

Data sheet | Technical Description and Installation Instructions

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DML02 | DML02_ex version:

Viscosity sensor VLO-M2 | VLO-M2_ex



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Notes about the data sheet

Use and safekeeping

- This data sheet is an integral component of the viscosity sensor.
- Keep the data sheet in the immediate vicinity of the place of use.
- In case of transfer to third parties, pass on the data sheet or relevant content to them.
- Read the data sheet carefully.
- We reserve the right to make changes.

⚠ WARNING

Use of the VLO-M2_ex version

This document is only valid in connection with the VLO-M2_ex with the safety instructions DB-KU-100206-*. The asterisk (*) stands for the version.

Function

The data sheet provides information for safe use and installation of the viscosity sensor.

Symbols used

The following symbols are used in the data sheet to draw attention to dangerous situations and to indicate instructions for action:

Symbol	Description
⚠ WARNING	Leads to death or serious injury if not avoided.
NOTICE	Information on facts that do not involve physical injury.
▶	Single-step handling instruction
1. / 2. / 3.	Multi-step handling instruction

Safety notes

Intended use

- Depending on the ordered version, the measuring instrument can also measure explosive and inflammable media.
- Measuring instruments for use in hazardous areas are specially marked on the type plate.
- The viscosity sensor is to be used exclusively for measuring the viscosity of fluids. Only permitted media may be used.
- Check by means of the type plate whether the ordered measuring instrument can be used for its intended purpose in the area relevant for approval (e.g. explosion protection).
- Failure to observe the area of application can impair safety. The manufacturer shall not be held liable for damage arising from improper use.

Qualification of personnel

- The viscosity sensor may be installed by specialist personnel only.

Operating safety

- The owner/operator is responsible for interference-free operation of the viscosity sensor.
- Only operate the viscosity sensor in a technically perfect and safe operating condition.
- In case of increased medium temperature, ensure protection against accidental contact to avoid burns.
- Unauthorised modifications or repairs to the viscosity sensor are not permitted and can lead to unforeseeable dangers.

Product safety

- The viscosity sensor complies with the guidelines listed in the EU Declaration of Conformity. By affixing the CE mark, TrueDyn Sensors AG confirms this fact.



Product description

Overview

The viscosity sensor was designed for measuring the viscosity and density of fluids. This takes place using a microelectromechanical system (MEMS) with a micro-channel shaped liked the Greek letter omega (omega chip), which is built into an internal bypass.

When the medium flows through the viscosity sensor, the bypass arrangement generates a pressure gradient via the microchannel, which allows the medium to reach the omega chip. The medium influences the physical properties of the excited sensor (resonance frequency and quality), and these are digitised and evaluated in the microcontroller. The measured values can be read out via the serial interface (RS-485, Modbus).

Thus, density measurements in the range of 0...1600 kg/m³ at a flow rate of 0...10 l/h can be realised.

Further options are available regarding an extended density range, viscosity measurement and density measurement of gases. The specifications can be found in the corresponding documentation.

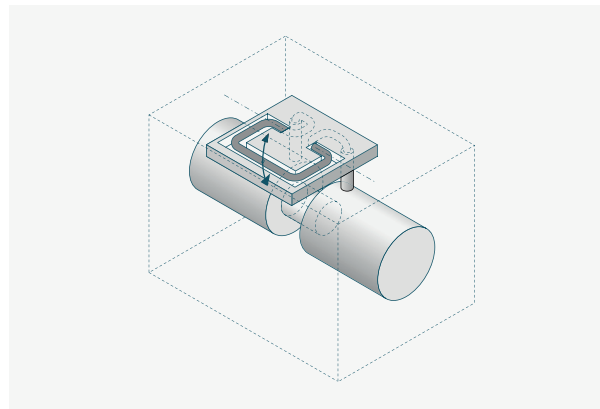
Omega chip

The omega chip, a vibronic microsystem, is the heart of the measuring system and is used for sensor signal

generation in the overall system. An essential component of this microsystem is a silicon tube (microchannel), which is electrostatically set into oscillation in a vacuum atmosphere. To compensate for temperature effects, a platinum resistor is integrated, which allows local real-time temperature measurement. The omega chip essentially consists of crystalline silicon and glass.

Density measurement

The viscosity sensor uses the omega chip for density measurement. For this purpose, the filled microchannel is brought to resonant oscillation and analysed.



Measuring principle (omega chip)

The resulting resonant frequency of the microchannel depends on the mass and thus on the density of the medium in the microchannel: The greater the density of the medium, the lower the resonant frequency. Thus

the resonant frequency is a function of the medium density.

$$f \propto \sqrt{\frac{E \cdot I}{\rho_{\text{Tube}} \cdot A_{\text{Tube}} + \rho_{\text{Fluid}} \cdot A_{\text{Fluid}}}}$$

f = resonant frequency, E · I = stiffness of the tube, ρ_{Tube} = tube density, A_{Tube} = tube cross-section, ρ_{Fluid} = medium density, A_{Fluid} = medium cross-section

Possible applications

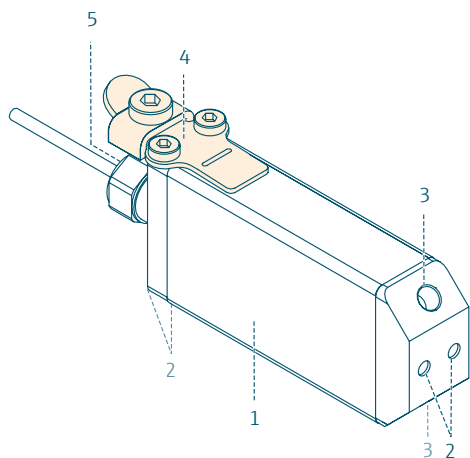
The viscosity and density sensor can be used for direct and indirect density measurements. While a product property or quality can be determined with the direct measurement, an indirect measurement using tables and calculation algorithms makes it possible to determine the concentration of fluid mixtures.

The viscosity sensor can be used in the following applications, for example:

- Supplement volumetric flow measurement in orifice plates, turbines or displacement devices to enable mass measurement. The viscosity sensor takes into account temperature changes and (if an additional pressure sensor is connected) pressure changes into account.
- Monitoring and controlling the quality of fuel mixtures such as E10 or biodiesel.



Product design



Product design of viscosity sensor VLO-M2 | VLO-M2_ex

- 1 Viscosity sensor VLO-M2(_ex)
- 2 Mounting holes for mechanical fastening (6 x M3 threaded holes)
- 3 Fluid interface (2 x M5 threaded holes)
- 4 Clamp on grounding plate with screws M3×6 TORX
- 5 Electronic interface for communication and power supply

NOTICE

For the VLO-M2 (non-ex), item 4 (clamp on grounding plate with screws M3×6 TORX) is not applicable. Marked orange in the graphic.

Scope of delivery

- Viscosity sensor (including transport safety devices)

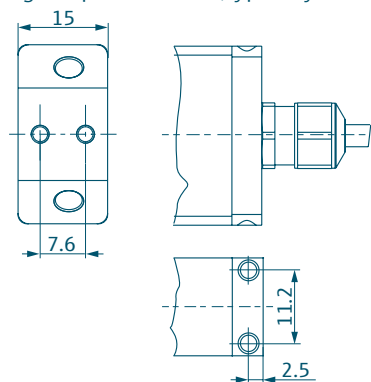
Product identification

The viscosity sensor is identified by a consecutive, eleven-digit serial number. This is installed on the outside of the housing and can also be viewed via Modbus.

Installation, start-up and uninstallation

Fastening the viscosity sensor mechanically

- Fix the viscosity sensor with M3 screws using the provided mounting holes (4 mm depth). Maximal tightening torque 30 cNm (typically 15 to 20 cNm)



Dimensions in mm for mechanical fastening

Making the fluid connections for the viscosity sensor

- With a flow rate >10 l/h, installation in a bypass line is recommended to limit the flow rate through the viscosity sensor to <10 l/h.
- The bypass line can be led to a collecting tank or back to the main line.

⚠ WARNING

Danger of injury due to dangerous process conditions and pipe break

- Empty and depressurize the pipeline before installing the viscosity sensor.
- Take high temperatures into account.
- If necessary, fasten the viscosity sensor mechanically.

NOTICE

Clogging of the microchannel

- If necessary, install a filter upstream of the viscosity sensor to prevent the microchannel from clogging.

NOTICE

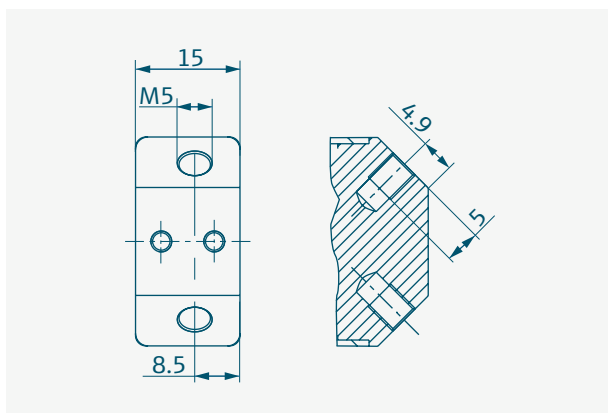
Delayed measurement signal for installation in bypass

- Note the time delay, for example for open-loop process control.

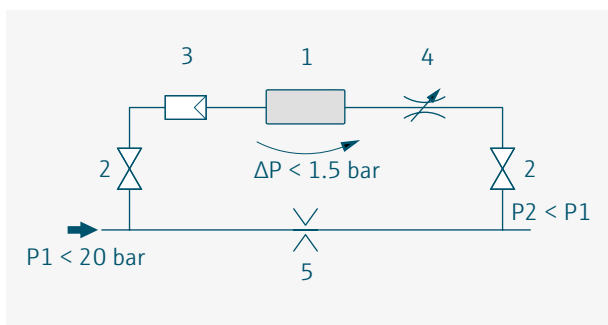
1. Remove all remaining packaging materials.
2. Remove transportation safety devices on fluid connections.



3. Install the viscosity sensor at fluid connections with M5 connectors (thread depth 5 mm) in the pipeline, whereby flow and installation direction are not relevant. Also follow the instructions in the operating manual of the connector used.



Dimensions in mm for fluid installation



Installation example: 1 = Viscosity sensor; 2 = Valve; 3 = Filter; 4 = Flow restrictor; 5 = Orifice

Making the electrical connections for the viscosity sensor

⚠ WARNING

Death or severe injury due to incorrect connection

- ▶ Electrical connection work may be carried out by correspondingly trained specialist personnel only.
- ▶ Observe installation codes and requirements valid in the respective country.
- ▶ Comply with local occupational safety requirements.

⚠ WARNING

No current-limiting fuse

- ▶ Ensure overcurrent protection ($I_{\max} = 500 \text{ mA}$) through external circuit.

⚠ WARNING

Use in areas with an explosion hazard

The viscosity sensor VLO-M2 (non-ex) has no approval for use in hazardous areas.

- ▶ When operating in areas with an explosion hazard, ensure explosion protection.
- ▶ Connect the viscosity sensor to the higher-level system. Observe the cable assignment, see "Cable assignment" on page 11.

NOTICE

RS485 point-to-point connection

- ▶ The variant VLO-M2_ex is designed for a RS485 point-to-point connection.
- ▶ Variant VLO-M2_ex: On the client side a 330 Ω termination resistor must be used between the RS485 lines (D0 and D1).

- ▶ The serial interface is based on the "Modbus over serial line" specification.

Integrating the viscosity sensor into the system

The viscosity sensor sends the measured data to the readout system via the data line in Modbus RTU transmission mode. General settings of the serial Modbus RTU interface:

NOTICE

- ▶ Modbus RTU protocol implemented according to specification V1.1b3
- ▶ Modbus registers refer to the start value 0
- ▶ For the sensor the typical response time is 10...20 ms
- ▶ For further Modbus information see section Modbus

NOTICE

The viscosity sensor does not include a pressure sensor. However, it is possible to write the externally measured pressure into the viscosity sensor (see special documentation for gas measurement).

Switching on the viscosity sensor

- ▶ Switch on the power supply. After the power supply is switched on, the viscosity sensor starts automatically after an initialization routine.



Uninstalling the viscosity sensor

⚠ WARNING

Danger to personnel and environment from media that are hazardous to health

- ▶ Ensure that no media hazardous to health or the environment can escape when loosening the fluid connection.
- ▶ Ensure that no residues of hazardous substances can escape from the viscosity sensor when the mechanical fastenings are loosened by changing their position.

1. Disconnect the cable connections of the electrical connections from the viscosity sensor.
2. Disconnect the fluid connections.
3. Undo the mechanical fastening.

Cleaning and repair

Carrying out cleaning of the housing

NOTICE

Cleaning agents may cause damage to the housing

- ▶ Do not use high-pressure steam.
- ▶ Use only permitted cleaning agents.
- ▶ Permitted cleaning agents:
 - Somat Intensive Machine Cleaner
 - Methyl or isopropyl alcohol
 - Water

Carrying out cleaning of the microchannel

NOTICE

Damage to the microchannel possible

- ▶ Use only permitted cleaning agents.

1. Flush with permitted cleaning agents.

Permitted cleaning agents:

- isopropanol (IPA), ethanol, petroleum ether (e.g. petroleum 80 to 110), acetone, hexane and somat intensive machine cleaner

2. Then, flush with dry air until there is no more cleaning agent in the microchannel.
3. Fill the sensor with fluid with a known density or viscosity value. Deviations from the nominal density value that are greater than the specified maximum measuring deviation indicate residues in the microchannel.

Disposal

Disposing of the viscosity sensor

⚠ WARNING

Danger to personnel and environment from media that are hazardous to health

- ▶ Ensure that the viscosity sensor and all cavities are free of any residues of the measuring medium that are hazardous to health or the environment.
- ▶ Send viscosity sensor components for recycling. Observe codes and requirements valid in the country.

Product specification

General

Measured variable	Density, viscosity and variables derived from it (e.g. standard density, concentration, etc.)
Permitted media	NOTICE Damage to the microchannel possible. ▶ Do not use helium or strong bases. Particulate free (<30 µm) media such as: ■ Gasoline, diesel, kerosene ■ OME (synthetic materials) ■ Oils and lubricants ■ Water-based media ■ Methanol, ethanol, isopropanol ■ LPG* ■ AdBlue®* ■ Glycol mixtures* Concentration packages: ■ Various sugars in water ■ Invert sugar in water ■ High fructose corn syrup ■ Methanol in water ■ Ethanol in water ■ Salt in water ■ Minerals in water ■ Hydrogen peroxide in water ■ Ethylene glycol in water ■ Butane in propane



- User-specific concentration packages upon request

Other media can be used after individual clarification.

*Optional

For information on gas density measurement, see special documentation: Density sensor for gases.

Measurement performance

Max. measurement deviation for liquids

(For gases, see special documentation for gases.)

- Viscosity: $\pm[0.2 \text{ mPa s} + 5\% \text{ from measurement}]$
- Density: $\pm 0.2 \text{ kg/m}^3$ or $0.0075 \times \text{abs}(T-25 \text{ °C}) \text{ kg/m}^3$ if the value is $> 0.2 \text{ kg/m}^3$
- Temperature: $\pm 0.15 \text{ °C}$ or $\pm[0.005 \times \text{abs}(T-25 \text{ °C})] \text{ °C}$ if the value is $> 0.15 \text{ °C}$

NOTICE

Pressure-dependent density measurement accuracy

The viscosity sensor is calibrated to 1 bar (abs) by default. At higher pressure the viscosity sensor indicates a density that is too low. At pressure change Δp , the density deviation is $\Delta \rho$:

$$\Delta \rho = (0.07 \pm 0.02) \frac{\text{kg}}{\text{m}^3 \cdot \text{bar}} \cdot \Delta p$$

- ▶ Note pressure-dependent density measurement accuracy.
- ▶ If necessary, correct the measured density value due to the influence of pressure:

$$\rho_{\text{Fluid}} = \rho_{\text{mess}} + \Delta \rho$$

Here, ρ_{Fluid} is the actual density at process pressure and ρ_{meas} is the density measured by the density sensor.

- ▶ Order option: Calibration to desired pressure (1 to 20 bar (abs)).

Repeatability

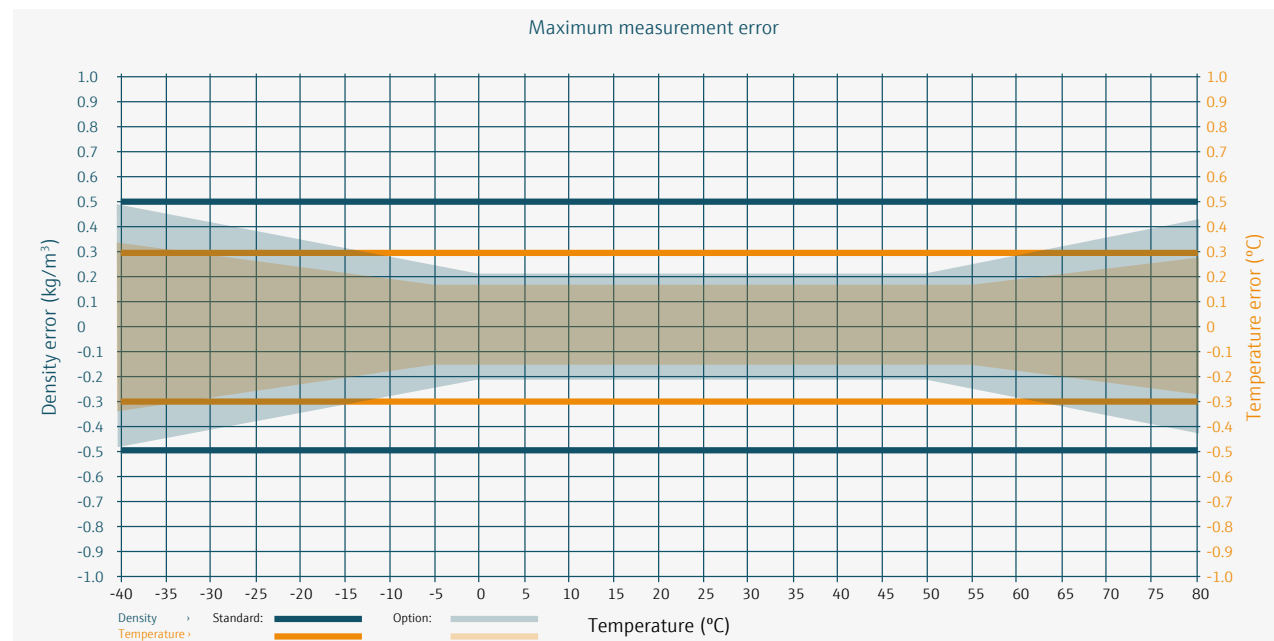
- Viscosity: $\pm 0.1 \text{ mPa s}$
- Density: $\pm 0.1 \text{ kg/m}^3$
- Temperature: $\pm 0.05 \text{ °C}$

Temperature conditions

Permitted medium temperature -40 to +60 °C

Permitted ambient temperature -40 to +60 °C

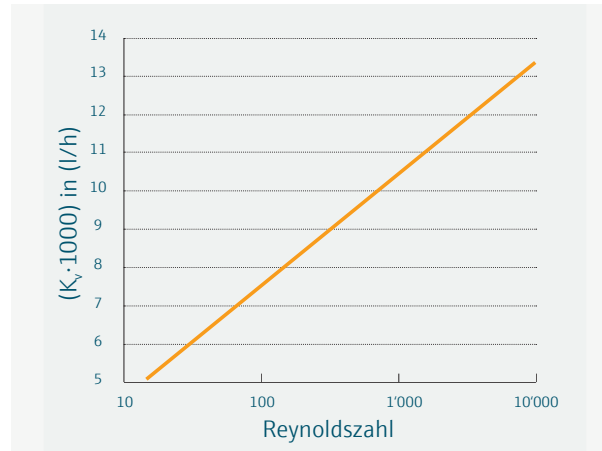
Permitted storage temperature -40 to +60 °C





Area of application

Permitted measured density value	0 to 1600 kg/m ³
Permitted viscosity range	0,1 to 50 mPa s
Permitted medium pressure	0 to 20 bar (abs) Burst pressure 80 bar (abs)
Permitted particle size	Max. 30 µm
Permitted flow range	0 to 10 l/h 0 to 1 l/min for gases
NOTICE Permitted means that the measuring accuracy of the sensor is within the given specifications.	
Vibrations	Vibrations (<20 kHz) have no influence on the measuring accuracy due to the high working frequency of the microchannel.
Inlet and outlet runs	Inlet and outlet runs have no influence on the measuring accuracy.
Flow/pressure loss conditions	NOTICE To ensure proper operation, the flow rate (Q) must not exceed 10 l/h. For gas measurements, the upper limit is 1 l/min.
Units	[K _v]= m ³ /h, [Q]=l/h, [Δp]=bar, [ρ]=kg/m ³ , [η]= mPa s



Flow factor versus Reynolds number ($K_v(Re) = [1.28 \ln(Re) + 1.60] \pm 10\%$)

Determining the flow factor ($K_v \cdot 1000$ l/m³)

The flow factor can be read by means of the Reynolds number (Re) via the figure Flow / pressure loss conditions.

Determination of Re via Q , ρ and η

$$Re \cong \frac{Q \cdot \rho}{2 \cdot \eta}$$

Determination of Q via Δp

$$Q = K_v \cdot 1000 \text{ l/m}^3 \sqrt{\frac{\Delta p}{1 \text{ bar}} \cdot \frac{1000 \text{ kg/m}^3}{\rho}}$$

Determination of Δp via Q

$$\Delta p = \left(\frac{Q}{K_v \cdot 1000 \text{ l/m}^3} \right)^2 \cdot \frac{\rho}{1000}$$

Calculation

If one of the needed factors such as Q is not available, several iteration steps are needed.

Response time

- The viscosity and density is recorded with a measuring rate of at least 30 Hz. As a result of internal processing and filtering, the maximum group delay is 1 s.
- The temperature is recorded with a measuring rate of 2 Hz. As a result of internal processing and filtering, the maximum group delay is 2.5 s.

Ambient conditions

Climate class

In accordance with:

- IEC/EN 60068-2-1
- IEC/EN 60068-2-2
- IEC/EN 60068-2-30

Electromagnetic compatibility

EMC 2014/30/EU (EN 61326-1)

Vibration and shock resistance

In accordance with:

- IEC/EN 60068-2-6
- IEC/EN 60068-2-27
- IEC/EN 60068-2-64

Protection class

IP54 (IEC 60529)

Flow/pressure loss conditions



Materials

Housing	- Stainless steel: – 1.4404 (316L) – 1.4542 (AISI/SUS 630)
Wetted parts	- BOROFLOAT® 33 glass - Silicon - Epoxy resin - Stainless steel: – 1.4542 (AISI/SUS 630) - Alternative to stainless steel: – 2.4605 (Alloy 59)

Dimensions

Housing	30 x 66 x 15 mm ³ (without cable, cable gland and connection for protective ground)
Weight	<200 g
Dimensions of measurement channel	160 x 200 µm (500 nl)

Fluid interface

Fluid interfaces	2 x M5 threaded holes at a 45° angle to the side and front surface
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Electrical interface

Cable design	Permanently installed cable. Connecting cable type KS-Li-9YD11Y 4xAWG 28, manufacturer: Kabel Sterner
Cable length	3 m (optionally up to 20 m)
Cable outer diameter	2.3 mm
Wire diameter	4 x AWG 28

Level control

Digital communication lines and power supply in one common shielded cable

- Unidirectional, RS485

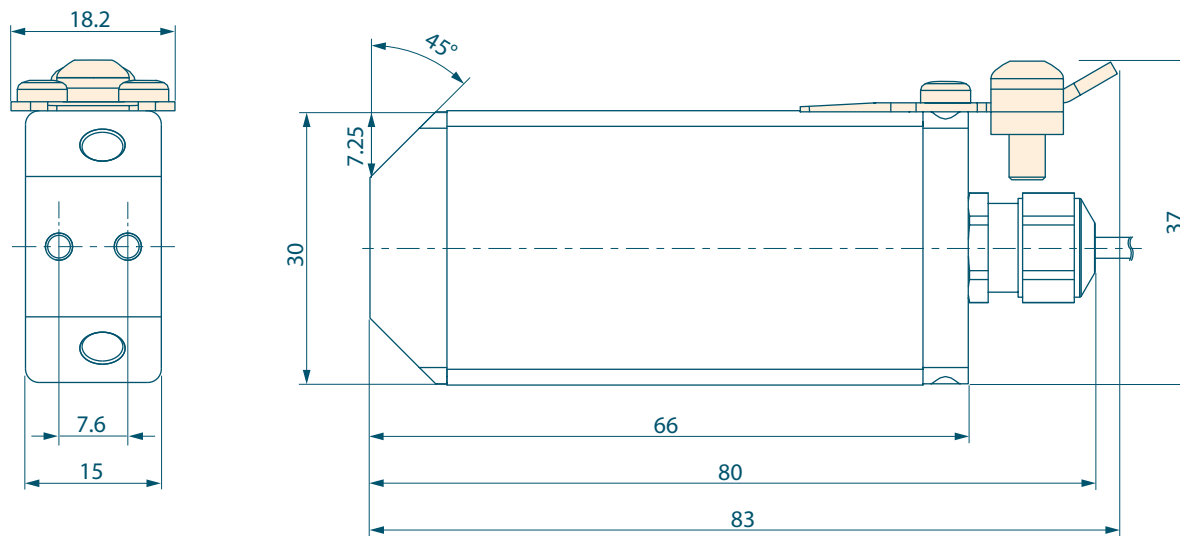
NOTICE

For the variant VLO-M2_ex

- Provide a 330 Ω termination resistor on the client side (see Page 6)

For the variant VLO-M2 (non-ex)

- For the integration in RS485-Modbus a bus termination according to specification "Modbus over serial line V1.02" has to be provided.



Design, dimensions in mm

(orange parts valid for VLO-M2_ex only)

**Energy supply**

Maximum current draw 26 mA, maximum power consumption 350 mW.

NOTICE

The power supply unit must be safety tested (e.g. PELV, SELV). For the variant VLO-M2_ex

- Supply: 9.4 V to 13.3 V (typical: 12 V)

For the variant VLO-M2 (non-ex)

- Supply: 5 V to 13.3 V

⚠ WARNING

For VLO-M2_ex, observe safety instructions DB-KU-100206-*. The asterisk (*) stands for the version.

- Zener barriers (supply and RS485)

Dielectric strength

Version VLO-M2_ex

The reference potential (GND) is connected to the housing and the ground connection (see product design). There is no galvanic isolation between the supply circuits, the communication interface and GND.

Dielectric strength (continued)

Version VLO-M2 (non-ex)

There is a capacitive coupling between the reference potential (GND) and the housing (ground). The dielectric strength is 50 V. There is no galvanic isolation between the supply circuits, the communication interface and GND.

The cable shield is connected to the sensor housing. The shield must be connected to the protective earth on the connection side according to the "Modbus over serial line V1.02" specification.

Cable assignment**Wire color Assignment**

yellow	RS485 B, D1
green	RS485 A, D0
brown	GND (signal ground), common
white	V _{DD} (supply voltage)

NOTICE

The wire color code does not comply with the "Modbus over serial line V1.02" specifications.

Certificates and approvals**CE marking**

The viscosity sensor meets the legal requirements of the EC directives. TrueDyn Sensors AG confirms the successful testing of the viscosity sensor with the attachment of the CE mark.

IECEX, ATEX**⚠ WARNING**

Applies to the VLO-M2_ex version

Depending on the version, the product complies with the following directives:

		VLO-M2	VLO-M2_ex
ATEX	2014/34/U(L96/309)		✓
LVD	2014/35/EU(L96/357)	✓	✓
EMC	2014/30/EU(L96/79)	✓	✓
RoHS	2011/65EU(L174/88)	✓	✓

The following standards are complied with:

	VLO-M2	VLO-M2_ex
EN 61010-1: 2010	✓	✓
EN IEC 60079-0: 2018		✓
EN 60079-11: 2012		✓
EN 61326-1: 2013	✓	✓
EN 61326-2-3: 2013	✓	✓
EN 50581: 2012	✓	✓



Legal restrictions

Fields of industry For legal reasons, the sensor may not be used in the following industries in the USA:

- Military (any applications in the military field whatsoever, including airplanes, vehicles or military structures. This does not include fuel delivery and fuel dispensing when refuelling on the ground)
- Aerospace (applications in flying objects of any kind. Excluded from this is fuel delivery and fuel dispensing when refuelling on the ground)
- Fuel cells (use in stationary or mobile fuel cells)
- Medical devices (objects or substances used for medical purposes for human beings - the pharmaceutical industry is not affected)

Modbus

Default settings:

Baud rate	19200 BAUD
Data bits	8
Parity	Even
Byte order	1-0-3-2
Stop bits	1 bit
Modbus address	247
FlowControl	None (0)
Transmission type	Modbus RTU (protocol)
Temperature unit	°C
Pressure unit	bar abs
Pressure Value	1.01325 [bar]
Density unit	kg/m ³
Dynamic viscosity unit	mPa s
Kinematic viscosity unit	mm ² /s

The following Modbus RTU functions are supported:

Code	Name	Description
0x03	Read Holding Registers	Read a consecutive holding register block

0x04	Read Input Registers	Read one or more successive registers
0x06	Write Single Register	Write one single register
0x10	Write Multiple Registers	Write multiple successive registers

NOTICE

The following Modbus RTU functions are not supported

- ▶ 0x02 Read Discrete Inputs
- ▶ 0x07 Read Exception Status
- ▶ 0x08 Diagnostics
- ▶ 0x0B Get Comm Event Counter
- ▶ 0x0C Get Comm Event Log

When addressing the devices, it is essential to ensure that there are not two devices with the same address. In such a case an abnormal behaviour of the whole serial bus can occur, because the master is then no longer able to communicate with all existing slaves on the bus.

Compared to the "Modbus over serial line V1.02" protocol, the following differences exist:

- ▶ 3.6 Cables - The cable strands are not twisted together.
- ▶ 3.7 Visual Diagnostics - There is no LED display on the sensor.
- ▶ "Line Polarisation" is not necessary for the sensor and is not provided.

Min. 32 sensors (non-ex) are supported in the bus system.



Modbus Register Information

Info

The following access code must be written into register 2176 (parameter: enter access code) to enable the maintenance access: 8646 (UINT16).

Name	Address	Data type	Selection/input	Operator	Maintenance
PIN (Product identification number)	110 ...117	STRING16		r	r
Serial number	101 ...107	STRING14		r	r
Firmware version	7276 ...7279	STRING8		r	r
Build number	109	UINT16		r	r
Device name	7262 ...7269	STRING16		r	r
Device tag	4900 ...4907	STRING16		r	r
Access level	2177	UINT16	0: Operator 1: Maintenance 2: Service (only TrueDyne)	r	r
Startup counter	118 ...119	UINT32		r	r

SW option	2794	UINT16	0: Density 1: Viscosity 2: Concentration & density 3: Concentration & viscosity 4: Viscosity compensated density 5: Concentration & viscosity compensated density	r	r
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Config

Modbus

Name	Address	Data type	Selection/input	Operator	Maintenance
Modbus address	4909	UINT16	1 ...247	r	r/w
Baud rate	4911	UINT16	3: 9600 4: 19200 5: 38400 6: 57600 7: 115200	r	r/w
Parity	4913	UINT16	0: None / 2 stop bits 1: Even / 1 stop bit 2: Odd / 1 stop bit 3: None / 1 stop bit	r	r/w

r = read / w = write / Modbus registers refer to the start value 0



Byte order	4914	UINT16	0: 0-1-2-3 1: 3-2-1-0 2: 2-3-0-1 3: 1-0-3-2	r	r/w
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Device

Name	Address	Data type	Selection/input	Operator	Maintenance
Restart Device	6816	UINT16	0: False 1: True	r/w	r/w
Device Tag	4900 ...4907	STRING16	Freely selectable	r	r/w
Enter Access code	2176	UINT16	0...65535 For maintenance 8646	r/w	r/w
Set access level	2179	UINT16	0: Operator 1: Maintenance 2: Service (TrueDyne only)	r	r/w
Reset Device	201	UINT16	0: Off 1: Reset to SW-defaults	r	r/w

Sensor

Name	Address	Data type	Selection/input	Operator	Maintenance
Pressure compensation mode	5183	UINT16	0: Off (internal pressure = 1.01325 bar) 1: Fixed Value 2: External Value	r	r/w

Fixed pressure value	5184 ...5185	FLOAT32	r	r/w
External pressure value	2439 ...2440	FLOAT32	r	r/w

NOTICE

- For pressure compensation, the pressure can be written as a fixed parameter. By default, the pressure value is 1.01325 bar abs.
- The viscosity sensor does not include a pressure sensor. However, it is possible to write the externally measured pressure into the viscosity sensor (see special documentation for gas measurement).
- For frequent writing of the pressure value, please set the "Pressure compensation mode" to "External value" and use the "External pressure value" parameter. This value is not stored in the EEPROM. Frequent writing of the "Fixed pressure value" parameter can lead to a memory violation in the EEPROM.

Pressure unit	2129	UINT16	0: bar abs 1: bar gauge 2: psi abs 3: psi gauge 4: kPa abs 5: kPa gauge	r	r/w
Density unit	2106	UINT16	0: g/cm ³ 1: g/cc 2: kg/l 3: kg/m ³ 4: lb/ft ³ 5: lb/gal 6: SG liquid 7: SG gas	r	r/w

NOTICE

- Specific gravity (SG liquid) is calculated with the current temperature (T) in relation to water, SG Gas in relation to air.

$$SG = \frac{\rho_{\text{medium}}(T)}{\rho_{\text{water}}(T)} \quad SG = \frac{\rho(T)}{\rho_{\text{air}}(T)}$$

r = read / w = write / Modbus registers refer to the start value 0



Temperature unit	2108	UINT16	0: °C 1: K 2: °F 3: °R	r	r/w
Dynamic viscosity unit	2110	UINT16	0: cP 1: P 2: Pa s 3: mPa s	r	r/w
Kinematic viscosity unit	2111	UINT16	0: m²/s 1: mm²/s 2: cSt 3: St	r	r/w
Enter density single point	205 ...206	FLOAT32	enter density of the known media to perform a single point adjustment	r	r/w
¹Set density single point adjustment (using a predefined media)	2510	UINT16	0: Off 1: Water 2: Air 3: Hydrogen 4: Nitrogen 5: Methane 6: CO ₂ 7: Argon	r	r/w
Enter density offset	5528 ...5529	FLOAT32	manually enter density offset	r	r/w
Reset density offset	207	UINT16	0: Off 1: Reset	r	r/w
Enter viscosity single point	208 ...209	FLOAT32	enter viscosity of the known media to perform a single point adjustment	r	r/w

Set viscosity single point adjustment (using a predefined media)	2511	UINT16	0: Off 1: Water 2: Ethanol 3: Isopropanol	r	r/w
Enter viscosity offset	5530 ...5531	FLOAT32	manually enter viscosity offset	r	r/w
Reset viscosity offset	210	UINT16	0: Off 1: Reset	r	r/w

MinMaxValues

Name	Address	Data type	Selection/input	Operator	Maintenance
Density min	2600 ...2601	FLOAT32		r	r/w
Density max	2604 ...2605	FLOAT32		r	r/w
Temperature min	2608 ...2609	FLOAT32		r	r/w
Temperature max	2612 ...2613	FLOAT32		r	r/w
Pressure min	2616 ...2617	FLOAT32		r	r/w
Pressure max	2620 ...2621	FLOAT32		r	r/w
Concentration min	2624 ...2625	FLOAT32		r	r/w
Concentration max	2628 ...2629	FLOAT32		r	r/w

r = read / w = write / Modbus registers refer to the start value 0



Viscosity min	2632 ...2633	FLOAT32	r	r/w
Viscosity max	2636 ...2637	FLOAT32	r	r/w

NOTICE

- ¹For balancing with gases: see special documentation for gases.

Concentration

Name	Address	Data type	Selection/input	Operator	Maintenance
² Concentration model liquid For gas concentration models, see "Special documentation density sensor DLO-M2 DLO-M2_ex for gases".	26491	UINT16	0: Off 1: User coeffs 2: Fructose in water 3: Glucose in water 4: Sucrose in water 5: Invert sugar in water 6: Hydrogen peroxide in water 7: Ethanol in water (OIML) 8: Methanol in water 9: Ethyleneglycol in water 10: HFCS42 11: HFCS55 12: HFCS90 13: Sodium chloride in water 14: Total dissolved solids in water 15: Butane in Propane	r	r/w

² Concentration unit	2438 ...2588	UINT16	0: reserved 1: °Brix 2: °Balling 3: reserved 4: reserved 5: %Vol@20°C 6: °Plato 7: reserved 8: %ABV@20°C 9: %mass 10: mg/l 11: reserved 12: User conc. 13: %mol 14: mol/l@20°C	r	r/w
² Custom concentration model name	2584 ...2588	STRING10	Description of the customised concentration model.	r	r/w

NOTICE

- ²Desired liquid and gas types must be specified when ordering.
- Customer-specific concentration models can be parameterised by TrueDyne on request.

r = read / w = write / Modbus registers refer to the start value 0



Process Variable

Name	Address	Data type	Selection/input	Operator	Maintenance
Density	2012 ...2013	FLOAT32		r	r
Viscosity compensated density	2030 ...2031	FLOAT32		r	r
Temperature	2016 ...2017	FLOAT32		r	r
Pressure	2088 ...2089	FLOAT32		r	r
Dynamic viscosity	2018 ...2019	FLOAT32		r	r
Kinematic viscosity	2082 ...2083	FLOAT32		r	r
Concentration	2597 ...2598	FLOAT32		r	r

Status

Name	Address	Data type	Selection/input	Operator	Maintenance
³ Density in range	12	UINT16	0: False 1: True	r	r
^{3,4} Viscosity in range	17	UINT16	0: False 1: True	r	r
³ Temperature in range	14	UINT16	0: False 1: True	r	r
³ Pressure in range	15	UINT16	0: False 1: True	r	r
³ Concentration in range	16	UINT16	0: False 1: True	r	r
⁴ Sensor state ready	13	UINT16	0: False 1: True	r	r
⁵ Internal memory functional	18	UINT16	0: False 1: True	r	r

NOTICE

- ▶ ³The check is carried out according to the 'Min' and 'Max' values defined in the parameters (see p. 15-16).
- ▶ ⁴The status of the sensor is checked internally on an ongoing basis. In normal operation, "Sensor state ready" 1 (true) is output. If the properties of the sensor are outside a defined range, e.g. in the event of faults caused by air bubbles in the sensor, this parameter is set to 0 (false).
- ▶ ⁵If there are repeated write errors to the internal memory (EEPROM), this parameter is set to 0 (false).

r = read / w = write / Modbus registers refer to the start value 0



Download area

On our website www.truedyne.com you will find this document and other useful documents in our download area.

Documents and files

Product information

- Data sheet
- Safety notes
- STEP file
- Special documentation density sensor DLO-M2 | DLO-M2_ex for gases
- Calibration certificate (optional)

Declarations of conformity

- CE marking EU declaration of conformity
- RoHS III EU declaration of conformity

Training courses

- Basics of density measurement training



https://www.truedyne.com/vlo-m2_ex_download_en



https://www.truedyne.com/vlo-m2_download_en



Website

Are you looking for more innovative sensors for density and viscosity? Visit our website www.truedyne.com and learn more about our current product portfolio.

Product portfolio

Sensors for measuring fluids

For example:

- DLO-M2 density sensor
- VLO-M2 viscosity and density sensor
- FLT-M1 flow sensor

Sensors for measuring gases

- DGF-I1 density sensor
- Nanomass density sensor



- www.truedyne.com

