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Exclusion of liability

We made every endeavor to ensure the accuracy of the contents of this document. However, errors cannot be ruled out. Consequently, we accept no liability for such errors as may exist nor for any damage or loss whatsoever which may arise as a result of such errors. The content of the manual is checked regularly. Any corrections required will be incorporated in future editions. We welcome any suggestions for improvements.

All details are subject to technical modifications.

All content of this manual is subject to revision without notice.

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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 will acquaint you with the product and assist you in obtaining maximum benefit in the applications for which it is designed.

Keep the manual in the vicinity of the device for immediate reference.

Note that the information on the unit's engineering contained in the documentation was that available at the time of publication. There may be deviations in technical details, figures, and dimensions as a result.

If you discover errors while reading the documentation or have additional suggestions or notes, contact us at:

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Technische Dokumentation
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Germany

The editorial department looks forward to receiving your input.

Our motto: “Putting experience into practice”
Customer Service
Contact our technical sales department if you have any questions on our product. When contacting us, always include the model/type designation, serial no. and part-no. of the product:
Fax: +49 (0) 6897 / 509 - 846
E-Mail: filtersystems@hydac.com

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 FILTER SYSTEMS GmbH.

Refer to these at www.hydac.com ➔ General terms and conditions.
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 the topic I am looking for.

WHERE can I find the information I’m looking for?
The documentation has a table of contents at the beginning. There, 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 every time the manual is revised or changed.
Safety information and instructions

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

Obligations and Liability

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

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

In addition, the accident prevention rules and regulation applicable at the location of use are to be observed.

The FCU has been designed and constructed in accordance with the current state of the art and recognized safety regulations. Nevertheless, hazards may be posed to the life and limb of the individual using the product or to third parties. Risk of damage may be posed to the product or other equipment and property.

The FCU is only to be used as follows:

- Solely for its designated use
- Only when in safe, perfect condition.

Immediately remedy any malfunctions that might impair safety.

Always keep the operating and maintenance instructions near the measurement device.

In addition to the operating instructions, the general and local regulations on accident prevention and environmental protection are to be made available and observed.

Ensure that all information relating to safety and potential hazards of the FCU are kept in a legible condition. Replace them if necessary. Replace them if necessary.

Check the hoses and connectors for leaks on a daily basis.

![WARNING]

**Hydraulic systems are pressurized**

Danger of bodily injury

- Depressurize the system before performing any work on it.
Explanation of Symbols and Warnings, etc.

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

- **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.

- **DANGER**
  - Denotes situations which can lead to severe injuries if safety precautions are not observed.

- **NOTICE**
  - Denotes situations which can lead to property damage if safety precautions are not observed.

 Proper/Designated Use

The Contamination Sensor (FCU) was developed for temporary or 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.
Improper Use

Any use other than described above is prohibited.

Improper use may result in hazard to life and limb.

Example of improper use:

- Improper connection of the FCU pressure and return flow hoses.
- Sealing of the FCU return line.

What to Do in Case of Emergency

In the event of an emergency, immediately disconnect the FCU from the power supply and from the hydraulic system.

Properly dispose of any escaping fluid in accordance with environmental guidelines.

Maintenance, Servicing and Troubleshooting

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

Secure all operating media against accidental start up.

When performing any maintenance, servicing, inspection or repair work, disconnect the FCU from the power supply and ensure that it cannot be switched back on inadvertently.

Check that released threaded joints were refit tightly.

Always check the safety devices to see that they function properly after performing maintenance work.

Modifications to the FCU

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

Any conversion modifications require written permission from HYDAC FILTER SYSTEMS GMBH.

Immediately replace any parts which are not in perfect condition.

Use only original spare parts (OEM).
Training of personnel

The owner is obliged to only let persons work on the FCU, who:

- are familiar with the fundamental occupational safety and accident prevention regulations and have been properly instructed in the use of the FCU.
- they have read and understood these operating instructions.

Only properly trained and instructed personnel may work with the FCU.

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

Staff who are still being trained may only work on the FCU when supervised by a suitably experienced person.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Individuals</th>
<th>Instructed individuals</th>
<th>Personnel with technical training/ engineering background</th>
<th>Electricians</th>
<th>Supervisor with the appropriate authority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Transportation</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commissioning</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Operation</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Troubleshooting/locating the source of malfunction</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Remediing of mechanical faults</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remediing of electrical faults</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>maintenance</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Servicing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Decommissioning/storage</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
Checking the Scope of Delivery

The FluidControl Unit FCU comes packed and ready for operation.

Before commissioning the SFC, check the content of the package to make sure everything is present.

The following items are supplied:

<table>
<thead>
<tr>
<th>Item</th>
<th>Pc.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>FluidControl Unit FCU 2xxx-4</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Mains device and connection cable (configuration depends on the order)</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>hp-hose with mini measurement port DN4, L=2000 mm</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>Suction hose DN 6 with CPC quick-release coupling, L=1000 mm</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>Suction hose DN 6 with CPC quick-release coupling, L=250 mm</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>Return hose DN 7, L = 2000 m</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>Connection cable FCU &lt;-&gt; PC</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>CD-ROM with FluMoS light software</td>
</tr>
<tr>
<td>-</td>
<td>1</td>
<td>Operating and Maintenance Instructions</td>
</tr>
<tr>
<td>-</td>
<td>1</td>
<td>Calibration certificate</td>
</tr>
</tbody>
</table>
Description of the FCU

The FCU FluidControl Unit can determine the solid particle contamination of mineral oils on a continuous basis.

With the FCU, it is possible to record, save and display the Cleanliness Class completely automatically during continuous operation in accordance with NAS 1638 and/or SAE AS4059 or ISO 4406.

The measured values can be printed out online in the form of either tables or graphs by means of the built-in printer or sent via serial interface to a PC or a central display unit for visualization purposes there.

Filter units can for example be actuated via relay outputs.

For input and output functions, the FCU possesses a keyboard, an LCD (Liquid Crystal Display), a dot-matrix printer, control relay outputs and a serial data interface.

The FCU possesses a measurement port 1604 as an input for connection with the hydraulic unit, as well as a DN 7 plug nipple as a return flow outlet.

A flow rate control valve is available for setting the measurement flow rate. This is protected against larger particle contamination by an upstream filter.

Media from a depressurized reservoir can be inspected using the integrated pump with the enclosed suction hoses (DN8).

The FCU has a rechargeable battery for ~ 5 hours of operation independent of the mains network.

The FCU has a measured value memory for up to 3000 measured values, which are stored in the form of logs (maximum of 100).
Operating elements / Dimensions

<table>
<thead>
<tr>
<th>Item</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>High pressure port = INLET</td>
</tr>
<tr>
<td>b</td>
<td>Return port connection - OUTLET</td>
</tr>
<tr>
<td>C</td>
<td>Switch - On/Off</td>
</tr>
<tr>
<td>D</td>
<td>Electrical connection - 24 V DC</td>
</tr>
<tr>
<td>E</td>
<td>Serial interface</td>
</tr>
<tr>
<td>F</td>
<td>Control port</td>
</tr>
<tr>
<td>G</td>
<td>Sealing cover</td>
</tr>
<tr>
<td>H</td>
<td>Suction port SUCTION INLET (only 2xx0-4)</td>
</tr>
<tr>
<td>I</td>
<td>Change-over valve (only 2xx0-4)</td>
</tr>
<tr>
<td>J</td>
<td>Dot-matrix printer</td>
</tr>
<tr>
<td>K</td>
<td>Display</td>
</tr>
<tr>
<td>L</td>
<td>Keyboard</td>
</tr>
<tr>
<td>M</td>
<td>Flow rate regulator</td>
</tr>
</tbody>
</table>
Restrictions Pertaining

NOTICE

Impermissible operating conditions

The FCU will be destroyed

► The FCU may only be used with mineral oils or mineral oil-based raffinates.
<table>
<thead>
<tr>
<th>Item</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Optical sensor</td>
</tr>
<tr>
<td>5</td>
<td>Flow rate sensor</td>
</tr>
<tr>
<td>7</td>
<td>Flow rate control valve (adjustable)</td>
</tr>
<tr>
<td>8</td>
<td>Filter</td>
</tr>
<tr>
<td>9</td>
<td>Flow control valve</td>
</tr>
<tr>
<td>10</td>
<td>Pressure control valve</td>
</tr>
<tr>
<td>15</td>
<td>Pressure accumulator</td>
</tr>
<tr>
<td>20</td>
<td>Pump</td>
</tr>
<tr>
<td>21</td>
<td>Change-over valve</td>
</tr>
<tr>
<td>22</td>
<td>Shut-off valve</td>
</tr>
</tbody>
</table>
FCU Function Description

<table>
<thead>
<tr>
<th>Item</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Optical sensor</td>
</tr>
<tr>
<td>2</td>
<td>Infrared LED</td>
</tr>
<tr>
<td>3</td>
<td>Photodetector</td>
</tr>
<tr>
<td>4</td>
<td>Evaluation electronics</td>
</tr>
<tr>
<td>5</td>
<td>Flow rate sensor</td>
</tr>
<tr>
<td>6</td>
<td>Display</td>
</tr>
<tr>
<td>7</td>
<td>Flow rate control valve (adjustable)</td>
</tr>
<tr>
<td>8</td>
<td>Filter</td>
</tr>
<tr>
<td>9</td>
<td>Flow control valve</td>
</tr>
<tr>
<td>10</td>
<td>Pressure control valve</td>
</tr>
<tr>
<td>11</td>
<td>Serial interface</td>
</tr>
<tr>
<td>12</td>
<td>Keyboard</td>
</tr>
<tr>
<td>13</td>
<td>Relay</td>
</tr>
<tr>
<td>14</td>
<td>Printer</td>
</tr>
<tr>
<td>15</td>
<td>Pressure accumulator</td>
</tr>
</tbody>
</table>
A continuous flow of oil runs through an optical sensor (1) comprised of an infrared LED (2) and a photo receiver (3). The contamination particles present in the flow of oil cause pulse-like darkenings of the light beam, which are both classified as measurement signals in accordance with particle size and counted by an evaluation electronics system (4).

The measurement of the flow rate, which is necessary for specifying the contamination class, is carried out by a built-in flow rate sensor (5), the signals from which are also channeled to the electronic evaluation system (4).

Ultimately, the evaluation electronics (4) calculate on a continuous basis the particle counts and the SAE / NAS or ISO contamination classes for the reference volume of 100 ml, based on the measurement signals from the optical sensor and the flow rate sensor.

Here the measured values (up to 3000) are also stored on a continuous basis as they arise, together with date and time, in a manner that is safe from network outages. A battery-buffered real-time clock is available for this purpose.

A flow control valve (7) is available for adjusting the pressure fluctuation-independent flow of oil.

A hydraulic filter (8) with electrical contamination indicator is positioned upstream from this for the purpose of protecting against failure due to contamination.

The permanently adjusted valves (9) and (10) and the diaphragm memory (15) enable the connection to extraction points for the pressure range of 1 ... 350 bar at the "Inlet" access point.

The FCU can be operated via keyboard (12). Characteristic values for the measurement can be modified and various kinds of presentation can be selected in the LCD display (6).

If not set otherwise, the following information is continuously displayed during the measurement (see also in this connection the chapter "The Display of the FCU"):

- selected measurement mode
- Progress of the ongoing measurement
- Current value of the measurement results for 2 of the 4 particle size channels
- Tendency: increasing or decreasing ↓
- Current flow value
- only in the event of fault -> Error messages

Furthermore, the FCU also possesses 3 built-in relays with the following functions:

Relays 1 and 2 are limit value switches (change-over contacts) and also serve to control a filtration unit.

Relay 3 outputs the operational readiness signal (DEVICE READY) (closing device; closed when FCU is ready for operation)
The evaluation electronics in the FCU continuously monitors for this purpose the following:

- the particle sensor
- the filter clogging indicator
- the flow rate sensor
- the power supply voltage
- the internal evaluation electronics

The contact from Relay 3 is always closed during normal operation. Relay 3 opens the contact when a malfunction is recognized.

A corresponding fault message appears automatically in the display in the event of a malfunction, and the storing of data is interrupted. (see also in this connection the chapter Error Messages / Troubleshooting)

As soon as the error has been rectified, the evaluation electronics recognizes this fact, resets the fault message fully automatically and closes the Relay 3 contacts. Both the measuring operations and the storing of data are resumed.

This ensures that measurement operations can restart without requiring the intervention of operating personnel after malfunctions such as voltage loss, flow errors caused by drops in pressure, etc. have been eliminated in permanent online operation.

All of the measured and stored measured values can be read out via the serial interface (11), e.g. by means of a PC. (Software and cable are included with the unit as supplied.)

The built-in printer (14) documents the measurements in the form of tables or graphs.
Electrical connection of the FCU

The FCU is equipped with a battery. This allows network-independent measurement (with online printout) from ~ 5 hours and measurements with internal pump: viscosity-dependent from ~ 2 hours.

The battery is automatically recharged when the power adapter is plugged in, regardless of whether the FCU is switched on or off at the switch or not.

Connecting the "POWER INPUT"

Insert the hollow plug on the supplied power adapter into the rear bush "POWER INPUT". Switch on the FCU on or off at the On/Off switch on the rear side.

This connection is used for supplying the FCU electronics and battery charging circuit with power.
Connecting the "POWER INPUT PUMP"

**NOTICE**

**Overloading the internal pumps**

The FCU will be destroyed

- Operate the FCU only using the original power adapter. The integrated overload protection protects the FCU pump.

Insert the hollow plug on the supplied power adapter into the rear bushing "PUMP INPUT".

In the SETUP menu, check whether the item Pump supply is set to "external". You can find details on page 67.

If the parameter is set to "internal", the pump is only supplied with power via the battery if the power adapter is also connected.
Connecting the "PC" interface

You can communicate with a PC via this interface. This interface is designed in the standard version as RS232 and optionally as RS485.

Serial RS 232 Interface (Standard)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>screen</td>
</tr>
<tr>
<td>2</td>
<td>TXD Transmission line</td>
</tr>
<tr>
<td>4</td>
<td>RXD Receiving line</td>
</tr>
<tr>
<td>8</td>
<td>GND Ground</td>
</tr>
</tbody>
</table>

A corresponding cable for connecting the FCU to a PC is included in the scope of delivery.

Serial RS 485 Interface (OPTIONAL)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Signal function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>screen</td>
</tr>
<tr>
<td>2</td>
<td>T- (TA) Transmission data</td>
</tr>
<tr>
<td>4</td>
<td>R- (RA) Received data</td>
</tr>
<tr>
<td>8</td>
<td>GND Ground</td>
</tr>
<tr>
<td>9</td>
<td>T+ (TB) Transmission data</td>
</tr>
<tr>
<td>11</td>
<td>R+ (RB) Received data</td>
</tr>
<tr>
<td>15</td>
<td>+5 V Supply, bus termination</td>
</tr>
</tbody>
</table>

The pin assignment corresponds to DIN 66348 (DIN measurement bus)
"Control" – Connecting the control port

Contact assignment (switched position when the FCU is ready for operation)

Relay 1, programmable by user

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>NC contact</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>NO contact</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Base contact</td>
<td></td>
</tr>
</tbody>
</table>

Relay 2, programmable by user

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>NC contact</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>NO contact</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Base contact</td>
<td></td>
</tr>
</tbody>
</table>

Relay 3, Device ready

<table>
<thead>
<tr>
<th>Pin</th>
<th>Description</th>
<th>Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>NC contact</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>NO contact</td>
<td></td>
</tr>
</tbody>
</table>

2A is the maximum load for the relay contacts. Maximum switching voltage: 24 V DC / 50 V AC, maximum switching power: 30 W / 50 VA.

Pin 1: 24 V operating voltage (in battery operation 12 V), maximum load capacity 200 mA

Pin 4: Ground (GND)

Pin 5: Battery switch-off
When pin 5 is connected to pin 4, the FCU is not supplied by integrated batteries. This enables the FCU to be remote-controlled-switched on and off via an external power supply. The battery will however still be charged, if a power adapter is connected.
### Relay Functions

The following tables show the switched position of the relays in the various operating modes in keeping with the operating condition or measurement result.

<table>
<thead>
<tr>
<th>M1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement currently in progress</td>
</tr>
<tr>
<td>Measurement stopped</td>
</tr>
<tr>
<td>After the first measured value is available: Flow error</td>
</tr>
<tr>
<td>Flow rate within set range</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>M2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceed</td>
</tr>
<tr>
<td>Measured value ≥ upper limit</td>
</tr>
<tr>
<td>After switch-on or start of a measurement.</td>
</tr>
<tr>
<td>Goes out again when measured value ≤ lower limit</td>
</tr>
<tr>
<td>Measured value ≥ upper limit</td>
</tr>
<tr>
<td>After switch-on or start of a measurement.</td>
</tr>
<tr>
<td>Goes out again when measured value ≤ lower limit</td>
</tr>
<tr>
<td>Fall below</td>
</tr>
<tr>
<td>≤ lower limit</td>
</tr>
<tr>
<td>After switch-on or start of a measurement.</td>
</tr>
<tr>
<td>Goes out again when measured value ≥ upper limit</td>
</tr>
<tr>
<td>≤ lower limit</td>
</tr>
<tr>
<td>After switch-on or start of a measurement.</td>
</tr>
<tr>
<td>Goes out again when measured value ≥ upper limit</td>
</tr>
<tr>
<td>Within range</td>
</tr>
<tr>
<td>Lower limit ≤ measured value ≤ upper limit</td>
</tr>
<tr>
<td>After switching the unit on or starting a measurement or Measured value &lt; lower limit or Measured value &gt; upper limit</td>
</tr>
<tr>
<td>Lower limit ≤ measured value ≤ upper limit</td>
</tr>
<tr>
<td>After switching the unit on or starting a measurement or Measured value &lt; lower limit or Measured value &gt; upper limit</td>
</tr>
<tr>
<td>Outside range</td>
</tr>
<tr>
<td>Measured value ≤ lower limit or</td>
</tr>
<tr>
<td>After switching the unit on or</td>
</tr>
<tr>
<td>Measured value ≤ lower limit or</td>
</tr>
<tr>
<td>After switching the unit on or starting a</td>
</tr>
<tr>
<td>Relay 1</td>
</tr>
<tr>
<td>--------</td>
</tr>
<tr>
<td>measured value ≥ upper limit</td>
</tr>
<tr>
<td>starting a measurement or lower limit &lt; measured value &lt; upper limit</td>
</tr>
<tr>
<td>No function</td>
</tr>
</tbody>
</table>

**M3**
- Measurement is currently in progress and one or more of the last 5 measured values > limit
- 5 consecutive measured values ≤ limit or measurement stopped
- After the first measured value is available: Flow error
- Flow rate within set range

**M4**
- Start or result of check measurement after test cycle time ≥ upper limit
- Measurement is currently in progress and the measured values > limit
- 5 consecutive measured values ≤ limit or measurement stopped
- After the first measured value is available: Flow error
- Flow rate within set range

**M5**
- Measurement currently in progress
- Measurement stopped
- After the first measured value is available: Flow error
- Flow rate within set range

**M6**
- Measurement currently in progress
- Measurement stopped
- After the first measured value is available: Flow error
- Flow rate within set range
<table>
<thead>
<tr>
<th></th>
<th>Relay 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><img src="image" alt="Diagram" /></td>
</tr>
<tr>
<td><strong>All operating modes</strong></td>
<td><img src="image" alt="Diagram" /></td>
</tr>
<tr>
<td>FCU ready for operation</td>
<td><img src="image" alt="Diagram" /></td>
</tr>
<tr>
<td>FCU not ready for operation</td>
<td><img src="image" alt="Diagram" /></td>
</tr>
</tbody>
</table>
### Programmable limit values FCU 2210-5

<table>
<thead>
<tr>
<th></th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M2: Switching limits</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A channel SAE 4 µm(c)</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>B channel SAE 6 µm(c)</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>C channel SAE 14 µm(c)</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>D channel SAE 21 µm(c)</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>4 µm(c) channel ISO</td>
<td>12</td>
<td>25</td>
</tr>
<tr>
<td>6 µm(c) channel ISO</td>
<td>10</td>
<td>23</td>
</tr>
<tr>
<td>14 µm(c) channel ISO</td>
<td>9</td>
<td>21</td>
</tr>
<tr>
<td>Flow rate</td>
<td>0</td>
<td>150</td>
</tr>
<tr>
<td><strong>M3: Filtration limit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO</td>
<td>12 / 10 / 9</td>
<td>25 / 23 / 21</td>
</tr>
<tr>
<td>SAE</td>
<td>2 / 2 / 4</td>
<td>15 / 15 / 15</td>
</tr>
<tr>
<td><strong>M4: Filtration limits</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ISO</td>
<td>12 / 10 / 9</td>
<td>25 / 23 / 21</td>
</tr>
<tr>
<td>SAE</td>
<td>2 / 2 / 4</td>
<td>15 / 15 / 15</td>
</tr>
<tr>
<td><strong>M4: Test cycle time</strong></td>
<td></td>
<td>1440</td>
</tr>
<tr>
<td><strong>M5: Number of measurements</strong></td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td><strong>M6: Start delay</strong></td>
<td>0</td>
<td>255</td>
</tr>
<tr>
<td><strong>M6: Number of measurements</strong></td>
<td>1</td>
<td>100</td>
</tr>
</tbody>
</table>
Hydraulic connection of the FCU

**WARNING**

Hydraulic systems are pressurized

Danger of bodily injury

► Depressurize the system before performing any work on it.
Conducting Measurements via the High-Pressure Port (INLET)

NOTICE

If the OUTLET connection is closed or blocked

The FCU will be damaged.

► Never seal the OUTLET connection.

► Put the free end of the OUTLET return hose into an unpressurized container.

To connect the FCU, proceed as follows:

1. Plug the return-line hose into the OUTLET connector and route it into a suitable container, e.g. hydraulic tank.
2. Set the change-over valve [A] to the setting INLET.
3. Set the flow rate control valve to a value of 5.
4. Check the system pressure. Ensure that this does not exceed a pressure of 350 bar.
5. Connect the high pressure hose to the INLET connection.
6. Now connect the other end of the high pressure hose to the system.

Oil can start to flow through the FCU as soon as the system has been connected to the pressure fitting and a measurement has been started. Observe the autostart function.
Conducting measurements via the integrated pump (SUCTION INLET)

**NOTICE**

**Change-over INLET / SUCTION INLET after a high pressure measurement**

The pump will be damaged.

► Wait at least 5 minutes after a high pressure measurement before changing over the suction port connection.
  The pressure in the installed pulsation damper must first be reduced via the OUTLET connection.

To connect the FCU, proceed as follows:

1. Plug the return-line hose into the OUTLET connector and route it into a suitable container, e.g. hydraulic tank.
2. Set the change-over valve to the setting SUCTION.
3. Open the flow rate control valve completely.
4. Attach the suction hose to the SUCTION INLET connection.
5. Put the other end of the suction hose into the fluid to be measured.
Switching on the FCU

When the FCU is switched on, various things are shown in the display, i.e. model no., firmware version, available memory, battery charge status, bus address and, possibly, error messages (cf. Error Messages / Troubleshooting chapter).

Example:

1. HYDAC FILTER SYSTEMS
   FCU 2210    V3.22

2. Memory: 25.4%  61
   Battery: 13.49 V   80%

3. Bus address: 1
   Battery: 13.49 V   80%

4. Viscosity range:
   1 … 10 mm²/s

5. Measure -> OK/START
   Abort       -> STOP

The FCU is ready for operation.

Selecting the Viscosity Range

During startup, the viscosity range currently set is shown in the display. Before the first measurement, check the viscosity of the fluid to be measured and correct the settings if required. You can find details on change-over of the viscosity range on page 69.

The FCU provides two viscosity ranges for selection:

1 … 10 mm²/s
5 … 1000 mm²/s
Starting up the FCU

Conducting Measurements via the High-Pressure Port (INLET)

On the FCU2210-5, a magnetic valve at the INLET prevents oil from flowing through the FCU as soon as a pressure line is connected.

Pressing the START button releases the flow of oil through the device and starts the measurement.

If you press the “STOP” button, the measurement stops and the solenoid valve closes.

Set the flow rate to approx. 100 ml/min. using the flow control valve on the front.

If an error message appears in the display, turn the flow control valve in the required direction until the error message disappears and measurement operation starts automatically.

Conducting measurements via the integrated pump SUCTION INLET

[Table]

**NOTICE**

<table>
<thead>
<tr>
<th>Overloading the internal pumps</th>
</tr>
</thead>
<tbody>
<tr>
<td>The FCU will be destroyed</td>
</tr>
<tr>
<td>- Operate the FCU only using the original power adapter.</td>
</tr>
<tr>
<td>- The integrated overload protection protects the FCU pump.</td>
</tr>
</tbody>
</table>

Turn the flow control valve knob on the front side of the FCU all the way clockwise.

The installed FCU pump can be supplied with power "internally" via the integrated battery or "externally" via the power adapter.

Check the setting for "internal" or "external" in the Pump supply menu. For details on change-over, see page 67.

The factory setting of the FCU is "internal".

One battery charge is sufficient for conducting measurements using the pump for ~ 2 hours.

In order to make use of the full viscosity range, you must connect both power adapters. You can find the permitted viscosity ranges when operating with an internal pump on page 94.

The power consumption of the pump is dependent on the viscosity of the fluid to be conveyed. Starting with a viscosity of > 150 mm²/s and upwards, the power consumption is so great that the overload protection feature of the power adapter connected may respond after a certain amount of time and the power supply will be shut off.

This prevents the pump motor from overheating. The ongoing measurement will be interrupted with a flow error. The power supply will then switch the power supply back on automatically after it has cooled.
Actuate the "START" key to start the measurement. The flow rate is automatically set to ~ 100 ml/min insofar as the viscosity of the medium permits this.
Operating the FCU

The various operating menus of the FCU are described below. The following conventions are used:

- **Fixed display texts** are highlighted in light gray (printed version) or yellow (PDF file).
- **Variable display texts** (user entries) are highlighted in bold (printed version) or magenta (PDF file)
- **Comments** are shown in *italics*.

**Function of the Keys**

Control buttons (gray)

- **ok start**
  Confirm entries / Start measurement

- **stop**
  Cancel entries / Stop measurement

- **Scroll through menus (when the “…” menu symbol is displayed)**

- **Scroll through Selection. Raise/lower numbers and letters (in Input mode)**
Menu and Number Keys (red)

**mode**
Select measurement operation
(with/without relay actuation)

**setup**
Basic settings
(Autostart, date, time, etc.)

**memory**
Editing measured value memory
(name of the measuring point, measurement intervals, deleting, etc.)

**print**
Print out
(Online, measured value memory, etc.)

**limits**
Set limits for controlling filtration units (via relays 1 and 2)

Display ISO code
(This key responds only when a measurement is being carried out)

Display SAE or NAS Code
(This key responds only when a measurement is being carried out)

Display particle counts
(This key responds only when a measurement is being carried out)

Display – Lighting
1x - goes out again after ~ 20 s.
2x – stays switched on (press 1x to switch off)

Key Combinations

Insert space in measuring position designation.
Press the keys simultaneously.

Deleting space in measuring position designation
Press the keys simultaneously.

Switch to the PowerUp menu.
Press the keys simultaneously. This is possible only if no measurement had been started beforehand.

Activate / deactivate keypad lock.
Press the keys simultaneously.
FCU menus

MODE - select operating mode

In the Menu mode, select the operating mode in which the measurement is to be carried out. When the FCU is switched on, the operating mode last used last is preset.

- M1: Measure
- M2: Measure + Switch
- M3: Filter to
- M4: Filter from to
- M5: Measure + Autostop
- M6: Autostop pump

Confirm entries and start measurement. When autostart is activated, confirmation occurs automatically immediately after switching on the FCU.

Accept the setting and exit the MODE menu.
MODE "M1: Measure"

Mode M1 "Measurement" is used for measuring oil cleanliness without using the control functions.

Typical applications: Short-time measurement of system cleanliness

MODE "M2: Measuring and switching"

Mode M2 "Measure + switch" can be used for measuring the cleanliness of the oil in the hydraulic system, at the same time offering the possibility of controlling limit relays for signaling purposes. This means that this menu enables the user to have external devices switched by two relays. An example of this would be an alarm indicator lamp on a control panel.

Possible reference values for triggering these switching sequences:

- The flow (volumetric flow rate)
- Cleanliness rating of the hydraulic fluid (indicated according to NAS or SAE or ISO)

Typical applications: Signal switching to a control panel at fully automated test benches.

MODE "M3: Filter to" (performance of automatic filtration)

Mode M3 "Filter to" enables the FCU to assume control of an external filtration unit (e.g. OF5C). In so doing, the external filtration unit is controlled in such a way that it is switched off by the FCU after it has fallen below the specified limit 5 times.

Typical applications: Flushing of hydraulic systems and documentation of the oil cleanliness rating achieved by way of an online printout.
MODE "M4: Filtering from to" (performance of automatic filtration)

Mode M4 "Filter from ... to" enables the FCU to assume control of an external filtration unit (e.g. OF5C). The external filtration unit will be controlled thereby in such a way that the oil cleanliness in the tank to be monitored will always be within the specified limits.

If the lower limit value is reached or if it is not met, then the FCU will switch off the unit to be actuated and the test cycle time begins. After the test cycle time has elapsed, the FCU carries out a testing measurement (100 ml) and checks whether the measured values lie within the limit values. If "yes", then the test cycle time begins again; if "no", then the unit is switched on in order to filter the fluid.

If the test cycle time setting is below LIMITS 0 [min], then this function is switched off.

Typical applications: Long-term monitoring and filtration of the oil cleanliness in hydraulic systems and documentation thereof via an online printout.

Mode "M5: Measure Autostop"

Mode M5 "Measure+autostop" enables the number (1 to 100) of single measurements to be programmed via the FCU’s high-pressure port, after which measurement operation is concluded automatically. When online printing is activated, the result of the last measurement is additionally outputted in the form of particle counts (absolute value).

Typical applications: Routine analysis of the cleanliness of a hydraulic system using a defined number of measurements.

Mode "M6: Autostop pump"

Mode M6 "Autostop pump" enables the number (1 to 100) of single measurements to be programmed via the FCU’s SUCTION INLET, after which measurement operation is concluded automatically.

The integrated pump starts up when the OK/START button is pressed.

The first measurement begins immediately after the set start delay. (The start delay is used to air-bleed and rinse the FCU)

When online printing is activated, the result of the last measurement is additionally outputted in the form of particle counts (absolute value).

Typical applications: Gauging the oil cleanliness of a tank or an oil sample.
MEMORY Menu

In the MEMORY menu you can set the storage of logs.

The percentage shown in the display indicates how much of the memory has been used. 0.0% = Memory empty <-> 100 % Memory full.

MEMORY 0.0%
Meas. point

MEMORY 0.0%
Averaging interval

MEMORY 0.0%
Selective deletion

MEMORY 0.0%
Delete all

MEMORY 0.0%
Change meas. – point

MEMORY 0.0%
Memory mode

Confirm entries

Accept the setting and exit the Memory menu.
Designating the measurement point

The measuring position designation is used for conveniently assigning a log to a measurement site at which a measurement is being or was performed. It is stored together with the measured results and appears on the log printouts.

The measurement site designation can be selected from among 20 customizable designations.

The FCU features a memory for entering 20 measurement point designations. This enables frequently occurring designations to be permanently configured and called up as needed.

Select the respective measurement point via the keys.

The first letter blinks.

Navigate to the position desired using the keys.

Select the characters from the table via the keys.

Numbers can be entered directly via the keypad.

Confirm the designation for the measurement point.

Abort and exit without saving.

The following characters can be selected:

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>.</td>
<td>:</td>
<td>!</td>
<td>&quot;</td>
<td>$</td>
<td>%</td>
<td>&amp;</td>
<td>/</td>
<td>(</td>
<td>)</td>
</tr>
<tr>
<td>,</td>
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<td>‘</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>b</td>
<td>c</td>
<td>d</td>
<td>e</td>
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<td>i</td>
<td>j</td>
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<td>k</td>
<td>l</td>
<td>m</td>
<td>n</td>
<td>o</td>
<td>p</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>q</td>
<td>r</td>
<td>s</td>
<td>t</td>
<td>u</td>
<td>v</td>
<td>w</td>
<td>x</td>
<td>y</td>
<td>z</td>
</tr>
<tr>
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<td>è</td>
<td>ë</td>
<td>ö</td>
<td>ü</td>
<td>ß</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a</td>
<td>b</td>
<td>C</td>
<td>D</td>
<td>E</td>
<td>F</td>
<td>G</td>
<td>H</td>
<td>I</td>
<td>J</td>
</tr>
<tr>
<td>K</td>
<td>L</td>
<td>M</td>
<td>N</td>
<td>O</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Insert character: Press the \text{ok} + \text{start} keys simultaneously and a space will be inserted in front of the character just marked.

Delete character: Press the \text{ok} + \text{start} keys simultaneously and the character just marked will be deleted from the measuring point designation.

Setting the averaging interval

Entering an averaging interval enables the data quantity which accumulates during a measurement to be reduced.

An averaging interval of > 0 min causes only the mean value of all measurements completed within this interval to be saved and printed out.

The 0 min setting causes the averaging function to be deactivated. Each measured value is immediately saved and printed out.

The values 0 ... 1440 minutes are possible for the averaging interval. The current, non-averaged measured value is always shown in the FCU display.

<table>
<thead>
<tr>
<th>memory</th>
<th>MEMORY 0,0 %</th>
<th>ok</th>
<th>start</th>
</tr>
</thead>
</table>

Averaging interval

Averaging interval: \(x\) [min]

or

\[
\begin{array}{cccc}
7 & 6 & 5 \\
4 & 3 & 2 & 1 \\
0 & 0 & 0 & 0 \\
\end{array}
\]

Confirm entries.

Abort and exit without saving.
Selective deletion

This menu item enables individual or several logs to be deleted. Various criteria are available for selecting the logs to be deleted.

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit without saving.

Log selection: Log selection

xxx / yyy — The default value is the last log number. Change values

Are you sure? OK = YES STOP = NO

YES – The selected logs are deleted.

No – Abort and exit
Log selection:

**Date**

Date of log:
**dd.mm.yyyy**

Are you sure?
**OK = YES**  **STOP = NO**

YES - The selected logs of **dd.mm.yyyy** are deleted.

Abort and exit without saving.

Log selection:

**Meas. point**

Measuring point:
**Designation X**

Are you sure?
**OK = YES**  **STOP = NO**

YES – The selected logs of **Designation X** are deleted.

Abort and exit without saving.
Log selection:
Date + Measuring point

Date of log:
dd.mm.yyyy

Date of log:
dd.mm.yyyy

Measuring point:
Designation X

Measuring point:
Designation X

Are you sure?
OK = YES  STOP = NO

YES – The selected logs of the date dd.mm.yyyy and the measuring point are deleted.
Abort and exit without saving.

Delete all
This menu item enables the entire log memory to be deleted

MEMORY 0.0%

Are you sure?
OK = YES  STOP = NO

YES - All logs are deleted.
Abort and exit.
**Change meas. – point**

This menu item enables the designation of a measuring point to be changed.

This menu item enables the designation of a measuring point to be changed.

**MEMORY 0,0 % 0**

**Change meas. point**

**Xxx dd.mm.yyyy hh:mm**

**Designation X**

**Xxx dd.mm.yyyy hh:mm**

**Designation X**

**Change measurement point:**

**Designation X**

**or**

**Change measurement point:**

**Designation X**

Confirm entries.

Abort and exit without saving.
Setting the memory mode

This menu item determines how the FCU behaves when its log memory is full.

**Overwrite**

Once 100 logs or 3000 measured values have been stored, the next log overwrites the oldest one in the memory.

If the memory is 100% full, the oldest log in the memory is deleted. This can continue to be repeated during an ongoing measurement until only one (i.e. the current) log is in memory. Then the oldest log line is deleted.

**Stop if full**

Once 100 logs or 3000 measured values have been stored, you can start no further measurements. Delete one or more logs in order to carry out further measurements.

A current measurement is stopped when the memory is 100% full.
PRINT menu

The PRINT menu enables printouts to be initiated of stored logs, ongoing measurements, the table of contents and the parameter list.

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit.
Logs

Stored logs can be outputted via the built-in printer. Various criteria are available for selecting the logs to be printed.

- **PRINT**
  - Logs

- **Log selection:**
  - Log selection

- **Log selection:**
  - Date

- **Log selection:**
  - Meas. point

- **Log selection:**
  - Date + Measuring point

Confirm entries

Abort and exit.

- **Log selection:**
  - Log selection

- **Log number:**
  - from: xxx to: yyy

Press this key to confirm the operating mode selected and to initiate measurement.

- **Printout format:**
  - List

- **Printout format:**
  - Graph

Press this key to confirm the operating mode selected and to initiate measurement.

- **Printout of:**
  - ISO
Printout of:
NAS (SAE)

The selected logs are printed.

Abort and exit

Log selection:
Date

Date of log:
dd.mm.yyyy

Press this key to confirm the operating mode selected and to initiate measurement.

Printout format:
List

Printout format:
Graph

Press this key to confirm the operating mode selected and to initiate measurement.

Printout of:
ISO

Printout of:
NAS (SAE)

The selected logs are printed.

Abort and exit

Log selection:
Meas. point

Measuring point:
Designation X
Press this key to confirm the operating mode selected and to initiate measurement.

**Printout format:**
- **List**

**Printout format:**
- **Graph**

Press this key to confirm the operating mode selected and to initiate measurement.

**Printout of:**
- **ISO**

**Printout of:**
- **NAS (SAE)**

The selected logs are printed.

Abort and exit

---

**Log selection:**

**Date + Measuring point**

**Date of log:**
- **dd.mm.yyyy**

Press this key to confirm the operating mode selected and to initiate measurement.

**Measuring point:**
- **Designation X**

Press this key to confirm the operating mode selected and to initiate measurement.

**Printout format:**
- **List**

**Printout format:**
- **Graph**
Press this key to confirm the operating mode selected and to initiate measurement.

**Printout of:**
ISO

**Printout of:**
NAS (SAE)

The selected logs are printed.

Confirm entries and initiate printing.

Abort and exit.

PRINT Contents

A summary of the logs stored in memory is printed out. The following is output for each log: log number, measuring position designation, starting and stopping time, and number of log lines.

Confirm entries and initiate printing.

Abort and exit.

PRINT All parameters

All the current settings are outputted.

Confirm entries and initiate printing.

Abort and exit.
Paper feed

The printer paper is transported ~ 1 cm.

- PRINT
  - Paper feed

Confirm entries and start paper feed.

- Abort and exit.

Online printout

The measured values are outputted on line and on the printer.

- PRINT
  - Online printout

- Online printout:
  - ON
  - OFF

Press this key to confirm the operating mode selected and to initiate measurement.

- Printout format:
  - List
  - Graph

Press this key to confirm the operating mode selected and to initiate measurement.

- Printout of:
  - ISO
  - NAS (SAE)

Confirm entries
Abort and exit.

**Print out, cancel**

A current print operation is aborted.

Abort and exit.

**LIMITS menu**

The LIMITS menu enables settings (limits) to be entered for the various operating modes.

Abort and exit.
MODE M2

**LIMITS**

**M2: Relay 1**

**LIMITS**

**M2: Relay 2**

Press this key to confirm the operating mode selected and to initiate measurement.

**M2:Rx Meas. channel:**

*xx m chan. unit*

Press this key to confirm the operating mode selected and to initiate measurement.

**M2:Rx Switch func.:**

*No function*

**M2:Rx Switch func.:**

*Within range*

**M2:Rx Switch func.:**

*Outside range*

**M2:Rx Switch func.:**

*Exceed*

**M2:Rx Switch func.:**

*Fall below*

Press this key to confirm the operating mode selected and to initiate measurement.

**M2:Rx Limit values:**

*↓xxx   ↑yyy Unit*

Jump from value to value.

**M2:Rx Limit values:**

*↓xxx   ↑yyy Unit*

Select limit values by scrolling through them using the keys.

Press this key to confirm the operating mode selected and to initiate measurement.
Abort and exit.

MODE M3

LIMITS
M3: Filter to

M3: Limit values:
( xx / yy / zz ) Standard

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit.

MODE M4

LIMITS
M4: Filter from to

M4: Limit values:
( xx / yy / zz ) Standard

Press this key to confirm the operating mode selected and to initiate measurement.

M4: Test cycle time:
xxx min

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit.
Limit values table

<table>
<thead>
<tr>
<th>Flow rate</th>
<th>FCU 2210-5</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 µm SAE</td>
<td></td>
</tr>
<tr>
<td>6 µm SAE</td>
<td></td>
</tr>
<tr>
<td>14 µm SAE</td>
<td></td>
</tr>
<tr>
<td>21 µm SAE</td>
<td></td>
</tr>
<tr>
<td>4 µm ISO</td>
<td></td>
</tr>
<tr>
<td>6 µm ISO</td>
<td></td>
</tr>
<tr>
<td>14 µm ISO</td>
<td></td>
</tr>
</tbody>
</table>

MODE M5

LIMITS

M5: Number of measurements

M5 Number of measurements:

n

or

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit.

n = 1 ... 100
MODE M6

**LIMITS**

**M6: Start delay**

- **M6 Start delay:**
  - **t** [sec]
  - **t** = 5 … 120
  - **ok**
  - **start**

Press this key to confirm the operating mode selected and to initiate measurement.

- **M6 Number of measurements:**
  - **n**
  - **n** = 1 … 100
  - **ok**
  - **start**

Press this key to confirm the operating mode selected and to initiate measurement.

- **Abort and exit.**
The SETUP menu enables settings to be entered which apply to several or all of the FCU’s operating modes.

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit.
**Autostart**

This menu item enables a setting to be entered determining whether the FCU has to be started manually after having been switched on or whether it automatically performs a measurement in a preselected MODE.

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit.
Abort at Q=0

This menu item enables a setting to be entered determining how the FCU acts when the current flowing through the sensor drops to a value of “0” while a measurement is in progress.

Measurement can either be interrupted or stopped altogether. An interrupted measurement automatically continues when a sufficient flow rate is present again.

This function works in all operating modes.

Abort at Q=0:

- no
- yes

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit.
Setting the pump start delay

When conducting measurements with the aid of an external pump or an external filtration unit (e.g. OF5C), this function enables the user to operate the pump for a limited period of time within which a flow has to start at the FCU.

When the pump start delay has elapsed and the FCU does not detect any flow, measurement is stopped and the unit connected via a relay is switched off so as to prevent damage caused by dry running of the pump. This function is in effect in all operating modes except M2.

Measurement resumes as soon as enough flow is available. The stopping time ranges from 1 to 200 seconds (practical recommendation: 60 seconds).

The 0 sec. setting causes the averaging function to be deactivated. This means that the FCU waits as long as you wish for flow.

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit.
Setting the date and time

The date and time are displayed and can be changed.

Press this key to confirm the operating mode selected and to initiate measurement.

Correct the time.

Abort and exit.

Confirm entries.

Abort and exit.
Set bus address
The standard setting is 1; this setting should not be changed. If several units featuring DIN measurement bus interfaces (type code / - BUS) are connected to one bus, a bus address between 1 and 31 has to be allocated to each unit. An address may not be allocated twice.

Set bus address:

- Bus address: 1
- Bus address: 3

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit.

Display operating hours
The operating hours of the unit are displayed. The operating hours meter only records the measurement time.

Display operating hours:

- Operating hours: xxxx h

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit.
Pump supply:

The FCU’s integrated pump can be supplied either externally via one of the two power supply units supplied with the FCU or by the integrated batteries.

The external power supply unit provides for a higher voltage than the batteries, which means higher viscosities can be conveyed when it is used. For more information, see chapter “Technical Data”.

Check the battery status

The current battery charge is shown.

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit.
POWERUP menu

The POWERUP menu is only available when the FCU is powered up and as long as no measurement has been started. Settings are made here which are normally rarely changed.

The POWERUP menu is accessed by simultaneously pressing the + keys.

| + | Powerup Language |
| + | Viscosity range |
| + | Test volume |

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit the Powerup menu.
Selecting the language

This menu item enables the language for the texts shown in the display and on printouts to be selected.

Language

Applying the submenu selected.

Language: German

Language: English

Language: French

Language: Programmable

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit the Powerup menu.

Setting the viscosity range

The viscosity range of the fluid to be measured must be set here. Here we differentiate between low viscosity (1 … 10 mm²/s) and high viscosity (5 … 1000 mm²/s) mediums.

Check or correct the viscosity range before starting the measurement.

Viscosity range

Applying the submenu selected.

Viscosity range: 1 … 10 mm²/s

Viscosity range: 5 … 1000 mm²/s

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit.
Setting the measured volume

The volume that is analyzed for the determination of a measured value can be set here. Permitted values range from 10 ... 100.

Test volume

Applying the submenu selected.

Measurement volume:

100 ml

Depending on the key, the value is increased / decreased by 1 ml.

Or

Measurement volume:

XXX ml

Press this key to confirm the operating mode selected and to initiate measurement.

Abort and exit.
FCU Display

1. The FCU is working in MODE M1 (measuring the cleanliness class).
2. Display of the measured flow rate (100 ml/min is recommended).
3. Indicates elapsed measuring time in %. Begins at 0%; the cleanliness class is displayed again at 100%.
4. Specification of the currently determined contamination. You can switch back and forth between the display in ISO or SAE coding and the display of particle counts with the keys.
   - During the representation of the contamination class in SAE class, the figures / letters in brackets state the selected particle size range: (A): >4 µm , (B): >6 µm, (C): >14 µm ,(D): >21 µm
   - The particle sizes displayed can be selected with the keys and .
   - The "tendency arrow" serves to display even very slight changes (: increasing contamination, ↓: decreasing contamination). It even indicates changes which would not otherwise be remarked upon by the specification of Contamination Class alone.
   - If the determined contamination lies above the specified display range (see page 94), >25 >23 or >12 / >15 are shown in all particle size ranges..
5. One can select between differential and cumulative displays of numbers of
particles by using the keys [key1] [key2]. The selected presentation is indicated in the display by a "D" (differential) or "C" (cumulative) behind the display of the expired measurement time.

Differential representation means: particle count in the particle size ranges:
4…6 µm(c), 6…14 µm(c), 14…21 µm(c), >21 µm(c)

Cumulative representation means: particle count in the particle size ranges:
>4 µm(c), >6 µm(c), >14 µm(c), >21 µm(c)

If the determined particle count lies above the specified display range (see page 94), ">>>>>>" is shown in all particle size ranges as the particle count.
Brief Overview of the Menu Structure

**MODE**
- M1: Measure
- M2: Measure + Switch
- M3: Filter to
- M4: Filter from to
- M5: Measure + Autostop
- M6: Autostop pump

**MEMORY**
- Meas. point
- Measuring point xx
- Designation xx
- Averaging interval
- X min.
- Selective deletion
- Log selection
- Log number: from: xxx to: xxx
- Date
- Date of log: dd.mm.yyyy
- Meas. point
- Designation x
- Date + Measuring point
- Date of log: dd.mm.yyyy
- Measuring point
- Designation x

**PRINT**
- Logs
- Log selection
- List
- Graph
- Date
- List
- Graph
- Meas. point
- List
- Graph
- Date + Measuring point
- List
- Graph

**PRINT**
- Contents
- All parameters
- Paper feed
- Online printout
- ON
- OFF

**LIMITS**
- M2: Relay 1
- M2: R1 Meas. Channel:
- Limit values ... (acc. Table)
- M2: R1 Switch func:
- No function
- Within range
- Outside range
- Exceed
- Fall below
M2: Relay 2
M2: R2 Meas. Channel:
Limit values ... (acc. Table)
M2: R2 Switch func:
No function
Within range
Outside range
Exceed
Fall below
M3: Filter to
M3: Limits:
\[ (xx/xx/xx) \text{ Unit} \]
M4: Filter from to
M4: Limits:
\[ (xx/xx/xx) \text{ Unit} \]
M4: Test cycle time:
X [min]
M5: Qty. Measurements
X
M6: Start delay
M6: Start delay
XX s
M6: Qty. Measurements
X

SETUP

Autostart
Yes
M1: Measure
M2: Measure + Switch
M3: Filter to
M4: Filter from to
M5: Measure + Autostop
M6: Autostop pump
no
Abort at Q=0
Yes
No
Pump start delay
X [s]
Date / Time
Date
dd.mm.yyyy
Time
Hh:mm:ss
Bus address
X
Operating hours
X [h]
Pump supply:
External
Internal
Battery status
xx.xx V yy %
POWERUP

Language
English
French
Programmable
Viscosity range
1 ... 10 mm²/s
5 ... 1000 mm²/s
Test volume
x [ml]
## Error Messages and Troubleshooting

<table>
<thead>
<tr>
<th>Error message</th>
<th>Cause(s)</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Invalid parameter</strong></td>
<td>You have entered a value which is outside the permitted value range (e.g. NAS 23).</td>
<td>Display the permitted value ranges using the keys ↑ and ↓ by scrolling above the maximum values. Then the minimum value is automatically displayed.</td>
</tr>
<tr>
<td><strong>Check parameter</strong></td>
<td>The self-monitoring function of the FCU has detected a check sum error for one or more parameters. Cause: Strong electromagnetic interference has changed the parameters.</td>
<td>Rest all parameters using the keyboard or transfer the parameters with the FluMoS software.</td>
</tr>
<tr>
<td><strong>Defective parameter:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>No. xx</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Measurement ended</strong></td>
<td>The setting for the &quot;Memory mode&quot; parameter is at &quot;Stop if full&quot;.</td>
<td>Delete the reports or set the &quot;Memory mode&quot; parameter to &quot;Overwrite&quot;. For details see page 48.</td>
</tr>
<tr>
<td><strong>Memory for measured values full</strong></td>
<td>The maximum number of reports or measured values has been reached. No more values can be stored.</td>
<td></td>
</tr>
<tr>
<td><strong>Value not accepted</strong></td>
<td>An error occurred while storing a value in EEPROM.</td>
<td>Repeat the entry or continue the measurement. If the fault recurs, contact HYDAC.</td>
</tr>
<tr>
<td>Error message</td>
<td>Cause(s)</td>
<td>Remedy</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Number of defective logs:</td>
<td>The self-monitoring function of the FCU has detected a check sum error for one or more stored logs. Possible causes</td>
<td>The defective logs are deleted automatically. After the next power up, this message is not displayed again if it was just a brief malfunction. If this message is displayed several times, this means that the internal back-up battery is probably dead. Send the FCU to HYDAC for repair.</td>
</tr>
<tr>
<td></td>
<td>• Strong electromagnetic interference has changed the measured value memory.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• The internal back-up battery is dead.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• A measurement has been started and terminated — for example as a result of the FCU being switched off — without any measured values being stored.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• A measurement previously conducted resulted only in a flow error.</td>
<td>→ The protocol contains no values.</td>
</tr>
<tr>
<td></td>
<td>→ The protocol contains no values.</td>
<td></td>
</tr>
<tr>
<td>No logs stored!</td>
<td>You have tried to print logs, but the FCU memory is empty.</td>
<td>Carry out measurements.</td>
</tr>
<tr>
<td>Too few points</td>
<td>You have tried to print a graph, but the selected log has insufficient measurement values (min. 3) to produce a graph.</td>
<td>Print out the protocol in the form of a list.</td>
</tr>
<tr>
<td>Battery needs charging</td>
<td>The rechargeable batteries are dead.</td>
<td>Measurements are still possible. However, it is better to connect a power adapter, in particular for printing.</td>
</tr>
<tr>
<td>Use power supply</td>
<td>The rechargeable batteries are dead.</td>
<td>The batteries require a charging time of ~ 11 hours. You can operate the FCU using a connected power supply.</td>
</tr>
<tr>
<td>Error message</td>
<td>Cause(s)</td>
<td>Remedy</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Flow rate error! Correct: 0 ml</td>
<td>There is no oil flowing through the particle sensor (possibly only air).</td>
<td>Turn the flow control valve control knob clockwise.</td>
</tr>
<tr>
<td></td>
<td>The flow rate sensor is faulty.</td>
<td>Check the change-over valve setting.</td>
</tr>
<tr>
<td></td>
<td>Measurement volumes are set to 0 in the PowerUp Menu. (Starting with Firmware Version 3.20, the minimum measurement volume is min. 10 ml)</td>
<td>Check the hydraulic connections.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check the pressure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fluid must flow through the return hose on the OUTLET from a pressure of &gt;30bar/420psi. The pressure control valve must open (see circuit diagram)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Change the measured volume to between 10 ... 100 ml</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Send the FCU to HYDAC for repair.</td>
</tr>
<tr>
<td></td>
<td>The batteries are exhausted as a result of measurements being carried out via the integrated pump without additional power supply unit.</td>
<td>Connect both power adapters (see page 23).</td>
</tr>
<tr>
<td>Flow rate error! Correct: 15 ml</td>
<td>The flow through the particle sensor is lower than the minimum value of 50 ml/min required to take measurements.</td>
<td>Turn the flow control valve clockwise until measurement operation starts.</td>
</tr>
<tr>
<td>Flow rate error! Correct: 250 ml</td>
<td>The flow through the particle sensor is higher than the maximum value of 150 ml/min permitted to take measurements.</td>
<td>Turn the flow control valve counterclockwise until measurement operation starts.</td>
</tr>
<tr>
<td>Flow rate error!</td>
<td>The internal filter is contaminated. Because of the inlet pressure of &lt;2 bar, the &quot;Filter contaminated&quot; fault message is not issued.</td>
<td>Replace the FCU filter element.</td>
</tr>
<tr>
<td>Filter contaminated</td>
<td>The internal protection filter for the flow control valve of the FCU is exhausted.</td>
<td>Replace the FCU filter element.</td>
</tr>
<tr>
<td>external inlet active</td>
<td>The clogging indicator fitted in the OF5C has been activated, the OF5C filter is exhausted.</td>
<td>Replace the filter element at OF5C.</td>
</tr>
<tr>
<td>Error message</td>
<td>Cause(s)</td>
<td>Remedy</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Internal printer not ready</td>
<td>Paper roll empty</td>
<td>Insert a new roll of paper.</td>
</tr>
<tr>
<td></td>
<td>Printer fault</td>
<td>Send the FCU to HYDAC for repair.</td>
</tr>
<tr>
<td>Error in selected language</td>
<td>The last language selected and stored in the FCU has been changed due to an internal fault.</td>
<td>Download the FCU languages to the FCU again using the PC software package FluMoS.</td>
</tr>
<tr>
<td></td>
<td>The internal back-up battery is dead.</td>
<td>If the fault recurs, send the FCU to HYDAC for repair.</td>
</tr>
<tr>
<td>Reload languages</td>
<td>The internal memory for languages has been partially changed due to an internal fault.</td>
<td>Download the FCU languages to the FCU again using the PC software package FluMoS.</td>
</tr>
<tr>
<td></td>
<td>The internal back-up battery is dead.</td>
<td>If the fault recurs, send the FCU to HYDAC for repair.</td>
</tr>
<tr>
<td>Calibration defect</td>
<td>The calibration values in the EEPROM have been altered due to electrical interference.</td>
<td>Send the FCU to HYDAC for repair.</td>
</tr>
<tr>
<td>Device ID defect</td>
<td>Internal device designations in the EEPROM have been altered due to electrical interference.</td>
<td>No measures required, as these values do not affect the FCU function.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Send the FCU to HYDAC for repair.</td>
</tr>
<tr>
<td>Water/air in oil</td>
<td>Warning message when a sample exhibits a high water or air content.</td>
<td>Nothing needs to be done unless this message pops up when the fluid is clear.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>If this fault message also occurs when the fluid is clear, then send the FCU to HYDAC for repair if necessary.</td>
</tr>
</tbody>
</table>
Performing maintenance

Carry out the specified configuration, maintenance and inspection work every six months or, at the latest, when an error message or malfunction makes it necessary.

Secure all operating media against accidental start up.

Disconnect the FCU from the power supply when performing any maintenance, inspection or repair work.

Once maintenance work is complete, check that the FCU is still working properly.

Any screwed fittings which have been undone/removed are to be checked to see that they have been properly resecured.

Cleaning the FCU

Clean the control panel with a clean, moist cloth. Do not use any chemical cleaning agents, as these may damage the film attached to the surface of the FCU. Clean the outside of the FCU with a moist cloth.

Changing the FCU Filter Element

The FCU has an internal filter element with a differential pressure switch. The differential pressure switch switches at 2 bar. The message "Filter clogged" will appear on the display. Ensure that the flow rate control valve is not closed.

If the filter is contaminated, but the differential pressure of 2 bar cannot be achieved (e.g. with an inlet pressure <2 bar), then there will be no indication on the display. Only the message "Flow error" will appear in such cases.

To change the filter, proceed as follows:

1. Put a suitable drip tray in place to catch the oil (~0.5 l).

   Turn the FCU so that the rear side faces upwards. Ensure that the flow rate control valve is not damaged.
2. Unscrew the screw plug with a size 19 ring spanner by turning it counterclockwise.

3. Pull the filter element out upwards by the strap.

4. Take the strap out of the old filter elements and push this over the new filter element. Dispose of the old filter element correctly according to local regulations and guidelines.

5. Moisten the O-ring on the new filter element slightly with fluid.
6. Place the new filter element with the strap into the FCU.
   Press the filter element down into the filter mount.
   Do not use excessive force or a hammer, etc.

7. Check the screw plug O-ring for damage.
   Replace it if necessary.

8. Insert and manually screw in the screw plug clockwise.
   Tighten the screw plug with a size 19 ring spanner.

9. The filter element change is now complete.
Back-flushing the FCU
If the sensor is blocked, use the flushing set available as an accessory. The part-no. can be found in the spare parts list.
A description of how to back-flush is included with the flushing set.

Internal dot-matrix impact printer – replace paper roll / ink ribbon

1. 2. 3. 4. 5. 6. 7. 8.
Performing maintenance

10.

11.

12.

13.

14.

15.

16.

17.

18.
Disposing of the FCU

When decommissioning and/or disposing of the FCU, observe all local guidelines and regulations pertaining to occupational safety and environmental protection. This applies in particular to the oil in the unit, components covered with oil and electronical components.

After disassembling the unit and separating the various materials, reuse them or dispose of them properly in accordance with local regulations.

Storing the FCU

Rinse the FCU completely with n-heptane before putting it into storage.

Dispose of used cleaning agents and rinsing oils properly.

Storage conditions

Storage temperature: -20 … 85°C / -4 … 185°F
Relative humidity: max. 90%, noncondensing

Calibrating the FCU

We recommend that the FCU be recalibrated every 2 to 3 years. You will receive a calibration certificate at the time of each calibration.
Customer Service

Shipping address for calibration and repair:

Germany

HYDAC Service GmbH
Product Support, Werk 10
66128 Saarbrücken, Germany
Telephone: +49 (0) 6897 509 883
Fax: +49 (0) 6897 509 324
E-Mail: service@hydac.com

USA

HYDAC Technology Corporation, HYCON Division
2260 City Line Road
USA-Bethlehem, PA 18017
P.O. Box 22050
USA-Lehigh Valley, PA 18002-2050
Telephone: +1 (0) 610 266 0100
Fax: +1 - 610 - 2 31-04 45
E-Mail: sales@hydacusa.com
Internet: www.hydacusa.com

Australia

HYDAC Pty. Ltd.
109 Dohertys Road
P.O. Box 224
AUS-3025 Altona North
Telephone: +61 - 3 - 92 72 89 00
Fax: +61 - 3 - 93 69 89 12
E-Mail: info@hydac.com.au
Brasilien

HYDAC TECNOLOGIA LTDA
Estrada Fukutaro Yida, 225
CEP 09852-060
Cooperativa
BR-São Bernardo do Campo – SÃO PAULO
Telephone: +55 - 11 - 4393.6600
Fax: +55 - 11 - 4393.6617
E-Mail: hydac@hydac.com.br
Homepage www.hydac.com.br

China

HYDAC TECHNOLOGY (SHANGHAI) LIMITED
28 Zhongpin Lu
Shanghai Minhang Economic &
Technological Development Zone
SHANGHAI 200245; P.R. CHINA
Telephone: (0086) 21/64 63 35 10
Fax: (0086) 21/64 30 02 57
E-Mail: hydacsh@hydac.com.cn
## Spare parts

<table>
<thead>
<tr>
<th>Part no.</th>
<th>Article designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>349154</td>
<td>Filter element replacement set, consisting of: 1x filter element, 1x O-ring, 1x support ring</td>
</tr>
<tr>
<td>1260891</td>
<td>Filter element</td>
</tr>
<tr>
<td>1251557</td>
<td>High-pressure measuring hose, DN 4, 5000 mm long</td>
</tr>
<tr>
<td>349150</td>
<td>High-pressure measuring hose, DN 4, 2000 mm long</td>
</tr>
<tr>
<td>349151</td>
<td>Return-line hose, DN 7, 2000 mm long</td>
</tr>
<tr>
<td>1251558</td>
<td>Return-line hose, DN 7, 5000 mm long</td>
</tr>
<tr>
<td>3036098</td>
<td>Suction hose with coupling, DN 6, 1000 mm long</td>
</tr>
<tr>
<td>3068209</td>
<td>Suction hose with coupling, DN 6, 250 mm long</td>
</tr>
<tr>
<td>349204</td>
<td>Connecting cable FCU – PC</td>
</tr>
</tbody>
</table>
| 349155  | Package of paper rolls, printer (5 rolls)  
Roll diameter: 50 mm  
Roll width: 58 mm |
| 349156  | Ribbon cartridge for dot-matrix printer |
| 3090803 | Power supply (without connecting cable)  
Primary: 90-264 V AC  
Secondary: 24 V DC, 2300 mA |
| 6008448 | Connecting cable for power supply  
Euro plug, 2 m long |
| 6008447 | Connecting cable for power supply  
Plug for UK, 2 m long |
| 6008446 | Connecting cable for power supply  
Plug for USA, 2 m long |
| 6008449 | Connecting cable for power supply  
Plug for AUS, 2 m long |
## Accessories

<table>
<thead>
<tr>
<th>Part no.</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3040814</td>
<td>Carrying case, including filter element replacement set for mineral oil, 2 rolls of paper, 1 ribbon cartridge for printer</td>
</tr>
<tr>
<td>1204501</td>
<td>FCU back-flushing kit (mineral oil model)</td>
</tr>
<tr>
<td>3355176</td>
<td>FluMoS light Software (download available free of charge at <a href="http://www.hydac.com">www.hydac.com</a>)</td>
</tr>
<tr>
<td>3371637</td>
<td>FluMoS Professional Software</td>
</tr>
<tr>
<td>3053829</td>
<td>LabView Driver Package (Software)</td>
</tr>
<tr>
<td>3143926</td>
<td>Windows Driver Package (Software)</td>
</tr>
<tr>
<td>3028133</td>
<td>Reservoir Extraction Unit REU 1430-1-M (230V AC/50Hz/1Phase)</td>
</tr>
<tr>
<td>3086166</td>
<td>FCU adapter kit for sample bottles with connection thread GL55 in accordance with DIN 168-1 (scope of delivery without sample bottle)</td>
</tr>
<tr>
<td>3143465</td>
<td>Sample bottle 250 ml with connection thread GL 55 in accordance with DIN 168-1</td>
</tr>
<tr>
<td>3487290</td>
<td>Suction strainer</td>
</tr>
</tbody>
</table>
Explanation of the measuring technology terms used

**Single measurement:** This refers to the analysis of the contamination of a specified sample quantity (*measurement volume*). The result of a single measurement is the *measured value*.

**Measuring point**
The name of the location at which the FCU is connected to the hydraulic system. This designation (max. 20 characters) can be entered in the FCU for documentation purposes.

*Example:* pump press W3

**Measurement volume:** Sample quantity which is analyzed for determining a measured value. (The measurement volume can be set by the user)

**Measured value**
The contamination codes determined by a single measurement, shown as a three-digit ISO code or NAS codes or SAE codes of the individual particle size channels.

**Measurement:** After the "OK/START" - key is pressed, a *single measurement* begins, followed immediately upon completion by the next *single measurement* until the "STOP" - key is pressed (mode M1, M2, M4) or the target cleanliness (mode M3) is reached.

This series of *single measurements* is referred to as a *measurement* for convenience reasons.

**Log:** A measurement is described by a *log*. It is comprised of the *log header* and the *log lines*. The FCU saves up to 100 logs.

**Log header:** The log header contains:
- A log number (a consecutive log number is automatically generated every time a measurement sequence is initiated).
- The designation of the *measurement point* (can be entered by the user), date + time of the beginning and end of the *measurement sequence* (generated automatically)
- *Averaging interval*
- *Number of log lines* *Measurement volume*

*Example:*
Memory log:.......................6
Measuring point:.................25
from:..............................15.09.2003, 8:32
to:.................................15.09.2003, 10:42
Averaging interval:.............10 min
Number of log lines:...........13
Measurement volume:.........100 ml

**Log line:** A *log line* consists of the time and results (4 particle channels and flow rate with NAS) (3 particle channels and flow rate with ISO and SAE) of a measurement.

The FCU can store up to 3000 log lines.
Overview - ISO 4406 / SAE AS 4059 and NAS 1638 classes

ISO 4406:1999

In ISO 4406:1999, particle counts are determined cumulatively, i.e. > 4 µm(c), >6 µm(c) and >14 µm(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.

ISO 4406 table

Allocation of particle counts to cleanliness classes:

<table>
<thead>
<tr>
<th>Class</th>
<th>Particle count / 100 ml</th>
<th>Class</th>
<th>Particle count / 100 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>More than</td>
<td>Up to (and including)</td>
<td>More than</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
<td>16,000</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>32,000</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>4</td>
<td>64,000</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>8</td>
<td>130,000</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>16</td>
<td>250,000</td>
</tr>
<tr>
<td>5</td>
<td>16</td>
<td>32</td>
<td>500,000</td>
</tr>
<tr>
<td>6</td>
<td>32</td>
<td>64</td>
<td>1,000,000</td>
</tr>
<tr>
<td>7</td>
<td>64</td>
<td>130</td>
<td>2,000,000</td>
</tr>
<tr>
<td>8</td>
<td>130</td>
<td>250</td>
<td>4,000,000</td>
</tr>
<tr>
<td>9</td>
<td>250</td>
<td>500</td>
<td>8,000,000</td>
</tr>
<tr>
<td>10</td>
<td>500</td>
<td>1,000</td>
<td>16,000,000</td>
</tr>
<tr>
<td>11</td>
<td>1,000</td>
<td>2,000</td>
<td>32,000,000</td>
</tr>
<tr>
<td>12</td>
<td>2,000</td>
<td>4,000</td>
<td>64,000,000</td>
</tr>
<tr>
<td>13</td>
<td>4,000</td>
<td>8,000</td>
<td>130,000,000</td>
</tr>
<tr>
<td>14</td>
<td>8,000</td>
<td>16,000</td>
<td>32,000,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Note: increasing the measurement reference by 1 causes the particle count to double.

Example: ISO class 18 / 15 / 11 means:

<table>
<thead>
<tr>
<th>Cleanliness class</th>
<th>Particle count / 100 ml</th>
<th>Size ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>130,000 – 250,000</td>
<td>&gt; 4 µm (c)</td>
</tr>
<tr>
<td>15</td>
<td>16,000 – 32,000</td>
<td>&gt; 6 µm (c)</td>
</tr>
<tr>
<td>11</td>
<td>1,000 – 2,000</td>
<td>&gt; 14 µm (c)</td>
</tr>
</tbody>
</table>

Are in 100 ml of the analyzed sample.

Overview of the differences between ISO 4406:1987 and ISO 4406:1999

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 5 µm</td>
<td></td>
<td>&gt; 4 µm (c)</td>
</tr>
<tr>
<td>&gt; 15 µm</td>
<td></td>
<td>&gt; 6 µm (c)</td>
</tr>
<tr>
<td>&gt; 14 µm (c)</td>
<td></td>
<td>&gt; 14 µm (c)</td>
</tr>
</tbody>
</table>

Dimension determined

<table>
<thead>
<tr>
<th>Dimension determined</th>
<th>Longest dimension of a particle</th>
<th>Diameter of the area-equivalent circle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ISO 11171:1999</td>
</tr>
</tbody>
</table>

Test dust

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ACFTD dust</td>
<td></td>
<td>ISO 12103-1A1</td>
</tr>
<tr>
<td>SAE Fine, AC Fine</td>
<td></td>
<td>ISO 12103-1A2</td>
</tr>
<tr>
<td>SAE 5-80 µm ISO MTD Calibration dust for particle counters</td>
<td>ISO 12103-1A3</td>
<td></td>
</tr>
<tr>
<td>SAE Coarse Coarse fraction</td>
<td>ISO 12103-1A4</td>
<td></td>
</tr>
</tbody>
</table>

Comparable size ranges

<table>
<thead>
<tr>
<th>Comparable size ranges</th>
<th>Old ACFTD calibration</th>
<th>Comparable ACFTD calibration</th>
<th>New NIST calibration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 1 µm</td>
<td>4 µm (c)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 µm</td>
<td>6 µm (c)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15 µm</td>
<td>14 µm (c)</td>
<td></td>
</tr>
</tbody>
</table>
SAE AS 4059

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

The SAE cleanliness classes are based on particle size, number and distribution. The particle size determined depends on the measurement process and calibration; consequently the particle sizes are labeled with letters (A-F).

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

### SAE AS 4059 table

<table>
<thead>
<tr>
<th>Size ISO 4402</th>
<th>&lt; 1 µm</th>
<th>&gt; 5 µm</th>
<th>&gt; 15 µm</th>
<th>&gt; 25 µm</th>
<th>&gt; 50 µm</th>
<th>&gt; 100 µm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size ISO 11171</td>
<td>&lt; 4 µm&lt;sub&gt;(c)&lt;/sub&gt;</td>
<td>&gt; 6 µm&lt;sub&gt;(c)&lt;/sub&gt;</td>
<td>&gt; 14 µm&lt;sub&gt;(c)&lt;/sub&gt;</td>
<td>&gt; 21 µm&lt;sub&gt;(c)&lt;/sub&gt;</td>
<td>&gt; 38 µm&lt;sub&gt;(c)&lt;/sub&gt;</td>
<td>&gt; 70 µm&lt;sub&gt;(c)&lt;/sub&gt;</td>
</tr>
<tr>
<td>Size code</td>
<td>a</td>
<td>b</td>
<td>c</td>
<td>D</td>
<td>E</td>
<td>F</td>
</tr>
<tr>
<td>000</td>
<td>195</td>
<td>76</td>
<td>14</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>00</td>
<td>390</td>
<td>152</td>
<td>27</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>780</td>
<td>304</td>
<td>54</td>
<td>10</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1,560</td>
<td>609</td>
<td>109</td>
<td>20</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>3,120</td>
<td>1,220</td>
<td>217</td>
<td>39</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>6,250</td>
<td>2,430</td>
<td>432</td>
<td>76</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>12,500</td>
<td>4,860</td>
<td>864</td>
<td>152</td>
<td>26</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>25,000</td>
<td>9,730</td>
<td>1,730</td>
<td>306</td>
<td>53</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>50,000</td>
<td>19,500</td>
<td>3,460</td>
<td>612</td>
<td>106</td>
<td>16</td>
</tr>
<tr>
<td>7</td>
<td>100,000</td>
<td>38,900</td>
<td>6,920</td>
<td>1,220</td>
<td>212</td>
<td>32</td>
</tr>
<tr>
<td>8</td>
<td>200,000</td>
<td>77,900</td>
<td>13,900</td>
<td>2,450</td>
<td>424</td>
<td>64</td>
</tr>
<tr>
<td>9</td>
<td>400,000</td>
<td>156,000</td>
<td>27,700</td>
<td>4,900</td>
<td>848</td>
<td>128</td>
</tr>
<tr>
<td>10</td>
<td>800,000</td>
<td>311,000</td>
<td>55,400</td>
<td>9,800</td>
<td>1,700</td>
<td>256</td>
</tr>
<tr>
<td>11</td>
<td>1,600,000</td>
<td>623,000</td>
<td>111,000</td>
<td>19,600</td>
<td>3,390</td>
<td>512</td>
</tr>
<tr>
<td>12</td>
<td>3,200,000</td>
<td>1,250,000</td>
<td>222,000</td>
<td>39,200</td>
<td>6,780</td>
<td>1,020</td>
</tr>
</tbody>
</table>

### Cleanliness codes according to SAE

**Absolute particle count larger than a defined particle size**

Example: cleanliness class to AS 4059:6

The maximum permissible particle count in the individual size ranges is bold-faced in the above table.

Cleanliness class to AS 4059:6B

Size B particles may not exceed the maximum number indicated for code 6
6 B = max. 19,500 particles > 5 µm in size
Specifying a cleanliness code for each particle size

Example: cleanliness class to AS 4059: 7 A / 7 B / 6 C / 5 D

<table>
<thead>
<tr>
<th>Cleanliness class</th>
<th>Particle count / 100 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size A ( &gt; 1 µm / &gt; 4 µm(c))</td>
<td>100,000</td>
</tr>
<tr>
<td>Size B ( &gt; 5 µm / &gt; 6 µm(c))</td>
<td>38,900</td>
</tr>
<tr>
<td>Size C ( &gt; 15 µm / &gt; 14 µm(c))</td>
<td>3460</td>
</tr>
<tr>
<td>Size D ( &gt; 25 µm / &gt; 21 µm(c))</td>
<td>306</td>
</tr>
</tbody>
</table>

Specifying the highest cleanliness code measured

Example: Cleanliness code according to AS 40596 A – F

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

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 classes in relation to the particle concentration determined:

<table>
<thead>
<tr>
<th>Cleanliness class</th>
<th>Maximum particle count / 100 ml</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2...5 µm</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>00</td>
<td>625</td>
</tr>
<tr>
<td>0</td>
<td>1,250</td>
</tr>
<tr>
<td>1</td>
<td>2,500</td>
</tr>
<tr>
<td>2</td>
<td>5,000</td>
</tr>
<tr>
<td>3</td>
<td>10,000</td>
</tr>
<tr>
<td>4</td>
<td>20,000</td>
</tr>
<tr>
<td>5</td>
<td>40,000</td>
</tr>
<tr>
<td>6</td>
<td>80,000</td>
</tr>
<tr>
<td>7</td>
<td>160,000</td>
</tr>
<tr>
<td>8</td>
<td>320,000</td>
</tr>
<tr>
<td>9</td>
<td>640,000</td>
</tr>
<tr>
<td>10</td>
<td>1,280,000</td>
</tr>
<tr>
<td>11</td>
<td>2,560,000</td>
</tr>
<tr>
<td>12</td>
<td>5,120,000</td>
</tr>
<tr>
<td>13</td>
<td>10,240,000</td>
</tr>
<tr>
<td>14</td>
<td>20,480,000</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Specification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured value display</td>
<td>Continuous view in LCD display</td>
</tr>
<tr>
<td>Self-diagnosis:</td>
<td>Continuous self-monitoring with error indication in LCD display</td>
</tr>
<tr>
<td>Particle size channels:</td>
<td>4µm(<em>{(c)}) / 6µm(</em>{(c)}) / 14µm(<em>{(c)}) / 21 µm(</em>{(c)})</td>
</tr>
<tr>
<td>Measurement range (calibrated)</td>
<td>SAE 2 ... 12&lt;br&gt;ISO 12 / 10 / 09 ... 23 / 21 / 18</td>
</tr>
<tr>
<td>Indication range:</td>
<td>SAE 2 ... 15&lt;br&gt;ISO 12 / 10 / 07 ... 25 / 23 / 21</td>
</tr>
<tr>
<td>Accuracy:</td>
<td>± 1/2 class (ISO,NAS,SAE)</td>
</tr>
<tr>
<td>Calibration:</td>
<td>ISO 11943</td>
</tr>
<tr>
<td>Recalibration:</td>
<td>Recommended: every 2 to 3 years</td>
</tr>
<tr>
<td>Battery-buffered log memory:</td>
<td>Can accommodate up to 3000 measured values.</td>
</tr>
<tr>
<td>Inlet operating pressure:</td>
<td>Pressure connection (INLET): 1 ... 350 bar&lt;br&gt;Suction connection (SUCTION): 0.5 bar</td>
</tr>
</tbody>
</table>
The minimum inlet pressure required to achieve a flow rate of 100 ml/min at the high-pressure inlet (INLET) for a given viscosity can be found by referring to the graph below.

### Required pressure at the high pressure inlet of the FCU to achieve a flow of 100 ml/min.
(flow regulator completely opened, new filter element)

<table>
<thead>
<tr>
<th>Pressure [bar]</th>
<th>Viscosity in mm²/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>10</td>
<td>200</td>
</tr>
<tr>
<td>15</td>
<td>300</td>
</tr>
<tr>
<td>20</td>
<td>400</td>
</tr>
<tr>
<td>25</td>
<td>500</td>
</tr>
<tr>
<td>30</td>
<td>600</td>
</tr>
<tr>
<td>35</td>
<td>700</td>
</tr>
<tr>
<td>40</td>
<td>800</td>
</tr>
<tr>
<td>45</td>
<td>900</td>
</tr>
<tr>
<td>50</td>
<td>1000</td>
</tr>
</tbody>
</table>

**Connectors: Rear:**
- **INLET:** Mini measurement coupling DN4
- **SUCTION:** CPC quick-release coupling Series LC DN6
- **OUTLET:** DN 7 plug nipple

**Return-line (OUTLET) flow rate:**
- max. 800 ml/min at INLET > 300 bar

**Return-line (OUTLET) operating pressure:**
- max. 3 bar counterpressure

**Measurement flow rate:**
- 50 ... 150 ml/min
<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permitted viscosity range:</td>
<td>(high pressure inlet - INLET) 1 … 1000 mm²/s</td>
</tr>
<tr>
<td>Permitted viscosity range:</td>
<td>(internal pump - SUCTION INLET) max. 150 mm²/s in continuous operation</td>
</tr>
<tr>
<td></td>
<td>max. 350 mm²/s short-term (max. 10 minutes)</td>
</tr>
<tr>
<td>Fluid temperature range:</td>
<td>0 … 70°C</td>
</tr>
<tr>
<td>Supply voltage:</td>
<td>24 V DC, ± 25%</td>
</tr>
<tr>
<td>Power consumption:</td>
<td>100 W max.</td>
</tr>
<tr>
<td>Battery-powered operating duration:</td>
<td>Measurement without pump or pump supplied externally: ~ 5 hours</td>
</tr>
<tr>
<td></td>
<td>Measurement with pump: depending on viscosity ~ 2 hours</td>
</tr>
<tr>
<td>Built-in printer:</td>
<td>Dot-matrix printer</td>
</tr>
<tr>
<td>Serial port:</td>
<td>RS 232 (for models /-BUS RS 485) with 15-pin Sub D plug</td>
</tr>
<tr>
<td>Ambient temperature:</td>
<td>0 … 55°C</td>
</tr>
<tr>
<td>Storage temperature:</td>
<td>-20 … 85°C</td>
</tr>
<tr>
<td>Relative humidity;</td>
<td>max. 90%, noncondensing</td>
</tr>
<tr>
<td>Protection class</td>
<td>IP40</td>
</tr>
<tr>
<td>Weight:</td>
<td>~ 15.8 kg</td>
</tr>
</tbody>
</table>
### Factory default settings

<table>
<thead>
<tr>
<th>Menu</th>
<th>FCU 2210-5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>POWERUP Menu</strong></td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>German</td>
</tr>
<tr>
<td>Viscosity range</td>
<td>5 … 100 mm²/s</td>
</tr>
<tr>
<td>Test volume</td>
<td>100 ml</td>
</tr>
<tr>
<td><strong>MEMORY Menu</strong></td>
<td></td>
</tr>
<tr>
<td>Meas. point</td>
<td>HYDAC FCU 2210</td>
</tr>
<tr>
<td>Memory mode</td>
<td>Overwrite</td>
</tr>
<tr>
<td>Averaging interval</td>
<td>0 min</td>
</tr>
<tr>
<td><strong>PRINT menu</strong></td>
<td></td>
</tr>
<tr>
<td>Online printout</td>
<td>on</td>
</tr>
<tr>
<td>Printout format</td>
<td>Graph</td>
</tr>
<tr>
<td>Printout of</td>
<td>ISO</td>
</tr>
<tr>
<td>Log duration</td>
<td>0.5 h / page (30 cm)</td>
</tr>
<tr>
<td><strong>SETUP menu</strong></td>
<td></td>
</tr>
<tr>
<td>Autostart</td>
<td>No</td>
</tr>
<tr>
<td>Autostart function</td>
<td>M1: Measure</td>
</tr>
<tr>
<td>Abort at Q=0</td>
<td>No</td>
</tr>
<tr>
<td>Pump start delay</td>
<td>0 seconds</td>
</tr>
<tr>
<td>Bus address</td>
<td>1</td>
</tr>
<tr>
<td>Pump supply:</td>
<td>internal</td>
</tr>
<tr>
<td><strong>LIMITS Menu</strong></td>
<td></td>
</tr>
<tr>
<td>M2:R1 Measurement channel</td>
<td>Flow rate</td>
</tr>
<tr>
<td>M2:R1 Switching function</td>
<td>No function</td>
</tr>
<tr>
<td>M2:R1 Limit values: below</td>
<td>90 ml</td>
</tr>
<tr>
<td>M2:R1 Limit values: above</td>
<td>110 ml</td>
</tr>
<tr>
<td>M2:R2 Measurement channel</td>
<td>Flow rate</td>
</tr>
<tr>
<td>M2:R2 Switching function</td>
<td>No function</td>
</tr>
<tr>
<td>M2:R2 Limit values: below</td>
<td>70 ml</td>
</tr>
<tr>
<td>M2:R2 Limit values: above</td>
<td>130 ml</td>
</tr>
<tr>
<td>M3: Limit values</td>
<td>17/14/11 ISO</td>
</tr>
<tr>
<td>M4 Limit values: below</td>
<td>17/14/11 ISO</td>
</tr>
<tr>
<td>M4 Limit values: above</td>
<td>23/19/16 ISO</td>
</tr>
<tr>
<td>M4: Test cycle time</td>
<td>120 min</td>
</tr>
<tr>
<td>M5: No. of measurements</td>
<td>5</td>
</tr>
<tr>
<td>M6: Start delay</td>
<td>10 s</td>
</tr>
<tr>
<td>M6: No. of measurements</td>
<td>5</td>
</tr>
</tbody>
</table>
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