Active	You can use the checkbox to set whether the data point is to be transferred via the control system protocol or not.	Yes	Active/inactive
IOA	Data point address. The setting range is based on the setting for the "Octet number of information object address" parameter (octet 2 or 3).	Yes	Octet 2: 1...65535 Octet 3: 1...16777215
Name	Data point designation.	No	-
Type	Data point type.	No	-
Group	Data point group or groups. You must enter the group membership as a binary code (5 bits). A maximum of 5 groups is possible. Example: ▪ 00000: belongs to no groups ▪ 00001: group 1 ▪ 01000: group 4 ▪ 01001: group 1 and group 4	Yes	00000...11111
INTG	The value indicates whether the data point is to be included in a general query (1) or not (0).	Yes	0, 1
TH	Threshold value for measured values. The data point is only transferred again if the change of value is greater than the threshold value. ▪ If you enter the value 0, no threshold value is active. ▪ If you do not enter any value, the device adopts the threshold value defined by the device parameter. If no device parameter is available for the threshold value, no threshold value is active either. ▪ Notice: You can only enter a threshold value for data points of type 9, 10, 11, 12, 13, 14, 21, 34, 35 or 36.	Yes	0...32768
CT	Interval in ms for periodic transmission of the data point. If you set 0, the data point is not transmitted periodically. Notice: You can only enter an interval for data points of type 9, 11 or 13.	Yes	0...10000

Table 20: Configuring IEC 60870-5-101 data points

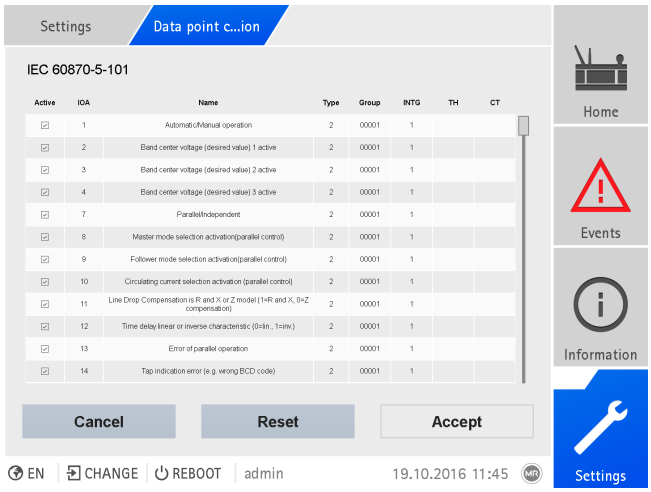


Figure 65: Configuring IEC 60870-5-101 data points

1. Go to **Settings** > **Data point configuration**.
2. Adjust the data points as required.
3. Press the **Accept** button to adopt the modified list of data points.
4. Restart the device to activate the modified list of data points.

8.1.5.7.2 Configuring IEC 60870-5-103 data points

You can adjust the following data point properties for the IEC 60870-5-103 control system protocol:

Column	Description	Modifiable	Setting range
Active	You can use the checkbox to set whether the data point is to be transferred via the control system protocol or not.	Yes	Active/inactive
TYP	Data point type code.	No	-
FUN	Data point function type. Notice: You can only use function type 254 for data points with type code 10 or 11.	Yes	0...255
INF	Data point information number. Notice: You can only use information number 0 for data points with function type 254.	Yes	0...255
GIN	Data point generic identification number. Notice: You can only use generic identification number 0 for data points with a function type other than 254.	Yes	0...65535
Data Type	Data point data type.	No	-
Name	Data point designation.	No	-

Column	Description	Modifiable	Setting range
Interrogation	The value indicates whether the data point is to be included in a general query (1) or not (0).	Yes	0, 1
Threshold	Threshold value for measured values. The data point is only transferred again if the change of value is greater than the threshold value. ▪ If you enter the value 0, no threshold value is active. ▪ If you do not enter any value, the device adopts the threshold value defined by the device parameter. If no device parameter is available for the threshold value, no threshold value is active either.	Yes	0...1000000000

Table 21: Configuring IEC 60870-5-103 data points

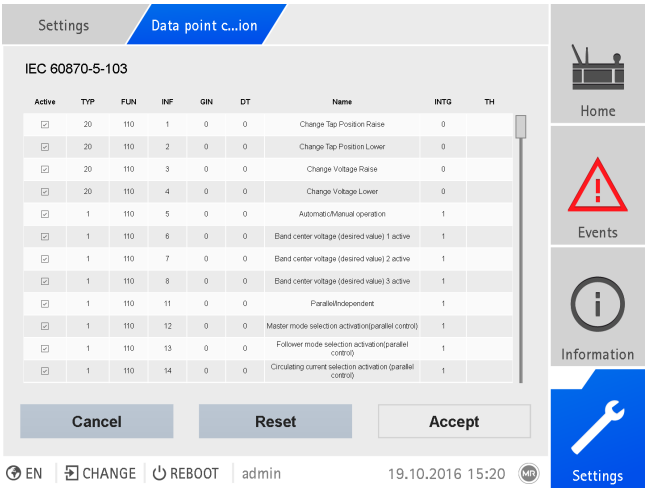


Figure 66: Configuring IEC 60870-5-103 data points

1. Go to **Settings** > **Data point configuration**.
2. Adjust the data points as required.
3. Press the **Accept** button to adopt the modified list of data points.
4. Restart the device to activate the modified list of data points.

8.1.5.7.3 Configuring IEC 60870-5-104 data points

You can adjust the following data point properties for the IEC 60870-5-104 control system protocol:

Column	Description	Modifiable	Setting range
Active	You can use the checkbox to set whether the data point is to be transferred via the control system protocol or not.	Yes	Active/inactive
IOA	Data point address.	Yes	1...16777215
Name	Data point designation.	No	-
Type	Data point type.	No	-

Column	Description	Modifiable	Setting range
Group	Data point group or groups. You must enter the group membership as a binary code (5 bits). A maximum of 5 groups is possible. Example: ▪ 00000: belongs to no groups ▪ 00001: group 1 ▪ 01000: group 4 ▪ 01001: group 1 and group 4	Yes	00000...11111
INTG	The value indicates whether the data point is to be included in a general query (1) or not (0).	Yes	0, 1
TH	Threshold value for measured values. The data point is only transferred again if the change of value is greater than the threshold value. ▪ If you enter the value 0, no threshold value is active. ▪ If you do not enter any value, the device adopts the threshold value defined by the device parameter. If no device parameter is available for the threshold value, no threshold value is active either. Notice: You can only enter a threshold value for data points of type 9, 10, 11, 12, 13, 14, 21, 34, 35 or 36.	Yes	0...32768
CT	Interval in ms for periodic transmission of the data point. If you set 0, the data point is not transmitted periodically. Notice: You can only enter an interval for data points of type 9, 11 or 13.	Yes	0...10000

Table 22: Configuring IEC 60870-5-104 data points

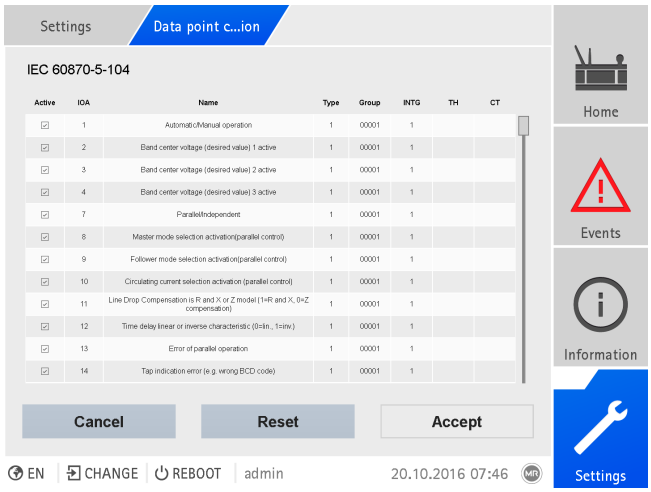


Figure 67: Configuring IEC 60870-5-104 data points

1. Go to **Settings** > **Data point configuration**.
2. Adjust the data points as required.
3. Press the **Accept** button to adopt the modified list of data points.
4. Restart the device to activate the modified list of data points.

8.1.5.7.4 Configuring Modbus data points

You can adjust the following data point properties for the Modbus control system protocol:

Column	Description	Modifiable	Setting range
Active	You can use the checkbox to set whether the data point is to be transferred via the control system protocol or not.	Yes	Active/inactive
Type	Data point type	No	-
Index1	Data point address	Yes	0...65535
Index2	Optional second data point address. This is used automatically for data points able to transfer values greater than 16 bits. Please note that the Index2 address always follows on from the Index1 address exactly.	No	-
Name	Data point designation	No	-

Table 23: Configuring Modbus data points

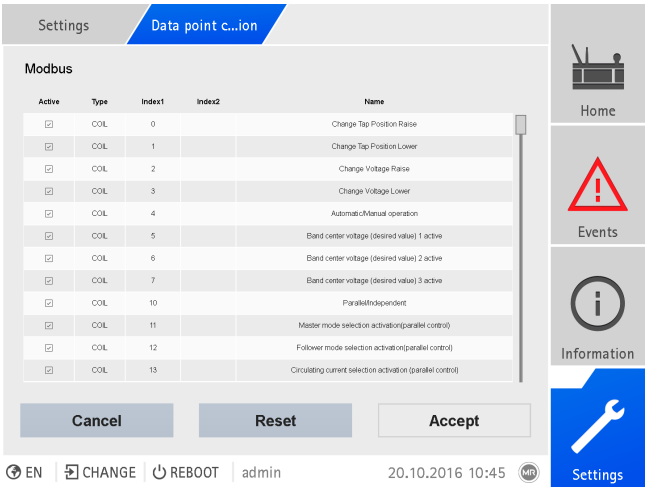


Figure 68: Configuring Modbus data points

1. Go to **Settings** > **Data point configuration**.
2. Adjust the data points as required.
3. Press the **Accept** button to adopt the modified list of data points.
4. Restart the device to activate the modified list of data points.

8.1.5.7.5 Configuring DNP3 data points

You can adjust the following data point properties for the DNP3 control system protocol:

Column	Description	Modifiable	Setting range
Active	You can use the checkbox to set whether the data point is to be transferred via the control system protocol or not.	Yes	Active/inactive
OBJGROUP	The OBJGROUP column indicates the data point object group: ▪ AI = Analog Input ▪ AO = Analog Output ▪ BI = Binary Input ▪ BO = Binary Output ▪ CT = Counter	No	-
INDEXADDR	Data point address.	Yes	0...4294967296
CLASS	Data point class. ▪ 0: Static ▪ 1...3: Event Notice: You can only set the data point class for data points of object groups AI, BI, and CT.	Yes	0...3
PREFSTATICVAR	For a data point of class 0 (Static), you can define the following variation depending on the object group: ▪ BI: 1, 2 ▪ BO: 2 ▪ AI: 2, 4 ▪ AO: 2 ▪ CT: 1, 2, 5, 6	Yes	0...6
PREFEVENTVAR	For a data point of classes 1...3 (Event), you can define the following variation depending on the object group: ▪ BI: 1, 2, 3 ▪ BO: no value ▪ AI: 2, 4 ▪ AO: no value ▪ CT: 1, 2, 5, 6	Yes	0...6

Column	Description	Modifiable	Setting range
NAME	Data point designation.	No	-
Deadband	Threshold value for analog inputs. The data point is only transferred again if the change of value is greater than the threshold value. ▪ If you enter the value 0, no threshold value is active. ▪ If you do not enter any value, the device adopts the threshold value defined by the device parameter. If no device parameter is available for the threshold value, no threshold value is active either. Notice: The threshold value has the same unit as the data point value. Take note of the list of data points.	Yes	0...32768

Table 24: Configuring DNP3 data points

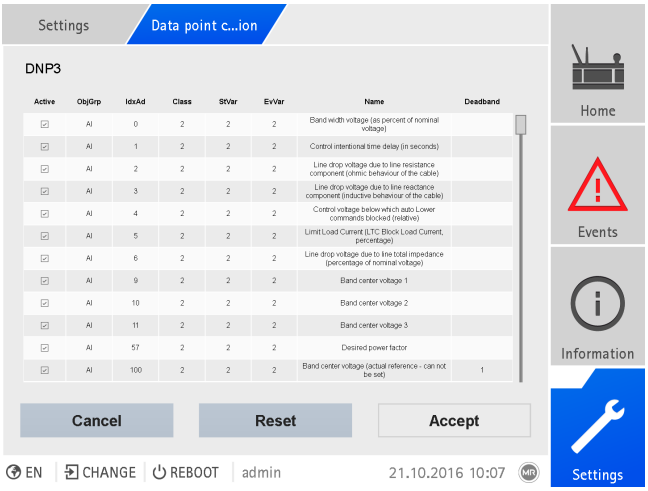


Figure 69: Configuring DNP3 data points

1. Go to **Settings** > **Data point configuration**.
2. Adjust the data points as required.
3. Press the **Accept** button to adopt the modified list of data points.
4. Restart the device to activate the modified list of data points.

8.1.5.7.6 Resetting the data point configuration to factory settings

If you want to reset the data point configuration to factory settings, proceed as follows:

1. Go to **Settings** > **Data point configuration**.
2. Press the **Reset** button.
   ⇨ The message Reset appears.
3. Press the **Yes** button to reset the data point configuration to the factory settings.
4. Restart the device to activate the modified list of data points.

8.1.5.7.7 Exporting and importing the data point configuration

You can export the data point configuration, e.g., to back it up or import it into another device. You will find more information in the Import/Export Manager [▶Section 8.1.15, Page 118] section.

8.1.6 Name plate

You can enter the data of the nameplates from the transformer, on-load tap-changer and motor-drive unit and display it later.

When operating ETOS® with the MSENSE® VAM option, you must enter the correct serial number for every on-load tap-changer. This entry is necessary to ensure the correct assignment of the vibro-acoustic records in the external database.

8.1.6.1 Enter the name plate data

You can enter the name plate data for the transformer, the on-load tap-changer and the motor-drive unit.

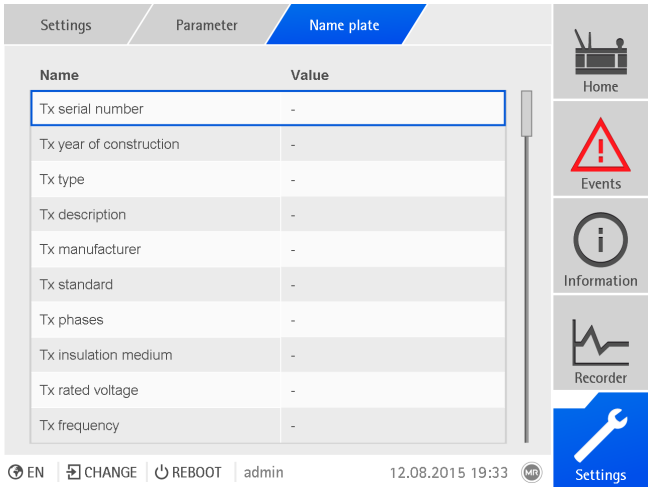


Figure 70: Nameplate

▶ Go to **Settings** > **Parameter** > **System** > **Name plate**.

8.1.6.2 Displaying the name plate

You can display the nameplate data for the transformer, on-load tap-changer, and motor-drive unit.

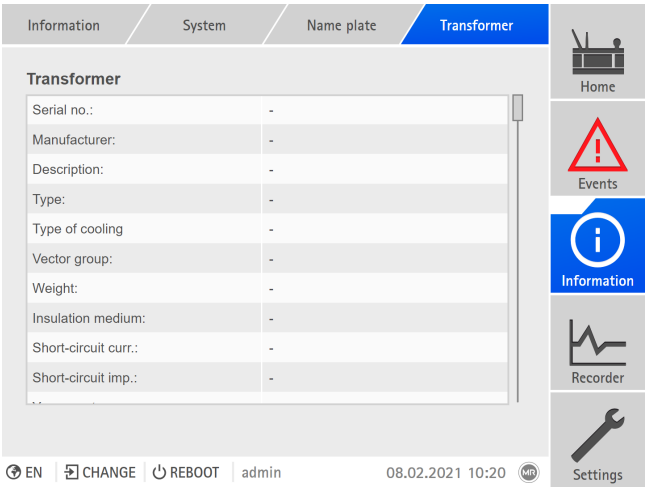


Figure 71: Transformer nameplate

► Go to **Information** > **System** > **Name plate** > **On-load tap-changer/Motor**.

8.1.7 Displaying measured value recorder (optional)

You can use the optional measured value recorder function to display the progress of measured values and signals over time.

If you access it via the web visualization, you can select a maximum of 10 measured values.

To display the measured value recorder, proceed as follows:

1. Go to **Recorder**.

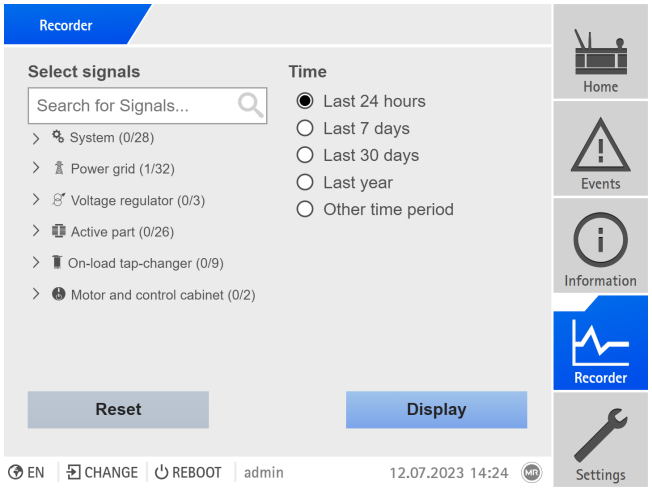


Figure 72: Recorder

2. Select the **signals** to be displayed.
3. If necessary, set the desired **Axis** for each signal.
4. Set the **Time period** for the measured value display.
5. Press **Display** to call up the measured value display (data log).

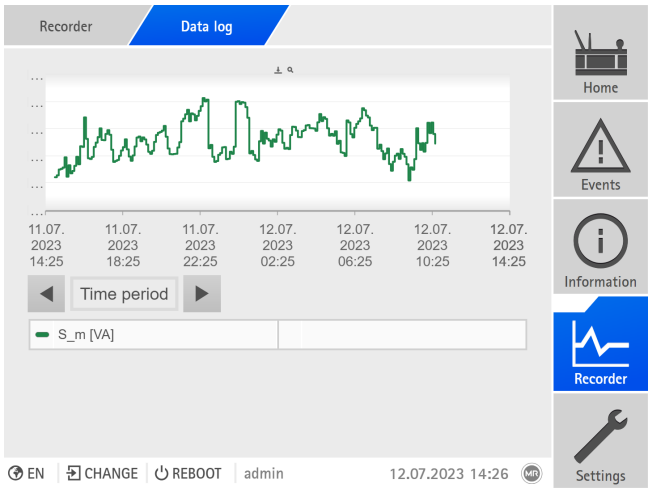


Figure 73: Data log

6. Move the mouse indicator to a **measurement point** for more information.
7. Use the mouse to drag a selection window in order to zoom into the diagram. Select the button to reduce the diagram back to its original size.
8. Select the button to save the displayed measured values as a csv file.

8.1.8 Linking signals and events

The device enables you to link digital inputs (GPI) and control system commands (SCADA) with device functions, digital outputs (GPO), and control system messages.

The digital inputs available are each permanently linked to a *Generic digital input* event message and the control system commands available are each permanently linked to a*Generic SCADA command* event message for this purpose.

Input/command	Event message
Digital input 1[1)]	Generic digital input 1
Digital input 2[1)]	Generic digital input 2
...	...
Digital input 42[1)]	Generic digital input 42
Generic SCADA command 1	Generic SCADA command 1
Generic SCADA command 2	Generic SCADA command 2
...	...
Generic SCADA command 10	Generic SCADA command 10

Table 25: Linking of digital inputs and control system commands with event messages

[1)] The number of available digital inputs depends on the order-specific device configuration.

You can link the event messages with device functions, digital outputs, and control system messages. You can also link all other event messages (e.g. *Undervoltage U<*) with digital outputs and control system messages. Corresponding parameters, for which you need to enter the relevant event number, are provided for this purpose.

8.1.8.1 Linking functions

You can link the *General purpose input* or *Generic SCADA command* events with device functions. This allows you to remotely control the device using digital inputs or commands via the control system (SCADA). Depending on your device configuration, various functions are available for this purpose via parameters.

To establish the link, you have to enter the corresponding event number in the desired parameter.

Note that you can only enter the event numbers of the *General purpose input* or *Generic SCADA command* events.

If you enter event number 500, the link is disabled.

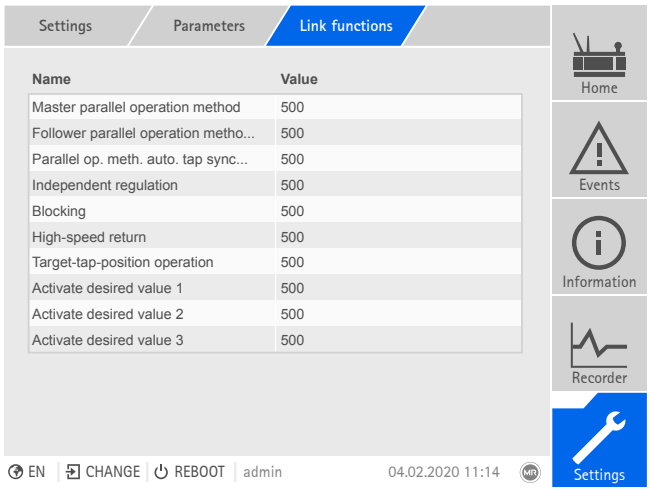


Figure 74: Linking functions

✓ The desired event number is known [▶Section 8.1.11, Page 107].

1. Go to **Settings** > **Parameter** > **System** > **Link functions**.
2. Select the desired parameter.
3. Enter the desired event number.
4. Press the **Accept** button to save the modified parameter.

Activate remote mode

If the assigned event is active, the device activates remote mode.

Activate local mode

If the assigned event is active, the device activates local mode.

8.1.8.2 Linking digital outputs

You can link each event with a digital output. The device provides a maximum of 20 digital outputs for this purpose. When you link a digital output to an event, the device issues a signal to this output if the event occurs. The signal persists until the event stops. A parameter is available for each available digital output.

To forward input signals or control system commands, you need to link the digital outputs or control system messages with the *General purpose input* or *Generic SCADA command* events.

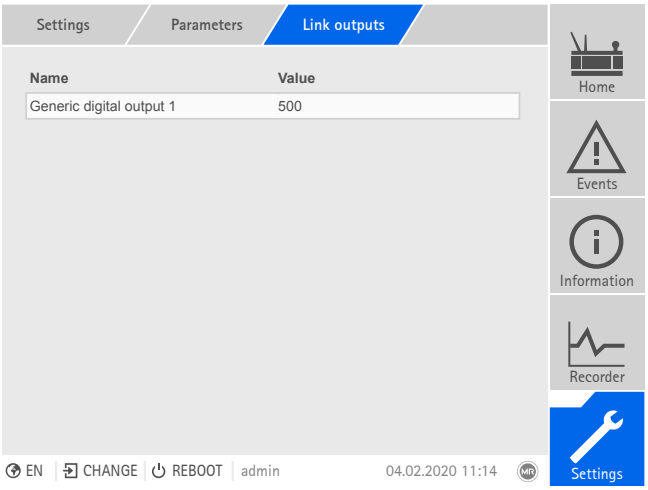


Figure 75: Linking digital outputs

✓ The desired event number is known [▶Section 8.1.11, Page 107].

1. Go to **Settings** > **Parameter** > **System** > **Link outputs**.
2. Select the desired parameter.
3. Enter the desired event number.
4. Press the **Accept** button to save the modified parameter.

Generic digital output X

You can use this parameter to link the digital output with an event message. To do so, enter the desired event number.

If you enter event number 500, the link is disabled.

8.1.8.3 Linking control system messages

You can link each event with a control system message. The device provides 25 SCADA messages for this purpose. When you link a SCADA message to an event, the device sets the data point to "On" when the event occurs. When the event stops, the device sets the data point to "Off". A parameter is available for each available SCADA message.

To forward control system commands, you need to link the control system messages to the *General purpose input* or *Generic SCADA command* events.

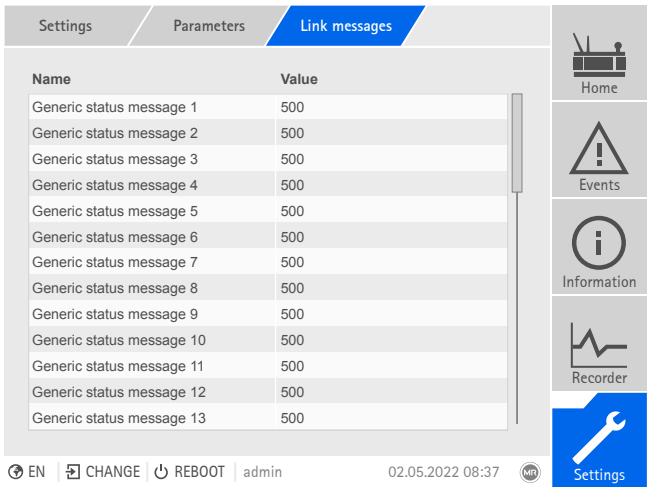


Figure 76: Linking SCADA messages

✓ The desired event number is known.

► Go to **Settings** > **Parameters** > **System** > **Link messages**.

Generic status message X

You can use this parameter to link the SCADA message with an event message. To do so, enter the desired event number.

If you enter event number 500, the link is disabled.

8.1.9 Configuring digital inputs and outputs

Upon delivery, the configurable digital inputs and outputs of the device are configured as follows:

- Input: High active
- Output: N/O contact (NO)

You can change this configuration if necessary.

If you have connected sensors over the MR sensor bus, you must select the "Modbus" signal type for the desired functions. Observe the additional information provided in the MR sensor bus section.

8.1.9.1 DIO configuration

Ensure that the configuration of the digital inputs and outputs is suitable for the functions used. Otherwise, malfunctions may occur in the device and the connected periphery.

The following information is displayed in tabular form for configuring the digital inputs and outputs. Grayed-out elements cannot be changed.

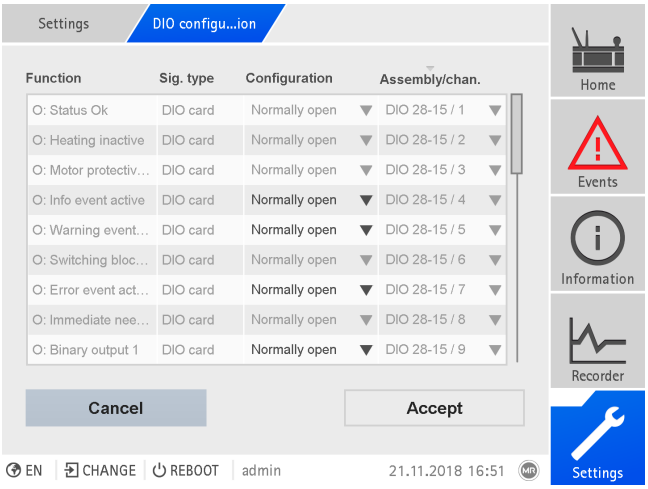


Figure 77: Configuring digital inputs and outputs

The operation described below is only possible if you access the visualization using a computer. You can only change the configuration of the digital inputs and outputs if you have a Parameter Configurator or Administrator role.

When in delivery status, you can log in as the administrator as follows:

- User name: `admin`
- Password: `admin`

To configure the device's digital inputs and outputs, proceed as follows:

1. Go to **Settings** > **DIO configuration**.
2. Where necessary, select the buttons ▲ or ▼ to sort the properties in a column alphabetically.
3. Configure the properties as desired.
4. Press the **Accept** button.
5. Confirm the security prompt with **Yes** to save the changes.

Function

Function of the digital input (I: ...) or the digital output (O: ...). You can adjust the designation.

Signal type

Select the signal type:

- Digital: Digital input
- Modbus (MR sensor bus)

Configuration

Configure the device's digital inputs and outputs as follows:

- DI: High active or low active
- DO: N/O contact (NO), N/C contact (NC); Note: If the device is disconnected or in the event of an error, the digital outputs are always open (no bi-stable relay).

Assembly Channel

Channel of the DIO assembly to which the function is linked. Functions that are not linked with a channel are identified with "-". Note the connection diagram supplied.

8.1.10 Configuring analog inputs and outputs (optional)

You can flexibly configure the device's analog inputs and outputs and assign device functions.

The device supports analog sensors with linear characteristic curves and only outputs analog signals with linear characteristic curves.

If you have connected sensors over the MR sensor bus, you must select the "Modbus" signal type for the desired functions. Observe the additional information provided in the MR sensor bus section.

Also refer to

Information about connecting analog sensors [▶ 55]

8.1.10.1 Creating a backup

You need to create a backup to be able to reset the system in the event that any incorrect configuration settings are made. To do so, proceed as follows:

1. Go to **Settings > Export**.
2. Select the option **Settings** to export a backup copy of the current settings.
3. Select the desired **Interface** (USB or PC).
4. Press the **Export** button to start the export.

8.1.10.2 AIO configuration

NOTICE

Damage to the device and sensors!

Incorrectly connected and configured analog inputs/outputs may result in damage to the device and sensor.

► Follow information about connecting analog sensors [▶Section 6.3.4, Page 55].

► Configure analog inputs and outputs according to the connected sensors.

The following information is displayed in tabular form for configuring the analog inputs and outputs. Grayed-out elements cannot be changed.

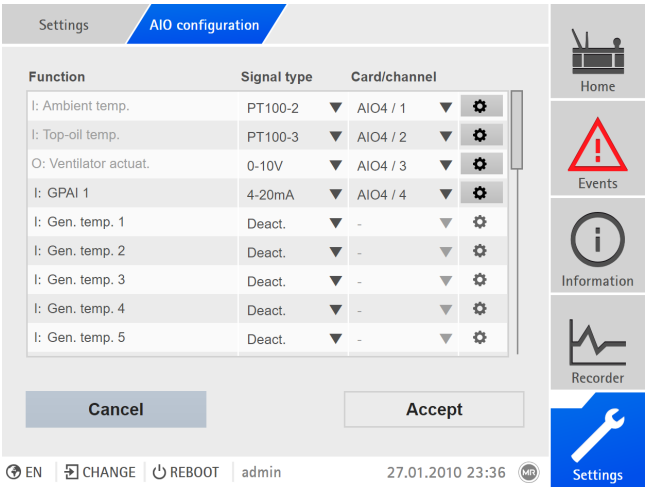


Figure 78: Configuring analog inputs/outputs

You can only change the configuration of the analog inputs and outputs if you have a Parameter Configurator or Administrator role.

When in delivery status, you can log in as the administrator as follows:

- User name: `admin`
- Password: `admin`

1. Go to **Settings** > **AIO configuration**.
2. Configure the properties such as **Function**, **Sign. type** and **Card/channel**.
3. Select the ⚙ button to configure the values as desired.

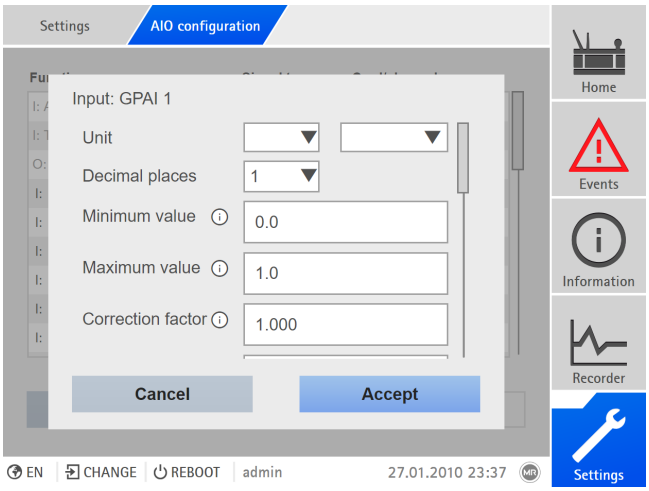


Figure 79: Entering values

4. Press the **Accept** button.
5. Confirm the security prompt with **Save** to save the changes.

Function

Function of the digital input (I: ...) or the digital output (O: ...). You can adjust the designation.

Signal type

Select signal type of analog sensor or deactivate analog output.

- 4...20 mA
- PT100-2/3/4, PT1000-2/3/4
- Modbus (MR sensor bus)

Card/channel

Select the slot and channel of the analog sensor. Note the connection diagram supplied. This property is only available for GPAI.

Unit

Set the unit of the signal. This property is only available for GPAI.

Decimal places

Set up to three decimal places. This property is only available for GPAI.

Minimum/maximum value

Set the minimum and maximum values of the sensor, e.g. with a 4...20 mA signal, the corresponding measured value for 4 mA and the corresponding value for 20 mA.

This property is not available if the sensors are connected over the MR sensor bus (Modbus).

Correction factor and correction offset

Setting a correction offsets systematic errors of the analog signals. The correction is determined by multiplying a factor by the sum of the offset. The minimum and maximum values of the function values apply as a limit value for the correction. There is no limit for the correction offset.

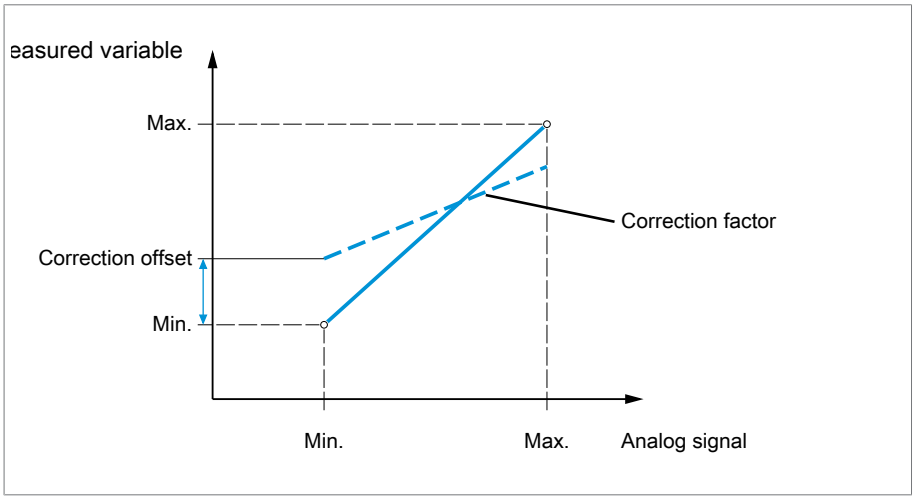


Figure 80: Analog signal with linear characteristic curve, correction factor <1 and correction offset

Correction factor

Set the correction factor (m) for the correction of the function value (x). The corrected function value (y) is: y = (m * x) + t. This property is only available for inputs.

Correction offset

Set the offset (t) for the correction of the function value (x). The corrected function value (y) is: y = (m * x) + t. This property is only available for inputs.

Correction offset

Set the offset (t) for the correction of the function value (x). The corrected function value (y) is: y = (m * x) + t. This property is only available for inputs.

Correction factor and offset

Setting a correction offsets systematic errors of the analog signals. The correction is determined by multiplying a factor by the sum of the offset. The minimum and maximum values of the function value apply as a limit value for the correction. There is no limit for the correction offset.

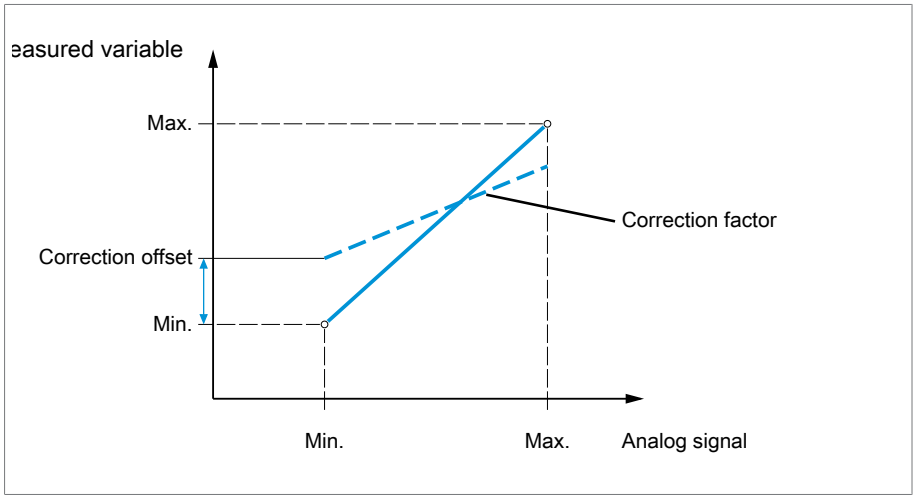


Figure 81: Analog signal with linear characteristic curve, correction factor <1 and correction offset

8.1.11 Event management

The device is equipped with event management, which allows you to detect various device operating statuses and to adapt the behavior of the device. You can call up an overview of the possible events in the device.

8.1.11.1 Displaying and acknowledging events

To display the events currently active, proceed as follows:

► Go to **Events**.

⇨ A list of currently pending events appears.

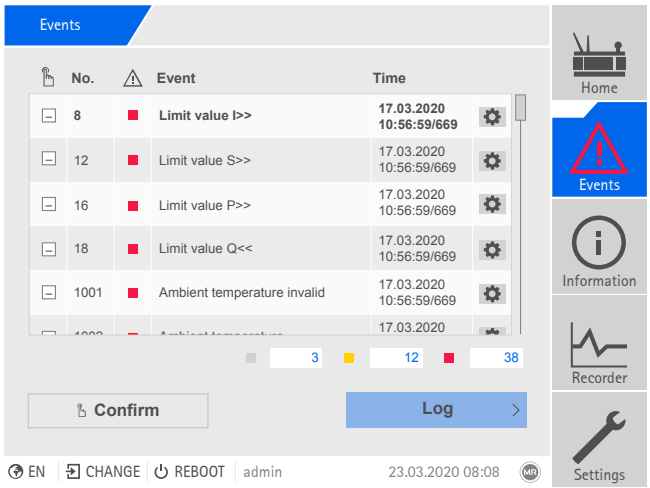


Figure 82: Overview of events currently active

Acknowledging events

Acknowledgeable events must be acknowledged in the event overview so that they are no longer displayed. All other events are automatically removed once the cause has been fixed (e.g. limit value is no longer exceeded).

To acknowledge the events, proceed as follows:

► To acknowledge the events, highlight the desired events in the column, then press the **Acknowledge** button.

⇨ The events have been acknowledged.

8.1.11.2 Configuring events

The events have the following properties:

Property	Description
Event name	Brief name of event. If you delete all of the text, the standard text is displayed.
Event description	Description of event. If you delete all of the text, the standard text is displayed.
Event troubleshooting	Instructions for troubleshooting the cause of an event. If you delete all of the text, the standard text is displayed.
Category	▪ Error (red) ▪ Warning (yellow) ▪ Info (gray) This setting affects the color of the *Alarm* LED and the event symbol in the primary navigation.
Report	If you activate this option, the event is shown on the display and, if configured accordingly, issued via an output and the control system protocol.
Save	If you activate this option, the event is stored in the event memory.
Multi-set (not configurable)	The event can be triggered several times without having been deactivated in the meantime.
High active (not configurable)	High active: The device generates a signal if the event is pending. Low active: The device generates a signal so long as the event is not pending. If the event is pending, the signal is reset.
Acknowledgeable (not configurable)	Acknowledgeable events must be acknowledged in the event overview so that they are no longer displayed. All other events are automatically removed once the cause has been fixed (e.g. limit value is no longer exceeded).
Blocking (not configurable)	If the event is active, it blocks automatic voltage regulation.

Table 26: Properties of events

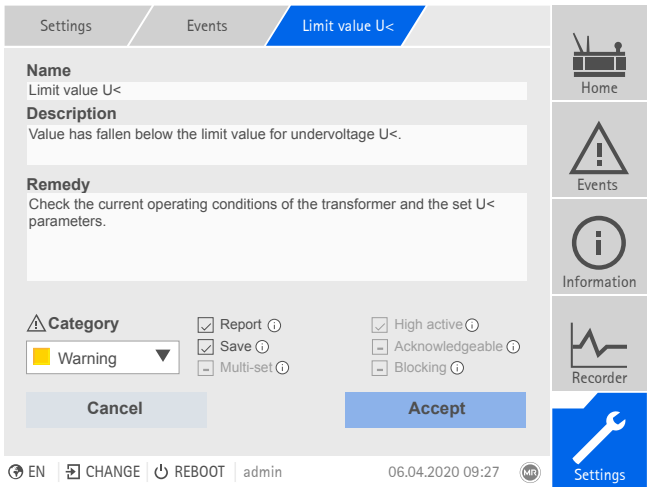


Figure 83: Configuring events

To configure an event, proceed as follows:

1. Go to **Settings** > **Events**.
2. Select the event to be changed in the list.
3. Select the desired options.
4. Press the **Accept** button to save the change.

8.1.11.3 Displaying event memory

Past events are stored in the event memory. You can adjust the display of events using different filters. The following filters are available for this purpose:

Filter	Description
Time	Date and time of event
Category	Event category: ▪ Error (red) ▪ Warning (yellow) ▪ Info (gray)
Status	Event coming/going: Event coming Event going
Components	System components
Event	Up to 3 events can be selected

To call up the event memory, proceed as follows:

1. Go to **Events** > **Event memory**.

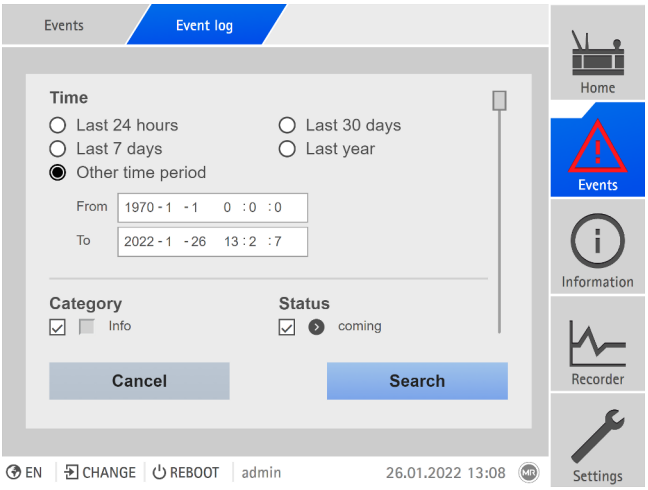


Figure 84: Event memory

2. Set the desired **Filter**.
3. Select the desired events in the **Events** list.
4. Press the **Search** button to display the desired events.

Exporting events

You can export the event memory entries currently displayed as a csv file. If you first create a filter, only the filtered entries are exported.

To export the events, proceed as follows:

✓ First, connect using Connect PC or connect a storage medium to the USB port on the CPU I/CPU II module.

1. Press the **Export** button.
2. Select the desired option for data transmission (PC or USB).

⇨ The data is exported.

8.1.11.4 Exporting the event messages overview

You can call up an overview of the possible events in the device.

✓ First, connect using Connect PC or connect a storage medium to the USB port on the CPU I module.

1. Go to **Export** > **Event list**.
2. Select the location where you want to save it.
3. Press the **Start export** button.

⇨ The overview of event messages is exported.

8.1.12 User administration

User administration is based on a system of roles. You must assign a role to every user. You can define access rights to parameters and events for each role.

8.1.12.1 User roles

The access rights to device functions and settings are controlled using a hierarchical system of roles. The system has 5 different roles with different access rights. Some of these access rights are fixed, but you can configure the access rights to particular parameters and events. Note the Setting access rights to parameters and events [▶Section 8.1.12.4, Page 115] section.

If you are not logged in on the device, you will assume the "Data display" user role.

Upon delivery, the following roles are provided:

Role	Description
Data display	User who can only view data of relevance to operation. ▪ Display all parameters ▪ Display all events
Diagnostics	User who can view data and log data of relevance to operation. ▪ Display all parameters ▪ Display all events ▪ Export log data
Operator	User who can view data of relevance to operation and acknowledge events. The user can perform manual tap-change operations using the device's controls. ▪ Display all parameters ▪ Display and acknowledge all events
Parameter configurator	User who can view and modify data of relevance to operation. ▪ Display and modify all parameters ▪ Import and export parameters ▪ Display, modify, and acknowledge all events
Administrator	User who can view and modify all data. ▪ Read all parameters ▪ Display, modify, and acknowledge all events

Table 27: Roles in delivery status

Access to the following areas of the device is linked to the roles:

Function	Data display	Diagnostics	Operator	Parameter configurator	Administrator
Administration	-	-	-	-	+
Restart device	-	-	+	+	+
Import	-	-	-	+	+
Export	-	+	-	+	+
Set date and time	-	-	+	+	+
Calling up the commissioning wizard	-	-	-	+	+
Calibrate resistor contact series	-	-	-	+	+
Actuation of the RAISE, LOWER, REMOTE, AVR AUTO, and AVR MANUAL keys	-	-	+	+	+
Setting topology	-	-	-	+	+
Configuring analog inputs and outputs	-	-	-	+	+
Configuring digital inputs and outputs	-	-	-	+	+
Setting TPLE	-	-	-	+	+
Configuring data points	-	-	-	+	+
Calling up the maintenance wizard	-	-	-	+	+
Changing tap position table	-	-	-	+	+
Enabling ECOTAP Modbus	-	-	-	+	+
Adding sensors to the MR sensor bus	-	-	-	+	+

Table 28: Access rights permanently linked to the roles

8.1.12.2 Changing the password

All users can change their passwords provided that the user account is not set up as a group account. You can only change a group account's password if you are logged in as the administrator.

Note that the password must satisfy the following requirements:

- At least eight characters
- At least three of the four following character types
  - Upper case letters
  - Lower case letters

– Numbers
– Special characters

To change the password, proceed as follows:

1. Select **Username** in the status line.

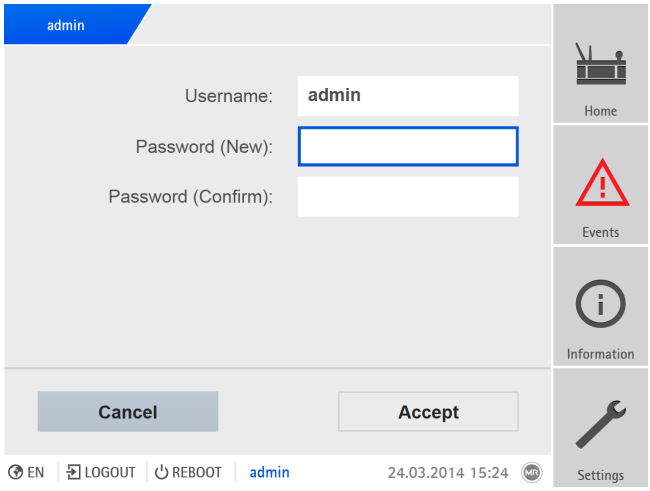


Figure 85: Changing the password

2. Enter the new **Password** twice.
3. Press the **Accept** button to save the changed password.

8.1.12.3 Creating, editing and deleting users

You can set the following options for all users:

- Username and password
- User role: You can assign a role to every user. The access rights to parameters and events are linked to the roles.
- Group access: With this option, you can declare a user account to be a group account (e.g. for access by different people). Users with group access cannot change their own password. The password can only be changed by the administrator.
- Active: You can activate or deactivate the user. Deactivated users cannot log in. The user data is still stored in the device.
- Auto login: You can activate the Auto-login function for a user. This user is automatically logged in when the system is restarted or another user logs out.

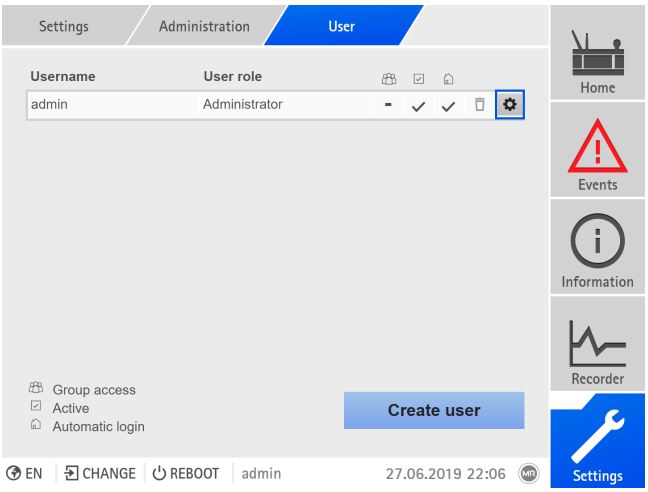


Figure 86: Overview of users created

You can only create, edit, and delete users if you are assigned an administrator role.

When in delivery status, you can log in as the administrator as follows:

- User name: `admin`
- Password: `admin`

Creating users

To create a new user, proceed as follows:

1. Go to **Settings** > **User administration** > **User accounts**.
2. Press the **Create user** button.
3. Enter the **Username** and then the **Password** twice.
4. Select the desired **User role**.
5. If necessary, activate the **Group access**, **Active** or **Automatic login** options.
6. Press the **Accept** button to save the user.

Editing users

To edit an existing user, proceed as follows:

1. Go to **Settings** > **User administration** > **User accounts**.
2. In the list, select the ⚙ button for the desired user.
3. Make the amendments desired.
4. Press the **Accept** button to save the user.

Deleting a user

To delete an existing user, proceed as follows:

1. Go to **Settings** > **User administration** > **User accounts**.
2. In the list, select the button for the desired user.
3. Press the **Accept** button to delete the user.

8.1.12.4 Setting access rights to parameters and events

You can configure access rights to parameters and events for the available roles. The following options are available for this purpose:

- Read: Parameter/event may be displayed.
- Write: Parameter/event may be modified.
- Acknowledge: Event may be acknowledged.

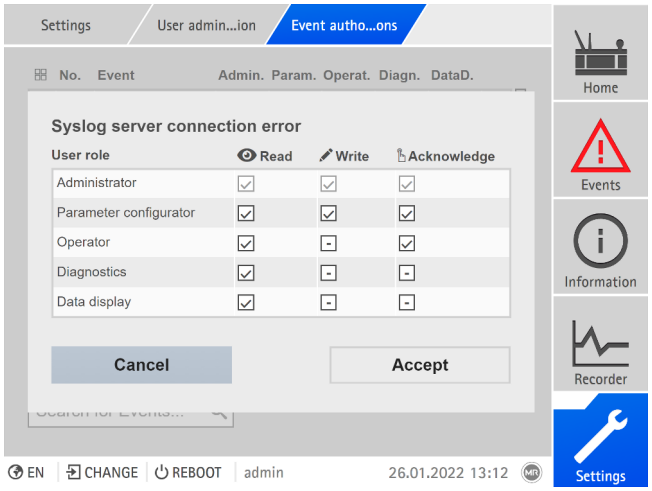


Figure 87: Setting access rights for an event

You can only change access rights if you are assigned an administrator role.

When in delivery status, you can log in as the administrator as follows:

- User name: `admin`
- Password: `admin`

Setting access rights to parameters/events

1. Go to **Settings** > **User administration** > **Parameter authorizations** or **Event authorizations**.

   ⇨ A list of all parameters or events appears.
2. Edit the desired entry in the list using the button.
3. Select the desired options.

4. Press the **Accept** button to save the change.
5. Restart the device to apply the changed rights.

8.1.13 Hardware

Under Hardware, you can display information on the device's hardware. You will find information about the signal level of the individual channels for the assemblies.

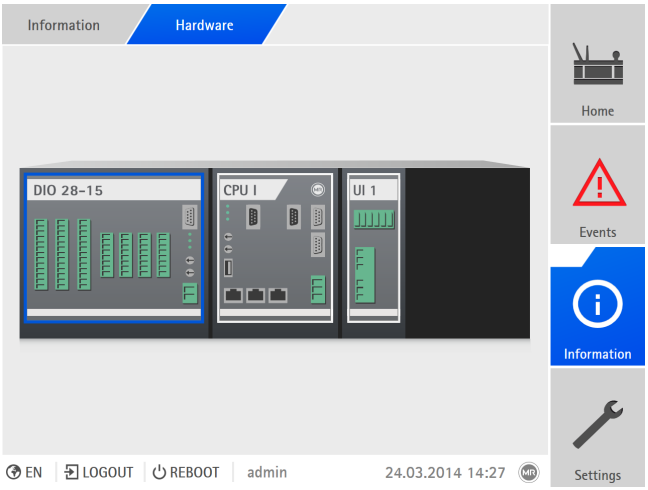


Figure 88: Displaying information for the device's hardware (example)

1. Go to **Information** > **System** > **Hardware**.
2. Select the desired **Assembly** in order to display the signal levels of the channels.

8.1.13.1 Status of the DIO assembly

You can display the status of the digital inputs and outputs of the DIO assembly.

- Terminal pin
- Status of the input (I: …) or output (O: …)
  - Blue: There is a signal (logical 1) at the input or output.
  - Gray: There is no signal (logical 0) at the input or output.
- Linked function

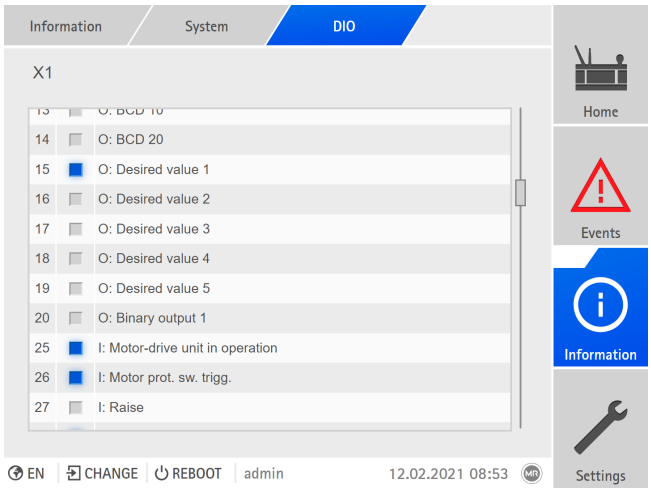


Figure 89: Status of the DIO assembly

8.1.13.2 Status of the AIO assembly

You can display the status of the analog inputs and outputs of the AIO assembly. If a value is not within the permitted range, this value will be displayed in red.

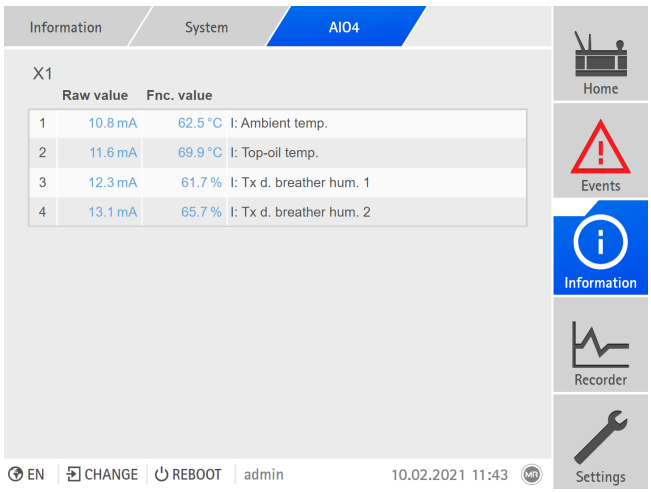


Figure 90: Status of the AIO assembly

8.1.14 Software

Under Software, you can display the version status of the software components of the device.

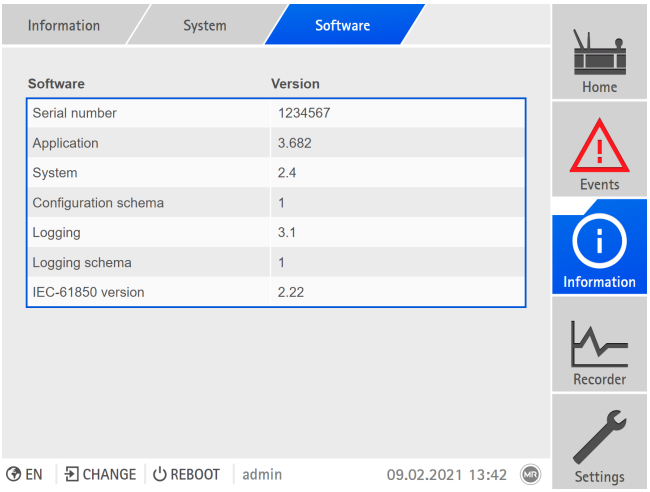


Figure 91: Information about the device's software

► Go to **Information** > **System** > **Software**.

8.1.15 Import/export manager

The device is equipped with an import/export manager, which can be used to export and import various data.

To transfer the data, the following options are available:

Option	Description
USB	Data transfer via USB port on rear of CPU I/CPU II assembly.
PC	Data transfer via PC using web-based visualization.

Table 29: Data transfer options

8.1.15.1 Importing data (software version 3.800 and later)

Depending on your device configuration, you can import the following data:

Option	Description
System image	Complete image of the system (software and configuration), with or without history (recorded data). During import, you can select which of the following settings are to be imported: ▪ Parameters (settings, access rights) ▪ Events (category, behavior, text, access rights) ▪ User configuration If available, you can also import the settings of the following functions: ▪ Topology ▪ AIO configuration ▪ DIO configuration ▪ Tap position table ▪ Sensor bus ▪ Certificates
Customer program	Customer program import (TPLE).
Language	Import of additional languages. You can install a maximum of five different languages on the device. If five languages are already installed, you will be asked to delete one during the import process.
SSL certificate	Import of an SSL certificate with associated key: ▪ Server certificate (.crt + .pem) ▪ Client certificate (.crt + .pem) ▪ Client CA (.crt) For the import, you will have to compress the certificate (*.crt) and key (*.pem) in a zip file. You can import certificates with the following key authentication: ▪ RSA with 1,024 bits ▪ ECDSA with 256 bits ("secp256r1" or "prime256v1" curve).

Option	Description
Settings	You can import device settings from a backup file of this device, an update file or a different device. During import, you can select which of the following settings are to be imported: ▪ Parameters (settings, access rights) ▪ Events (category, behavior, text, access rights) ▪ User configuration If available, you can also import the settings of the following functions: ▪ Topology ▪ AIO configuration ▪ DIO configuration ▪ Tap position table ▪ Sensor bus ▪ Certificates
Data point configuration	Data point configuration import
SCADA configuration	Import of the control system configuration (e.g. SCD file for IEC 61850).
Sensor bus	Sensor description of the sensors for MR sensor bus.

Table 30: Importing data

If you import the settings of the AIO/DIO configuration of a system in which sensors are linked via sensor bus, you must also select the sensor bus option for the import. Otherwise you must re-link the sensor signals with the device functions (AIO configuration [▶Section 8.1.10, Page 103] or DIO configuration [▶Section 8.1.9, Page 101]). The same applies if you want to import a sensor bus configuration. In this case, you must also import the AIO/DIO configuration or manually link the sensor signals with the device functions manually.

NOTICE

Damage to the file system!

The file system can be damaged due to an incorrect data transmission process. A damaged file system can lead to the device no longer being functional.

► Do not disconnect the device from the power supply during the import.

► In addition, during the download, do not remove the USB flash drive or disconnect the network connection.

To import data, proceed as follows:

1. Go to **Settings** > **Import**.
2. Select the desired option for data transmission (PC or USB).
3. Select **Browse**, select the file to be imported and select **Start upload**.
   ⇨ The file is checked.

4. Optional: Select the desired options for the import.
5. Press the **Start update** button.
   ⇨ **NOTICE!** The device function (monitoring/control) is stopped.

⇨ The data is imported, then the device is restarted. During the restart, the relays are reset.

Also refer to

- Configuring analog inputs and outputs (optional) [▶ 103]
- Configuring digital inputs and outputs [▶ 101]

8.1.15.2 Exporting data

The device stops logging the measured value log data for the duration of the export.

You can export the following data from the device, depending on your device configuration:

Backup

Option	Description
System image (.rhi)	Complete image of the system (software and configuration). If you are using the option "with history", all of the event memory entries are also exported. If you select the "with TPLE" option, the customer program is exported. You can select whether you would like to export all records or only records from the last 10 days.
Settings (.rhi)	Device settings: ▪ Parameters (settings, access rights) ▪ Events (category, behavior, text, access rights) ▪ User configuration If available, the settings of the following functions are also exported: ▪ Topology ▪ AIO configuration ▪ DIO configuration ▪ Tap position table ▪ Sensor bus ▪ Certificates
Customer program (TPLE) (.rhi)	Customer program export (TPLE).
Data point configuration (.rhi)	Data point configuration of the control system.

Option	Description
Sensor-bus device description (.rhi)	Sensor description of the sensors for MR sensor bus.
Custom sensor-bus dev. description (.rhi)	Sensor description of the sensors for MR sensor bus that have been created with the sensor editor.

Table 31: Exporting data: Backup group

Information

Option	Description
Operating instructions (.zip)	Operating instructions, protocol specifications.
Licenses (.zip)	License text of the software components used.
SCADA configuration (.zip)	Control system configuration (e.g. ICD file for IEC 61850).

Table 32: Exporting data: Information group

System

Option	Description
Event list (.csv)	Complete list of all possible events.
Parameter list (.csv)	Parameter list with descriptive text and values (min, max, current).
System configuration (.xml)	System configuration.
RADIUS library (.zip)	Dictionary for importing on a RADIUS server.

Table 33: Exporting data: System group

Records

Option	Description
Event log (.csv)	All event memory entries.
Security log (.csv)	Logbook of all instances of access and changes relating to security.
Recorder (.zip)	Measured value memory export.
VAM export (.zip)	Export of vibro-acoustic records. You can export the data in its entirety or select certain records.
Maintenance logbook (.xml)	Export of entries in the maintenance logbook.

Table 34: Exporting data: Records group

Only remove the USB stick once the data transfer is complete. Otherwise, data may be lost.

To export data, proceed as follows:

1. Go to **Settings** > **Export**.
2. Select the desired option for the export and follow the instructions on the screen.

8.1.15.3 VAM export

You can export the vibro-acoustic records as a zip file.

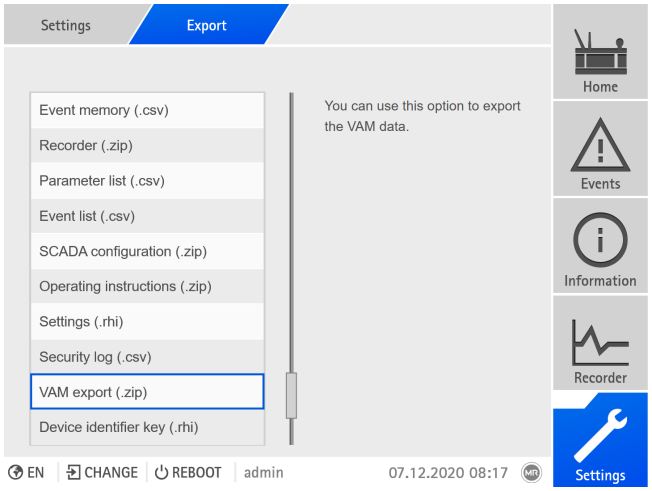


Figure 92: VAM export

► Go to **VAM export (.zip)**.

Two options will be presented for selection: Complete export or User-defined export.

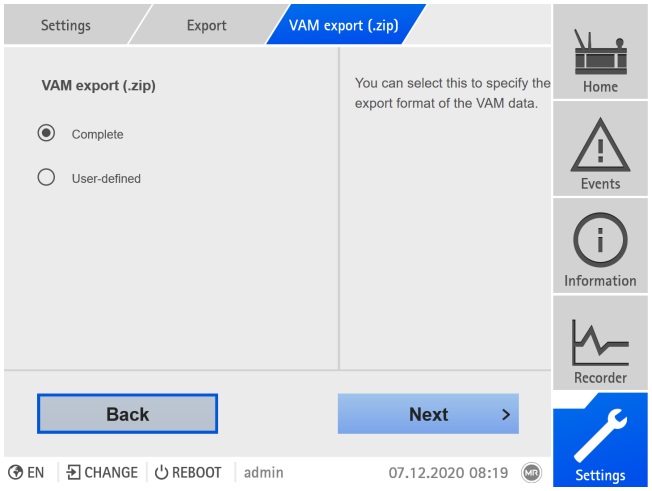


Figure 93: VAM export selection

Depending on the file format and the data volume, the complete VAM export will take longer.

There are 3 options available:

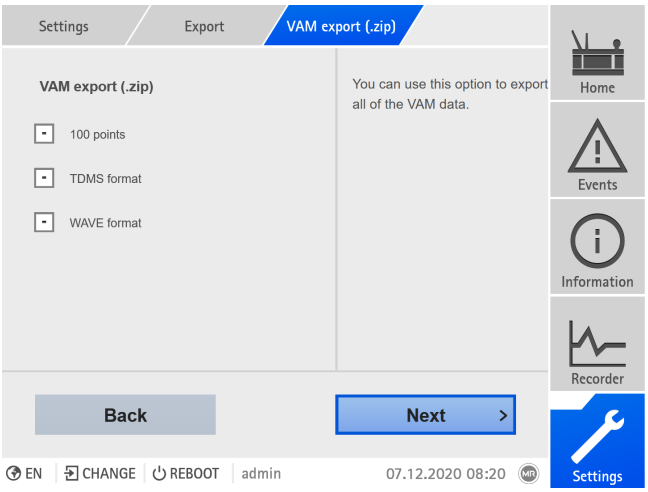


Figure 94: Complete VAM export

By selecting **100 points** and **TDMS format**, the data necessary for the standard online report will be exported. The **WAVE format** is necessary in addition for the extended online report. Contact Maschinenfabrik Reinhausen GmbH for the online report.

The latest information about your product and the description of the data exchange can be found on the customer portal: https://portal.reinhausen.com/mydevices/.

With the user-defined VAM export option, you can filter data or select data from the list. The number of signals is limited to 100. All three formats will be exported (**100 points, TDMS format** and **WAVE format**).

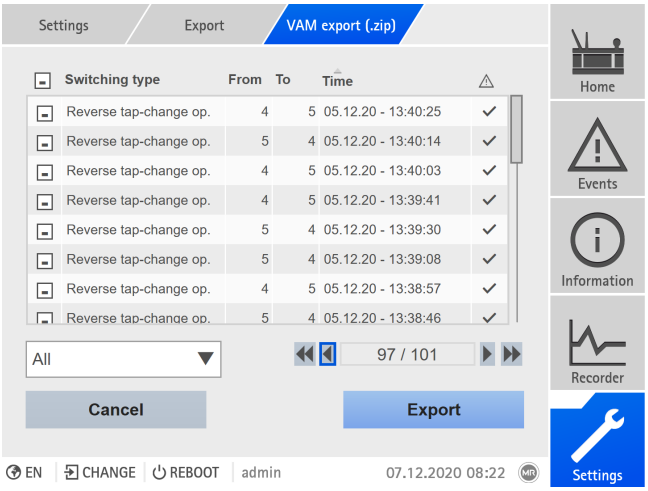


Figure 95: User-defined VAM export

8.1.16 Transformer Personal Logic Editor (TPLE)

You can use the Transformer Personal Logic Editor (TPLE) function to program simple logical links via the web-based visualization. You can also link the inputs and outputs available on the device using function modules.

Note that the device does not meet the requirements of a protective device. Therefore, do not use TPLE to produce protective functions.

8.1.16.1 Function

8.1.16.1.1 Function groups

There are 10 function groups available that you can use to combine various sub-tasks into one function. In one function group, you can link up to 12 function modules with variables. You can rename function groups and activate or deactivate them individually.

8.1.16.1.2 Variables

The following types of variables for information processing are available for TPLE:

- Event inputs: You can use all the device's events as inputs for a function.
- Event outputs: 100 generic events are available as outputs for functions.
- Binary inputs: You can use all the device's configured digital inputs and up to 42 generic inputs of the device as inputs for a function.
- Binary outputs: You can use all the device's configured digital outputs and up to 20 generic outputs of the device as outputs for a function. If there is a control system present, 10 generic control system messages are available.
- Analog inputs: You can use all the device's configured analog inputs as inputs for a function.
- Binary flags: You can use up to 100 binary flags as variables to store intermediate values. You can use binary flags as inputs and outputs for a function.
- Analog flags: You can use up to 50 analog flags as variables to store intermediate values. You can use analog flags as inputs and outputs for a function.
- Discrete inputs: You can use all the device's available discrete inputs as inputs for a function.

8.1.16.1.3 Function modules

TPLE provides various function modules for processing the information.

8.1.16.1.3.1 AND

Description	AND, logical AND link
Inputs	Input 1…4 (BOOL)
Outputs	Output (BOOL)
Parameter	None
Function	If all configured inputs are TRUE, the output is TRUE, otherwise it is FALSE.
Initial state	All inputs and outputs are FALSE. Non-configured inputs are assumed to be TRUE. If no input is configured, the module is not run so it remains in its initial state.

Table 35: AND function module

8.1.16.1.3.2 NAND

Description	NAND, logical NOT-AND link
Inputs	Input 1…4 (BOOL)
Outputs	Output (BOOL)
Parameter	None
Function	If all configured inputs are TRUE, the output is FALSE, otherwise it is TRUE.
Initial state	All inputs and outputs are FALSE. Non-configured inputs are assumed to be TRUE so that they have no impact on the output. If no input is configured, the output therefore remains in the initial state of FALSE.

Table 36: NAND function module

8.1.16.1.3.3 OR

Description	OR, logical OR link
Inputs	Input 1…4 (BOOL)
Outputs	Output (BOOL)
Parameter	None
Function	If one of configured inputs is TRUE, the output is TRUE, otherwise it is FALSE.
Initial state	All inputs and outputs are FALSE. Non-configured inputs are assumed to be FALSE.

Table 37: OR function module

8.1.16.1.3.4 NOR

Description	NOR, logical NOT-OR link
Inputs	Input 1…4 (BOOL)
Outputs	Output (BOOL)
Parameter	None
Function	If all configured inputs are FALSE, the output is TRUE, otherwise it is FALSE.
Initial state	All inputs and outputs are FALSE. Non-configured inputs are assumed to be FALSE so that they have no impact on the output. If no input is configured, the output remains in the initial state of FALSE anyway.

Table 38: NOR function module

8.1.16.1.3.5 XOR

Description	XOR, logical EXCLUSIVE-OR link
Inputs	Input 1…2 (BOOL)
Outputs	Output (BOOL)
Parameter	None
Function	If an odd number of inputs is TRUE, the output is TRUE, otherwise it is FALSE.
Initial state	All inputs and outputs are FALSE. Non-configured inputs are assumed to be FALSE so that they have no impact on the output. If no input is configured, the output therefore remains in the initial state of FALSE.

Table 39: XOR function module

8.1.16.1.3.6 NOT

Description	NOT, logical NOT link
Inputs	Input (BOOL)
Outputs	Output (BOOL)
Parameter	None
Function	If the input is TRUE, the output is FALSE, otherwise it is TRUE.
Initial state	All inputs and outputs are FALSE. If the input is not configured, it is assumed to be TRUE so that the output remains in the initial state of FALSE.

Table 40: NOT function module

8.1.16.1.3.7 Current impulse relay

Description	RS, current impulse relay
Inputs	Trigger (BOOL) Set (BOOL) Reset (BOOL)
Outputs	Output (BOOL)
Parameter	None
Function	If the Reset input is TRUE, Output forcibly becomes FALSE. If the Reset input is FALSE and the Set input is TRUE, Output forcibly becomes TRUE. If the Reset and Set inputs are FALSE, the status of Output changes when there is a rising edge at the Trigger input. If there is no edge at the Trigger input, Output remains unchanged.
Initial state	All inputs and outputs are FALSE. Non-configured inputs are assumed to be FALSE so that they have no impact on the output.

Table 41: Current impulse relay function module

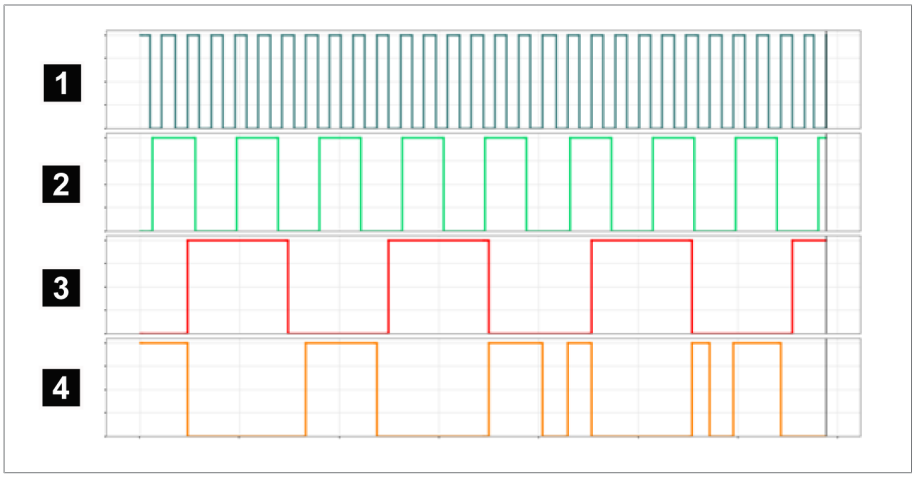


Figure 96: Example of RS

1	Trigger	2	Set
3	Reset	4	Output

8.1.16.1.3.8 Switch-on delay

Description	TON, switch-on delay
Inputs	Input (BOOL)
Outputs	Output (BOOL)
Parameter	Time ms (UINT32), 1...1,000,000, default = 1,000

Function	If Input has a rising edge, the internal timer is set to zero and starts to run. When the internal timer has reached or exceeded the parameter value, Output becomes TRUE and the counter stops running. If Input becomes FALSE, Output also instantly becomes FALSE. If the value of Time_ms is less than the cycle time, the cycle time applies instead.
Initial state	All inputs and outputs are FALSE.

Table 42: Switch-on delay function module

8.1.16.1.3.9 Switch-off delay

Description	TOFF, switch-off delay
Inputs	Trigger (BOOL) Reset (BOOL)
Outputs	Output (BOOL)
Parameter	Time ms (UINT32), 1...1,000,000, default = 1,000
Function	If Input becomes TRUE, Output also instantly becomes TRUE, this condition takes priority. If Input has a falling input, the internal timer is set to zero and starts to run. When the internal timer has reached or exceeded the parameter value, Output becomes FALSE and the counter stops running. If Input is FALSE and the Reset input becomes TRUE, Output instantly and forcibly becomes FALSE and the internal timer is set to the configured desired value. If the value of Time_ms is less than the cycle time, the cycle time applies instead.
Initial state	All inputs and outputs are FALSE.

Table 43: Switch-off delay function module

8.1.16.1.3.10 Pulse

Description	PLSE, pulse
Inputs	Trigger (BOOL)
Outputs	Output (BOOL)
Parameter	Time ms (UINT32), 1...1,000,000, default = 1,000

Function	If there is a rising edge at the Trigger input at any time, the internal timer is set to zero and starts to run, the output becomes TRUE. If the Trigger input becomes FALSE again during the pulse time, this has no impact on the expiration of the pulse time. Once the internal timer has expired, the output becomes FALSE. If the value of Time_ms is less than the cycle time, the cycle time applies instead.
Initial state	All inputs and outputs are FALSE.

Table 44: Pulse function module

8.1.16.1.3.11 Symmetrical pulse generator

Description	CLCK, symmetrical pulse generator
Inputs	Enable (BOOL)
Outputs	Output (BOOL)
Parameter	Time ms (UINT32), 1...1,000,000, default = 1,000
Function	The internal timer runs for a long as Enable is TRUE. When the internal timer has reached or exceeded the configured time value, the status of the output changes and the timer is restarted. The configured time therefore corresponds to half the period duration of the resulting signal. If the Enable input becomes FALSE, the output also instantly becomes FALSE and the internal timer is reset. If the value of Time_ms is less than the cycle time, the cycle time applies instead.
Initial state	All inputs and outputs are FALSE.

Table 45: Symmetrical pulse generator function module

8.1.16.1.3.12 Counter (forwards/backwards)

Description	COUNT, incremental counter
Inputs	Trigger (BOOL) Direction (BOOL) Reset (BOOL) Lock (BOOL)
Outputs	SINT32 (SINT32) REAL32 (REAL32)
Parameter	Reset value (SINT32), -10,000,000… +10,000,000, default = 0

Function	If there is a rising edge at Reset, the output value is set to the value of the Reset value parameter. A rising edge at Reset takes priority over all other inputs. For as long as Lock is TRUE, the pulse signal is not evaluated and the counter reading is retained. If no input is assigned, the default value FALSE is assumed. When Direction input = FALSE, the output value is incremented by one with every rising edge at the Trigger input. When Direction input = TRUE, the output value is decremented by one with every rising edge at the Trigger input.
Initial state	All inputs and outputs are zero or FALSE.

Table 46: Counter (forwards/backwards) function module

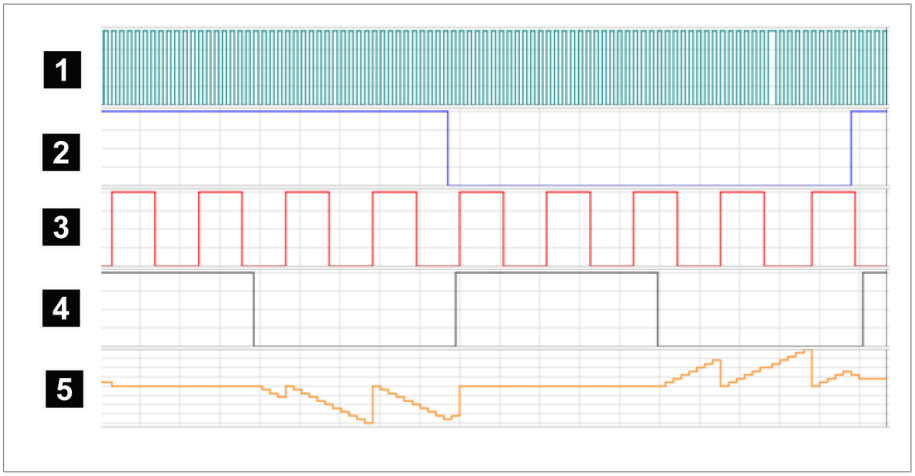


Figure 97: Example of COUNT

1 Trigger	2 Direction
3 Reset	4 Lock
5 Output	

8.1.16.1.3.13 Analog threshold value switch with hysteresis

Designation	THRES, threshold value switch with hysteresis
Inputs	Input (REAL32)
Outputs	Output (BOOL) Error (BOOL)
Parameter	On Limit (REAL32), -10,000,000… +10,000,000, default = 10,000,000 Off Limit (REAL32), -10,000,000 … +10,000,000, default = -10,000,000

Function	On Limit ≥ Off Limit setting: ▪ If the value of Input is greater than On Limit, Output becomes TRUE. ▪ If the value of Input is less than or equal to Off Limit, Output becomes FALSE. On Limit < Off Limit setting: ▪ If the value of Input is greater than On Limit and at the same time less than Off Limit, Output becomes TRUE. Otherwise, the Output is FALSE.
Initial state	All inputs and outputs are zero or FALSE.

Table 47: Analog threshold value switch with hysteresis function module

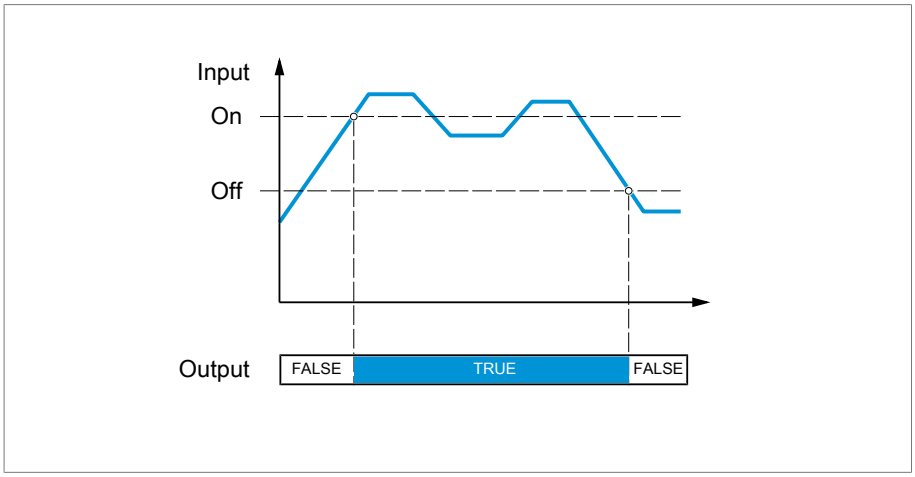


Figure 98: Analog threshold value switch with the On Limit > Off Limit setting

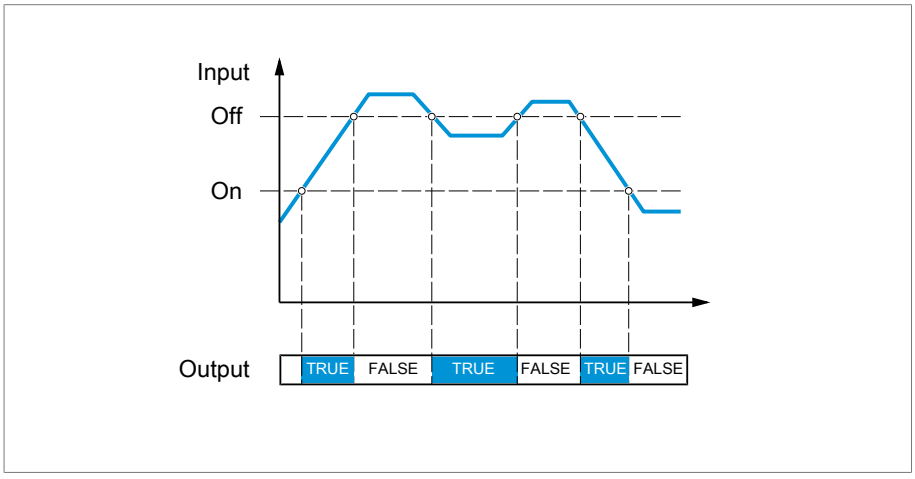


Figure 99: Analog threshold value switch with the On Limit < Off Limit setting

8.1.16.1.3.14 Analog multiplication

Description	MUL, analog multiplication
Inputs	Value (REAL32) Multiplier (REAL32)
Outputs	Result (REAL32) Overflow (BOOL)
Parameter	Constant multiplier (REAL32), -1,000,000...+1,000,000; default = 1
Function	Result = Value * Multiplier * Constant multiplier If the REAL32 range of numbers is exceeded, the Overflow output becomes TRUE.
Initial state	All inputs and outputs are zero or FALSE.

Table 48: Analog multiplication function module

8.1.16.1.3.15 Analog division

Description	DIV, analog division
Inputs	Divident (REAL32) Divisor (REAL32)
Outputs	Result (REAL32) DivByZero (BOOL) Overflow (BOOL)
Parameter	Constant divisor (REAL32), -1,000,000...+1,000,000; default = 1
Function	Result = Dividend / Divisor / Constant Divisor If dividing by zero, the DivByZero output becomes TRUE and Result is set to zero. If the REAL32 range of numbers is exceeded, the Overflow output becomes TRUE and Result is set to zero.
Initial state	All inputs and outputs are zero or FALSE.

Table 49: Analog division function module

8.1.16.1.3.16 Analog addition

Description	ADD, analog addition
Inputs	Input 1 (REAL32) Input 2 (REAL32)
Outputs	Result (REAL32) Overflow (BOOL)
Parameter	Offset (REAL32), -1,000,000...+1,000,000; default = 0

Function	Result = Input 1 + Input 2 + Offset If the REAL32 range of numbers is exceeded, the Overflow output becomes TRUE.
Initial state	All inputs and outputs are zero or FALSE.

Table 50: Analog addition function module

8.1.16.1.3.17 Analog subtraction

Description	SUB, analog subtraction
Inputs	Input 1 (REAL32) Input 2 (REAL32)
Outputs	Result (REAL32) Overflow (BOOL)
Parameter	Offset (REAL32), -1,000,000...+1,000,000; default = 0
Function	Result = Input 1 - Input 2 – Offset If the REAL32 range of numbers is exceeded, the Overflow output becomes TRUE.
Initial state	All inputs and outputs are zero or FALSE.

Table 51: Analog subtraction function module

8.1.16.1.3.18 Rising edge

Description	RTRG, rising edge trigger
Inputs	Input (BOOL)
Outputs	Output (BOOL)
Parameter	-
Function	When the input changes from FALSE to TRUE, the output becomes TRUE for one cycle of the function group and then changes back to FALSE.
Initial state	All inputs and outputs are FALSE.

Table 52: Rising edge function module

8.1.16.1.3.19 Falling edge

Description	FTRG, falling edge trigger
Inputs	Input (BOOL)
Outputs	Output (BOOL)
Parameter	-
Function	When the input changes from TRUE to FALSE, the output becomes TRUE for one cycle of the function group and then changes back to FALSE.
Initial state	All inputs and outputs are FALSE.

Table 53: Falling edge function module

8.1.16.1.3.20 Average value

Description	AVRG, average value
Inputs	Input (REAL32) Enable (BOOL) Reset (BOOL) Autorepeat (BOOL)
Outputs	Average (REAL32) Done (BOOL) Started (BOOL) SampleCount (UINT32)
Parameter	Time ms (UINT32): 1...2,000,000,000, default = 10,000 Sample time ms (UINT32): 1...10,000,000, default = 1,000
Function	Averaging starts with a rising edge of Enable. This does not affect averaging which is already underway. Any output value remaining from earlier is retained. The Done output becomes FALSE, the Started output becomes TRUE. Active averaging is interrupted with a rising edge of Reset. Average is set to zero, Done and Started become FALSE. If Enable is also TRUE during the rising Reset edge, a new averaging process is started. Done becomes TRUE and Started becomes FALSE once averaging is complete. Done remains TRUE until a Reset is detected or new averaging is triggered by a rising edge of Enable. If AutoRepeat and Enable are TRUE, a new averaging process is automatically started each time averaging is completed. Done is set for one cycle each time averaging is completed. The SampleCount output states how many samples have already been recorded. Sample time ms is the desired sample time in milliseconds. It is rounded up to the next whole multiple of the task cycle time and has a lower limit of at least one task cycle time. Time ms is the time period desired for averaging. It is internally rounded up to the next whole multiple of the sample time and has a lower limit of at least one sample time.
Initial state	All inputs and outputs are FALSE.

Table 54: Average value function module

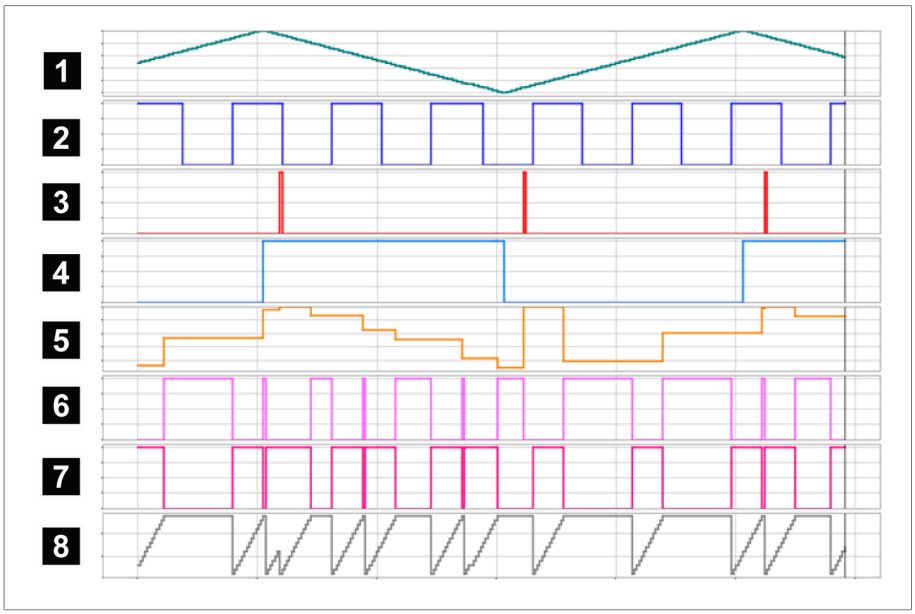


Figure 100: AVRG

1	Input	2	Enable
3	Reset	4	AutoRepeat
5	Average	6	Done
7	Started	8	SampleCount

8.1.16.1.3.21 Scaling

Description	SCAL, scaling
Inputs	Input (REAL32)
Outputs	Output (REAL32) Error (BOOL)
Parameter	Min In (REAL32): -10,000,000...+10,000,000, default = -10,000,000 Max In (REAL32): -10,000,000...+10,000,000, default = +10,000,000 Min Out (REAL32): -10,000,000...+10,000,000, default = -10,000,000 Max Out (REAL32): -10,000,000...+10,000,000, default = +10,000,000

Function	Output is calculated using the following formula: `Output = Min Out + (Max Out - Min Out) x (Input - Min In) / (Max In - Min In)` Output is set to 0 and Error = TRUE when: ▪ Input is not within the parameters Min In and Max In ▪ Min In is greater than Max In ▪ Min Out is greater than Max Out ▪ Max In is the same size as Min In (division by zero)
Initial state	All inputs and outputs are FALSE.

Table 55: Scaling function module

8.1.16.1.3.22 Bridge

Designation	BRDG, Bridge
Inputs	Analog Input (REAL32) Digital Input (BOOL)
Outputs	Analog Output (REAL32) Digital Output (BOOL)
Parameter	-
Function	Copies the value of Analog Input to Analog Output and Digital Input to Digital Output.
Initial state	All inputs and outputs are zero or FALSE.

Table 56: Bridge function module

8.1.16.1.3.23 RTOI

Description	RTOI, Real-to-Integer conversion
Inputs	Analog Input (REAL32)
Outputs	Analog Output (SINT32)
Parameter	-
Function	Copies the value of Analog Input to Analog Output and converts REAL32 to SINT32.
Initial state	All inputs and outputs are zero.

Table 57: RTOI function module

8.1.16.1.3.24 ITOR

Description	ITOR, Integer-to-real conversion
Inputs	UINT32 (UINT32) SINT32 (SINT32)
Outputs	Output U (REAL32) Output S (REAL32)

Parameter	-
Function	The value of UINT32 is output converted to Output U, the value of SINT32 is output converted to Output S.
Initial state	All inputs and outputs are zero.

Table 58: NAND function module

8.1.17 Linking to the visualization of external devices

You can create links to the web-based visualization of up to 5 devices. This enables you to call up the visualizations of other devices directly from the visualization of the ISM® device without having to know their IP address.

You can only call up the link to the visualization of an external device if you call up the visualization via a PC web browser. If you want to call up the visualizations of external devices via the MControl touch panel, you must add the IP addresses of the external devices as additional "servers" in the touch panel configuration.

8.1.17.1 Setting up an external visualization

To set up a link to the visualization of an external device, you must set the parameters described in the following.

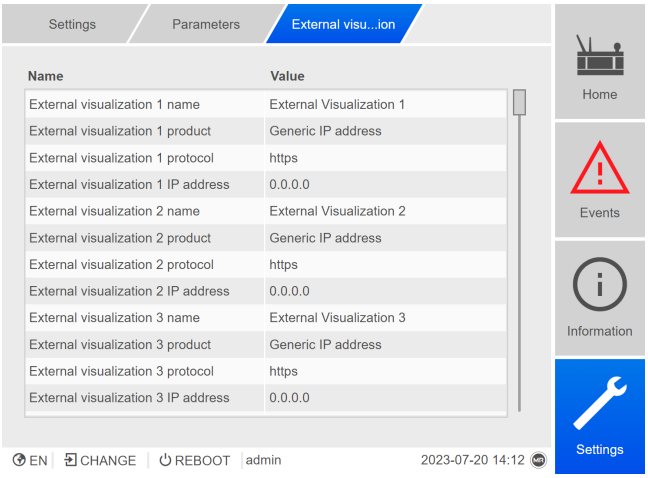


Figure 101: External visualization

► Go to **Settings** > **Parameters** > **System** > **External visualization**.

External visualization name

Use this parameter to set the designation for the link to the visualization of the external device (e.g., the designation of the external device).

External visualization product

Use this parameter to select the product whose visualization is to be called up. By doing so, depending on the product, a defined path is linked to the IP address of the external visualization (e.g., `<IP address>/visu/home`). If you select the "Generic IP address" option, a path will not be used.

External visualization protocol

Use this parameter to set the protocol for calling up the external visualization. You can select the following options:

- https
- http

External visualization IP address

Use this parameter to set the IP address of the external visualization.

8.1.17.2 Calling up an external visualization

To call up an external visualization, proceed as follows:

1. Go to **Information** > **System** > **External visualization**.

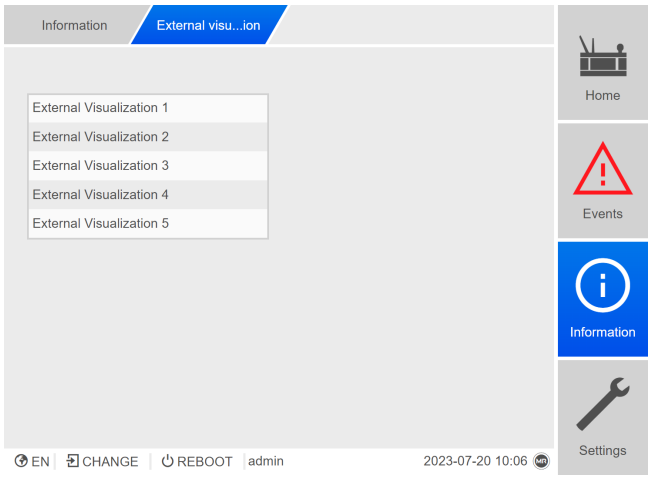


Figure 102: External visualization

2. Select the desired visualization.
   ⇨ The visualization will be opened in a new tab in the browser.
3. If necessary, select the **Reopen** button to reopen the external visualization.

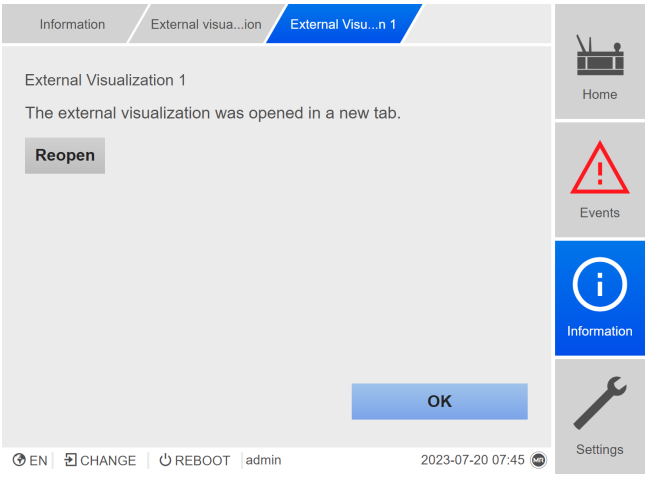


Figure 103: Visualization 1

8.2 On-load tap-changer

8.2.1 Displaying VAM analysis

For each recorded tap-change operation, you will receive the following information:

- Tap-change operation type
- Start position and end position of the tap-change operation.
- Time of the tap-change operation
- Status

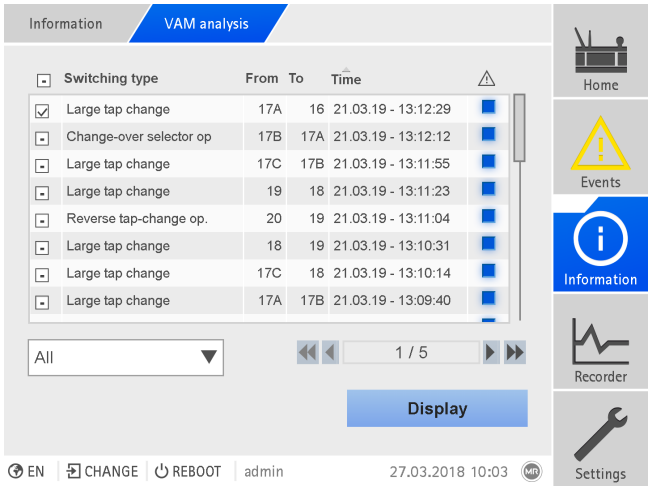


Figure 104: VAM analysis

► Go to **Information > On-load tap-changer > VAM analysis**.

Tap-change operation type

The monitoring system distinguishes between the following types of tap-change operations:

- Change-over selector operation: The change-over selector also changes in this tap-change operation.
- Small tap change: Tap selector operation in which the distance between the stationary selector contacts used for this tap-change operation is small.
- Moderate tap change: Tap selector operation in which the distance between the attached selector contacts used for this tap-change operation is moderate.
- Large tap change: Tap selector operation in which the distance between the attached selector contacts used for this tap-change operation is large.
- Reverse tap-change operation: Tap-change operation in which the tap changes in the opposite direction to the most recent tap-change operation and does not involve actuation of the selector.

Status information

Color code	Meaning
Blue	No anomalies: Plausibility criteria met and limit values not exceeded
Yellow	Limit value was exceeded
Gray	The evaluation could not be carried out

Filter options

Using the drop-down menu, you can limit the selection of tap-change operations to those of a specific tap-change operation type or to those involving a specific property.

- Selection according to tap-change operation type:
  - Change-over selector operation
  - Small, medium or large tap change
  - Reverse tap-change operation
- Selection according to property:
  - All
  - Marked
  - Evaluation ok
  - Anomalies
  - Without evaluation

Display of selected tap-change operations

To display individual tap-change operations with the associated VAM signal and the stored limit value as a curve, proceed as follows:

1. Place a check mark ☑ in the first column in front of the tap-change operation that is to be displayed as a curve. Up to 100 tap-change operations can be shown in the visualization via web browser. A maximum of 10 tap-change operations can be shown on the device display.
2. Confirm via the **Display** button.
   ⇨ They will be displayed differently depending on the number of selected tap-change operations.

If more than one tap-change operation is selected, then the limit value curve display will be omitted for the purpose of clarity:

Number of selected tap-change operations	1	2–100	>100
Display of VAM signal	Yes	Yes	No
Display of limit value curve	Yes	No	No

The following figure shows an example of the visualization of an individual tap-change operation:

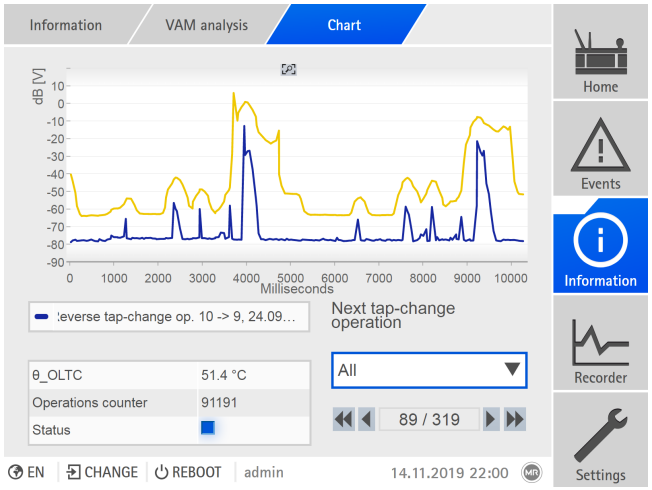


Figure 105: Display of a tap-change operation

The following figure shows an example of how multiple selected tap-change operations are shown at the same time:

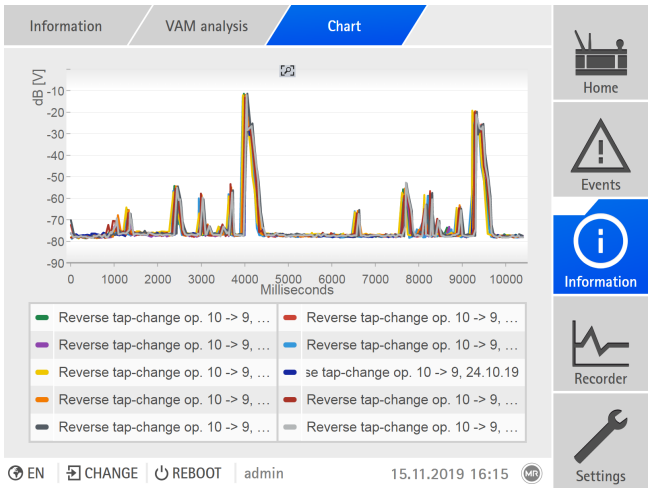


Figure 106: Display of multiple tap-change operations

If multiple tap-change operations are selected for the visualization, it is possible to hide or show individual tap-change operations by clicking on them in the key.

Using the web-based ISM™ Intuitive Control visualization allows you to zoom into an area of the signal. To do this, hold down the left mouse button and draw a frame around the desired area. To return to the original representation, click on the  symbol.

8.3 Active part

8.3.1 Temperature monitoring

You can set 4 limit values for every measured temperature. If the measured temperature is greater than limit value > or >>, the device triggers an event message. If the measured temperature is less than limit value < or <<, the device triggers an event message.

You can view the temperature curve under "Information".

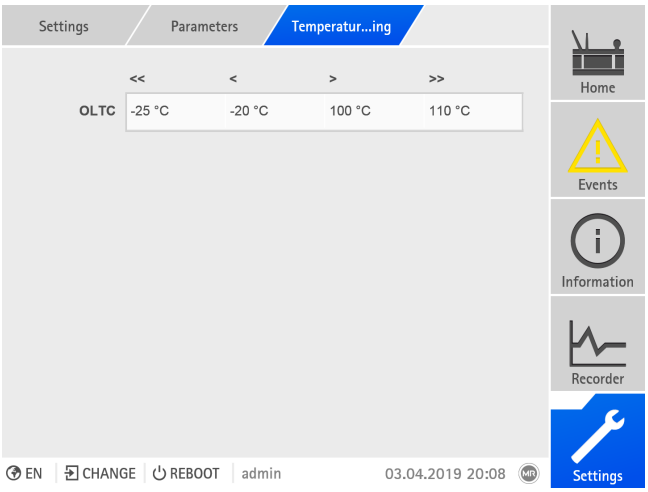


Figure 107: Temperature monitoring

► Go to **Settings** > **Parameter** > **Temperature monitoring**.

8.4 On-load tap-changer

8.4.1 Vibro-acoustic monitoring of the on-load tap-changer (VAM)

8.4.1.1 Setting VAM update guidelines

Using the update guidelines, you can define which tap-change operations are recorded and analyzed. You can select the following options:

Option	Description
Evaluation and statistics update	The tap-change operation is recorded, checked for plausibility and evaluated. The statistics update ensures the self-learning of the yellow limit value curve (envelope curve).
No statistics update	The tap-change operation is recorded, checked for plausibility and evaluated. The statistics are not updated. If a limit value curve has already been learned, limit value violations can nevertheless occur. In the event of doubt, contact the Maschinenfabrik Reinhausen GmbH Technical Service department.
No evaluation	The tap-change operation recording will not be analyzed or evaluated. The VAM analysis display does not show any information for this tap-change operation.

Table 59: VAM update guidelines

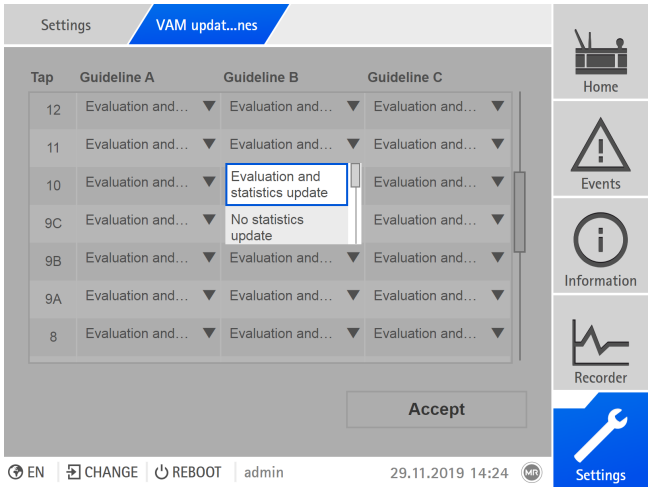


Figure 108: VAM update guidelines

1. Go to **Settings > VAM update guidelines**.
2. Select the desired tap position and, with multi-column application, the desired on-load tap-changer column (A, B or C).
3. Set the parameter.

4. Press the **Accept** button to save the modified parameter.

8.4.1.2 Displaying VAM analysis

For each recorded tap-change operation, you will receive the following information:

- Tap-change operation type
- Start position and end position of the tap-change operation.
- Time of the tap-change operation
- Status

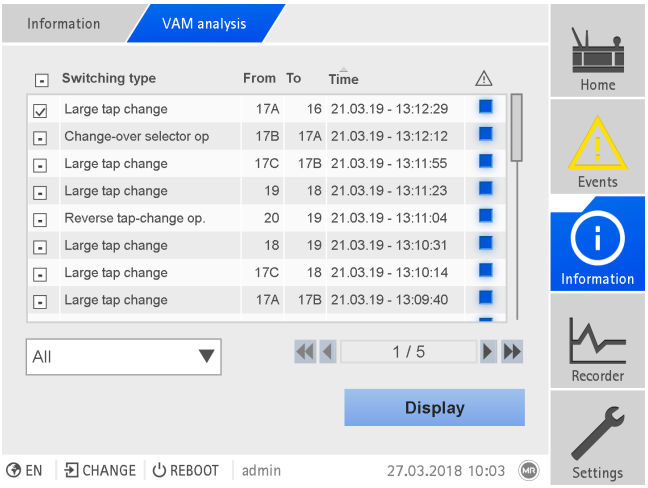


Figure 109: VAM analysis

► Go to **Information > On-load tap-changer > VAM analysis**.

Tap-change operation type

The monitoring system distinguishes between the following types of tap-change operations:

- Change-over selector operation: The change-over selector also changes in this tap-change operation.
- Small tap change: Tap selector operation in which the distance between the stationary selector contacts used for this tap-change operation is small.
- Moderate tap change: Tap selector operation in which the distance between the attached selector contacts used for this tap-change operation is moderate.
- Large tap change: Tap selector operation in which the distance between the attached selector contacts used for this tap-change operation is large.
- Reverse tap-change operation: Tap-change operation in which the tap changes in the opposite direction to the most recent tap-change operation and does not involve actuation of the selector.

Status information

Color code	Meaning
Blue	No anomalies: Plausibility criteria met and limit values not exceeded
Yellow	Limit value was exceeded
Gray	The evaluation could not be carried out

Filter options

Using the drop-down menu, you can limit the selection of tap-change operations to those of a specific tap-change operation type or to those involving a specific property.

- Selection according to tap-change operation type:
  - Change-over selector operation
  - Small, medium or large tap change
  - Reverse tap-change operation
- Selection according to property:
  - All
  - Marked
  - Evaluation ok
  - Anomalies
  - Without evaluation

Display of selected tap-change operations

To display individual tap-change operations with the associated VAM signal and the stored limit value as a curve, proceed as follows:

1. Place a check mark ☑ in the first column in front of the tap-change operation that is to be displayed as a curve. Up to 100 tap-change operations can be shown in the visualization via web browser. A maximum of 10 tap-change operations can be shown on the device display.
2. Confirm via the **Display** button.
   ⇨ They will be displayed differently depending on the number of selected tap-change operations.

If more than one tap-change operation is selected, then the limit value curve display will be omitted for the purpose of clarity:

Number of selected tap-change operations	1	2–100	>100
Display of VAM signal	Yes	Yes	No
Display of limit value curve	Yes	No	No

The following figure shows an example of the visualization of an individual tap-change operation:

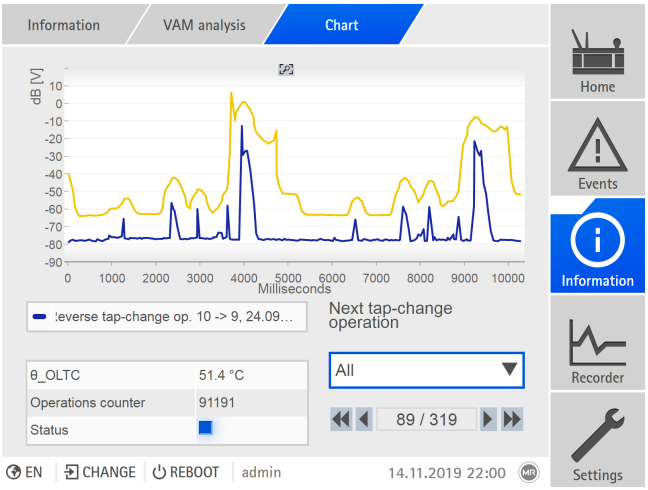


Figure 110: Display of a tap-change operation

The following figure shows an example of how multiple selected tap-change operations are shown at the same time:

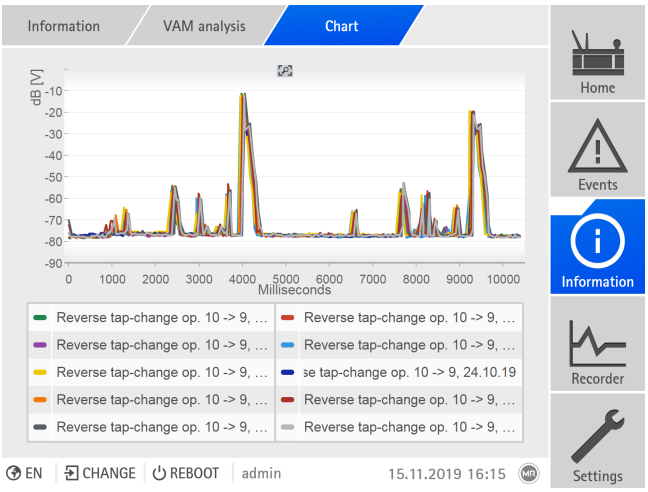


Figure 111: Display of multiple tap-change operations

If multiple tap-change operations are selected for the visualization, it is possible to hide or show individual tap-change operations by clicking on them in the key.

Using the web-based ISM™ Intuitive Control visualization allows you to zoom into an area of the signal. To do this, hold down the left mouse button and draw a frame around the desired area. To return to the original representation, click on the  symbol.

8.4.1.3 Resetting VAM

The software in the MSENSE® VAM monitoring system uses a self-learning algorithm which approximates the limit values towards the vibro-acoustic signal progression as the number of tap-change operations increases. The statistics stored for this can be reset in this display window.

Resetting the counter

The first and the second anomalies in an evaluation cluster are indicated via a yellow status message in the VAM analysis display. A third anomaly arising in an evaluation cluster triggers an additional event message. This event message is transmitted to a connected SCADA system.

By selecting "Counters", you reset the counters that are used to trigger the events for the vibro-acoustic evaluation. The learned statistics are retained.

Resetting the statistics

The stored statistics are used, among other things, to display the learned limit value (yellow curve [▶Section 4.6.1, Page 33]).

When you select "Statistics", you reset the learned statistics and the counters that are used to evaluate the vibro-acoustic signals.

1. Go to **Settings > Reset VAM**.
2. Select the desired option.
3. Press the **Accept** button to reset the values.

8.4.2 OLTC data

In this menu, you can set parameters for the on-load tap-changer (OLTC).

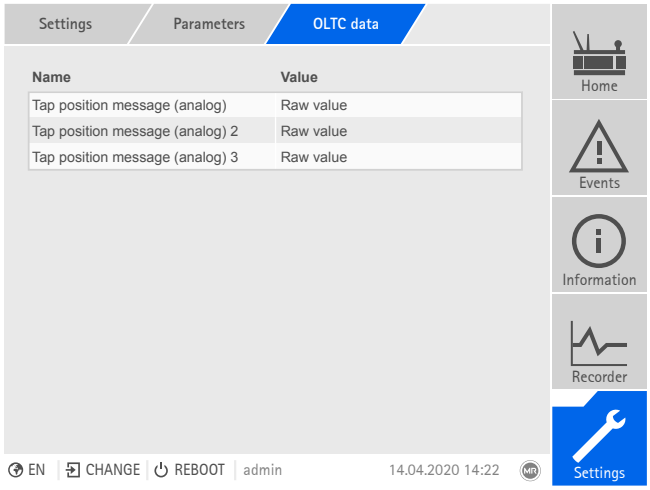


Figure 112: OLTC data

▶ Go to **Settings** > **Parameters** > **On-load tap-changer** > **OLTC data**.

8.4.2.1 Setting the tap position message (optional)

If you issue the tap position of the on-load tap-changer via an analog output or digital outputs (BCD, gray, etc.), you can set whether the device is to use the raw value or the adjusted value for the control system in accordance with the tap position table [▶Section 8.4.3, Page 151]. You can use this setting to ensure that pass-through positions of the on-load tap-changer are not reported as a separate tap position.

If you issue the tap position via several outputs, you can set this behavior for each output separately.

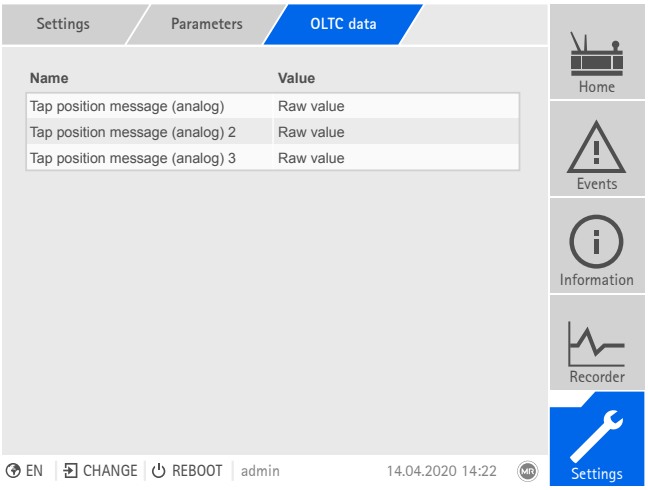


Figure 113: OLTC data (example with 3x tap position message via analog outputs)

1. Go to **Settings > Parameters > On-load tap-changer > OLTC data**.
2. Select the desired parameter.
3. Set the desired parameter.
4. Press the **Accept** button to save the modified parameter.

Tap position capture (optional):

The current tap position of the on-load tap-changer is transmitted from the motor-drive unit to the device. You can use this parameter to set whether the transmitted tap position should be interpreted as a raw value or according to the tap position table.

8.4.3 Changing tap position designation (optional)

This function allows you edit the designation of the tap position. The designations are displayed on the main screen when each of the tap positions is active and are used for the control system.

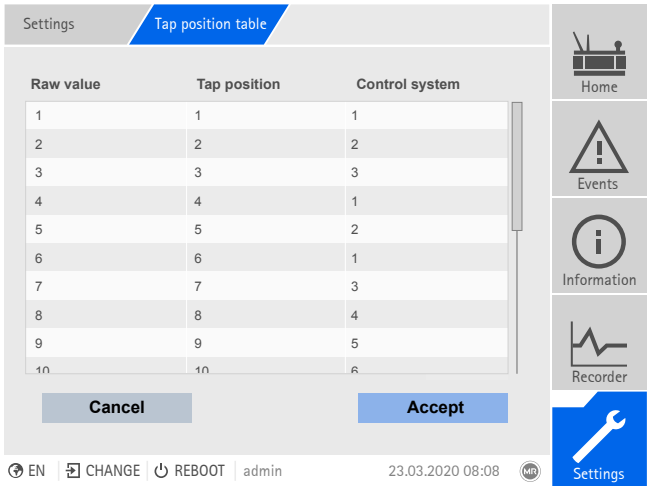


Figure 114: Tap position table

1. Go to **Settings > Tap position table**.
2. Enter the designation for the tap position and for the control system.
3. Click on the **Accept** button.

9 Inspection and maintenance

This chapter contains information about inspecting and maintaining the product.

9.1 Care

You can clean the VAM sensor, the VAM sensor adapter and the housing of the control cabinet with a dry cloth. You can clean the inside of the control cabinet with a dry cloth.

9.2 Inspection

Inspect the functionality of the signal lamp in the control cabinet once per year.

9.3 Maintenance

Maintenance of the monitoring system is not required However, check the state and functionality of the monitoring system as part of maintenance work on the transformer.

Technical Service

Maschinenfabrik Reinhausen GmbH
Technical Service
Postfach 12 03 60
93025 Regensburg
Germany
Phone: +49 94140 90-0
Fax: +49 9 41 40 90-7001
E-mail: service@reinhausen.com
Internet: www.reinhausen.com

10 Fault elimination

10.1 General faults

Characteristics/details	Cause	Remedy
No function ▪ Device not starting	No voltage supply	Check the voltage supply
	Fuse tripped	Contact Maschinenfabrik Reinhausen GmbH
Relay chatter	High EMC load	Use shielded cables or external filters
	Poor grounding	Check the functional ground

Table 60: General faults

10.2 Event messages

Event	Color code	Definition	Remedy
VAM: Recording running	gray	The recording starts at the beginning of the tap-change operation and ends when the vibro-acoustic data record is stored.	Wait until the recording is complete.
VAM: Recording not possible	yellow	Recording is not possible if the tap-change operation is invalid or there is a sensor error.	Check the function and wiring of the sensor, the tap position capture, the K1/K2 response contacts and the device configuration.
VAM: Recording being analyzed	gray	Recordings are being analyzed. Recordings are being analyzed. Results will be available after the analysis.	Wait until the analysis is finished.
VAM: Sensor signal invalid	yellow	Sensor data invalid.	Check the function and wiring of the sensor.
VAM: Anomalies in the switching pattern	yellow	A switching pattern anomaly was detected by the monitoring system when evaluating the vibro-acoustic signals.	Check the error details and evaluation and send them to MR Service.
VAM: Evaluation not possible	yellow	The vibro-acoustic signals cannot be analyzed due to additional influences.	Verify that the sensor is positioned correctly and avoid signal interruptions. Export the error details and evaluation and send them to MR Service.

Table 61: Event messages

10.3 Human-machine interface

Characteristics/details	Cause	Corrective measure
No display/screen is loaded	Power supply interrupted.	Check the voltage supply.
	Error when loading the current screen in the browser.	Press [F5] key to update the screen.
	Fuse faulty.	Contact Maschinenfabrik Reinhausen.

Characteristics/details	Cause	Corrective measure
Connection cannot be established with visualization	Connection cable defective.	Check connection cable.
	IP addresses of visualization and SCADA are in the same subnet.	Check the setting of the IP addresses of the device and correct where necessary.
	PC not in same subnet as visualization.	Check the setting of the IP addresses of the device and PC and correct where necessary.
Browser displays an SSL warning when establishing a connection to the visualization.	The browser does not accept an SSL connection with a signed certificate that is non-public (this is the default status of the device).	Import signed SSL certificate or adjust browser settings.
	The device SSL certificate has expired.	Import SSL certificate.
	The device date/time is set incorrectly.	Set the date and time.
		When using time synchronization via SNTP: check SNTP server.
	IP address of interface ETH2.2 has changed.	Import SSL certificate with new IP address ("Alternative applicant name").

Table 62: Human-machine interface

10.4 Other faults

If you cannot find a solution to a malfunction, please contact Technical Service and have the following information available:

- Serial number
  - Nameplate (can be found on CPU assembly)
- Software version

Please provide answers to the following questions:

- Has the software been updated?
- Has there previously been a problem with this device?
- Have you previously contacted Maschinenfabrik Reinhausen about this issue? If yes, then who was the contact?

Technical Service

Maschinenfabrik Reinhausen GmbH
Technical Service
Postfach 12 03 60
93025 Regensburg
Germany
Phone: +49 94140 90-0
E-mail: service@reinhausen.com
Internet: www.reinhausen.com

You will find an overview of the services available for the product in the customer portal: https://portal.reinhausen.com

11 Disassembly

⚠ DANGER

Electric shock!

Risk of fatal injury due to electrical voltage. Always observe the following safety regulations when working in or on electrical equipment.

- ▶ Disconnect the equipment.
- ▶ Lock the equipment to prevent an unintentional restart.
- ▶ Make sure all poles are de-energized.
- ▶ Ground and short-circuit.
- ▶ Cover or cordon off adjacent energized parts.

The following describes how to remove the control cabinet safely.

1. Disconnect the control cabinet from the supply voltage.
2. **⚠ WARNING!** Electric shock! Depending on the product version, there can also be dangerous residual voltages present in the control cabinet even after the supply voltage has been shut off which could lead to serious injuries. Wait at least five minutes and ensure that the control cabinet is de-energized.
3. Disconnect all connection lines (sensor cable, control cable to the motor-drive unit, customer cables, grounds etc.) in the control cabinet.
4. Close the control cabinet door.
5. **⚠ WARNING!** Attach the lifting gear to the control cabinet lifting eyes and ensure that the lifting gear cable angle does not fall below 45° relative to the horizontal.. Otherwise, the control cabinet may become damaged and serious injuries may result.

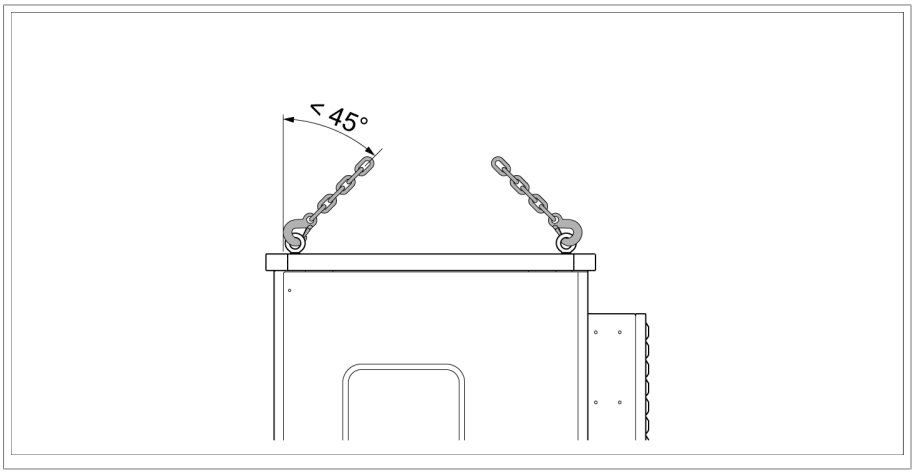


Figure 115: Removing the control cabinet

6. **⚠ WARNING!** Remove and lower the control cabinet using the lifting gear. While doing so, ensure that the lifting gear cable angle does not fall below 45° relative to the horizontal. Otherwise, the control cabinet may become damaged and serious injuries may result.

⇨ The control cabinet is removed.

12 Disposal

Observe the national requirements applicable in the country of use.

13 Technical data

13.1 Control cabinet standalone version

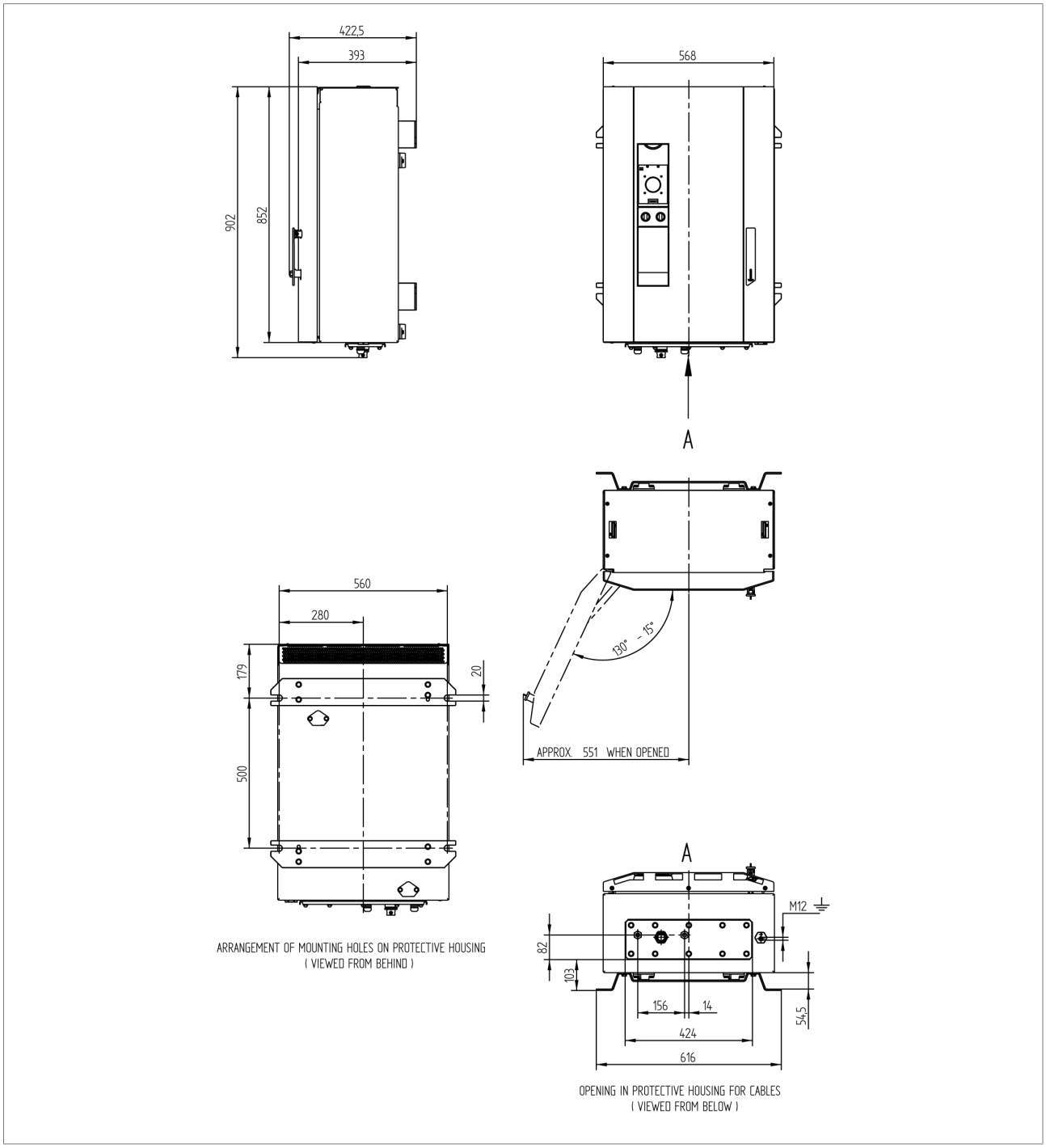


Figure 116: Dimensions of the control cabinet (MSENSE® VAM)

Control cabinet	MSENSE® VAM
Dimensions (width x height x depth)	616 x 848 x 420 mm
Power consumption	Max. 11.3 A
Voltage supply	220...240 V AC
Frequency	50 Hz
Heating power	130 W (controlled)
Plug socket	220...240 V AC, max. 10 A
Permitted ambient temperature during operation	-25 °C...+50 °C
Degree of protection (DIN EN 60529)	IP 66
Weight	Approx. 53 kg

Table 63: Technical data for the control cabinet

13.1.1 Connection terminals

Terminal block	Maximum permitted operating voltage
X1	Max. 250 VAC
X10	Max. 150 VAC

Table 64: Maximum permitted operating voltage of the connection terminals for external circuits

13.2 Power supply QS3.241

	PULS QS3.241
Permissible voltage range	85...276 VAC 88...375 VDC U_N: 100...240 VAC U_N: 110...300 VDC
Permissible frequency range	50/60 Hz
Maximum power consumption (continuous)	66 W

Table 65: QS3.241 assembly technical data

13.3 CPU (central processing unit) II

	CPU II
Processor	433 MHz
RAM	256 MB
Interfaces	1x serial RS232/485 (electrically isolated) 3x Ethernet 10/100 Mbps 1x USB 2.0 1x CAN (electrically isolated) 1x CAN
NVRAM (SRAM with battery backup)	512 kB
Application memory	Max. 4 GB
Power supply	+24 V DC (18...36 V DC)
Power consumption	Max. 22 W

Table 66: Technical data for the CPU II assembly

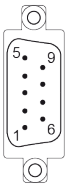
Interface	Pin	Description
	2	RXD (RS232)
	3	TXD (RS232)
	5	GND (RS232, RS485)
	6	RXD+/TXD+ (RS485)
	9	RXD-/TXD- (RS485)

Table 67: COM2 (RS232, RS485)

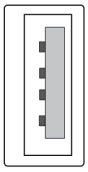
Interface	Pin	Description
	1	VCC
	2	D-
	3	D+
	4	GND

Table 68: USB 2.0

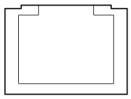
Interface	Pin	Description
	1	TxD+
	2	TxD-
	3	RxD+
	4	NC
	5	NC
	6	RxD-
	7	NC
	8	NC-

Table 69: ETH1, ETH 2.1, ETH 2.2 (RJ45)

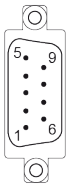
Interface	Pin	Description
	2	CAN-L
	3	CAN-GND
	7	CAN-H

Table 70: CAN1, CAN2

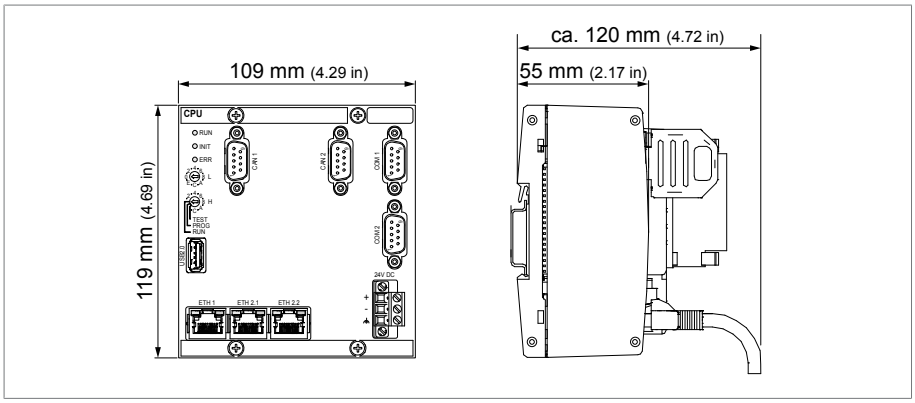


Figure 117: CPU dimensions

Optional accessories	
CAN bus	Terminating resistor ▪ D-SUB plug connector (9-pole) ▪ R = 120 Ω
	Connector with terminal strip for directly connecting CAN lines
Media converter for COM2 interface (only RS232)	Adapter from D-SUB (9-pole) to fiber-optic cable: ▪ ACF660/ST: F-ST, 660 nm, range max. 60 m at 40 kBd ▪ ACF660/SMA: F-SMA, 660 nm, range max. 60 m at 40 kBd ▪ ACF850/ST: F-ST, 850 nm, range max. 1,000 m at 40 kBd ▪ ACF850/SMA: F-SMA, 850 nm, range max. 1,000 m at 40 kBd

Table 71: Optional accessories

13.4 DIO 28-15 digital inputs and outputs

		DIO 28-15
Inputs (plug-based electrical isolation)	Quantity	28
	Logical 0	0...10 V AC (RMS) 0...10 V DC
	Logical 1	18...260 V AC (RMS) 18...260 V DC (RMS)
	Input current	min. 1.3 mA
	Simultaneity factor (at 70°C ambient temperature and input voltage ≥ 230 V)	max. 50%
Outputs (floating relay outputs)	Number (number of change-over contacts in parentheses)	15 (9)
	Contact load capacity	Alternating current mode: U_N: 230 V AC; I_N: 5 A Direct current mode: See diagram
	Simultaneity factor (if output is loaded with 5 A)	Up to 60°C: 100%, > 60°C: -5%/K

Table 72: Technical data for the DIO 28-15 assembly

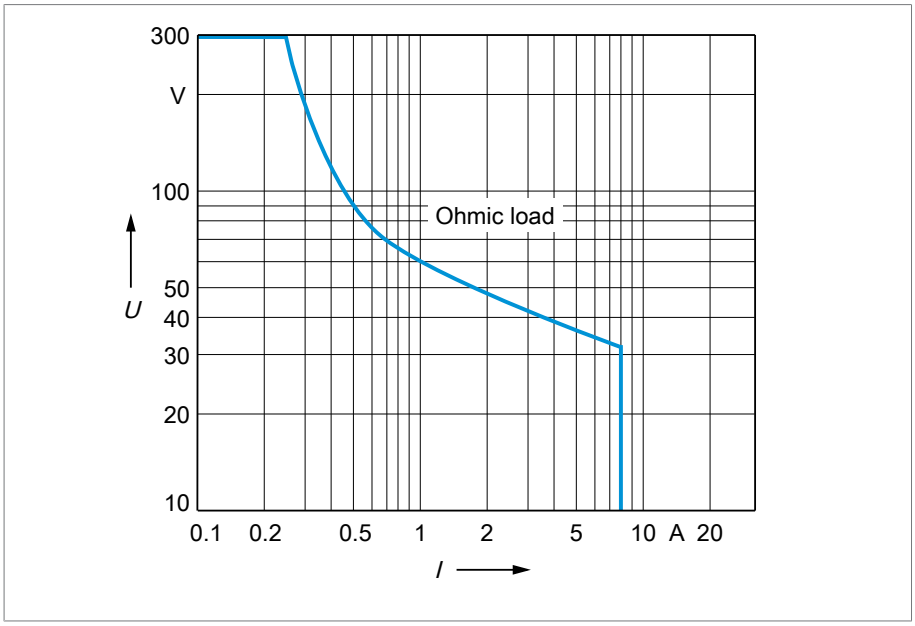


Figure 118: Contact load capacity of digital outputs with resistive load

⚠ CAUTION

Electric shock!

The inputs of the DIO assembly have plug-based electrical isolation. A mixture of voltage ranges (e.g. extra low voltage and low voltage) or various phases within a plug can lower the protection against electric shock.

► Use the same voltage ranges within a plug.

► Use the same phase within a plug.

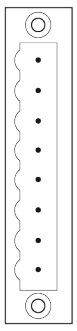
Interface	Pin				Description
	1	9	17	25	Input
	2	10	18	26	Input
	3	11	19	27	Input
	4	12	20	28	Input
	5	13	21	29	Input
	6	14	22	30	Input
	7	15	23	31	Input
	8	16	24	32	Common

Table 73: Digital inputs

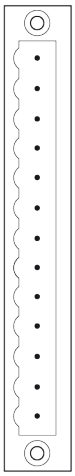
Interface	Pin			Description
	1A	6 A	11 A	Break contact
	1C	6C	11C	Source contact
	1B	6B	11B	Make contact
	2 A	7 A	12 A	Break contact
	2C	7C	12C	Source contact
	2B	7B	12B	Make contact
	3 A	8 A	13 A	Break contact
	3C	8C	13C	Source contact
	3B	8B	13B	Make contact
	4C	9C	14C	Source contact
	4B	9B	14B	Make contact
	5C	10C	15C	Source contact
	5B	10B	15B	Make contact

Table 74: Digital outputs

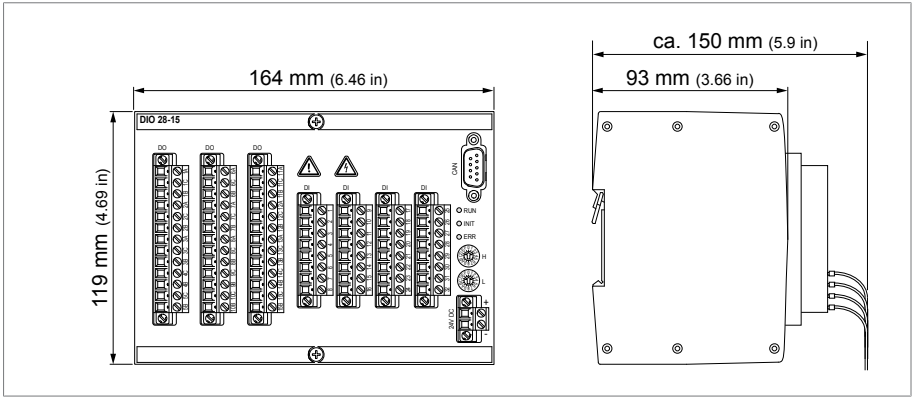


Figure 119: DIO 28-15 dimensions

13.5 AIO 2 analog inputs and outputs

Channels (input or output)		2
Inputs	Measuring range	0...10 V 0...20 mA 4...20 mA
	Load resistance (0/4...20 mA)	Max. 300 Ω

Outputs	Signal range	0...10 V 0...20 mA 4...20 mA
	Load resistance (0/4...20 mA)	Max. 500 Ω
Resistor contact series		Maximum resistance 100 Ω...10 kΩ, max. 35 tap positions

Table 75: Technical data for the AIO 2 assembly

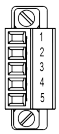
Interface	Pin		Description
	1	6	I OUT (+): Current output +
	2	7	I/U IN (+) U OUT (+): Voltage input +, current input +, voltage output +
	3	8	I/U IN (-): Voltage input -, current input -
	4	9	I/U OUT (-): Voltage output -, current output -
	5	10	Not used

Table 76: Analog inputs and outputs

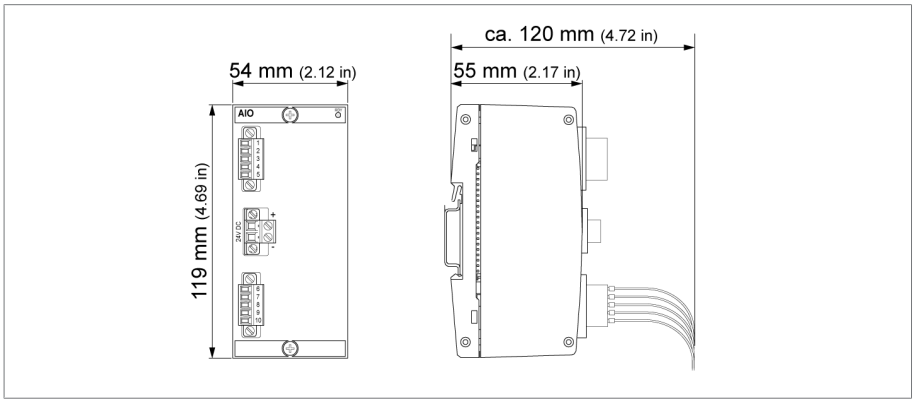


Figure 120: AIO 2 dimensions

13.6 VI 4 vibration sensor input module

	VI 4
Analog inputs	For vibration sensors based on the IEPE standard
Input voltage	24 V DC
Power consumption	Max. 200 mA
Operating temperature	-25 °C...+70 °C
Relative humidity operation	5…95% non-condensing

	VI 4
Storage temperature	-40 °C...+85 °C
Relative humidity storage	5…95% condensing

Table 77: VI 4 vibration sensor input module

13.7 VS 1 vibration sensor

	VS 1
Sensor type	Piezo vibration sensor
Housing	Hermetically sealed
Working temperature	-50°C…+125°C
Protection class	IP67 in accordance with IEC 60529
Resistance to corrosion	316L, stainless steel

Table 78: VS 1 vibration sensor

13.8 Sensor cable

	Sensor cable
Ready for use on one side	Plug in an angled design with 5-pole M12 socket for connection to the VS 1 sensor
Degree of protection	When screwed on: IP68 in accordance with IEC 60529
Permissible operating temperature range, fixed routing	-40°C…+105°C
Permissible operating temperature range, flexible routing	-20°C…+105°C
Properties	Halogen-free, silicon-free, oil-resistant, UV-resistant
Flame resistance	In accordance with UL 758/1581 FT2
Shielding	Drain wire and shielding connected to union nut

Table 79: Sensor cable

Glossary

EMC

Electromagnetic compatibility

GPI

General Purpose Input

GPO

General Purpose Output

IP

Internet Protocol

PRP

Redundancy protocol in accordance with IEC 62439-3 (Parallel Redundancy Protocol)

RSTP

Redundancy protocol in accordance with IEEE 802.1D-2004 (Rapid Spanning Tree Protocol)

SCADA

Technical processes are monitored and controlled using a computer system (Supervisory Control and Data Acquisition)

SNMP

SNMP (Simple Network Management Protocol) is a protocol for managing network devices.

SNTP

NTP (Network Time Protocol) is a standard for synchronizing clocks in computer systems using packet-based communication networks. SNTP (Simple Network Time Protocol) is the simplified version of NTP.

TPLE

Transformer Personal Logic Editor

List of key words

P

Q

R

S

T

U

V

W

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8459861/03 EN - MSENSE® VAM -
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