ifm electronic

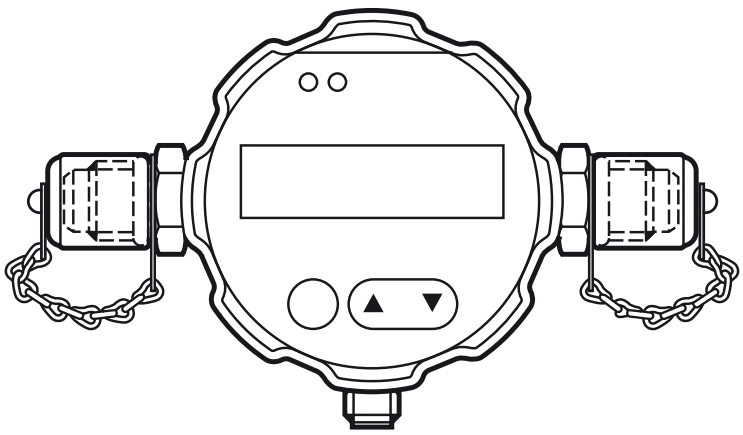
CE

Operating instructions
Optical particle monitor

efector160®

LDP100

UK



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Contents

1 Symbols used

▶ Instructions

→ Cross-reference

Important note
Non-compliance can result in malfunction or interference.

Information
Supplementary note.

2 Safety instructions

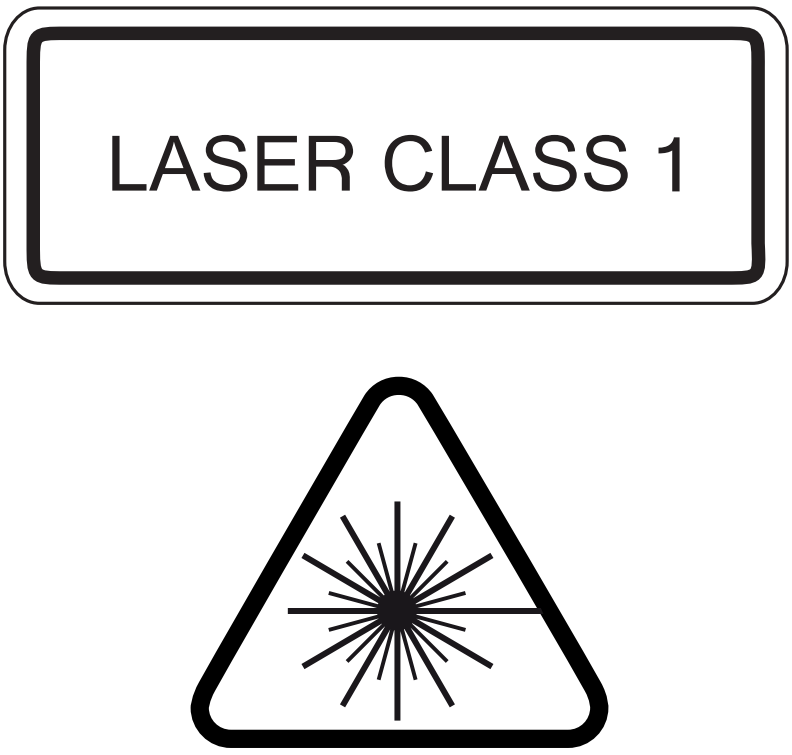
2.1 Basic safety instructions

- Please read the product description prior to setup of the unit. Ensure that the product is suitable for your application without any restrictions.
- In order to guarantee the correct condition of the device during operation it is necessary to use the device only for media to which the wetted materials are sufficiently resistant (→ Technical data).
- Responsibility as to whether the measurement devices are suitable for the respective application lies with the operator. The manufacturer assumes no liability for consequences of misuse by the operator.
- Installation, electrical connection, set-up, operation and maintenance of the unit must only be carried out by qualified personnel authorised by the machine operator. Improper installation and use of the device results in a loss of warranty claims.

2.2 Laser-specific safety instructions

- Never remove the covers! The device uses a laser and there is the risk of injury caused by the laser radiation.
- The device contains a laser sensor classified as a "Class 1" product during normal use (pursuant to 21 CFR, subchapter J of the Health and Safety Act of 1968). These instructions do not contain any service information regarding installed parts. Service should only be performed by trained service personnel.
- The device has been evaluated and tested in accordance with EN61010-1:1993 ("Safety Requirements For Electrical Equipment For Measurement, Control, and Laboratory Use"), IEC 825-1:1993 ("Safety of Laser Products") and other relevant industry norms (e.g. ISO 4406, ISO 6149-2).

A label indicating the laser class pursuant to 21CFR has been applied to the device. A copy of this label can be seen in the drawing below.



3 Functions and features

The device is a compact particle monitor for continuous monitoring of the contamination and wear in hydraulic fluids and lubricants.

3.1 Applications

The device is designed for use in pressure lines with not more than 420 bar.

The device is equipped with two Minimess connections via which it is connected to the pressure system. The device is usually installed in a bypass by Teeing off a pressure line. Then the system pressure provides the required flow.

The system pressure can vary but it must not have any peaks or high fluctuations during the measurement (→ 5.3.1 Pressure stability). Relatively constant pressure conditions are to be aimed for. If pressure peaks are present it may be necessary to throttle back the system pressure downstream of the counter.

To ensure reliable operation, the device requires a constant volume flow between 50 and 400 ml/min. This value applies to both directions of flow; the direction can be freely selected.

In additon to the cleanliness level the device also displays the housing temperature.

3.2 Restriction of the application area

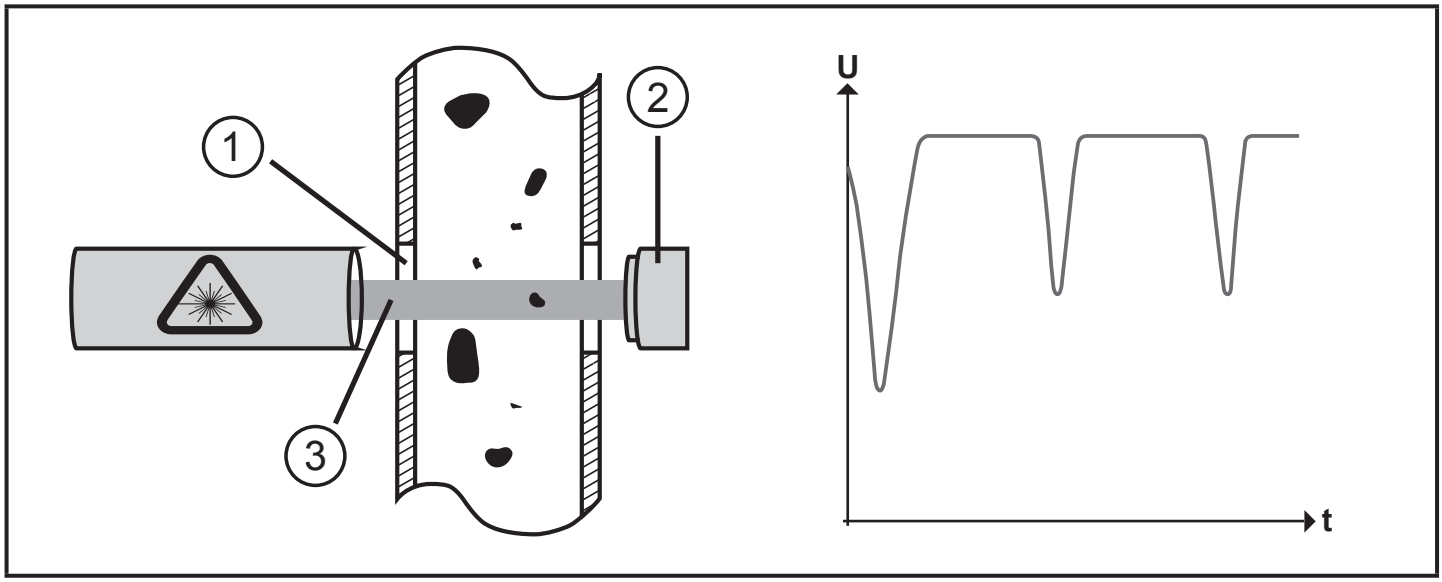
Correct measurement presupposes that the measured fluid is free of bubbles and water droplets.

Pressure Equipment Directive (PED): The device complies with section 3, article (3) of the Directive 97/23/EC and is designed and manufactured for media of fluid group 2 (stable gases and non-superheated liquids) in accordance with the sound engineering practice.

4 Function

4.1 Measuring principle

The unit operates to the principle of light extinction. The particles are classified in a measuring cell with regard to their size and number using a laser. The measured value is provided according to ISO 4406:99 (factory setting) or SAE AS4059E.



U: Voltage of the photodiode
t: Time

The components are: a measurement cell through which the fluid flows (1), a laser beam (3) and a photo diode (2). As a particle passes through the laser beam, the light intensity detected by the photo diode is reduced. The larger the particle, the larger the decrease of the intensity.

4.2 Processing of the measured signals

The device continuously determines the measured values / data and provides them via the assigned outputs / interfaces (→ 6 Electrical connection):

- Data via the CAN bus (→ 10.1)
- Configurable analogue output 4...20 mA (→ 9.3)
- Binary alarm output (→ 9.2).

In addition the device stores the data in the integrated memory.

4.2.1 Determination of the range number to ISO 4406:99

The range number to ISO 4406:99 can be calculated on the basis of the current value measured on the analogue output to the following formula (OZ = range number, I = current on the analogue output):

$$OZ = \frac{26}{16\ mA} \times I\ [mA] - \frac{26}{4}$$

The current range covers the range numbers to ISO 4406:99 from 0 to 26.

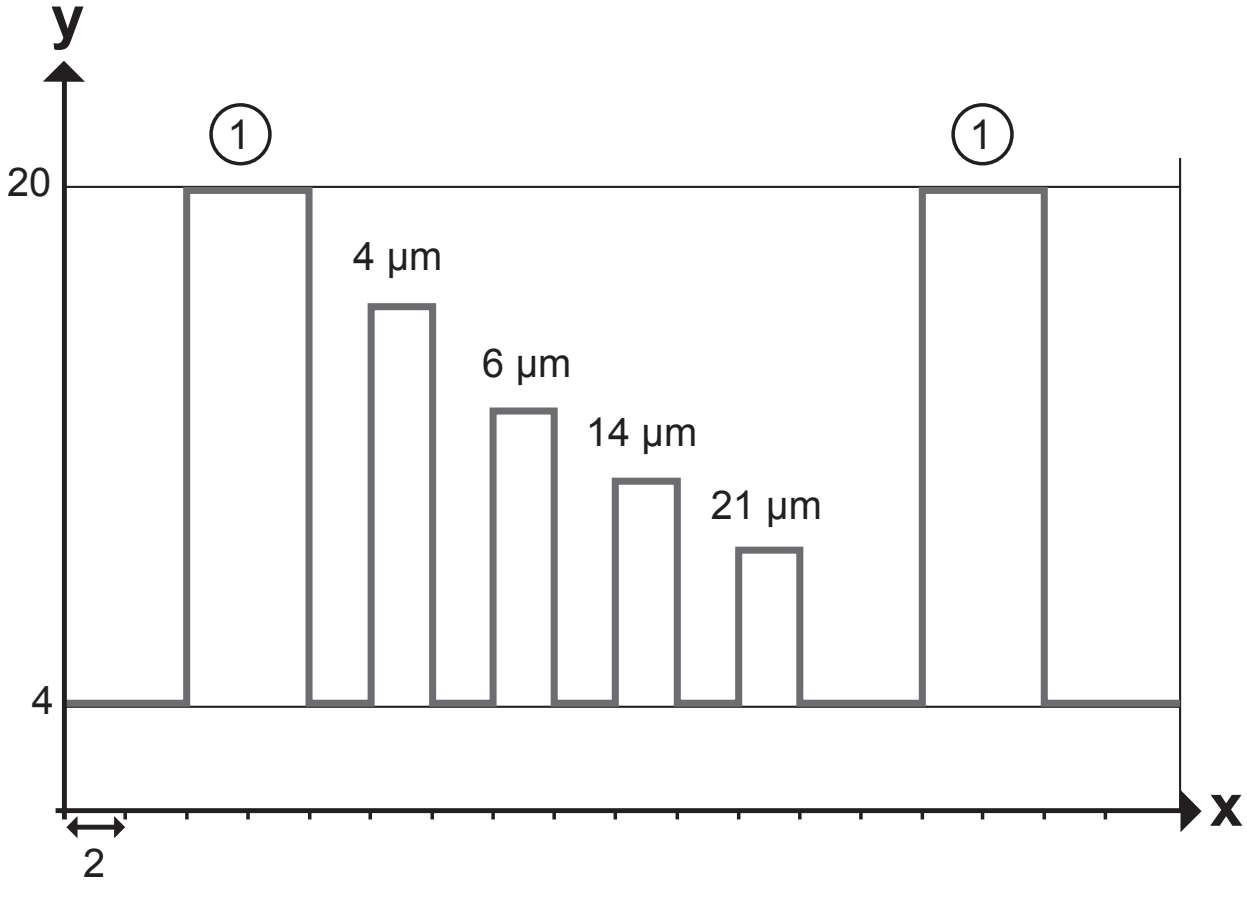
A current value of 4 mA corresponds to a range number of 0; a current value of 20 mA corresponds to a range number of 26. The values are on a linear characteristic curve.

Range number	0	13	26
I_{out} in mA	4	12	20

UK

4.2.2 Sequential data output via the analogue output

If sequential data output is selected, the range numbers are output one after the other:



1: start sequence
y: current in mA,
x: time in seconds

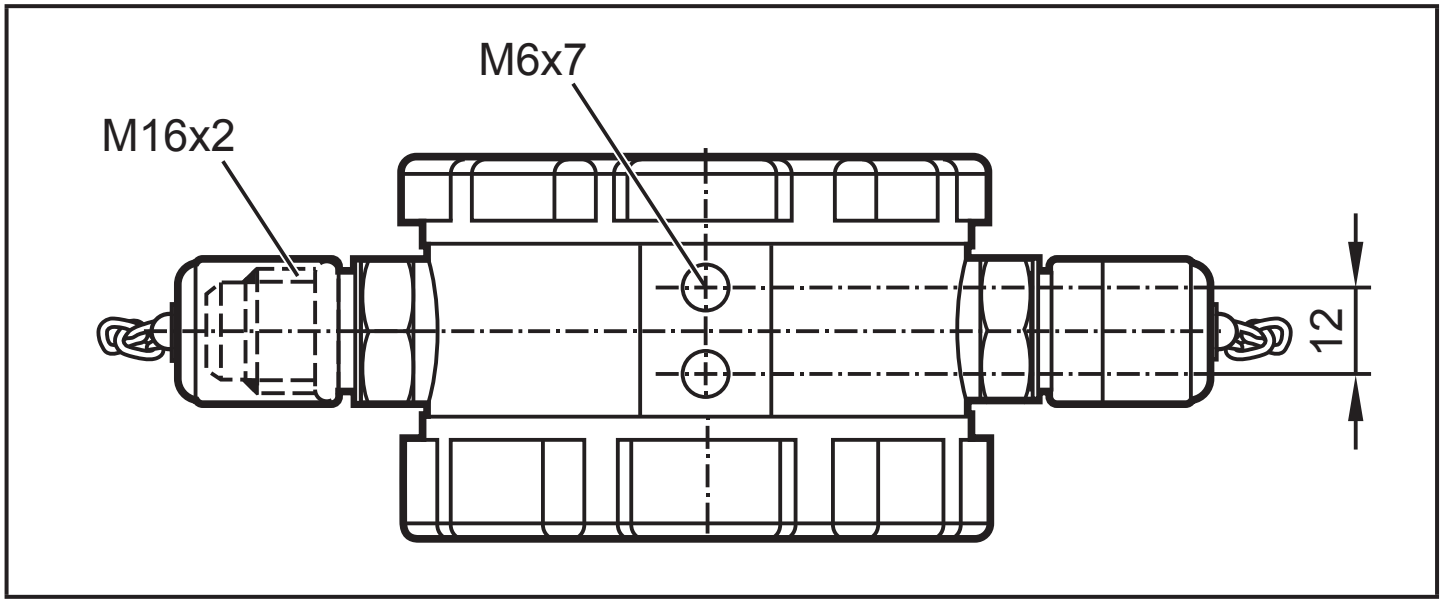
After the start sequence the measured values are output in 4 size channels *) as current pulses.
*) Size channel 6 µm, for example, includes all particles ≥ 6 µm during the measurement

5 Installation

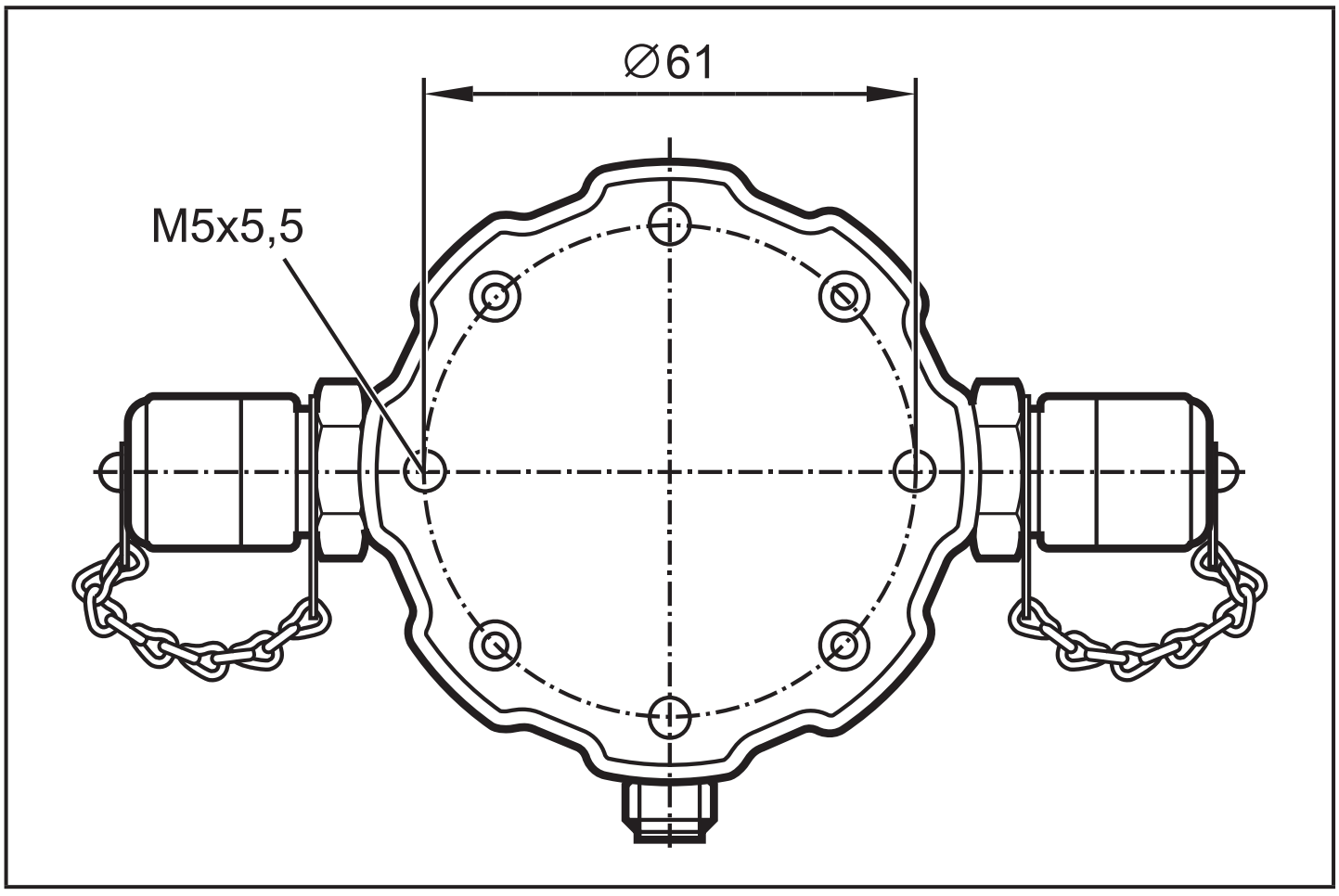
5.1 Assembly drawings

Drawing with the relevant mounting dimensions:

View from below:



View of the back:



5.2 Installation

The device is equipped with two M16x2 Minimess connections via which it is connected to the pressure system. The device is usually installed in a bypass by Teeing off a pressure line. Then the system pressure provides the required flow.

To get meaningful measuring results, the installation must be located in a position that is relevant for the measuring task. It is also recommended to install the device at a location that is easily accessible to ensure good readability of the display.

Rule for the bypass length: the shorter the better. With increasing length there is a higher risk that larger particles settle.

Make sure that the pressure is sufficiently high to guarantee the required flow volume, in particular within Minimess lines (→ 5.3.2 Volume flow and viscosity).

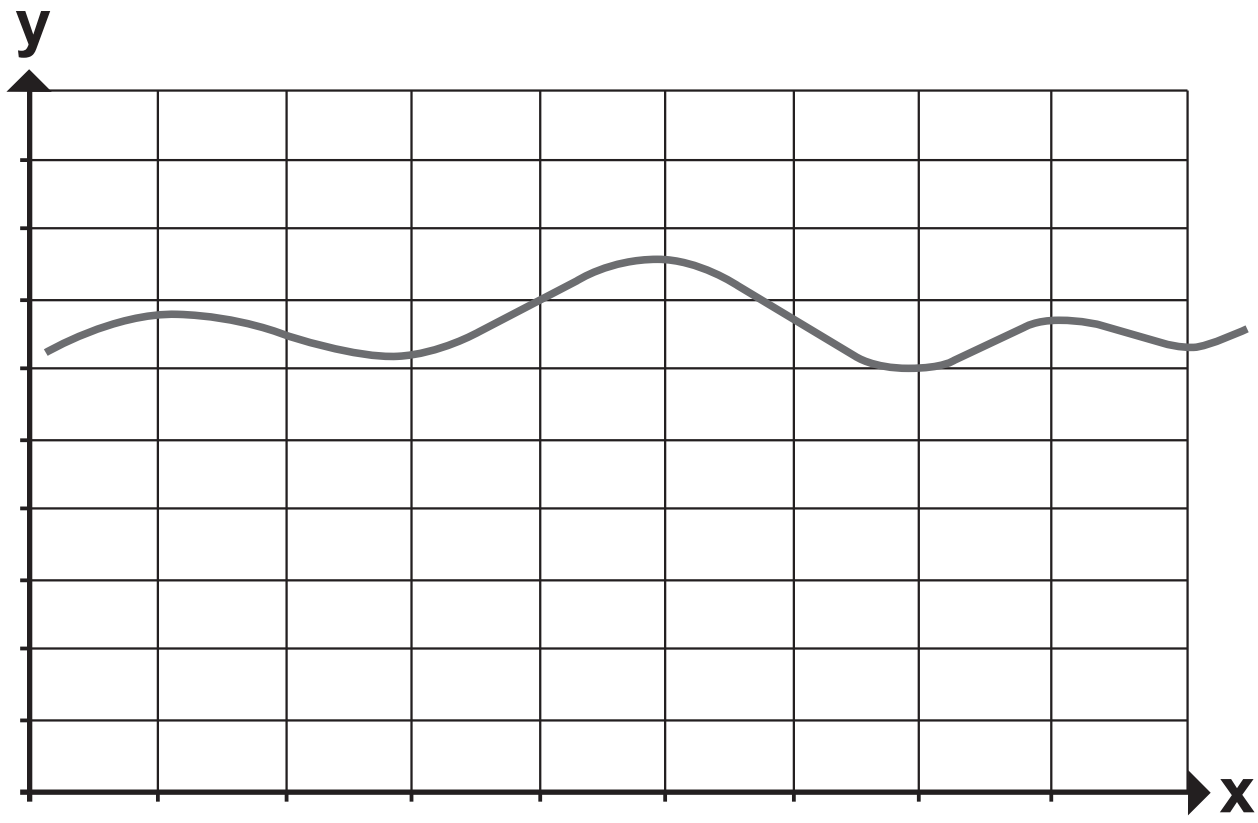
5.3 Conditions

5.3.1 Pressure stability

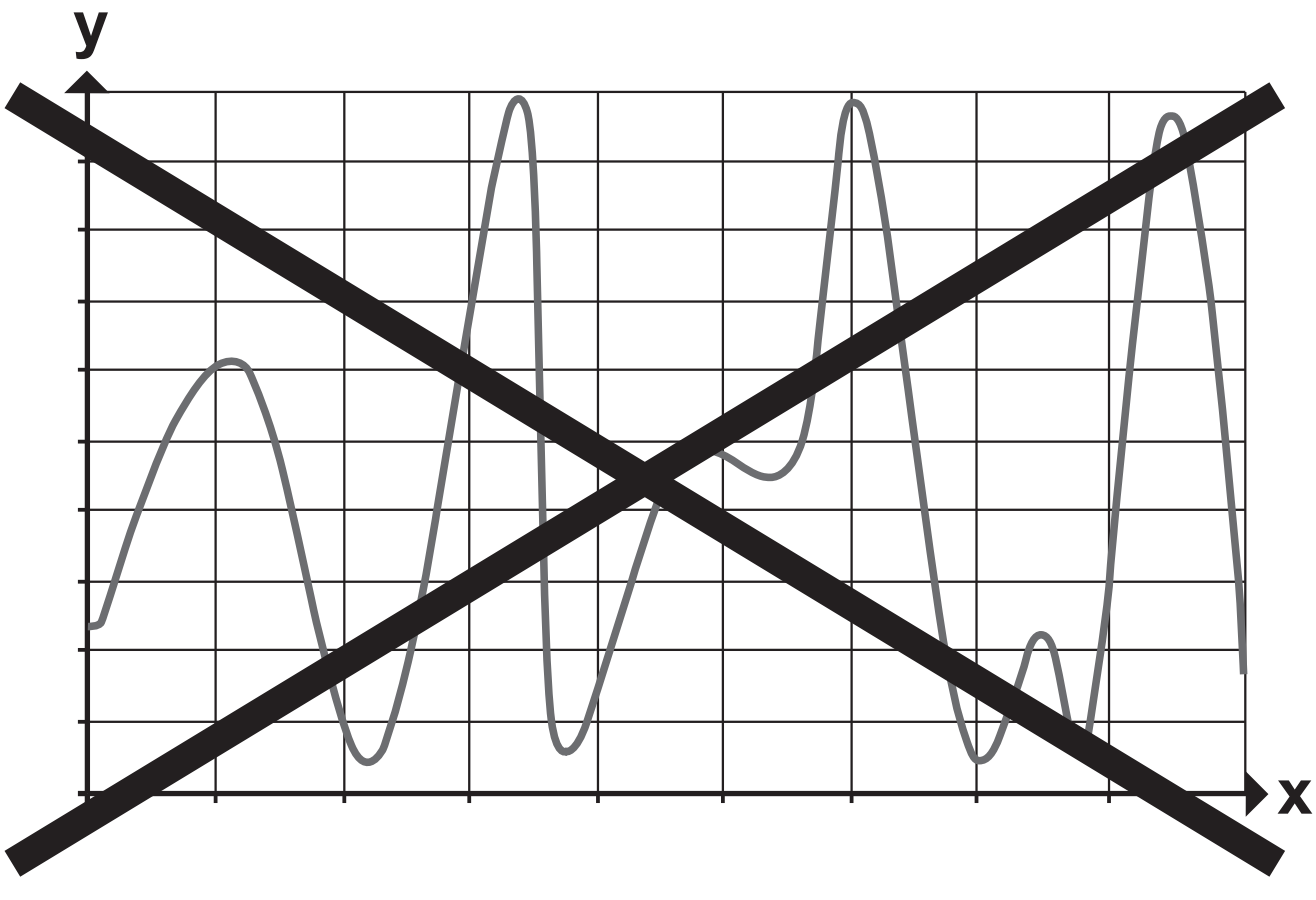
The system pressure can vary but it must not have any peaks or high fluctuations during the measurement. Relatively constant pressure conditions are to be aimed for. It may be necessary to decrease the system pressure after counting.

From experience it is recommended to connect a control oil line. Usually there are moderate pressure conditions at this point; furthermore a volume flow of 400 ml/min is no problem for the control circuit at usual conditions. If there is no control circuit, a possible filter/coolant circuit is a good alternative.

Example: acceptable pressure characteristics



Example: unacceptable pressure characteristics

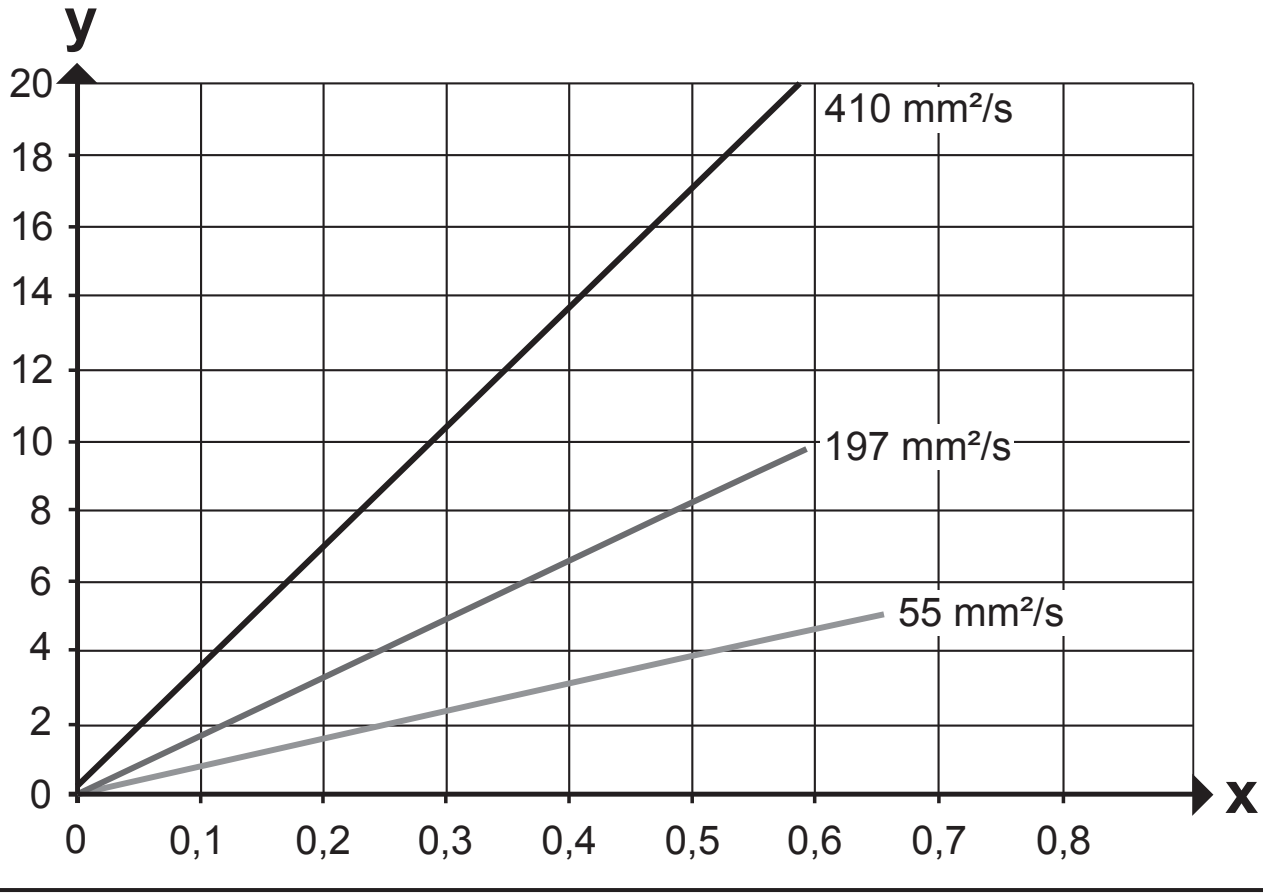


5.3.2 Volume flow and viscosity

To ensure reliable operation, the device requires a constant volume flow between 50 and 400 ml/min. This value applies to both directions of flow; the direction can be freely selected.

Make sure that the pressure is sufficiently high to guarantee the required volume flow, in particular with high viscosities.

The following figure illustrates pressure difference against volume flow for various viscosities:



y: Δp in bar, x: volume flow in l/min

You can estimate the required pressure difference (Δp) for a flow volume using the figure above.

5.3.3 Free of bubbles and water droplets

There must be no bubbles or water droplets in the fluid to be measured. Otherwise the result of the measurement may be falsified.

High range numbers are usually an indicator for bubble and water droplet formation in the measured fluid. It may also be possible to recognise this state by the same range numbers in the size channels. Evaluation with the naked eye is very unreliable.

The following can help reduce the formation of bubbles or water droplets:

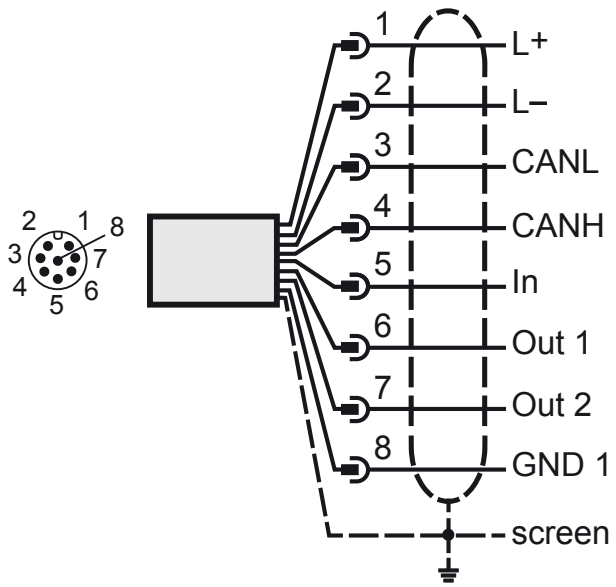
- ▶ Introduce flow or pressure regulation downstream of the measuring point.
- ▶ If the volume flow is generated by a pump: Aim for low-pulsation. Install the pump upstream of the measuring point since installation on the suction side may lead to bubbles forming which might result in an incorrect particle count.

6 Electrical connection

- The unit must be connected by a qualified electrician.
- The national and international regulations for the installation of electrical equipment must be adhered to.
- Voltage supply to EN50178, SELV, PELV, VDE0100-410/A1.
- Use a screened sensor cable.

▶ Disconnect power.

▶ Connect the unit as follows:



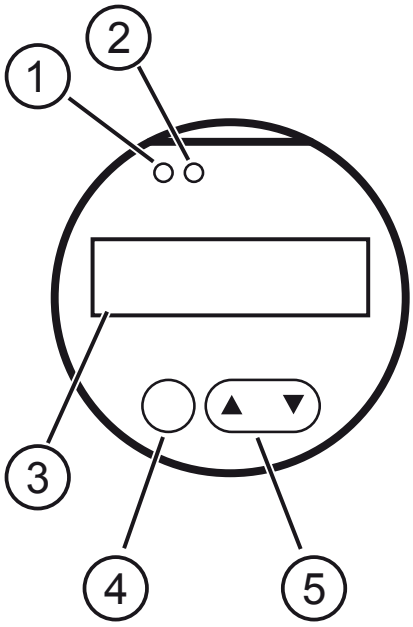
1: L+	9...33 V DC
2: L-	0 V DC [1])
3: CANL	CAN communication
4: CANH	CAN communication
5: In	Switching input [2])
6: Out 1	4...20 mA
7: Out 2	Alarm; open collector output.
8: GND 1	Signal ground Out 1
screen [1])	
[1]) L- and screen are connected to the housing. [2]) Low level activates measuring cycle	

Output Out2 is an open collector output without short-circuit protection; it has no overload or over temperature protection!
I_{max} = 0.5 A

The following sockets are available as accessories:

8-pole, screened M12 socket; straight	E80021
8-pole, screened M12 socket; angled	E80022

7 Controls and LED indicators



1: LED green **[power]**
2: LED red **[alarm]**
3: Display
4: Selection button **[Enter]**
5: "Up" button **[▲]** / "down" button **[▼]**

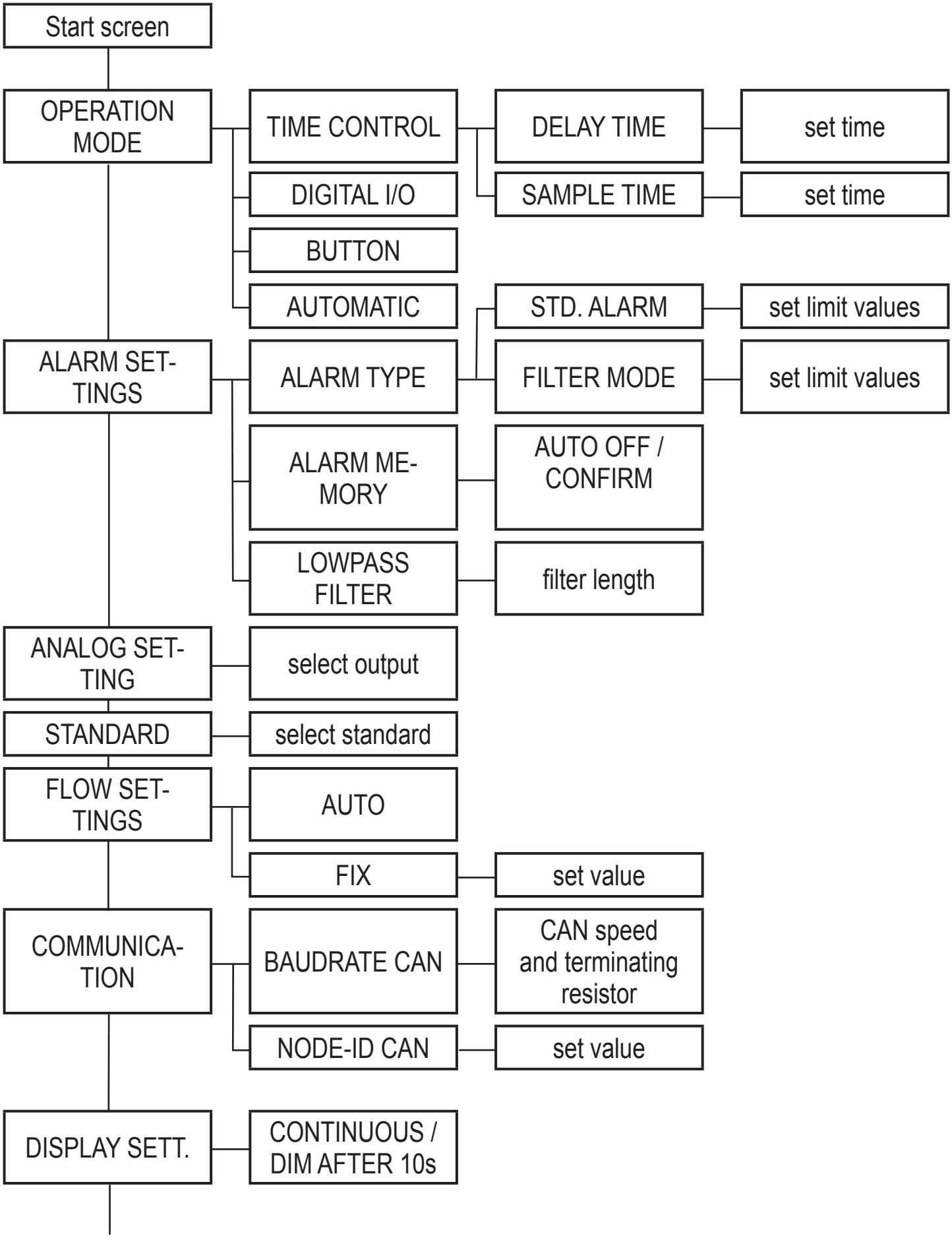
4: Selection button [Enter]
By means of the selection button you can jump to the next menu level; if values are to be set, press the selection button to jump to the next position.
5: "Up" button [▲] / "down" button [▼]
By means of these buttons you can navigate in the menu and scroll through entries.

Other functions of the buttons:

- **Back:** press the "up" button **[▲]** and the "down" button **[▼]** simultaneously.
- **Change values:** The requested parameter is chosen in the menu structure with the "up" **[▲]** or the "down" button **[▼]**. If you press the selection button [Enter], the parameter value can be changed with the "up" **[▲]** or "down" **[▼]** button. Any changes are confirmed by pressing the selection button [Enter].

If you jump to the next higher level before pressing the selection button, the changes are not saved.

8 Menu structure



9 Parameter setting

9.1 Operating mode

The following operating modes are available and can be selected via the menu:

- **TIME CONTROL:** The device works with a set time of measurement and idle time between the measurements.

For the time-controlled measurement there may be a time shift of 2 to 3 s due to the adjustment of the laser.

- **DIGITAL I/O:** the device measures as long as there is a signal on the input. The digital input of the device is active when connected to ground.

For the digitally-controlled measurement a minimum measuring time of 60 s is recommended. The cleaner the oil, the longer the minimum measurement time should be. A cleanliness level of 15 according to ISO 4406:99 should be checked with a measurement time of 120 s.

- **BUTTON:** This measurement is started and stopped by pressing the (Enter) button.

For the manually-controlled measurement a minimum measuring time of 60 s is also recommended.

- **AUTOMATIC:** Here the measuring time is dynamically controlled and depends on the flow and the particle concentration.

This mode is recommended for changing operating conditions since it automatically defines the measurement time and therefore achieves optimum results of measurement.

9.2 Alarm configuration

The following alarm modes can be set in the ALARM SETTINGS menu item:

- **STD. ALARM** (standard alarm)**:** The device activates the alarm as soon as a channel exceeds a threshold.
- **FILTER MODE:** Is suitable to monitor a cleaning process; the device activates the alarm when all channels set have dropped below the threshold.

The alarm thresholds can be set separately for each size channel: If a size class should not be taken into account, its value must be "0".

The digital alarm output (Out2) connects to ground (negative switching). The max. switching voltage is 36 V.

9.3 Analogue output configuration

The ANALOG SETTING function allows selecting a size channel (→ 4.2.2 Sequential data output via the analogue output) whose measuring value is provided via the 4...20mA output.

The typical characteristic curve of the analogue output is described in → 4.2.1 Determination of the range number to ISO 4406:99. With sequential output the range numbers are output one after the other.

The maximum load depends on the supply voltage (technical data at www.ifm.com → New search → Enter the article number).

9.4 Default

The device can display the cleanliness level in accordance with two standards:

- ISO 4406-99
- SAE AS4059E

9.5 Configuration flow

At FLOW SETTINGS the following parameters can be selected:

- **AUTO:** The device does not only detect the particle size and their number but also the flow. The concentration is calculated on the basis of these values.
- **FIX:** Each measurement has some imprecision. If the volumetric flow quantity is constant and known, it is possible to set this fixed value on the device. Then the device calculates the concentration on the basis of the fixed volumetric flow.

9.6 Communication

The CAN bus can be configured by means of the COMMUNICATION menu (→ 10 Communication).

9.7 Configuration display

In the DISPLAY SETT. menu item the following settings can be selected:

- Dimming after 10 s (factory setting).
- Continuous lighting.

9.8 Sensor parameters

In the SENSOR PARA. menu the measured particle concentration as well as a number of diagnostic parameters can be seen.

9.8.1 Flow settings

The bar graph allows an evaluation if the flow is within the optimum range.

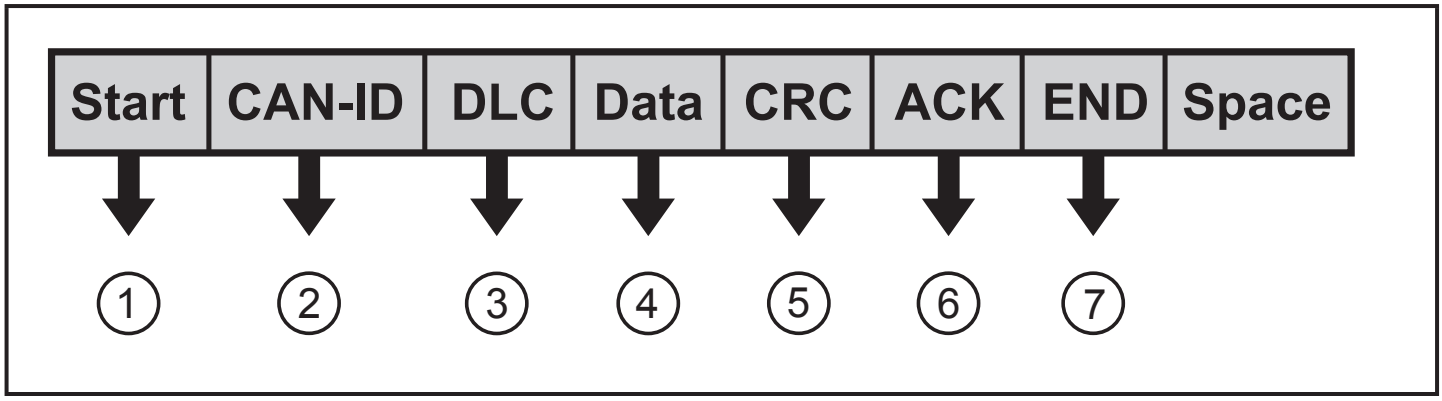
If the flow is not in the optimum range, the measurement accuracy may decrease.

10 Communication

10.1 CAN bus

The CAN bus is a serial bus system in which all connected stations are equal. That means that each control device (CAN node) can transmit and receive. Due to the linear structure of the network the bus system is completely available for all stations if one station fails.

The CAN interface of the present device conforms to the CAN 2.0B Active Specification. The data packages correspond to the format shown in the following figure (the figure is for illustration purposes, the implementation conforms to the CAN 2.0B specification).



1: Start of message
2: Address, service type (e.g. PDO, SDO)
3: Data Length Code
4: User data (up to 8 bytes)
5: CyclicRedundancyChecksum
6: Receiver sets bit to "Low"
7: End of message

The factory setting of the Node ID of the device is: 32
On delivery the device is set to a baud rate of 125 Kbits/s.

10.2 CANopen Object Directory of the device

The device is based on a CANopen profile. Basically the CANopen profiles are organised in a table ("object directory"). All device profiles share the "communication profile" by means of which the basic device data is enquired or set. Examples of this device data are:

- Device designation
- Hardware and software version
- Error status
- Used CAN identifier

The device profiles describe the special capabilities and parameters of a "class" of devices.

The table in chapter 14 Appendix (UK) contains communication-relevant elements to be found in the object directory of the device. Apart from a few exceptions the possible settings conform to the CANopen standard as described in "DS-301".

11 Operation

When the supply voltage has been applied, the unit is in the operating mode. It carries out the measurement and evaluation functions and generates output signals according to the set parameters.

LED operation indicators:

Operating status	LED green (power)	LED red (alarm)	Out 2 (Alarm)
Device ready for operation, no alarm [1])	ON	OFF	OFF
Device ready for operation, alarm [1]).	ON	ON	ON
[1]) observe parameter setting (parameter: ALARM SETTINGS)			

The device is factory-set to a time-controlled measurement with a measuring period of one minute and an idle time of 10 seconds. After power-on the device starts automatically with the measuring cycles and displays the results.

11.1 Troubleshooting

Error	Possible cause	Recommended measures
• No communication via the CAN bus possible. • Current outputs < 4 mA	Cable not correctly connected.	▶ Check the correct electrical connection of the sensor, the data cable and the power cable. ▶ Observe the specified wiring.
	The operating voltage is outside the specified range.	▶ Always operate the device between 9 and 33 V DC.
All size channels display identical values.	Air in the oil	▶ Connect the device on the pressurised side. ▶ Increase the distance to the pump.
• Laser current high • Photo voltage low (Feedback via CAN bus)	Air in the oil	▶ Connect the device on the pressurised side. ▶ Increase the distance to the pump.
	Contaminated cell	▶ Clean the device using clean oil or solvent (e.g. Isopropanol).

12 Technical data and scale drawing

Technical data and scale drawing at www.ifm.com → New search → Enter the article number.

13 Maintenance, repair, disposal

- Clean the unit if badly soiled.
- In case of damage replace the unit.
- It is not possible to repair the unit.
- After use dispose of the unit in an environmentally friendly way in accordance with the applicable national regulations.
- In case of returns ensure that the unit is free from soiling, especially of dangerous and toxic substances. For transport only use appropriate packaging to avoid damage of the unit.

More information at www.ifm.com

14 Appendix (UK)

14.1 Communication Profile Area

Communication Profile Area					
Indx	**S-idx**	**Name**	**Type**	**Default**	**Description**
1000	0	device type	u32, ro	0x194	Sensor, see DS404
1001	0	Errorregister	u8, ro	0x00	mandatory, see DS301
1008	0	Product Code	u32, ro	0x4C445031	LDP100
1017	0	producerheartbeat time	u16, rw	0x1388	heartbit time in ms, range: 0..65535
1018		identityobject	record		
	0	Numberofentries	u8, ro	0x04	largestsubindex
	1	Vendor ID	u32, ro	0x0069666	ifm electronic
	2	Product Code	u32, ro	0x4C445031	LDP100
	3	Revision Number	u32, ro	0x64	Device dependant
	4	Serial Number	u32, ro		Device dependant
1800		Transmit PDO1 Parameter	record		
	0	Numberofentries	u8, ro	0x05	largestsubindex
	1	COB-ID	u32, rw	0x180+NodeID	COB-ID used by PDO, range: 0x181..0x1FF, can be changed while not operational
	2	transmission type	u8, rw	0xFF	cyclic + synchro-nous, asynchro-nous values: 1-240, 254, 255
	5	eventtimer	u16, rw	0x1F4	event timer in ms for asynchronous TPDO1

Communication Profile Area					
Indx	**S-idx**	**Name**	**Type**	**Default**	**Description**
1801		Transmit PDO2 Parameter	record		
	0	Numberofentries	u8, ro	0x05	largestsubindex
	1	COB-ID	u32, rw	0x280+NodeID	COB-ID used by PDO, range: 0x281..0x2FF, can be changed while not operational
	2	transmission type	u8, rw	0xFF	cyclic + synchro-nous, asynchro-nous values: 1-240, 254, 255
	5	eventtimer	u16, rw	0x1F4	event timer in ms for asynchronous TPDO2
1802		Transmit PDO3 Parameter	record		
	0	Numberofentries	u8, ro	0x05	largestsubindex
	1	COB-ID	u32, rw	0x380+NodeID	COB-ID used by PDO, range: 0x381..0x3FF, can be changed while not operational
	2	transmission type	u8, rw	0xFF	cyclic + synchro-nous, asynchro-nous values: 1-240, 254, 255
	5	eventtimer	u16, rw	0x1F4	event timer in ms for asynchronous TPDO3

Communication Profile Area					
Indx	**S-idx**	**Name**	**Type**	**Default**	**Description**
1A00		TPDO1 Mapping Parameter	record		
	0	Numberofentries	u8, ro	0x05	largestsubindex
	1	PDO Mapping for 1st app obj. to be mapped	u32, co	0x20000220	Operating hours time stamp of the measurement, 4 bytes
	2	PDO Mapping for 2nd app obj. to be mapped	u32, co	0x20010108	ISO4µm, 1 byte in 2001h, sub 01
	3	PDO Mapping for 3rd app obj. to be mapped	u32, co	0x20010208	ISO6µm, 1 byte in 2001h, sub 02
	4	PDO Mapping for 4th app obj. to be mapped	u32, co	0x20010308	ISO14µm, 1 byte in 2001h, sub 03
	5	PDO Mapping for 5th app obj. to be mapped	u32, co	0x20010408	ISO21µm, 1 byte in 2001h, sub 04

Communication Profile Area					
Indx	**S-idx**	**Name**	**Type**	**Default**	**Description**
1A01		TPDO2 Mapping Parameter	record		
	0	Numberofentries	u8, ro	0x05	largestsubindex
	1	PDO Mapping for 1st app obj. to be mapped	u32, co	0x20000220	Operating hours time stamp of the measurement, 4 bytes
	2	PDO Mapping for 2nd app obj. to be mapped	u32, co	0x20020108	SAE4µm, 1 byte im 0x2002, sub 01
	3	PDO Mapping for 3rd app obj. to be mapped	u32, co	0x20020208	SAE6µm, 1 byte in 0x2002, sub 02
	4	PDO Mapping for 4th app obj. to be mapped	u32, co	0x20020308	SAE14µm, 1 byte in 0x2002, sub 03
	5	PDO Mapping for 5th app obj. to be mapped	u32, co	0x20020408	SAE21µm, 1 byte in 0x2002, sub 04

Communication Profile Area					
Indx	**S-idx**	**Name**	**Type**	**Default**	**Description**
1A02		TPDO3 Mapping Parameter	record		
	0	Numberofentries	u8, ro	0x05	largestsubindex
	1	PDO Mapping for 1st app obj. to be mapped	u32, co	0x20000120	Operating hours counter, 4 bytes
	2	PDO Mapping for 2nd app obj. to be mapped	u32, co	0x20030108	Oil status bits, 1 byte
	3	PDO Mapping for 3rd app obj. to be mapped	u32, co	0x20030708	Measurement bits, 1 byte
	4	PDO Mapping for 4th app obj. to be mapped	u32, co	0x20030808	Sensor status bits, 1 byte
	5	PDO Mapping for 5th app obj. to be mapped	u32, co	0x20040008	Temperature 1 byte
2000		Time related parameters of the sensor	record		
	0	Numberofentries	u8, ro	0x02	largestsubindex
	1	Operating hours counter	u32, ro		Sensor up time in seconds
	2	Operating hours time stamp of the measurement	u32, ro		Time stamp of the last measurement
2001		ISO measurement	record		
	0	Numberofentries	u8, ro	0x04	largestsubindex
	1	ISO4µm	u8, ro		
	2	ISO6µm	u8, ro		
	3	ISO14µm	u8, ro		
	4	ISO21µm	u8, ro		

Communication Profile Area					
Indx	**S-idx**	**Name**	**Type**	**Default**	**Description**
2002		SAE measurement	record		
	0	Numberofentries	u8, ro	0x04	largestsubindex
	1	SAE4µm	u8, ro		
	2	SAE6µm	u8, ro		
	3	SAE14µm	u8, ro		
	4	SAE21µm	u8, ro		

Communication Profile Area					
Indx	**S-idx**	**Name**	**Type**	**Default**	**Description**
2003		Condition Monitoring Bitfield	array		
	0	Numberofentries	u8, ro	0x08	largestsubindex
	1	Oilspecificbits	u8, ro		0: Concentration limit exceeded 1: High flow 2: Low flow
	2	reserved	u8, ro		
	3	reserved	u8, ro		
	4	reserved	u8, ro		
	5	reserved	u8, ro		
	6	reserved	u8, ro		
	7	Measurement info	u8, ro		0: Measurement in process 1: Automatic measurement mode 2: I/O measurement mode 3: Manual measurement mode 4: Alarm mode filter / standard
	8	Sensor alarm	u8, ro		0: Laser current high 1: Laser current low 2: Photo voltage high 3: Photo voltage low 4: Temperature high 5: Temperature low

Communication Profile Area					
Indx	**S-idx**	**Name**	**Type**	**Default**	**Description**
2004		Sensor Temperature	s8, ro		Oiltemperature in °C
2005		Flow index	u16, ro		Flow index (0..500)
2020		Commando	u8, wo		1: Start of a measurement 2: Stop of a measure-ment
2030		Measurement relatedsettings	record		
	0	Numberofentries	u8, ro	0x08	largestsubindex
	1	Measurement Time	u32, rw		Measurement Time in s
	2	Hold Time	u32, rw		Time between-Measurements
	3	Operation Mode	u16, rw		0: Time Control 1: Digital I/O 2: Button 3: Automatic
	4	Historydisable	u16, rw	0	0: Historyenabled 1: Historydisabled
2031		Startup Settings	record		
	0	Numberofentries	u8, ro	0x01	largestsubindex
	1	Startmode	u16, rw	0x0	0: Network with NMT Master (Init → PreOp → Start_ Remote_Node → Operational) > 0: Network without NMT Master (Init → Operational)

Communication Profile Area					
Indx	**S-idx**	**Name**	**Type**	**Default**	**Description**
2100		Readmem control functions	record		
	0	Numberofentries	u8, ro	0x04	largestsubindex
	1	Size ofhistoryme-mory	u32, ro	devicedepen-dand	size of memory in datasets
	2	Usedhistorymem	u32, ro		used datasets within memory (corresponds internaly to write pointer)
	3	Reading pointer, dataset	u32, ro		autoincrementing read pointer to a dataset for history memory reading; can be between 0 and current write pointer
	4	Clear historyme-mory	u16, wo		1: clearmemory
2101	0	Readmem Initiate segmented SDO data Upload	u16, ro		Appropriate Poin-ter has to be set (with 2100sub3) before start reading. Size of the record will be sent back on reading