ContaminationSensor

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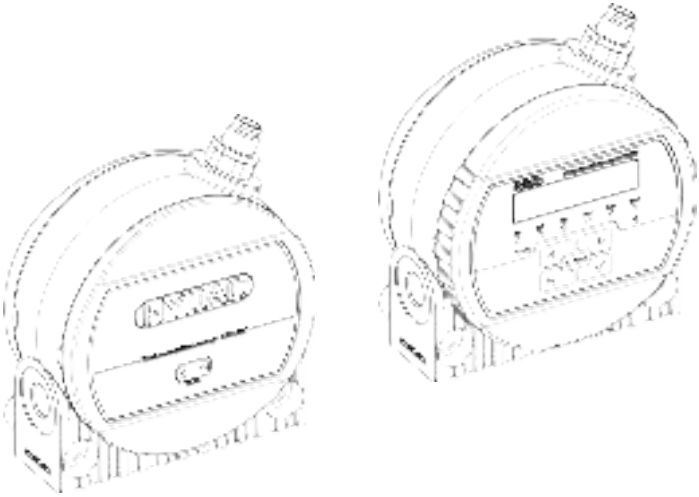
CS15xx-1-x
with RS485 interface

Valid from series no.	0002S04513K0015000
Valid from hardware index	A
Valid for firmware versions	1.10 – …



Operating instructions

4851498c / 2025-04

HYDAC INTERNATIONAL

EN

Translation / original language: German

This manual was prepared to the best of our knowledge. Nevertheless, and despite the greatest care, it cannot be ruled out that mistakes could have crept in. Please therefore understand that, unless stated otherwise below, our warranty and liability – irrespective of the legal grounds – are excluded in respect of the information in these instructions. In particular, we are not liable for loss of profit or other financial losses.

This exclusion of liability does not apply in cases of intent or gross negligence. Moreover, it does not apply to defects that were fraudulently concealed or whose absence was guaranteed, or in cases of culpable injury to life and limb and harm to health. If we negligently breach any material contractual obligation, our liability shall be limited to the foreseeable damage. Claims arising from product liability remain unaffected.

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Contents

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1. General

Before you use this product for the first time, read this manual at least up to the chapter "Operation". If you would like to carry out maintenance or troubleshooting, you can find the procedure in the respective chapters.

The use and the handling of the product as well as its use are not self-explanatory and are described in detail in this manual.

This manual will help you to use the product as intended, properly, effectively, and safely. Please refer to it every time you require specific details or actions.

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Validity of this manual

The diagrams and visualizations in this manual are meant for general illustration purposes. Therefore, representations and functional options can deviate from the delivered product.

We reserve the right to modifications to the contents of this manual without prior notice.

1.1 Target group of the manual

This manual was created for the following target group:

Target group	Tasks
Owner	Keep this manual and the applicable documents at the installation location of the product and also for later use. Ask the employees to read and follow the manual and the associated documents, in particular, the safety and warning instructions. Additionally, please observe the product-related instructions and requirements.
Operator, specialist personnel	Read, observe and follow this manual and the associated documents, in particular, the safety and warning instructions.

Tab. 1: Target groups

1.2 Illustrations in the manual

You will find illustrations in this manual. You can find details regarding these in the following chapters.

1.2.1 Depiction of warning signs

Information that draws your attention to specific or potential hazards is presented as warnings in these instructions.

Function of warnings

Warnings serve to protect you from accidents and injuries when handling the product and to prevent material and environmental damage.

Read and observe the warnings carefully and follow the specified steps precisely.

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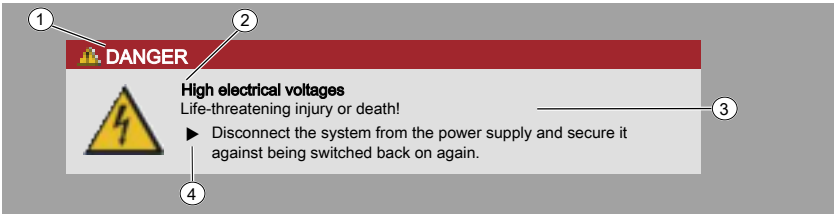
Warnings visually highlighted in boxes

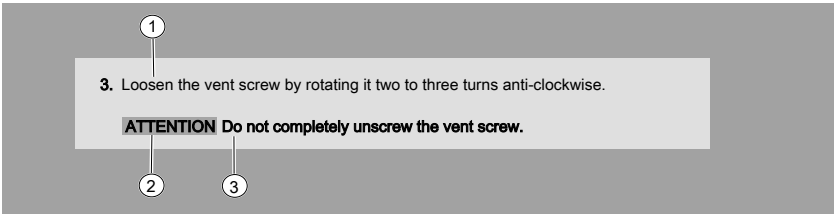
Warnings visually highlighted in boxes provide the following information in connection with a hazard:



1	**Warning level** How high is the risk potential? (▸Tab. 2, p. 7)	2	**Type and source of the hazard** What is the specific danger? What is the source of the danger?
3	**Consequences if not observed** What are the consequences if you fail to observe the instructions given in the warning (**4**)?	4	**Actions to be taken** What do you have to do specifically to safely eliminate the hazard?

Warnings integrated into the text

Warnings are sometimes integrated into the body of the text to keep the content easy to read. Example:



1	**Context** An action step in this example	2	**Warning level** How high is the risk potential? (▸Tab. 2, p. 7)
3	**Safety information** What do you have to do specifically to safely eliminate the hazard?		

Warning levels

The warning level in a warning gives you information on the risk potential associated with a hazard and failure to observe the appropriate warning.

Warning level	What this means for you
DANGER	Warns of dangers for **people** with a **high risk potential**. Failure to observe this warning is highly likely to result in serious injury or even death.
WARNING	Warns of dangers for **people** with a **medium risk potential**. Failure to observe this warning may result in serious injury or even death.
CAUTION	Warns of dangers for **people** with a **low risk potential**. Failure to observe this warning may result in minor to moderate injury.
ATTENTION	Warns of **property damage** with a **high risk potential**. Failure to observe this warning may result in serious property and environmental damage.

Tab. 2: Depiction of the warning levels

1.2.2 Representation of requirements

These are absolutely required for carrying out a work activity on the product and are marked with a check mark and are in bold in the text.

An example for the representation of requirements:

✓ The product is assembled and connected.

✓ The product is switched off.

1. Switch the product on.
2. Select an operating mode.
3. Switch the product off.

1.2.3 Representation of procedural instructions

In the case of procedural instructions, there are the two following representations:

Procedural instructions with a fixed sequence

Procedural instructions, the order of which must be strictly adhered to, are listed with sequential numbering (1., 2., 3., etc.).

An example for procedural instructions with a fixed sequence:

1. Remove the transport securing device.
2. First fill the product.
3. Switch the product on.

Procedural instructions with a random sequence

Procedural instructions with a random sequence are listed as bullet points.

An example of a procedural instruction with a random sequence:

- Clean the display.
- Rinse the product.

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1.2.4 Representation of intermediate results/results

In the case of some activities, it is necessary to carry out work steps with intermediate results and end results.

Intermediate results are the consequence of activities; they are marked with an indented arrow.

End results represent the end of an activity and are represented with a flag.

An example for a procedural instruction with intermediate result and final result:

1. Switch the product on.
   ⇨ The display lights up.
2. Press the button.

⚐ The product is ready for use.

1.2.5 Supplementary symbols

You will find the following symbols in the manual as additional details:

[▶##] Cross reference to a page/a chapter/a section or another document.

Glossary Terms in grey are explained in detail in the glossary, a chapter at the end of the manual.


Required tool.


Information for handling the product.

1.3 Warranty

For the warranty provided by us, please refer to our terms of delivery. They are made available to you at the conclusion of the contract at the latest. They can also be found at www.hydac.com -> General Terms and Conditions.

1.4 Notes on copyright

2. For safety

This section gives you important information on the safe handling and use of your product.

2.1 Intended use

The ContaminationSensor is used for continuous monitoring of fluid cleanliness in hydraulic and lubricating oil systems.

Intended use includes:

- Operation within the permitted operating conditions
- Adhering to all of the instructions in the operating instructions

Improper use / foreseeable misuse

Any other use, or use that goes beyond that indicated, is not permitted and is therefore considered improper use.

Improper use includes in particular:

- Operation outside of the permitted operating conditions

Claims for defects or liability

Claims for defects or liability – on whatever legal grounds – do not exist, particularly in the event of incorrect or improper installation, commissioning, use, handling, storage, maintenance, repair, use of unsuitable components or other circumstances for which the manufacturer is not responsible.

The manufacturer assumes no responsibility for determining the interfaces for installation in a system or the installation, use or functionality of the product in this system.

2.2 Obligations of the owner

As the operator, you have the following obligations in relation to the use of our product:

Instruction and training

- Provision of these instructions
  The operator must ensure that all employees who are assigned work on the product have read and understood these instructions.
- Regular training on correct use of the product and on the residual hazards associated with the product (▸Sec. 2.4 "General safety instructions")
- Readability of the warning signs on the product
  Warning signs that have become illegible must be replaced by the operator.

Occupational health and safety

- Creation of own risk assessment and implementation of required measures
  The operator must determine in their own risk assessment the sources of danger arising from the product being used in their machine or system. On this basis, the operator must independently define appropriate measures for safety of the machine or system and must compile the documentation of their product accordingly.
- Application of the occupational health and safety and accident prevention regulations applicable in the country of use

- Clear regulation of which people are responsible for the various types of activities (e.g. assembly, operation, troubleshooting, maintenance) and what qualifications they need to have
- Provision of personal protective equipment (▸Sec. 2.6 "Personal protective equipment")

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Compliance with standards and regulations

- Observance of the statutory inspection intervals for the system
  The operator must document the results of inspection in an inspection certificate and retain this certificate until the next inspection.
- Compliance with the environmental protection regulations applicable in the country of use

Cybersecurity / security concept for secure integration and configuration

The product offers up to two TCP/IP-based communication interfaces: a point-to-point WLAN connection (Access-Point Mode) and a LAN interface. Both interfaces are physically and logically separated from one another, meaning that direct communication between them is not possible. To ensure security when configuring and integrating the product into your system landscape, we recommend observing the following security measures:

- General safeguards
  - Firmware updates:
    Make sure that the sensor product is always operated with the latest firmware. Check regularly for available updates and install them as protection against known security vulnerabilities.
  - Supplementary information is available here ▸Sec. 3.1 "Supplementary product information — scan QR code".
  - User guide:
    Read the user manual carefully before operating the device and follow the instructions.
  - Access restrictions:
    Make sure that physical access to the device and its interfaces is limited to authorised individuals.
- Security of the WLAN interface (Access-Point Mode)
  - Changing SSID and password:
    Change the preset SSID and the default password of the access point to a strong, unique password. Avoid simple and easy-to-guess passwords.
  - Encryption:
    Enable encryption for the WLAN connection to prevent unauthorised access.
  - Disable the access point:
    After completing configuration and integration of the device, we recommend disabling the access point if it is no longer required.
  - Please note that if the WLAN is switched off, it will also no longer be possible to use the web UI via WLAN.

- Security of the LAN interface
  - Network segmentation: To minimise potential attack vectors on other systems, integrate the product in a separate network segment designed specifically for IoT products.
  - Firewall rules: Configure your firewall so that only the required ports and protocols are open for communication with the product. Block any connections that are not required.
  - For a list of ports used, see the relevant product description.
  - Access restrictions: Make sure that access to the LAN interface for the product is only possible for authorised systems or users.
  - Logging and monitoring: Enable logging of network activities and monitor any unusual or suspicious activities in order to detect security incidents at an early stage.
- Web UI security
  - HTTPS via LAN:
    In order to safeguard the product via HTTPS, the use of a reverse proxy is recommended. This ensures that communication takes place via HTTPS when using the Web UI via LAN in order to protect the data from interception and manipulation.
  - User roles and access permissions:
    Use the functionality available in the Web UI for managing user roles and access permissions to ensure that only authorised users can modify certain settings.
  - Session-Timeout:
    Enable automatic logoff (Session Timeout) in the event of inactivity in order to prevent unauthorised access via unmonitored sessions.
  - Regular password changes:
    Users should be prompted to change their password regularly and must observe strong password policies.
- Continuous security evaluation
  - Regular security checks:
    Carry out regular security checks and penetration tests to identify and resolve any system vulnerabilities promptly.
  - Update security guidelines:
    Adapt your security guidelines in response to new threats and technological developments.

Report security incidents

Create an emergency plan to cover the eventuality of a security incident and make sure that everyone involved knows how to respond. In case of a security incident involving the product, contact the following organisation:

HYDAC Incident Management

Email: info@certvde.com

2.3 Personnel qualifications

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The activities described in these instructions may only be carried out by individuals with specific specialist knowledge in the areas listed below:

Activity	Qualification
Transport / storage	• Specialist personnel for transportation and storage
Assembly	• Specialist personnel for electric and mechanical systems
Initial commissioning	
Maintenance	• Specialist personnel for hydraulics and mechanical systems
Troubleshooting	
Repair	
Shutdown	
Disassembly	
Disposal	
Handling, operation, operation monitoring	• Operating personnel
IT security Cyber Security	• Specialist personnel for IT security, network or IT administrator with appropriate authorisations

Requirements for specialist personnel:

- Specialist training, knowledge and experience in the mentioned area
- Knowledge of the relevant provisions.
- Knowledge about how to handle operating media.
- These individuals can assess work assigned to them, identify possible hazards and take suitable safety measures independently.
- For transport and storage: Safe handling / operation of lifting equipment and accessories.

Requirements for operating personnel:

- These individuals have received product-related instruction from the owner and have been informed of potential hazards arising from improper conduct.
- Knowledge about how to handle operating media.

Requirements for IT administrator:

- Extensive knowledge of IT security
- Administrator rights

2.4 General safety instructions

We develop our products in accordance with the latest technological developments. Nevertheless, it is impossible to design products in a way that eliminates all residual risks. An overview of the potential sources of danger is provided below.

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2.4.1 Hazard symbols/pictograms

The following safety signs / pictograms can be found in this manual. They indicate specific dangers to persons, property or to the surroundings. Observe these safety signs / pictograms and act with particular caution in such cases. Always keep all safety signs / pictograms complete and legible.

Warning signs used

These marks can be found for all safety and warning instructions in this manual which indicate particular dangers to persons, property or the environment.

Danger point warning

Signs used for giving orders

These symbols can be found for all safety and warning instructions in this manual which indicate particular dangers to persons, property or the environment.

Follow the direction.

Follow the instructions.

Used GHS symbols

These symbols can be found for all safety and warning instructions in this manual which indicate particular dangers to persons, property or the environment.

Hazardous to the environment

Signs used for the required specialist personnel

These symbols show the required training/knowledge for installation work and/or maintenance work.

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Specialist personnel – General/Operating personnel

These persons have a specialist training and several years of work experience. They are able to assess and perform the work assigned to them and to recognise potential hazards.

Specialist personnel – Electrical

These persons have specific specialist training and several years of work experience. They are able to assess and perform the work assigned to them and to recognise potential hazards.

Specialist personnel – Mechanical

These persons have specific specialist training and several years of work experience. They are able to assess and perform the work assigned to them and to recognise potential hazards.

Specialist personnel – Service/Administrator

These persons have been trained by the manufacturer and are authorised to perform service.

2.4.2 Dangers during the life cycle

The following dangers can occur in the various life cycles of the product:

Life cycle – transportation / storage

The following hazards can arise during the transport / storage life cycles:

NOTICE

Unsecured transport

The connector will be damaged.

- ▶ Transport the sensor in its original packaging.
- ▶ Secure the sensor during transport.

Life cycle – start-up / operation

The following dangers can arise during the start-up / operation life cycle:

DANGER

Danger due to unintended use

Bodily injury / Damage to property

- ▶ Use the product only with permitted operating media and only under permissible operating conditions.

NOTICE

Impermissible operating conditions or operating fluid.

The product will be damaged.

- ▶ Take note of the permitted operating modes.
- ▶ Note the permissible operating conditions.

2.5 Warning signs on the product

The following warning signs are displayed on the product, warning of specific dangers:

	Danger – electrical voltage
	Danger – hot surfaces
	Crushing hazard
	Danger – strong magnetic fields

2.6 Personal protective equipment

Personnel are required to wear protective equipment for certain activities.

The specific protective equipment required in each case is identified in the corresponding sections.

Required protective equipment – an overview

	Eye protection
	Protective gloves

Additional protective measures

- In addition, observe the notices regarding personal protective equipment in the safety data sheets of the operating medium.

3. Product and technical specifications

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The ContaminationSensor in the CS1500 range is the latest generation of the HYDAC online fluid sensor for continuous recording of solid contamination in fluids.

The version of the cleanliness classes can be selected either according to ISO/SAE or ISO/NAS. The digital interface makes operating the ContaminationSensor with mobile devices easier and more intuitive.

The field of application is now also being expanded to include new industry-standard communication interfaces such as Ethernet and CAN.

Applications

- Industrial hydraulic and lubrication systems
- Mobile hydraulics

Advantages

- Early detection of critical machine conditions
- Continuous oil condition monitoring
- Condition-based maintenance planning
- Easy operation and integration, both locally and as a cloud solution
- Secure operation thanks to smart functions such as turbidity detection
- Excellent cost effectiveness

3.1 Supplementary product information — scan QR code

For additional up-to-date product information, such as instructions and certificates, or to find product tips and tricks on our home page, scan the QR code on the product label.

The QR code takes you to the digital product file, where you can download the latest documents, such as:

- Operating instructions
- Calibration certificate
- CE declaration
- Overview sheet with factory settings for the ContaminationSensor and the WLAN password
- Cyber Security for network-compatible devices, information for the operator
- Firmware

3.2 Checking the scope of supply

Here you will find the scope of supply for the product.

- Check the packaging and the product for damage.
  Report any damage in transit to the forwarding agent or the HYDAC department in charge.
- Check the scope of supply for completeness.

The scope of supply includes:

Qty.	Designation
1	ContaminationSensor CS15xx (model as per order – see model code)
2	O-ring (Ø 4.8 * 1.78 mm, 80 Shore) (Only for connection type *flange connection* = model code: CS15xx-x-1 /-xxx)
1	Quick guide

Tab. 3: Checking the scope of supply

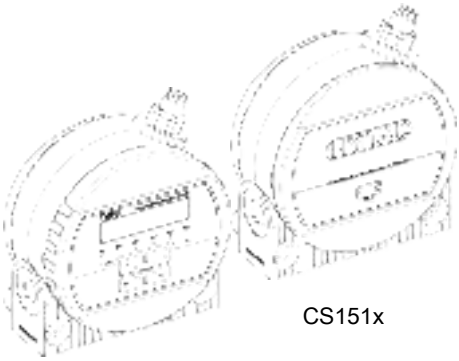

Fig. 1: Checking the scope of supply

3.3 Characteristics

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If you are aware of the technical data of the product, you will be able to use it optimally.

General data	
Operating media	• CS15x0-…: Mineral oil based raffinate • CS15x1-…: phosphate esters
Smart features	• Display of the last 10 events as a histogram via the digital user interface • Adaptive measuring cycles for very clean fluids and changing measuring conditions • Self-diagnostics – continuous with error display via LED, display and digital interface
Digital interface	• Wireless configuration and operation via smartphone • Visualisation of measurement data and sensor status • Cleanliness limit assistant • Log memory data • Creation of reports in PDF format
Installation position	Optional (Recommendation: vertical flow direction)
Flow direction	Any
Display (CS152x only)	LED, 6 figures, each with 17 segments
Measurement variables	• ISO classes (>4µm >6µm >14µm >21µm) only ISO code on display (>4µm >6µm >14µm) SAE (SAE AS 4059) or • ISO classes (>2µm >5µm >15µm >25µm) only ISO code on display (>2µm >5µm >15µm) NAS (NAS 1638)
Service variables	• Flow (status display), for details, see. ▸Fig. , p. 41. • Drive (%) • Temp (°C) or (°F)
Permissible ambient temperature range	-30 … 80 °C / -22 … 176 °F

General data	
Permitted storage temperature range	-40 … 80 °C / -40 … 176 °F
Permitted relative humidity	≤ 95%, non-condensing
Sealing material	
• CS15x0	FPM / FKM
• CS15x1	EPDM
Protection class	III (safety extra-low voltage)
Protection class according to DIN 40050 / EN 60529 / IEC 529 / VDE 0470	IP 67 (for screw-fitted connector plug)
Pollution degree	1 pursuant to EN 61010-1 [1)]
Operating height / altitude	≤ 5000 m above sea level
Weight	≈ 1.3 kg

[1)] Inside the housing.

Tab. 4: Technical data – General

Hydraulic data	
Measurement range	From 20 ... 32,000,000 particles per 100 ml corresponds to ISO class 4 to 25
Accuracy	±½ ISOclass in range ISO13/11/10 ... 23/21/18
Permitted operating pressure	≤ 350 bar / ≤ 5075 psi
Hydraulic connection	• Threaded connection, G¼ in accordance with ISO228 • Flange connection, DN 4
Permitted measured flow rate	30 … 500 ml/min
Permitted viscosity range.	1 … 1000 mm²/s
Media temperature range	0 … 85 °C / 32 … 185 °F

Tab. 5: Technical data – hydraulic data

Electrical data	
Connection plug	M12x1, pursuant to IEC 61984 / DIN VDE 0627, for more information see communication interfaces.
Supply voltage	24 V DC ± 10%, residual ripple < 10 %
Power consumption	5 watts (plus connected loads such as switching output or analogue output)

Tab. 6: Technical data – electrical data

Radio interface	
W-LAN	2.4 GHz, IEEE 802.11 b/g/n
, FCC ID:	For details, see ▸Sec. 11.4 "Approvals".
IC:	For details, see ▸Sec. 11.4 "Approvals".
PMN:	CS1500

Tab. 7: Technical data - radio interface

Communication interfaces	CS15xx-1-x
Connection plug	Plug connection M12x1, 8-pole, pin, in accordance with VDE 0627 and IEC 61984
RS485 interface	• Modbus RTU, 2-wire, half-duplex • HSI (HYDAC Sensor Interface), 1-wire, (HYDAC proprietary protocol)
Analogue output	2-wire technology 4°...°20°mA output (active): load ≤ 500 Ω Accuracy: ± 1% FS (FullScale)
Switching output	n-, p-switching or Push Pull, parameterisable, switching current ≤ 300 mA

Tab. 8: Technical data – communication interfaces CS15xx-1-x

3.4 Type label

Details for identifying the product are found on the type labels on the product as well as their components. Always mention the part number and the serial number when contacting HYDAC.

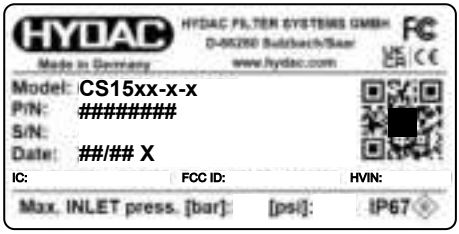

Fig. 2: Decoding the model code

Model	Model code, for details, see ▸Sec. 3.4.1 "Decoding the model code"
P/N	Part no.
S/N	Series no.
Date	Year / week of manufacture – hardware index
IC	IC registration number
FCC ID	FCC registration number
HVIN	Hardware Version Identification Number
Max. INLET press.:	Maximum operating pressure

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3.4.1 Decoding the model code

The ContaminationSensor has the following model code:

CS	1	5	2	0	-	0	-	0	/-	000

Type

CS = ContaminationSensor

Series

1 = 1000 series,
4 particle size channels

Coding of the contamination

5 = ISO4406;1987: >2 µm, >5 µm, >15 µm, >25 µm
NAS1638: 2-5 µm, 5-15 µm, 15-25 µm, >25 µm switchable
ISO4406;1999 / SAE AS 4059: >4 µm(c), >6 µm(c), >14 µm(c), >21 µm(c) switchable

Options

1 = Without display
2 = with a display continuously rotatable through 270°

Operating media

0 = Mineral oil based with FPM seals
1 = Phosphate ester with EPDM seals

Communication interface

0 = Plug connection M12x1, 8-pole
Ethernet / ModBus TCP or
Ethernet / MQTT (configurable)
Limit value switching output

1 = Plug connection M12x1, 8-pole
RS485 / HSI or RS485 /
ModBus RTU (configurable)
Limit value switching output
Analogue output (4...20 mA)

Hydraulic connection

0 = Pipe or hose connection
1 = Flange connection

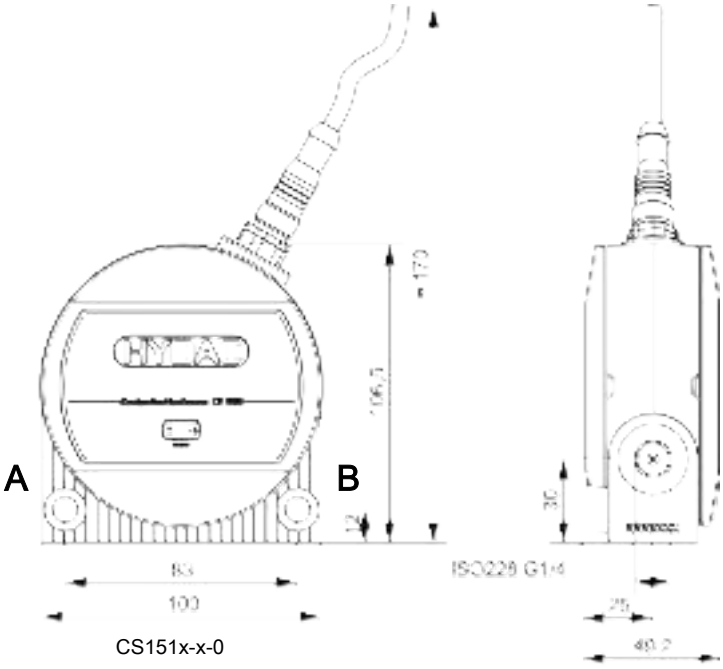
Modification number

000 = Standard
Txxx = Technical modification
with optional smart algorithms
Cxxx = Customer-specific modification
with optional smart algorithms

Fig. 3: Model code

3.5 Dimensions

The ContaminationSensor has the following unit dimensions:



CS151x-x-0

All dimensions in mm.

Fig. 4: Unit dimensions CS151x-x-x

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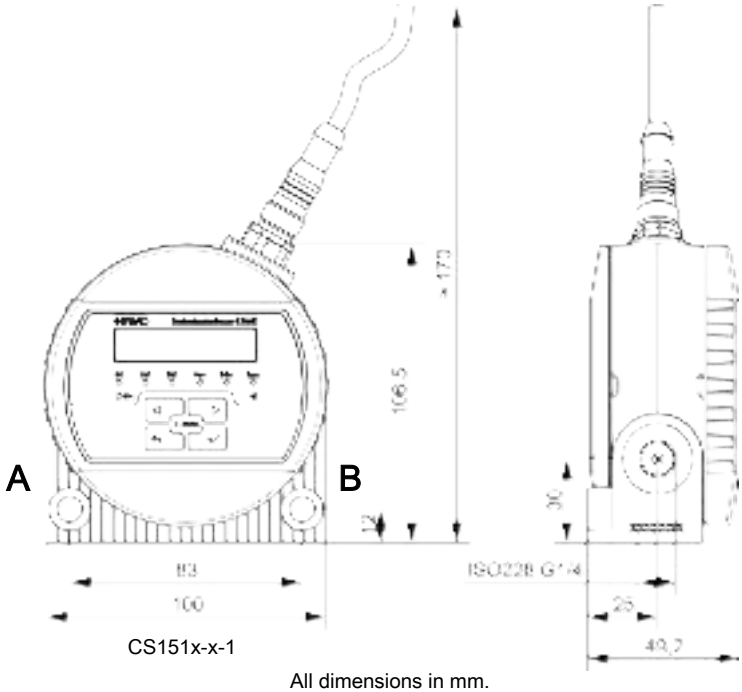
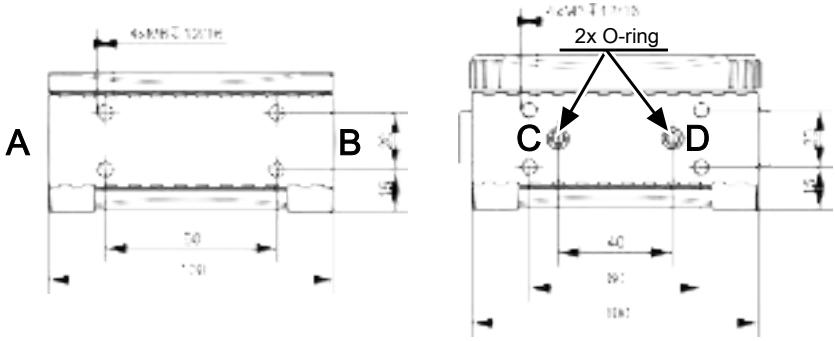


CS151x-x-1

All dimensions in mm.

Fig. 5: Unit dimensions CS152x-x-x



Pipe connection
CS15xx-x-0

Flange connection
CS15xx-x-1

All dimensions in mm.

Fig. 6: Underside view / drilling pattern

3.6 Components and operating units

The following components and parts can be found on the ContaminationSensor.

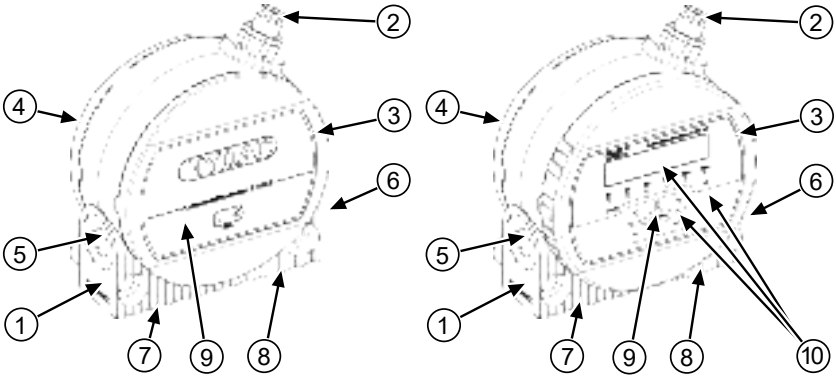


Fig. 7: Components and operating units

1	Sensor housing with mounting holes
2	Connection plug
3	Front cover, only for CS1x2x with display, rotatable through 270°
4	Back cover
5	Hydraulic connection
6	Hydraulic connection
7	Hydraulic connection (only for flange connection)
8	Hydraulic connection (only for flange connection)
9	Status display
10	Display and keyboard (CS1x2x only), for details see Reading the display / Using the keyboard (CS1x2x only)

4. Transport and storage

You will find the respective notice on the prevention of damage to the product during transport or storage in this chapter.

The ContaminationSensor can be carried by hand. Avoid applying pressure to the display when carrying.

NOTICE

Unsecured transport

The connector will be damaged.

- ▶ Transport the sensor in its original packaging.
- ▶ Secure the sensor during transport.

Store the sensor in a clean and dry place, if possible in the supplied packaging. Do not remove the packing until you are ready to install the unit.

After use, thoroughly clean the sensor with Cleanoil before storing. Use and dispose of the cleaning agents and flushing oils used properly and in an environmentally friendly manner.

Storage conditions, see ▸Sec. 3.3 "Characteristics".

5. Assembly, installation and commissioning

An optimally assembled and installed product ensures a safe and continuous operation.

This chapter provides information on mounting, hydraulic and electrical installation, and final commissioning.

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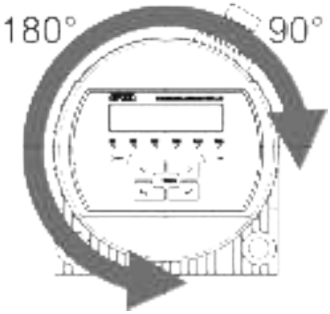
The installer of the system is responsible for the safety of a system in which a ContaminationSensor has been installed.

5.1 Rotating the display (CS1x2x only)

The display can be rotated continuously through a total of 270°, 180° to the left and 90° to the right. Turn the display by hand in the desired direction.

NOTICE **Do not use any tools to rotate the display.**



5.2 Mounting/securing the contamination sensor

This chapter contains various permissible mounting options for the ContaminationSensor.

When selecting the location, pay attention to the environmental conditions such as temperature, dust, water, etc.

Mount the sensor according to the following examples: For the drilling pattern, see ▸Sec. 3.5 "Dimensions".

Mounting on a wall or on a bracket

Mount the ContaminationSensor on a wall using two M8 hexagon socket head screws according to ISO 4762 with a length of at least 40 mm or on a panel using four M6 hexagon socket head screws according to ISO 4762.

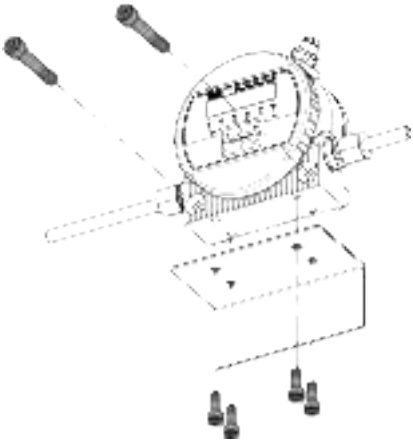


Fig. 8: Mounting on a wall or bracket

Mounting on a sub plate / flange connection

Mount the ContaminationSensor on a wall using two M8 hexagon socket head screws according to ISO 4762 with a length of at least 40 mm or on a panel using four M6 hexagon socket head screws according to ISO 4762 on a mounting sub plate or control or valve block.

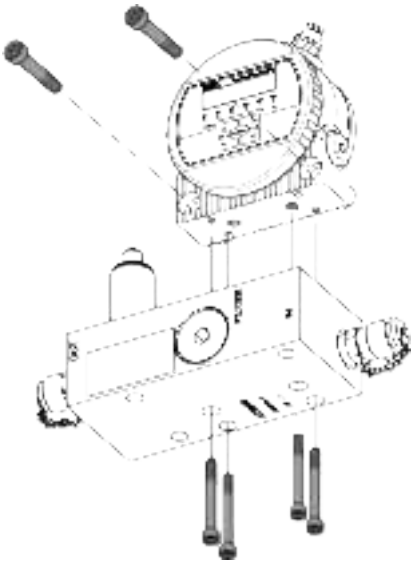


Fig. 9: Mounting on a sub plate with flange connection

5.3 Hydraulic connection

Determine the operating pressure of the hydraulic system so that the permissible pressure and flow rate are achieved at the input of the ContaminationSensor. Use an A / C connection as the INLET and a B / D as the OUTLET.

If possible, install the ContaminationSensor in such a way that air cannot collect in the sensor, e.g. not at the highest position in the hydraulic system.
A flow through the ContaminationSensor from bottom to top helps to remove unwanted air.

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Select the connection type for your sensor type according to the following chapters:

Threaded connection (nur CS15xx-x-0)

The hydraulic connection is made via the threaded connections A and B. For details of the connection thread, see ▸Sec. 3.3 "Characteristics".

Fig. 10: Threaded connection using the example of CS1x2x.

Flange connection (nur CS15xx-x-1)

The hydraulic connection is made via connections C and D. Two O-rings [2] are used to seal the space between the ContaminationSensor and a flange, mounting or sub plate. Four M6 threads are provided for attaching the ContaminationSensor. Connections A and B are closed with screw plugs [1].

Fig. 11: Flange connection using the example of CS1x2x.

5.3.1 Flow rate, differential pressure and viscosity characteristics

The flow rate Q is dependent on the pressure difference Δp and the viscosity η of the medium.
The diagrams show the dependency on pressure difference Δp and viscosity η characteristics at different flow rates Q. All the values shown in the diagrams apply regardless of the direction of flow, A->B or B->A.

Observe the permissible measurement volume flow, see ▸Sec. 3.3 "Characteristics".

If you do not achieve the required flow rates, we offer you an extensive range of accessories with various conditioning modules.

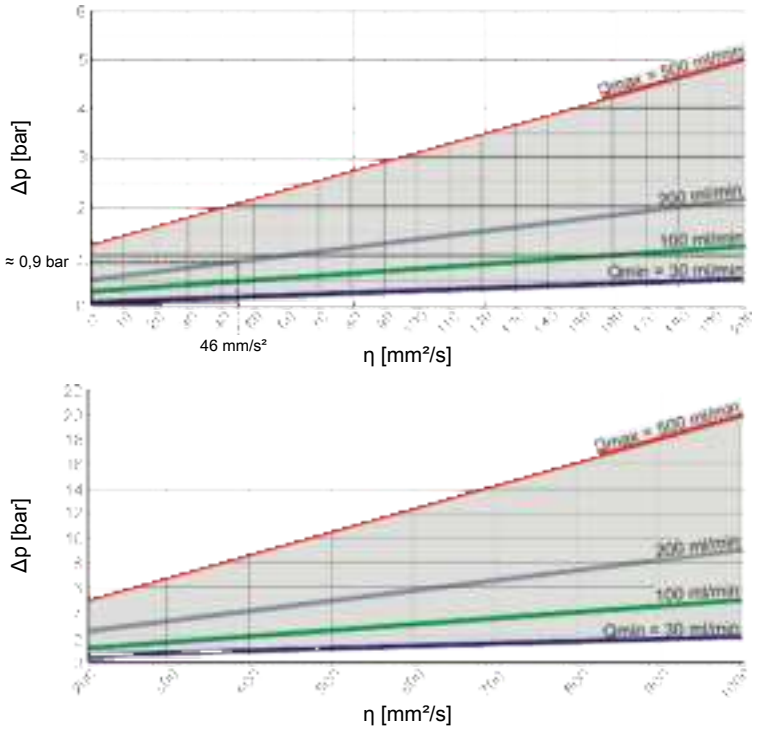

Fig. 12: Flow rate, differential pressure and viscosity characteristics

For example:
You are using a fluid with a viscosity η of 46 mm²/s at a pressure difference Δp of ≈ 0.9 bar. This will give you a flow rate of ≈ 200 ml/min.

5.3.2 Finding a measurement point in the hydraulic system

To obtain continuous and contemporaneous cleanliness values, carefully select the appropriate measurement point according to the following guidelines:

	Select the measurement point so that the measuring volume comes from a turbulent, well-flowing environment. For example: on a pipe bend, etc.
	Install the sensor near the measurement point to achieve the most timely results possible.
	When installing, make sure that no siphon is created so as to avoid the deposition of particles in the line (sedimentation).

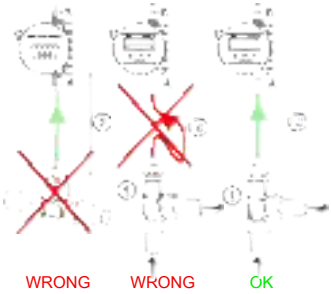

Fig. 13: Finding a measuring point in the hydraulic system

5.3.3 Hydraulic connection of the sensor

To connect the ContaminationSensor to the hydraulic system, follow the below steps:

1. Connect the return line to the outlet of the ContaminationSensor. Recommended pipe diameter ≥ 4 mm.
2. Connect the other end of the return line to the system tank, for example.
3. Check the pressure at the measurement point. Note the maximum operating pressure.
4. Connect the measuring line to the inlet of the ContaminationSensor. We recommend a line internal diameter of ≤ 4 mm to prevent particle deposition (sedimentation).
5. If you expect to find particles ≥ 400 µm in size in the hydraulic system, install a dirt strainer upstream of the ContaminationSensor. (e.g. CM-S). This prevents the measuring cell from becoming blocked.
6. Connect the other end of the measuring line to the measuring connection on the hydraulic system.
7. As soon as the ContaminationSensor is connected to the pressure line, oil begins to flow.
8. The hydraulic connection is complete.

5.4 Electrical connection

To achieve the optimal performance of the product, the electrical connection and proper integration, for example, to the power supply and/or interfaces, etc., is an important part of the process.

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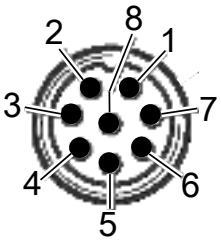
Pin assignment - connector for CS15xx-1-x

1	Voltage supply +	VIN+
2	Analogue output + (active)	4 … 20 mA
3	GND voltage supply	VIN – / GND
4	-	n.c.
5	HSI (HYDAC Sensor Interface)	HSI / 1-wire
6	RS485 +	
7	RS485 -	
8	Switching output (p-, n-switching or push-pull, parameterisable, switching current ≤ 300mA)	



The connector housing is electrically connected to the sensor housing.

5.4.1 Single-ended cordset / connecting cable - colour coding

Suitable sockets/plugs, single-ended cordset or connecting cables, as well as the colour coding of these cables, can be found in the ▸Sec. 11.3 "Accessories" chapter.

5.4.2 Connection examples

Here are several connection examples:

Connection example CS15xx-1-…

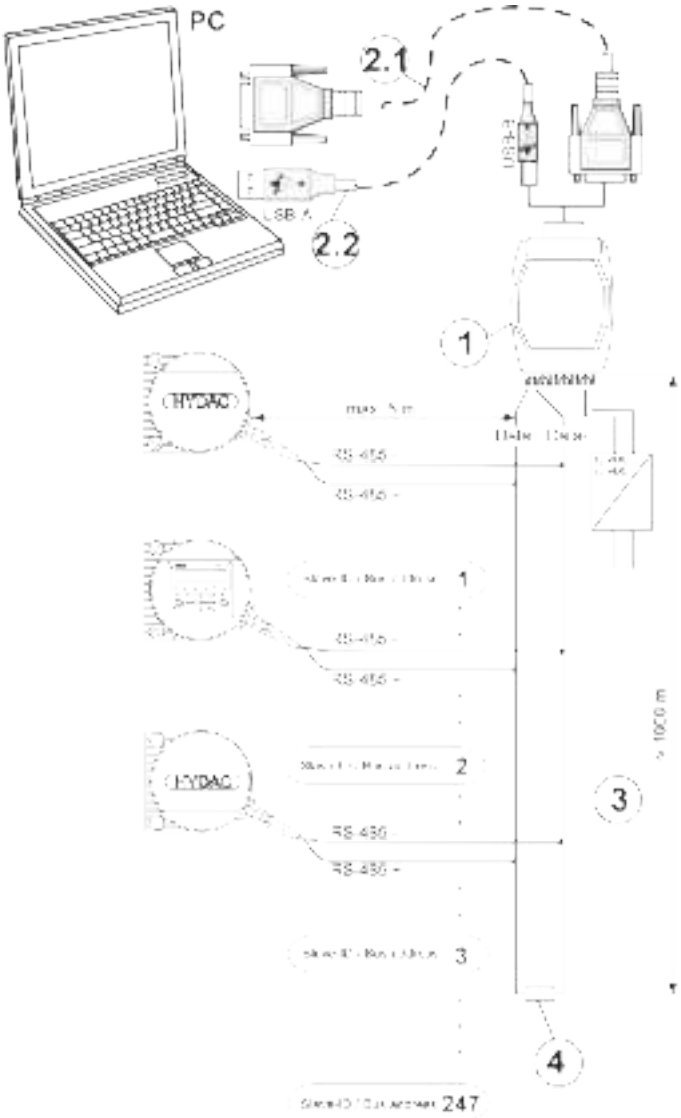


Fig. 14: Connection example CS15xx-1-…

1	Interface
2.1	Connection cableRS232
2.2	Connection cable USB A<->B
3	Cable length
4	Terminal resistance

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5.5 Initial start-up

Proceed as follows for start-up:

✓ The ContaminationSensor is connected hydraulically, as described in the previous chapters.

✓ The ContaminationSensor is, as described in the previous chapters, electrically connected or connected to a voltage source.

1. Start the hydraulic system and open the existing shut-off valves.
   ⇨ Check the status LED or the display of the ContaminationSensor.
   After ≥ two minutes, the LED status must light up green or the display must show something.
2. Check the hydraulic connection for leaks. Eliminate leakages immediately.

Initial start-up is complete.

5.6 Connecting via WLAN

Observe the information on cyber security, for details see ▸Sec. 2.2 "Obligations of the owner".

Information on the WLAN connection

The product generates a WLAN access point for a direct Point-to-Point connection between the end device and the ContaminationSensor for configuration via the Web UI.

The WLAN connection is not intended to be a permanent data connection, so the ContaminationSensor cannot be integrated into an existing WLAN network.

SSID and the type of encryption of the access points can be configured in the WLAN settings. For more information please refer to ▸Sec. 2.2 "Obligations of the owner".

HYDAC recommends retaining the designation of the WLAN network (SSID) to ensure clear identification of the ContaminationSensor.

If you have forgotten the WPA2 Key for the WLAN interface, reset the ContaminationSensor to the default settings. For details, see ▸Sec. 7.1 "Performing restart".

The WLAN interface can be switched off. This option can be found in the settings under WLAN. When the default settings are restored, the WLAN interface is active.

The wireless interface can be reactivated using the display button on the ContaminationSensor or with a reset to default settings. Please see -> Switch on/off W-LAN using film button or reset to default settings.

Please note that after the WLAN interface has been disabled, a connection can only be made with a wired connection.

Please note that a simultaneous connection to the ContaminationSensor and the internet cannot be guaranteed in most cases.

To ensure a smooth connection, we recommend disabling the *Connect automatically* option for the WLAN of the ContaminationSensor.

The connection to the ContaminationSensor can be disrupted by the use of (automatic) VPN solutions (e.g. Apple Private Relay). The simultaneous use of automatic VPNsolutions and connection to the ContaminationSensor is therefore not recommended.

Connecting the ContaminationSensor via WLAN

Proceed as follows to establish a WLAN connection to the ContaminationSensor:

✓ The WLAN on the ContaminationSensor is activated.

1. Establish a WLAN connection between the ContaminationSensor and your mobile device. To do this, check the available WLAN connections on your device and select the ContaminationSensor WLAN.

   ⇨ With the default settings, the name according to CS1500SNxxx corresponds to the SSID. Here, xxx corresponds to the serial number of the ContaminationSensor.

2. The web UI of the ContaminationSensor is accessed automatically after a successful connection via WLAN. The transfer to the web UI of the ContaminationSensor is automatic.

⚐ The web UI of the ContaminationSensor opens.

If the automatic opening of the web UI of the ContaminationSensor does not work on your end device, you can open the web UI manually. The following steps provide further detail:

✓ The WLAN on the ContaminationSensor is activated.

1. The WLAN connection to the ContaminationSensor is established.
2. Open the browser on your end device.
3. Enter the URL http://cs1500 in the address bar of your browser.

⚐ The web UI of the ContaminationSensor opens.

6. Default settings

The ContaminationSensor is supplied with the following default settings:

For details on the default settings, refer to the overview sheet with the default settings in the digital product file, see ▸Sec. 3.1 "Supplementary product information — scan QR code".).

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6.1 Resetting the WLAN password to the default settings

To reset the WLAN password to the default settings, proceed as follows.

✓ The plug connector for the ContaminationSensor is plugged in and connected to the supply voltage.

1. Disconnect the plug connector with the supply voltage from the ContaminationSensor.
2. Connect the plug connector with the supply voltage to the ContaminationSensor.
   ⇨ The status LED flashes green for ≈ 5 seconds and then orange for ≈ 5 seconds.
3. During this phase during which the LED is flashing orange, disconnect the plug connector with the supply voltage from the ContaminationSensor.
4. Connect the plug connector with the supply voltage to the ContaminationSensor.
   ⇨ The status LED flashes green for ≈ 5 seconds and then orange for ≈ 5 seconds.
5. During this phase during which the LED is flashing orange, disconnect the plug connector with the supply voltage from the ContaminationSensor.
6. Connect the plug connector with the supply voltage to the ContaminationSensor.
   ⇨ The status LED flashes green for ≈ 5 seconds and then orange for ≈ 5 seconds.
7. During this phase during which the LED is flashing orange, disconnect the plug connector with the supply voltage from the ContaminationSensor.
8. Connect the plug connector with the supply voltage to the ContaminationSensor.
   ⇨ The status LED flashes green for ≈ 5 seconds and then orange for ≈ 5 seconds. The WLAN symbol lights up blue.

The WLAN password has been reset to the default setting.

For details of the default setting for the WLAN password, see ▸Sec. 3.1 "Supplementary product information — scan QR code".

7. Operation

Procedures, notes and tips for optimum, fault-free operation can be found in this chapter.

The ContaminationSensor has various measuring modes, making it a universal sensor for different operating modes. In addition, the switching output or analogue output can provide a lot of information, such as measured values, or a signal can be output when limit values are reached, or a unit/pump can be switched.

Details on setting the basic functions can be found in the following chapters.

Explanation of terms

Certain terms are contained in the following chapters. You will find the explanation here:

- **Measurement point**
  The name of the point on the hydraulic, lubrication or fluid system where the measurement is taken
- **Measuring volume**
  Sample quantity that is analysed to determine a measured value
- **Measured value**
  Cleanliness class determined by a single measurement, displayed as a three-digit ISO code or NAS class or SAE class of the individual particle size channels
- **Measurement duration**
  After the measurement duration has elapsed, the measured value is updated on the display and at the interfaces. The maximum measurement duration can be parameterised using the web UI. The sensor automatically uses dynamic measurement intervals up to this maximum duration.
- **Measurement**
  After the ContaminationSensor has been supplied with power and the boot process has been completed, an individual measurement begins. After this has been completed, the next individual measurement is added immediately, and this continues until the ContaminationSensor is disconnected from the power supply. This sequence of individual measurements is referred to in simplified terms as a measurement.

7.1 Performing restart

To restart the ContaminationSensor, disconnect the power supply for > 10 seconds.

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7.2 Status display - CS1x1x

When the ContaminationSensor is switched on or supplied with power, the start-up phase takes ≈ 45 seconds. The status LED then lights up green.

Fig. 15: Front panel with status LED and WLAN symbol - CS151x

1	Status LED	Status display is lit in solid green or flashing red; for details, see below.
2	WLAN	• Off when the WLAN connection is deactivated. • Flashes while communicating. • Lights up continuously when the WLAN connection is active.

7.3 Reading the display/operating the keyboard - CS1x2x

If the ContaminationSensor is switched on or supplied with voltage, the display shows HYDAC CS152x in scrolling text, depending on the type. The firmware version is then displayed for two seconds. INITIALIZING then starts, followed by MEASURING after which the first measured value appears.

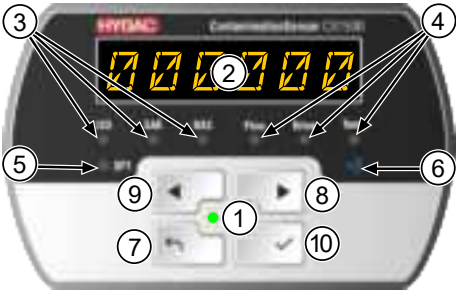

Fig. 16: Display and keyboard - CS152x

1	Status LED	Status display is lit in solid green or flashing red; for details, see ▸Sec. 8 "Rectifying malfunctions".
2	Display	6-digit display with 17 segments each
3	Measurement variable	Display of the respective measurement variable, e.g. ISO, SAE, NAS

4	Service variable	Display of the respective service variable, e.g. Flow, Drive, Temp
5	SP1	Switching output status display. If the LED lights up, switching output is activated. This means that the switch is closed.
6	WLAN	• Off when the WLAN function is deactivated. • Flashes while WLAN is communicating. • Lights up continuously when the WLAN function is active.
7/8	/	Scroll through the ISO / SAE / NAS / Flow / Drive / Temp display. Navigate through the menu. Select numbers.
9		Jump one menu level higher. To exit the menu without changing the values, press the button until SAVE appears on the display. Use the buttons to switch to CANCEL and confirm with the button or wait 30 seconds without pressing a button. Exit the menu without changing any values.
10		Jump down one menu level. Confirm a changed value at the lowest menu level. Confirm at the highest menu level to save or discard a value change.

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7.3.1 Displaying measurement variables and service variables

The display shows measurement variables and service variables. The difference between measurement variables and service variables is that measurement variables are calibrated and the service variables only provide information about the current operating conditions.

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Displaying measurement variables

The measurement variables provide information about the cleanliness classes of the medium.

ISO cleanliness class

Measured value ISO code (>4µm >6µm >14µm)
Example: 3-digit ISO code for 20.18.15.°µm

SAE cleanliness class

Measured value SAE class
Example: Class 6.1 for SAE A (>4 µm)

ISO cleanliness class

Measured value ISO code (>2µm >5µm >15µm)
Example: 3-digit ISO code for 20.18.15.°µm

NAS cleanliness class

Measured value NAS class
Example: Class 13.2 for the size range 15-25 µm

Displaying service variables

The service sizes indicate the current operating conditions in the ContaminationSensor.

Flow - flow rate area

The flow rate through the ContaminationSensor is displayed as the status. As the contamination measurement is independent of the flow, the display of this service variable has no influence on the measurement accuracy.

Example: OK

Each status display corresponds to an approximate flow rate area, see table.

Display status Web UI display	Flow rate area
Flow 2 Low	< 30 ml/min
Low	≈ 30 – 60 ml/min
OK -	≈ 60 – 100 ml/min
OK	≈ 100 – 250 ml/min
OK +	≈ 250 - 450 ml/min
High	≈ 450 – 500 ml/min
Flow 2 High	> 500 ml/min

Tab. 9: Flow - flow rate area

Drive – LED power

Power (1-100%) of the measuring cell transmitter LED in the ContaminationSensor.

Example: 60 %

Temp – Temperature

Fluid temperature in the ContaminationSensor.

Example: 29.5 °C (or 84.2 °F)

7.4 Web user interface/web UI overview

The web user interface, or web UI, or the ContaminationSensor is designed to permit intuitive sensor navigation, use and configuration.

The web UI is divided into several main areas:

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- Status display
  - The status display is located at the top centre and contains current information about the status of the ContaminationSensor and information related to the recorded measured values.
  - Click on the status to receive more information about the device.
- Main menu
  - The main menu is located at the top right of the page and allows quick access to the various configuration areas.
  - Click on the gear icon to open the menu view.
- Main display area - ISO4406/SAE
  - The current measured values and set limit values are displayed in the central area of the main view.
  - Move the limit values after unlocking the value controllers in the upper right corner.
  - Click on the display to see a summary of the recorded measured values
- Main display area level 2 - summary
  - The summary of the recorded measurement values by classification is displayed here.
  - Click on the respective map again to access the detailed view.
- Main display area level 3 - detailed view
  - This is where you can see a detailed display of the recorded values with notes on certain events, such as exceedance of limit values.
- View report.
  - Creates a measured value report as a PDF to be downloaded/saved, for details, see ▸Fig. 17, p. 44.

Configuring the ContaminationSensor

- General – measurement recording settings
  - Maximum measurement time, limits the maximum length of a measurement cycle.
    This setting is optimised for most applications by the default setting.
    If the conditions in your system deviate significantly from the standard conditions, the measurement time can be adjusted using this setting. In general, the rule of thumb is that a longer measurement time leads to statistically more stable measured values if the operating medium is very clean.
- Displayed calibration
  - Switch the display in the web UI between ISO/SAE and ISO/NAS.
- Limit values – settings for the limit values of the measured variables
  Use the manual input or the limit value assistant to determine suitable settings for

your system in accordance with ISO 12669 or the HYDAC Contamination Handbook.

- Restore default values.
  Resets all limit values to the default settings.
- Discard, discard current input.
- Save, save changed settings.

- LAN - settings for the LAN interface
  - DHCP active/inactive – Use DHCP for automatic assignment of LAN settings by your on-site IT administrator or set up the device manually.
  - IP address/subnet mask/Gateway/DNS – Set the values manually according to the specifications of your IT administrator

> Incorrect configuration can result in you no longer being able to access the device via LAN. Contact your IT administrator.
>
> Observe the safety instructions when configuring the device interfaces. Please refer to ▸Sec. 2.2 "Obligations of the owner".

- WLAN – Settings for the WLAN interface
  - Active/inactive: switch the WLAN interface on or off.
  - SSID/Name: enter the SSID of the WLAN that is to be generated by the ContaminationSensor
  - WPA2 encryption: switch the encryption of the WLAN interface on or off.
  - Password: enter the WLAN password if encryption is activated.
- Language
  - Select the desired language.

Contact support

Do you need more support? Click on Support in the menu to view the relevant contact information and request assistance.

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View report

The following information can be found in the PDF of the report to be downloaded / saved:

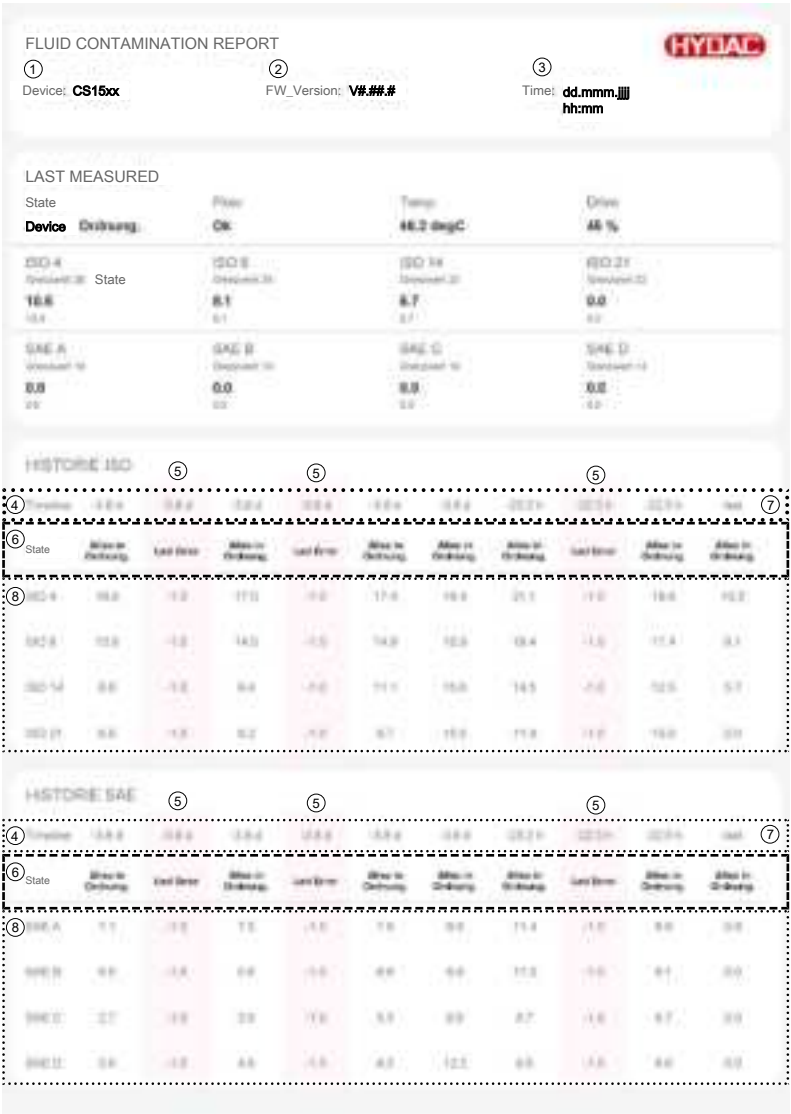

Fig. 17: View report

1	Device type	5	Columns highlighted in red denote a deviation of the device status from xxx.
2	Firmware version	6	The status automatically resets to xxx.
3	Date/time	7	The last 10 results are displayed.
4	New entries are triggered by events, e.g. a value changes by ≥ 0.5 classes, or the sensor status changes if a limit value is exceeded or there is a device error.	8	Each measured value is not averaged over the time period, it corresponds to the measured value at a given time.

7.5 Using the switching output – Switch OUT

You can use the switching output Switch Out with the operating modes Device Ready , Limit, as well as the type and polarity of the switching function described below and set the limit values.

After the boot sequence has been completed, the SP1 switching output is closed or conductive. This state is maintained for the first measurement duration (WAIT period). Depending on the operating mode, the switching output can be used as a Device Ready function.

Device Ready	**Switching output: open / non-conductive** **LED SP1: off**	**Switching output: closed / conductive** **LED SP1: on**
-	-	Can be used as the Device ready signal. Conductive, except in the event of a fault.

Tab. 10: Switching function for operating mode Device Ready

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Betriebsart Limit	Switching output: open / non-conductive LED SP1: off	Switching output: closed / conductive LED SP1: on
BEYOND Above limit value	A measured value of the selected measuring channel is ≥ the upper limit value UPPER.	After switching on the ContaminationSensor or starting a measurement. The switching output closes again when all measured values of the selected measuring channel are < the set lower limit value LOWER.
BELOW Lower limit value	All measured values of the selected measuring channel are ≤ the set lower limit value LOWER.	After switching on the ContaminationSensor or starting a measurement. The switching output closes again when a measured value of the selected measuring channel is > the set upper limit value UPPER.
WITHIN Within the limit values	All measured values of the selected measuring channel are ≥ the set lower limit value LOWER and ≤ above the set upper limit value UPPER.	After switching on the ContaminationSensor or starting a measurement. The switching output closes again when a measured value of the selected measuring channel is < the set lower limit value LOWER or > the set upper limit value UPPER.
Outside Outside of the limit values	A measured value of the selected measuring channel is ≤ the set lower limit value LOWER or a measured value of the selected measuring channel is ≥ the set upper limit value UPPER.	After switching on the ContaminationSensor or starting a measurement. The switching output closes again when a measured value of the selected measuring channel is> the set lower limit value LOWER or< the set upper limit value UPPER.
OFF No switching function	-	Conductive, except in the event of a fault.

Tab. 11: Switching function for operating mode Limit

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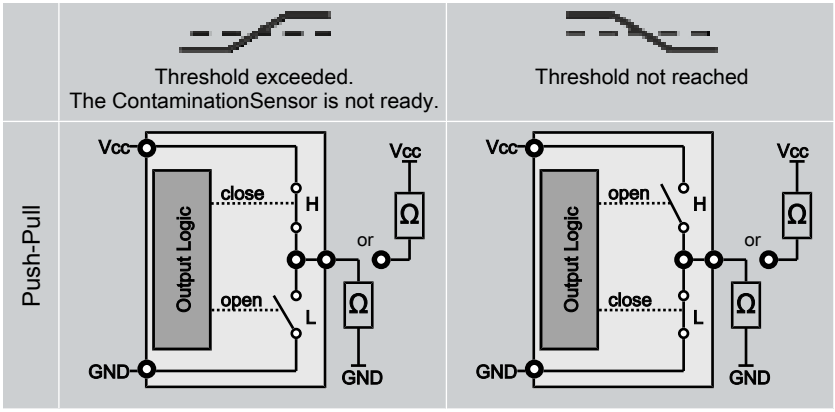
Polarity Active High

Vcc	ContaminationSensor operation voltage
Vuser	User-defined voltage
Ω	User-defined load
Push Pull	High Side and Low Side switches alternate.
	• Active driving and lowering of currents ≤ 300 mA
	• Parallel switching of outputs not possible
P-Switch (PNP Config)	High Side switching (P), meaning that the High Side switch is permanently open.
	• Active driving of currents ≤ 300 mA
	• Can be operated with a voltage (15 … 60 V) that differs from that of the ContaminationSensor
	• Parallel switching of similar outputs possible
N-Switch (NPN Config)	Low Side switching (N), meaning that the Low Side switch is permanently open.
	• Active driving of currents ≤ 300 mA
	• Parallel switching of similar outputs possible



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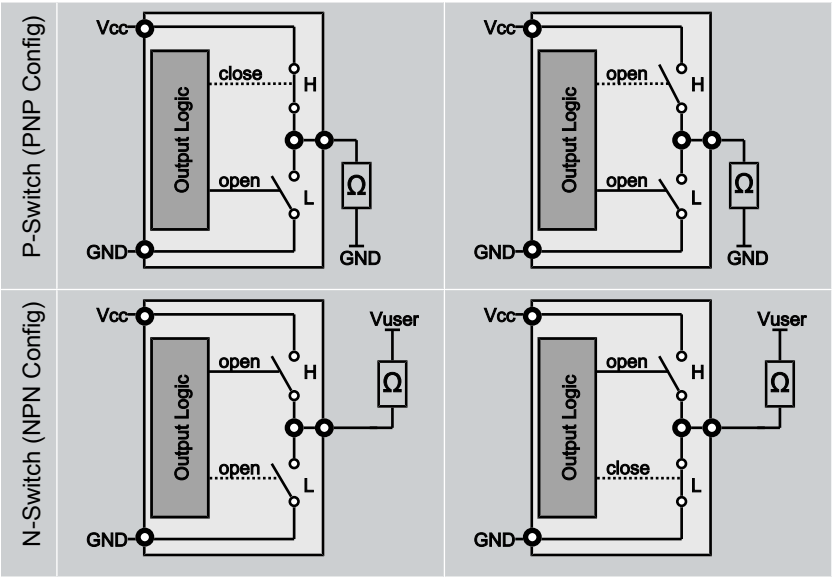
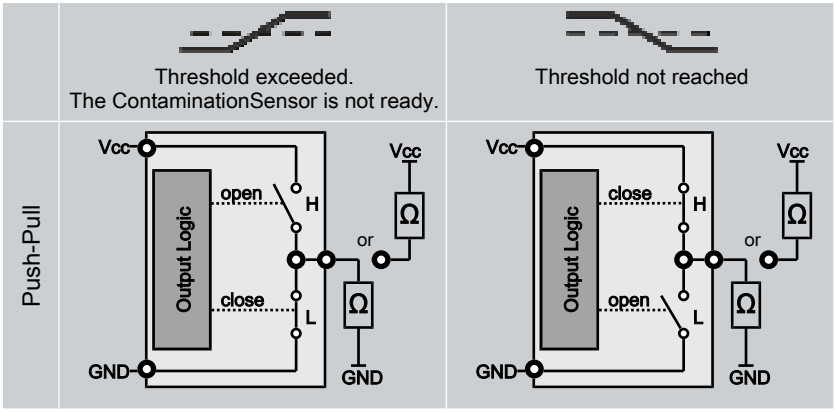
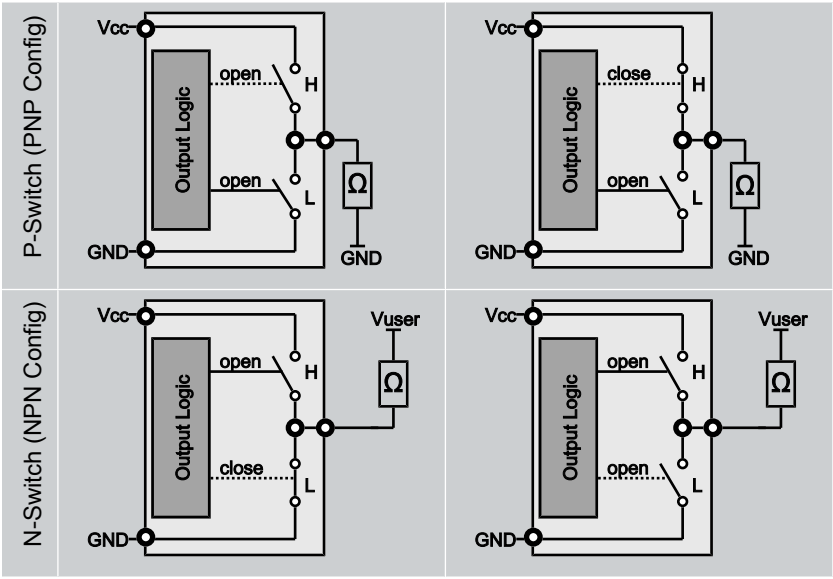


Tab. 12: Switching output - Active High

Polarity Active Low

Vcc	ContaminationSensor operation voltage
Vuser	User-defined voltage
Ω	User-defined load
Push Pull	High Side and Low Side switches alternate. • Active driving and lowering of currents ≤ 300 mA • Parallel switching of outputs not possible
P-Switch (PNP Config)	High Side switching (P), meaning that the High Side switch is permanently open. • Active driving of currents ≤ 300 mA • Can be operated with a voltage (15 … 60 V) that differs from that of the ContaminationSensor • Parallel switching of similar outputs possible
N-Switch (NPN Config)	Low Side switching (N), meaning that the Low Side switch is permanently open. • Active driving of currents ≤ 300 mA • Parallel switching of similar outputs possible





Tab. 13: Switching output - Active Low

7.6 Modbus®-RTU implementation

Modbus®-RTU communication is via the RS 485 interface. In this case, the master (PC or control) must request the measured values from the ContaminationSensor (Slave).

Each bus participant must have a unique address. The address 0 is reserved for a Broadcast.

Reading out measured values via RS485 / adjusting the sensor

Measured values can be read out from the ContaminationSensor via various interfaces. The following chapters explain the various interfaces with the necessary tools.

The following Modbus® mapping is identical for both communication methods:

Read Holding Register

Function Code 0x03		adress	D [D)]
Slave address	1	0x0000	1
RTU baudrate	0 = 9600, 1 = 19200, 2 = 38400, 3 = 57600, 4 = 115200	0x0001	1

Function Code 0x03		adress	D [D)]
RTU Stop Bits	0 = 1 Stopbit, 1 = 1,5 Stopbit, 2 = 2 Stopbit	0x0002	0
RTU Parity	0 = None, 1 = Odd, 2 = Even	0x0003	0

[D)] = default setting

Tab. 14: Read Holding Register

Write Holding Register

Function Code single 0x06 Function Code multible 0x10		adress	D [D)]
Slave address	1	0x0000	1
RTU baudrate	0 = 9600, 1 = 19200, 2 = 38400, 3 = 57600, 4 = 115200	0x0001	1
RTU Stop Bits	0 = 1 Stopbit, 1 = 1,5 Stopbit, 2 = 2 Stopbit	0x0002	0
RTU Parity	0 = None, 1 = Odd, 2 = Even	0x0003	0

[D)] = default setting

Tab. 15: Write Holding Register

Read Input Register

Function Code 0x04		adress	
Status text Ch1 and Ch2		0x0000	
Status text Ch3 and Ch4		0x0001	
Status text Ch5 and Ch6		0x0002	
Status text Ch7 and Ch8		0x0003	
Status text Ch9 and Ch10		0x0004	
Status text Ch11 and Ch12		0x0005	
Status text Ch13 and Ch14		0x0006	
Status text Ch15 and Ch16		0x0007	

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Function Code 0x04		adress	
Status Code		0x0008	
ISO 4	To nearest 1/10 of a class	0x0009	
ISO 6	To nearest 1/10 of a class	0x000A	
ISO 14	To nearest 1/10 of a class	0x000B	
ISO 21	To nearest 1/10 of a class	0x000C	
SAE A	To nearest 1/10 of a class	0x000D	
SAE B	To nearest 1/10 of a class	0x000E	
SAE C	To nearest 1/10 of a class	0x000F	
SAE D	To nearest 1/10 of a class	0x0010	
ISO 2	To nearest 1/10 of a class	0x0011	
ISO 5	To nearest 1/10 of a class	0x0012	
ISO 15	To nearest 1/10 of a class	0x0013	
ISO 25	To nearest 1/10 of a class	0x0014	
NAS 2	To nearest 1/10 of a class	0x0015	
NAS 5	To nearest 1/10 of a class	0x0016	
NAS 15	To nearest 1/10 of a class	0x0017	
NAS 25	To nearest 1/10 of a class	0x0018	
Temperature	To nearest 1/10 °C	0x0019	
Flow	ml/min	0x001A	
Drive	%	0x001B	
Counts ISO 4		0x001C	
		0x001D	
Counts ISO 6		0x001E	
		0x001F	
Counts ISO 14		0x0020	
		0x0021	
Counts ISO 21		0x0022	
		0x0023	
Counts ISO 2		0x0024	
		0x0025	

Function Code 0x04		adress	
Counts ISO 5		0x0026	
		0x0027	
Counts ISO 15		0x0028	
		0x0029	
Counts ISO 25		0x003A	
		0x003B	
Serial number		0x003C	
		0x003D	

Tab. 16: Read Input Register

Read-Coil-Register

Function Code 0x01		adress	D [D)]
enable wireless	0 = Off 1 = On	0x0000	1

[D)] = default setting

Tab. 17: Read-Coil-Register

Write-Coil-Register

Function Code single 0x05 Function Code multiple 0x05		adress	D [D)]
Enable wireless	0 = Off, 1 = On	0x0000	1
Protocol (RS485 only)	0 = Modbus, 1 = HSI	0x0001	1
Reset wireless to default	1 = Reset to default	0x0002	0

[D)] = default setting

Tab. 18: Write-Coil-Register

7.6.1 Connecting and reading out the ContaminationSensor via RS485

The RS485 interface is a two-wire interface and works in half-duplex mode. The number of CS15xx units per RS485 bus is limited to 247. Use the bus addresses 1 … 247 for addressing.

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The length of the bus line and the size of the terminal resistance depend on the quality of the cable used. Connect several CS15xx units via the RS485 interfaces as shown in the following figure:

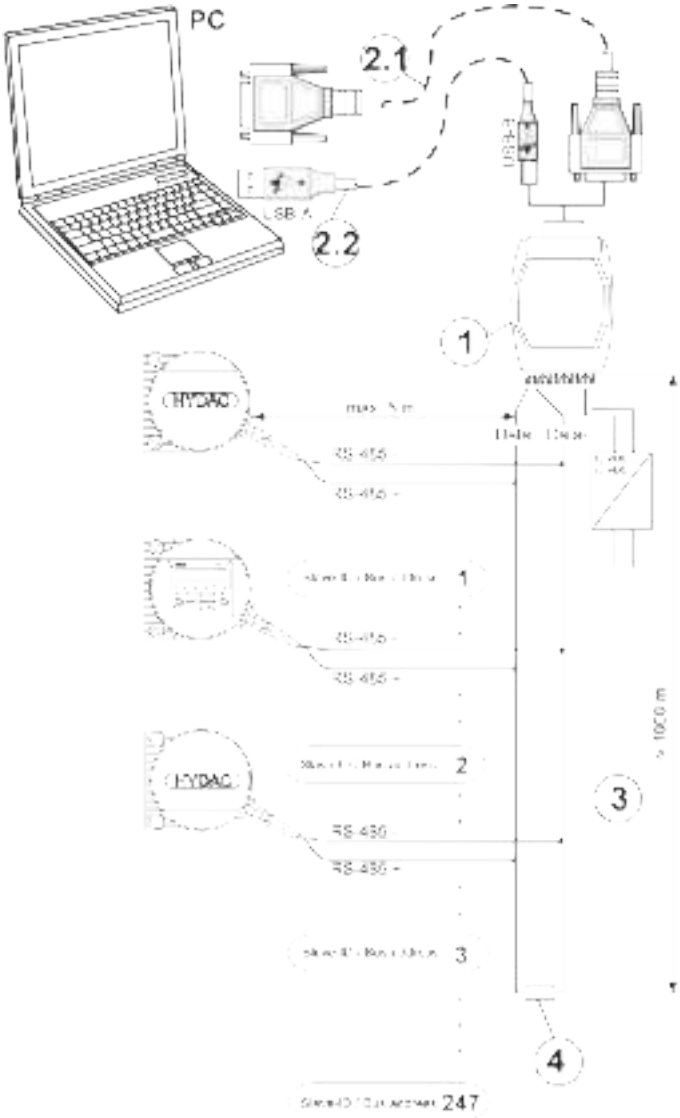


Fig. 18: Connecting / reading out ContaminationSensor via RS485

Use the following settings for communication via the COM interface:

Bits per second	=	19200 Baud @ Modbus 9600 Baud @ HSI
Data bits	=	8
Parity	=	None
Stop bits	=	1
Protocol	=	None

Tab. 19: Communication Parameters

7.7 Using and evaluating analogue output – Analogue OUT

The measured values can be output in time-coded form via the analogue output Analog. The transmission takes up to 52 seconds, depending on the setting. This transmission is not interrupted after the end of the measurement time, when a new measured value is received.

Due to the time delay in the transmission of the measured values, it is possible that a ContaminationSensor with a display will show a different measured value than that displayed in a connected control system.

Select the desired measured value for the analogue output in the measurement menu:

- SAE class according to AS 4059, for details refer to ▸Sec. 7.7.1 "SAE classes according to AS 4059".
- ISO class according to ISO 4406 (> 4 µm, > 6 µm, > 14 µm), for details refer to ▸Sec. 7.7.2 "ISO class according to ISO 4406 > 4 µm, > 6 µm, > 14 µm".
- ISO class according to ISO 4406 (> 2 µm, > 5 µm, > 15 µm), for details refer to ▸Sec. 7.7.3 "ISO class according to ISO 4406 > 2 µm, > 5 µm, > 15 µm".
- NAS class according to NAS 1638, for details refer to ▸Sec. 7.7.4 "NAS classes according to NAS 1638 National Aerospace Standard".
- Fluid temperature, for details refer to ▸Sec. 7.7.5 "TEMP fluid temperature".

7.7.1 SAE classes according to AS 4059

The following SAE measured values can be read out via the analogue output:

- SAE
- SAE.MAX
- SAE A / SAE B / SAE C / SAE D
- SAE+T
- HDA.SAE

The current strength of 4.8...19.2 mA of the output signal depends on the cleanliness class according to SAE = 0.0 ... 14.0 (to the nearest 0.1 of a class) or an error, as described below:

Current I	SAE class / error
I < 4.0 mA	Cable break
4.0 mA < I < 4.1 mA	Device error, the ContaminationSensor is not ready.
4.1 mA < I < 4.3 mA	Not defined
4.3 mA < I < 4.5 mA	Flow rate error, the flow rate through the ContaminationSensor is too low.
4.5 mA < I < 4.8 mA	Not defined
I = 4.8 mA	SAE = 0
…	…
I = 19.2 mA	SAE = 14.0
19.2 mA < I < 19.8 mA	Not defined
19.8 mA < I < 20 mA	No measured value, flow rate is too high.

Tab. 20: Analogue output for SAE classes

Formulas for calculation:

- If the cleanliness class according to SAE is known, the current I can be calculated: I = 4.8 mA + SAE class * (19.2 mA - 4.8 mA) / 14
- If the current I is known, the cleanliness class according to SAE can be calculated: SAE Class = (I - 4.8 mA) * (14/14.4 mA)

SAE

The analogue SAE signal consists of the four measured values of the SAE classes A/B/C/D,, which are time-coded and transmitted as shown in the figure.

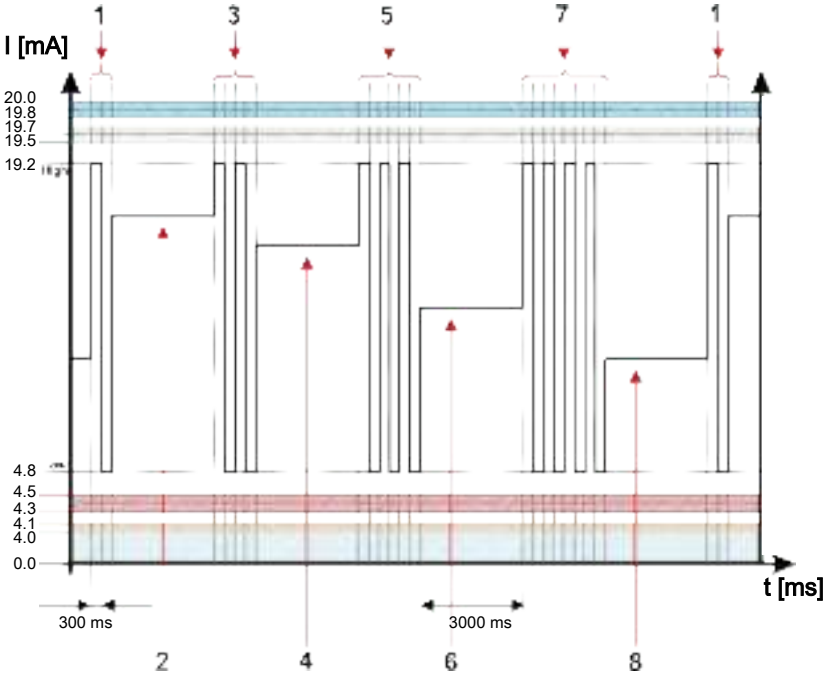


Fig. 19: Example: Analogue output signal SAE classes A/B/C/D, time-coded

Item	Signal	Description	Current I
1	Code	Measured value 1	1x (High / Low)
2	Measured value	SAE A	mA for the corresponding measured value
3	Code	Measured value 2	2x (High / Low)
4	Measured value	SAE B	mA for the corresponding measured value
5	Code	Measured value 3	3x (High / Low)
6	Measured value	SAE C	mA for the corresponding measured value
7	Code	Measured value 4	4x (High / Low)
8	Measured value	SAE D	mA for the corresponding measured value

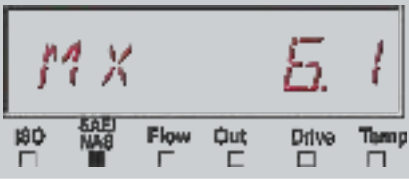
EN

SAE.MAX

The SAE.MAX measured value refers to the largest class of the four SAE A-D classes (corresponding to > 4 $\mu m_{(c)}$, > 6 $\mu m_{(c)}$, > 14 $\mu m_{(c)}$, > 21 $\mu m_{(c)}$).

The signal is updated after the measurement period has elapsed. The measurement period is set in the PowerUp menu under M.TIME.

The SAE.MAX signal is output depending on the maximum SAE class.

SAE classes	SAE.MAX (SAE A-D)
SAE 6.1A / 5.7B / 6.0C / 5.5D	

Tab. 21: Example: SAE.MAX

The SAE classification consists of whole numbers. In order to be able to recognise a change or trend more quickly, a resolution of 0.1 of a cleanliness class has been implemented. The decimal value is converted to a whole number and rounded up.

For example: According to SAE 4059, a readout of SAE 5.7 corresponds to class SAE 6.

SAE A / SAE B / SAE C / SAE D.

The SAE A / SAE B / SAE C / SAE D analogue signal consists of a measured value (SAE A / SAE B / SAE C or SAE D) and is transmitted permanently, as shown in the figure. The measurement period is set in the PowerUp menu under M.TIME.

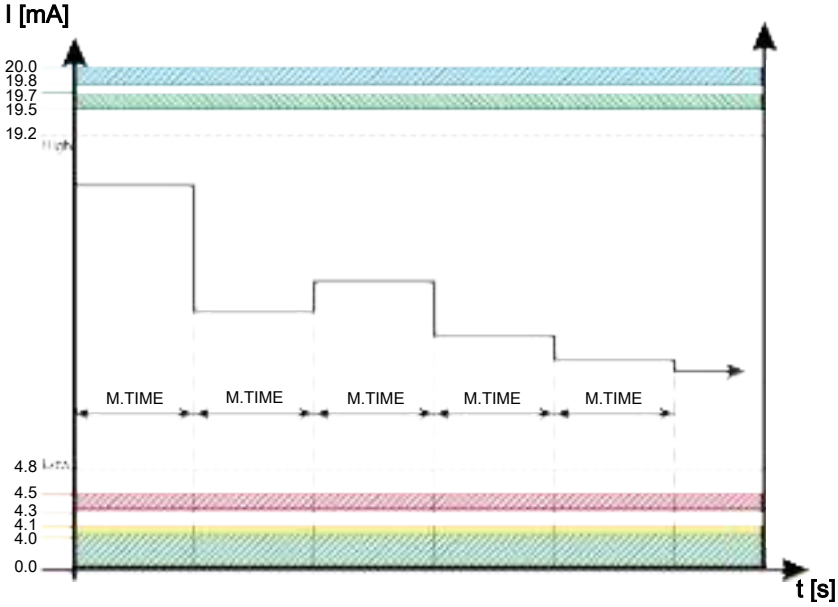


Fig. 20: Example: Analogue output signal class SAE A / SAE B / SAE C or SAE D

EN

SAE+T

The SAE+T analogue signal consists of five measured values (SAE A, SAE B, SAE C, SAE D and temperature), which are transmitted in a time-coded format.

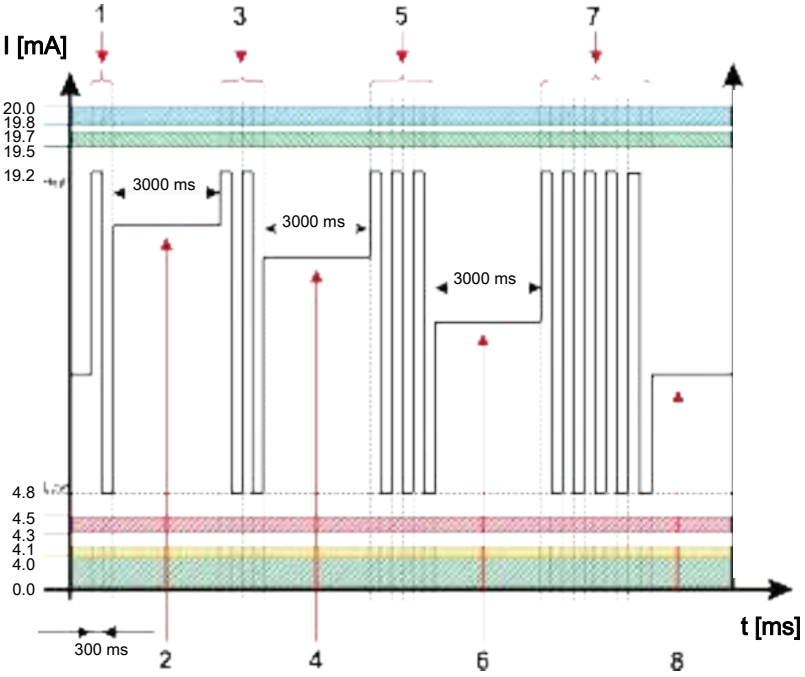


Fig. 21: Example: Analogue output signal SAE+T

Item	Signal	Description	Current I
1	Code	Measured value 1	1x (High / Low)
2	Measured value	SAE A	mA for the corresponding measured value
3	Code	Measured value 2	2x (High / Low)
4	Measured value	SAE B	mA for the corresponding measured value
5	Code	Measured value 3	3x (High / Low)
6	Measured value	SAE C	mA for the corresponding measured value
7	Code	Measured value 4	4x (High / Low)
8	Measured value	SAE D	mA for the corresponding measured value

Item	Signal	Description	Current I
9	Code	Measured value 5	5x (High / Low)
10	Measured value	Temp.	mA for the corresponding measured value

EN

HDA.SAE

The HDA.SAE signal consists of six signals (START / SAE A / SAE B / SAE C / SAE D / Status) which are transmitted sequentially. Synchronisation with the downstream control system is a requirement.

The output of the analogue signal is as follows:

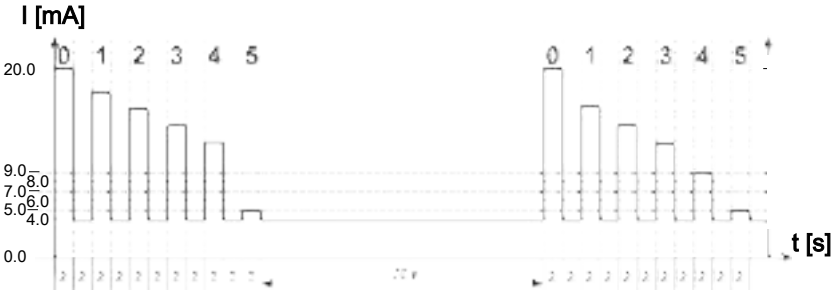


Fig. 22: Example: HDA.SAE analogue output

Item	Signal	Description	Current I
0	Signal	Start	20mA
	Pause	-	4mA
1	Signal	Measured value SAE A	mA for the corresponding measured value
	Pause		4mA
2	Signal	Measured value SAE B	mA for the corresponding measured value
	Pause		4mA
3	Signal	Measured value SAE C	mA for the corresponding measured value
	Pause		4mA
4	Signal	Measured value SAE D	mA for the corresponding measured value
	Pause		4mA
5	Signal	Status	mA for the corresponding measured value
	Pause		4mA

HDA.SAE signal 1/2/3/4

The current range depends on the cleanliness class on a scale of SAE=0.0 - 14.0 (to the nearest 0.1 of a class).

Current I	SAE class / error
I < 4.0 mA	Cable break
I = 4.0 mA	SAE = 0
…	…
I = 20.0 mA	SAE = 14.0

Tab. 22: HDA.SAE signal 1/2/3/4

Formulas for calculation:

- If the cleanliness class according to SAE is known, the current can be calculated: I = 4 mA + SAE class * (20 mA – 4 mA) / 14
- If the current I or the voltage U is known, the cleanliness class according to SAE can be calculated: SAE class = (I – 4 mA) * (14/16 mA)

HDA.SAE status signal 5

The current strength of the status signal depends on the status of the ContaminationSensor, as described in the following table.

Current I	Status
I = 5.0 mA	The ContaminationSensor is working without error.
I = 6.0 mA	Device error, the ContaminationSensor is not ready.
I = 7.0 mA	The flow rate is too low.
I = 8.0 mA	ISO < 9 < 8 < 7 or SAE < 0 or NAS < 0
I = 9.0 mA	No measured value, flow rate is not defined or is too high.

If the status signal is 6.0 / 7.0 / 9.0 mA, analogue signals 1 to 4 are output at 20 mA.

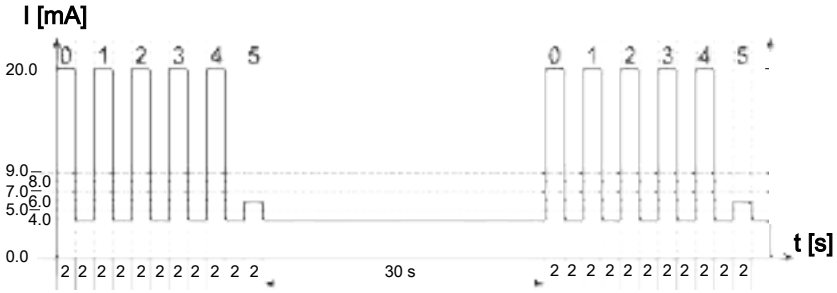


Fig. 23: Example: status of analogue signal 5

Item	Signal	Description	Current I
0	Signal	Start	20mA
	Pause		4mA
1	Signal	Error	20mA
	Pause		4mA
2	Signal	Error	20mA
	Pause		4mA
3	Signal	Error	20mA
	Pause		4mA
4	Signal	Error	20mA
	Pause		4mA
5	Signal	Status	6mA
	Pause		4mA

If the status signal is 8.0 mA, analogue signals 1 to 4 are output as follows:

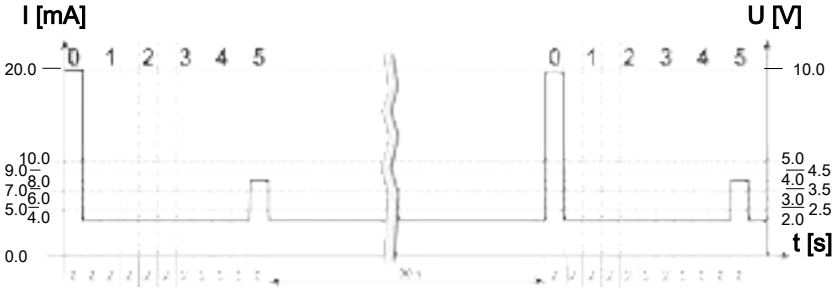


Fig. 24: Example: HDA signal out put of signal 1-4 in accordance with status 5

Item	Signal	Description	Current I
0	Signal	Start	20mA
	Pause	-	4mA
1	Signal	SAE A = 0	4mA
	Pause	-	4mA
2	Signal	SAE B = 0	4mA
	Pause	-	4mA
3	Signal	SAE C = 0	4mA
	Pause	-	4mA
4	Signal	SAE D = 0	4mA
	Pause	-	4mA
5	Signal	Status	8mA
	Pause	-	4mA

7.7.2 ISO class according to ISO 4406 > 4 µm, > 6 µm, > 14 µm

The following ISO measured values can be read out via the analogue output:

- ISO 4 / ISO 6 / ISO 14
- ISO
- ISO+T
- HDA.ISO

The current strength of 4.8 ... 19.2 mA of the output signal depends on the cleanliness class according to ISO 0.0 ... 24.28 (to the nearest 1 class) or an error, as described below:

Current I	ISO class / error
I < 4.0 mA	Cable break.
4.0 mA < I < 4.1 mA	Device error, the ContaminationSensor is not ready.
4.1 mA < I < 4.3 mA	Not defined.
4.3 mA < I < 4.5 mA	Flow rate error, the flow rate through the ContaminationSensor is too low.
4.5 mA < I < 4.8 mA	Not defined.
I = 4.8 mA	ISO = 0
…	…
I = 19.2 mA	ISO = 24.28
19.2 mA < I < 19.8 mA	Not defined
19.8 mA < I < 20 mA	No measured value, flow rate is too high.

Tab. 23: Analogue output for ISO class

Formulas for calculation:

- If the cleanliness class according to ISO is known, the current I or voltage U can be calculated:
  I = 4.8 mA + ISO class * (19.2 mA - 4.8 mA) / 24.28
- If the current I or the voltage U is known, the cleanliness class according to ISO can be calculated:
  ISO Class = (I - 4.8 mA) * (24.28/14.4 mA)

ISO 4 / ISO 6 / ISO 14

The ISO 4 / ISO 6 / ISO 14 analogue signal consists of a measured value (> 4 µm or > 6 µm or > 14 µm) and is transmitted permanently, as shown in the figure. The measurement period is set in the PowerUp menu under M.TIME.

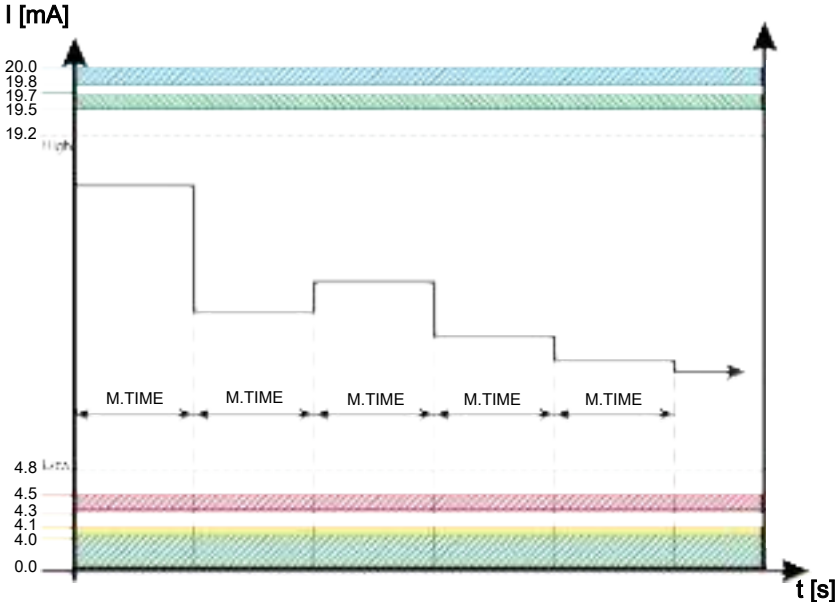


Fig. 25: Example: Analogue output signal class ISO 4 / ISO 6 or ISO 14

EN

ISO

The ISO code analogue signal consists of three measured values (> 4 $\mu m_{(c)}$ / > 6 $\mu m_{(c)}$ / > 14 $\mu m_{(c)}$), which are transmitted in a time-coded format.

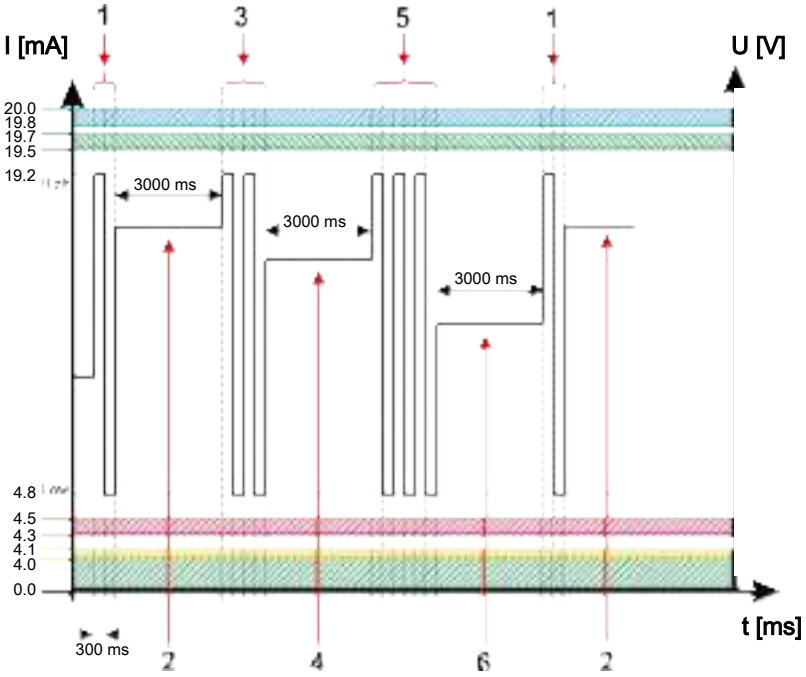


Fig. 26: Example: Analogue output signal ISO code, time-coded

Item	Signal	Description	Current I
1	Code	Measured value 1	1x (High / Low)
2	Measured value	ISO 4	mA for the corresponding measured value
3	Code	Measured value 2	2x (High / Low)
4	Measured value	ISO 6	mA for the corresponding measured value
5	Code	Measured value 3	3x (High / Low)
6	Measured value	ISO 14	mA for the corresponding measured value

ISO+T

The ISO+T analogue signal consists of four measured values, which are transmitted in a time-coded format.

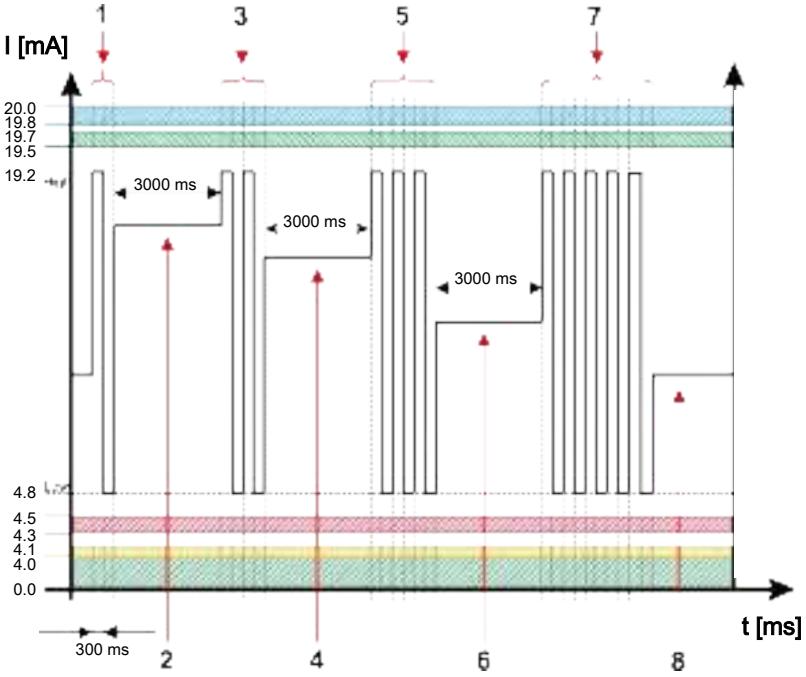


Fig. 27: Example: Analogue output signal ISO+T

Item	Signal	Description	Current I
1	Code	Measured value 1	1x (High / Low)
2	Measured value	ISO 4	mA for the corresponding measured value
3	Code	Measured value 2	2x (High / Low)
4	Measured value	ISO 6	mA for the corresponding measured value
5	Code	Measured value 3	3x (High / Low)
6	Measured value	ISO 14	mA for the corresponding measured value
9	Code	Temp.	5x (High / Low)
10	Measured value	Temp.	mA for the corresponding measured value

EN

HDA.ISO

The HDA.ISO analogue signal for HDA 5500 consists of six signals (START / ISO 4 / ISO 6 / ISO 14 / ISO 21 / Status) which are transmitted sequentially. Synchronisation with the downstream control system is a requirement.

The output of the signal is as follows:

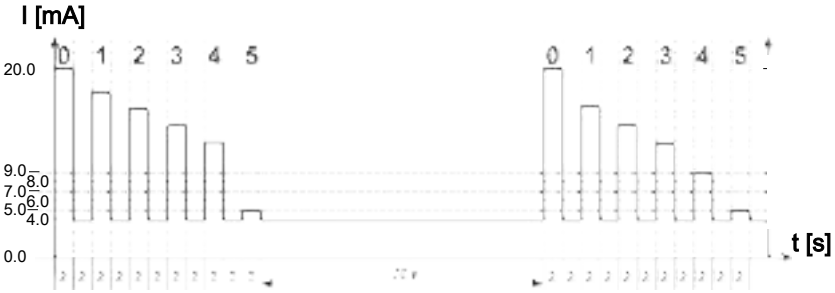


Fig. 28: Example: HDA.ISO analogue output

Item	Signal	Description	Current I
0	Signal	Start	20mA
	Pause	-	4mA
1	Signal	ISO 4	mA for the corresponding measured value
	Pause		4mA
2	Signal	ISO 6	mA for the corresponding measured value
	Pause		4mA
3	Signal	ISO 14	mA for the corresponding measured value
	Pause		4mA
4	Signal	ISO 21	mA for the corresponding measured value
	Pause		4mA
5	Signal	Status	mA or V for the corresponding status
	Pause		4mA

HDA.ISO signal 1/2/3/4

The current strength of 4 ... 20 mA or the voltage of 2 … 10 V of the output signal depends on the cleanliness class according to ISO 0.0 ... 24.28 (to the nearest 1 class), as described below:

Current I	ISO class / error
I < 4.00 mA	Cable break
I = 4.00 mA	ISO = 0
…	…
I = 19.82 mA	ISO = 24
I = 20.00 mA	ISO = 24.28

Tab. 24: HDA.ISO signal 1/2/3/4

Formulas for calculation:

- If the cleanliness class according to ISO is known, the current I can be calculated:
  I = 4 mA + ISO class * (20 mA – 4 mA) / 24.28
- If the current I is known, the cleanliness class according to ISO can be calculated:
  ISO Class = (I – 4 mA) * (24.28 / 16 mA)

HDA.ISO status signal 5

The current strength of the status signal depends on the status of the ContaminationSensor, as described in the following table.

Current I	Status
I = 5.0 mA	The ContaminationSensor is working without error.
I = 6.0 mA	Device error, the ContaminationSensor is not ready.
I = 7.0 mA	The flow rate is too low.
I = 8.0 mA	ISO < 9 < 8 < 7 or SAE < 0 or NAS < 0
I = 9.0 mA	No measured value, flow rate is not defined or is too high.

If the status signal is 6.0 / 7.0 / 9.0 mA, analogue signals 1 to 4 are output at 20 mA.

EN

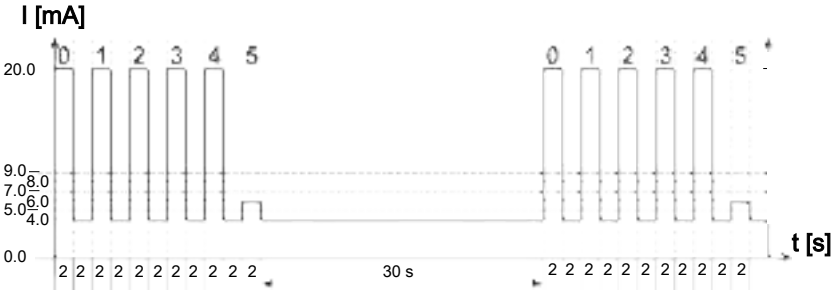


Fig. 29: Example: status of analogue signal 5

Item	Signal	Description	Current I
0	Signal	Start	20mA
	Pause		4mA
1	Signal	Error	20mA
	Pause		4mA
2	Signal	Error	20mA
	Pause		4mA
3	Signal	Error	20mA
	Pause		4mA
4	Signal	Error	20mA
	Pause		4mA
5	Signal	Status	6mA
	Pause		4mA

If the status signal is 8.0 mA or 4.0 V, analogue signals 1 to 4 are output as follows:

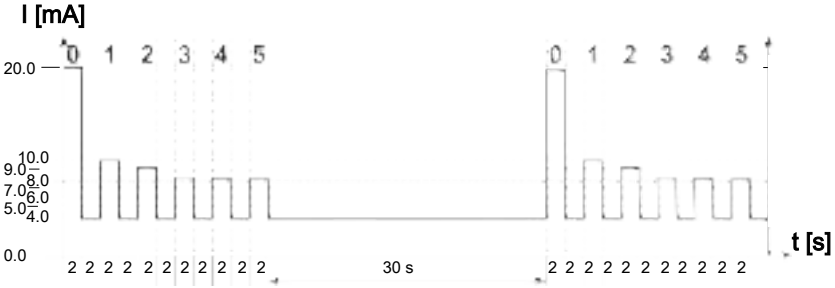


Fig. 30: Example: HDA signal output of signal 1-4 in accordance with status 5

Item	Signal	Description	Current I
0	Signal	Start	20mA
	Pause	-	4mA
1	Signal	ISO 4 = 9	9.93mA
	Pause		4mA
2	Signal	ISO 6 = 8	9.27mA
	Pause		4mA
3	Signal	ISO 14 = 7	8.61mA
	Pause		4mA
4	Signal	ISO 21 = 6	7.95mA
	Pause		4mA
5	Signal	Status	8mA
	Pause		4mA

EN

7.7.3 ISO class according to ISO 4406 > 2 µm, > 5 µm, > 15 µm

The following ISO measured values can be read out via the analogue output:

- ISO 2 / ISO 5 / ISO 15
- ISO
- ISO+T
- HDA.ISO

The current strength of 4.8 ... 19.2 mA of the output signal depends on the cleanliness class according to ISO 0.0 ... 24.28 (to the nearest 1 class) or an error, as described below:

Current I	ISO class / error
I < 4.0 mA	Cable break.
4.0 mA < I < 4.1 mA	Device error, the ContaminationSensor is not ready.
4.1 mA < I < 4.3 mA	Not defined.
4.3 mA < I < 4.5 mA	Flow rate error, the flow rate through the ContaminationSensor is too low.
4.5 mA < I < 4.8 mA	Not defined.
I = 4.8 mA	ISO = 0
…	…
I = 19.2 mA	ISO = 24.28
19.2 mA < I < 19.8 mA	Not defined
19.8 mA < I < 20 mA	No measured value, flow rate is too high.

Tab. 25: Analogue output for ISO class

Formulas for calculation:

- If the cleanliness class according to ISO is known, the current I or voltage U can be calculated:
  I = 4.8 mA + ISO class * (19.2 mA - 4.8 mA) / 24.28
- If the current I or the voltage U is known, the cleanliness class can be calculated according to ISO:
  ISO Class = (I - 4.8 mA) * (24.28/14.4 mA)

ISO 2 / ISO 5 / ISO 15

The ISO 2 / ISO 5 / ISO 15 analogue signal consists of a measured value (> 2 µm or > 5 µm or > 15 µm) and is transmitted permanently, as shown in the figure. The measurement period is set in the PowerUp menu under M.TIME.

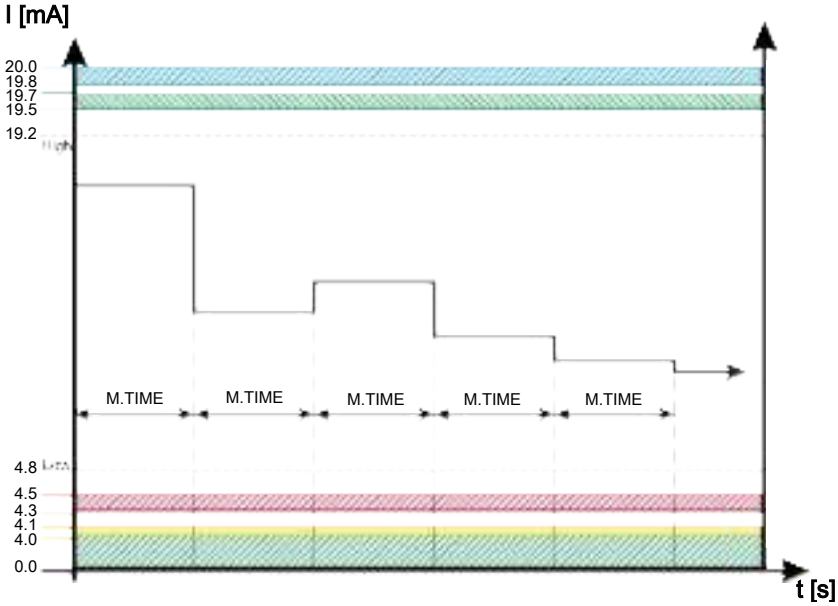


Fig. 31: Example: Analogue output signal class ISO 2 / ISO 5 or ISO 15

EN

ISO

The ISO code analogue signal consists of three measured values (> 2 $\mu m_{(c)}$ / > 5 $\mu m_{(c)}$ / > 15 $\mu m_{(c)}$), which are transmitted in a time-coded format.

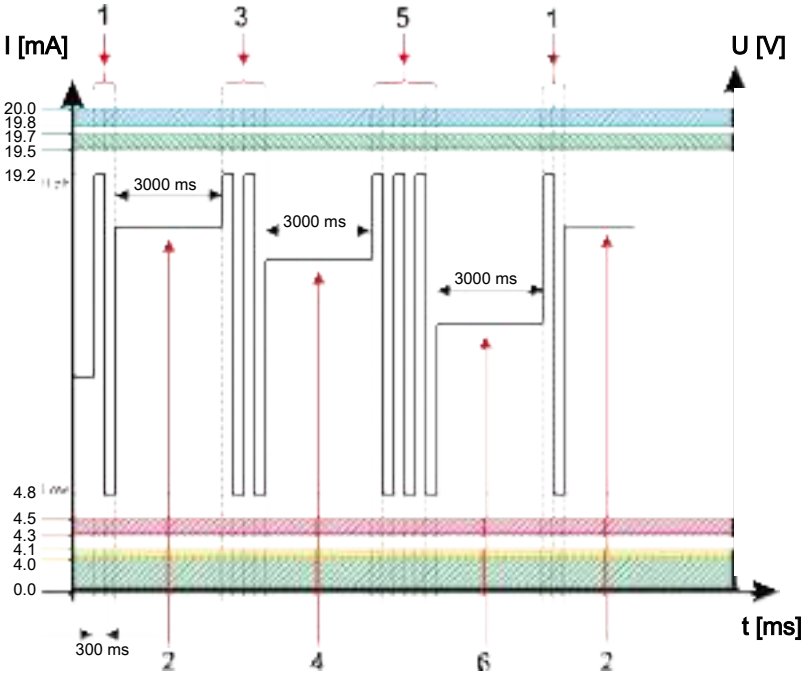


Fig. 32: Example: Analogue output signal ISO code, time-coded

Item	Signal	Description	Current I
1	Code	Measured value 1	1x (High / Low)
2	Measured value	ISO 2	mA for the corresponding measured value
3	Code	Measured value 2	2x (High / Low)
4	Measured value	ISO 5	mA for the corresponding measured value
5	Code	Measured value 3	3x (High / Low)
6	Measured value	ISO 15	mA for the corresponding measured value

ISO+T

The ISO+T analogue signal consists of four measured values, which are transmitted in a time-coded format.

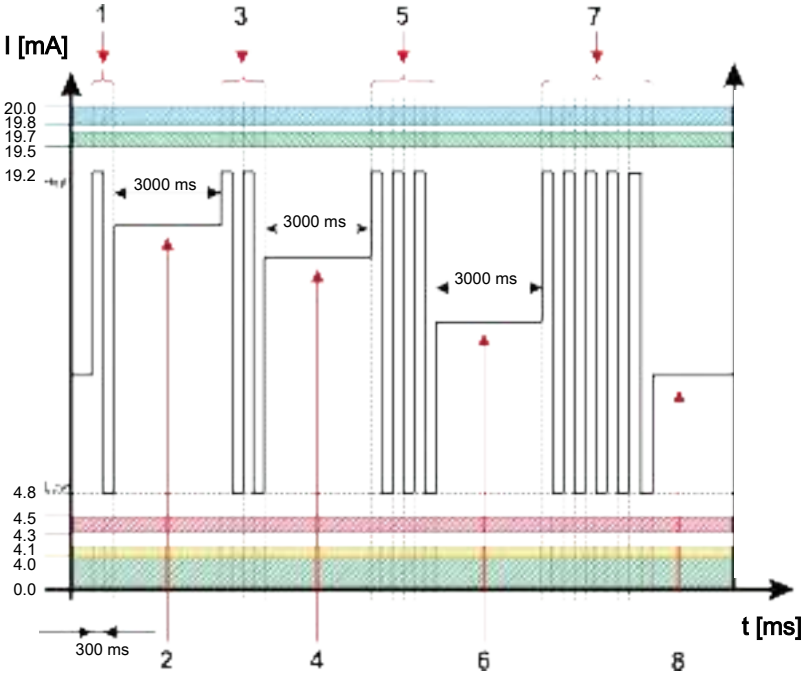


Fig. 33: Example: Analogue output signal ISO+T

Item	Signal	Description	Current I
1	Code	Measured value 1	1x (High / Low)
2	Measured value	ISO 2	mA for the corresponding measured value
3	Code	Measured value 2	2x (High / Low)
4	Measured value	ISO 5	mA for the corresponding measured value
5	Code	Measured value 3	3x (High / Low)
6	Measured value	ISO 15	mA for the corresponding measured value
9	Code	Temp.	5x (High / Low)
10	Measured value	Temp.	mA for the corresponding measured value

EN

HDA.ISO

The HDA.ISO analogue signal for HDA 5500 consists of six signals (START / ISO 2 / ISO 5 / ISO 15 / ISO 25 / Status) which are transmitted sequentially. Synchronisation with the downstream control system is a requirement.

The output of the signal is as follows:

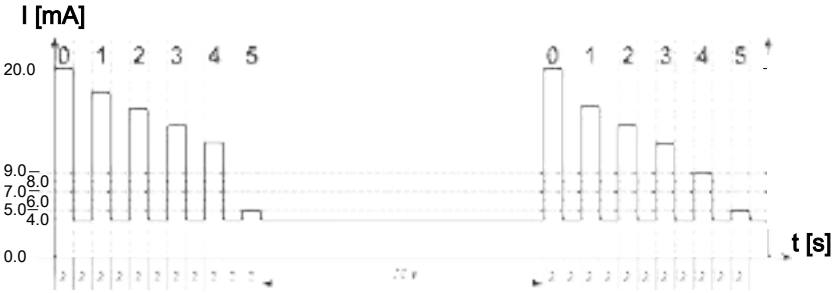


Fig. 34: Example: HDA.ISO analogue output

Item	Signal	Description	Current I
0	Signal	Start	20mA
	Pause	-	4mA
1	Signal	ISO 2	mA for the corresponding measured value
	Pause		4mA
2	Signal	ISO 5	mA for the corresponding measured value
	Pause		4mA
3	Signal	ISO 15	mA for the corresponding measured value
	Pause		4mA
4	Signal	ISO 25	mA for the corresponding measured value
	Pause		4mA
5	Signal	Status	mA or V for the corresponding status
	Pause		4mA

HDA.ISO signal 1/2/3/4

The current strength of 4 ... 20 mA or the voltage of 2 … 10 V of the output signal depends on the cleanliness class according to ISO 0.0 ... 24.28 (to the nearest 1 class), as described below:

Current I	ISO class / error
I < 4.00 mA	Cable break
I = 4.00 mA	ISO = 0
…	…
I = 19.82 mA	ISO = 24
I = 20.00 mA	ISO = 24.28

Tab. 26: HDA.ISO signal 1/2/3/4

Formulas for calculation:

- If the cleanliness class according to ISO is known, the current I can be calculated: I = 4 mA + ISO class * (20 mA – 4 mA) / 24.28
- If the current I is known, the cleanliness class can be calculated according to ISO: ISO Class = (I – 4 mA) * (24.28 / 16 mA)

HDA.ISO status signal 5

The current strength of the status signal depends on the status of the ContaminationSensor, as described in the following table.

Current I	Status
I = 5.0 mA	The ContaminationSensor is working without error.
I = 6.0 mA	Device error, the ContaminationSensor is not ready.
I = 7.0 mA	The flow rate is too low.
I = 8.0 mA	ISO < 9 < 8 < 7 or SAE < 0 or NAS < 0
I = 9.0 mA	No measured value, flow rate is not defined or is too high.

If the status signal is 6.0 / 7.0 / 9.0 mA, analogue signals 1 to 4 are output at 20 mA.

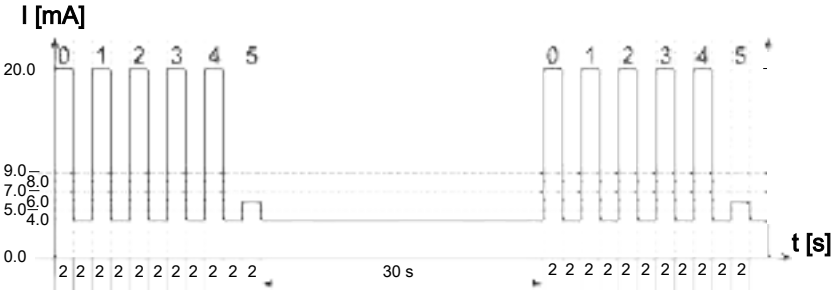


Fig. 35: Example: status of analogue signal 5

Item	Signal	Description	Current I
0	Signal	Start	20mA
	Pause		4mA
1	Signal	Error	20mA
	Pause		4mA
2	Signal	Error	20mA
	Pause		4mA
3	Signal	Error	20mA
	Pause		4mA
4	Signal	Error	20mA
	Pause		4mA
5	Signal	Status	6mA
	Pause		4mA

If the status signal is 8.0 mA or 4.0 V, analogue signals 1 to 4 are output as follows:

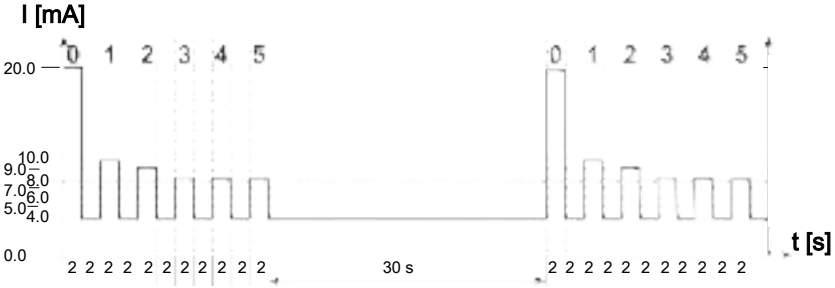


Fig. 36: Example: HDA signal output of signal 1-4 in accordance with status 5

Item	Signal	Description	Current I
0	Signal	Start	20mA
	Pause	-	4mA
1	Signal	ISO 2 = 9	9.93mA
	Pause		4mA
2	Signal	ISO 5 = 8	9.27mA
	Pause		4mA
3	Signal	ISO 15 = 7	8.61mA
	Pause		4mA
4	Signal	ISO 25 = 6	7.95mA
	Pause		4mA
5	Signal	Status	8mA
	Pause		4mA

7.7.4 NAS classes according to NAS 1638 National Aerospace Standard

The following NAS classes can be read out via the analogue output:

- NAS
- NAS.MAX
- NAS 2 / NAS 5 / NAS 15 / NAS 25
- NAS+T
- HDA.NAS

The designations NAS 2 / NAS 5 / NAS 15 / NAS 25 always refer to the corresponding particle size range according to the following table:

Designation	NAS 2	NAS 5	NAS 15	NAS 25
Particle size range	2 … 5 µm	5 … 15 µm	15 … 25 µm	≥ 25 µm

Tab. 27: NAS- classes per particle size range

The current strength of 4.8 ... 19.2 mA of the output signal depends on the cleanliness class according to NAS 0.0 ... 14.0 (to the nearest 0.1 class) or an error, as described below:

Current I	NAS class / error
I < 4.0 mA	Cable break.
4.0 mA < I < 4.1 mA	Device error, the ContaminationSensor is not ready.
4.1 mA < I < 4.3 mA	Not defined.
4.3 mA < I < 4.5 mA	Flow rate error, the flow rate through the ContaminationSensor is too low.
4.5 mA < I < 4.8 mA	Not defined.
I = 4.8 mA	NAS = 0
…	…
I = 19.2 mA	NAS = 14.0
19.2 mA < I < 19.8 mA	Not defined.
19.8 mA < I < 20 mA	No measured value, flow rate is too high.

Tab. 28: Analogue output for NAS classes

Formulas for calculation:

- If the cleanliness class according to NAS is known, the current I can be calculated:
  I = 4.8 mA + NAS class * (19.2 mA - 4.8 mA) / 14
- If the current I is known, the cleanliness class according to NAS can be calculated:
  NAS class = (I - 4.8 mA) * (14 / 14.4 mA)

EN

NAS

The analogue signal of NAS 2 / 5 / 15 / 25 consists of the four measured values which are time-coded and transmitted as shown in the figure.

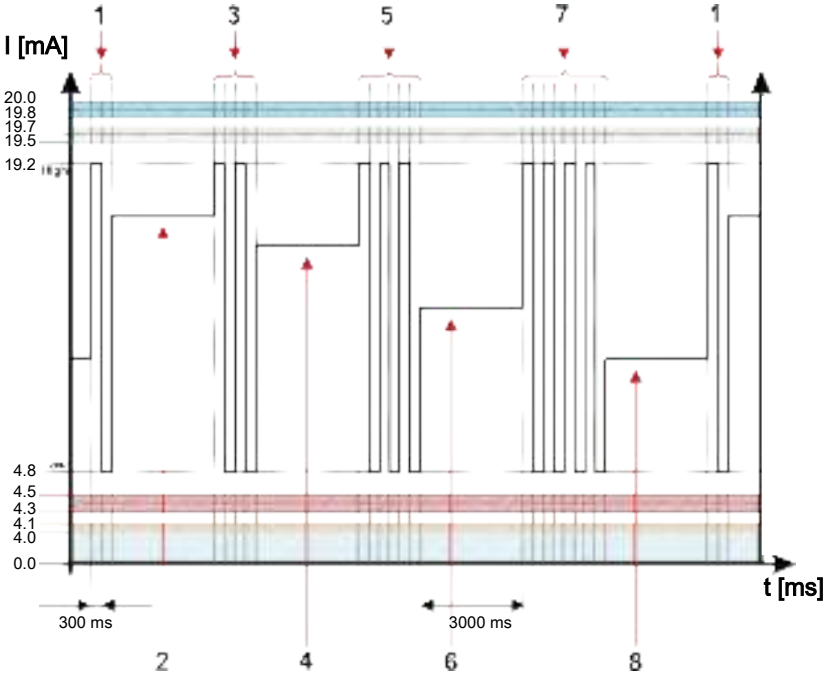


Fig. 37: Example: Analogue output signal NAS classes 2-5 µm / 5-15 µm / 15-25 µm / ≥ 25 µm, time-coded

Item	Signal	Description	Current I
1	Code	Measured value 1	1x (High / Low)
2	Measured value	NAS 2	mA for the corresponding measured value
3	Code	Measured value 2	2x (High / Low)
4	Measured value	NAS 5	mA for the corresponding measured value
5	Code	Measured value 3	3x (High / Low)
6	Measured value	NAS 15	mA for the corresponding measured value
7	Code	Measured value 4	4x (High / Low)
8	Measured value	NAS 25	mA for the corresponding measured value

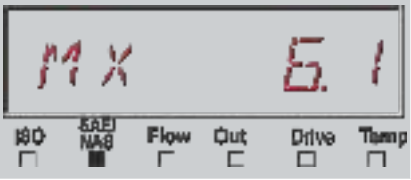
EN

NAS.MAX

The NAS.MAX measured value refers to the largest class of the classes determined by the four particle size ranges.

The signal is updated after the measurement period has elapsed. The measurement period is set in the PowerUp menu under M.TIME.

The NAS.MAX signal is output based on the maximum NAS class.

NAS classes	NAS.MAX
NAS 6.1 / 5.7 / 6.0 / 5.5	

Tab. 29: Example: NAS.MAX

The NAS classification consists of whole numbers. In order to be able to recognise a change or trend more quickly, a resolution of 0.1 of a cleanliness class has been implemented. The decimal value is converted to a whole number and rounded up.

For example: According to NAS, a readout of NAS 5.7 corresponds to class NAS 6.

NAS 2 / NAS 5 / NAS 15 / NAS 25

The NAS 2 / NAS 5 / NAS 15 / NAS 25 analogue signal consists of a measured value, and is transmitted permanently, as shown in the figure. The measurement period is set in the PowerUp menu under M.TIME.

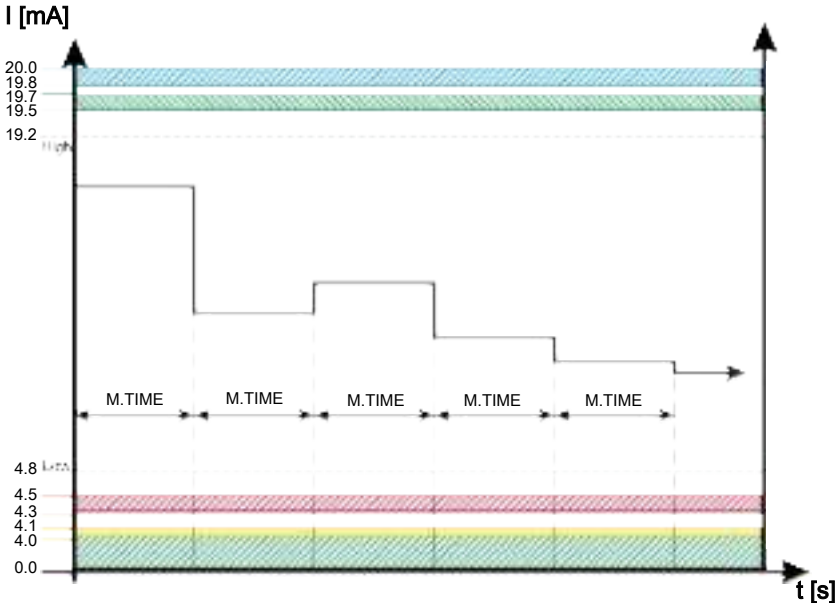


Fig. 38: Example: Analogue output signal class NAS 2 / NAS 5 / NAS 15 or NAS 25

EN

NAS+T

The NAS+T analogue signal consists of five measured values, which are transmitted in a time-coded format.

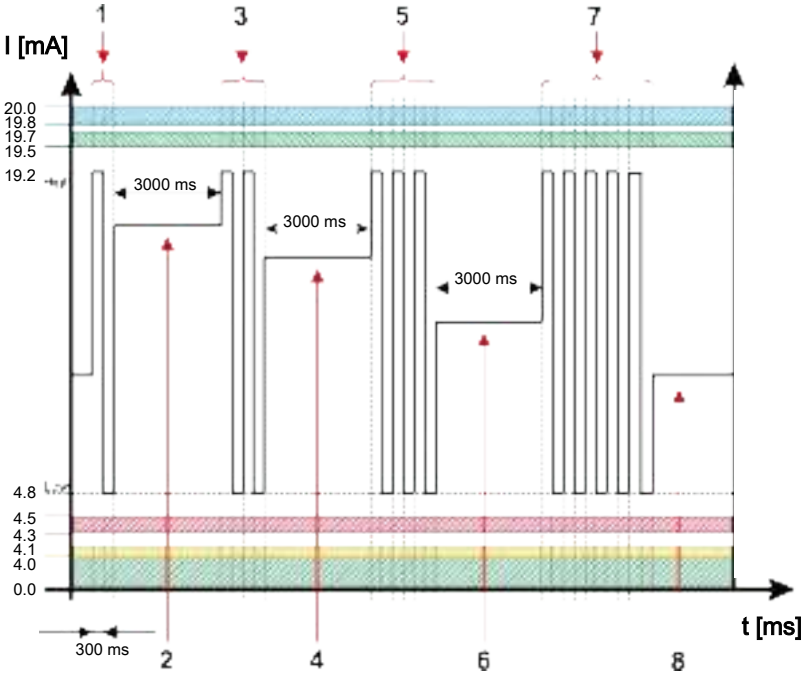


Fig. 39: Example: Analogue output signal NAS+T

Item	Signal	Description	Current I
1	Code	Measured value 1	1x (High / Low)
2	Measured value	NAS 2	mA for the corresponding measured value
3	Code	Measured value 2	2x (High / Low)
4	Measured value	NAS 5	mA for the corresponding measured value
5	Code	Measured value 3	3x (High / Low)
6	Measured value	NAS 15	mA for the corresponding measured value
7	Code	Measured value 4	4x (High / Low)
8	Measured value	NAS 25	mA for the corresponding measured value

Item	Signal	Description	Current I
9	Code	Measured value 5	5x (High / Low)
10	Measured value	Temp.	mA for the corresponding measured value

EN

HDA.NAS

The HDA.NAS signal for the HDA 5500 consists of six signals (START / NAS 2 / NAS 5 / NAS 15 / NAS 25 / Status) which are transmitted sequentially. Synchronisation with the downstream control system is a requirement.

The output of the analogue signal is as follows:

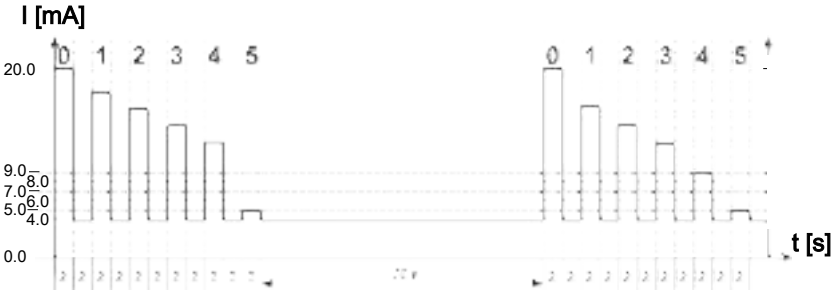


Fig. 40: Example: HDA.NAS analogue output

Item	Signal	Description	Current I
0	Signal	Start	20mA
	Pause		4mA
1	Signal	NAS 2	mA for the corresponding measured value
	Pause		4mA
2	Signal	NAS 5	mA for the corresponding measured value
	Pause		4mA
3	Signal	NAS 15	mA for the corresponding measured value
	Pause		4mA
4	Signal	NAS 25	mA for the corresponding measured value
	Pause		4mA
5	Signal	Status	mA or V for the corresponding status
	Pause		4mA

HDA.NAS signal 1/2/3/4

The current range depends on the cleanliness class on a scale of NAS =0.0 - 14.0 (accuracy 0.1 of a class).

Current I	NAS class / error
I < 4.0 mA	Cable break
I = 4.0 mA	NAS = 0
…	…
I = 20.0 mA	NAS = 14.0

Tab. 30: HDA.NAS signal 1/2/3/4

Formulas for calculation:

- If the cleanliness class according to NAS is known, the current I can be calculated:
  I = 4 mA + NAS class * (20 mA – 4 mA) / 14
- If the current I or the voltage U is known, the cleanliness class according to NAS can be calculated:
  NAS class = (I– 4 mA) * (14 / 16 mA)

HDA.NAS status signal 5

The current strength of the status signal depends on the status of the ContaminationSensor, as described in the following table.

Current I	Status
I = 5.0 mA	The ContaminationSensor is working without error.
I = 6.0 mA	Device error, the ContaminationSensor is not ready.
I = 7.0 mA	The flow rate is too low.
I = 8.0 mA	ISO < 9 < 8 < 7 or SAE < 0 or NAS < 0
I = 9.0 mA	No measured value, flow rate is not defined or is too high.

If the status signal is 6.0 / 7.0 / 9.0 mA, analogue signals 1 to 4 are output at 20 mA.

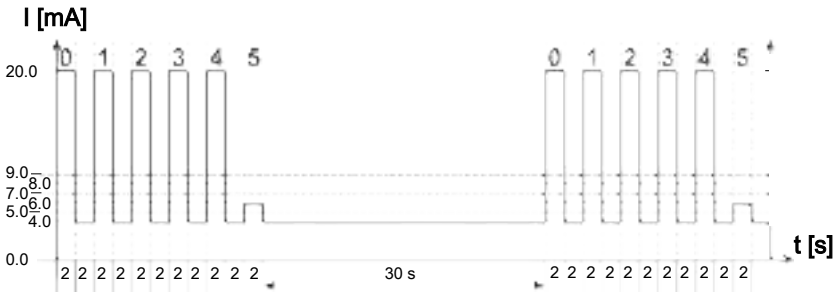


Fig. 41: Example: status of analogue signal 5

Item	Signal	Description	Current I
0	Signal	Start	20mA
	Pause		4mA
1	Signal	Error	20mA
	Pause		4mA
2	Signal	Error	20mA
	Pause		4mA
3	Signal	Error	20mA
	Pause		4mA
4	Signal	Error	20mA
	Pause		4mA
5	Signal	Status	6mA
	Pause		4mA

If the status signal is 8.0 mA, analogue signals 1 to 4 are output as follows:

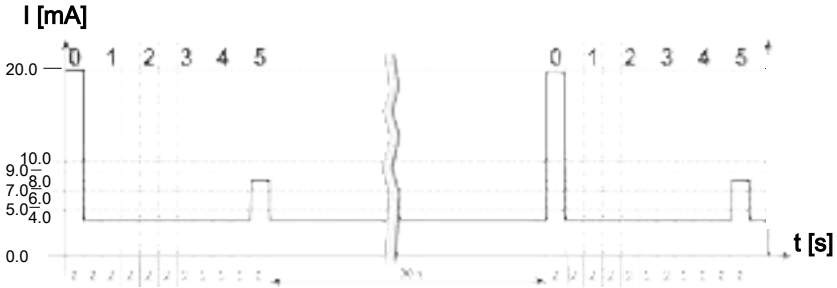


Fig. 42: Example: HDA signal output of signal 1-4 in accordance with status 5

Item	Signal	Description	Current I
0	Signal	Start	20mA
	Pause		4mA
1	Signal	NAS 2 = 0	4mA
	Pause		4mA
2	Signal	NAS 5 = 0	4mA
	Pause		4mA
3	Signal	NAS 15 = 0	4mA
	Pause		4mA
4	Signal	NAS 25 = 0	4mA
	Pause		4mA
5	Signal	Status	3mA
	Pause		4mA

7.7.5 TEMP fluid temperature

The current range 4.8 ...19.2 mA depends on the fluid temperature of -25 ... 100 °C (to the nearest 1 °C) or -13 ...212 °F (to the nearest 1°F), as described in the following table:

EN

Current I	Temperature / error
I < 4.0 mA	Cable break.
4.0 mA < I < 4.1 mA	Device error, the ContaminationSensor is not ready.
4.1 mA < I < 4.3 mA	Not defined.
4.3 mA < I < 4.5 mA	Flow rate error, the flow rate through the ContaminationSensor is too low.
4.5 mA < I < 4.8 mA	Not defined.
I = 4.8 mA	-25 °C / -13 °F
…	…
I = 19.2 mA	100 °C / 212 °F
19.2 mA < I < 19.8 mA	Not defined.
19.8 mA < I < 20 mA	No measured value, flow rate is too high.

Tab. 31: Analogue output temperature

Formulas for calculation:

- If the temperature is known, the current I can be calculated:
  I = 4.8 mA + (temperature [°C] + 25) * (19.2 mA - 4.8 mA) / 125
  I = 4.8 mA + (temperature [°F] + 13) * (19.2 mA - 4.8 mA) / 225
  If the current I is known, the temperature can be calculated:
  Temperature [°C] = ((I - 4.8 mA) * ((125 / 14.4 mA)) – 25
  Temperature [°F] = ((I - 4.8 mA) * ((225 / 14.4 mA)) - 13

8. Rectifying malfunctions

This chapter contains details of the status code on the electrical interface and status LED, web UI or display.

The 16-bit status code is set according to the following table.

Bit	Text Web UI Display	Description	Remedy	Status LED	Device Ready
-	Everything OK	-	-	Green, permanently lit	Ready
0	MEASURING	First measurement cycle after start-up, no measured value available yet	-	Green, permanently lit	Ready
1	INITIALIZING	Initialisation of hardware on start	-	Green, flashing	Ready
2	-	-	-	-	-
3	-	-	-	-	-
4	-	-	-	-	-
5	-	-	-	-	-
6	LIMIT EXCEEDED	The set limit value has been exceeded or not reached.	-	Red, permanently lit	Ready
7	TURBIDITY	The operating medium is contaminated with air or water or is too cloudy.	Clean the operating medium by degassing, dewatering and filtering.	Red, permanently lit	Ready

EN

Bit	Text Web UI Display	Description	Remedy	Status LED	Device Ready
8	TOO DIRTY	There are too many particles in the operating fluid; the coincidence limit has been exceeded.	Pre-filter the operating fluid.	Red, permanently lit	Ready
9	TOO CLEAN	The maximum measuring time was exceeded and there were too few particles	The cleanliness class of the operating medium is good, filtering can be switched off.	Red, permanently lit	Ready
10	NO FLOW	The ContaminationSensor cannot measure a flow rate.	Check the flow rate through the ContaminationSensor.	Red, permanently lit	Ready
11	FLOW TOO HIGH	The flow rate has been detected as being too high for measurement.	Reduce the flow rate through the ContaminationSensor.	Red, permanently lit	Ready
12	FLOW TOO LOW	The flow rate has been detected as being too low.	Increase the flow rate through the ContaminationSensor.	Red, permanently lit	Ready
13	AUTOADJUST ERROR	The measuring cell is blocked or the hardware is defective.	Flush the ContaminationSensor by reversing the flow direction or send the ContaminationSensor to HYDAC Service.	Red, flashing	Not ready
14	LED ERROR	The transmission LED is defective.	Send the ContaminationSensor to HYDAC Service.	Red, flashing	Not ready
15	SYSTEM ERROR	The hardware is faulty.	Send the ContaminationSensor to HYDAC Service.	Red, flashing	Not ready

Tab. 32: Rectifying a malfunction

8.1 Reading out status signal via the HDA 5500

The current strength of the status signal depends on the status of the ContaminationSensor, as described in the following table.

Current I	Status
I = 5.0 mA	The ContaminationSensor is working without error.
I = 6.0 mA	Device error, the ContaminationSensor is not ready.
I = 7.0 mA	The flow rate is too low.
I = 8.0 mA	ISO < 9 < 8 < 7 or SAE < 0 or NAS < 0
I = 9.0 mA	No measured value, flow rate is not defined or is too high.

If the status signal is 6.0 / 7.0 / 9.0 mA, analogue signals 1 to 4 are output at 20 mA.

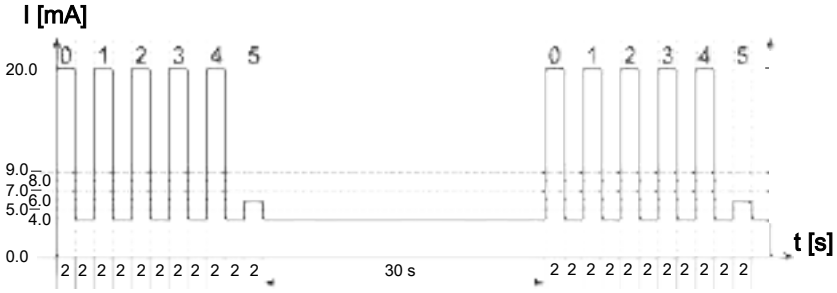


Fig. 43: Example: status of analogue signal 5

Item	Signal	Description	Current I
0	Signal	Start	20mA
	Pause		4mA
1	Signal	Error	20mA
	Pause		4mA
2	Signal	Error	20mA
	Pause		4mA
3	Signal	Error	20mA
	Pause		4mA
4	Signal	Error	20mA
	Pause		4mA

Item	Signal	Description	Current I
5	Signal	Status	6mA
	Pause		4mA

EN

If the status signal is 8.0 mA, analogue signals 1 to 4 are output as follows:

Signal	Current I
1	I = 10.0 mA
2	I = 9.2 mA
3	I = 8.6 mA
4	I = 8.0 mA

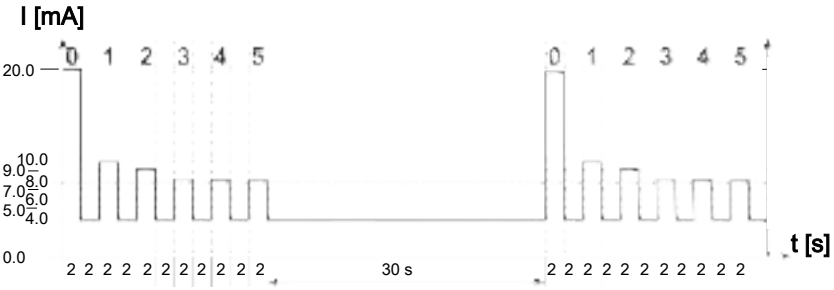


Fig. 44: Example: HDA-signal output – signal 1 to 4

9. Performing maintenance

The ContaminationSensor is maintenance-free.

Cleaning the display / user interface

Clean the display / user interface with a clean, damp cloth. Do not use any cleaning agents as these can damage the surface film.

Calibrating the pH sensor

Recalibration of the ContaminationSensor is recommended every 2 - 3 years at a HYDAC-certified customer workshop or service centre, unless regulated by other applicable rules. Addresses can be found at www.hydac.com.

10. Decommissioning/Disposal

In the following chapters, you will be provided with information regarding temporary shutdown/final decommissioning and disposal of the product.

EN

10.1 Temporary shutdown

If the product is being temporarily shut down, the following measures are adequate:

1. Switch the product off and disconnect it from all sources of energy.
2. Follow all the notices in the *Transport/storage* chapter.

10.2 Permanent shutdown

If the product is being shut down permanently, proceed as follows:

- Empty the product fully, including all the components, before the shutdown.
- Fully disconnect the product from the surrounding units.
- Slacken or remove the electric, pneumatic or hydraulic connections insofar as they are present.

10.3 Disposal/Recycling

Dismount and recycle the product that cannot be used any more, not as a whole unit, but in individual parts and according to the kind of the materials. After dismantling the product and separating its various materials into categories, dispose of all parts in an environmentally friendly manner according to the local specifications.

Dispose of the drained operating fluids and operating materials according to the local specifications in an environmentally friendly manner.

11. Annex

This Annex contains additional information on the product.

11.1 Contacting Customer Service

EN

Contact details such as the telephone numbers, e-mail and mailing addresses for the Hotline, product support, Customer Service, branch offices, service partners for maintenance, repair and spare parts can be found on our homepage www.hydac.com.

HYDAC SYSTEMS & SERVICES GMBH
Friedrichsthaler Str. 15, Werk 13
66450 Neunkirchen - Heinitz
Germany

Phone:	+49 6897 509 01
Fax:	+49 6897 509 324
E-mail:	service@hydac.com
Homepage:	www.hydac.com

11.2 Spare parts

Use only original spare parts for a long and defect-free life cycle of the product. When ordering spare parts and accessories make sure to always indicate the exact model code and the serial number.

Designation		Qty.	Part no.
O-ring for flange connection, CS15x0	(4,8x1,78 - 80 Shore, FPM)	1	6003048
O-ring for flange connection, CS15x1	(4,8x1,78 - 80 Shore, EPDM)	1	637473

Tab. 33: Spare parts

11.3 Accessories

Use only original spare parts for a long and defect-free life cycle of the product. When ordering spare parts and accessories make sure to always indicate the exact model code and the serial number.

The following accessories are available:

Designation		Qty.	Part no.
ContaminationSensor Interface	CSI-D-5	1	3249563
FluMoT		1	3355177
HYDAC digital display unit	HDA5500-0-2-AC-006	1	909925
HYDAC digital display unit	HDA5500-0-2-DC-006	1	909926

Tab. 34: Accessory

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Adapter kit/connection kit

Socket with screw clamp

ZBE0P, Screw connection socket, , , Socket M12x1, 8-pole, A–coded

Description	Part no.
Screw connection socket, ZBE0P, -	6055444

ZBE44, Screw connection socket, shielded, , Socket M12x1, 8-pole, A–coded

Description	Part no.
Screw connection socket, ZBE44, -	3281243

Single-ended cordset

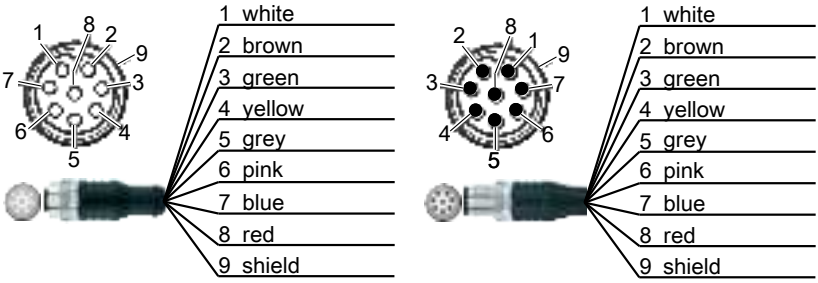
ZBE0P, Single-ended cordset, unshielded, black, Socket M12x1, 8-pin, angled A-coded <-> Open cable end

Description	Part no.
Single-ended cordset, Length: 2 m, ZBE0P-02 Cable sheath: -, colour: black, -	6052697
Single-ended cordset, Length: 5 m, ZBE0P-05 Cable sheath: -, colour: black, -	6052698

ZBE42S, Single-ended cordset, shielded, 8 Socket, M12x1-pole, straight A-coded <-> Open cable end

Description	Part no.
Single-ended cordset, length: 2 m, ZBE42S-02 black, -, -	3281220
Single-ended cordset, length: 5 m, ZBE42S-05 black, -, -	3281239
Single-ended cordset, length: 10 m, ZBE42S-10 black, -, -	3449681
Single-ended cordset, length: 20 m, ZBE42S-20 black, -, -	3654932

Single-ended cordset - colour coded



Socket Male connector

Fig. 45: Colour coding example: M12x1 socket / connector, A coded, 8 pin, shielded

Connection cable

ZBE43, Connection cable, unshielded, black, Socket M12x1, 8-pole, A-coded <-> Male connector M12x1, 8-pole, A-coded

Description	Part no.
Connection cable, Length: 0.5 m, ZBE43-005 Cable sheath: -, colour: black, -	4193544

ZBE43S, Connection cable, shielded, black, Socket M12x1, 8-pole, A-coded <-> Male connector M12x1, 8-pole, A-coded

Designation	Part no.
Connection cable, L: 5 m, ZBE43S-05 Cable sheath: -, colour: black, -	3281240
Connection cable, L: 10 m, ZBE43S-10 Cable sheath: -, colour: black, -	3519768

11.4 Approvals

In this chapter you can find conditions and details on the different approvals.

Conditions for FCC and IC approval:

The following conditions are required for FCC and IC approval:

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Changes or modifications to this device not expressly approved by HYDAC could void the FCC approval to operate this device.

This device complies with Section 15 of the FCC regulations and contains licence-exempt transmitters and receivers that comply with the licence-exempt RSS standards of Innovation, Science and Economic Development Canada.

The operation of the device is subject to the following two conditions:

- The device must not cause harmful interference and
- The device must accept any interference, including interference that may cause undesired operation of the device.

This device was tested and complies with the limit values for a digital device of class A in accordance with part 15 of the FCC provisions. These limit values should provide appropriate protection from damage and defects when the device is operated in a commercial environment. This device generates and uses high frequency energy and can emit this. If it is not installed and used according to the operating instructions, it can disrupt radio communication. Operation of this device in a residential area can cause damage. In this case, the use must bear the costs of any damage caused themselves.

This device complies with FCC and IC radiation exposure limits set forth for an uncontrolled environment. This device should be installed and operated with minimum distance of 20 cm between the radiator and your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

FR

Toute modification de cet appareil qui n'a pas été expressément autorisée par HYDAC peut entraîner le retrait de l'autorisation de la FCC pour l'utilisation de cet appareil.

Cet appareil correspond à la partie 15 des règles de la FCC et contient des émetteurs/récepteurs exemptés de licence conformes aux standards RSS exemptés de licence d'Innovation, Science and Economic Development Canada.

Le fonctionnement est soumis aux deux conditions suivantes :

- L'appareil ne doit pas causer d'interférences nuisibles et
- L'appareil doit accepter toutes les interférences reçues, y compris les interférences qui pourraient entraîner un fonctionnement indésirable de l'appareil.

Cet appareil a été testé et respecte les valeurs seuils d'un appareil numérique de la classe A conformément à la partie 15 des règlements du FCC. Ces valeurs seuils doivent permettre une protection adéquate contre les interférences nuisibles lorsque l'appareil fonctionne dans un environnement commercial. Cet appareil génère, utilise et peut émettre de l'énergie à haute fréquence. S'il n'est pas installé ou utilisé conformément aux instructions d'utilisation, il peut entraîner des interférences nuisibles au niveau de la radiocommunication. L'utilisation de cet appareil dans une zone résidentielle peut causer des interférences nuisibles. Dans ce cas, l'utilisateur doit éliminer ces interférences à ses frais.

Cet appareil est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet appareil doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

Ce transmetteur ne doit pas etre place au meme endroit ou utilise simultanement avec un autre transmetteur ou antenne.

Tab. 35: Conditions of FCC and IC approval

11.5 Declaration of conformity

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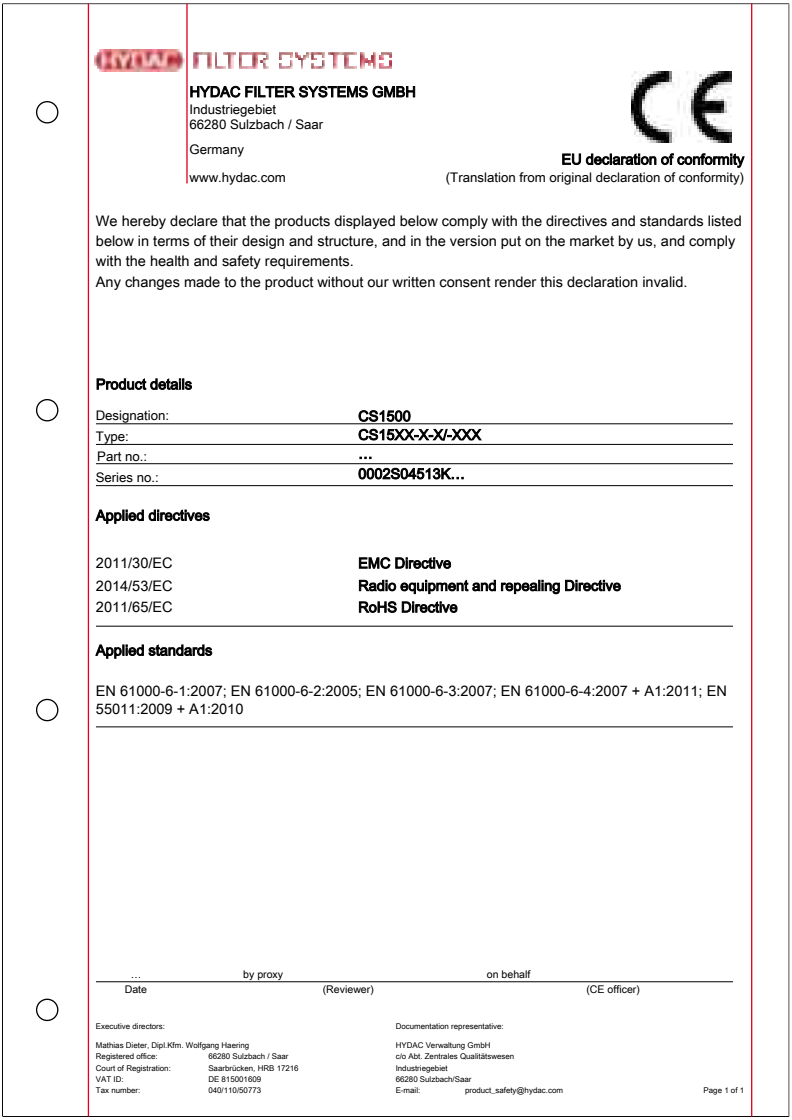
The declaration of conformity is provided here for information.



HYDAC FILTER SYSTEMS

HYDAC FILTER SYSTEMS GMBH
Industriegebiet
66280 Sulzbach / Saar
Germany
www.hydac.com

EU declaration of conformity
(Translation from original declaration of conformity)

We hereby declare that the products displayed below comply with the directives and standards listed below in terms of their design and structure, and in the version put on the market by us, and comply with the health and safety requirements.
Any changes made to the product without our written consent render this declaration invalid.

Product details

Designation:	**CS1500**
Type:	**CS15XX-X-X/-XXX**
Part no.:	**...**
Series no.:	**0002S04513K...**

Applied directives

2011/30/EC	**EMC Directive**
2014/53/EC	**Radio equipment and repealing Directive**
2011/65/EC	**RoHS Directive**

Applied standards

EN 61000-6-1:2007; EN 61000-6-2:2005; EN 61000-6-3:2007; EN 61000-6-4:2007 + A1:2011; EN 55011:2009 + A1:2010

...	by proxy	on behalf
Date	(Reviewer)	(CE officer)

Executive directors:
Mathias Dieter, Dipl.Kfm. Wolfgang Haering
Registered office: 66280 Sulzbach / Saar
Court of Registration: Saarbrücken, HRB 17216
VAT ID: DE 815001609
Tax number: 040/110/50773

Documentation representative:
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c/o Abt. Zentrales Qualitätswesen
Industriegebiet
66280 Sulzbach/Saar
E-mail: product_safety@hydac.com

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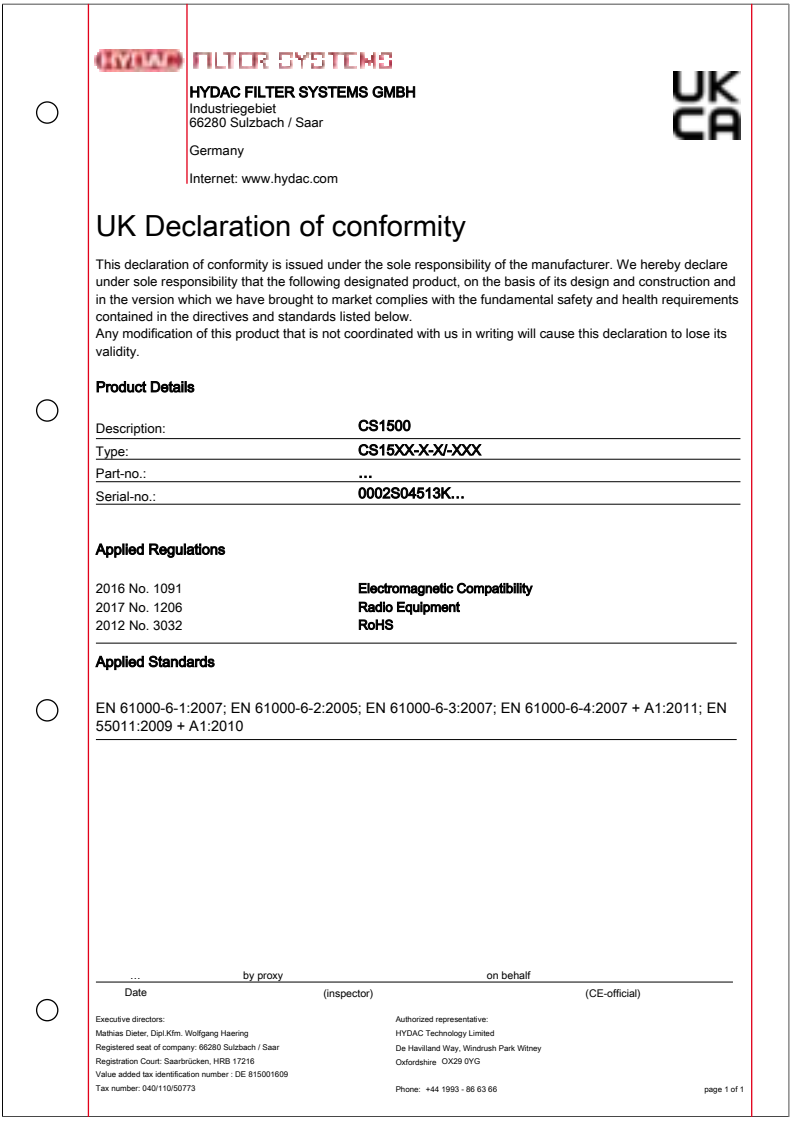
Fig. 46: Declaration of conformity EU



HYDAC FILTER SYSTEMS

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UK CA

UK Declaration of conformity

This declaration of conformity is issued under the sole responsibility of the manufacturer. We hereby declare under sole responsibility that the following designated product, on the basis of its design and construction and in the version which we have brought to market complies with the fundamental safety and health requirements contained in the directives and standards listed below.
Any modification of this product that is not coordinated with us in writing will cause this declaration to lose its validity.

Product Details

Description:	**CS1500**
Type:	**CS15XX-X-X/-XXX**
Part-no.:	**...**
Serial-no.:	**0002S04513K...**

Applied Regulations

2016 No. 1091	**Electromagnetic Compatibility**
2017 No. 1206	**Radio Equipment**
2012 No. 3032	**RoHS**

Applied Standards

EN 61000-6-1:2007; EN 61000-6-2:2005; EN 61000-6-3:2007; EN 61000-6-4:2007 + A1:2011; EN 55011:2009 + A1:2010

...	by proxy	on behalf
Date	(inspector)	(CE-official)

Executive directors:
Mathias Dieter, Dipl.Kfm. Wolfgang Haering
Registered seat of company: 66280 Sulzbach / Saar
Registration Court: Saarbrücken, HRB 17216
Value added tax identification number : DE 815001609
Tax number: 040/110/50773

Authorized representative:
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Phone: +44 1993 - 86 63 66

Fig. 47: Declaration of conformity UKCA

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Glossary

DHCP

Dynamic Host Configuration Protocol – makes it possible for a DHCP server to automatically assign IP addresses to clients.

DNS

The DNS translates domain names into IP addresses to allow your browser to load internet resources. Every device connected to the internet has its own unique IP address, which is used by other devices to search for the device.

FKM

The term "Fluororubber" (abbreviation FKM according to DIN SIO 1629 [earlier: FPM] and FKM according to ASTM D 1418) represents an entire group of rubbers, which have, as a common characteristic, vinylidene difluoride as one of its monomers.

Installer

The installer of an installation is the person who installs, extends, modifies or maintains and installation and may refer to someone who has not installed, extended, modified or maintained the installation, but who has inspected the work performed as an expert and taken responsibility for its proper execution.

LAN

An acronym for Local Area Network

Modbus

Modbus® is a registered trademark of Schneider Electric U.S.A., Inc. MODICON, Inc., Industrial Automation Systems One Hight Street North Andover, Massachusetts 01845

Reference: Modicon Modbus® Protocol Reference Guide – PIMBUS-300

QR code

The abbreviation QR stands for "quick response". This is a two-dimensional QR code,

SSID

SSID stands for Service Set Identifier and is the network name of an internet user. Also known as a network ID or SSID name, it refers to a WLAN network that can be viewed by everyone.

URL

A URL (Uniform Resource Locator) is the address of a website on the internet. It contains a unique web address that leads to a specific website, e.g. https://###.###.###.###.

Web UI

The web user interface is a web-based user interface used to read, operate and configure the product.

WLAN

Is the abbreviation for Wireless LAN (Local Area Network). Means the same thing as Wi-Fi.

EN

WPA2

WPA2 is a security protocol for wireless networks based on Advanced Encryption Standard (AES) technology. It is used with the IEEE 802.11a, b, g, n and ac W-LAN standards and ensures data is encrypted to prevent unauthorised access.

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