



INTERNATIONAL

CS 2000 series Contamination Sensor

Operating and maintenance instructions

English (translation of original instructions)

Valid from firmware versions V 1.10 up

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Preface

For you, as the owner of a product manufactured by us, we have produced this manual, comprising the most important instructions for its **operation** and **maintenance**.

It is intended to help you become acquainted with the ins and outs of the product and use it properly.

You should keep it in the vicinity of the product so it is always at your fingertips.

Sometimes the information contained in the documentation cannot always keep up with changes made to the product as we attach considerable importance to keeping our products cutting-edge. Consequently, there might be deviations in technical details, illustrations and dimensions.

If you discover errors while reading the documentation or have suggestions or other useful information, please don't hesitate to contact us:

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We look forward to receiving your input.

Our motto: “Putting experience into practice”

Customer Service

If you have any questions, suggestions, or encounter any problems of a technical nature, please don't hesitate to contact us. When contacting us, please always include the model/type designation and article no. of the product:

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Modifications to the Product

We would like to point out that changes to the product (e.g. purchasing options, etc.) may result in the information in the operating instructions no longer being completely accurate or sufficient.

When making modifications or performing repair work to components affecting the safety of the product, the product may not be put back into operation until it has been examined and released by a HYDAC representative.

Please notify us immediately of any modifications made to the product whether by you or a third party.

Warranty

For the warranty provided by us, please refer to the General Terms of Sale and Delivery of HYDAC Filtertechnik GmbH.

They are available at: www.hydac.com ⇨ Legal information.

Using the documentation



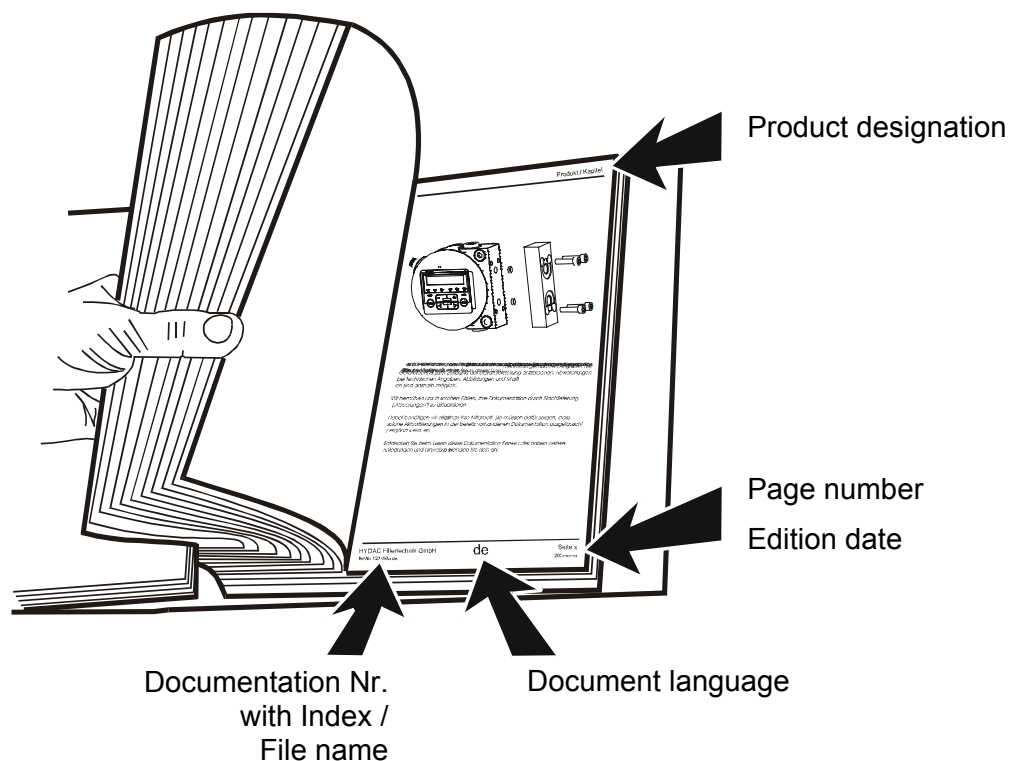
Please note that the method described above of locating specific information does not release you from your responsibility for carefully reading the entire manual prior to starting the unit up for the first time and carefully rereading the manual at regular intervals later on.

WHAT do I want to know?

I determine which topic I am looking for.

WHERE can I find the information I'm looking for?

The document has a table of contents at the beginning. I select the chapter I'm looking for and the corresponding page number.



The documentation number with its index enables you to order another copy of the operating and maintenance instructions. The index is incremented by one number every time the manual is revised or changed.

1 General Safety Precautions

These operating instructions contain the key instructions for properly and safely operating the CS.

1.1 Obligations and Liability

The basic prerequisite for the safe and proper handling and operation of the CS is knowledge of the safety instructions and warnings.

These operating instructions in general, and the safety precautions in particular, are to be adhered to by all those who work with the CS.

Adherence is to be maintained to pertinent accident prevention regulations applicable at the site where the product is used.

The safety precautions listed herein are limited solely to using the CS.

The CS has been designed and constructed in accordance with the current state of the art and recognized safety regulations. Nevertheless, hazard may be posed to the life and limb of the individual using the product or to third parties. The CS is only to be used as follows:

- solely for its designated use
- only when in a safe, perfect condition
- any faults or malfunctions which might impair safety are to be properly repaired or remedied immediately.

Our General Terms and Conditions apply. They are made available to the owner upon concluding purchase of the unit at the latest. Any and all warranty and liability claims for personal injuries and damage to property shall be excluded in the event they are attributable to one or more of the following causes:

- improper use of the CS or use deviating from its intended use
- Improper assembly, installation, commissioning, operation and maintenance of the CS
- operating the CS when the system equipment or systems are defective
- modifications to the CS made by the user or purchaser
- Improper monitoring of unit components that are subject to wear and tear
- improperly performed repair work

1.2 Explanation of Symbols and Warnings, etc.

The following designations and symbols are used in this manual to designate hazards, etc.:

1.2.1 Basic Symbols



DANGER denotes situations which can lead to death if safety precautions are not observed.



WARNING denotes situations which can lead to death if safety precautions are not observed.



CAUTION denotes situations which can lead to severe injuries if safety precautions are not observed.



TIP denotes situations which can lead to property damage if safety precautions are not observed.

1.3 Proper/Designated Use

The Contamination Sensor (CS) was developed for the continuous monitoring of particulate contamination in hydraulic systems.

Analyzing the type, size and quantity of contamination enables quality standards to be verified and documented, and the requisite optimization measures to be implemented.

Any other use shall be deemed to be improper and not in keeping with the product's designated use; the manufacturer accepts no liability for any damage resulting from such use.

Proper or designated use of the product extends to the following:

- Maintaining adherence to all the instructions contained herein.
- Performing requisite inspection and maintenance work.

1.4 Improper Use

Any use deviating from the proper/designated use described above is prohibited.

Improper use may result in hazard to life and limb.

Example of improper use:

- unsuitable fluid flow through the CS
- improper connection of the CS pressure and return flow lines.

1.5 Informal Safety Precautions



Make sure to always keep the operating instructions in the vicinity of the product.

Apart from the operating instructions, any and all general and local regulations pertaining to accident prevention and environmental protection are to be made available and observance to be maintained to them.

Make sure to keep the safety and hazard symbols and warnings on the CS in a legible condition.

The power plug/cord of the product is to always be pulled before opening any components of the CS. Tests conducted with the housing open may only be performed by properly trained, certified electricians. This also applies to all repair work or to any modifications to electrical components approved by HYDAC.

The hoses and connection fittings are to be checked daily for leakage (visual check). The electrical components of the CS are to also be regularly checked (visual check once a month). Any loose connections or damaged cables are to be replaced immediately.

	<div data-bbox="683 813 1136 902"> WARNING</div> <div data-bbox="667 965 1203 1001">Hydraulic systems are under pressure</div> <div data-bbox="715 1064 1350 1131"><ul style="list-style-type: none">➤ The hydraulic system must be depressurized before performing any work</div>
--	---

1.6 Training and Instruction of Personnel

The CS may only be operated by properly trained and instructed personnel.

The areas of responsibility of your staff must be established in a clear-cut manner.

Staff undergoing training may not use the CS unless supervised by an experienced staff member.

Activity	Individuals	Individuals undergoing training	Individuals with technical training/ engineering background	Electrician	Supervisor with the appropriate authority
Packing Transportation		X	X		X
Commissioning			X	X	X
Operation		X	X	X	X
Troubleshooting/ locating the source of malfunction			X	X	X
Remedying of mechanical faults			X		X
Remedying of electrical faults				X	X
Maintenance		X	X	X	X
Repair work					X
Shutdown Storage		X	X	X	X

1.7 Safety measures to be followed in normal operation

Do not operate the CS unless all the safety devices function properly.

The product must be checked once daily for external damage and the proper functioning of the safety devices.

1.8 Electrical Hazards

Any work involving the power supply may only be done by a properly trained, certified electrician.

Make sure to check the electrical equipment of the product on a regular basis. Any loose connections or damaged cables are to be remedied/replaced immediately.

If work on live components is required, a second individual should be present to switch off the unit if necessary.

1.9 Maintenance, Servicing and Troubleshooting

The prescribed adjustment, maintenance/servicing and inspection work is to be conducted in a timely fashion.

All operating media are to be protected/isolated in case the product is accidentally started up.

The CS is to be disconnected from the power supply and protected against being inadvertently switched back on when performing any maintenance, servicing, inspection or repair work.

Check any screwed fittings which have been removed to see that they have been properly secured.

Always check the product to see that it functions properly when performing maintenance and servicing work.

1.10 Modifications to the CS

Do not make any modifications (design modifications, extensions) to the CS without the prior consent of the manufacturer.

Any design modifications or extensions may not be made without HYDAC Filbertechnik GmbH's express prior written approval.

Immediately replace any machine components which are not in perfect condition.

Only use original (OEM) spare parts and wearing parts. Non-OEM components have no guarantee that they have been designed and manufactured so as to comply with loading and safety requirements.

1.11 Cleaning the CS and Disposal of the Media and Agents Used

The cleaning agents and flushing oils used are to be handled and disposed of properly.

The manufacturers' instructions relating to possible use, personal protective equipment and appropriate disposal must be observed.

2 Packing, Transportation, Storage and Disposal

2.1 Transportation Packing

The CS is delivered packed in foils.

When receiving and unpacking the product check it for damage in transit. Report any damage to the forwarding agent immediately .

The packing material is to be disposed of as specified by law or national regulations or be reused.

2.2 Storage

Store the CS in a clean, dry place, in the original packing, if possible. Do not remove the packing until you are ready to install the unit.

Completely drain the CS before it is put into storage for an extended period of time (flush with n-heptane if necessary) to prevent it from gumming up.

The cleaning agents and flushing oils used are to be handled and disposed of properly.

2.2.1 Storage conditions

Storage temperature: -20°C ... +85°C / -4°F ... +185°F

Relative humidity: max. 90%, non-condensing

Period of storage max. 6 months

2.3 Disposal / Recycling and Decommissioning

When decommissioning and/or disposing of the CS, observe all local guidelines and regulations pertaining to occupational safety and environmental protection. This applies in particular to the oil contained in the unit, to components coated in oil and to electronic components.

After disassembling the unit and separating the various materials, they can be reused or are to be disposed of properly in accordance with local regulations.

3 Scope of Delivery

The ContaminationSensor CS is delivered packed and ready to operate. Before starting up the CS, please check no items are missing from the package.

The following items are supplied:

Item	Qty.	Description
1	1	ContaminationSensor CS2000, ready for connection
-	1	Connection cable CS <-> PC
-	1	Operating and maintenance instructions



4 Technical Description of the CS

4.1 General data

The ContaminationSensors of the CS 2000 series are stationary measuring devices for continuously monitoring solid particle contamination in hydraulic systems.

They have been specifically developed for applications in the test rig area, where it is necessary to record measurement values in the hydraulic system and display these values remotely on the control panel, as well as to store the data on a PC.

Device types CS 2030, 2130 and 2230 are designed for applications with mineral oils and various synthetic hydraulic fluids (e.g. HLP, HLPD), whilst types CS 2031, 2131 and 2231 are only allowed to be operated with certain fluids in the HFD group (e.g. HFD-R, phosphate tester). If you are unclear about suitability for use with particular fluids, please contact the sensor manufacturer to inquire about usability.

Because the other device properties are identical, the types CS 203X, 213X and 223X are dealt with below for the sake of simplicity.

Particulate contamination is recorded using a fiber-optic infrared measurement cell patented by HYDAC and can be output as particle counts or as contamination classes in accordance with NAS 1638 or ISO 4406:1987 / SAE AS 4059 or ISO 4406:1999.

The particulate contamination is recorded in the following particle size ranges:

CS 203x				
Particle count / NAS channels	5..15µm	15..25µm	25..50µm	> 50µm
ISO channels	> 5µm	> 15µm		
CS 213x				
Particle count / NAS channels	2..5µm	5..15µm	15..25µm	> 25µm
ISO channels	> 2µm	> 5µm	> 15µm	
CS 223x				
Particle count / NAS channels	4..6µm _(c)	6..14µm _(c)	14..21µm _(c)	> 21µm _(c)
ISO channels	> 4µm _(c)	> 6µm _(c)	14 µm _(c)	

The CS is designed to be connected to low-pressure hydraulic lines from which a small oil flow portion is branched off for measurement.

By varying the internal orifices, it is possible for the sensors to be configured at the factory for various operating conditions (pressure/viscosity ranges).

An integrated pressure relief valve protects the ContaminationSensor against pressures of as much as 350 bar / 5000 psi.

The measured contamination class or the particle counts are continuously output via various (some optional) electrical outputs (relay, PLC interface, serial display interface, analog current output 4-20 mA, fieldbus interface) and can thus be registered and displayed by means of a PLC, an analog voltmeter or a PC.

4.2 CS Design

The ContaminationSensor consists of the following components:

- Aluminum housing
- Hydraulic connections "Eingang / Inlet" and "Ausgang / Outlet"
- Fiber-optic infrared measurement cell
- Pressure control valve
- Electronics, consisting of:
 - Signal processing and microprocessor board
 - Printed circuit board with connection terminals and internal power supply unit
 - Module printed circuit board for optional outputs
 - Power supply unit for internal supply voltages
 - Cable glands for the electrical connections

4.3 Restrictions pertaining to use



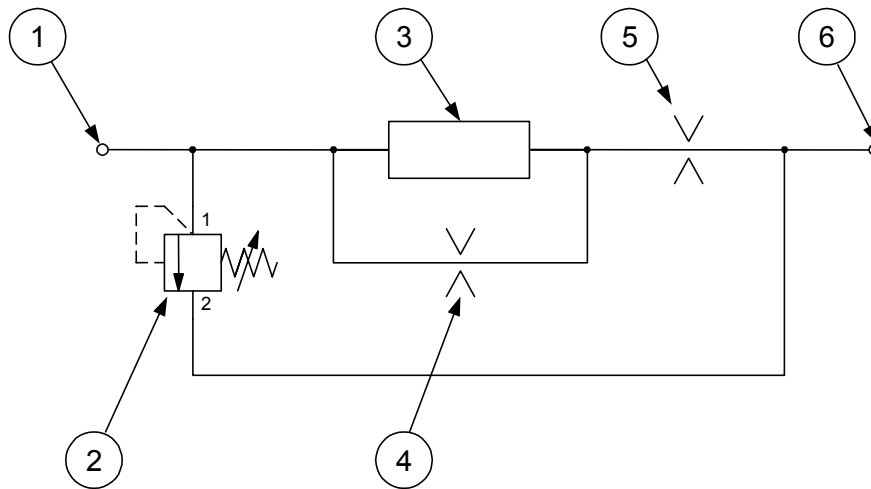
The CS 2X30 is designated for mineral oils (or mineral-oil-based raffinates). The CS 2X31 is suitable for phosphate testers.

Please contact us first before using the unit with other fluids.

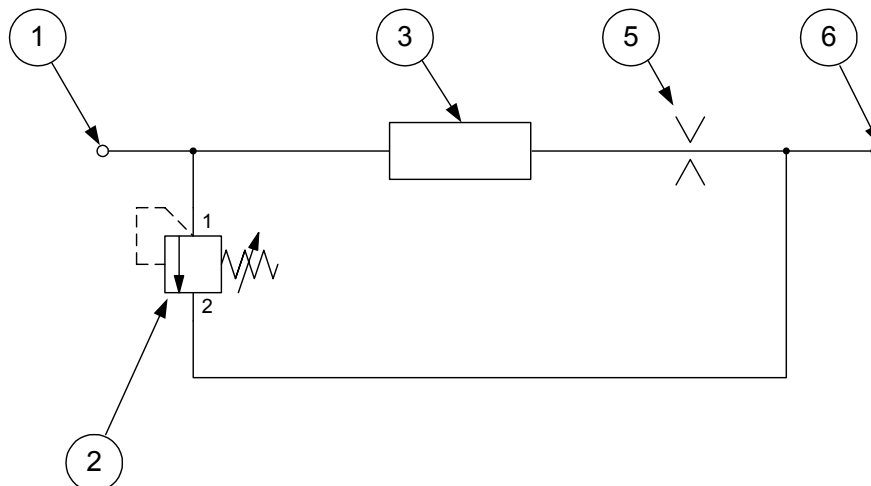
4.4 Hydraulic Schematic

Legend:	
Item	Description
1	Eingang / Inlet
2	Differential pressure relief valve 40 bar
3	Fiber-optic infrared measurement cell
4	Bypass with orifice
5	Output orifice
6	Ausgang / Outlet

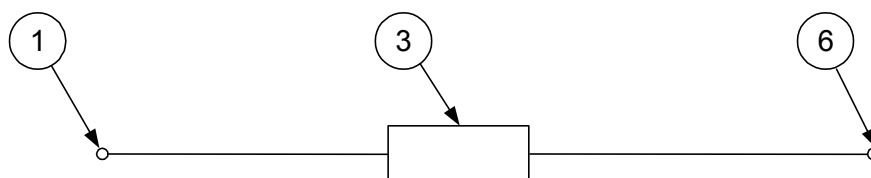
4.4.1 Hydraulic schematic for pressure/viscosity ranges 1 and 2



4.4.2 Hydraulic schematic for pressure/viscosity ranges 3 and 4



4.4.3 Hydraulic schematic for CS 2xxx0



5 Installation and Operation

5.1 Electrical Installation

5.1.1 Terminal Assignment

There are two M16x1.5 cable glands through which the electrical power supply and signal lines can be routed into the housing.

The housing of the ContaminationSensor contains the identification of the terminal assignment that specifies the particular configuration.

The terminals used feature spring-cage technology and are suitable for the following conductor cross sections:

Terminals for supply voltage	up to 2.5 mm ²
Terminals 1 – 23	up to 0.5 mm ²

Power Terminal

Supply voltage	PE	Case Ground	Declaration: 1. Pair of clamps is for Supply Voltage. 2. Pair of clamps is for additional connection from a load (CSD for Example).
	0 V	Supply Voltage 0 V	
	0 V	Supply Voltage 0 V	
	24 V	Supply Voltage 24 V	
	24 V	Supply Voltage 24 V	

Signal Terminal

Digital Output for PLC	1	PLC Ground
	2	24 V from PLC
	3	PNP Output to PLC
Serial RS 232 Display port	4	RS 232 Ground
	5	RS 232 TxD
	6	RS 232 RxD
Module port:	7	Assignment dependent upon output modul
	8	
	9	
	10	
	11	
	12	
Relay 1	13	Relay 1, NO
	14	Relay 1, C
Relay 2	15	Relay 2, NO
	16	Relay 2, C
Ready relay	17	Ready Relay, NC
	18	Ready Relay, NO
	19	Ready Relay, C
Analog Input	20	Analog Supply +12 V
	21	Analog Signal Channel 1
	22	Analog Ground
	23	Analog Signal Channel 2

The terminal assignment of the module port varies according to the various optional output modules.

The terminal assignments of the individual modules are shown below:

RS 232 Modul (Option –0)

You will find the description for this module in Chapter 11.

RS 232	7	Free
	8	Free
	9	Ground
	10	Free
	11	TxD
	12	RxD

Analog module (Option –1)

You will find the description for this module in Chapter 13.

Analog	7	4 - 20 mA (+)
	8	Free
	9	Free
	10	Free
	11	Free
	12	4 - 20 mA (-)

DIN measurement bus module (option –2)

You will find the description for this module in Chapter 10.

DIN Measurement Bus	7	RB (+)
	8	BUS 5 V
	9	BUS Ground
	10	TB (+)
	11	TA (-)
	12	RA (-)

Ethernet module (Option –5)

You will find the description for this module in Chapter 12.

Ethernet	7	RxD+
	8	RxD-
	9	TxD+
	10	TxD-
	11	Free
	12	Free

RS 232 / analog module (option –6)

This module represents a combination of the variants RS 232 (Option –0) and Analog (Option –1). A description of the functionalities can be found in Chapter 11 and Chapter 12.

RS232 / analog	7	4 - 20 mA (+)
	8	4 - 20 mA (-)
	9	Ground
	10	Free
	11	TxD
	12	RxD

RS 485 / analog module (option –7)

This module represents a combination of the variants DIN Measurement Bus Module (Option –2) and Analog (Option –1). A description of the functionalities can be found in Chapters 10 and 13.

RS485 / analog	7	RA (-)
	8	4 - 20 mA (-)
	9	4 - 20 mA (+)
	10	TA (-)
	11	TB (+)
	12	RB (+)

5.2 Electrical connection of the CS

Before continuing, check whether the CS is suitable for your display/data capturing system by carefully examining the technical specifications.

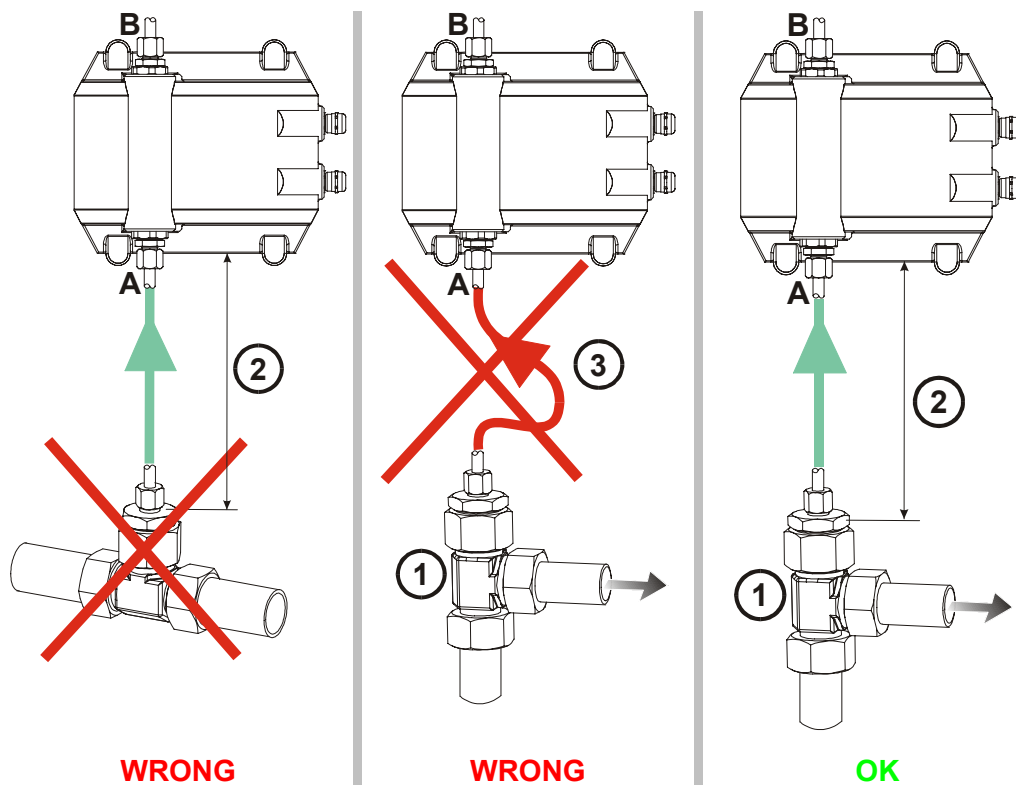
First connect the signal lines (pins/terminals 1 to 23).

Then connect the supply voltage.

CS starts measurement operation as soon as the supply voltage is applied.

5.3 Selecting a measurement point

- ① The measurement point should be selected so that the measured volume comes from a turbulent area with a good through-flow. For example: on a pipe elbow, etc.
- ② The CS has to be installed in the vicinity of the measurement point in order to obtain precision-timed results.
- ③ While installing the measurement line, avoid creating a "siphon" trap for sedimentation (particle deposits in the line).



5.4 Hydraulic connection of the CS

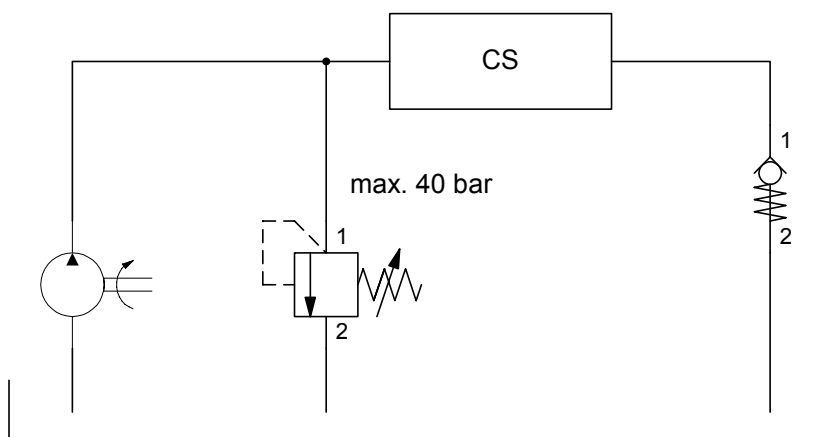
Determine the system pressure of the hydraulic facility and see whether it is within the permissible range for the INLET port.

TIP

➤ **The pressure in the measurement cell is not allowed to exceed 40 bar!**

The built-in pressure relief valve does not open until there is a pressure differential of 40 bar between the INLET and OUTLET.

If pressure values greater than 40 bar occur on the INLET connection and the OUTLET connection is not depressurized at the same time, the CS must be protected by an additional pressure relief valve (e.g.: ConditioningModule Inlet, CM-I).



Example for protecting the CS if OUTLET is not depressurized



Warning: Oil starts to flow through the CS as soon as the system has been connected to the pressure fitting.

This is why it is vital that connection be done in the sequence specified above.

The return-line connector (OUTLET) must never be obstructed or closed off!

1. Connect the CS hydraulically to your system as follows:
2. First connect the return-flow line (not supplied) to the OUTLET port of the CS.
(Connector thread: G1/4, ISO 228. Recommended internal diameter of conduit: >4 mm)
3. Now connect the other end of the return-flow line, e.g. to the system tank.
4. Check the pressure at the measurement point; it has to be within the specified limits.

5. First connect the measurement line (not supplied) to the INLET port of the CS.

(Connector thread: G1/4, ISO 228. Recommended internal diameter of conduit (to prevent particle sedimentation): ≤ 4 mm)

6. Now connect the other end of the measurement line to the measurement point.
7. Installation of the CS is now complete and it now continuously outputs the measured values via the electrical interface(s).

5.5 Removing the CS from the Hydraulic System

1. Disconnect the CS from the voltage supply.
2. Disconnect the other electrical connectors.
3. Remove the measurement hose from the hydraulic system first, then from the INLET port of the CS.
4. Remove the return-flow line from the OUTLET port of the CS .

The CS can now be removed.

6 Description of the Measuring Modes

6.1 Mode M1: Measure

Continuous measurement without special switching functions.

The current measurement result is output via the available interfaces after the measurement interval has elapsed.

6.2 Mode M2: Measure and switch

Continuous measurement, with relays 1 and 2 being switched according to the set measuring channels, switching functions and limit values.

The current measurement result is output via the available interfaces after the measurement interval has elapsed.

6.3 Mode M3: Filter until

Measuring mode in which relay 1 is closed, until 5 successive measurements reach or are cleaner than the set target cleanliness value. Measurement in mode 3 is then stopped.

Once relay 1 has been opened, it remains open until a measurement is restarted. (A restart can be triggered using the DIN measurement bus interface, the RS 232 display interface or by switching the electrical power supply off/on.)

6.4 Mode M4: Filter from until

Measuring mode in which relay 1 is closed, until 5 successive measurements reach or are cleaner than the set target cleanliness value (lower limit).

The relay is then opened and the test cycle time is started. After the test cycle time has elapsed, relay 1 is closed and a measurement is performed.

If the upper cleanliness value (upper limit) is reached or not exceeded, relay 1 remains closed until 5 successive measurements once again reach or are cleaner than the set target cleanliness value.

If the upper cleanliness value (upper limit) is not reached or was exceeded, relay 1 is opened again and the test cycle time is restarted.

6.5 Switching behavior of the relays:

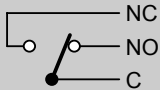
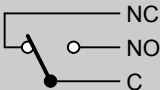
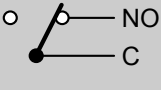
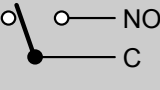
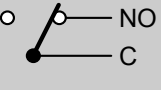
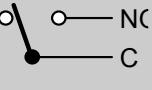
The following table describes the switching behavior of the three relays in the various measuring modes.

The position of the relays is updated after a measurement interval has elapsed, by comparing the current measured values with the limit values.

Directly after the CS is switched on, the Common (C) and Normally Closed (NC) contacts of all relays are connected together. As soon as the operational readiness of the CS has been established, the C and NO contacts are connected together on the Ready relay.

Relays 1 and 2 are not switched until after the first measurement interval has expired.

	Ready relay on 	Ready relay off 	Relay 1 on 	Relay 1 off 	Relay 2 on 	Relay 2 off
M1						
	CS ready for operation	CS not ready for operation	Measurement currently in progress	Measurement stopped	After first value is present: Flow error	Flow in nominal range
M2 (measuring channels 1 / 2 / 3 / 4 / 5 / 6 / 9 / 10)						
Exceed	CS ready for operation	CS not ready for operation	\geq upper limit	After switch-on or start of a measurement. Off <u>again</u> if \leq lower limit	\geq upper limit	After switch-on or start of a measurement. Off <u>again</u> if \leq lower limit
Fall below	CS ready for operation	CS not ready for operation	\leq lower limit	After switch-on or start of a measurement. Off <u>again</u> if \geq upper limit	\leq lower limit	After switch-on or start of a measurement. Off <u>again</u> if \geq upper limit
Within range	CS ready for operation	CS not ready for operation	Lower limit \leq value \leq upper limit	After switch-on or start of a measurement. Off <u>again</u> if value $<$ lower limit <u>or</u> Measured value $>$ upper limit	Lower limit \leq value \leq upper limit	After switch-on or start of a measurement. Off <u>again</u> if value $<$ lower limit <u>or</u> Measured value $>$ upper limit
Outside range	CS ready for operation	CS not ready for operation	Value \leq lower limit <u>or</u> Value \geq upper limit	After switch-on or start of a measurement. Off <u>again</u> if lower limit $<$ value $<$ upper limit	Measured value \leq lower limit <u>or</u> Value \geq upper limit	After switch-on or start of a measurement. Off <u>again</u> if lower limit $<$ value $<$ upper limit
No function	CS ready for operation	CS not ready for operation		Always off		Always off
M2 (measuring channels 7 and 8)						
Exceed	CS ready for operation	CS not ready for operation	A value \geq particular	After switch-on or start of	A value \geq particular	After switch-on or start of

	Ready relay on	Ready relay off	Relay 1 on	Relay 1 off	Relay 2 on	Relay 2 off
						
			upper limit	a measurement . Off <u>again</u> if all values \leq particular lower limit	upper limit	a measurement. Off <u>again</u> if all values \leq particular lower limit
Fall below	CS ready for operation	CS not ready for operation	All values \leq particular lower limit	After switch-on or start of a measurement . Off <u>again</u> if a value \geq particular upper limit	All values \leq particular lower limit	After switch-on or start of a measurement. Off <u>again</u> if a value \geq particular upper limit
Within range	CS ready for operation	CS not ready for operation	Particular lower limit \leq all value \leq particular upper limit	After switch-on or start of a measurement . Off <u>again</u> if a value $<$ particular lower limit <u>or</u> A value $>$ particular upper limit	Particular lower limit \leq all value \leq particular upper limit	After switch-on or start of a measurement. Off <u>again</u> if a value $<$ particular lower limit <u>or</u> A value $>$ particular upper limit
Outside range	CS ready for operation	CS not ready for operation	A value \leq particular lower limit <u>or</u> A value \geq particular upper limit	After switch-on or start of a measurement . Off <u>again</u> if particular lower limit $<$ all values $<$ particular upper limit	A value \leq particular lower limit <u>or</u> A value \geq particular upper limit	After switch-on or start of a measurement. Off <u>again</u> if particular lower limit $<$ all values $<$ particular upper limit
No function	CS ready for operation	CS not ready for operation		Always off		Always off
M3						
	CS ready for operation	CS not ready for operation	Measurement in progress and one or more of the last 5 measurements $>$ limit	5 measurements in succession \leq limit <u>or</u> measurement stopped	After first value is present: Flow error	Flow rate within set range

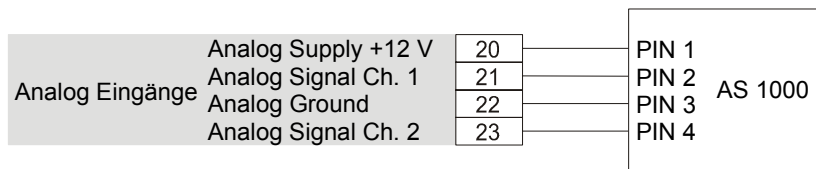
	Ready relay on	Ready relay off	Relay 1 on	Relay 1 off	Relay 2 on	Relay 2 off
M4						
Start or result of the check measurement after test cycle time: a value \geq particular upper limit	CS ready for operation	CS not ready for operation	Measurement in progress and in one or more of the last 5 measurements: a value $>$ particular lower limit	In 5 successive measurements: all values \leq particular lower limit <u>or</u> <u>measurement stopped</u>	After first value is present: Flow error	Flow in nominal range
After end of test cycle for duration of a check measurement			Test cycle time has elapsed	Off again if all values $<$ particular upper limit Restart test cycle time		

7 Analog inputs

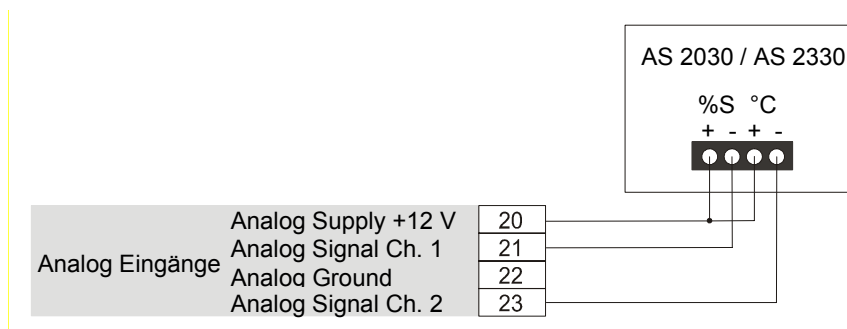
The 4 ... 20 mA outputs of a HYDAC AquaSensor can be connected to the two analog inputs.

The connection assignments are shown in the following figure.

7.1 Connection assignment AS 1000 series



7.2 Connection assignment AS 2000 series



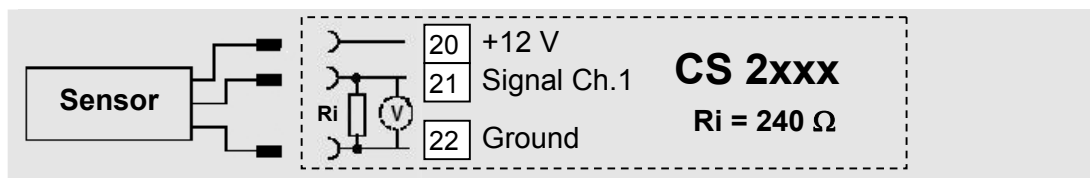
The level of saturation [%] and temperature [°C] can then be used as measuring channel for switching the relays in mode M2.

This information can additionally be passed on via the optional serial interface modules (DIN measurement bus module, RS232 module and Ethernet module) for evaluation (e.g. CoCoS). It is not possible to transfer the signals with the analog module.



This means both contamination by solid particles and by water can be monitored via a single bus line.

It is possible to connect an analog 4 ... 20 mA, 3-wire sensor from another manufacturer. (Sensor configuration as current source – this means the signals are grounded.)

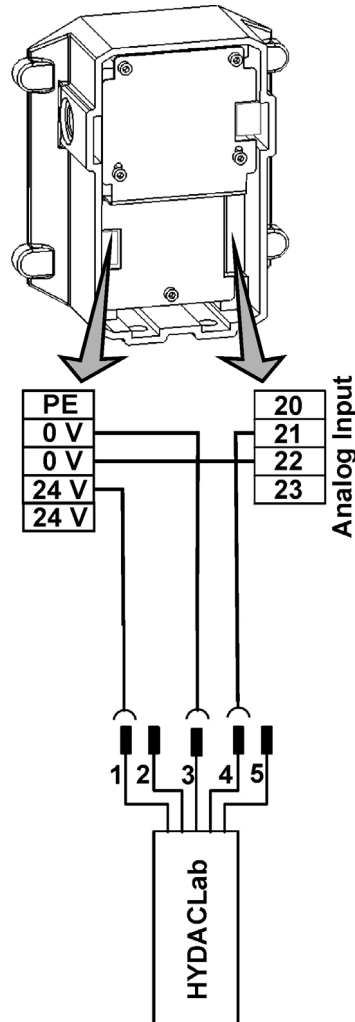


See also in this connection Sections "*Configure 4 ... 20 mA Input Channels*" and "*Display AD Channels*" in the Chapter "*Serial RS232 display and parameterizing interface*".

7.3 HYDACLab Wiring Diagrams

The 24 V voltage supply of the HYDACLab (HLB) is to be tapped at the voltage supply of the CS.

The 4 ... 20 mA output of the HYDACLab must be set up in the CS at the analog input module on terminal no. 21 (Analog Signal Channel 1).



The CS2000 evaluates the time-coded analog signal of the HYDACLab and thus obtains values for saturation, temperature, relative change in viscosity, relative change in dielectric constant value and sensor status.

The values transferred from HYDACLab can **not** be used in Mode M2 as measurement channels for switching the relays.

This information can additionally be passed on via the optional serial interface modules (DIN measurement bus module, RS232 module and Ethernet module) for evaluation. It is not possible to transfer the signals with the analog module.

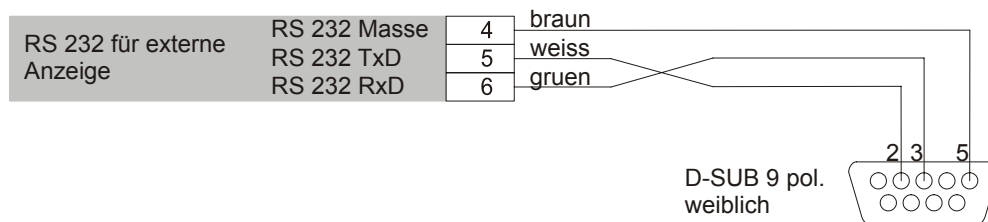
8 Serial RS232 Display and Parameter Setting Interface

Measurement results and messages are output as text via the serial RS 232 display interface. Furthermore, the parameters of the ContaminationSensor can be set via this interface.

8.1 Connecting the Serial RS232 Display Interface

Disconnect the CS from the voltage supply and switch your PC off.

Connect the serial RS 232 display interface of the CS to any vacant COM port on your PC as shown in the following figure.

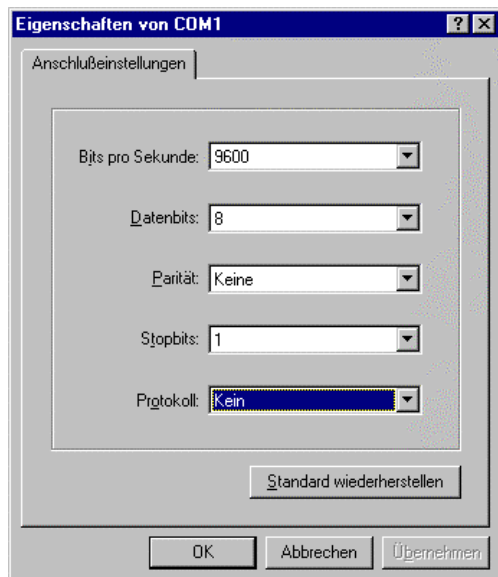


Connecting the serial display interface to a PC

Start your PC and call up a terminal program (e.g. Hyperterminal).

Configure the COM interface you are using as follows:

9600 baud, 8 data bit, 1 stop bit, no parity, no protocol



Hyperterminal configuration

Reconnect the electrical power supply to the CS.

8.2 Measured value output and messages via the RS 232 display interface

The CS is always in display mode after it is switched on:

- Initially, the text *HyOAC* appears in the terminal window
- After the set measurement interval, the current measurement result (e.g.: *ISO Code : 25.22.20*) or a fault message is output
- If there is a flow error, i.e. the flow rate through the measurement cell is not within the permitted range, this is displayed by outputting: *"F XXX"*, where xxx is the unfiltered flow in ml/min.
- "999999" is output in case of malfunctions in the particle measurement cell (e.g. due to a component defect or very high water or air content in the oil).
- "Stop" is output if the measurement is stopped (mode M3: Target cleanliness reached, or via DIN measurement bus command)
- In mode M4, the time in minutes until the next check measurement is displayed once the target cleanliness has been reached, e.g.: *"t 25"*

8.3 Parameter setting via the serial RS232 display interface

Pressing the Enter key moves you from display mode to operating mode. (The ContaminationSensor does not perform any measurements in operation mode, therefore the Ready relay is switched off.)

8.3.1 Operating mode



Texts that appear in the terminal window are displayed in *italics*.

The following display appears after operating mode starts:

*HYDAC Filtrertechnik GmbH
Contamination Sensor CS2230
Hardware Version 3.0
Firmware Version V4.10 – 27/03/2008
HYDAC Contamination Sensor offline!
Measuring cycle stopped
x - Restart Measurement
p - Enter Parameter Mode
Press key (x, p) and Return!*

Press the "x" key and then the Return key to return to display mode. The following display appears:

*HYDAC ContaminationSensor online!
Measuring cycle restarted
x – Restart Measurement
p – Enter Parameter Mode
Press key (x, p) and Return*

Press the “p” key and then the Return key to enter Parameter mode, in which you can program the CS settings.

8.3.2 Parameter mode

The following display appears after Parameter mode starts:

Parameter Mode:

x - Go back

t - Measuring Cycle Time

m - Measuring Mode

2 - Limits Mode M2

3 - Limits Mode M3

4 - Limits Mode M4

b - Set DIN-Bus Address and Name (for CS models with DIN-Bus module only)

e - Set IP Address (for CS models with Ethernet Interface only)

p - Pump Protection

o - PLC Output Format

r - RS232-Display Output Format

i - Current Output Format (for CS models with analog module only)

c - Check Current Output (for CS models with analog module only)

f - Flow Check

s - Sensor Check

a - Configure 4..20 mA Input Channels

h - Display AD Channels

d - Recover Factory Default Settings

z – Show Device Info

Press key (x, t, m, ...) and Return!

8.3.3 Measurement interval

The measurement interval is set using **t = Measuring time** (20 to 120 sec).

If a time shorter than 20 s is set (only for test purposes), this is not stored in the EPROM, so that after a reset of the CS the last stored measurement interval set within the permitted range (20 to 120 s) is restored.

It is not possible to set a time < 2 s or > 120 s.

Current measuring cycle time (s) set to: 20

New value for measuring cycle time (s) (press Return only to keep setting): 60
'Return'

Current measuring cycle time (s) set to: 60

(Das Messintervall wurde im Beispiel von 20s auf 60s verlängert.)

8.3.4 Measuring mode

m = Measuring mode selects the measuring mode (M1, M2, M3 or M4)

Current Mode: 3

1=M1, 2=M2, 3=M3, 4=M4

Press key (1, 2, 3, 4) and Return (press Return only to keep setting) **2 'Return'**

Current value for measuring mode: 2

(The measuring mode was changed from M3 to M2 in this example.)

8.3.4.1 Settings for measuring mode M2

2 = Limits Mode 2 makes the settings for measuring mode M2.

Measurement channel for relay 1 (alarm relay):

		CS 203x	CS 213x	CS 223x
0	⇒ NAS/SAE channel 0/A	5 µm – 15µm	2 µm – 5 µm	> 4 µm
1	⇒ NAS/SAE channel 1/B	15 µm – 25 µm	5 µm – 15 µm	> 6 µm
2	⇒ NAS/SAE channel 2/C	25 µm – 50 µm	15 µm – 25 µm	> 14 µm
3	⇒ NAS/SAE channel 3/D	> 50 µm	> 25 µm	> 21 µm
4	⇒ ISO channel 0	> 5 µm	> 2 µm	> 4 µm
5	⇒ ISO channel 1	> 15 µm	> 5 µm	> 6 µm
6	⇒ ISO channel 2	>25 µm	> 15 µm	> 14µm
7	⇒ NAS/SAE	Channel 0-3 / A-D	Channel 0-3 / A-D	Channel 0-3 / A-D
8	⇒ ISO Code	ISO channel 0/1	ISO channel 0/1/2	ISO channel 0/1/2
9	⇒ Flow rate			
10	⇒ LED current			
11	⇒ 4..20 mA input channel 1			
12	⇒ 4..20 mA input channel 2			

Limit value function for relay 1 (alarm relay)

- 0 -> No function
- 1 -> Within range
- 2 -> Outside range
- 3 -> Upper limit value exceeded (lower limit value for hysteresis)
- 4 -> Value below lower limit value (upper limit value for hysteresis)

Limit values for selected measuring channel relay 1 (alarm relay)

Depending on the selected measuring channel, first the lower limit value(s) then the upper limit value(s) are entered.

Measuring channel for relay 2 (warning relay):

Same selection of measuring channels as for relay 1.

Limit value function for relay 2 (warning relay)

Same selection of limit value functions as for relay 1.

Limit values for selected measuring channel relay 2

Entry as for relay 1

Example for CS 223X:

Relay 1, measuring channel:

0=SAE A, 1=SAE B, 2=SAE C, 3=SAE D,
4=ISO ch.0, 5=ISO ch.1, 6=ISO ch.2, 7=SAE A..D,
8=ISO code, 9=flow, 10=LED
11=4..20 mA input ch.1, 12=4..20 mA input ch.2

current setting: 3

new setting (press Return only to keep setting): **8 'Return'**

current setting: 8

Relay 1, switching function

(0=no function, 1= within range, 2=outside range, 3= exceed, 4=fall below)

current setting: 4

new setting (press Return only to keep setting): **'Return'**

current setting : 4

Relay 1, lower limit 1:

current setting: 17

new setting (press Return only to keep setting): **16 'Return'**

current setting : 16

Relay 1, upper limit 1:

current setting: 20

new setting (press Return only to keep setting): **'Return'**

current setting : 20

Relay 1, lower limit 2:

current setting: 15

new setting (press Return only to keep setting): **14 'Return'**

current setting : 14

Relay 1, upper limit 2:

current setting: 18

new setting (press Return only to keep setting): **17 'Return'**

current setting : 17

Relay 1, lower limit 3:

current setting: 13

new setting (press Return only to keep setting): **12 'Return'**

current setting : 12

Relay 1, upper limit 3:

current setting: 15

new setting (press Return only to keep setting): **'Return'**

current setting : 15

(Because the ISO code was selected, a three-value code must be entered each for the lower and for the upper limit value, i.e. a total of 6 values. In the example shown above, the ISO code for the lower limit value is 16/14/12 and for the upper limit value is 20/17/15.)

Relay 2, measuring channel

0=SAE A, 1=SAE B, 2=SAE C, 3=SAE D,

4=ISO ch.0, 5=ISO ch.1, 6=ISO ch.2, 7=SAE A..D,

8=ISO code, 9=flow, 10=LED

11=4..20 mA input ch.1, 12=4..20 mA input ch.2

current setting: 4

new setting (press Return only to keep setting): **9 'Return'**

current setting : 9 (selection made: flow)

Relay 2, switching function

(0=no function, 1= within range, 2=outside range, 3= exceed, 4=fall below)

current setting: 0

new setting (press Return only to keep setting): **1 'Return'**

current setting : 1 (selection made: within range)

Relay 2, lower limit 1:

current setting: 30

new setting (press Return only to keep setting): **50 'Return'**

current setting : 50

Relay 2, upper limit 1:

current setting: 150

new setting (press Return only to keep setting): **'Return'**

current setting : 150

(50 and 150 ml/min respectively were entered for the lower and upper limit values.)

8.3.4.2 Settings for measuring mode M3

3 = Limits Mode 3 makes the settings for measuring mode M3.

Example for CS 223X:

Contamination Code Selection

0=SAE , 1=ISO

current setting: 0

new setting (press Return only to keep setting): 1 'Return'

current setting : 1

lower limit 1:

current setting: 5

new setting (press Return only to keep setting): 16 'Return'

current setting : 16

lower limit 2:

current setting: 5

new setting (press Return only to keep setting): 14 'Return'

current setting : 14

lower limit 3:

current setting: 5

new setting (press Return only to keep setting): 12 'Return'

current setting : 12

(In the example, the target cleanliness for mode M3 was changed from SAE 5A, 5B, 5C to ISO 16/14/12)

8.3.4.3 Settings for measuring mode M4

4 = Limits Mode 4 makes the settings for measuring mode M4.

Contamination Code Selection

0=SAE , 1=ISO

current setting: 0

new setting (press Return only to keep setting): 1 'Return'

current setting : 1

lower limit 1:

current setting: 5

new setting (press Return only to keep setting): **16 'Return'**

current setting : 16

lower limit 2:

current setting: 5

new setting (press Return only to keep setting): **14 'Return'**

current setting : 14

lower limit 3:

current setting: 5

new setting (press Return only to keep setting): **12 'Return'**

current setting : 12

upper limit 1:

current setting: 8

new setting (press Return only to keep setting): **22 'Return'**

current setting : 22

upper limit 2:

current setting: 8

new setting (press Return only to keep setting): **'Return'**

current setting : 19

upper limit 3:

current setting: 8

new setting (press Return only to keep setting): **16 'Return'**

current setting : 16

test cycle time in minutes:

current setting: 60

new setting (press Return only to keep setting): **120 'Return'**

current setting : 120

(In the example, for mode M4 the target cleanliness was changed from SAE 5A, 5B, 5C to ISO 16/14/12, the cleanliness class for new cleaning was changed from SAE 8A, 8B, 8C to ISO 22/19/16 and the test cycle time from 60 min to 120 min)

8.3.4.4 BUS address and measurement point name

b = Set DIN-Bus Address and Name enters the BUS address for the DIN measurement bus and the measurement point name.

DIN-Bus Address: 1

measurement point: HYDAC

New value for DIN-Bus Address (press Return only to keep setting): 2

DIN-Bus Address set to: 2

*New measurement point: (press Return only to keep setting): **Testpoint***

measurement point: Testpoint

Current DIN-BUS Address: 2

Current measurement point: Testpoint

(In this example, the BUS address was changed from 1 to 2 and the measurement point name from "HYDAC" to "Testpoint".)

DIN-Bus Address: 1

measurement point: HYDAC

DIN-Bus Address fixed by DIP switch !

*New measurement point: (press Return only to keep setting): **Testpoint***

measurement point: Testpoint

Current DIN-BUS Address: 1

Current measurement point: CS 2230

(In this example, the measurement point name was changed from "HYDAC" to "Testpoint", the DIN-BUS address could not be changed because it was set to 1 by DIP switch.)

8.3.4.5 IP-Address

e = Set IP Address enters the IP address for the Ethernet interface. The IP address has the format xxx.xxx.xxx.xxx, where xxx values can be between 0 and 255.

Example:

IP address part 1:

current setting: 129

new setting (press Return only to keep setting): 192

current setting: 192

IP address part 2:

current setting: 42

new setting (press Return only to keep setting): 168

current setting: 168

IP address part 3:

current setting: 14

new setting (press Return only to keep setting): 16

current setting: 16

IP address part 4:

current setting: 150

new setting (press Return only to keep setting): 36

current setting: 36

In this example, the IP address was changed from 129.42.14.150 to 192.168.16.36.

8.3.4.6 Dry-running protection

p = Pump protection enables a pump controlled by the ContaminationSensor via relay 1 to be protected against running dry in operating modes M1, M3 and M4. If there is not a sufficient volumetric flow after the start of the measurement or after a flow error occurs, the pump is switched off by relay 1 after expiration of the measurement interval during which the pump protection time runs down. This means the pump is only switched off after two measurement intervals have expired. Entering 0 deactivates this function!

actual Pump protection time : 0 s

New value for Pump protection time (press Return only to keep setting): 10

Actual value for Pump protection time: 10

(In the example, the deactivated function was activated and 10 s entered as the time.)

8.3.4.7 PLC interface

o = PLC Output Format selects whether the NAS/SAE class (1 value) or the ISO code (3 values) is output via the PLC interface.

Additionally, the output frequency can be varied. (See chapter 9.)

Current PLC Output Format: ISO

Enter 1 for SAE or 2 for ISO (press Return only to keep setting): 1

Selected PLC Output Format: SAE

Current PLC Output Format: SAE

PLC Output Frequency Divider: 1

New value (1..4) for PLC output frequency divider (press Return only to keep setting): 2

PLC output frequency divider set to: 2

(In the example, the output format was changed from ISO to SAE and the output frequency is halved)

8.3.4.8 Display interface

r = RS - -232 Display Output Format enables a header (max. 25 characters) to be entered for display on the screen. In addition, specification can be made as to whether

- the NAS/SAE maximum (single-digit in the form xx; the highest value of the contamination classes determined in the 4 measurement channels is displayed),
- the ISO code (CS 213X and 223X : three-digit in the form xx.xx.xx; CS 203X : two-digit in the form xx.xx),
- the flow (in the form FL xxx, where xxx = flow in ml/min)
- ISO code and flow in alternation
- the contamination class in SAE channel A / NAS channel 0
- the contamination class in SAE channel B / NAS channel 1
- the contamination class in SAE channel C / NAS channel 2
- the contamination class in SAE channel D / NAS channel 3 or
- the cumulative particle counts and the flow (in the form K0,K1,K2,K3/F) (where Ki=cumulative particle counts in channel i and F = flow in ml/min)

if configuration from 2 analog signals (see 8.4.3.13):

- the cumulative particle counts, the flow and the 2 analog signals (in the form K0,K1,K2,K3/FAI1,AI2) (where Ki=cumulative particle counts in channel i, F = flow in ml/min and Ali=analog signal in channel i)
- the ISO code, the flow and the 2 analog signals (CS 213X and 223X : three-digit in the form xx.xx.xx/F/AI1,AI2; CS 203X : two-digit in the form xx.xx/F/AI1,AI2) (with F = flow in ml/min and Ali=analog signal in channel i)

if configuration of the analog signal as HYDACLab Signal (see 8.4.3.13):

- the cumulative particle counts, the flow and the 5 values of the HYDACLab (in the form of K0,K1,K2,K3/F/%sat,Temp,RelVisco,RelDK,State) (where Ki=cumulative particle counts in channel i, F = flow in ml/min and HYDACLab values for saturation, temperature, rel. change in viscosity, rel. change in dielectric constant value, sensor status)
- the ISO code, the flow and the 2 analog signals (CS 213X and 223X : three-digit in the form xx.xx.xx/ F/%sat,Temp,RelVisco,RelDK,State; CS 203X : two-digit in the form xx.xx/F/%sat,Temp,RelVisco,RelDK,State) (with F = flow in ml/min and HYDACLab values for saturation, temperature, relative change in viscosity, relative change in dielectric constant value, sensor status) are to be displayed.

Example for CS 223X (without analog signals):

Header in display output: SAE B

Measurement value in display output: SAE ch. B

Enter new header ('Return' = no header!):

New header in display output: 'no header'

Enter new measurement value ('Return' = keep current setting):

1 = SAE max. , 2 = ISO Code , 3 = Flow rate, 4 = Toggle ISO/Flow

5 = SAE ch. A, 6 = SAE ch. B, 7 = SAE ch. C, 8 = SAE ch. D

9 = cumulative particle counts / flow rate

New measurement value in display output: ISO code

(In the example, the output format display was changed from SAE ch. B with header "SAE B" to ISO code without header)

8.3.4.9 Adjusting current interface

i = **Current Output Format** selects whether the NAS/SAE class (1 value) or the particle information of the 4 channels will be output via the current interface.

Example for CS 223X:

Current Output Format: 1

SAE max.

New Current Output Format:

(1=SAE max., 2=Particle Counts) (press Return only to keep setting): **2**

Current Output Format: 2

Particle Counts

(In the example, the output format for the current interface was changed from SAE max. to particle counts.)

8.3.4.10 Testing current interface

c = **Check Current Output** enables the 4..20 mA current output (optional) to be checked. The current measured under this menu option is output at the 4..20 mA current output until operation mode is exited.

Example:

Check current output

*Enter current (between 2.5 and 24.0 mA) as xx.x mA or enter 'x' to exit: **10.0***

(In the example, a current of 10.0 mA was set.)

8.3.4.11 Flowcheck

f = **Flow check** causes four values to be output continuously in order to provide information about whether the oil flow rate through the sensor is appropriate for determining the contamination.

The values each represent the flow rate in ml/min measured on the basis of the average time taken for the particles to flow through the four particle size channels.

Air bubbles in the oil make themselves apparent, for example, when the first value or the first two values is/are significantly lower than the other values.

Droplets in a second fluid phase, such as water, fats, etc. are made apparent in a similar way.

A dash "-" is output if no particles were counted in a channel.

Examples:

f

Check values: 121, 118, 124, 112 (flow rate ok!)

Check values: 125, 130, 110, - (flow rate ok, no particles in 4th channel)

Check values: 11, 48, 121, 102 (flow rate not ok! Possibly air bubbles!))

8.3.4.12 Check particle sensor

When **s = Sensor check**, the particle sensor can be checked. (If, for example, the error code "999999" is outputted via the RS-232 display interface or the Ready relay is open

Examples:

s

Sensor current ok ! (253 digit)

Sensor current low ! (1 digit) Light source of sensor may be defective

Sensor current high ! (820 digit) Water / air in oil or measurement section is contaminated

8.3.4.13 4 ... 20 mA inputs - configure

When **a = Configure 4..20 mA Input Channels**, the two analog 4..20 mA inputs can be configured.

First, the mode for the analog signal must be selected. One can choose between: no analog signals, Standard (that means 2 analog signals) or the reading of the HYDACLab signal via analog signal channel 1.

It is necessary to enter the measured values for 4 mA and 20 mA sensor current and a designation when "Standard" is selected. (The name is read out by the CoCoS software and used as an axis name.)

Example: (configuration for HYDAC AquaSensor AS 2030 / 2330)

a

Analog Input Mode

0 = No Analog input, 1 = Standard (2xAI), 2 = HYDACLab signal

Current setting: 2

New setting (press Return only to keep setting): '1' 'Return'

Channel 1 value for 4.0 mA:

Current setting: 0.0

*New setting (press Return only to keep settings): **'Return'***

Channel 1 value for 20.0 mA:

Current setting: 100.0

*New setting (press Return only to keep settings): **'Return'***

Channel 1 designation:

Current string: Fill level

New designation (max. 16 characters) (press Return only to keep settings):
%Saturation 'Return'

Channel 2 value for 4.0 mA:

Current setting: 0.0

*New setting (press Return only to keep settings): **-20 'Return'***

Channel 2 value for 20.0 mA:

Current setting: 16.0

*New setting (press Return only to keep settings): **120 'Return'***

Channel 2 designation:

Current string: Pressure

New designation (max. 16 characters) (press Return only to keep settings):
Temperature 'Return'

8.3.4.14 4..20 mA inputs - display current measured values

Function available only if 2 analog inputs have been configured (see 8.3.4.13).

When ***h* = Display AD Channels**, the current measured values of the two analog 4..20 mA inputs are displayed

Example: (configuration for HYDAC AquaSensor AS 203x / 233x)

h

Channel 1 4.0 mA Configuration Value: 0.0

Channel 1 20.0 mA Configuration Value: 100.0

%Saturation Value: 35.6

Channel 2 4.0 mA Configuration Value: -20.0

Channel 2 20.0 mA Configuration Value: 120.0

Temperature Value: 55.4

Press key (x, 'Return'): **x 'Return'**

Entering '**Return**' updates the values, **x 'Return'** exits the display and returns to parameter mode

8.3.4.15 Master reset

d = Set default values resets all values that can be set in the parameter mode menu (except the configuration of the analog inputs) to their default values (see Chapter 10.6 Parameter List for more information)

Factory default settings recovered !



Do not forget to exit parameter and operation mode again after the setting before you disconnect the programming connection, otherwise no measurements will be performed!

If you do this nevertheless, it is possible to "Reset" the ContaminationSensors by briefly interrupting the electrical power supply. Once the electrical power supply has been restored, the ContaminationSensor automatically restarts in display mode.

9 PLC interface output signals

Depending on the set output format (ISO code or NAS/SAE classes), the PLC interface either outputs a three-value ISO code or the NAS/SAE classes of the four particle size channels coded in the form of pulses.

The number of pulses output corresponds to the ISO class + 1 or the SAE/NAS class + 1. (This means class "0" can also be output.)

The default pulse frequency is approx. 10 Hz (50ms high / 50ms low), but can be changed in parameter mode, e.g. divided by 2 (→100ms high / 100ms low), 3 (→150ms high / 150ms low) or 4 (→ 200ms high / 200ms low).

There is a 1 second pause between outputting the two values of the ISO code or between the NAS/SAE classes of two channels (irrespective of the pulse frequency selected).

The measurement result is output again after 10 seconds (irrespective of the pulse frequency selected). The output is not synchronized with the measurement interval. This means once an output is started it is continued to its conclusion, even if a new measured value becomes available in the meantime.

In the event of a flow or device error, no pulses are output via the PLC interface. The same applies if the measurement is stopped (modes M3 and M4).

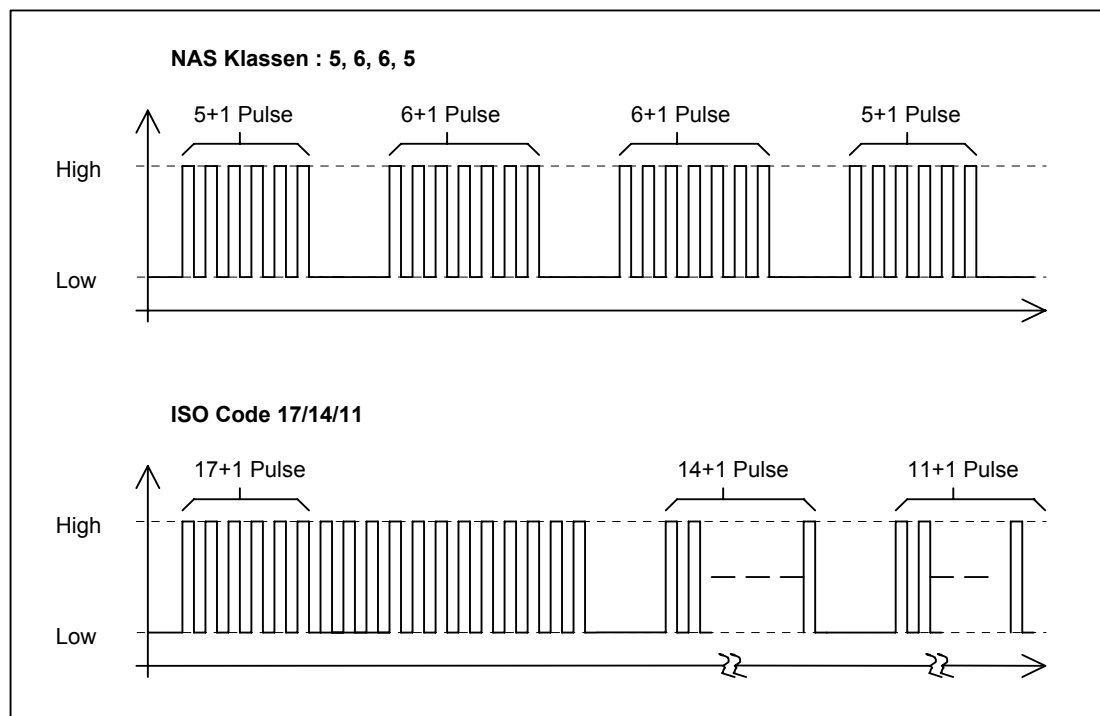


Figure 1: Examples

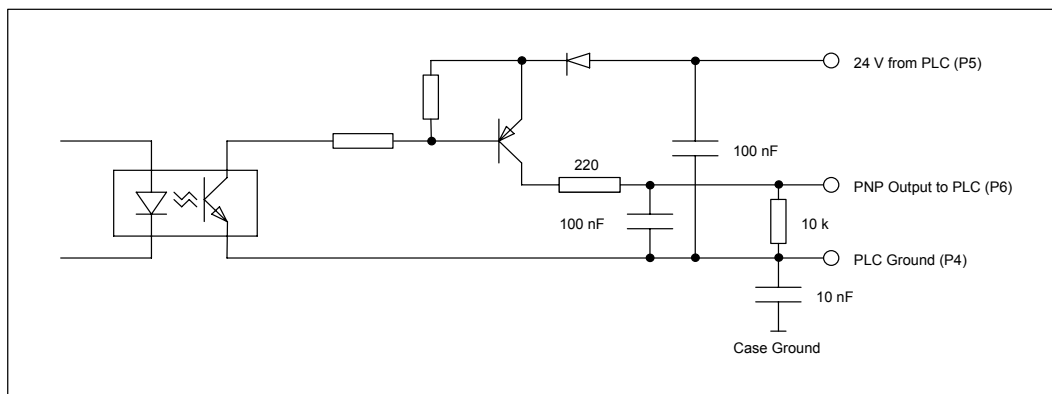


Figure 2: PLC output switching of the CS

10 DIN measurement bus module (option -2)

10.1 Interface

The configuration of the interface and the protocol structure required for communication are in accordance with the criteria defined in DIN 66348 Part 2.

Basically, the electrical properties correspond to those of an RS 485 interface, however with the additional feature of implementation of the electrical isolation between the interface module and the remainder of the circuit as required in the aforementioned DIN standard.

Data can only be transmitted via this interface using a 4-wire bus in full-duplex mode.

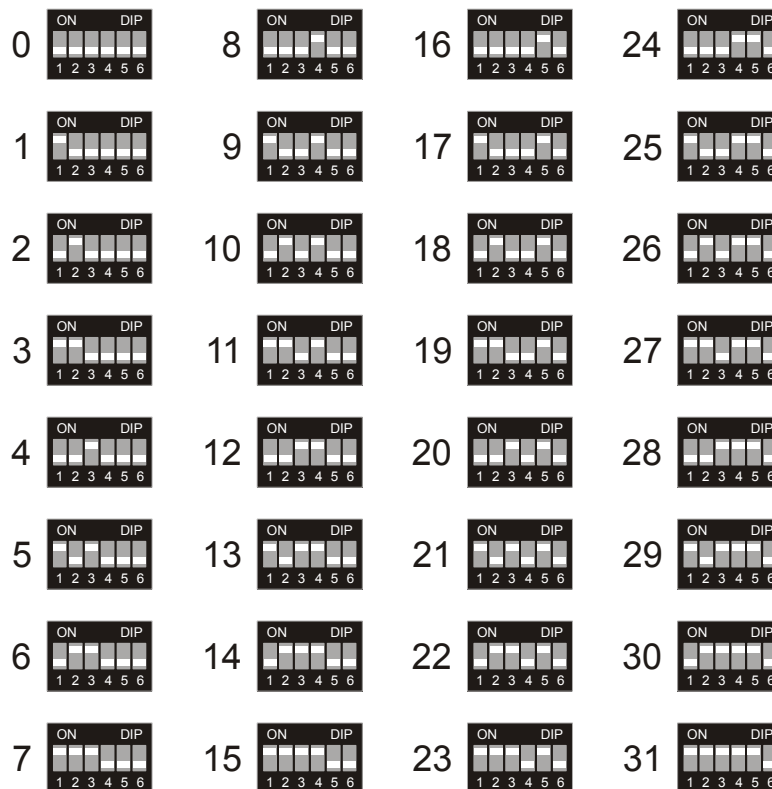
10.2 Bus address

Since several CSs can be connected to the same bus, each sensor has to be assigned an address of its own by which it is accessed. The address range in accordance with DIN 66348 ranges from 1 to 31. In view of the fact that each address may only be assigned once, this means that the maximum number of devices is 31.

When the DIP switch is in the "0" position, the bus address stored in the CS's memory is used. The BUS address can be set in parameter mode (see the "Parameter Mode" section in the "Serial RS232 Display and Parameter Setting Interface") or via one of the optional digital interfaces in the range from 1 to 31.

In any other position, the bus address of the CS is fixed and cannot be changed either in parameter mode or using one of the optional digital interfaces.

10.3 Settings of the bus address with DIP switch



10.4 DIN measurement bus commands

All transfers are ASCII-coded, i.e. values are not transmitted in binary format. Strings are transferred with a prefix stating the number of places. The string itself is set inside quotation marks (""). The DIN measurement bus only transmits 7-bit characters, therefore characters with a binary value above 127 are transferred in an escape sequence. The sequence is initiated with a '@' followed by a hexadecimal value as the ASCII character

e.g.: 'Pump 12' -----> 8 "Pump 12"
 'Behälter 3' -----> 12 "Beh@84lter 3" ä --> 132 binary --> 84 hex

A send request without previous command transfer returns error status, status and operating status.

e.g. : '1024 00 22' :

Explanation:

Error status: 1024 (flow error, see below)

Status: 00 (no new measured value)

Operating status: 22 (Measuring mode M2, measurement in progress, see below)

Error status:

Name	Binary value	Meaning
COMAND_ERROR	64	Incorrect bus command was received.
TX_ERROR	512	Error in transmit protocol
Q_ERROR	1024	Flow error
ISENSOR_ERROR	4096	Error, LED current, particle sensor

Status:

Name	Binary value	Meaning
COUNT_READY	1	New measurement present */

Operating status:

The tens digit shows the measuring mode number:

1x --> M1, 2x --> M2, etc.

The units digit defines the exact status:

The following applies to M1 (Measure), M2 (Measure and switch), M3 (Filter to):

- x0 Measurement off
- x1 Wait for correct flow rate
- x2 Measurement currently in progress

The following applies to M4 (Filter from to):

- 40 Measurement off
- 41 Wait for correct flow rate
- 42 Measurement currently in progress, testing for lower limit
- 43 Waiting time running
- 44 Waiting time timed out, wait for correct flow rate
- 45 Measurement currently in progress, testing for upper limit

10.5 Commands

A command always consists of a command number and the associated parameters. Some commands cause the CS to give a response on the next send request. The response is always prefixed by the command number. If the response is longer than one data block, it is sent in several blocks.

Command '8': Program parameters in CS

Command '9': Read parameter in CS

Command '11': Read measured particles (differential) (online)

Command '12': Read measured contamination class (online)

Command '13': Stop measurement

Command '14': Start measurement

Command '15': Test parameter

Command '16': Reset error status

Command '17': Read out LED send current

Command '18': Read out flow info

Command '19': Set parameter to factory settings:

Command '109': Query device and version

10.5.1 Command '8': Set parameter

The individual parameters in the CS (limit values, monitoring times, measurement point name, etc.) can be set with this command. The command number is followed by a parameter number and the parameter value.

Example: Set parameter 21 to 0

SEND : '8 21 0'

!!! Not all parameters can be programmed !!!

10.5.2 Command '9': Read out parameter

The command number is followed by the number of the required parameter.

Example: Read out parameter 21

SEND : '9 21'

RECEIVE : '9 21 1'

Explanation:

Read out parameter: 21

Parameter value: 1

!!! All parameters can be read !!!

10.5.3 Command '11': Read measured particles (differential) (online)

The values of the current measurement are transferred:

CS 203X: 5...15 µm, 15...25 µm, 25...50 µm, >50 µm particle counts, flow rate, water content and temperature.

CS 213X: 2...5 µm, 5...15 µm, 15...25 µm, >25 µm particle counts, flow rate, water content and temperature.

CS 223X: 4...6 µm, 6...14 µm, 14...21 µm, >21 µm particle counts, flow rate, water content and temperature.

with connected HLB1000 at analog input 1:

CS 203X: 5...15 µm, 15...25 µm, 25...50 µm, >50 µm particle counts, flow, water content, temperature, relative change in viscosity, relative change in dielectric constant value and sensor status.

CS 213X: 2...5 µm, 5...15 µm, 15...25 µm, >25 µm particle counts, flow, water content, temperature, relative change in viscosity, relative change in dielectric constant value and sensor status.

CS 223X: 4...6 µm, 6...14 µm, 14...21 µm, >21 µm particle counts, flow, water content, temperature, relative change in viscosity, relative change in dielectric constant value and sensor status.

Example with 2 analog signals:

SEND: '11'

RECEIVE: '11 50453 4324 234 67 100 34.7 52.0'

Explanation:

Particle counts (5..15 µm/2..5 µm/4..6 µm): 50453

Particle counts (15..25 µm/5..15 µm/6..14 µm): 4324

Particle counts (25..50 µm/15..25 µm/14..21 µm): 234

Particle counts (>50 µm/>25 µm/>21 µm): 67

Flow rate: 100 ml/min

Measured value Analog input 1 (e.g. water content) : 34.7

Measured value Analog input 2 (e.g. Temperature) : 52.0



The information about the water content and temperature is only available if a HYDAC AquaSensor is connected to the analog input channels. (The measured values are determined at the end of the measurement interval of the particle counting.)

Example with HYDACLab:

SEND: '11'

RECEIVE: '11 50453 4324 234 67 100 34.7 52.0 11.0 -17.0 2'

Explanation:

Particle counts (5..15 µm/2..5 µm/4..6 µm): 50453

Particle counts (15..25 µm/5..15 µm/6..14 µm): 4324

Particle counts (25..50 µm/15..25 µm/14..21 µm): 234

Particle counts (>50 µm/>25 µm/>21 µm): 67

Flow rate: 100 ml/min

HYDACLab Measured value Saturation [%] : 34.7

HYDACLab Measured value Temperature [°C] : 52.0

HYDACLab Measured value Rel. change in viscosity [%] : 11.0

HYDACLab Measured value Rel. change in dielectric constant value [%] :
-17.0

HYDACLab Measured value Sensor status : 2

Note on HYDACLab Sensor status:

1 = Reference phase

- 2 = Operating phase
- 3 = Oil status not plausible
- 4 = Internal error



The information is available only if a HYDAC HYDACLab is connected to the analog input channel 1. (The measured values are evaluated from the HDA.ISO signal and the current values are output with the end of the measurement interval of the particle count.)

10.5.4 Command '12': Read measured contamination class online)

Revise/expand

The values of the current measurement are transferred in the form of contamination classes:

Parameter 21 determines whether NAS/SAE or ISO classes are transferred (see chapter 10.6 Parameter List).

SEND : '12' (parameter 21 = 0)

RECEIVE : '12 6 7 7 6 100 34.7 52.0'

Explanation:

NAS/SAE class (channel 0):	6
NAS/SAE class (channel 1):	7
NAS/SAE class (channel 2):	7
NAS/SAE class (channel 3):	6
Flow rate:	100 ml/min
Measured value Analog input 1 (e.g. water content) :	34.7
Measured value Analog input 2 (e.g. Temperature) :	52.0

SEND : '12' (parameter 21 = 1)

RECEIVE : '12 21 18 15 12 100 34.7 52.0'

Explanation:

ISO class (channel 0):	21
ISO class (channel 1):	18
ISO class (channel 2):	15
ISO class (channel 3):	12
Flow rate:	100 ml/min
Measured value Analog input 1 (e.g. water content) :	34.7
Measured value Analog input 2 (e.g. Temperature) :	52.0



The information about the water content and temperature is only available if a HYDAC AquaSensor is connected to the analog input channels. (The measured values are determined at the end of the measurement interval of the particle counting.)

Example with HYDACLab:

SEND: '12' (Parameter 21 = 0)

RECEIVE: '12 6 7 7 6 100 34.7 52.0 11.0 -17.0 2'

Explanation:

NAS/SAE class (channel 0):	6
NAS/SAE class (channel 1):	7
NAS/SAE class (channel 2):	7
NAS/SAE class (channel 3):	6
Flow rate:	100 ml/min
HYDACLab Measured value Saturation [%]:	34.7
HYDACLab Measured value Temperature [°C]:	52.0
HYDACLab Measured value Rel. change in viscosity [%]:	11.0
HYDACLab Measured value Rel. change in dielectric constant value [%] :	-17.0
HYDACLab Sensor status :	2

Note on HYDACLab Sensor status:

- 1 = Reference phase
- 2 = Operating phase
- 3 = Oil status not plausible
- 4 = Internal error



The information is available only if a HYDAC HYDACLab is connected to the analog input channel 1. (The measured values are evaluated from the HDA.ISO signal and the current values are output with the end of the measurement interval of the particle count.)

10.5.5 Command '13': Stop measurement

This command ends a measurement that is in progress:

SEND : '13'

10.5.6 Command '14': Start measurement

This command starts a specified measurement program (M1...M4);

SEND : '14'

10.5.7 Command '17': Read out LED current

This command reads out the current value of the send current of the sensor LED (digital value between 0 and 1023).

SEND : '17'

RECEIVE : '17 156'

Explanation:

LED current: 156 digits

10.5.8 Command '19': Set parameter to factory settings:

This command resets the settings of the CS that can be changed by the user to the factory settings (see "Parameter List" section and "Factory Settings" section in "Technical Data" chapter)

SEND : '19'

10.5.9 Command '109': Request device version

The response comes in the form of three strings specifying the device type, the device family and the version number of the firmware.

SEND: '109'

RECEIVE : '109 6 "CS2130" 6 "CS 2000 " 5 "V4.00"

Explanation:

Number of digits in string: 7

Device type: CS 2130

Number of digits in string: 7

Device family: CS 2000

Number of digits in string: 5

Firmware Version: V4.00

10.6 Parameter list / Parameter List

Alle Parameter sind entweder vom Typ String oder Integer.

All parameters are either strings or integers.

No.	String	Read-only	Description	Ex-works setting	Min	Max
0		Yes	For internal use			
1		Yes	For internal use			
2		Yes	For internal use			
3		Yes	For internal use			
4		Yes	ContaminationSensor Model: 0 --> CS 2030 / CS 2031 1 --> CS 2130 / CS 2131 2 --> CS 2230 / CS 2231	1	0	2
5	X	Yes	No to Serial.	Yyyyyy		
6	X	Yes	No to Sensor.	XxxAyyyyyy		
7	X	Yes	Calibration date			
8		No	Measurement interval	60	20	120
9	X	No	Measurement point (max. 20 characters)	HYDAC		
10		Yes	For internal use			
11		Yes	For internal use			
12		No	Lower limit value M2, Relay 1, Channel 9 / 10	80	0	999
13		No	Upper limit value M2, Relay 1, Channel 9 / 10	120	0	999
14		No	Limit value function for Relay 1 (in M2) 0 -> no function 1 -> within range 2 -> outside range 3 -> exceed (upper limit value exceeded (lower limit value for hysteresis)) 4 -> fall below (value below lower limit value (upper limit value for hysteresis))	4	0	4

No.	String	Read-only	Description	Ex-works setting	Min	Max
15		No	Measurement channel for Relay 1 (in M2) 0 --> NAS/SAE Ch.0 (5-15 µm / 2-5 µm / >4 µm) 1 --> NAS/SAE Ch.1 (15-25 µm / 5-15 µm / >6 µm) 2 --> NAS/SAE Ch.2 (25-50 µm / 15-25 µm / >14 µm) 3 --> NAS/SAE Ch.3 (>50 µm / >25 µm / >21 µm) 4 --> ISO Ch.0 (>5 µm / >2 µm / >4 µm) 5 --> ISO Ch.1 (>15 µm / >5 µm / >6 µm) 6 --> ISO Ch.2 (>25 µm / >15 µm / >14 µm) 7 --> NAS/SAE Channel 0 to 3 8 --> ISO Code 9 --> flow 10 --> LED current 11 --> 4..20 mA input channel 1 12 --> 4..20 mA input channel 2	8	0	9
16		No	Lower limit value M2, Relay 2, Channel 9 / 10	40	0	999
17		No	Upper limit value M2, Relay 2, Channel 9 / 10	75	0	999
18		No	Limit value function for Relay 2 (in M2) 0 -> no function 1 -> within range 2 -> outside range 3 -> exceed (upper limit value exceeded (lower limit value for hysteresis)) 4 -> fall below (value below lower limit value (upper limit value for hysteresis))	4	0	4
19		No	Measuring channel for Relay 2 (in M2) 0 --> NAS/SAE Ch.0 (5-15 µm / 2-5 µm / >4 µm) 1 --> NAS/SAE Ch.1 (15-25 µm / 5-15 µm / >6 µm) 2 --> NAS/SAE Ch.2 (25-50 µm / 15-25 µm / >14 µm) 3 --> NAS/SAE Ch.3 (>50 µm / >25 µm / >21 µm) 4 --> ISO Ch.0 (>5 µm / >2 µm / >4 µm) 5 --> ISO Ch.1 (>15 µm / >5 µm / >6 µm) 6 --> ISO Ch.2 (>25 µm / >15 µm / >14 µm) 7 --> NAS/SAE channel 0 to 3 8 --> ISO Code 9 --> flow 10 --> LED current 11 --> 4..20 mA input channel 1 12 --> 4..20 mA input channel 2	8	0	9
20		Yes	For internal use			
21		No	Unit for Command 12 0--> NAS/SAE 1 --> ISO	1	0	1
22		No	Lower limit value in M3 Channel 0 (NAS/SAE / ISO)	18		

No.	String	Read-only	Description	Ex-works setting	Min	Max
23		No	Lower limit value in M3 Channel 1 (NAS/SAE / ISO)	15		
24		No	Lower limit value in M3 Channel 2 (NAS/SAE / ISO)	12		
25		No	Lower limit value in M4 Channel 0 (NAS/SAE / ISO)	18		
26		No	Lower limit value in M4 Channel 1 (NAS/SAE / ISO)	15		
27		No	Lower limit value in M4 Channel 2 (NAS/SAE / ISO)	12		
28		No	Upper limit value in M4 Channel 0 (NAS/SAE / ISO)	22		
29		No	Upper limit value in M4 Channel 1 (NAS/SAE / ISO)	19		
30		No	Upper limit value in M4 Channel 2 (NAS/SAE / ISO)	16		
31		No	Test cycle time in M4 (in minutes)	60	0	1440
32		Yes	For internal use			
33		No	Address for DIN-MESSBUS	1	1	31
35		Yes	For internal use			
36		Yes	For internal use			
37		Yes	For internal use			
38		Yes	For internal use			
39		Yes	For internal use			
40		No	Unit of limit value in M3 0 --> NAS/SAE, 1 --> ISO	1	0	1
41		No	Unit of limit value in M4 0 --> NAS/SAE, 1 --> ISO	1	0	1
43		No	Pump pre-running time in seconds relay 1 switched off (Pump Protection)	0	0	200
44		Yes	For internal use			
45		Yes	For internal use			
46		No	IP Address part 1	192	0	255
47		No	IP Address part 2	168	0	255
48		No	IP Address part 3	16	0	255

No.	String	Read-only	Description	Ex-works setting	Min	Max
49		No	IP Address part 4	36	0	255
50		Yes	For internal use			
51		Yes	For internal use			
52		No	Analog input 1, Configured value for 4 mA		-9999	9999
53		No	Analog input 1, Configured value for 20 mA		-9999	9999
54	X	No	Analog input 1, designation (max. 15 characters)			
55		Yes	For internal use			
56		Yes	For internal use			
57		No	Analog input 2, Configured value for 4 mA		-9999	9999
58		No	Analog input 2, Configured value for 20 mA		-9999	9999
59	X	No	Analog input 2, designation (max. 15 characters)			
60		Yes	For internal use			
61		Yes	For internal use			
62		Yes	For internal use			
63		Yes	For internal use			
64		Yes	For internal use			
65		Yes	For internal use			
66		Yes	Analog input mode	0	0	2
67		Yes	For internal use			
68		Yes	For internal use			
69		Yes	For internal use			
70		Yes	For internal use			
71		Yes	For internal use			
72		Yes	For internal use			
73		Yes	For internal use			
74		Yes	For internal use			
75		Yes	For internal use			
76		Yes	For internal use			
77		Yes	For internal use			

No.	String	Read-only	Description	Ex-works setting	Min	Max
78		Yes	For internal use			
79		Yes	For internal use			
80		No	Measuring mode M1..M4 --> 0..3	1	0	3
81	X	No	Header for RS232 Display Output	No to Header		
82		No	Unit for RS232 Display Output CS 2230: 1 = SAE max. , 2 = ISO Code , 3 = Flow rate, 4 = Toggle ISO/Flow, 5 = SAE ch. A, 6 = SAE ch. B, 7 = SAE ch. C, 8 = SAE ch. D, 9 = cum. particle counts / flow rate CS2030/2130: 1 = NAS max. , 2 = ISO Code , 3 = Flow rate, 4 = Toggle ISO/Flow , 5 = NAS ch. 0, 6 = NAS ch. 1, 7 = NAS ch. 2, 8 = NAS ch. 3, 9 = cum. particle counts / flow rate	2	1	8
83		No	Unit for PLC Output 1--> NAS/SAE, 2 --> ISO	2	1	2
84		No	Lower limit value 1 M2, Relay 1, Channel 0-8	16	0	999
85		No	Lower limit value 2 M2, Relay 1, Channel 0-8	13	0	999
86		No	Lower limit value 3 M2, Relay 1, Channel 0-8	10	0	999
87		No	Lower limit value 4 M2, Relay 1, Channel 0-8 (not used)	7	0	999
88		No	Upper limit value 1 M2, Relay 1, Channel 0-8	18	0	999
89		No	Upper limit value 2 M2, Relay 1, Channel 0-8	15	0	999
90		No	Upper limit value 3 M2, Relay 1, Channel 0-8	12	0	999
91		No	Upper limit value 4 M2, Relay 1, Channel 0-8 (not used)	9	0	999
92		No	Lower limit value 1 M2, Relay 2, Channel 0-8	16	0	999
93		No	Lower limit value 2 M2, Relay 2, Channel 0-8	13	0	999
94		No	Lower limit value 3 M2, Relay 2, Channel 0-8	10	0	999
95		No	Lower limit value 4 M2, Relay 2, Channel 0-8 (not used)	7	0	999
96		No	Upper limit value 1 M2, Relay 2, Channel 0-8	18	0	999
97		No	Upper limit value 2 M2, Relay 2, Channel 0-8	15	0	999

No.	String	Read-only	Description	Ex-works setting	Min	Max
98		No	Upper limit value 3 M2, Relay 2, Channel 0-8	12	0	999
99		No	Upper limit value 4 M2, Relay 2, Channel 0-8 (not used)	9	0	999

11 RS 232 Module (Option –0)

This module uses the same data transfer protocol as described in the DIN measurement bus chapter.

The RS 232 module enables the ContaminationSensor to be connected directly to a standard RS 232 computer port (COM port) without using an interface converter.

However, it is not possible to network several units with the RS 232 module.

Furthermore, the RS 232 interface has a lower interference immunity than the RS 485 interface.



Caution! This serial RS 232 interface cannot be used for parameter setting with a terminal program.

Always use the RS 232 display interface for this application, see the "Analog Inputs" chapter.

12 Ethernet Module (Option –5)

The Ethernet module is designed for the standardized cabling version "10 Base-T" and corresponds to the criteria defined in IEEE 802.3 (bit rate 10 Mbps, transfer medium: Twisted Pair (UTP/STP) cable).

The data is transferred via the globally standardized TCP/IP communication protocol.

12.1 Setting the IP address

Before you set an IP address, coordinate the application with your IT department. Assignment of an IP address is subject to certain internal company regulations and overriding international regulations.



The IP address of every single device can be set to identify it in the network.

Only use IP addresses that are assigned to you by the IT department. Failure to observe this requirement can result in network failure.

The IP address is set when the parameters are set using the RS232 display and parameter setting interface (as described in chapter **8.3.4.5**). This module uses the same data transfer protocol as described in chapter **10**.



When the device is accessed via Ethernet LAN, it is only the IP address that is important and the bus address is ignored.

12.2 Devices with an Ethernet module offer the following 2 applications

The following applications are available at the same time.



However, we recommend exclusively using individual mode in order to avoid timing problems and malfunctions.

12.2.1 Transferring commands via the TCP/IP protocol

The same commands are available as described in chapter **10.5** DIN Measurement Bus Module. However, the ASCII-coded commands are transferred via the TCP/IP protocol. Refer to chapter **10.4** for the composition of the commands and their responses.

12.2.2 CS 2000 as WebServer

The CS 2000 performs the task of a WebServer. The CS 2000 Ethernet module offers the opportunity to display the current measurement data (cumulative particle counts, ISO classes) as well as some device data (e.g. device type, firmware, serial number) on a connected PC using a web browser (e.g. Internet Explorer).

The screens are stored in HTML format in the CS 2000 WebServer and can be called up in the PC browser by entering the corresponding IP address in the address box (see section 12.1).

For example:

Adresse	http://192.168.0.30/
---------	----------------------

An HTML screen appears with the following structure:

HYDAC Contamination Sensor CS 2230

Serial No. 431C120999 Firmware 4.00

Measuring Point HYDAC Filtersystems

Current Readings

Particle Size	Counts / 100ml	ISO Code
> 4 µ	10620	14
> 6 µ	3015	12
> 14 µ	756	10
> 21 µ	102	

Sensor Flow rate [ml/min]	104
Temperature [°C]	Optional values. Only when using HYDAC AquaSensors
Saturation [%]	

The HTML page is refreshed every 15 seconds, which means it always displays the current measurement results.

However, the values for temperature ([°C]) and saturation ([%]) are only output if a HYDAC AquaSensor or a HYDACLab is connected to the CS.

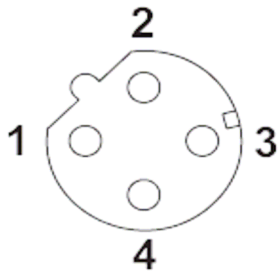


The CS 2000 with Ethernet modul performs the task of a WebServer. If you make a connection to the CS 2000, another client is blocked

from accessing this function for the duration of the connection, i.e. the WebServer only ever communicates with one client at a time. However, it is possible to call up the WebServer with a web browser (e.g. Internet Explorer) at the same time as accessing the device in accordance with Chapter 12.2.1.

12.3 Electrical Installation

The CS 2000 with Ethernet module has a "D"-coded M12 Industrial Ethernet connection socket in accordance with IEC 61076-2-101



Assignment:

PIN 1 : TxD+ (terminal 9)
PIN 2 : RxD+ (terminal 7)
PIN 3 : TxD- (terminal 10)
PIN 4 : RxD- (terminal 8)

The following connection lines are available as optional accessories:

	Stock number
ZBE 45-05 (Ltg.M12-D-4p 5mSteck/RJ45Patch)	3346100
ZBE 45-10 (Ltg.M12-D-4p10mSteck/RJ45Patch)	3346101
ZBE 46-05 (Ltg.M12-D-4p 5mSteck/RJ45Crossover)	3346102
ZBE 46-10 (Ltg.M12-D-4p10mSteck/RJ45Crossover)	3346103

13 Analog module (option –1)

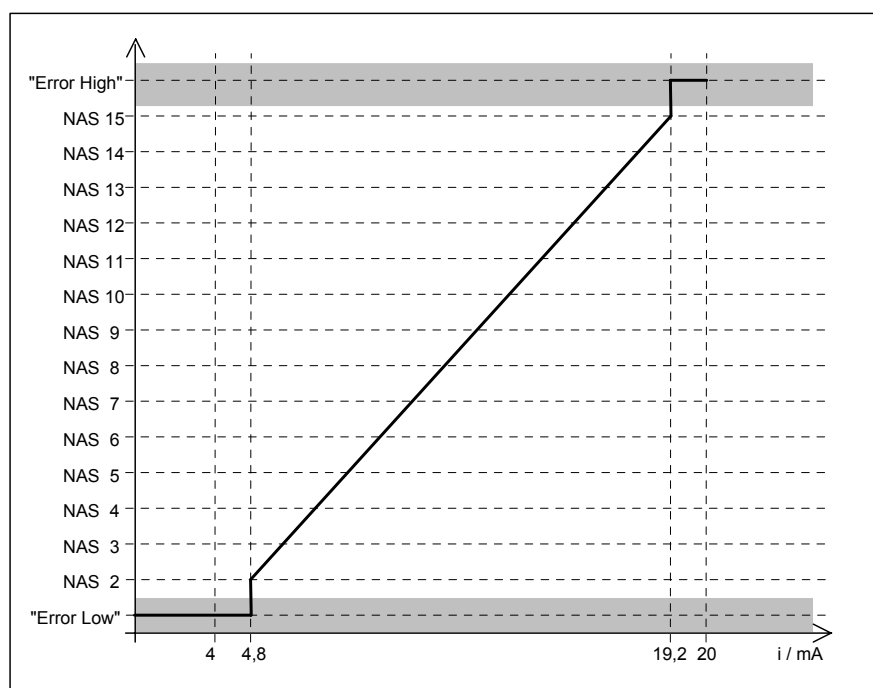
The measurement results are output as follows as current between 4 mA and 20 mA (load $\leq 500 \Omega$):

If NAS max. or SAE max. was selected in parameter mode under "i":

	Current 4-20 mA
Measurement range from NAS=2 / SAE =2	4.8 mA
Measurement range to NAS =15 / SAE =12	19.2 mA
"Error Low"	4 mA
"Error High"	20 mA

"Error Low" means: Device is not ready for measuring (e.g. due to defective sensor, however also due to excessive air or water content)

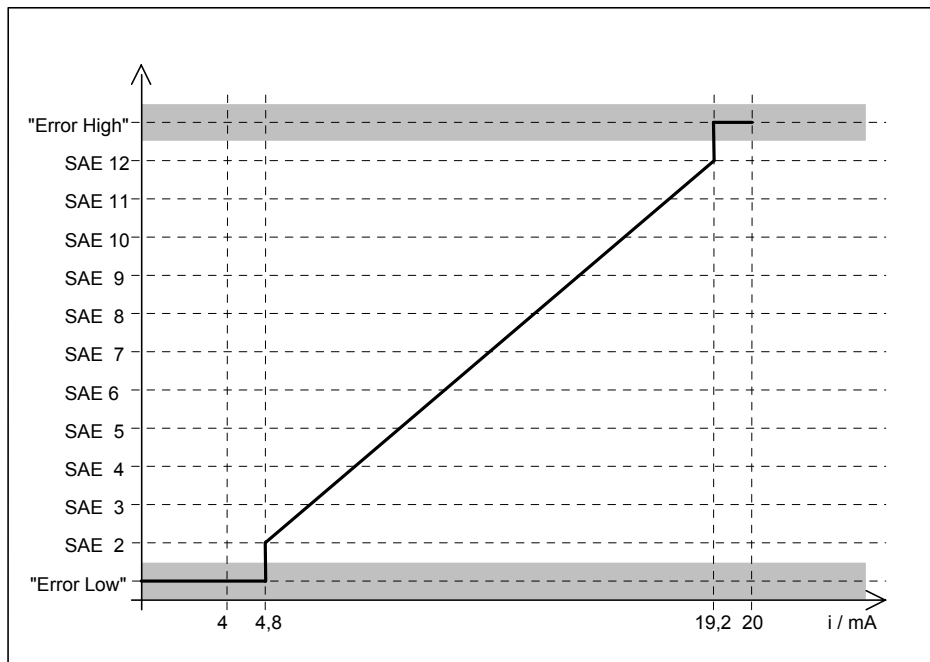
"Error High" means: Flow error



The NAS class is calculated from the measured current i as follows:

$$\text{"NAS value"} = 1 + (i - 4.8 \text{ mA}) \times 13 / 14.4$$

NAS class = "NAS value" rounded to whole number



The SAE class is calculated from the measured current i as follows:

$$\text{"SAE value"} = 1 + (i - 4.8 \text{ mA}) \times 11 / 14.4$$

SAE class = "SAE value" rounded to whole number

If Particle counts was selected in parameter mode under "i":

	Period	Current 4-20 mA
"ID" for particle channel 1	300 ms 300 ms	19.2 mA 4.8 mA
Log (particle count channel 1)	3000 ms	4.8 mA-19.2 mA
"ID" for particle channel 2	300 ms 300 ms 300 ms 300 ms	19.2 mA 4.8 mA 19.2 mA 4.8 mA
Log (particle count channel 2)	3000 ms	4.8 mA-19.2 mA
...
"Error Low"	0%	4 mA
"Error high"	100%	20 mA

After an "ID" for the particle channel, the particle count of the particular channel is output as a current between 4.8 and 19.2 mA.

The current is calculated as follows: $I(n) = I_{\min} + \log(n) \times (I_{\max} - I_{\min}) / (\log(n_{\max}) - \log(n_{\min}))$

Where: n = particle count

n_{\min} = minimum particle count (1)

n_{\max} = maximum particle count (20.480.00)

I_{\min} = minimum current (4.8mA)

I_{\max} = maximum current (19.2mA)

Log = Logarithm base 10

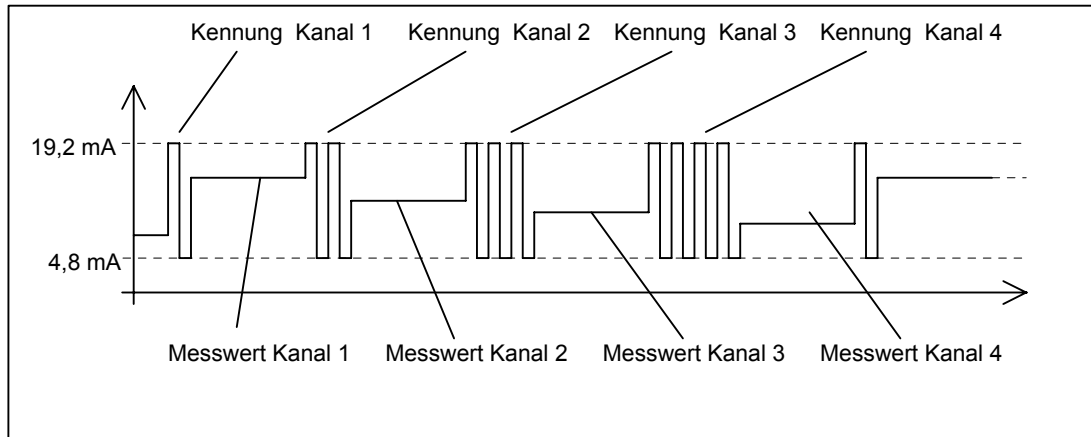
This results in: **$I(n) = 4.8 \text{ mA} + \log(n) \times 1.9695 \text{ mA}$**

If the particle count is greater than 20,480,000, then 19.2 mA is output. If the particle count = 0, then 4.8 mA is output.

The particle count is calculated from the current as follows:

$$n(I) = 10^{(I - 4.8 \text{ mA}) / 1.9695 \text{ mA}}$$

Example:



14 Cleanliness classes - brief overview

14.1 Cleanliness class - ISO 4406:1999

In ISO 4406:1999 particle counts are determined cumulatively, i.e. $> 4 \mu\text{m}_{(c)}$, $>6 \mu\text{m}_{(c)}$ and $>14 \mu\text{m}_{(c)}$ (manually by filtering the fluid through an analysis membrane or automatically using particle counters) and allocated to measurement references.

The goal of allocating particle counts to references is to facilitate the assessment of fluid cleanliness ratings.

In 1999 the "old" ISO 4406:1987 was revised and the size ranges of the particle sizes undergoing analysis redefined. The counting method and calibration were also changed.

This is important for the user in his everyday work: even though the measurement references of the particles undergoing analysis have changed, the cleanliness code will change only in individual cases. When drafting the "new" ISO 4406:1999 it was ensured that not all the existing cleanliness provisions for systems had to be changed.

14.1.1 ISO 4406 table

Allocation of particle counts to cleanliness classes:

Number of particles / 100 ml			Number of particles / 100 ml		
Class	More than	Up to (and including)	Class	More than	Up to (and including)
0	0	1	15	16,000	32,000
1	1	2	16	32,000	64,000
2	2	4	17	64,000	130,000
3	4	8	18	130,000	250,000
4	8	16	19	250,000	500,000
5	16	32	20	500,000	1,000,000
6	32	64	21	1,000,000	2,000,000
7	64	130	22	2,000,000	4,000,000
8	130	250	23	4,000,000	8,000,000
9	250	500	24	8,000,000	16,000,000
10	500	1,000	25	16,000,000	32,000,000
11	1,000	2,000	26	32,000,000	64,000,000
12	2,000	4,000	27	64,000,000	130,000,000
13	4,000	8,000	28	130,000,000	250,000,000
14	8,000	16,000			

Note: increasing the measurement reference by 1 causes the particle count to double.

Example: ISO class 18 / 15 / 11 means:

Cleanliness class	Particle count / ml	Size ranges
18	1,300 – 2,500	> 4 µm _(c)
15	160 – 320	> 6 µm _(c)
11	10 – 20	> 14 µm _(c)

are found in 1 ml of an analyzed sample.

14.1.2 Changes from ISO4406:1987 to ISO4406:1999

	“old” ISO 4406:1987	“new” ISO 4406:1999	
Size ranges	> 5 µm > 15 µm	> 4 µm _(c) > 6 µm _(c) > 14 µm _(c)	
Dimension determined	Longest dimension of a particle	Diameter of the area-equivalent circle ISO 11171:1999	
Test dust	ACFTD dust	1-10 µm ultra fine fraction	ISO 12103-1A1
		SAE Fine, AC Fine	ISO 12103-1A2
		SAE 5-80 µm ISO MTD Calibration dust for particle counters	ISO 12103-1A3
		SAE Coarse Coarse fraction	ISO 12103-1A4
Comparable size ranges	Old ACFTD calibration	Comparable ACFTD dusts	New NIST calibration
	----- 5 µm 15 µm	< 1 µm 4.3 µm 15.5 µm	4 µm _(c) 6 µm _(c) 14 µm _(c)

14.2 Cleanliness class - SAE AS 4059

Like ISO 4406, NAS 4059 describes particle concentrations in liquids. The analysis methods can be applied in the same manner as ISO 4406:1999.

An additional feature in common with ISO 4406:1999 is that cleanliness classes are grouped on the basis of cumulative number of particles (i.e. all particles that are larger than a certain limit value are $>4\text{ }\mu\text{m}$, for example).

As opposed to ISO, SAE AS 4059 uses different limit values among the various particle sizes for contamination classes.

For this reason, the corresponding designation of the particle size being examined always has to be added, e.g.:

AS 4059 class 6B \triangleq 9731 – 19500 particle $> 6\text{ }\mu\text{m}$ (see table 14.2.1)

AS 4059 class 8A/7B/6C \triangleq 3-value ISO code $>4\mu\text{m}/>6\mu\text{m}/>14\mu\text{m}$

If an SAE class is given acc. to AS 4059 without a letter, then it is always particle size B ($> 6\text{ }\mu\text{m}$).

The following table shows the cleanliness in relation to the particle concentration determined.

14.2.1 SAE AS 4059 table

		Maximum particle count / 100 ml					
Size ISO 4402		$> 1\text{ }\mu\text{m}$	$> 5\text{ }\mu\text{m}$	$> 15\text{ }\mu\text{m}$	$> 25\text{ }\mu\text{m}$	$> 50\text{ }\mu\text{m}$	$> 100\text{ }\mu\text{m}$
Size ISO 11171		$> 4\text{ }\mu\text{m}_{(c)}$	$> 6\text{ }\mu\text{m}_{(c)}$	$> 14\text{ }\mu\text{m}_{(c)}$	$> 21\text{ }\mu\text{m}_{(c)}$	$> 38\text{ }\mu\text{m}_{(c)}$	$> 70\text{ }\mu\text{m}_{(c)}$
Size coding		A	B	C	D	E	F
Classes	000	195	76	14	3	1	0
	00	390	152	27	5	1	0
	0	780	304	54	10	2	0
	1	1,560	609	109	20	4	1
	2	3,120	1,220	217	39	7	1
	3	6,250	2,430	432	76	13	2
	4	12,500	4,860	864	152	26	4
	5	25,000	9,730	1,730	306	53	8
	6	50,000	19,500	3,460	612	106	16
	7	100,000	38,900	6,920	1,220	212	32
	8	200,000	77,900	13,900	2,450	424	64
	9	400,000	156,000	27,700	4,900	848	128
	10	800,000	311,000	55,400	9,800	1,700	256
	11	1,600,000	623,000	111,000	19,600	3,390	512
	12	3,200,000	1,250,000	222,000	39,200	6,780	1,020

14.2.2 SAE definition

14.2.2.1 Absolute particle count larger than a defined particle size

Example: Cleanliness class according to AS 4059: 6

The maximum permissible particle count in the individual size ranges is shown in the table in boldface.

Cleanliness class acc. to AS 4059= 6 B

Size B particles may not exceed the maximum number indicated for class 6

6 B = max. 19,500 particles > 5 µm in size

14.2.2.2 Specifying a cleanliness class for each particle size

Example: Cleanliness class according to AS 4059=7 B / 6 C / 5 D

Cleanliness class	Particle count / 100 ml
Size B (> 5 µm / > 6 µm _(c))	38,900
Size C (>15 µm / >14 µm _(c))	3460
Size D (>25 µm / > 21 µm _(c))	306

14.2.2.3 Specifying the highest cleanliness class measured

Example: Cleanliness class according to AS 4059= 6 B – F

The 6 B – F specification requires a particle count in size ranges B – F . The respective particle concentration of cleanliness class 6 may not be exceeded in any of these ranges.

14.3 Cleanliness Class - NAS 1638

Like ISO 4406, NAS 1638 describes particle concentrations in liquids. The analysis methods can be applied in the same manner as ISO 4406:1999.

In contrast to ISO 4406, certain particle ranges are counted in NAS 1638 and attributed to measurement references.

The following table shows the cleanliness in relation to the particle concentration determined.

		Maximum particle count / 100 ml					
		2..5 µm	5..15 µm	15..25 µm	25..50 µm	50..100 µm	> 100 µm
Cleanliness class	00	625	125	22	4	1	0
	0	1,250	250	44	8	2	0
	1	2,500	500	88	16	3	1
	2	5,000	1,000	178	32	6	1
	3	10,000	2,000	356	64	11	2
	4	20,000	4,000	712	128	22	4
	5	40,000	8,000	1,425	253	45	8
	6	80,000	16,000	2,850	506	90	16
	7	160,000	32,000	5,700	1,012	180	32
	8	320,000	64,000	11,400	2,025	360	64
	9	640,000	128,000	22,800	4,050	720	128
	10	1,280,000	256,000	45,600	8,100	1,440	256
	11	2,560,000	512,000	91,200	16,200	2,880	512
	12	5,120,000	1,024,000	182,400	32,400	5,760	1,024
	13	10,240,000	2,048,000	364,800	64,800	11,520	2,048
	14	20,480,000	4,096,000	729,000	129,600	23,040	4,096







Increasing the class by 1 causes the particle count to double on average.

15 Error Messages and Troubleshooting

Error message	Cause(s)	Remedy
F 225	The flow through the CS is outside of the set, permitted range. F = Error 225 = Flow is approx. 225 ml/min.	Reduce the flow to the CS.
F 0	The CS does not detect a flow in the particle measurement cell. F = Error 0 = Flow is approx. 0 ml/min	Check if there is sufficient pressure at the sensor inlet. Increase the pressure if necessary. If the message remains, the measurement section is probably clogged. -> Ship unit in to HYDAC for repair.
999999	"999999" is output in case of malfunctions in the particle measurement cell due to - a component defect or - very high water or air content in the oil	Make sure that no oil with high water or air content enters the CS. If the message remains, the particle measurement cell is probably defective. -> Ship unit in to HYDAC for repair.

16 Showing display and error messages

When the CSD display is used (available as accessory), the messages from the CS2000 can be displayed directly as shown below:

View	Cause	Remedy
	Communication between the CS and display is malfunctioning.	Check the connection, supply voltage and connections to the CS and display. If the message remains, the CS is probably not functioning. -> Ship unit in to HYDAC for repair.
	The CS does not detect a flow in the particle measurement cell. F = Error 0 = Flow approx. 0 ml/min.	Check if there is sufficient pressure at the sensor inlet (INLET). Increase inlet pressure if necessary. If the message remains, the measurement section is probably clogged. -> Ship unit in to HYDAC for repair.
	The flow through the CS is outside of the set, permitted range (10 ...200 ml/min). F = Error 225 = Flow approx. 225 ml/min.	Reduce the flow to the CS.
	The toggle display function is activated. This means that during the measurement time, the display switches back and forth between Flow and ISO (display of 3-digit ISO code). FL = Flow 180 = 180 ml/min	Toggle funktion can be deactivated.
	The CS is in measurement mode M3. This means that it performs a measurement up to the set limit and shuts off.	Set the CS to measurement mode 1.
	Malfunction of the particle measurement cell due to: - Component defect or - Particles directly in front of the measurement cell or - Very high water or air content in the oil.	Make sure that no oil with high water or air content enters the CS. Rinse the CS. If the message remains, the particle measurement cell is probably defective. -> Ship unit in to HYDAC for repair.

17 Technical Data

General data	
Mounting position	Any (recommended: vertical position)
Measurement parameters CS 203x	5µm / 15µm / 25µm / 50 µm calibrated: ISO 11/10 ... 21/18 , NAS 2 ...15 Display: ISO 10/9 ... 23/21, NAS 2 ...15
Measurement parameters CS 213x	2µm / 5µm / 15µm / 25 µm calibrated: ISO 13/11/10...23/21/18, NAS 2 ...15 Display: ISO 12/10/9...25/23/21, NAS 2 ...15
Measurement parameters CS 223x	4µm _(c) / 6µm _(c) / 14µm _(c) / 21 µm _(c) Calibrated: ISO 13/11/10...23/21/18, SAE 2 ... 12 Display: ISO 12/10/9...25/23/21, SAE 2 ...12
Measurement interval	20 ... 120 seconds
Ambient temperature range	0° ... +55° C / -32° ... 131° F
Storage temperature range	-40° ... +80° C / -40° ... 176° F
relative humidity	max. 90%, non-condensing
Electrical safety class	III (low voltage protection)
IP class	IP 65
Weight	4 kg

Hydraulic data	
Measurement range	Display shows class from: ISO 7/6/5 - ISO 28/27/26 Calibrated within range ISO 13/11/10 - ISO 23/21/18
Accuracy	+/- 1/2 ISO class in the calibrated range
Operating pressure	0.5 ... 40 bar / 7 ... 580 psi
Pressure-stable	350 bar / 5000 psi
Ports	INLET: Thread G 1/4, ISO 228 OUTLET: Thread G 1/4, ISO 228
Permissible measuring flow rate	10 ... 200 ml/min
Fluid temperature range	0° ... +70° C / 32° ... 176°F

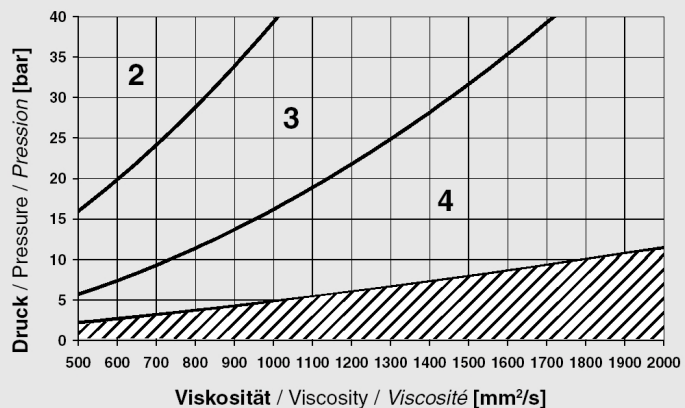
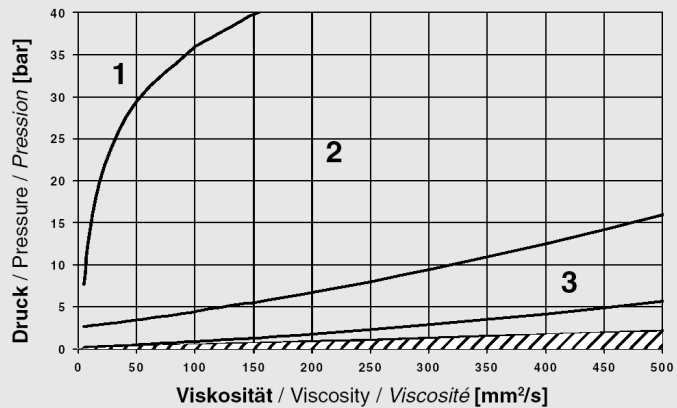
Hydraulic data**Pressure viscosity range**

(Model code =
CS 2xxx-1-U-**X**-x/-)

Druck - Viskositätsbereich

Pressure - viscosity range

Pression - plage de viscosité

**Electrical data**

Power supply voltage	24 V DC, residual ripple < 25%, (protected against polarity reversal)	
Current consumption	300 mA max.	
Outputs	<ul style="list-style-type: none"> - 3 relays (ready, warning, alarm) (max. 2A , 24 VDC / 50 VAC; 30 W / 50 VA) - RS 232 for external display - PLC signal 	
Outputs (optional)	<ul style="list-style-type: none"> - Analog signal 4-20 mA, load $\leq 500 \Omega$ <u>or</u> - DIN measurement bus <u>or</u> RS 232 <u>or</u> RS 485 <u>or</u> - Ethernet interface 	
Line cross section	Supply terminals	max. 2.5 mm ²
	Signal terminals	max. 0.5 mm ²

Electrical data

Input	2x analog signal 4..20 mA, Ri = 240 Ω, current source
-------	---

18 Recalibration / Service

We recommend recalibrating the sensor every 2 – 3 years.

19 Customer Service

Shipping address for calibration and repair:

HYDAC Servicenter GmbH
Rehgrabenstrasse, Werk 7
66125 Saarbrücken
Telephone: ++49 (0) 681 / 509 – 01

20 Differences between CS 203x / CS 213x / CS 223x

20.1 Display output

The ISO code is output by CS 2030 acc. to ISO 4406:1987 in double-value format:
>5µm / >15µm

20.2 PLC interface

The ISO code is output by CS 2030 acc. to ISO 4406:1987 in double-value format:
>5µm / >15µm

20.3 Limit values for relay functions in mode M2

If the ISO Code was selected as measurement channel, only two lower limit values (Parameters 84 and 85 for Relay 1, Parameters 90 and 91 for Relay 2) and two upper limit values (Parameters 87 and 88 for Relay 1 and Parameters 93 and 94 for Relay 2) are to be entered with the CS 2030.

20.4 Factory default settings

	Description	Value	
t	Measurement time	30 s	
m	Select measuring mode	M2	
2	Limits mode M2 relay 1	8=ISO code, 4=fall below	16/13/10 (lower limit) 18/15/12 (upper limit)
	Limits mode M2 relay 2	8=ISO code, 4=fall below	16/13/10 (lower limit) 18/15/12 (upper limit)
3	Limits mode M3	1=ISO	18/15/12
4	Limits mode M4	1=ISO	18/15/12 (lower limit) 22/19/16 (upper limit)
		Test cycle time	60 min.
b	Set DIN bus address and name	Address: 1	Name: HYDAC CS2000
f	Flow check	Not used	
p	Pump protection time	0 s	
o	PLC output format	1=ISO	
r	RS232 display output format	Header:	Display: 1=ISO
i	Current output format	1=SAE class / NAS class	
a	Configure 4..20 mA input	Analog input mode (0= no analog input)	
		Channel 1	
		Channel 2	
e	IP address	192.168.0.30	
d	Set default values	Sets all parameters to the values in this table.	

21 Model code and dimensions

HYDAC

INTERNATIONAL



ContaminationSensor CS 2000 series

Typenschlüssel / Model code / Code de commande

CS 2 2 3 0 - 1 - U - 3 - 2 / -

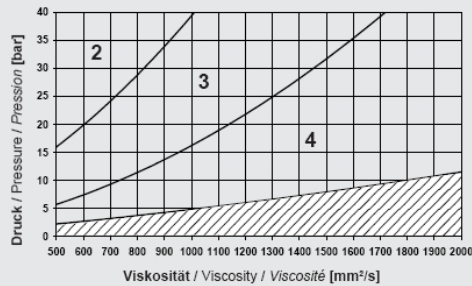
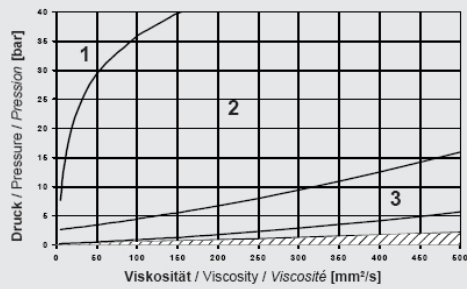
- 1 **Typ / Type / Modèle**
CS = Contamination Sensor
- 2 **Auflösung / Resolution / Résolution**
2 = 4 Partikelgrößenkanäle / 4 Particle Size Channels / 4 Canaux de taille de particules
- 3 **Kodierung der Verschmutzung / Contamination codes / Codification de la pollution**
0 = ISO 4406 : 1987; NAS 1638 / >5 µm >15 µm >25 µm >50 µm
1 = ISO 4406 : 1991; NAS 1638 / >2 µm >5 µm >15 µm >25 µm
2 = ISO 4406 : 1999; SAE AS 4059 (D) / >4 µm(c) >6 µm(c) >14 µm(c) >21 µm(c)
- 4 **Gehäuse / Housing / Boîtier**
3 = Für stationären Einsatz / For stationary use / Pour utilisation stationnaire
- 5 **Medien / Fluids / Fluide**
0 = Für Standard - Mineralöle / For standard mineral oils / Pour huiles minérales standard
1 = Für Phosphatester / For phosphate esters / Pour esters phosphates
- 6 **Optionen / Options / Options**
1 = Standard, ohne Optionen / Standard, without options / Standard, sans options
- 7 **Versorgungsspannung / Supply voltage / Tension d'alimentation**
U = 24 VDC
- 8 **Druck-Viskositätsbereich / Pressure-viscosity range / Pression-plage de viscosité**
1
2 } siehe nächste Seite / See next page / Voir page suivante
3
4 }
- 9 **Elektrischer Ausgang / Electrical output / Sortie électrique**
0 = RS232 (DIN-66348 Protokoll / Protocol / Protocole)
1 = Analog Ausgang (nur SAE/NAS und Partikelzählen) / Analogue output (only SAE/NAS and particle counts) / Sortie analogique (seulement SAE/NAS et nombre de particules) (4-20 mA)
2 = RS485 (DIN-66348 Protokoll / Protocol / Protocole)
5 = Ethernet (IEEE 802.3TCP / IP)
- 10 **Ergänzende Angaben / Supplementary details / Indications complémentaires**
ohne Angabe = Serie / no details = standard / Sans indication = Standard

Lieferumfang / Items supplied / Fournitures

- CS
- Programmierkabel / Programming cable / Câble de programmation
- Bedienungsanleitung / Manual / Notice d'utilisation
- Kalibrierzertifikat / Calibration certificate / Certificat d'étalonnage

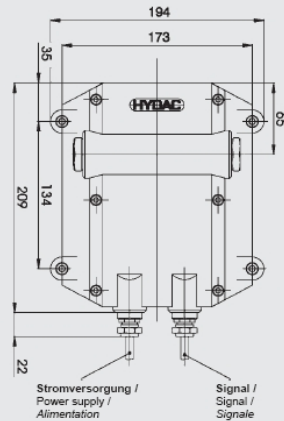
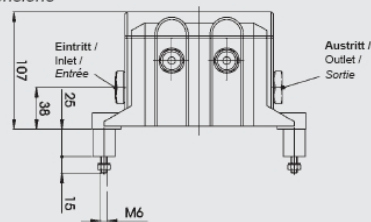
Druck - Viskositätsbereich

Pressure - viscosity range
Pression - plage de viscosité



Abmessungen

Dimensions
Dimensions



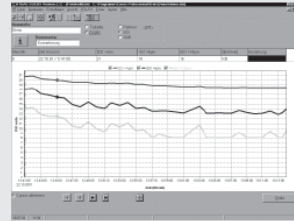
Zubehör

Accessories
Accessoires

Windows Software Treiber (DLL) Art.Nr.: 3143926
Windows software drivers (DLL) part no.: 3143926
Pilote logiciel Windows (DLL) Code article: 3143926

LabVIEW Software Treiber Art.Nr.: 3053829
LabVIEW software drivers part no.: 3053829
Pilote logiciel LabVIEW Code article: 3053829

PC Software Paket CoCoS Professional Art.Nr.: 3141522
PC software package CoCoS Professional part no.: 3141522
Kit logiciel PC CoCoS Professional Code article: 3141522



Contamination Sensor Display CSD

Contamination Sensor Display CSD
Afficheur-Contamination Sensor CSD



CSD - 1 - U

Contamination Sensor Display

Display Anzeigegröße /

Display character size /
Dimension d'affichage
1 14 mm
2 57 mm

Versorgungsspannung /

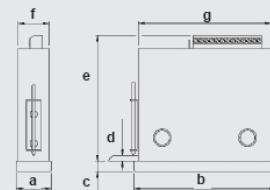
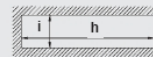
Supply voltage /
Tension d'alimentation
U 24 VDC

Artikel Nr. / part no. / Code article

CSD-1-U	3078272
CSD-2-U	3078273

Abmessungen

Dimensions
Dimensions



	a	b	c	d	e	f	g	h	i
CSD-1-U	48	96	8	.6	70	44	90	92	45
CSD-2-U	96	336	3	.6	61	88	328	329	89

Notes

Notes



INTERNATIONAL

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