Data sheet Suction set as accessory for neoxid group sensors, article no.: 200479

Product description:

With the suction set, gas can be safely extracted at approx. 400 ml/min and sensors from the neoxid group's NEO9XX series can be supplied.

Properties:

- Simple extraction of gas (and measurement of the volume concentration using a separate gas sensor from the NEO9XX series)

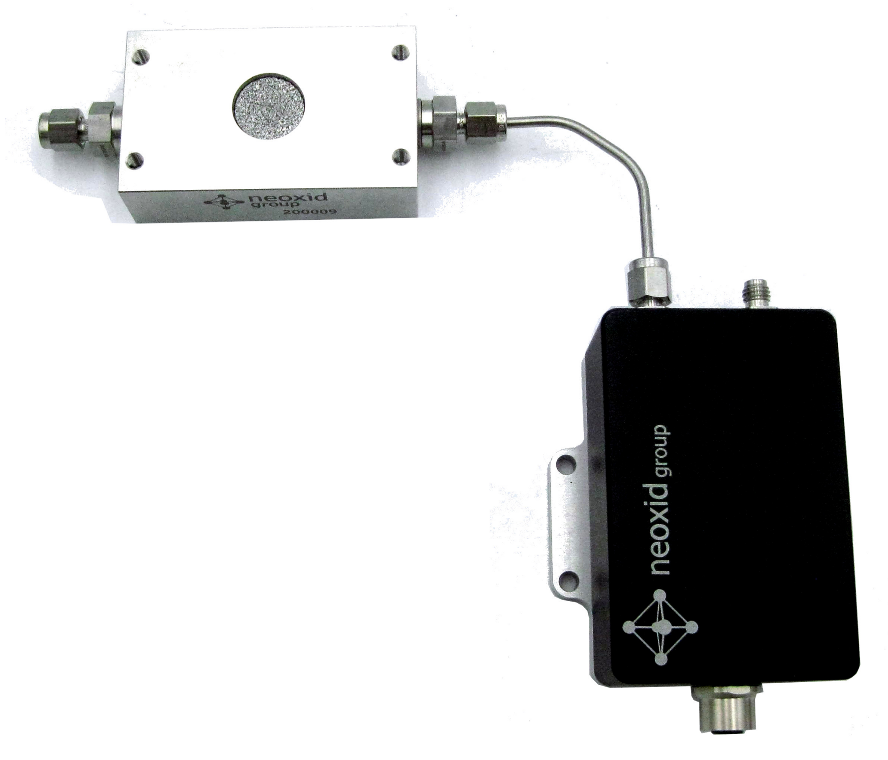


Figure 1: Suction set

Sensor system characteristics:

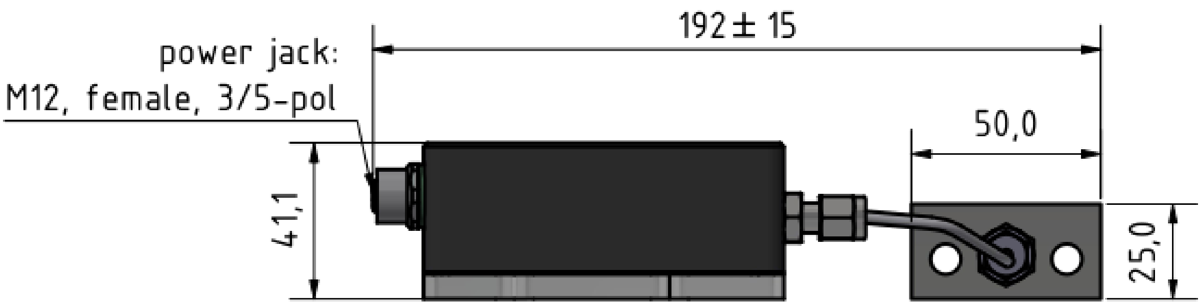
Supply voltage:	12 V DC
Energy consumption:	< 1,5 W
Start time:	< 3 s
Ambient temperature:	0 - 50°C
Print area:	Environment
Humidity:	0 - 100 % r.h. (non-condensing)
Size:	241 x 192 x 41 mm³
Weight:	750+ 360 g
Volume flow:	350 - 400 ml/min (air, N2)
Service life of the pump:	10.000h
Materials in contact with gas:	Stainless steel 316/316L, EPDM, PPS, silicone
SIL:	-
ATEX:	-
RoHS compliant:	Yes
Customs tariff number:	90271010
COO:	Germany

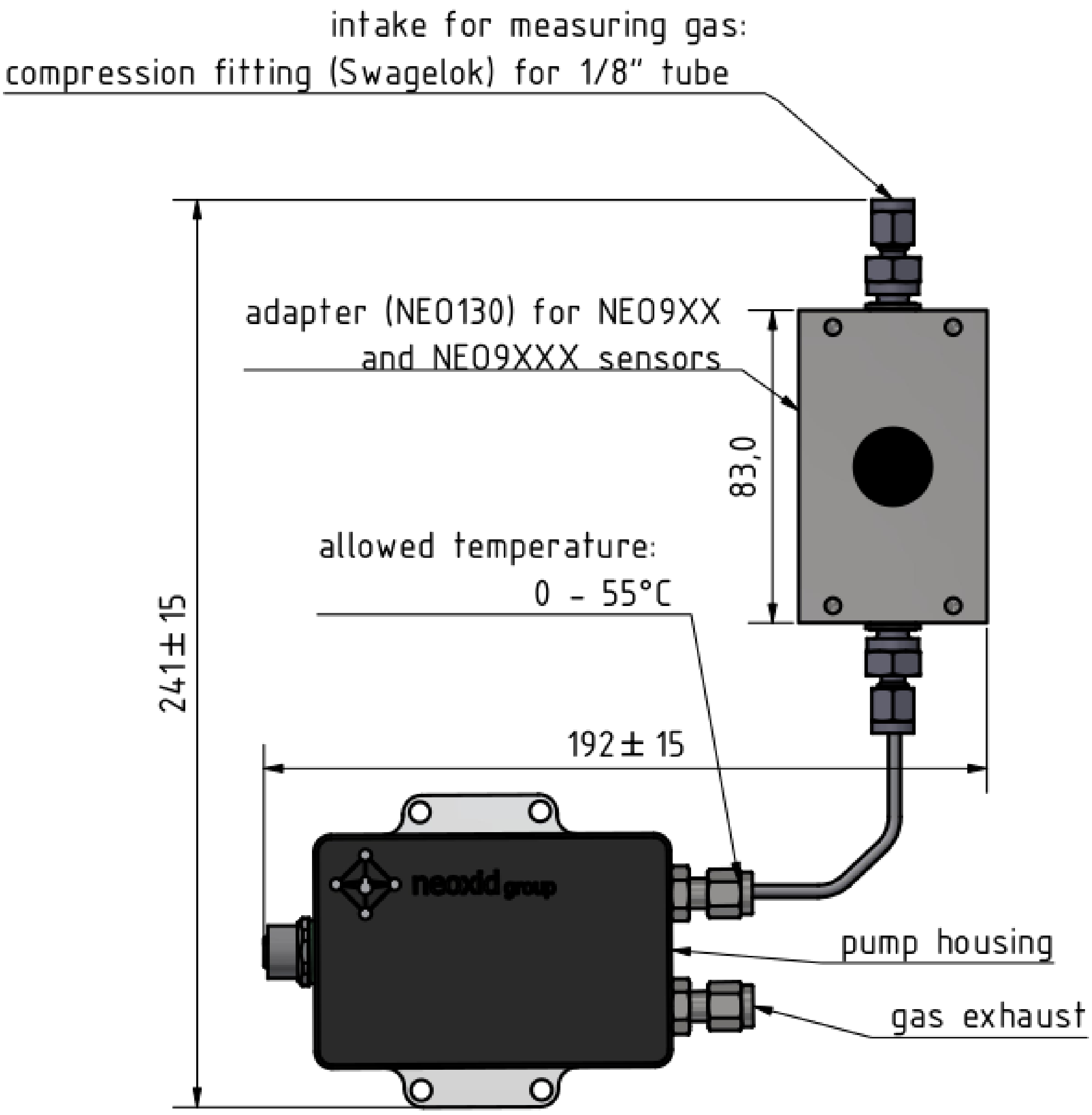
Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-Absaugset-V01_DE_EN.pdf

It contains further information on the extraction set and on initial commissioning.

Technical drawing:





Data sheet hydrogen concentration sensor NEO1002 especially for battery monitoring Version 15.6

Product description:

Sensor system for measuring the hydrogen concentration in air with temperature-compensated signal evaluation for monitoring batteries (battery monitoring sensor). Applicable in the range: 0.6 - 2 bara, 0 - 90% r.h. (non-condensing) and -40°C - 85°C. A mathematical prediction algorithm ensures very short on and off times.

Properties:

- Measurements in the range of 0-2 vol.-% H_2(½ LEL)
- Carrier gases Air
- Measuring signal independent of ambient temperature and pressure
- Detection of thermal runaway, pressure increase and reducing gases in a battery/rechargeable battery
- Successor to NEO966
- Signal output via CAN 2.0A or CAN 2.0B
- Factory calibrated and ready for immediate use
- CAN wake-up function when a certain H_2concentration is detected
- Encrypted CAN communication on demand

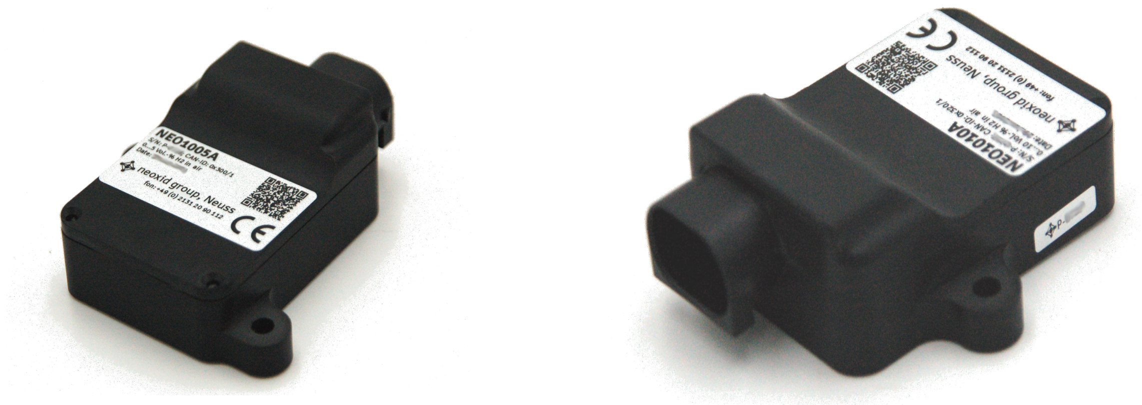


Figure 1a: H_2sensor system NEO1002 series

*...go to English version*

Sensor system characteristics:

Supply voltage: 9 - 30V DC

Energy consumption: < 2,4 W

Possible H_2sensitivity: 0 - 2 % by volume H_2

Accuracy: ± 0.2 % by volume H_2

Detection limit: < 0.2 % by volume H_2

Response time t_{90}: < 3 s

Decay time t_{10}: < 3 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[1]

Media temperature: - 40°C - 85°C

Ambient temperature: - 40°C - 85°C

Pressure range: 0.6 - 2 bar absolute

Air humidity: 0 - 90 % r.h. (non-condensing)

Carrier gas: Air

CAN signal: CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on page 13

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm

Housing: Size: 84.9 x 75.6 x 30.7 mm³
Material: Polyamide 6, 10% glass fibres, 20% mineral

Leakage rate: 10^{-5}mbar l / s [2]

IP code: IP6K7

Weight: < 80 g

ASIL: -

ATEX: -

---

1 The system is designed for continuous operation
2 Measured with forming gas 90/10, 1.5 bar absolute, room temperature

Service life: IP6K7 enclosure qualified with an expected Service life of 5 years.[3] The system has been tested with 100,000 switch-on and switch-off cycles.

Long-term stability/drift: < 0.1 vol.-% in the first 5,000h operating time

Maintenance interval : We recommend checking the H_2sensor every 6 months. check.

Measuring behaviour: The gas to be tested may have a maximum have a maximum velocity of 25m/s. In addition, a laminar flow is recommended. If the specification differs specification, the sensor must be tested for tested for functionality.

Connection cable: 3 m enclosed; more detailed information on page 9

RoHS compliant: Yes https://neoxid-cloud.de/Konformitaetserklaerung-RoHS_DE_EN_V02_scan.pdf

Customs tariff number: 90271010

COO: Germany / NRW

EC-79/2009 Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

Accuracy of the measured values:[4]

Size	**Accuracy**
Hydrogen concentration	± 0.2 vol.-% H_2
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[5]	± 0,3 °C
Pressure	± 20 mbar

Table1 : Statistical errors for individual measured variables

3 Measuring components are purely inorganic and are not consumed during measurement

4 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar

5 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber

Assembly:
The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO1XXX-Spritzguss.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing film of water. We recommend mounting the sensor system as shown in Figure 1a. If the sensor is mounted in a different spatial direction, there will be a small offset, which must be corrected via a specific CAN message on ID 0x680[6] . The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 2.3 Nm.

Hole pattern:

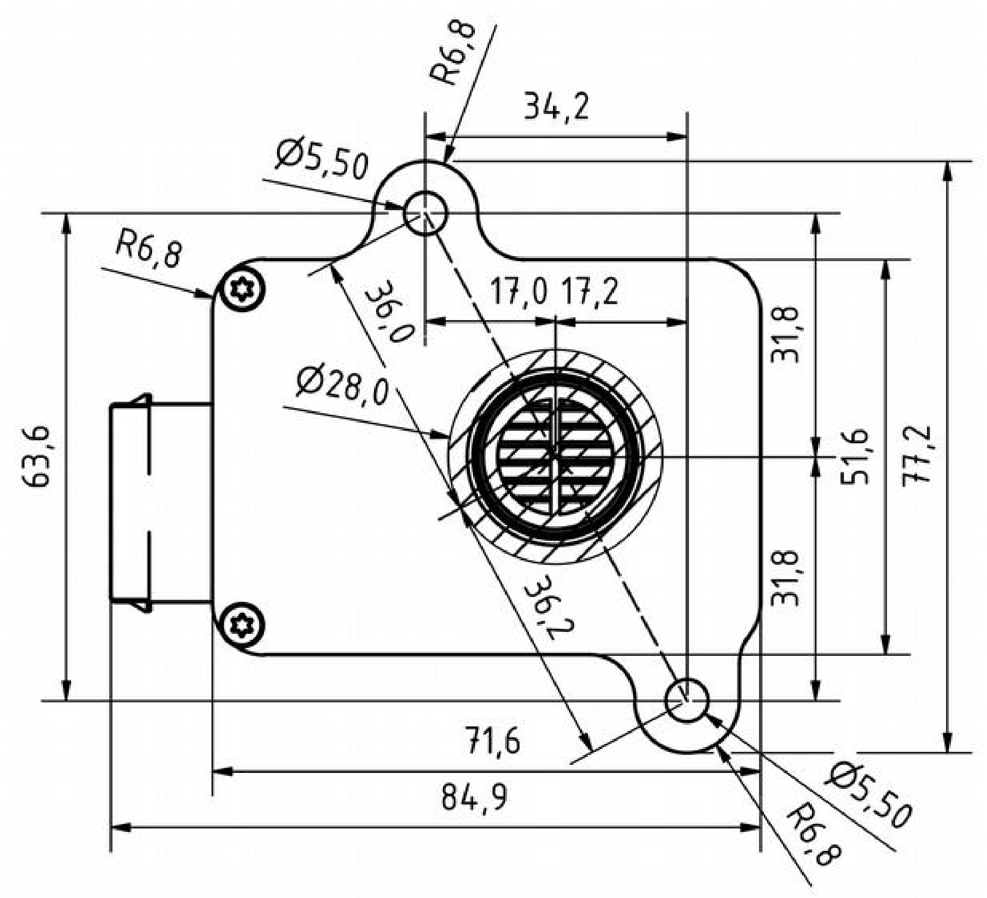


Figure 3a: Hole pattern of the H_2sensor system from below

6 See CAN Matrix Message Layout

Drilling template:

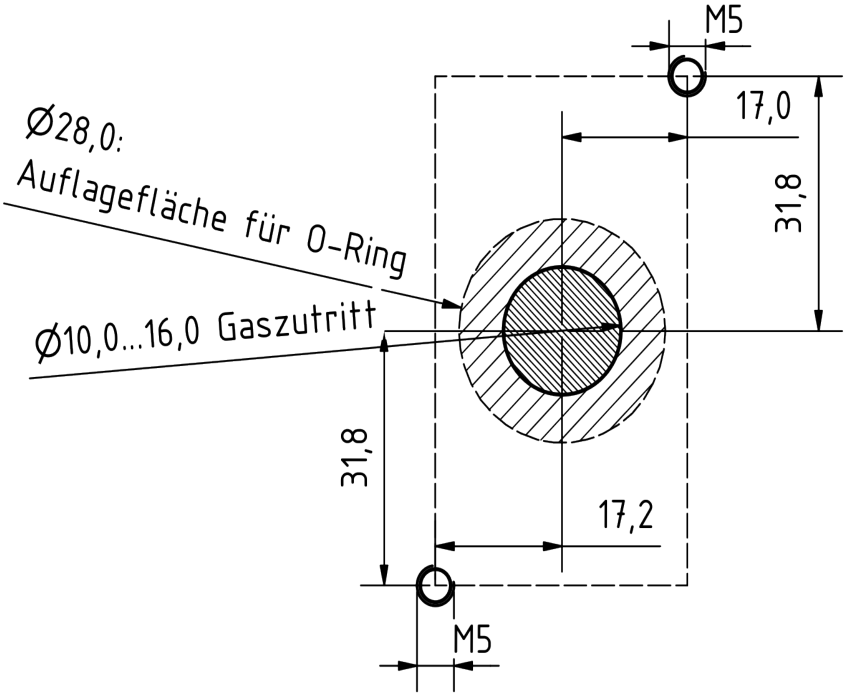
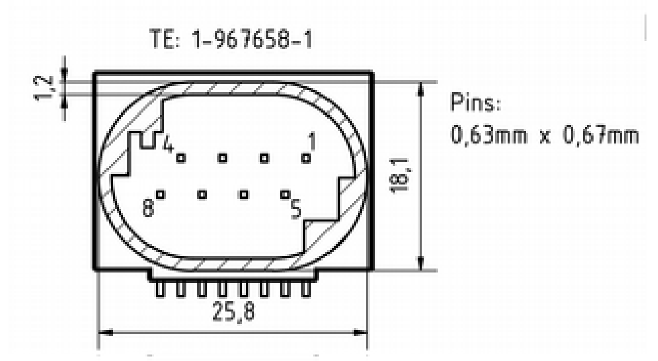


Figure 3b: Drilling template

	**PIN Assignment** Pin 1: 9...+30V DC (min.: 2.4W) Pin 2: 0V DC (GND) Pin 3: CAN-High Pin 4: CAN-Low Pin 5: Termination 1a* Pin 6: Termination 1b* Pin 7: Termination 2a* Pin 8: Termination 2b* *) connect termination a and b
8-pole housing socket: TE Connectivity MQS 1-967658-1	

Electrical PIN assignment

PIN no.	Description of the	Colour
1	VCC+ 9 ...+30V DC (min.: 2.4W)	white
2	GND 0V DC	brown
3	CAN-High	yellow
4	CAN-Low	green
5	Scheduling 1a*	pink
6	Scheduling 1b*	grey
7	Scheduling 2a*	red
8	Scheduling 2b*	blue

Information on hydrogen ignition by the NEO1002 from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

A heating element is used in the H_2sensor, which is heated with 5V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the sensor (a Zener diode prevents operating voltages > 15 V). At 32 V, the heating element burnt out and still did not cause the explosive stoichiometric gas mixture to explode. In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavern. The sample gas must diffuse through a membrane.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

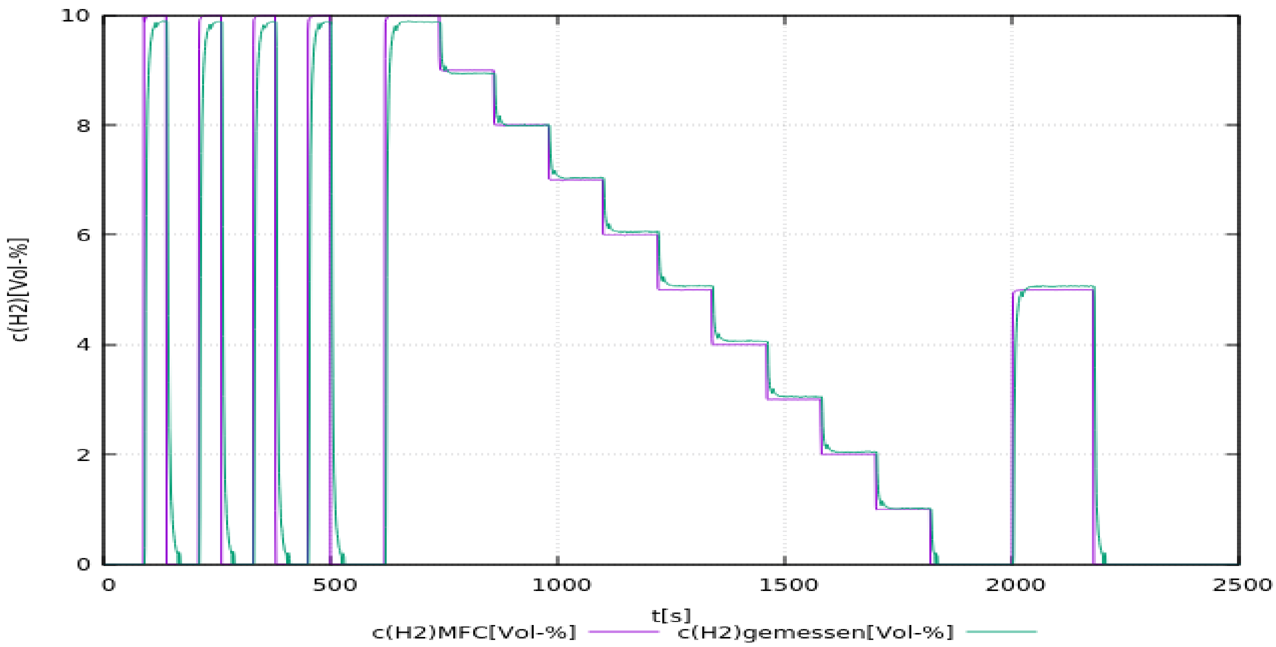


Figure 4: Test of a NEO1010 sensor system up to 10 vol.-% H_2in 13 vol.-% O_2. Measured with a total flow of 2,000 sccm.

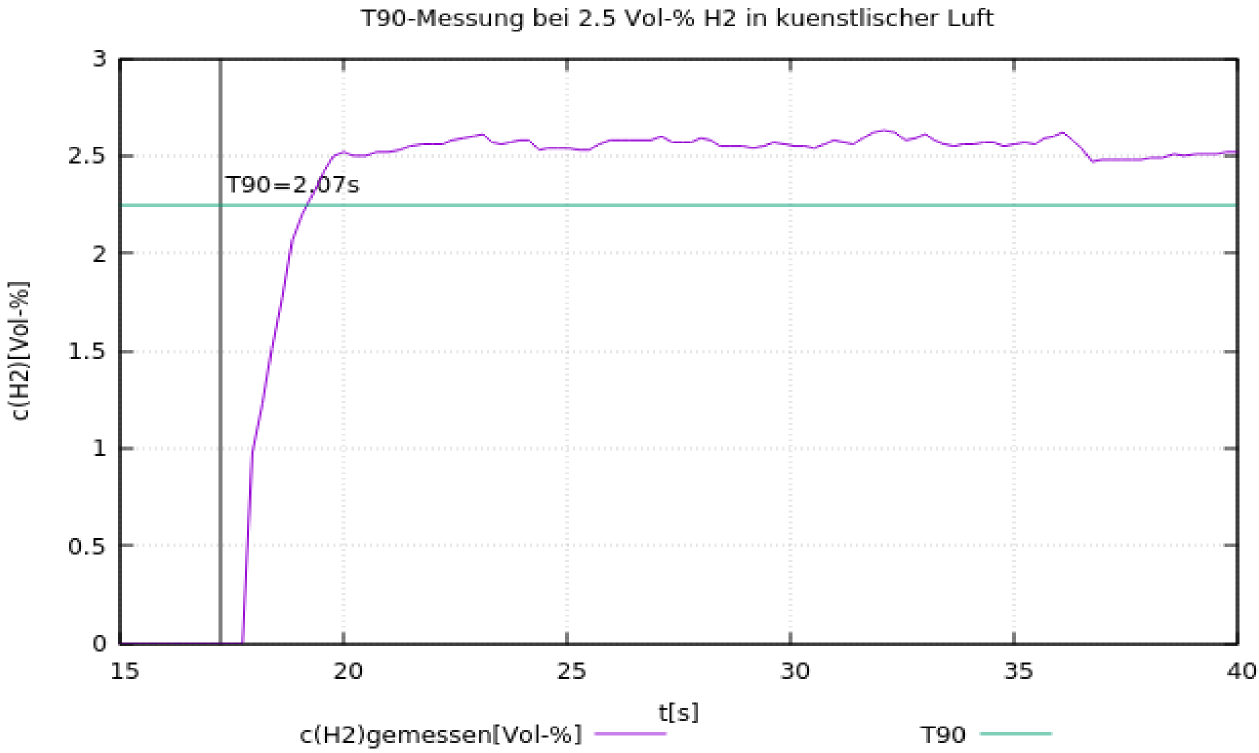


Figure 5: t_{90}time determination with a NEO1002 sensor system by switching from 0 vol.-% $H_2$to 2.5 vol.-% H_2. Measured with a total flow of 4,000 sccm.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. The sensor can be terminated externally via connection pins 5-8.
The first CAN message is delivered 5s after system start. It is possible for the sensor to send a predefined message on a desired ID at a certain hydrogen concentration (CAN wake-up). This could be used to wake up other devices in the network from sleep mode.

The CAN IDs of the sensor are as follows:

	CAN ID
NEO1002A (0-2 vol.-% H_2)	0x300 & 0x301

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to perform a zero point adjustment.
must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [7]

The sensor returns the following response after a successful zero point adjustment:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[8]
*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To change the ID on which the NEO1XXXA transmits, a CAN message can be sent:
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.

CAN2.0B - Series A

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. The sensor can be terminated externally via connection pins 5-8. CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message is delivered after 5s at system start.

The CAN IDs of the sensor are as follows:

7 Details can be found in the operating instructions under chapter: "Maintenance and service"
8 0xYY describes a measure for the set zero point adjustment

	CAN ID
NEO1002A (0-2 vol.-% H_2)	0x0CFF0C59 & 0x0CFF0D59

Set CAN ID (CAN2.0B):
To change the ID on which the NEO1XXXA transmits, a CAN message can be sent:
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.

Zero point adjustment (CAN2.0B) :
A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make an adjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [9]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[10]
*corresponds to the serial number of the individual sensor system.

9 Details can be found in the operating instructions under chapter: "Maintenance and service"

10 0xYY describes a measure for the set zero point adjustment

CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured hydrogen concentration exceeds the 0.5 % by volume limit (c(H_2) from <0.5 % by volume to >= 0.5 % by volume).

The following message is sent:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(*H_2*) = *(Msg0-20)/100*
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with the defined carrier gas, without humidity, normal pressure and in the absence of H_2, the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):

The corresponding DBC file is available at the following link:
https://neoxid-cloud.de/H2-Sensor_NEO1XXX_V146.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration [Vol.-%]: c(H_2) = (Msg0-20)/100
Msg 1(Bit 16-31): Water concentration [Vol.-%]: c($H_{(2)}O$) = (Msg1-20)/100
Msg 2(bit 32-47): Pressure [mbar]: *p = Msg2*
Msg 3(Bit 48-55): Temperature [°C]: *T = (Msg3-60)*
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0D59:
Msg 0(Bit 0-15): Hydrogen concentration_RAW[Vol.-%]: c(*H_2*) = *(Msg0-20)/100*
Measurement of hydrogen concentration, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with the defined carrier gas, without humidity, normal pressure and in the absence of H_2, the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait
Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

Example:
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Set the baud rate to 500 kbit/s or 250 kbit/s:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H2 in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Initiate maintenance:
0x680 0x00 0x77 0x61 0x72 0x74 0x75 0x6E 0x67

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapters and heaters:
Various adapters are available for mounting the sensor. For use in very humid environments or environments with liquid water or the risk of icing, there are heating cartridges that can be operated at a constant voltage. These can be fitted in the adapters. You can find the corresponding products under:
https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for the fine purification of gases by removing minimal impurities.

Data sheet NEO10XXX-CH_4

Version 15.6

Product description:

Sensor system for measuring the methane concentration and the hydrogen concentration in air, natural gas, nitrogen or oxygen-depleted air with temperature-compensated signal evaluation.

Properties:

- 0-100 vol.-% H_2
- 0-100 vol.-% CH_4
- Carrier gases air, N_2, O_2, natural gas, oxygen depleted air possible
- Measuring signal independent of temperature
- Signal output via CAN 2.0, Modbus RTU via RS485, 0-10V or 4-20mA
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Factory calibrated and ready for immediate use
- Encrypted CAN communication on demand

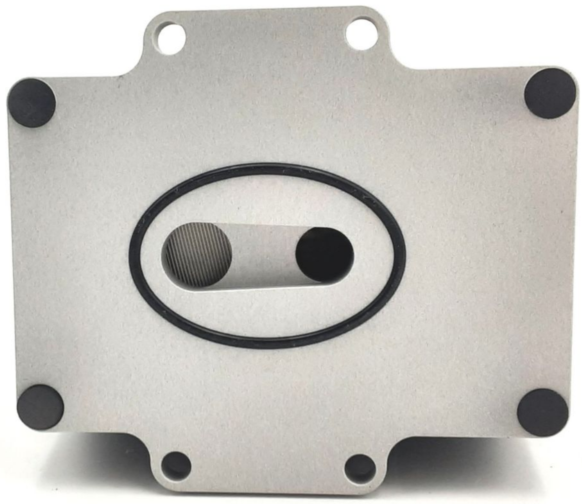


Figure 1: H2 concentration sensor version NEO10XXX-CH4

Sensor system characteristics:

Supply voltage: 12 - 32 V DC

Energy consumption: < 3 W

H_2sensitivity: 0 - 100 vol.-% H_2

H_2-accuracy: ± 2 vol.-% H_2

H_2detection limit: < 0.5 vol.-% H_2

CH_4sensitivity: 0 - 100 vol.-% CH_4

CH_4accuracy: ± 1 vol.-% CH_4

CH_4detection limit: < 0.3 vol.-% CH_4

Response time t_{90}: < 30 s

Decay time t_{10}: < 30 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[11]

Media temperature: - 40°C - 70°C

Ambient temperature: - 40°C - 70°C

Pressure range: atm ± 50mbar

Carrier gas: Natural gas, air, N_2, oxygen-depleted air

Cross-sensitivities: Helium, tbd

Signal :[12] CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on page25
Modbus RTU via RS485 interface on page 29
4-20 mA on page 28
0-10 V on page 28

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm for CAN bus and Modbus RTU
250 ppm at 4-20 mA or 0-10V

11 The system is designed for continuous operation
12 Signals are described in the "Explanation of signals" section

Housing: Size: 95 x 83 x 74 mm³, alloy EN AW 6060, Tighten M5 screws to the measuring chamber with 3Nm

Leakage rate: 10^{-5}mbar l / s [13]

IP code: IP6K7

Weight: < 700 g

SIL: -

ATEX: -

Service life: IP6K7 enclosure qualified with an expected Service life of 5 years .[14]

Measuring behaviour: The gas to be tested may have a maximum have a maximum velocity of 25m/s. In addition, a laminar flow is recommended. If the specification differs specification, the sensor must be tested for tested for functionality.

Connection cable: 3 m enclosed

RoHS compliant: Yes

Customs tariff number: 90271010

COO: Germany / NRW

13 Measured with forming gas 90/10, 1.5 bar absolute, room temperature

14 Measuring components are purely inorganic and are not consumed during measurement

Mounting the sensor:

The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO101XX-drawings-2D-CAD.zip

It is recommended to mount the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request. To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a room direction other than horizontal, a small offset occurs; this must be corrected via a specific CAN message on ID 0x680 (zero point adjustment, see page14).

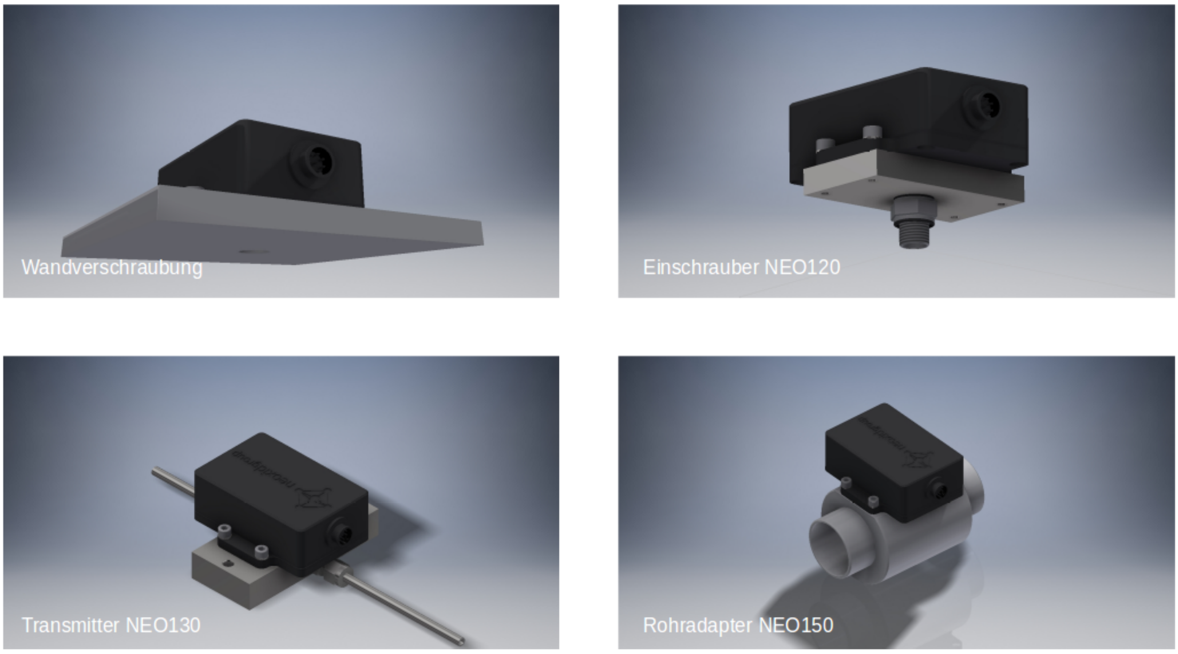


Figure 2a: Mounting the H_2sensor system

Drilling template:

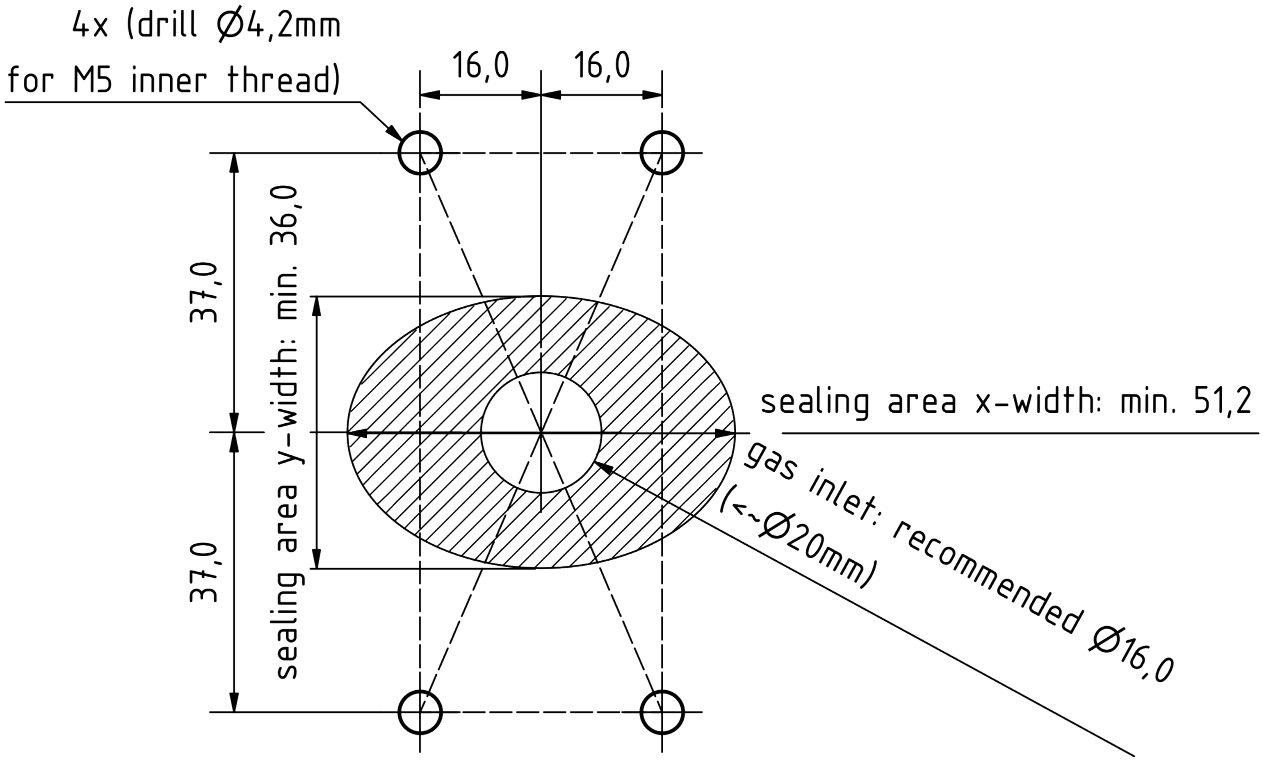
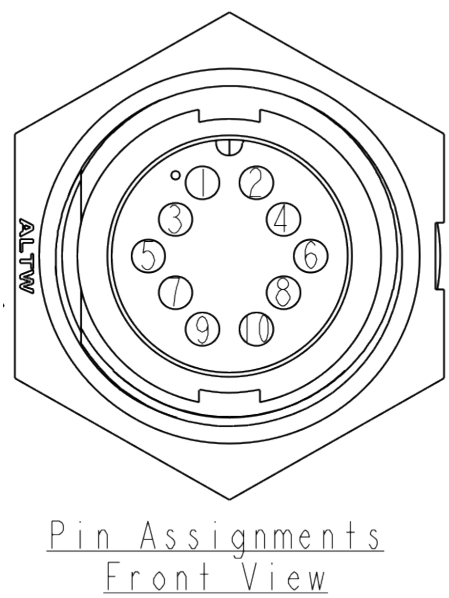


Figure 3b: Drilling template

Electrical PIN assignment

	**PIN assignment** Pin 1: 12...+32V DC (< 3W) Pin 2: 0V DC (GND) Pin 3: CAN-High Pin 4: CAN-Low Pin 5: (service port A)* Pin 6: (service port B)* Pin 7: DAC + / RS485 B Pin 8: DAC - / RS485 A Pin 9: nc Pin 10: nc *) not intended for customer use

Simultaneous signal output via CAN bus and an analogue interface

If required, the sensor's measurement data can be output simultaneously via the CAN bus interface and an analogue interface (4-20 mA, 0-10V). If an analogue interface (4-20 mA, 0-10V) is selected in addition to the CAN bus, the analogue signal is output via PIN 7 & 8. CAN addressing via the connector is then no longer possible!

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment. must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [15]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[16]

***corresponds to the serial number of the individual sensor system.**

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):

1st CAN message e.g. 0x340 or 0x0CFF1C59:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = *(Msg0-20)/100*
Msg 1(bit 16-31): Methane concentration *[vol.-%]: c*(CH_4) = *(Msg1-20)/100*
Msg 2(bit 32-47): Pressure [mbar]: *p = Msg2*
Msg 3(Bit 48-55): Temperature [°C]: *T = (Msg3-60)*
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO

2nd CAN message, e.g. CAN ID 0x341 or 0x0CFF1D59:
Msg 0(bit 0-15): Hydrogen concentration_RAW[vol.-%]: c(H_2) = *(Msg0-20)/100*
Measurement of hydrogen concentration, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $H_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version
Msg 6(Bit 56-63): Continuous message counter

The CAN IDs of the sensor are as follows:

	CAN-ID 1	**CAN-ID 2**	**CAN-ID 3**	**CAN-ID 4**
NEO10XXX-CH_4 (0-100 vol.-% H_2)	0x340 & 0x341	0x348 & 0x349	0x350 & 0x351	0x358 & 0x359

15 Details can be found in the operating instructions under chapter: "Maintenance and service"
16 0xYY describes a measure for the set zero point adjustment

Set CAN ID (CAN2.0A):
To set the CAN ID, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

CAN2.0B - Series A

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
First CAN message after 5s at system startup

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO10XXX-CH4 (0-100 vol.-% H_2)	0x0CFF1C59 & 0x0CFF1D59	0x0CFF1E59 & 0x0CFF1F59	0x0CFF2059 & 0x0CFF2159	0x0CFF2259 & 0x0CFF2359

Set CAN ID:
To set the CAN ID, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.

Zero point adjustment (CAN2.0B):
A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make an adjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [17]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[18]
*corresponds to the serial number of the individual sensor system.

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait

17 Details can be found in the operating instructions under chapter: "Maintenance and service"
18 0xYY describes a measure for the set zero point adjustment

Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

Example:
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Set the baud rate to 500 kbit/s or 250 kbit/s:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2 in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Initiate maintenance:
0x680 0x00 0x77 0x61 0x72 0x74 0x75 0x6E 0x67

Further CAN commands (CAN2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

Analogue 4-20mA - Series I

I[mA]	c($H_{2)}$ [vol.-%]	Comment
4 - 20 mA	0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration. This means that 50 vol-% $H_{(2)}$,for example, is then output as 12 mA for a 100 vol-% H_2sensor system.

Only the hydrogen concentration can be output in the analogue output. It should be noted that the analogue output of the sensors is subject to an additional error of 2% FS. The maximum permissible load is 450 Ohm.

Analogue 0-10V - Series I

U[V]	c($H_{2)}$ [vol.-%]	Comment
0 - 10 V	0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration in a range from 1V to 9V. This means that 50 vol-% $H_{(2)}$,for example, is then output as 5V for a 100 vol-% H_2sensor system.

Only the hydrogen concentration can be output in the analogue output. It should be noted that the analogue output of the sensors is subject to an additional error of 2% FS. The minimum measuring resistance is 10 kOhm.

Digital Modbus via RS485 - Series M

RS485 (Modbus RTU) Factory settings:

Name	Description of the	Register number (hex / dec)	INPUT register address (hex / dec) *
Hydrogen concentration	Hydrogen concentration = x / 100 - 20 vol.-% (Example: 2750 = 7.50 vol.-%)	0x7531 / dec30001	0x00 / dec0
Methane concentration	CH_4= x / 100 - 20 vol.-% (Example: 2405 = 4.05 vol.-%)	0x7532 / dec30002	0x01 / dec1
Status	32: Sensor maintenance required 16: Hydrogen present 8: Sensor in heating phase +0: Sensor fully functional +2: A parameter outside the defined area +4: Error: Sensor defective +6: Error: Measuring time defective	0x7533 / dec30003	0x02 / dec2
Pressure	Pressure = x - 20 mbar (Example: 1033 = 1013 mbar)	0x7534 / dec30004	0x03 / dec3
Empty byte		0x7535 / dec30005	0x04 / dec4
Operating voltage	Operating voltage = (x - 20) / 1000 V (Example: 12020 = 12.00 V)	0x7536 / dec30006	0x05 / dec5
Message counter	Run-up counter	0x7537 / dec30007	0x06 / dec6
Temperature	Temperature = x / 100 - 40 °C (Example: 6250 = 22.5°C)	0x7538 / dec30008	0x07 / dec7
Empty byte		0x7539 / dec30009	0x08 / dec8
Hydrogen concentration-raw value	Hydrogen concentration = x / 100 - 20 vol.-% (Example: 2750 = 7.50 vol.-%)	0x753A / dec30010	0x09 / dec9
Gross value	Raw value = 100 in the absence of water and hydrogen and otherwise normal air.	0x753B / dec30011	0x0A / dec10

* The hydrogen concentration is in the first input register (dec0). Analogue inputs - input registers (16-bit value) are in the address range dec30001 to dec39999. This means that the hydrogen concentration is in register dec30001.

Holding register:
In serial master-slave communication, our NEO sensors function as slaves with the start slave ID 1 in the factory setting. The analogue outputs - holding register (16-bit value) are in the address range dec40001 to dec49999.

Baud rate: 9.600
Parity: none
Stop Bits: 1
CRC: 16bit

Name	**Description of the**	**Register number (hex / dec)**	**HOLDING register address (hex / dec) ***
Baud rate	Set the baud rate of the Modbus RTU interface: 4.800 9.600 19.200 default: 9,600 Changes to the baud rate are only accepted after the sensor is restarted	0x9C41 / dec40001	0x00 / dec0
Slave ID	Slave ID of the sensor 1-200 default: 1 Changes to the slave ID are only applied after the sensor is restarted	0x9C42 / dec40002	0x01 / dec1
Mode parity	0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2 default: 0 = Parity: none, Stop Bit: 1 Mode change is only applied after restarting the sensor	0x9C43 / dec40003	0x02 / dec2
Zero point adjustment	Default: 0 If a 1 is entered in the is written here, a Zero point adjustment performed and then open the register 2 amended.	0x9C44 / dec40004	0x03 / dec3

* The baud rate is in the first holding register (dec0). Analogue outputs - holding registers (16-bit value) are in the address range dec40001 to dec49999. This means that the hydrogen concentration is in register dec40001.

Information on the registers:

The registers are defined as unsigned 16-bit integers. So they have a range from 0 to 65535. When reading out with a PLC, make sure that the data type is set to "Real" so that the unsigned integer can also be displayed as a comma number.

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapters and heaters:
Various adapters are available for mounting the sensor. For use in very humid environments or environments with liquid water or the risk of icing, there are heating cartridges that can be operated at a constant voltage. These can be fitted in the adapters. You can find the corresponding products under:
https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for the fine purification of gases by removing minimal impurities.

Data sheet NEO22005-CO_2

Version 15.6

Product description:

Sensor system for measuring the carbon dioxide concentration and the hydrogen concentration in air, nitrogen or oxygen-depleted air with temperature-compensated signal evaluation.

Properties:

- 0-5 vol.-% H_2
- 0-5 vol.-% CO_2
- Carrier gases air, N_2, O_2, oxygen depleted air possible
- Measuring signal independent of temperature
- Signal output via CAN 2.0, Modbus RTU via RS485, 0-10V or 4-20mA
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Factory calibrated and ready for immediate use
- Encrypted CAN communication on demand

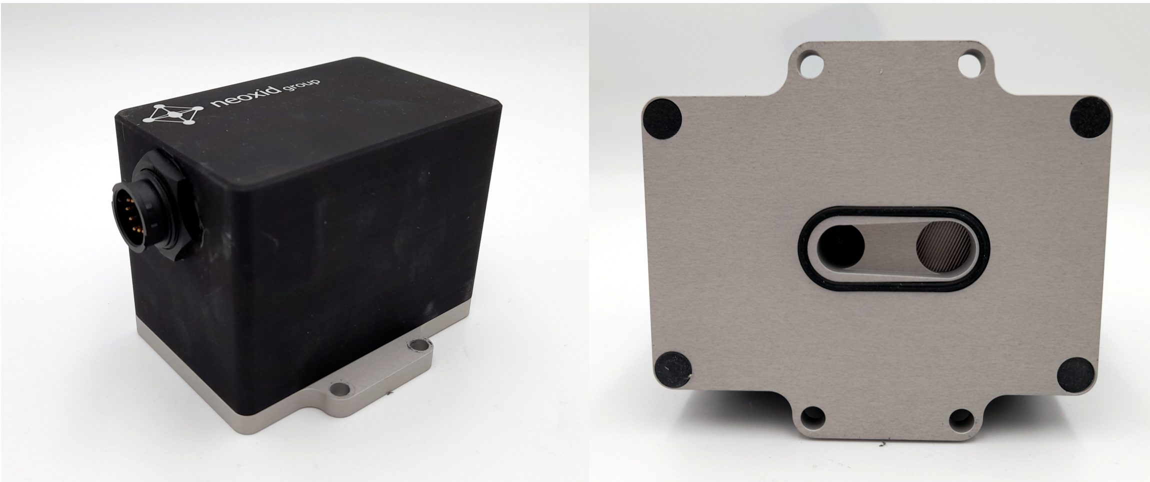


Figure 1: H_2concentration sensor version NEO22005-CO_2

Sensor system characteristics:

Supply voltage: 12 - 32 V DC

Energy consumption: < 3 W

H_2sensitivity: 0 - 5 vol.-% H_2

H_2accuracy: ± 0.3 vol.-% H_2

H_2detection limit: < 0.5 vol.-% H_2

CO_2sensitivity: 0 - 5 vol.-% CO_2

CO_2accuracy: ± 0.1 vol.-% CO_2

CO_2detection limit: < 0.1 vol.-% CO_2

Response time t_{90}: < 30 s

Decay time t_{10}: < 30 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[19]

Media temperature: - 40°C - 70°C

Ambient temperature: - 40°C - 70°C

Pressure range: atm ± 50mbar

Carrier gas: Air, N_2, oxygen depleted air

Cross-sensitivities: Helium, tbd

Signal :[20] CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on page25
Modbus RTU via RS485 interface on page 29
4-20 mA on page 28
0-10 V on page 28

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm for CAN bus and Modbus RTU
250 ppm at 4-20 mA or 0-10V

19 The system is designed for continuous operation
20 Signals are described in the "Explanation of signals" section

Housing:	Size: 95 x 83 x 74 mm³, alloy EN AW 6060, Tighten M5 screws to the measuring chamber with 3Nm
Leakage rate:	10^{-5}mbar l / s [21]
IP code:	IP6K7
Weight:	< 700 g
SIL:	-
ATEX:	-
Service life:	IP6K7 enclosure qualified with an expected Service life of 5 years .[22]
Measuring behaviour:	The gas to be tested may have a maximum have a maximum velocity of 25m/s. In
addition, a	laminar flow is recommended. If the
specification differs	specification, the sensor
must be tested for	tested for functionality.
Connection cable:	3 m enclosed
RoHS compliant:	Yes
Customs tariff number:	90271010
COO:	Germany / NRW

21 Measured with forming gas 90/10, 1.5 bar absolute, room temperature

22 Measuring components are purely inorganic and are not consumed during measurement

Mounting the sensor:

It is recommended to mount the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request. To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a room direction other than horizontal, a small offset occurs; this must be corrected via a specific CAN message on ID 0x680 (zero point adjustment, see page14).

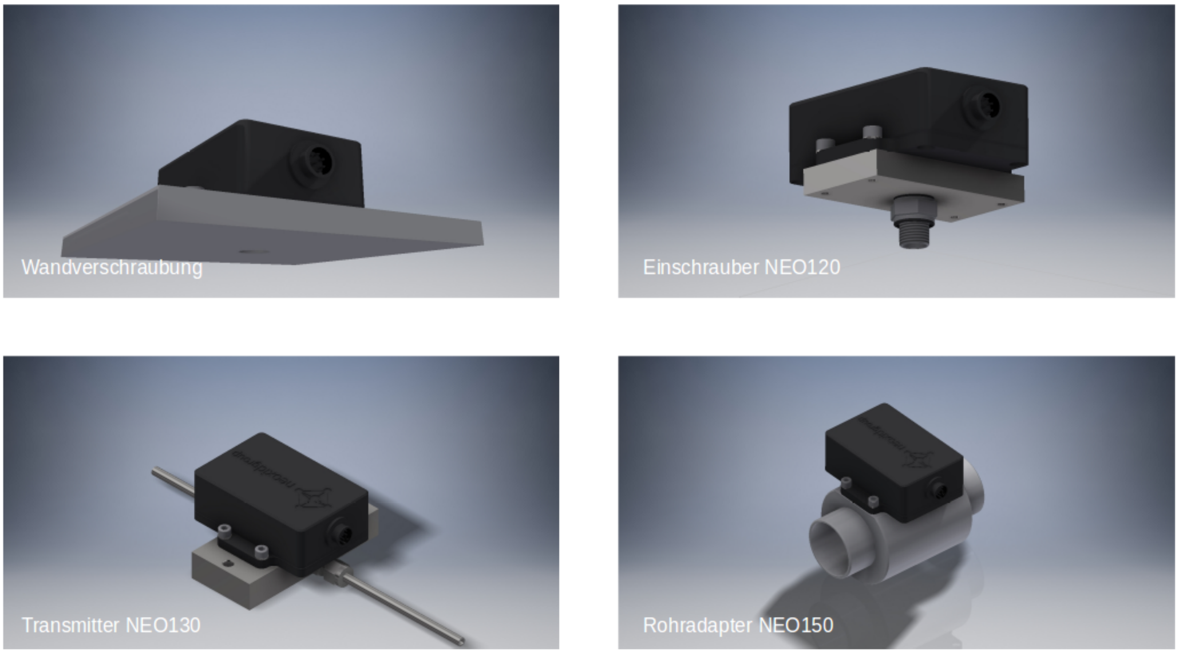


Figure 2a: Mounting the H_2sensor system

Drilling template:

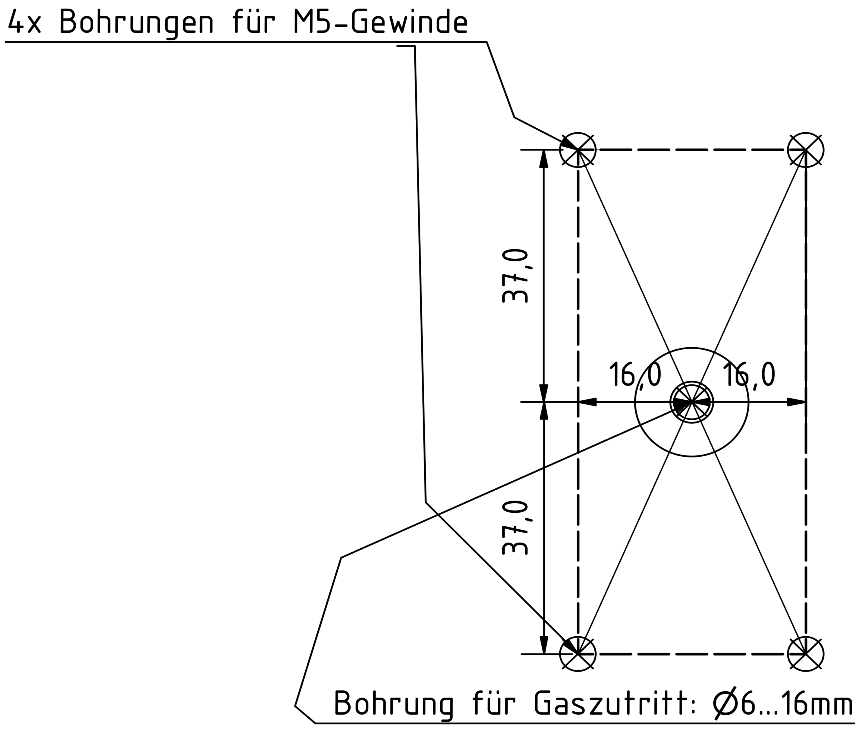
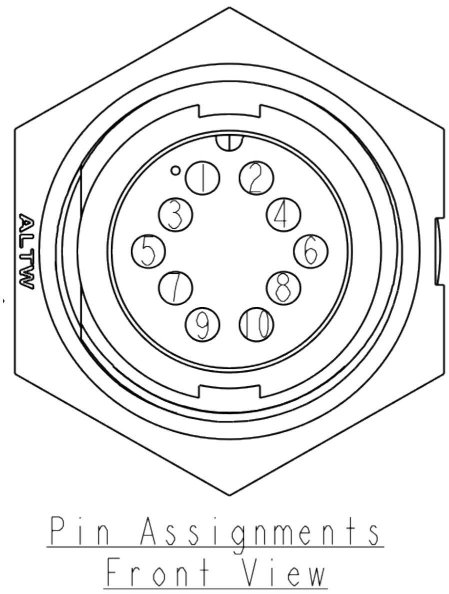


Figure 3b: Drilling template

Electrical PIN assignment

	**PIN assignment** Pin 1: 9...+30V DC (min.: 1.6W) Pin 2: 0V DC (GND) Pin 3: CAN-High Pin 4: CAN-Low Pin 5: (service port A)* Pin 6: (service port B)* Pin 7: nc Pin 8: nc Pin 9: DAC + / RS485 B Pin 10: DAC - / RS485 A *) not intended for customer use

Simultaneous signal output via CAN bus and an analogue interface

If required, the sensor's measurement data can be output simultaneously via the CAN bus interface and an analogue interface (4-20 mA, 0-10V). If an analogue interface (4-20 mA, 0-10V) is selected in addition to the CAN bus, the analogue signal is output via PIN 7 & 8. CAN addressing via the connector is then no longer possible!

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO22005-CO2 (0-100 vol.-% H_2)	0x340 & 0x341	0x348 & 0x349	0x350 & 0x351	0x358 & 0x359

Set CAN ID (CAN2.0A):
To set the CAN ID, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Zero point adjustment:
A specific 8-byte message on the CAN ID 0x680 can be used to make an adjustment. This is permanent and affects all outgoing H2 signals.

0x680: 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To make an adjustment, the system should be free of hydrogen/CO2 and be flushed with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air).

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[23]
*corresponds to the serial number of the individual sensor system.

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):

1st CAN message e.g. 0x340 or 0x0CFF1C59:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: $c(H_2) = (Msg0-20)/100$
Msg 1(bit 16-31): Carbon dioxide concentration [vol.-%]: $c(CO_2) = (Msg1-20)/100$
Msg 2(bit 32-47): Pressure [mbar]: $p = Msg2$
Msg 3(Bit 48-55): Temperature [°C]: $T = (Msg3-60)$
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO

2nd CAN message, e.g. CAN ID 0x341 or 0x0CFF1D59:
Msg 0(bit 0-15): Hydrogen concentration_RAW[vol.-%]: $c(H_2) = (Msg0-20)/100$
Measurement of hydrogen concentration, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of H_2 the following applies: Raw value = *100±1*

23 0xYY describes a measure for the set zero point adjustment

Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version
Msg 6(Bit 56-63): Continuous message counter

CAN2.0B - Series A

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
First CAN message after 5s at system startup

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO22005-CO2 (0-100 vol.-% H_2)	0x0CFF1C59 & 0x0CFF1D59	0x0CFF1E59 & 0x0CFF1F59	0x0CFF2059 & 0x0CFF2159	0x0CFF2259 & 0x0CFF2359

Set CAN ID:
To set the CAN ID, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.

Zero point adjustment (CAN2.0B):
A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make an adjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [24]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[25]
*corresponds to the serial number of the individual sensor system.

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait

24 Details can be found in the operating instructions under chapter: "Maintenance and service"
25 0xYY describes a measure for the set zero point adjustment

Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

Example:
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Set the baud rate to 500 kbit/s or 250 kbit/s:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Initiate maintenance:
0x680 0x00 0x77 0x61 0x72 0x74 0x75 0x6E 0x67

Further CAN commands (CAN2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

Analogue 4-20mA - Series I

I[mA]	c($H_{2)}$ [vol.-%]	Comment
4 - 20 mA	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration. This means that 2.5 vol-% $H_{(2),}$for example, is then output as 12mA with a 5 vol-% H_2sensor system.

Only the hydrogen concentration can be output in the analogue output. It should be noted that the analogue output of the sensors is subject to an additional error of 2% FS. The maximum permissible load is 450 Ohm.

Analogue 0-10V - Series I

U[V]	c($H_{2)}$ [vol.-%]	Comment
0 - 10 V	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration in a range from 1V to 9V. This means that 5 vol-% $H_{(2),}$for example, is then output as 5V for a 10 vol-% H_2sensor system.

Only the hydrogen concentration can be output in the analogue output. It should be noted that the analogue output of the sensors is subject to an additional error of 2% FS. The minimum measuring resistance is 10 kOhm.

Digital Modbus via RS485 - Series M

RS485 (Modbus RTU) Factory settings:

Slave ID: 1
Baud rate: 9600
Parity: none
Stop Bits: 1
CRC: 16bit

Name	**Description of the**	**Register addresses (hex / dec)**
Hydrogen concentration	Hydrogen concentration = x / 100 - 20 vol.-% (Example: 2750 = 7.50 vol.-%)	0x7531 / 30001
Carbon dioxide concentration	CO2 = x / 100 - 20 vol.-% (Example: 2405 = 4.05 vol.-%)	0x7532 / 30002
Status	32: Sensor maintenance required 16: Hydrogen present 8: Sensor in heating phase +0: Sensor fully functional +2: A parameter outside the defined Area +4: Error: Sensor defective +6: Error: Measuring time defective	0x7533 / 30003
Pressure	Pressure = x - 20 mbar (Example: 1033 = 1013 mbar)	0x7534 / 30004
Empty byte		0x7535 / 30005
Operating voltage	Operating voltage = (x - 20) / 1000 V (Example: 12020 = 12.00 V)	0x7536 / 30006
Message counter	Run-up counter	0x7537 / 30007
Temperature	Temperature = x / 100 - 40 °C (Example: 6250 = 22.5°C)	0x7538 / 30008
Empty byte		0x7539 / 30009
Hydrogen concentration-raw value	Hydrogen concentration = x / 100 - 20 vol.-% (Example: 2750 = 7.50 vol.-%)	0x753A / 30010
Gross value	Raw value = 100 in the absence of water and hydrogen and otherwise normal air.	0x753B / 30011

Holding register:

Name	Description of the	Register address
Baud rate	Set the baud rate of the Modbus RTU interface: 4800 9600 19200 default: 9600 Changes to the baud rate are only accepted after the sensor is restarted	0x9C41
Slave ID	Slave ID of the sensor 1-200 default: 1 Changes to the slave ID are only applied after the sensor is restarted	0x9C42
Mode	0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2 default: Parity: none, stop bit: 1 Mode change is only applied after restarting the sensor	0x9C43

Information on the registers:

The registers are defined as unsigned 16-bit integers. So they have a range from 0 to 65535. When reading out with a PLC, make sure that the data type is set to "Real" so that the unsigned integer can also be displayed as a comma number.

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapters and heaters:
Various adapters are available for mounting the sensor. For use in very humid environments or environments with liquid water or the risk of icing, there are heating cartridges that can be operated at a constant voltage. These can be fitted in the adapters. You can find the corresponding products under:
https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for the fine purification of gases by removing minimal impurities.

Data sheet adapter for gas sensors

NEO1XX, Version 15.6

Product description:

Adapter for gas sensors from the NEO9XX, NEO9XXHT and NEO4XX series. The adapters allow the sensor to be used as a screw-in unit **(NEO120)**, as a transmitter **(NEO130)**, as a pipe section **(NEO150),** for room monitoring **(NEO160)** or with a bypass **(NEO170).**

Properties:

- Rapid integration of hydrogen sensors into existing systems
- Simple design means that the adapters can be customised to meet individual customer requirements
- NEO170, NEO130 and NEO120 are made of blasted stainless steel **(1.4404).** Customised versions in 1.4301 are possible
- NEO150 and NEO160 are made of black anodised aluminium **(EN AW 6082)**
- with additional splash guard to keep liquid water away from the sensor
- No negative influence on the measuring behaviour of the sensors
- With fitting and retaining screws for **NEO20X** heating cartridges to prevent condensation

...go to English version

Characteristics - NEO120:

Material: Stainless steel 1.4404

Dimensions(LxWxH): 83x50x12mm³

Weight: 390 g

Accuracy of the dimensions: ± 0.1 mm

Roughness: < 6.7 µm

Connection option: Screw-in connector: G1/4", G1/2", M18x1.5 (others on request)

Cartridge heaters possible: Yes

Gasket: We recommend a USIT ring as a seal

STP/PDF drawing: https://neoxid-cloud.de/NEO120.zip

RoHS compliant: Yes

Customs tariff number (HS Code): 90268020

COO: Germany

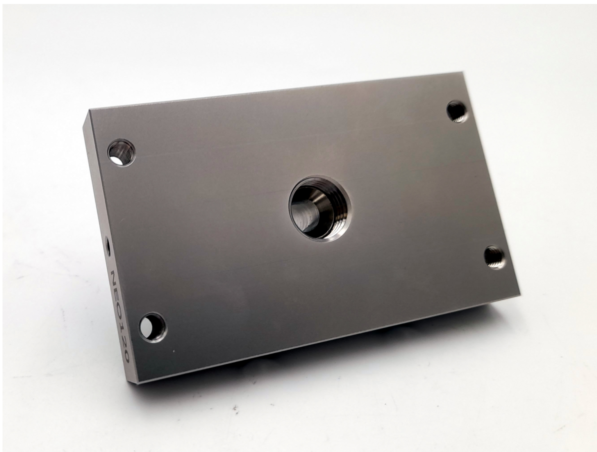


Figure 1: NEO120

Characteristics - NEO130:

Material: Stainless steel 1.4404

Dimensions(LxWxH): 83x50x25mm³

Weight: 690 g

Accuracy of the dimensions: ± 0.1 mm

Roughness: < 6.7µm

Connection option: 2x cylindrical ISO thread: G1/8", G1/4", G1/2", G1", G1 1/4"[26] (others on request)

Cartridge heaters possible: Yes

Screw-in unit: Can be purchased on request

Seal: Flat sealing due to EPDM O-ring in the sensor

STP/PDF drawing: https://neoxid-cloud.de/NEO130-2-Varianten.zip

RoHS compliant: Yes

Customs tariff number (HS Code): 90268020

COO: Germany

Figure 2: NEO130

26 For larger holes than 1/8", the width and height of the adapter increases accordingly

Characteristics - NEO150:

Material:	Aluminium EN AW 6082 black anodised
Dimensions(LxWxH):	134.5x85x76.5mm³
Weight:	870 g
Accuracy of the dimensions:	± 0.1 mm
Roughness:	< 6.7 µm
Connection option:	smooth tube: outer diameter: 40mm, 50mm, 73mm (other diameters on request)[27]
Cartridge heaters possible:	Yes
Seal:	Flat sealing due to EPDM O-ring in the sensor
STP/PDF drawing:	https://neoxid-cloud.de/NEO150.zip
RoHS compliant:	Yes
Customs tariff number (HS Code):	90268020
COO:	Germany

Figure 3: NEO150

27 For diameters > 50 mm, the dimensions are correspondingly larger

Characteristics - NEO160:

Material:	Aluminium EN AW 6082 black anodised
Dimensions(LxWxH):	95x83x8mm³
Weight:	50 g
Accuracy of the dimensions:	± 0.1 mm
Roughness:	< 6.7 µm
Connection option:	Wall screw connection
Cartridge heaters possible:	No
STP/PDF drawing:	https://neoxid-cloud.de/NEO160.zip
RoHS compliant:	Yes
Customs tariff number (HS Code):	90268020
COO:	Germany

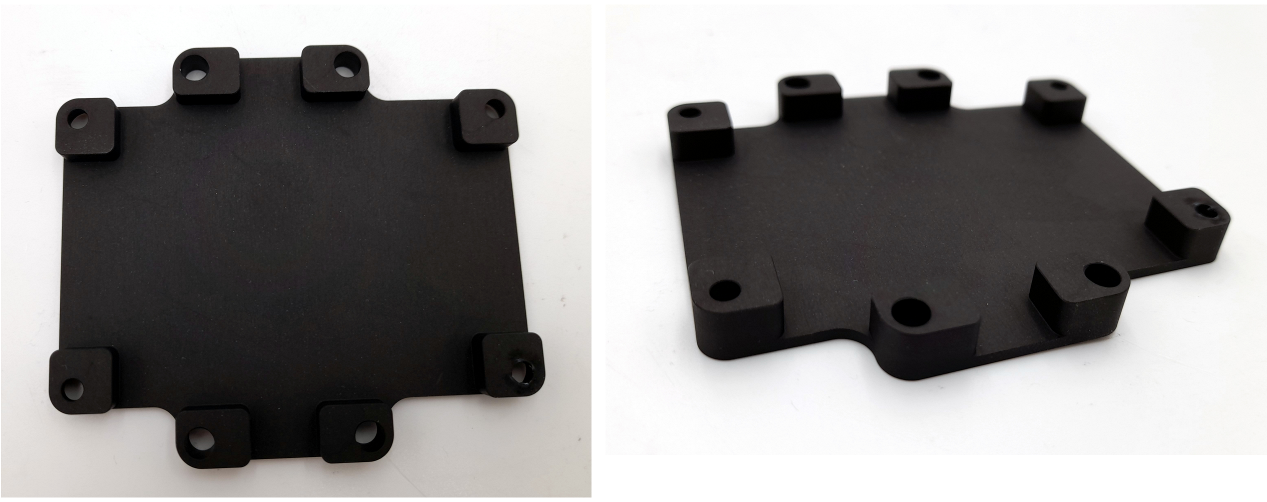


Figure 4: NEO160

Characteristics - NEO170:

Material: Stainless steel 1.4404 for the screw-on adapter and for
the bypass the bypass, 1.4571 for the large main pipe.

Dimensions(LxIDxAD): 360 x 68 x 76.1 mm³

Weight: 3250 g

Accuracy of the connection dimensions: ± 0.2 mm

Roughness: < 6.7 µm

Connection option: on request - single piece production

Cartridge heaters possible: Yes

STP/PDF drawing: https://neoxid-cloud.de/NEO170.zip

RoHS compliant: Yes

Customs tariff number (HS Code): 90268020

COO: Germany

Figure 5: NEO170

Mounting the sensor on the adapter:

During installation, it must be ensured that the opening is not blocked, e.g. by a condensing or freezing film of water. We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 2.5 Nm. The heatable NEO120, NEO130, NEO150 and NEO170 adapters are available on request. To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a room direction other than horizontal, a small offset occurs; this can be corrected via a specific CAN message on ID 0x680 .[28]

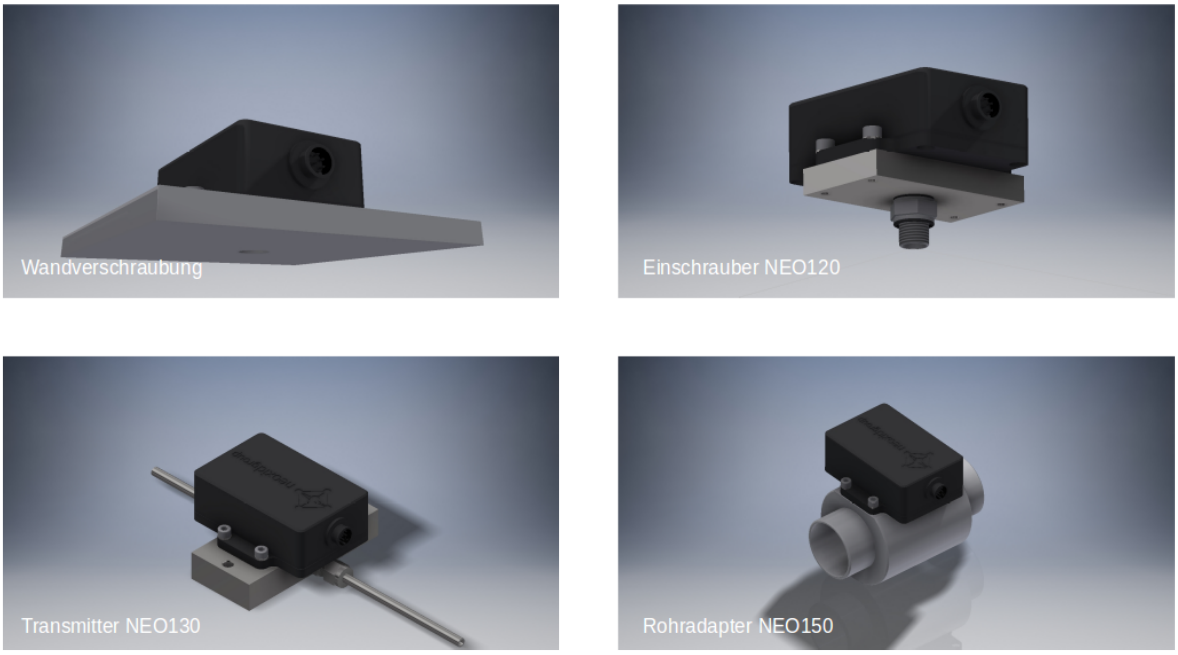


Figure 2a: Mounting the H_2sensor system

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected against condensation. To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The above-mentioned adapters (with the exception of the NEO160) can also be fitted with heating cartridges (NEO203), which are also available on request. The NEO130, NEO150 and NEO170 adapters are fitted with a ribbed plug as a further protective measure against small amounts of splash water. Care must be taken to ensure that the adapter is installed in such a way that this plug functions properly if an installation with a passing gas is used.

28 Details can be found in the respective sensor data sheet

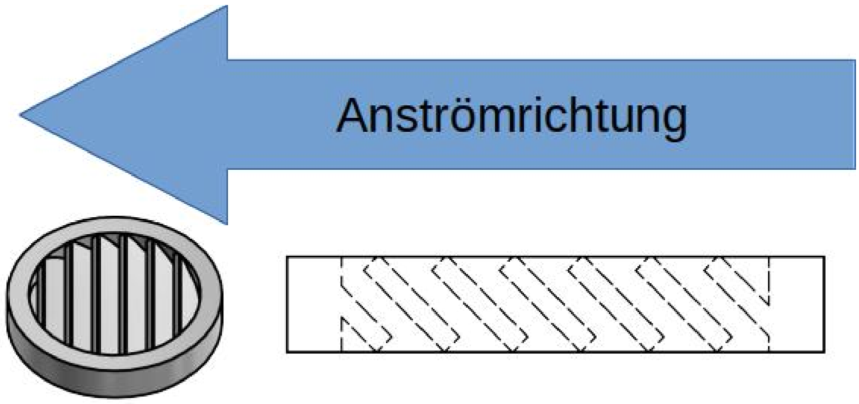


Figure 2b: Fitting ribbed plugs against the direction of flow

Data sheet hydrogen concentration sensor NEO1005I, NEO1010I, and NEO1100I, version 15.6

Product description:

Sensor system for measuring the hydrogen concentration in air, oxygen, nitrogen or oxygen-depleted air with temperature-, pressure- and humidity-compensated signal evaluation for automotive applications. Applicable in the range: 0.6 - 1.5 bara, 0 - 100% r.h. (non-condensing) and -40°C - 85°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measurements in the range of 0-5 vol.-% $H_{(2)}$ (**NEO1005**), 0-10 vol.-% $H_{(2)}$ (**NEO1010**) and 0-100 vol.-% $H_{(2)}$ (**NEO1100**)
- Carrier gases air, N_2, O_2, oxygen depleted air possible
- Measuring signal independent of pressure, temperature and humidity
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Signal output via CAN 2.0A or CAN 2.0B and 4-20mA
- Factory calibrated and ready for immediate use
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary.
- Encrypted CAN communication on demand

Figure 1a: H_2sensor system NEO1XXX series

...go to English version

Sensor system characteristics:

Supply voltage: 12 - 30V DC

Energy consumption: < 2,4 W

Possible H_2 sensitivity:
0 - 100 % by volume H_2 **NEO1100**
0 - 10 Vol.-% H_2 **NEO1010**
0 - 5 Vol.-% H_2 **NEO1005**

Accuracy: ± 0.3 vol.-% H_2[29] or± 2 vol.-% H_2[30]

Detection limit: < 0.3 vol% $H_{(2)}$ ([1])or < 0.5 vol% $H_{(2)}$ ([2])

Response time t_{90}: < 3 s[1],< 5 s[2]

Decay time t_{10}: < 3 s[1],< 5 s[2]

Start-up time after cold start:
< 5 s until the first message
< 70 s until quantification of the H_2 concentration[31]

Media temperature: - 40°C - 85°C/105°C[32]

Ambient temperature: - 40°C - 85°C/105°C[4]
The cold start at -40°C was tested.

Pressure range: 0.6 - 1.5 bar absolute

Humidity: 0 - 100 % r.h. (non-condensing)

Carrier gas: Air, depleted air, nitrogen, oxygen
Cross-sensitivities: Helium, tbd

Output signal:
CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on page 13
4-20 mA on page 28

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm

Housing:
Size: 84 x 82 x 29 mm^3
Material: polyamide 6, 10% glass fibres, 20% mineral

Leakage rate: 10^{-5} mbar l / s [33]

29 For 5% and 10% H_2 systems
30 For 100% H_2 systems
31 The system is designed for continuous operation
32 105°C are not suitable for continuous operation
33 Measured with forming gas 90/10, 1.5 bar absolute, room temperature

IP code: IP6K7

Weight: 80 g

SIL: SIL 2 is aimed for

Probability of default: FIT: 63.00
MTBF: 1,812 years
PFH: 6.30E-08
PFD: 6.3E-04

ATEX: -

Service life: IP6K7 enclosure qualified with an expected
Service life of 5 years.[34] The system has been tested
with 100,000 switch-on and switch-off cycles.

Long-term stability: Deviation <0.1 vol.-% in the first 5000h
Operating time

Maintenance interval : We recommend checking the H_2sensor every
6 months. check.

Measuring behaviour: The gas to be tested may have a maximum
have a maximum velocity of 25m/s. In
addition, a laminar flow is recommended. If the
specification differs specification, the sensor
must be tested for tested for functionality.

Connection cable: 3 m enclosed; more detailed information on
page 9

RoHS compliant: Yes https://neoxid-cloud.de/Konformitaetserklaerung-
RoHS_DE_EN_V02_scan.pdf

EMC compliant: Yes https://neoxid-cloud.de/EMV_NEO1XXX_neoxid-group.pdf

Customs tariff number: 90271010[35]

COO: Germany / NRW

EC-79/2009 Not subject to type-approval according to Annex I b),
Annex I defines the components to be tested only for
liquid hydrogen parts and those above 30 bar

34 Measuring components are purely inorganic and are not consumed during measurement
35 This product is not assigned to an ECCN. It therefore belongs to the EAR99 classification and can be traded freely.

Accuracy of the measured values:[36]

Size	Accuracy
Hydrogen concentration	*± 0.3 vol.-% H_2[37] or ± 2 vol.-% H_2[38]*
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[39]	*± 0,3 °C*
Pressure	*± 20 mbar*

Table2 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO1XXX-V09_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Assembly:
The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO1XXX-Spritzguss.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system as shown in Figure 1a. If the sensor is mounted in a different spatial direction, there will be a small offset[40] , which must be corrected via a specific CAN message on ID 0x680[41] . The retaining pins or screws may have a maximum diameter of 5.5 mm. We recommend a tightening torque of 2.3 Nm.

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be

36 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar
37 For 0-5 vol.% and 0-10 vol.% H_2systems
38 For 100 vol% H_2systems
39 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber
40 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.
41 See CAN Matrix Message Layout

lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The sensor is fitted with a ribbed plug as a protective measure against small amounts of splash water. It must be ensured that the sensor is installed in such a way that this plug functions properly if an installation with a gas flowing past is used.

Figure 1b: H_2sensor system NEO1XXX series from below

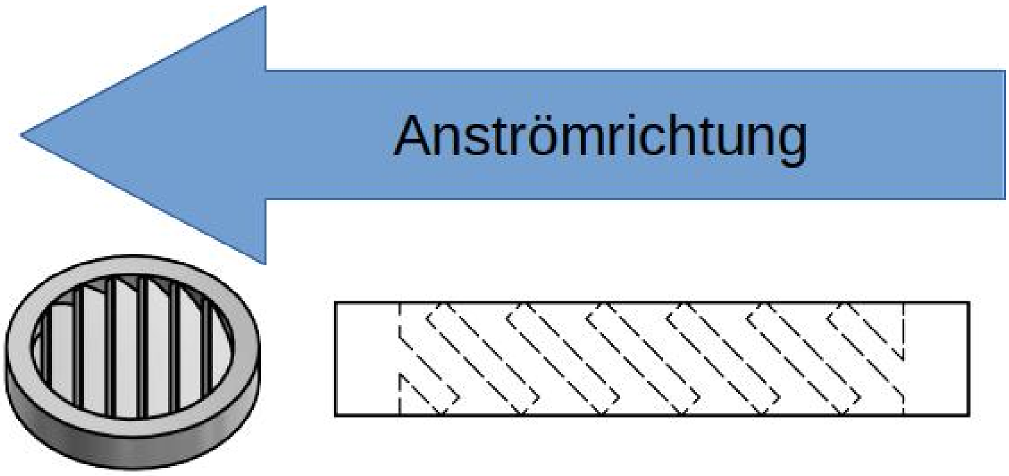


Figure 2a: Fitting ribbed plugs against the direction of flow

Hole pattern:

Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

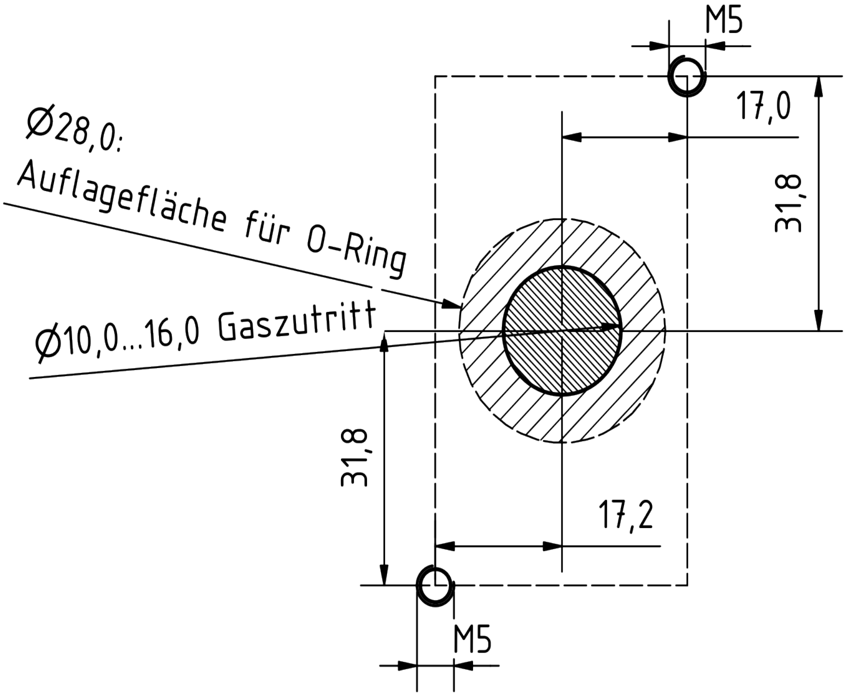
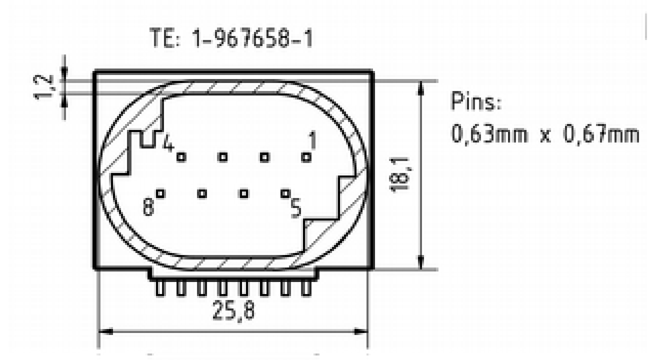


Figure 3b: Drilling template

	**PIN assignment** Pin 1: 12...+30V DC (min.: 2.4W) Pin 2: 0V DC (GND) Pin 3: CAN-High Pin 4: CAN-Low Pin 5: CAN loop-through / service port Pin 6: Analogue output + Pin 7: CAN loop-through / service port Pin 8: Analogue output -
8-pole housing socket: TE Connectivity MQS 1-967658-1	

Electrical PIN assignment

PIN no.	Description of the	Colour
1	VCC+ 12 ...+30V DC (min.: 2.4W)	white
2	GND 0V DC	brown
3	CAN-High	yellow
4	CAN-Low	green
5	Service Port A	pink
6	Analogue output +	grey
7	Service Port B	red
8	Analogue output -	blue

Information on hydrogen ignition by the NEO1XXX series from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

A heating element is used in the H_2sensor, which is heated with 5V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the sensor (a Zener diode prevents operating voltages > 15 V). At 32 V, the heating element burnt out and still did not cause the explosive stoichiometric gas mixture to explode. In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavern. The sample gas must diffuse through a membrane.

Catalytic materials are not installed in the H_2sensor, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

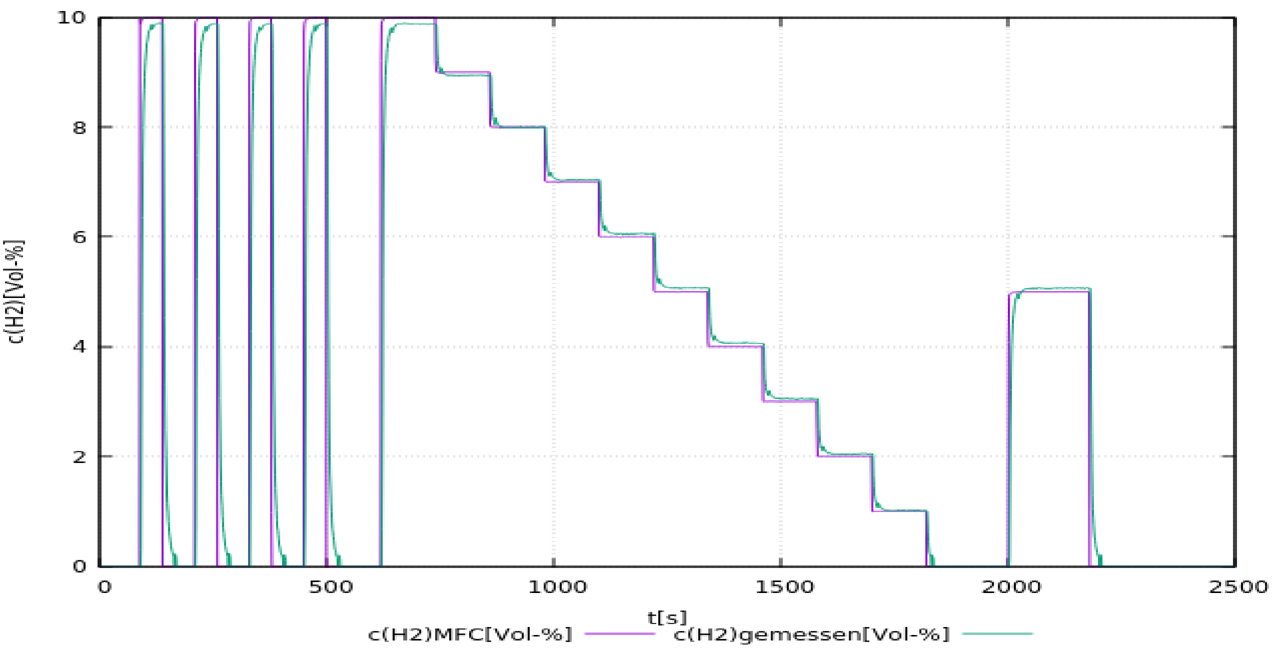


Figure 5a: Test of a NEO1010 sensor system up to 10 vol.-% H_2in 13 vol.-% O_2. Measured with a total flow of 2,000 sccm.

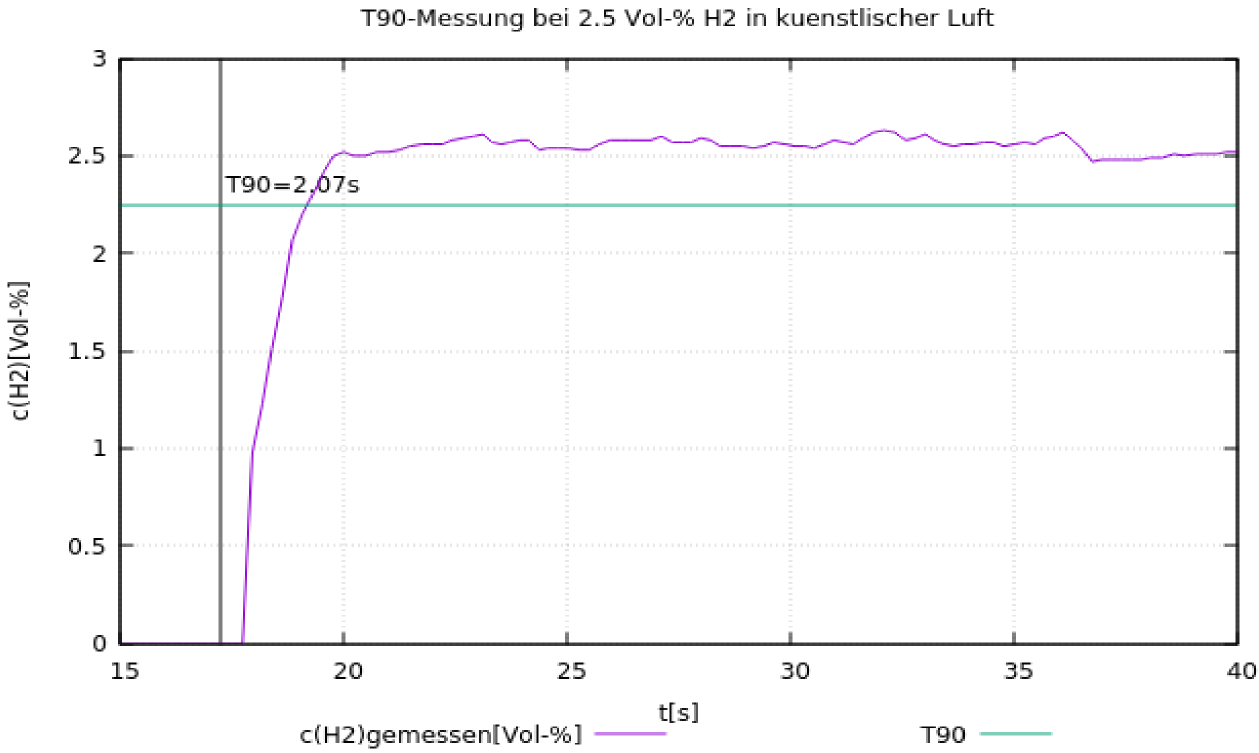


Figure 5b: t_{90}time determination with a NEO1005 sensor system by switching from 0 vol.-% $H_2$to 2.5 vol.-% H_2. Measured with a total flow of 4,000 sccm.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. The sensor can be terminated externally via connection pins 5-8.
The first CAN message is delivered 5s after system start. It is possible for the sensor to send a predefined message on a desired ID at a certain hydrogen concentration if required.

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO1005A (0-5 vol.-% H_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319
NEO1010A (0-10 vol.-% H_2)	0x320 & 0x321	0x328 & 0x329	0x330 & 0x331	0x338 & 0x339
NEO1100A (0-100 vol.-% H_2)	0x340 & 0x341	0x348 & 0x349	0x350 & 0x351	0x358 & 0x359

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment. must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [42]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[43]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To change the ID on which the NEO1XXXA transmits, a CAN message can be sent:
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver

42 Details can be found in the operating instructions under chapter: "Maintenance and service"
43 0xYY describes a measure for the set zero point adjustment

MCP2562. The CAN lines are not terminated as standard. CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message is delivered after 5s at system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO1005A (0-5 vol.-% H_2)	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359
NEO1010A (0-10 vol.-% H_2)	0x0CFF1459 & 0x0CFF1559	0x0CFF1659 & 0x0CFF1759	0x0CFF1859 & 0x0CFF1959	0x0CFF1A59 & 0x0CFF1B59
NEO1100A (0-100 vol.-% H_2)	0x0CFF1C59 & 0x0CFF1D59	0x0CFF1E59 & 0x0CFF1F59	0x0CFF2059 & 0x0CFF2159	0x0CFF2259 & 0x0CFF2359

Set CAN ID (CAN2.0B):
To change the ID on which the NEO1XXXA transmits, a CAN message can be sent:
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x200
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x200, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):
A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make a readjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To make an adjustment, the system should be free of hydrogen and purged with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [44]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[45]
*corresponds to the serial number of the individual sensor system.

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
The corresponding DBC file is available at the following link:
https://neoxid-cloud.de/H2-Sensor_NEO1XXX_V146.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration [Vol.-%]: $c(H_2)$ = (Msg0-20)/100
Msg 1(Bit 16-31): Water concentration [Vol.-%]: $c(H_{(2)}O)$ = (Msg1-20)/100
Msg 2(bit 32-47): Pressure [mbar]: p = Msg2
Msg 3(Bit 48-55): Temperature [°C]: T = (Msg3-60)
Temperature of the measuring chamber, usually higher than in the medium[46]

44 Details can be found in the operating instructions under chapter: "Maintenance and service"
45 0xYY describes a measure for the set zero point adjustment
46 temperature deviates significantly from the gas temperature, especially when the gas is stationary. A

Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0D59:

Msg 0(Bit 0-15): Hydrogen concentration_RAW[Vol.-%]: $c(H_2)$ = (Msg0-20)/100
Measurement of hydrogen concentration, without internal logic

Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $H_2$the following applies: Raw value = *100±1*

Msg 2(Bit 24-31): Status byte: see below.

Msg 3(Bit 32-47): *Serial* number

Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*

Msg 5(Bit 56-63): Continuous message counter

Example for the interpretation of CAN messages:

Hex message from Sensor:

CAN Msg1: CAN ID1 320 00 14 00 CE 03 ED 68 D8
CAN Msg2: CAN ID2 321 00 0A 63 00 50 D 92 CA

Decimal translation:

CAN Msg1: Byte0+1: 20, Byte 2+3: 206, Byte 4+5: 1005 Byte 6: 104, Byte 7: 216
CAN Msg2: Byte0+1: 10, Byte 2: 99, Byte 3: 0, Byte 4+5:1293 Byte 6: 146, Byte 7: 202

Sensor translation:

CAN Msg1: $c(H_{2)}$ [vol.-%]: 0, $c(H_{(2)}$ $_O)$[vol.-%]: 1.86, p[mbar]: 1005, T[°C]: 44, CRC: 216
CAN Msg2: $c(H_{2)}$_raw[vol.-%]: -0.1, raw: 99, status: 0, serial#: 1293, SV: 14.6 Counter: 202

direct correlation with the outside temperature is not possible.

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait
Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

Example:
"Sensor running; no $H_{(2)}$ .." → Status byte = 00000000 binary → 0 hexadecimal, 0 decimal
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal[47]
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal[48]
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Adjust baud rate:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Change CAN2.0 A/B:
0x680 0xA0 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Zero point adjustment:
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

47 If the supply voltage is not sufficient, status byte 2 is output and a full signal is output at the H2 concentration.
48 Status byte 32 is set if the temperature (T > 101°C && T less than -40°C), the relative humidity (r.h. > 99%), the pressure (p > 2700 mbara && less than 600 mbara) are outside the defined range or 5,000 operating hours. The status byte is only reset with a zero point adjustment!

Analogue 4-20mA - Series I

I[mA]	c(H_2) [vol.-%]	Comment
4 - 20 mA[49]	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration. This means that 2.5 vol-% $H_{(2)}$,for example, is then output as 12mA with a 5 vol-% H_2sensor system. In the heat-up phase and during a critical fault, a current <4mA is output (usually approx. 3mA)

It should be noted that the analogue output of the sensors is subject to an additional error of 2% FS. The maximum permissible load is 450 Ohm.

49 In earlier versions of this sensor, 7.2 to 20mA was given as the measuring range.

Data sheet hydrogen concentration sensor NEO1005, NEO1010, and NEO1100, version 15.6

Product description:

Sensor system for measuring the hydrogen concentration in air, oxygen, nitrogen or oxygen-depleted air with temperature-, pressure- and humidity-compensated signal evaluation for automotive applications. Applicable in the range: 0.6 - 1.5 bara, 0 - 100% r.h. (non-condensing) and -40°C - 85°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measurements in the range of 0-5 vol.-% $H_{(2)}$ (**NEO1005**), 0-10 vol.-% $H_{(2)}$ (**NEO1010**) and 0-100 vol.-% $H_{(2)}$ (**NEO1100**)
- Carrier gases air, N_2, O_2, oxygen depleted air possible
- Encrypted CAN communication on demand
- Measuring signal independent of pressure, temperature and humidity
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Signal output via CAN 2.0A or CAN 2.0B
- Connectors and contacts for crimping are included
- Factory calibrated and ready for immediate use
- CAN wake-up function when a certain H2 concentration is detected
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary.

Figure 1a: H_2sensor system NEO1XXX series

...go to English version

Sensor system characteristics:

Supply voltage: 9 - 30V DC

Energy consumption: < 2,4 W

Possible H_2sensitivity: 0 - 100 % by volume H_2 **NEO1100**
0 - 10 Vol.-% H_2 **NEO1010**
0 - 5 Vol.-% H_2 **NEO1005**

Accuracy: ± 0.3 vol.-% H_2[50] or± 2 vol.-% H_2[51]

Detection limit: < 0.3 vol% $H_{(2)}$ ([1])or < 0.5 vol% $H_{(2)}$ ([2])

Response time t_{90}: < 3 s[1],< 5 s[2]

Decay time t_{10}: < 3 s[1],< 5 s[2]

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[52]

Media temperature: - 40°C - 85°C/105°C[53]

Ambient temperature: - 40°C - 85°C/105°C[4]
The cold start at -40°C was tested.

Pressure range: 0.6 - 1.5 bar absolute

Humidity: 0 - 100 % r.h. (non-condensing)

Carrier gas: Air, depleted air, nitrogen, oxygen
Cross-sensitivities: Helium, tbd

CAN signal: CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on page 13

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm

Housing: Size: 84 x 82 x 29 mm^3
Material: Polyamide 6, 10% glass fibres, 20% mineral

Leakage rate: 10^{-5}mbar l / s [54]

Long-term stability/drift: <0.1 vol.-% in the first 5,000h operating time

50 For 5% and 10% H_2systems
51 For 100% H_2systems
52 The system is designed for continuous operation
53 105°C are not suitable for continuous operation
54 Measured with forming gas 90/10, 1.5 bar absolute, room temperature

IP code:	IP6K7
Weight:	80 g
ASIL:	ASIL B is aimed for
Probability of default:	FIT: 63.00 MTBF: 1,812 years PFH: 6.30E-08 PFD: 6.3E-04
ATEX:	-
Service life:	IP6K7 enclosure qualified with an expected Service life of 5 years.[55] The system has been tested
with	100,000 switch-on and switch-off cycles.
Long-term stability:	Deviation <0.1 vol.-% in the first 5000h Operating time
Maintenance interval : 6 months.	We recommend checking the H_2sensor every check.
Measuring behaviour:	The gas to be tested may have a maximum have a maximum velocity of 25m/s. In
addition, a specification differs must be tested for	laminar flow is recommended. If the specification, the sensor tested for functionality.
Connection:	Connector plug and 8x contacts for crimping are included. A cable can also be manufactured on
request	can also be manufactured.
RoHS compliant: RoHS_DE_EN_V02_scan.pdf	Yes https://neoxid-cloud.de/Konformitaetserklaerung-
EMC compliant:	Yes https://neoxid-cloud.de/EMV_NEO1XXX_neoxid-group.pdf
Customs tariff number:	90271010[56]
COO:	Germany / NRW
EC-79/2009	Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

55 Measuring components are purely inorganic and are not consumed during measurement

56 This product is not assigned to an ECCN. It therefore belongs to the EAR99 classification and can be traded freely.

Accuracy of the measured values:[57]

Size	Accuracy
Hydrogen concentration	*± 0.3 vol.-% H_2[58] or ± 2 vol.-% H_2[59]*
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[60]	*± 0,3 °C*
Pressure	*± 20 mbar*

Table3 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO1XXX-V09_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Assembly:
The stepfile and 2D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO1XXX-Spritzguss.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system as shown in Figure 1a. If the sensor is mounted in a different spatial direction, there will be a small offset[61] , which must be corrected via a specific CAN message on ID 0x680[62] . The retaining pins or screws may have a maximum diameter of 5.5 mm. We recommend a tightening torque of 2.3 Nm.

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The sensor is fitted with a ribbed plug as a protective measure against small amounts of splash water. It must be ensured that the sensor is installed in such a way that this plug functions properly if an installation with a

57 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar
58 For 0-5 vol.% and 0-10 vol.% H_2systems
59 For 100 vol% H_2systems
60 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber
61 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.
62 See CAN Matrix Message Layout

passing gas is used.

Figure 1b: H_2sensor system NEO1XXX series from below

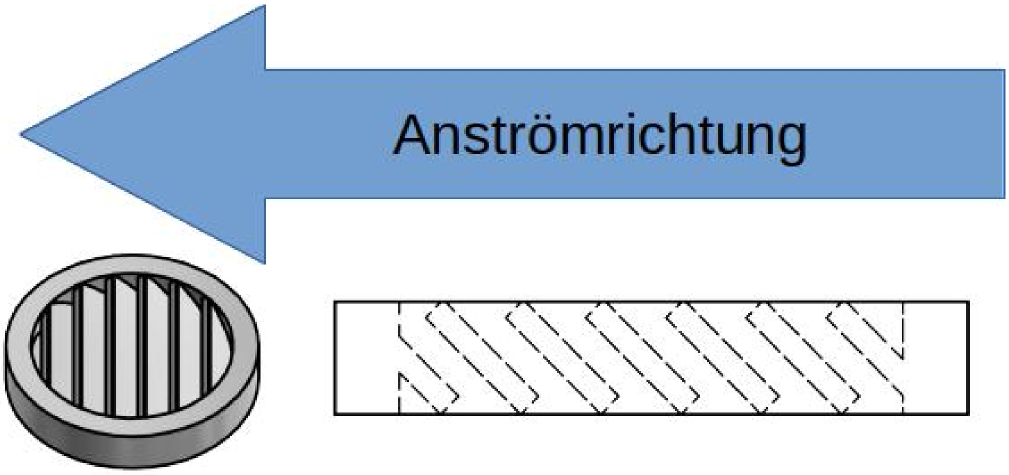


Figure 2a: Fitting ribbed plugs against the direction of flow

Hole pattern:

Figure 3a: Hole pattern of the H_2sensor system from below
Drilling template:

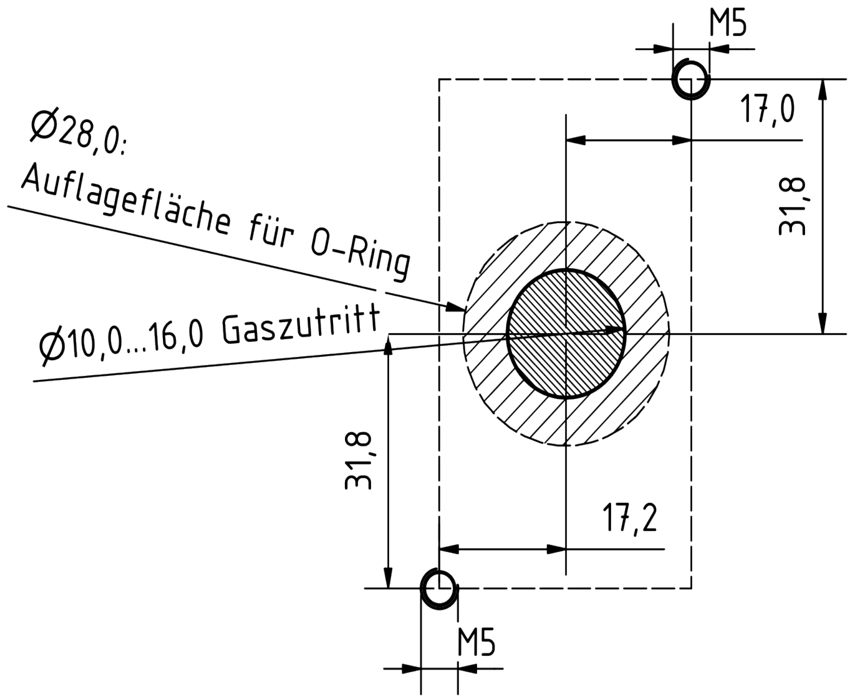
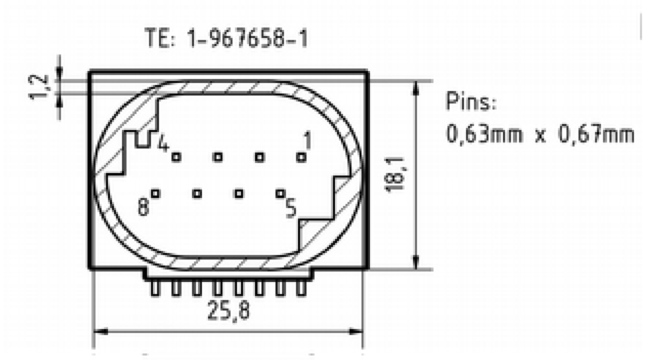


Figure 3b: Drilling template

	**PIN assignment** Pin 1: 9...+30V DC (min.: 2.4W) Pin 2: 0V DC (GND) Pin 3: CAN-High Pin 4: CAN-Low Pin 5: Termination 1a* Pin 6: Termination 1b* Pin 7: Termination 2a* Pin 8: Termination 2b* *) Short-circuiting 1a with 1b and 2a with 2b terminates the CAN line.
8-pole housing socket: TE Connectivity MQS 1-967658-1	

Information on hydrogen ignition by the NEO1XXX series from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

A heating element is used in the H_2sensor, which is heated with 5V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the sensor (a Zener diode prevents operating voltages > 15 V). At 32 V, the heating element burnt out and still did not cause the explosive stoichiometric gas mixture to explode. In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavern. The sample gas must diffuse through a membrane.

Catalytic materials are not installed in the H_2sensor, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

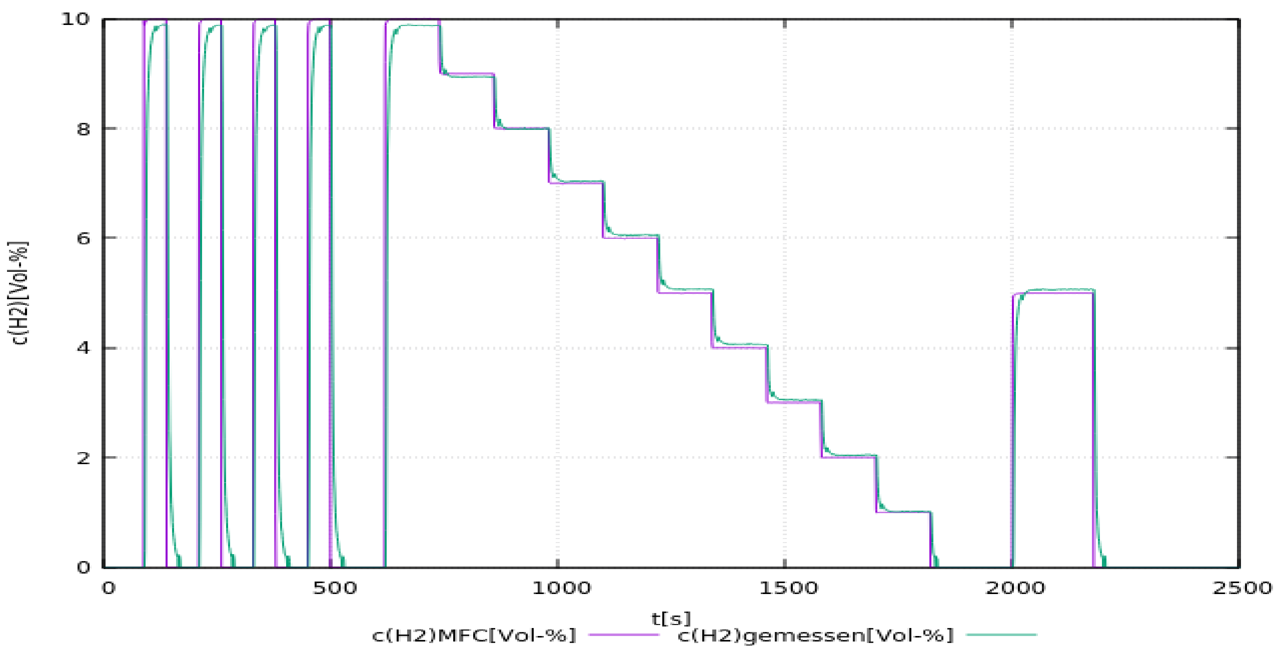


Figure 5a: Test of a NEO1010 sensor system up to 10 vol.-% H_2in 13 vol.-% O_2. Measured with a total flow of 2,000 sccm.

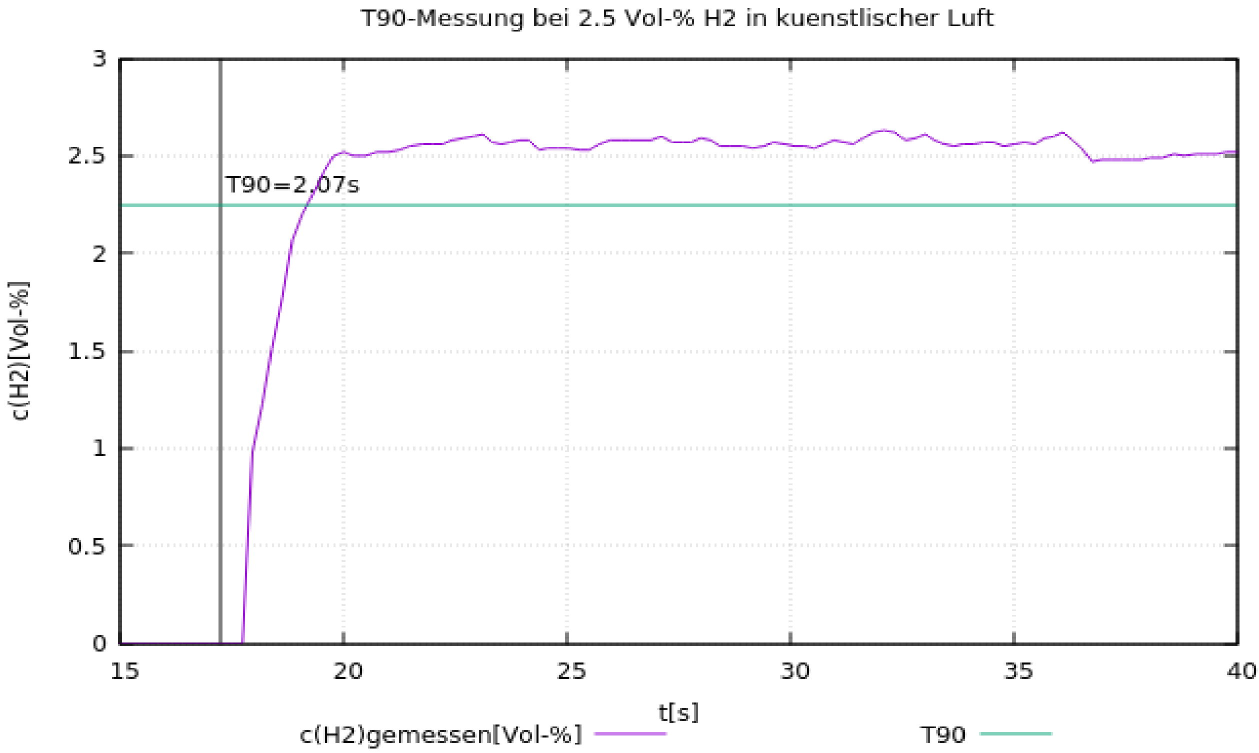


Figure 5b: t_{90}time determination with a NEO1005 sensor system by switching from 0 vol.-% $H_2$to 2.5 vol.-% H_2. Measured with a total flow of 4,000 sccm.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. The sensor can be terminated externally via connection pins 5-8.
The first CAN message is delivered 5s after system start. It is possible for the sensor to send a predefined message on a desired ID at a certain hydrogen concentration (CAN wake-up). This could be used to wake up other devices in the network from sleep mode.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	**CAN-ID 2**	**CAN-ID 3**	**CAN-ID 4**
NEO1005A (0-5 vol.-% H_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319
NEO1010A (0-10 vol.-% H_2)	0x320 & 0x321	0x328 & 0x329	0x330 & 0x331	0x338 & 0x339
NEO1100A (0-100 vol.-% H_2)	0x340 & 0x341	0x348 & 0x349	0x350 & 0x351	0x358 & 0x359

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment. must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [63]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[64]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To change the ID on which the NEO1XXXA transmits, a CAN message can be sent:
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver

63 Details can be found in the operating instructions under chapter: "Maintenance and service"
64 0xYY describes a measure for the set zero point adjustment

MCP2562. The CAN lines are not terminated as standard. The sensor can be terminated externally via connection pins 5-8. CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message is delivered after 5s at system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	**CAN-ID 2**	**CAN-ID 3**	**CAN-ID 4**
NEO1005A (0-5 vol.-% H_2)	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359
NEO1010A (0-10 vol.-% H_2)	0x0CFF1459 & 0x0CFF1559	0x0CFF1659 & 0x0CFF1759	0x0CFF1859 & 0x0CFF1959	0x0CFF1A59 & 0x0CFF1B59
NEO1100A (0-100 vol.-% H_2)	0x0CFF1C59 & 0x0CFF1D59	0x0CFF1E59 & 0x0CFF1F59	0x0CFF2059 & 0x0CFF2159	0x0CFF2259 & 0x0CFF2359

Set CAN ID (CAN2.0B):
To change the ID on which the NEO1XXXA transmits, a CAN message can be sent:
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):
A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make a readjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To make an adjustment, the system should be free of hydrogen and purged with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [65]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[66]
*corresponds to the serial number of the individual sensor system.

CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured hydrogen concentration exceeds the 0.5 % by volume limit (c(H_2) from <0.5 % by volume to >= 0.5 % by volume).

The following message is sent:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = *(Msg0-20)/100*
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $H_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*

65 Details can be found in the operating instructions under chapter: "Maintenance and service"
66 0xYY describes a measure for the set zero point adjustment

Msg 6(Bit 56-63): Continuous message counter

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
The corresponding DBC file is available at the following link:
https://neoxid-cloud.de/H2-Sensor_NEO1XXX_V146.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration [Vol.-%]: $c(H_2)$ = (Msg0-20)/100
Msg 1(Bit 16-31): Water concentration [Vol.-%]: $c(H_{(2)}O)$ = (Msg1-20)/100
Msg 2(bit 32-47): Pressure [mbar]: p = Msg2
Msg 3(Bit 48-55): Temperature [°C]: T = (Msg3-60)
Temperature of the measuring chamber, usually higher than in the medium[67]
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0D59:
Msg 0(Bit 0-15): Hydrogen concentration_RAW[Vol.-%]: $c(H_2)$ = (Msg0-20)/100
Measurement of hydrogen concentration, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $H_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 5(Bit 56-63): Continuous message counter

Example for the interpretation of CAN messages:

Hex message from Sensor:
CAN Msg1: CAN ID1 320 00 14 00 CE 03 ED 68 D8
CAN Msg2: CAN ID2 321 00 0A 63 00 50 D 92 CA

Decimal translation:
CAN Msg1: Byte0+1: 20, Byte 2+3: 206, Byte 4+5: 1005 Byte 6: 104, Byte 7: 216
CAN Msg2: Byte0+1: 10, Byte 2: 99, Byte 3: 0, Byte 4+5:1293 Byte 6: 146, Byte 7: 202

Sensor translation:
CAN Msg1: $c(H_2)$ [vol.-%]: 0, $c(H_{(2)}O)$[vol.-%]: 1.86, p[mbar]: 1005, T[°C]: 44, CRC: 216
CAN Msg2: $c(H_2)$_raw[vol.-%]: -0.1, raw: 99, status: 0, serial#: 1293, SV: 14.6 Counter: 202

Explanation of the status byte:

Bit 24	0: there is currently no H_2O condensation	1: if H_2O condensation is present (acute)
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait

67 temperature deviates significantly from the gas temperature, especially when the gas is stationary. A direct correlation with the outside temperature is not possible.

Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	0: there has never been H_2O condensation	1: if H_2O condensation ever occurred.

Example:
"Sensor running; no $H_{(2)}$ ..." → Status byte = 00000000 binary → 0 hexadecimal, 0 decimal
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal[68]
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal[69]
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Adjust baud rate:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Change CAN2.0 A/B:
0x680 0xA0 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Zero point adjustment:
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Further CAN commands (CAN2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

68 If the supply voltage is not sufficient, status byte 2 is output and a full signal is output at the H2 concentration.

69 Status byte 32 is set if the temperature (T > 101°C && T less than -40°C), the relative humidity (r.h. > 99%), the pressure (p > 2700 mbara && less than 600 mbara) are outside the defined range or 5,000 operating hours. The status byte is only reset with a zero point adjustment!

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapters and heaters:
Various adapters are available for mounting the sensor. For use in very humid environments or environments with liquid water or the risk of icing, there are heating cartridges that can be operated at a constant voltage. These can be mounted in the adapters.

Connection cable
Plugs and pins are included to connect the sensors. Alternatively, a standard 3 metre cable can be ordered. Special lengths are also available on request.

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for the fine purification of gases by removing minimal impurities.

FAQ:

The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Data sheet hydrogen concentration sensor NEO1005, NEO1010, and NEO1100, version 16.0

Product description:

Sensor system for measuring the hydrogen concentration in air, oxygen, nitrogen or oxygen-depleted air with temperature-, pressure- and humidity-compensated signal evaluation for automotive applications. Applicable in the range: 0.6 - 1.5 bara, 0 - 100% r.h. (non-condensing) and -40°C - 85°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measurements in the range of 0-5 vol.-% $H_{(2)}$ (**NEO1005**), 0-10 vol.-% $H_{(2)}$ (**NEO1010**) and 0-100 vol.-% $H_{(2)}$ (**NEO1100**)
- Carrier gases air, N_2, O_2, oxygen depleted air possible
- Encrypted CAN communication on demand
- Measuring signal independent of pressure, temperature and humidity
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Signal output via CAN 2.0A or CAN 2.0B
- Connectors and contacts for crimping are included
- Factory calibrated and ready for immediate use
- CAN wake-up function when a certain H2 concentration is detected
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary.

Figure 1a: H_2sensor system NEO1XXX series

...go to English version

Sensor system characteristics:

Supply voltage: 9 - 30V DC

Energy consumption: < 2,4 W

Possible H_2sensitivity:
0 - 100 % by volume H_2 **NEO1100**
0 - 10 Vol.-% H_2 **NEO1010**
0 - 5 Vol.-% H_2 **NEO1005**

Accuracy: ± 0.3 vol.-% H_2[70] or± 2 vol.-% H_2[71]

Detection limit: < 0.3 vol% $H_{(2)}$ ([1)]or < 0.5 vol% $H_{(2)}$ ([2)]

Response time t_{90}: < 3 s[1],< 5 s[2]

Decay time t_{10}: < 3 s[1],< 5 s[2]

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[72]

Media temperature: - 40°C - 85°C/105°C[73]

Ambient temperature: - 40°C - 85°C/105°C[4]
The cold start at -40°C was tested.

Pressure range: 0.6 - 1.5 bar absolute

Humidity: 0 - 100 % r.h. (non-condensing)

Carrier gas: Air, depleted air, nitrogen, oxygen
Cross-sensitivities: Helium, tbd

CAN signal: CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on page 13

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm

Housing: Size: 84 x 82 x 29 mm^3
Material: polyamide 6, 10% glass fibres, 20% mineral

Leakage rate: 10^{-5}mbar l / s [74]

Long-term stability/drift: <0.1 vol.-% in the first 5,000h operating time

70 For 5% and 10% H_2systems
71 For 100% H_2systems
72 The system is designed for continuous operation
73 105°C are not suitable for continuous operation
74 Measured with forming gas 90/10, 1.5 bar absolute, room temperature

IP code:	IP6K7
Weight:	80 g
ASIL:	ASIL B is aimed for
Probability of default:	FIT: 63.00 MTBF: 1,812 years PFH: 6.30E-08 PFD: 6.3E-04
ATEX:	-
Service life: with	IP6K7 enclosure qualified with an expected Service life of 5 years.[75] The system has been tested 100,000 switch-on and switch-off cycles.
Long-term stability:	Deviation <0.1 vol.-% in the first 5000h Operating time
Maintenance interval : 6 months.	We recommend checking the H_2sensor every check.
Measuring behaviour: addition, a specification differs must be tested for	The gas to be tested may have a maximum have a maximum velocity of 25m/s. In laminar flow is recommended. If the specification, the sensor tested for functionality.
Connection: request	Connector plug and 8x contacts for crimping are included. A cable can also be manufactured on can also be manufactured.
RoHS compliant: RoHS_DE_EN_V02_scan.pdf	Yes https://neoxid-cloud.de/Konformitaetserklaerung-
EMC compliant:	Yes https://neoxid-cloud.de/EMV_NEO1XXX_neoxid-group.pdf
Customs tariff number:	90271010[76]
COO:	Germany / NRW
EC-79/2009	Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

75 Measuring components are purely inorganic and are not consumed during measurement

76 This product is not assigned to an ECCN. It therefore belongs to the EAR99 classification and can be traded freely.

Accuracy of the measured values:[77]

Size	Accuracy
Hydrogen concentration	*± 0.3 vol.-% H_2*[78] *or ± 2 vol.-% H_2*[79]
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[80]	*± 0,3 °C*
Pressure	*± 20 mbar*

Table4 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO1XXX-V09_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Assembly:
The stepfile and 2D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO1XXX-Spritzguss.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system as shown in Figure 1a. If the sensor is mounted in a different spatial direction, there will be a small offset[81] , which must be corrected via a specific CAN message on ID 0x680[82] . The retaining pins or screws may have a maximum diameter of 5.5 mm. We recommend a tightening torque of 2.3 Nm.

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The sensor is fitted with a ribbed plug as a protective measure against small amounts of splash water. It must be ensured that the sensor is installed in such a way that this plug functions properly if an installation with a

77 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar
78 For 0-5 vol.% and 0-10 vol.% H_2systems
79 For 100 vol% H_2systems
80 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber
81 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.
82 See CAN Matrix Message Layout

gas flowing past is used.

Figure 1b: H_2sensor system NEO1XXX series from below

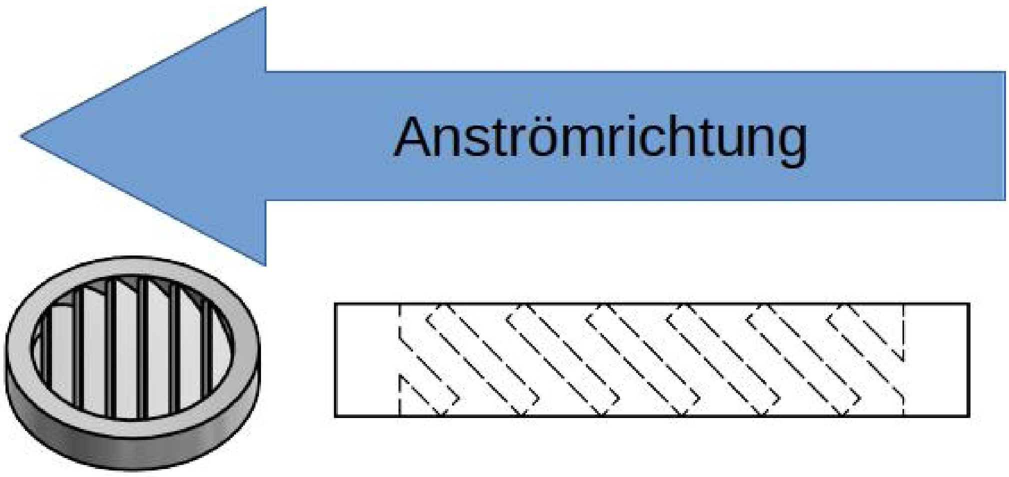


Figure 2a: Fitting ribbed plugs against the direction of flow

Hole pattern:

Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

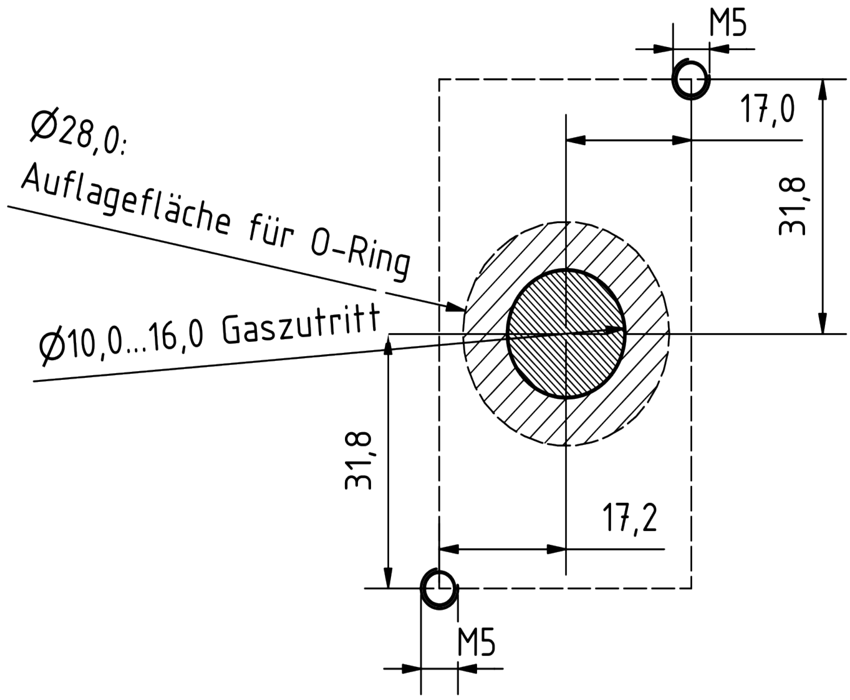
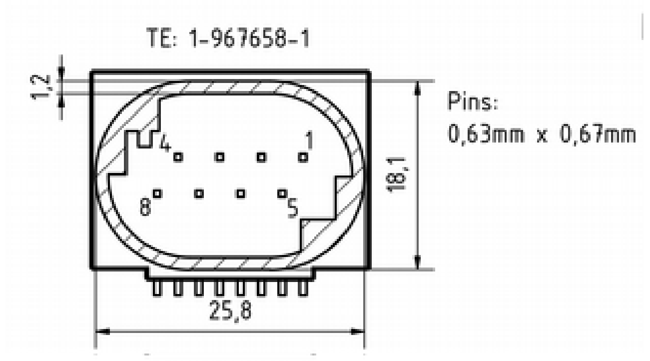


Figure 3b: Drilling template

	**PIN assignment** Pin 1: 9...+30V DC (< 2.4W) Pin 2: 0V DC (GND) Pin 3: CAN-High Pin 4: CAN-Low Pin 5: CAN-High loop-through Pin 6: CAN-Low loop through Pin 7: NC Pin 8: NC
8-pole housing socket: TE Connectivity MQS 1-967658-1	

Information on hydrogen ignition by the NEO1XXX series from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

A heating element is used in the H_2sensor, which is heated with 5V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the sensor (a Zener diode prevents operating voltages > 15 V). At 32 V, the heating element burnt out and still did not cause the explosive stoichiometric gas mixture to explode. In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavern. The sample gas must diffuse through a membrane.

Catalytic materials are not installed in the H_2sensor, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

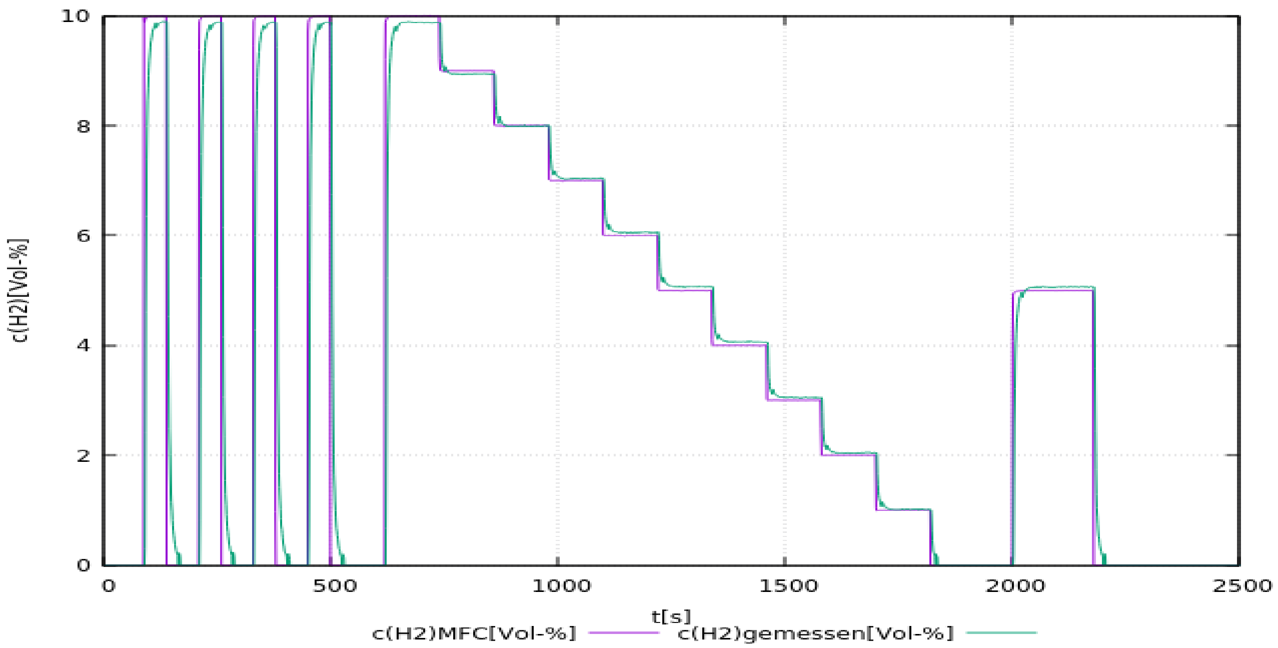


Figure 5a: Test of a sensor system NEO1010 up to 10 vol.-% H_2in 13 vol.-% O_2. Measured with a total flow of 2,000 sccm.

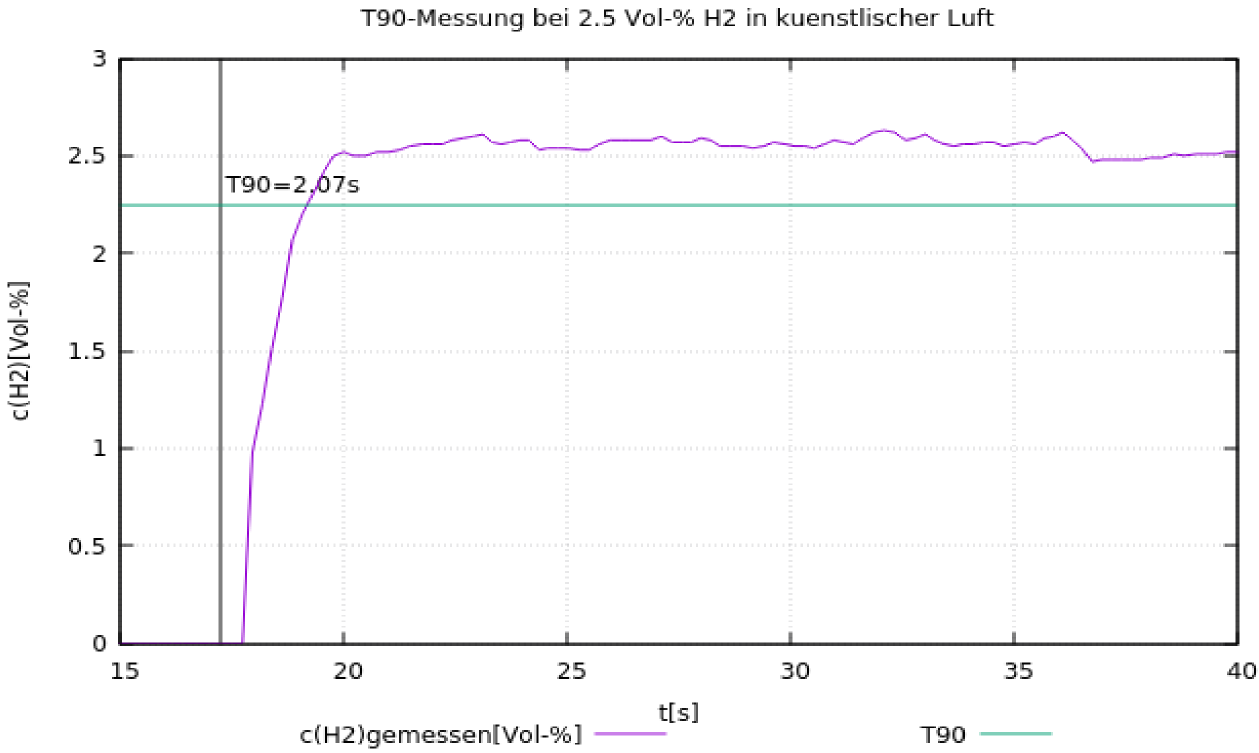


Figure 5b: t_{90}time determination with a NEO1005 sensor system by switching from 0 vol.-% $H_2$to 2.5 vol.-% H_2. Measured with a total flow of 4,000 sccm.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. The sensor can be terminated externally via connection pins 5-8.
The first CAN message is delivered 5s after system start. It is possible for the sensor to send a predefined message on a desired ID at a certain hydrogen concentration (CAN wake-up). This could be used to wake up other devices in the network from sleep mode.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	**CAN-ID 2**	**CAN-ID 3**	**CAN-ID 4**
NEO1005A (0-5 vol.-% H_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319
NEO1010A (0-10 vol.-% H_2)	0x320 & 0x321	0x328 & 0x329	0x330 & 0x331	0x338 & 0x339
NEO1100A (0-100 vol.-% H_2)	0x340 & 0x341	0x348 & 0x349	0x350 & 0x351	0x358 & 0x359

Zero point adjustment (CAN2.0A):

A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment. must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [83]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[84]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):

To change the ID on which the NEO1XXXA transmits, a CAN message can be sent:
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver

83 Details can be found in the operating instructions under chapter: "Maintenance and service"
84 0xYY describes a measure for the set zero point adjustment

MCP2562. The CAN lines are not terminated as standard. The sensor can be terminated externally via connection pins 5-8. CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message is delivered after 5s at system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO1005A (0-5 vol.-% H_2)	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359
NEO1010A (0-10 vol.-% H_2)	0x0CFF1459 & 0x0CFF1559	0x0CFF1659 & 0x0CFF1759	0x0CFF1859 & 0x0CFF1959	0x0CFF1A59 & 0x0CFF1B59
NEO1100A (0-100 vol.-% H_2)	0x0CFF1C59 & 0x0CFF1D59	0x0CFF1E59 & 0x0CFF1F59	0x0CFF2059 & 0x0CFF2159	0x0CFF2259 & 0x0CFF2359

Set CAN ID (CAN2.0B):
To change the ID on which the NEO1XXXA transmits, a CAN message can be sent:
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):
A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make a readjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To make an adjustment, the system should be free of hydrogen and purged with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [85]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[86]
*corresponds to the serial number of the individual sensor system.

CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured hydrogen concentration exceeds the 0.5 % by volume limit (c(H_2) from <0.5 % by volume to >= 0.5 % by volume).

The following message is sent:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: $c(H_2) = (Msg0-20)/100$
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of H_2 the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*

85 Details can be found in the operating instructions under chapter: "Maintenance and service"
86 0xYY describes a measure for the set zero point adjustment

Msg 6(Bit 56-63): Continuous message counter

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
The corresponding DBC file is available at the following link:
https://neoxid-cloud.de/H2-Sensor_NEO1XXX_V160.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration [Vol.-%]: $c(H_2)$ = (Msg0-20)/100
Msg 1(Bit 16-31): Water concentration [Vol.-%]: $c(H_{(2)}O)$ = (Msg1-20)/100
Msg 2(bit 32-47): Pressure [mbar]: p = Msg2
Msg 3(Bit 48-55): Temperature [°C]: T = (Msg3-60)
Temperature of the measuring chamber, usually higher than in the medium[87]
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0D59:
Msg 0(Bit 0-15): Hydrogen concentration_RAW[Vol.-%]: $c(H_2)$ = (Msg0-20)/100
Measurement of hydrogen concentration, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $H_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 5(Bit 56-63): Continuous message counter

Example for the interpretation of CAN messages:

Hex message from Sensor:
CAN Msg1: CAN ID1 320 00 14 00 CE 03 ED 68 D8
CAN Msg2: CAN ID2 321 00 0A 63 00 50 D 92 CA

Decimal translation:
CAN Msg1: Byte0+1: 20, Byte 2+3: 206, Byte 4+5: 1005 Byte 6: 104, Byte 7: 216
CAN Msg2: Byte0+1: 10, Byte 2: 99, Byte 3: 0, Byte 4+5:1293 Byte 6: 146, Byte 7: 202

Sensor translation:
CAN Msg1: $c(H_{2)}$ [vol.-%]: 0, $c(H_{(2)}O)$[vol.-%]: 1.86, p[mbar]: 1005, T[°C]: 44, CRC: 216
CAN Msg2: $c(H_{2)}$_raw[vol.-%]: -0.1, raw: 99, status: 0, serial#: 1293, SV: 14.6 Counter: 202

Explanation of the status byte:

Bit 24	0: there is currently no H_2O condensation	1: if H_2O condensation is present (acute)
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume

87 temperature deviates significantly from the gas temperature, especially when the gas is stationary. A direct correlation with the outside temperature is not possible.

Bit 29	0: No maintenance required	1: Sensor please wait
Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	0: there has never been H_2O condensation	1: if H_2O condensation ever occurred.

Example:
"Sensor running; no $H_{(2)}$ ..." → Status byte = 00000000 binary → 0 hexadecimal, 0 decimal
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal[88]
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal[89]
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Adjust baud rate:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Change CAN2.0 A/B:
0x680 0xA0 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Zero point adjustment:
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Further CAN commands (CAN2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

88 If the supply voltage is not sufficient, status byte 2 is output and a full signal is output at the H2 concentration.

89 Status byte 32 is set if the temperature (T > 101°C && T less than -40°C), the relative humidity (r.h. > 99%), the pressure (p > 2700 mbara && less than 600 mbara) are outside the defined range or 5,000 operating hours. The status byte is only reset with a zero point adjustment!

Data sheet hydrogen concentration sensor NEO974HT-ATEX, NEO983HT-ATEX and NEO986HT-ATEX, version 16.0, Marine

Product description:

Sensor system for measuring the hydrogen concentration in air, oxygen, nitrogen or oxygen-depleted air with temperature-, pressure- and humidity-compensated signal evaluation for automotive or industrial applications. Applicable in the range: 0.6 - 6 bara, 0 - 100% r.h. (non-condensing) and -40°C - 120°C.

Properties:

- Measuring ranges: 0-5 vol.-% $H_{(2)}$ (**NEO974HT-ATEX**), 0-10 vol.-% $H_{(2)}$ (**NEO983HT-ATEX**) or 0-100 vol.-% $H_{(2)}$ (**NEO986HT-ATEX**)
- Carrier gases air, N_2, oxygen from enriched air are possible
- Measuring signal independent of pressure, temperature and humidity
- Signal output via CAN 2.0, Modbus RTU via RS485, 0-10V or 4-20mA
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Factory calibrated and ready for immediate use
- Suitable for crankcase ventilation
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary
- CAN WakeUp function implemented

Figure 1a: H_2concentration sensor version NEO9XXHT-ATEX-Marine

Sensor system characteristics:

Supply voltage: 12 - 30 V DC[90]

Energy consumption: < 2,4 W

Possible H_2 sensitivity:

0 - 100 vol.-% H_2	**NEO986HT-ATEX**
0 - 10 vol.-% H_2	**NEO983HT-ATEX**
0 - 5 vol.-% H_2	**NEO974HT-ATEX**

Accuracy: ± 0.3 vol.-% H_2[91] or ± 2 vol.-% H_2[92]

Detection limit: < 0.3 vol.-% $H_{(2)}$ (1) or < 0.5 vol.-% $H_{(2)}$ (2)

Response time t_{90}: < 5 s

Decay time t_{10}: < 5 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2 concentration[93]

Media temperature: - 40°C - 120°C

Ambient temperature: - 40°C - 100°C
The cold start at -40°C was tested.

Pressure range: 0.6 - 5 bar absolute, i.e. 60 - 500 kPa

Humidity: 0 - 100 % r.h. (non-condensing)[94]

Carrier gas: Air, N_2, oxygen depleted air

Cross-sensitivities: Helium, tbd

Signal :[95] CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on page13
Modbus RTU via RS485 interface on page 15
4-20 mA on page 112
0-10 V on page 132

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm for CAN bus and Modbus RTU
250 ppm at 4-20 mA or 0-10V

90 For analogue 0-10V output, please apply more than 15 VDC.
91 For 0-5 vol.-% and 0-10 vol.-% H_2 systems
92 For 100 vol% H_2 systems
93 The system is designed for continuous operation
94 In particular, splash water must be kept away from the sensor opening
95 Signals are described in the "Explanation of signals" section

Housing: Size: 109 x 39 x 83 mm³, housing cover and base plate base plate in contact with media made of

1.4404, Tighten M5 screws to the measuring chamber
with 3Nm.

Leakage rate: <10^{-5}mbar l / s [96]

Long-term stability/drift: Deviation <0.1 vol.-% in the first 5,000h
Operating time

IP code: IP6K7

Weight: 950 g

SIL: -

ATEX: **II 2G/- Ex db IIB+H2 T1 Gb/- at -40°C < $_{T(a)}$< 100°C**
https://neoxid-cloud.de/Konformitaetserklaerung_Muster_scan.pdf

Type of protection: Flameproof Ex D

Service life: IP6K7 enclosure qualified with an expected
Service life of 5 years.[97] The system has been tested
with 100,000 switch-on and switch-off cycles.

Maintenance interval : We recommend checking the H_2sensor every
6 months. check.

Measuring behaviour: The gas to be tested may have a maximum have a maximum velocity of 25m/s. In
addition, a laminar flow is recommended. If the
specification differs specification, the sensor
must be tested for tested for functionality.

Connection cable: 3 m enclosed;

RoHS compliant: Yes https://neoxid-cloud.de/Konformitaetserklaerung-
RoHS_DE_EN_V02_scan.pdf

Customs tariff number: 90271010

COO: Germany / NRW

ECCN: EAR99

EC-79/2009 Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

96 Measured with forming gas 90/10, 1.5 bar absolute, room temperature

97 Measuring components are purely inorganic and are not consumed during measurement

Accuracy of the measured values:[98]

Size	Accuracy
Hydrogen concentration	*± 0.3 vol.-% H_2*[99] *or ± 2 vol.-% H_2*[100]
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[101]	*± 0,3 °C*
Pressure	*± 20 mbar*

Table5 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO9XXHT_ATEX-Marine-V011_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Mounting the sensor:
2-D drawing of the sensor is available here:
https://neoxid-cloud.de/NEO9XXX-TKMS-241205-mit-Teileliste.pdf
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request (see data sheet_Adapter_NEO1XX_V146_EN_EN). To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a spatial direction other than horizontally, a small offset[102] occurs; this must be corrected via a specific CAN message on ID 0x680 (zero point adjustment).

Scope of delivery:
In addition to the sensor unit, 4x M5 screws are supplied for mounting the sensor.

98 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar
99 For 0-5 vol.-% and 0-10 vol.-% H_2systems
100 For 100 vol.-% H_2systems
101 The temperature in the measuring chamber is always measured too high as the sensor elements heat up the measuring chamber
102 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The sensor can be fitted with heating cartridges, which are also available on request. In particular, standstill condensation can be effectively avoided in this way. As a further protective measure against small amounts of splash water, the sensor is fitted with two sintered metal discs.

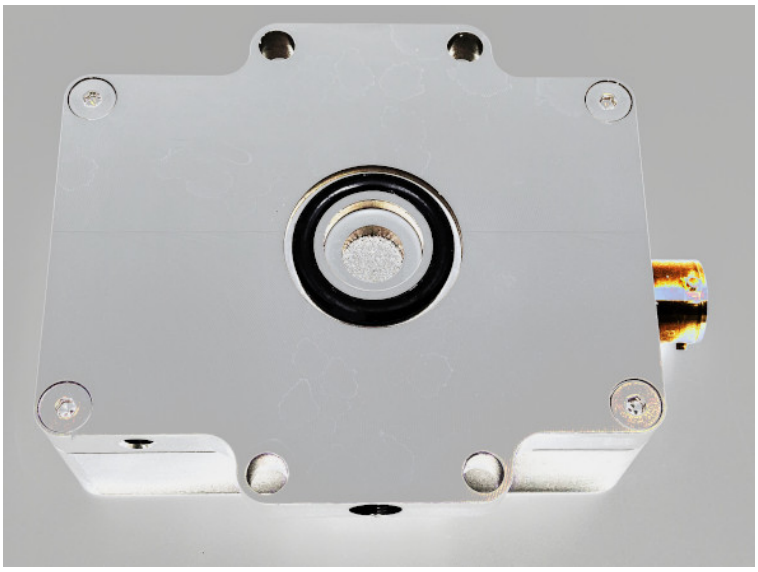


Figure 2b: NEO9XXHT-ATEX marine O-ring and sintered metal discs

Hole pattern:

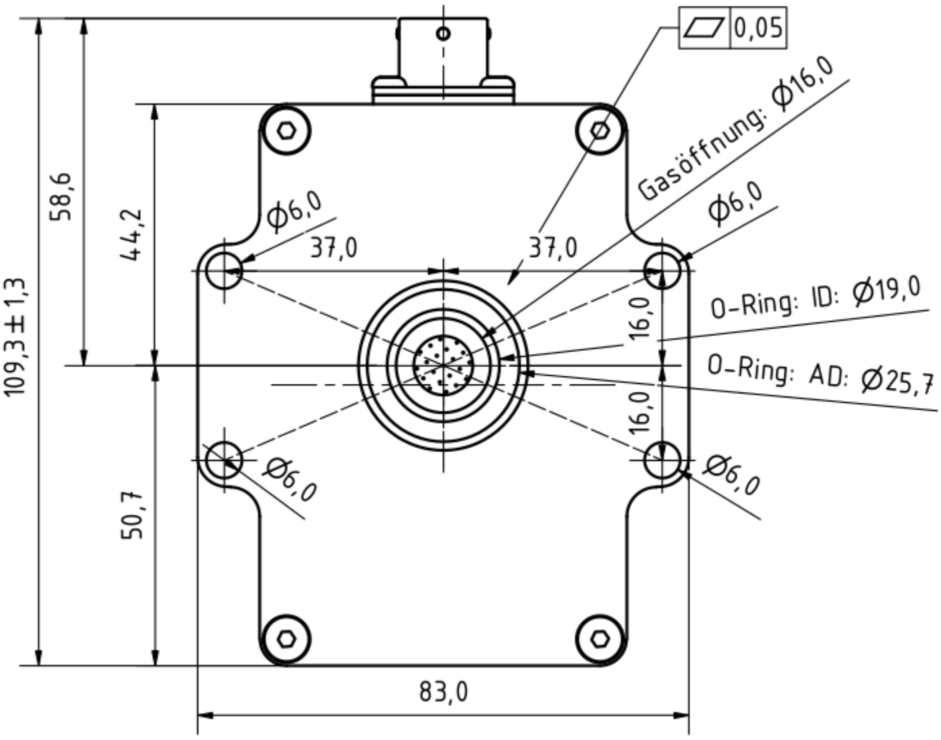


Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

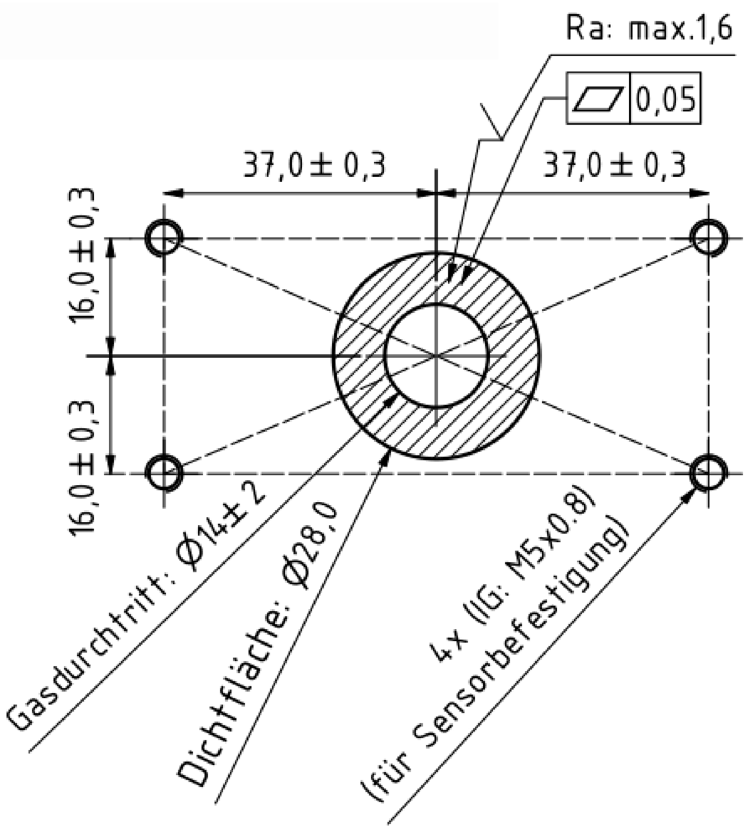
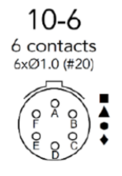
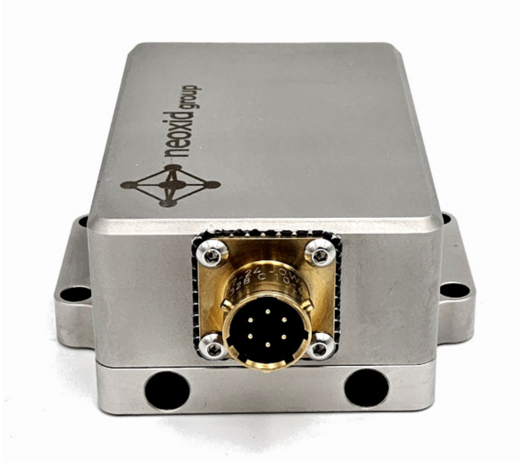


Figure 3b: Drilling template

Electrical PIN assignment

A: 24V+
B: 0V
C: __I+ (+)
E: __I- (-)





Pin A: Versorgungsspannung (24V+)
Pin B: Masse (GND)
Pin C: 4-20 mA Signal (I+)
Pin E: 4-20 mA Signal (I-)
Pin D: CAN-High (CANH)
Pin F: CAN-Low (CANL)

Information on hydrogen ignition by the NEO974HT-ATEX/NEO983HT-ATEX/ NEO986HT-ATEX from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

The H_2sensor NEO974HT-ATEX/NEO983HT-ATEX/NEO986HT-ATEX uses a heating element that is heated with 5 V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the NEO974HT-ATEX (a Zener diode prevents excessively high operating voltages). In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavity.

Catalytic materials are not installed in the H_2sensor NEO974HT-ATEX/NEO983HT-ATEX/NEO986HT-ATEX, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors NEO974HT-ATEX/NEO983HT-ATEX/NEO986HT-ATEX. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

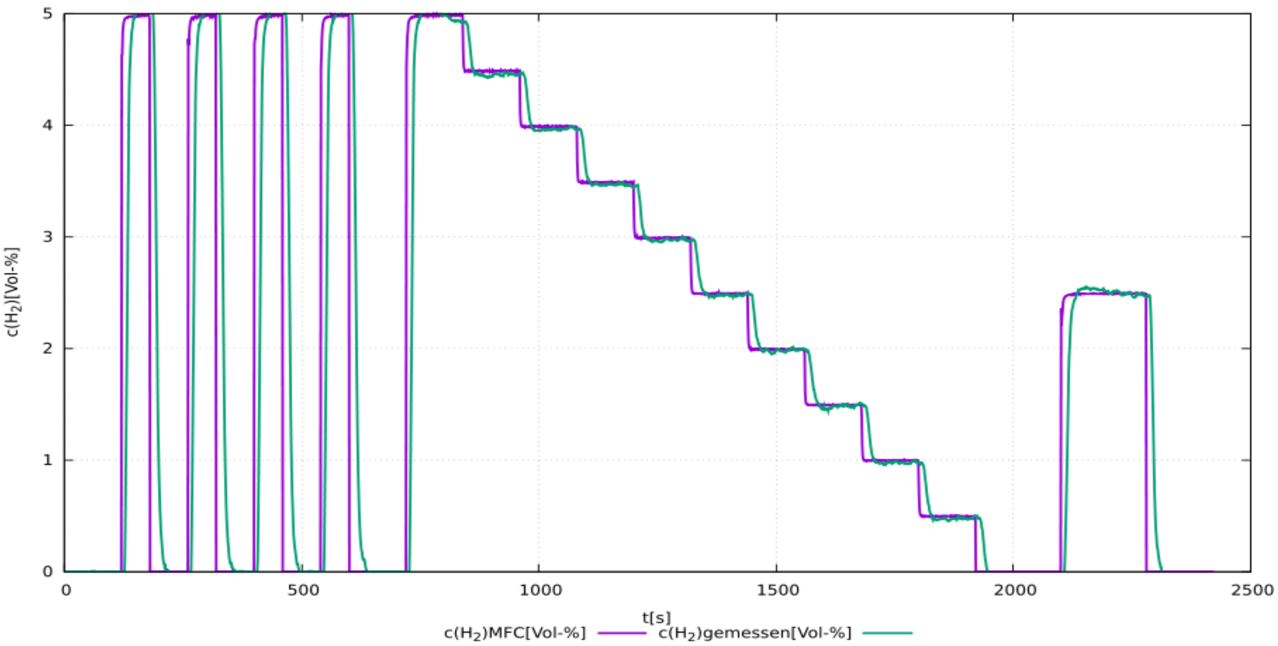


Figure 4a: Test of a sensor system NEO974HT-ATEX 0 - 5 vol.-% H_2in 21 vol.-% O_2. Measured with a total flow of 1,000 sccm.

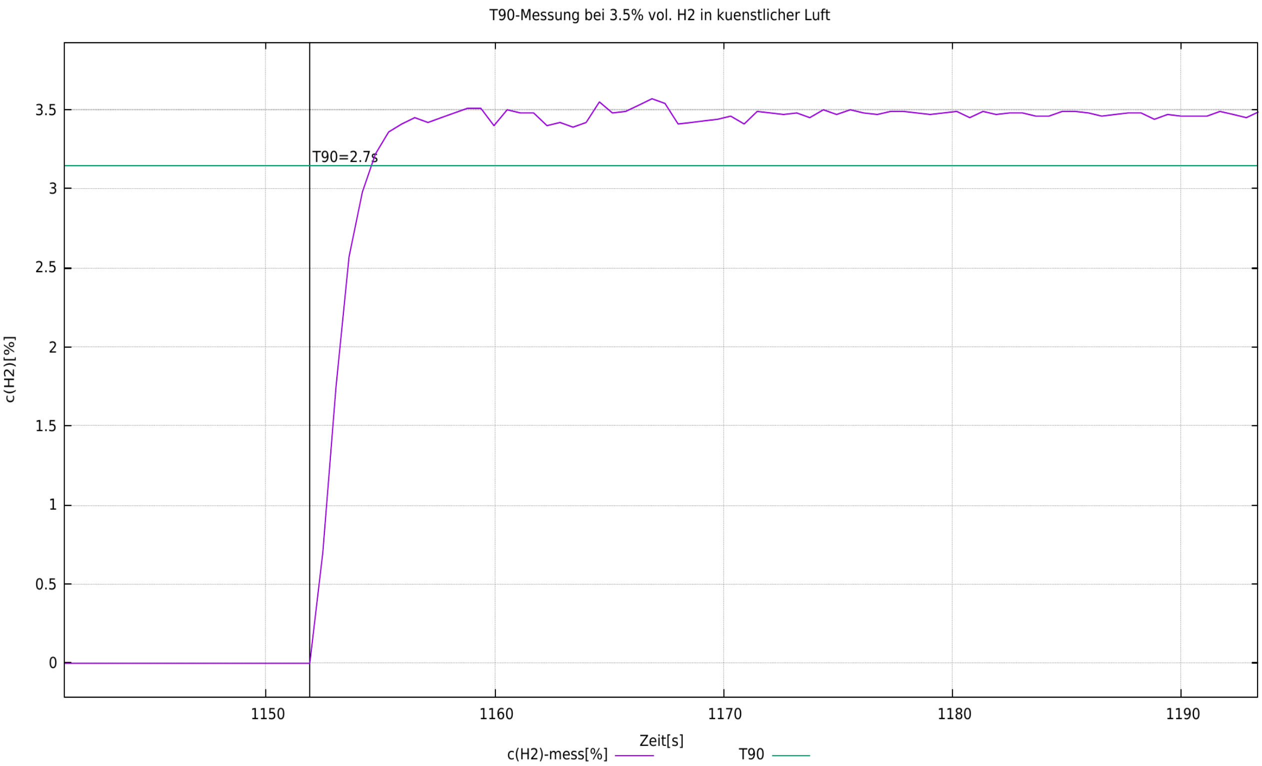


Figure 4b: t_{90}time determination with a sensor system by switching from 0 vol.-% $H_2$to 3.5 vol.-% H_2. Measured with a total flow of 1,000 sccm.

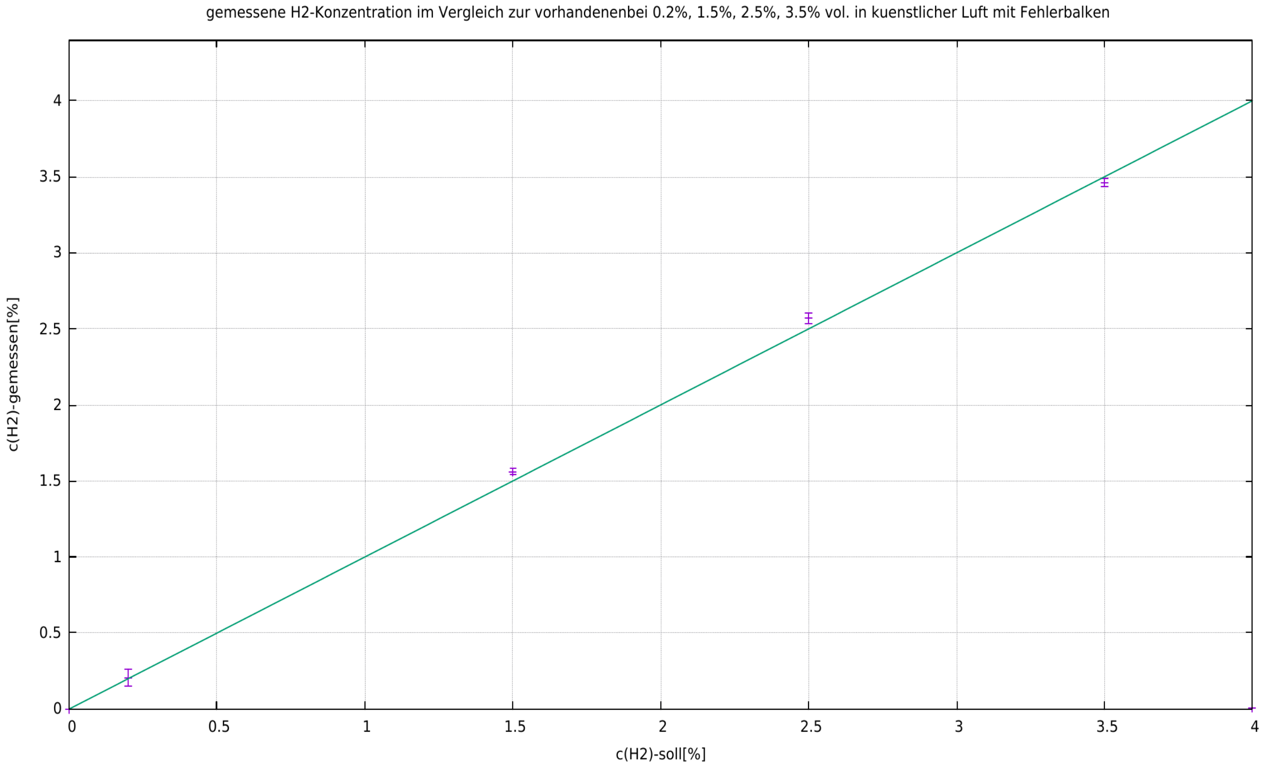


Figure 4c: Comparative measurement of the set hydrogen concentration and the measured hydrogen concentration with an error bar of three standard deviations of the measurement signal.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO974HTA (0-5 vol.-% H_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319
NEO983HTA (0-10 vol.-% H_2)	0x320 & 0x321	0x328 & 0x329	0x330 & 0x331	0x338 & 0x339
NEO986HTA (0-100 vol.-% H_2)	0x340 & 0x341	0x348 & 0x349	0x350 & 0x351	0x358 & 0x359

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment.
must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [103]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[104]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To set the CAN ID, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

103 Details can be found in the operating instructions under chapter: "Maintenance and service"
104 0xYY describes a measure for the set zero point adjustment

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/H2-Sensor_NEO9XX_V146.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = (Msg0-20)/100
Msg 1(Bit 16-31): Water concentration [vol.-%]: c($H_{(2)}O$) = (Msg1-20)/100
Msg 2(bit 32-47): Pressure [mbar]: p = Msg2
Msg 3(Bit 48-55): Temperature [°C]: *T = (Msg3-60)*
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration_RAW[vol.-%]: c(H_2) = (Msg0-20)/100
Measurement of the hydrogen content, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with the defined carrier gas, without humidity, normal pressure and in the absence of H_2, the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

Example for the interpretation of CAN messages:
Hex message from Sensor:
CAN Msg1: CAN ID1 320 00 14 00 CE 03 ED 68 D8
CAN Msg2: CAN ID2 321 00 0A 63 00 50 D 92 CA

Decimal translation:
CAN Msg1: Byte0+1: 20, Byte 2+3: 206, Byte 4+5: 1005 Byte 6: 104, Byte 7: 216
CAN Msg2: Byte0+1: 10, Byte 2: 99, Byte 3: 0, Byte 4+5:1293 Byte 6: 146, Byte 7: 202

Sensor translation:
CAN Msg1: c(H_2) [vol.-%]: 0, c($H_{(2)}O$)[vol.-%]: 1.86, p[mbar]: 1005, T[°C]: 44, CRC: 216
CAN Msg2: c(H_2) _raw[vol.-%]: -0.1, raw: 99, status: 0, serial#: 1293, SV: 14.6 Counter: 202

Explanation of the status byte:

Bit 24	0: there is currently no H_2O condensation	1: if H_2O condensation is present (acute)
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume

Bit 29	0: No maintenance required	1: Sensor please wait
Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	0: there has never been H_2O condensation	1: if H_2O condensation ever occurred.

Example:
"Sensor running; no $H_{(2)}$ .." → Status byte = 00000000 binary → 0 hexadecimal, 0 decimal
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal[105]
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal[106]
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN 2.0A):

Adjust baud rate:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Change CAN2.0 A/B:
0x680 0xA0 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Zero point adjustment:
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Further CAN commands (CAN 2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

105 If the supply voltage is not sufficient, status byte 2 is output and a full signal is output at the H2 concentration.

106 Status byte 32 is set if the temperature (T > 120°C && T less than -40°C), the relative humidity (r.h. > 99%), the pressure (p > 6000 mbara && less than 600 mbara) are outside the defined range or 5,000 operating hours. The status byte is only reset with a zero point adjustment!

Analogue 4-20mA - Series I

I[mA]	$c(H_{2})$ [vol.-%]	Comment
4 - 20 mA[107]	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration. This means that 2.5 vol-% $H_{(2)}$,for example, is then output as 12mA with a 5 vol-% H_2sensor system. In the heat-up phase and during a critical fault, a current <4 mA is output (usually approx. 3.6 mA)

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The maximum permissible load is 450 Ohm.

107 In earlier versions of this sensor, 7.2 to 20mA was given as the measuring range.

Digital Modbus via RS485 or EIA/TIA-485 - NEO series M

In serial master-slave communication, our NEO sensors function as slaves with the start slave ID 1 and a baud rate of 9,600 in 8N1, i.e. data bits: 8, parity: none, stop bits: 1. The 16-bit registers are defined as signed integers in big-endian, i.e. values in the range -32,768 to 32,767. The Modbus lines are not terminated.

Input register:

Name	Description of the	Scaling[108]	Unit	Register addresses	INPUT register address (hex / dec)
Hydrogen concentration	H_2Volume concentration (Example: 2030 = 20.3 vol.-%)	100	Vol.-%	3x257	0x100 / 256_{dec}
Water concentration	H_2O Volume concentration (Example: 2330 = 23.3 vol.-%)	100	Vol.-%	3x258	0x101 / 257_{dec}
Pressure	Pressure as absolute pressure (Example: 1033 = 1033 mbar)	1	mbar a	3x259	0x102 / 258_{dec}
Temperature	Temperature in measuring cavern (Example: 6250 = 62.5°C)	100	°C	3x260	0x103 / 259_{dec}
Hydrogen concentration _RAW	Hydrogen concentration (Example: 2750 = 27.5 vol.-%)	100	Vol.-%	3x261	0x104 / 260_{dec}
Gross value	Raw value = 100 in the absence of water and hydrogen and otherwise normal air.	1	-	3x262	0x105 / 261_{dec}
Status byte	See "Explanations on the status byte" in the "Signal explanation" section: "CAN".	1	-	3x263	0x106 / 262_{dec}
Serial number	S/N: P number, which is noted on the outside of the device. (Example: 3626 = P-3626)	1	-	3x264	0x107 / 263_{dec}
Software version	Version of the sensor software (Example: 156 = version 15.6)	10	-	3x265	0x108 / 264_{dec}
Message counter	High running counter 0-255	1	-	3x266	0x109 / 265_{dec}
Check value	00000000 01010101 value is 85, which can be used to check the byte order	1	-	3x267	0x10A / 266_{dec}

Holding register:

Name	Description of the	Regist	HOLDING

108 When reading with a PLC, make sure that the data type is set to "Real" so that the signed integer can also be displayed as a comma number.

		er addresses	Register address (hex / dec)
Baud rate	default: 9,600 Specifying the baud rate of the Modbus RTU interface: 4,800, 9,600 or 19,200	4x001	0x00 / 0_{dec}
Slave ID	default: 1 Possible slave IDs of the sensor 1-247	4x002	0x01 / 1_{dec}
Mode parity	default: 0 = parity: none, stop bit: 1 0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2	4x003	0x02 / 2_{dec}
Zero point adjustment	default: 0 If a 1 is written to the register, a zero point adjustment is carried out here and then changed the register to 2.	4x004	0x03 / 3_{dec}

Changes to the factory settings are only applied after restarting the sensor.

Data sheet hydrogen concentration sensor NEO974HT-ATEX, NEO983HT-ATEX and NEO986HT-ATEX, version 15.6

Product description:

Sensor system for measuring the hydrogen concentration in air, oxygen, nitrogen or oxygen-depleted air with temperature-, pressure- and humidity-compensated signal evaluation for automotive or industrial applications. Applicable in the range: 0.6 - 5 bara, 0 - 100% r.h. (non-condensing) and -40°C - 120°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measuring ranges: 0-5 vol.-% $H_{(2)}$ $_($**NEO974HT-ATEX**), 0-10 vol.-% $H_{(2)}$ $_($**NEO983HT-ATEX**) or 0-100 vol.-% $H_{(2)}$ $_($**NEO986HT-ATEX**)
- Carrier gases air, N_2, oxygen from enriched air are possible
- Measuring signal independent of pressure, temperature and humidity
- Signal output via CAN 2.0, Modbus RTU via RS485, 0-10V or 4-20mA
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Factory calibrated and ready for immediate use
- Suitable for crankcase ventilation
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary
- CAN WakeUp function implemented
- Encrypted CAN communication on demand

Figure 1a: H_2concentration sensor version NEO9XXHT-ATEX

...go to English version

Sensor system characteristics:

Supply voltage: 12 - 30 V DC[109]

Energy consumption: < 2,4 W

Possible H_2sensitivity:	0 - 100 vol.-% H_2	**NEO986HT-ATEX**
	0 - 10 vol.-% H_2	**NEO983HT-ATEX**
	0 - 5 vol.-% H_2	**NEO974HT-ATEX**

Accuracy: ± 0.3 vol.-% H_2[110] or ± 2 vol.-% H_2[111]

Detection limit: < 0.3 vol.-% $H_{(2)}$ ([1])or < 0.5 vol.-% $H_{(2)}$ ([2])

Response time t_{90}: < 5 s

Decay time t_{10}: < 5 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[112]

Media temperature: - 40°C - 120°C
(can also be calibrated down to -60°C)

Ambient temperature: - 40°C - 100°C
The cold start at -40°C was tested.

Pressure range: 0.6 - 6 bar absolute, i.e. 60 - 600 kPa
(can also be calibrated up to 0.25 bar a, i.e. 25 kPa)

Air humidity: 0 - 100 % r.h. (non-condensing)[113]

Carrier gas: Air, N_2, oxygen depleted air

Cross-sensitivities: Helium, tbd

Signal :[114] CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on page13
Modbus RTU via RS485 interface on page 17

4-20 mA on page 112
0-10 V on page 132

Output/measurement interval: 100 ms / 10 Hz

109 For analogue 0-10V output, please apply more than 15 VDC.
110 For 0-5 vol.-% and 0-10 vol.-% H_2systems
111 For 100 vol% H_2systems
112 The system is designed for continuous operation
113 In particular, splash water must be kept away from the sensor opening
114 Signals are described in the "Explanation of signals" section

Resolution:	100 ppm for CAN bus and Modbus RTU 250 ppm at 4-20 mA or 0-10V

Housing: Size: 95 x 83 x 48 mm³, housing cover made of EN AW 6060 and media-contacting base plate made of 316L or 1.4404, tighten M5 screws to the measuring chamber with 3Nm.

Leakage rate: <10^{-5}mbar l / s [115]

Long-term stability/drift: Deviation <0.1 vol.-% in the first 5000h Operating time

IP code: IP6K7

Weight: < 810 g

SIL: -

ATEX: **II 2G/- Ex db IIB+H2 T1 Gb/- at -40°C < $_{T(a)}$< 100°C**
https://neoxid-cloud.de/Konformitaetserklaerung_Muster_scan.pdf

Type of protection: Flameproof Ex D

Service life: IP6K7 enclosure qualified with an expected Service life of 5 years.[116] The system has been tested with 100,000 switch-on and switch-off cycles.

Maintenance interval : We recommend checking the H_2sensor every 6 months. check.

Measuring behaviour: The gas to be tested may have a maximum have a maximum velocity of 25m/s. In addition, a laminar flow is recommended. If the specification differs specification, the sensor must be tested for tested for functionality.

Connection cable: 3 m enclosed;

RoHS compliant: Yes https://neoxid-cloud.de/Konformitaetserklaerung-RoHS_DE_EN_V02_scan.pdf

Customs tariff number: 90271010

COO: Germany / NRW

ECCN: EAR99

EC-79/2009 Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

115 Measured with forming gas 90/10, 1.5 bar absolute, room temperature
116 Measuring components are purely inorganic and are not consumed during measurement

Accuracy of the measured values:[117]

Size	Accuracy
Hydrogen concentration	*± 0.3 vol.-% H_2*[118] *or ± 2 vol.-% H_2*[119]
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[120]	*± 0,3 °C*
Pressure	*± 20 mbar*

Table6 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO9XXATEX-V011_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Mounting the sensor:
The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO9XXHT-ATEX-Modell-und-Zeichnung.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request (see data sheet_Adapter_NEO1XX_V146_EN_EN). To use the sensor as a room monitoring sensor, the NEO160 adapter is available, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a spatial direction other than horizontally, a small offset[121] occurs; this must be corrected via a specific CAN message on ID 0x680 (zero point adjustment, see page). 14

Scope of delivery:
In addition to the sensor unit, 4x M5 screws are supplied for mounting the sensor, as well as a 3 m connection cable with cable end sleeves.

117 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar
118 For 0-5 vol.-% and 0-10 vol.-% H_2systems
119 For 100 vol.-% H_2systems
120 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber
121 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.

ATEX area:

The sensor as such is not suitable for installation in an explosive atmosphere. It should be connected to an explosive atmosphere. The resulting ATEX Zone 1 area can be seen here:

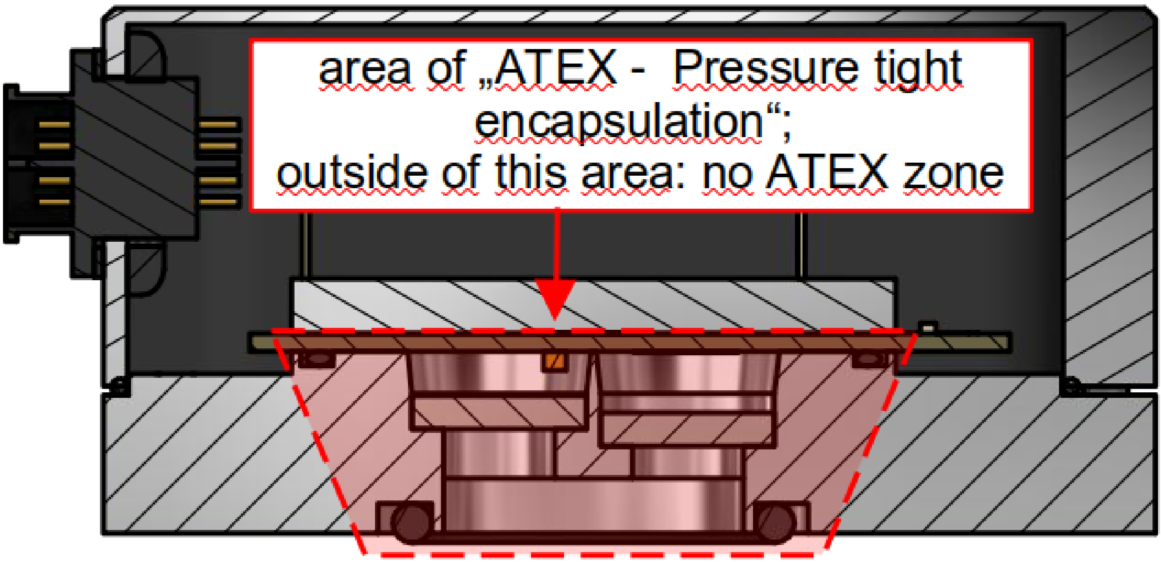


Figure 2a: Flameproof enclosure area

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The sensor can be equipped with heating cartridges, which are also available on request. In particular, standstill condensation can be effectively avoided in this way. As a further protective measure against small amounts of splash water, the sensor is fitted with two sintered metal discs.

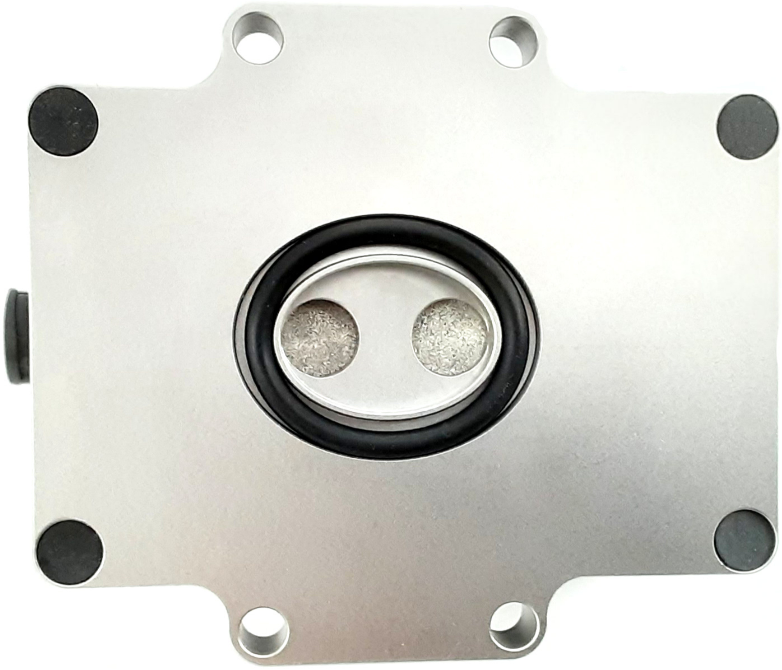


Figure 2b: NEO9XXHT-ATEX O-ring and sintered metal discs

Hole pattern:

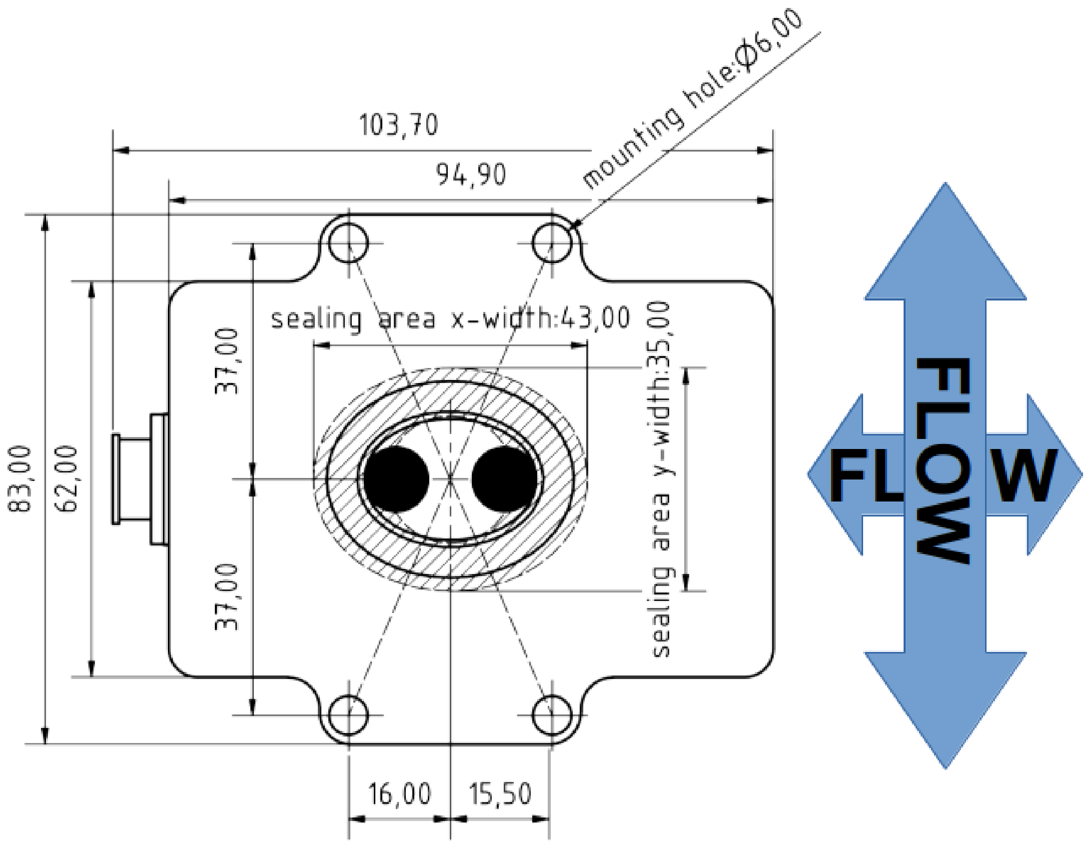


Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

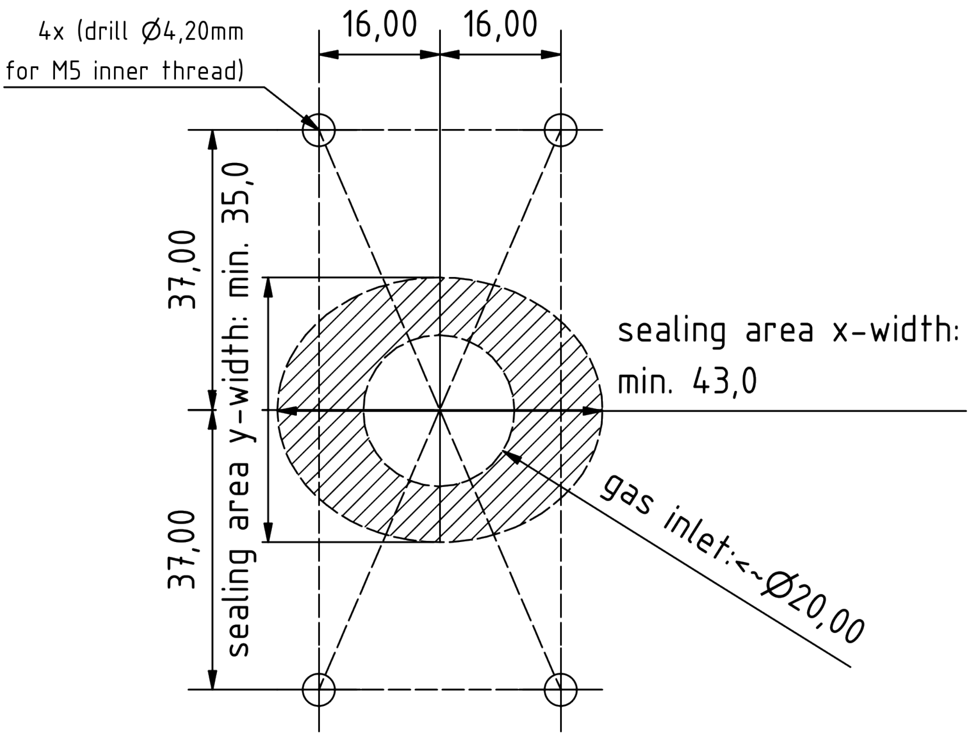
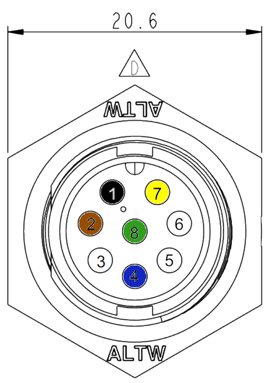


Figure 3b: Drilling template

Electrical PIN assignment



Housing plug

PIN no.	Description of the	Colour
1	VCC+ 12 ... 30V DC (min.: 2.4W)	black
2	GND 0V DC	brown
3	CAN-High (opt. DAC)+	white
4	CAN-Low (opt. DAC-)	blue
5	*service port A*	-
6	*service port B*	-
7	DAC + / RS485 A	yellow
8	DAC - / RS485 B	green
	Shielding (optional GND)	green/yellow

8-pin housing connector: Amphenol LTW: ABD-08RMMS-LC7001
8-pin cable socket: Amphenol LTW: BD-08BFFA-LL7001

The following figure 3c shows the enclosed connection cable with angled socket :

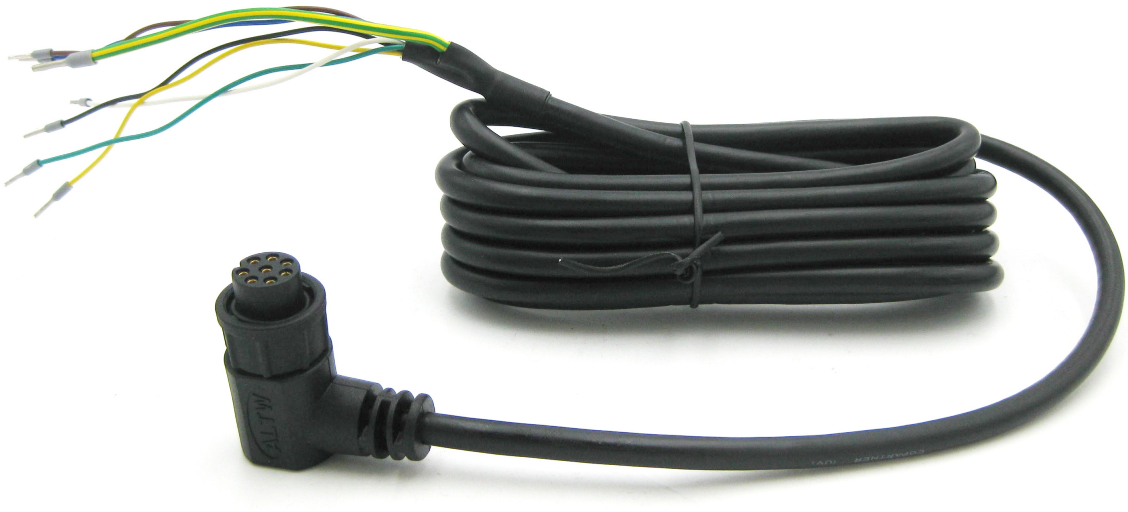


Figure *3c*: *Connection cable with angled socket*

Simultaneous signal output via CAN bus and an analogue interface
If required, the sensor's measurement data can be output simultaneously via the CAN bus interface and an analogue interface (4-20 mA, 0-10V). If an analogue interface (4-20 mA, 0-10V) is selected in addition to the CAN bus, the analogue signal is output via PIN 7 & 8. CAN addressing via the connector is then no longer possible!

Information on hydrogen ignition by the NEO974HT-ATEX/NEO983HT-ATEX/ NEO986HT-ATEX from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

The H_2sensor NEO974HT-ATEX/NEO983HT-ATEX/NEO986HT-ATEX uses a heating element that is heated with 5 V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the NEO974HT-ATEX (a Zener diode prevents excessively high operating voltages). In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavity.

Catalytic materials are not installed in the H_2sensor NEO974HT-ATEX/NEO983HT-ATEX/NEO986HT-ATEX, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors NEO974HT-ATEX/NEO983HT-ATEX/NEO986HT-ATEX. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.
Resolution and response behaviour:

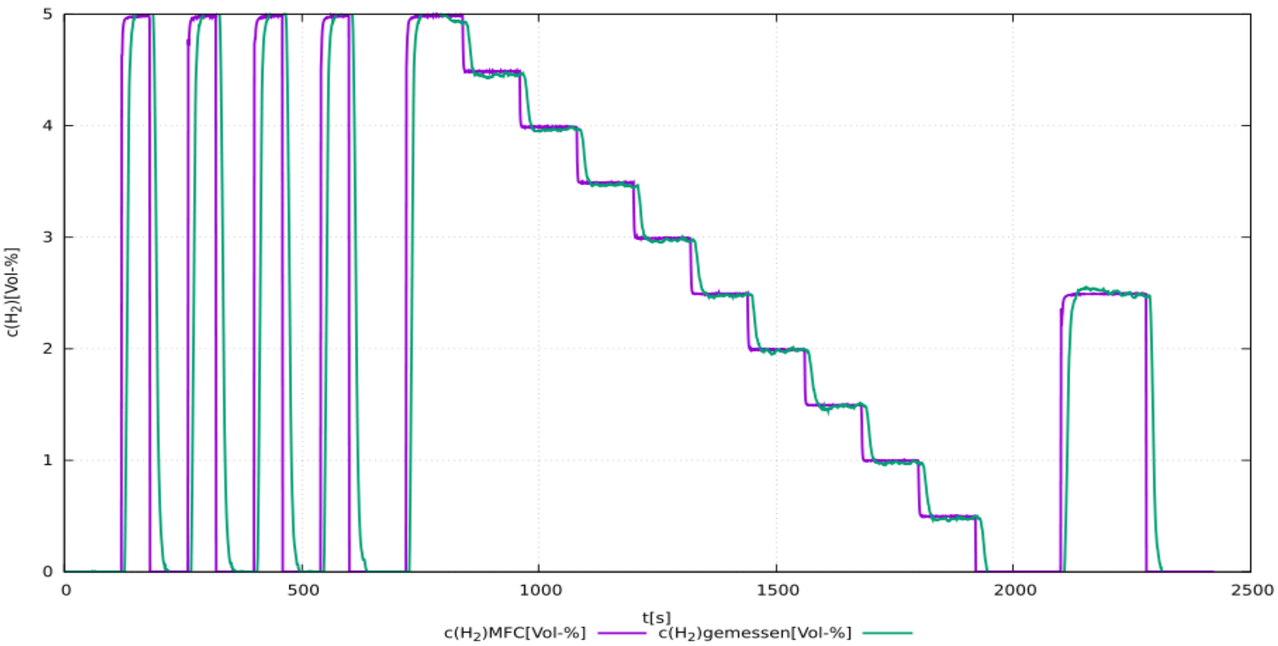


Figure 4a: Test of a sensor system NEO974HT-ATEX 0 - 5 vol.-% H_2in 21 vol.-% O_2. Measured with a total flow of 1,000 sccm.

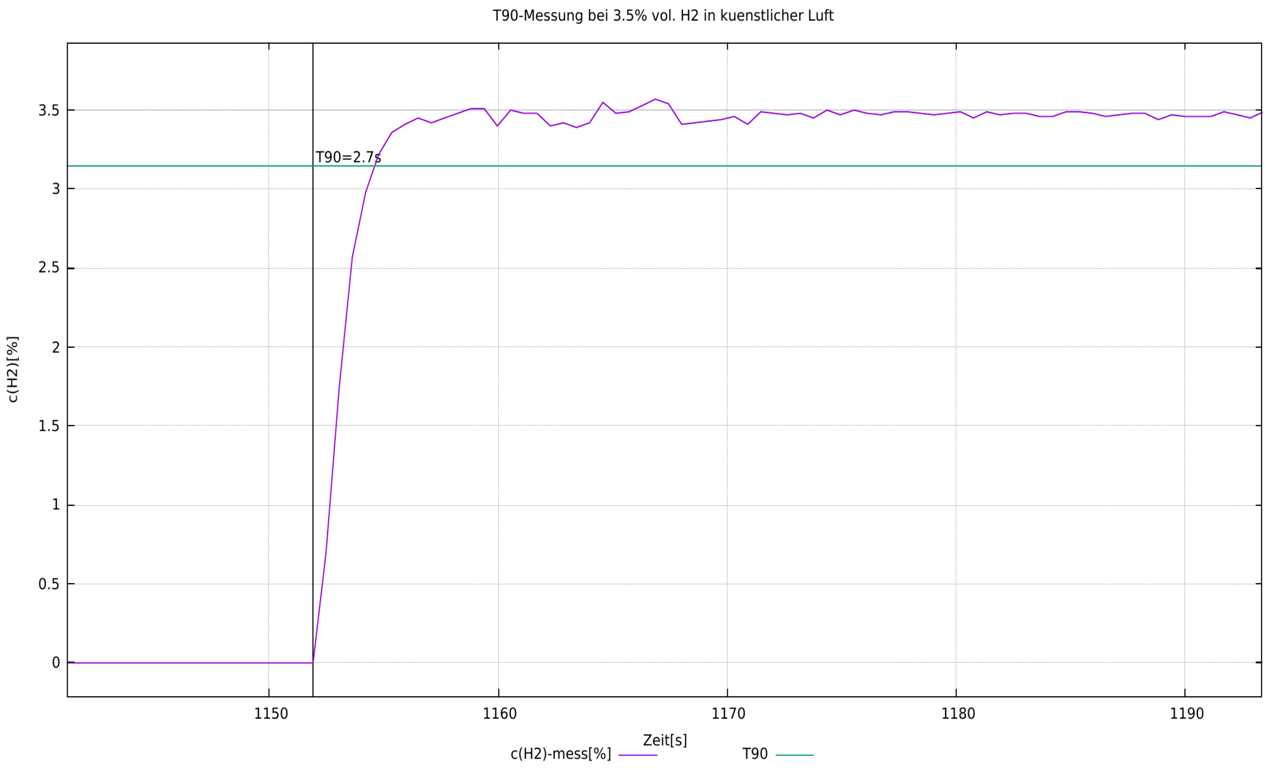


Figure 4b: t_{90}time determination with a sensor system by switching from 0 vol.-% $H_2$to 3.5 vol.-% H_2. Measured with a total flow of 1,000 sccm.

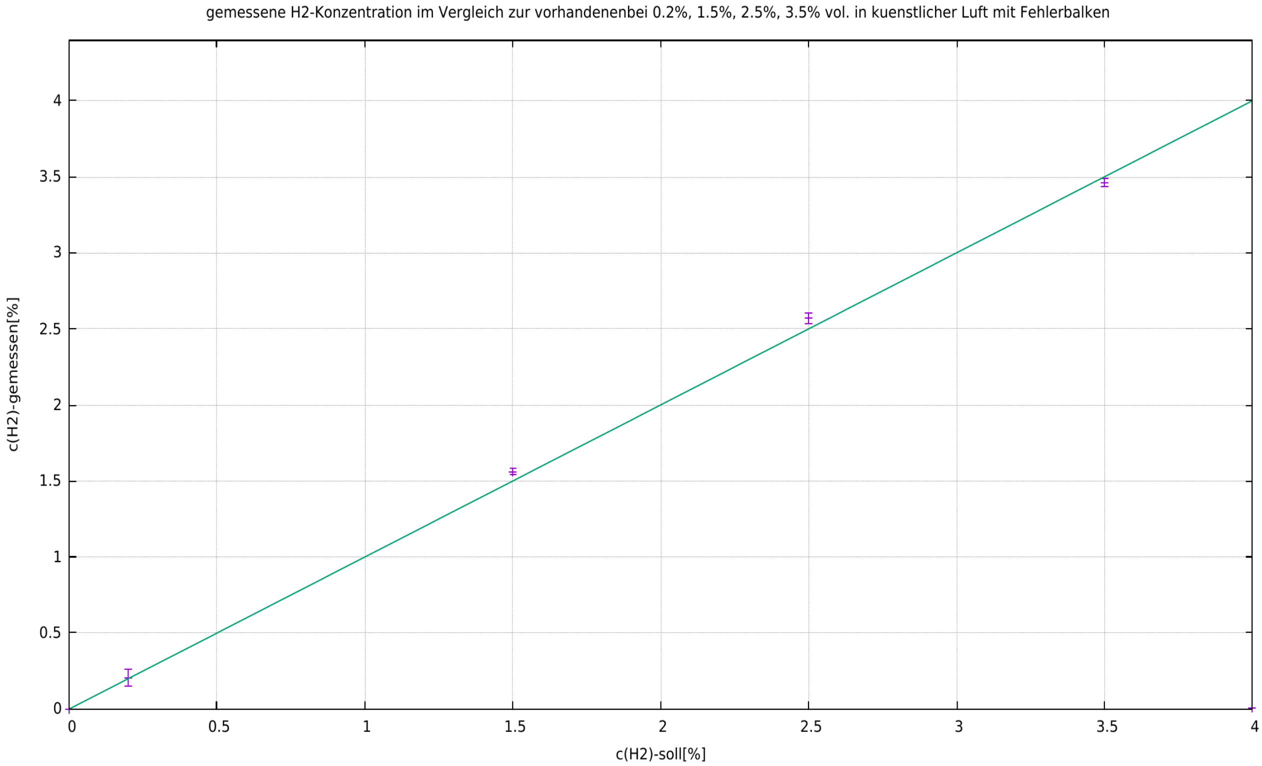


Figure 4c: Comparative measurement of the set hydrogen concentration and the measured hydrogen concentration with an error bar of three standard deviations of the measurement signal.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO974HTA (0-5 vol.-% H_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319
NEO983HTA (0-10 vol.-% H_2)	0x320 & 0x321	0x328 & 0x329	0x330 & 0x331	0x338 & 0x339
NEO986HTA (0-100 vol.-% H_2)	0x340 & 0x341	0x348 & 0x349	0x350 & 0x351	0x358 & 0x359

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment.
must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [122]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[123]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To set the CAN ID, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message after 5s at system start.

122 Details can be found in the operating instructions under chapter: "Maintenance and service"
123 0xYY describes a measure for the set zero point adjustment

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO974HTA (0-5 vol.-% H_2)	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359
NEO983HTA (0-10 vol.-% H_2)	0x0CFF1459 & 0x0CFF1559	0x0CFF1659 & 0x0CFF1759	0x0CFF1859 & 0x0CFF1959	0x0CFF1A59 & 0x0CFF1B59
NEO986HTA (0-100 vol.-% H_2)	0x0CFF1C59 & 0x0CFF1D59	0x0CFF1E59 & 0x0CFF1F59	0x0CFF2059 & 0x0CFF2159	0x0CFF2259 & 0x0CFF2359

Set CAN ID (CAN2.0B):
To set the CAN ID, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):
A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make an adjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [124]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[125]
*corresponds to the serial number of the individual sensor system.

CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured hydrogen concentration exceeds the 0.5 % by volume limit ($c(H_2)$ from <0.5 % by volume to >= 0.5 % by volume).

The following message is sent:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: $c(H_2) = (Msg0-20)/100$
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with the defined carrier gas, without humidity, normal pressure and in the absence of H_2, the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

124 Details can be found in the operating instructions under chapter: "Maintenance and service"
125 0xYY describes a measure for the set zero point adjustment

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/H2-Sensor_NEO9XX_V146.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: $c(H_2) = (Msg0-20)/100$
Msg 1(Bit 16-31): Water concentration [vol.-%]: $c(H_{(2)}O) = (Msg1-20)/100$
Msg 2(bit 32-47): Pressure [mbar]: p = Msg2
Msg 3(Bit 48-55): Temperature [°C]: *T = (Msg3-60)*
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0C59:
Msg 0(Bit 0-15): Hydrogen concentration_RAW[vol.-%]: $c(H_2) = (Msg0-20)/100$
Measurement of the hydrogen content, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with the defined carrier gas, without humidity, normal pressure and in the absence of H_2, the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

Example for the interpretation of CAN messages:
Hex message from Sensor:
CAN Msg1: CAN ID1 320 00 14 00 CE 03 ED 68 D8
CAN Msg2: CAN ID2 321 00 0A 63 00 50 D 92 CA

Decimal translation:
CAN Msg1: Byte0+1: 20, Byte 2+3: 206, Byte 4+5: 1005 Byte 6: 104, Byte 7: 216
CAN Msg2: Byte0+1: 10, Byte 2: 99, Byte 3: 0, Byte 4+5:1293 Byte 6: 146, Byte 7: 202

Sensor translation:
CAN Msg1: $c(H_2)$ [vol.-%]: 0, $c(H_{(2)}O)$[vol.-%]: 1.86, p[mbar]: 1005, T[°C]: 44, CRC: 216
CAN Msg2: $c(H_2)$ _raw[vol.-%]: -0.1, raw: 99, status: 0, serial#: 1293, SV: 14.6 Counter: 202

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait

Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

Example:
"Sensor running; no $H_{(2)}$ ..." → Status byte = 00000000 binary → 0 hexadecimal, 0 decimal
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal[126]
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal[127]
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN 2.0A):

Adjust baud rate:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Change CAN2.0 A/B:
0x680 0xA0 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Zero point adjustment:
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Further CAN commands (CAN 2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

126 If the supply voltage is not sufficient, status byte 2 is output and a full signal is output at the H2 concentration.

127 Status byte 32 is set if the temperature (T > 120°C && T less than -40°C), the relative humidity (r.h. > 99%), the pressure (p > 6000 mbara && less than 600 mbara) are outside the defined range or 5,000 operating hours. The status byte is only reset with a zero point adjustment!

Analogue 4-20mA - Series I

I[mA]	c(H_2) [vol.-%]	Comment
4 - 20 mA[128]	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration. This means that 2.5 vol-% $H_{(2)}$, for example, is then output as 12mA with a 5 vol-% H_2 sensor system. In the heat-up phase and during a critical fault, a current <4mA is output (usually approx. 3mA)

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The maximum permissible load is 450 Ohm.

Analogue 0-10V - Series I

U[V]	c(H_2) [vol.-%]	Comment
0 - 10 V	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration in a range from 1V to 9V. This means that 5 vol-% $H_{(2)}$, for example, is then output as 5V for a 10 vol-% H_2 sensor system. Values less than 1V indicate an error.

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The minimum measuring resistance is 10 kOhm.

The following diagram shows a connection diagram:

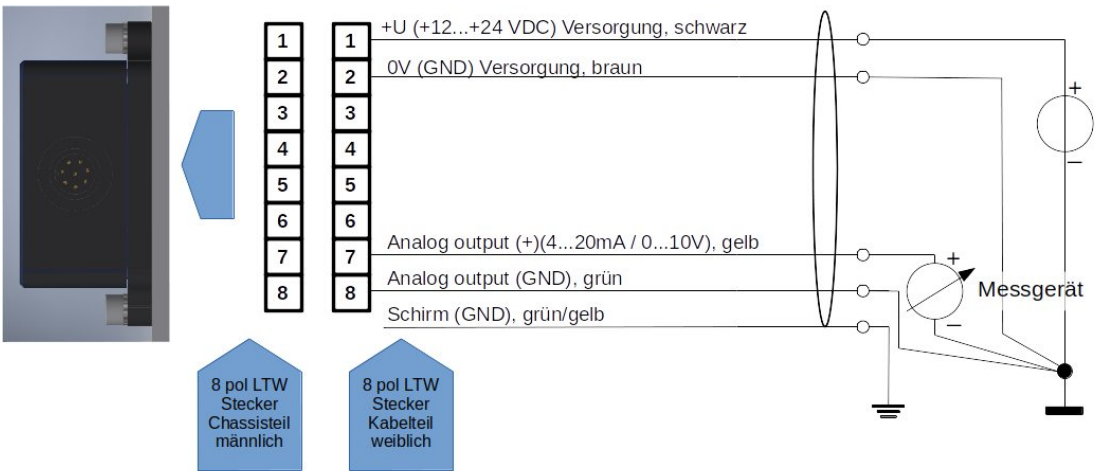


Figure 5: Wiring diagram

128 In earlier versions of this sensor, 7.2 to 20mA was given as the measuring range.

Digital Modbus via RS485 or EIA/TIA-485 - NEO series M

In serial master-slave communication, our NEO sensors function as slaves with the start slave ID 1 and a baud rate of 9,600 in 8N1, i.e. data bits: 8, parity: none, stop bits: 1. The 16-bit registers are defined as signed integers in big-endian, i.e. values in the range -32,768 to 32,767. The Modbus lines are not terminated.

Input register:

Name	Description of the	Scaling[129]	Unit	Register addresses	INPUT register address (hex / dec)
Hydrogen concentration	H_2Volume concentration (Example: 2030 = 20.3 vol.-%)	100	Vol.-%	3x257	0x100 / 256_{dec}
Water concentration	H_2O Volume concentration (Example: 2330 = 23.3 vol.-%)	100	Vol.-%	3x258	0x101 / 257_{dec}
Pressure	Pressure as absolute pressure (Example: 1033 = 1033 mbar)	1	mbar a	3x259	0x102 / 258_{dec}
Temperature	Temperature in measuring cavern (Example: 6250 = 62.5°C)	100	°C	3x260	0x103 / 259_{dec}
Hydrogen concentration _RAW	Hydrogen concentration (Example: 2750 = 27.5 vol.-%)	100	Vol.-%	3x261	0x104 / 260_{dec}
Gross value	Raw value = 100 in the absence of water and hydrogen and otherwise normal air.	1	-	3x262	0x105 / 261_{dec}
Status byte	See "Explanations on the status byte" in the "Signal explanation" section: "CAN".	1	-	3x263	0x106 / 262_{dec}
Serial number	S/N: P number, which is noted on the outside of the device. (Example: 3626 = P-3626)	1	-	3x264	0x107 / 263_{dec}
Software version	Version of the sensor software (Example: 156 = version 15.6)	10	-	3x265	0x108 / 264_{dec}
Message counter	High running counter 0-255	1	-	3x266	0x109 / 265_{dec}
Check value	00000000 01010101 value is 85, which can be used to check the byte order	1	-	3x267	0x10A / 266_{dec}

Holding register:

Name	Description of the	Regist	HOLDING

129 When reading with a PLC, make sure that the data type is set to "Real" so that the signed integer can also be displayed as a comma number.

		er addresses	Register address (hex / dec)
Baud rate	default: 9,600 Specifying the baud rate of the Modbus RTU interface: 4,800, 9,600 or 19,200	4x001	0x00 / 0_{dec}
Slave ID	default: 1 Possible slave IDs of the sensor 1-247	4x002	0x01 / 1_{dec}
Mode parity	default: 0 = parity: none, stop bit: 1 0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2	4x003	0x02 / 2_{dec}
Zero point adjustment	default: 0 If a 1 is written to the register, a zero point adjustment is carried out here and then changed the register to 2.	4x004	0x03 / 3_{dec}

Changes to the factory settings are only applied after restarting the sensor.

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapters and heaters:
Various adapters are available for mounting the sensor. For use in very humid environments or environments with liquid water or the risk of icing, there are heating cartridges that can be operated at a constant voltage. These can be fitted in the adapters. You can find the corresponding products under:
https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for the fine purification of gases by removing minimal impurities.

FAQ:
The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Hydrogen concentration sensor data sheet

NEO974HT-M12, NEO983HT-M12 and NEO986HT-M12, version 16.0

Product description:

Sensor system for measuring the hydrogen concentration in air, oxygen, nitrogen or oxygen-depleted air with temperature-, pressure- and humidity-compensated signal evaluation for automotive or industrial applications. Applicable in the range: 0.6 - 5 bara, 0 - 100% r.h. (non-condensing) and 40°C - 120°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measuring ranges: 0-5 vol.-% $H_{(2)}$ (**NEO974HT**), 0-10 vol.-% $H_{(2)}$ (**NEO983HT**) or 0-100 vol.-% $H_{(2)}$ (**NEO986HT**)
- Carrier gases air, N_2, O_2, oxygen-depleted air, methane, synthetic natural gas are possible
- Measuring signal independent of pressure, temperature and humidity
- Signal output via CAN 2.0, Modbus RTU via RS485, 0-10V or 4-20mA
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement. No sample extraction necessary.
- Can also be used in the intake manifold with H_2direct injection
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Factory calibrated and ready for immediate use
- Suitable for concentration measurement in the ventilation of the crankcase or in the recirculation of the fuel cell (recirculation sensor; for controlling the purge valve)
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary
- CAN WakeUp function implemented
- Encrypted CAN communication on demand

Figure 1: H_2concentration sensor version NEO9XXHT-M12

...go to English version

Sensor system characteristics:

Supply voltage: 12 - 30 V DC[130]

Energy consumption: < 2,4 W

Possible H_2sensitivity:

	0 - 100 vol.-% H_2	**NEO986HT-M12**
	0 - 10 vol.-% H_2	**NEO983HT-M12**
	0 - 5 vol.-% H_2	**NEO974HT-M12**

Accuracy: ± 0.3 vol.-% H_2[131] or ± 2 vol.-% H_2[132]

Detection limit: < 0.3 vol.-% $H_{(2)}$ (1) or < 0.5 vol.-% $H_{(2)}$ (2)

Response time t_{90}: < 5 s

Decay time t_{10}: < 5 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[133]

Media temperature: - 40°C - 120°C

Ambient temperature: - 40°C - 100°C
The cold start at -40°C was tested.

Pressure range: 0.6 - 5 bar absolute, i.e. 60 - 500 kPa

Humidity: 0 - 100 % r.h. (non-condensing)[134]

Carrier gas: Air, N_2, O_2, Oxygen from air, CH_4,
synthetic natural gas, also as O_2 in H_2variant
available[135] (see data sheet
Sensor system_NEO4XXHT_V146_EN_EN)

Cross sensitivities: Helium, tbd

Signal :[136] CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on
page13
Modbus RTU via RS485 interface on page 29
4-20 mA on page 112
0-10 V on page 132

130 For analogue 0-10V output, please apply more than 15 VDC.
131 For 0-5 vol.-% and 0-10 vol.-% H_2systems
132 For 100 vol.-% H_2systems
133 The system is designed for continuous operation
134 In particular, splash water must be kept away from the sensor opening
135 Info for electrolysis gases: If you flush this 0-5% H_2sensor in the carrier gas oxygen with nitrogen (even without hydrogen content), the H_2measurement will be falsified by a few volume per cent with a negative offset!
136 Signals are described in the "Explanation of signals" section

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm for CAN bus and Modbus RTU
250 ppm at 4-20 mA or 0-10V

Housing: Size: 95 x 83 x 48 mm³, housing cover made of
EN AW 6060 and media-contacting base plate made of
316L or 1.4404, tighten M5 screws to the measuring
chamber with 3Nm.

Long-term stability/drift: Deviation <0.1 vol.-% in the first 5000h
Operating time

Leakage rate: $<10^{-5}$mbar l / s [137]

IP code: IP6K7

Weight: < 810 g

SIL: -

ATEX: Zone I available on request (see data sheet
Sensor system_NEO9XXHT-
M12_ATEX_V149_EN_EN)

Service life: IP6K7 enclosure qualified with an expected
Service life of 5 years.[138] The system has been tested
with 100,000 switch-on and switch-off cycles.

Maintenance interval : We recommend checking the H_2sensor every
6 months. check.

Measuring behaviour: The gas to be tested may have a maximum
have a maximum velocity of 25m/s. In
addition, a laminar flow is recommended. If the
specification differs specification, the sensor
must be tested for tested for functionality.

Connection cable: 3 m enclosed; more detailed information on
page 185

RoHS compliant: Yes https://neoxid-cloud.de/Konformitaetserklaerung-
RoHS_DE_EN_V02_scan.pdf

Customs tariff number: 90271010

COO: Germany / NRW

137 Measured with forming gas 90/10, 1.5 bar absolute, room temperature
138 Measuring components are purely inorganic and are not consumed during measurement

ECCN:	EAR99
EC-79/2009	Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

Accuracy of the measured values:[139]

Size	Accuracy
Hydrogen concentration	*± 0.3 vol.-% H_2*[140] *or ± 2 vol.-% H_2*[141]
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[142]	*± 0,3 °C*
Pressure	*± 20 mbar*

Table7 : Statistical errors for individual measured variables

Operating instructions:

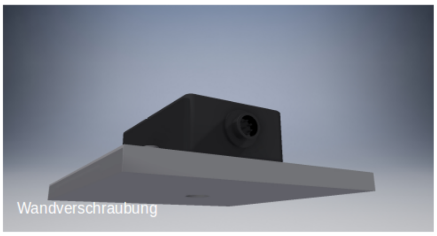
The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO9XXHT-M12-V08_DE_EN.pdf

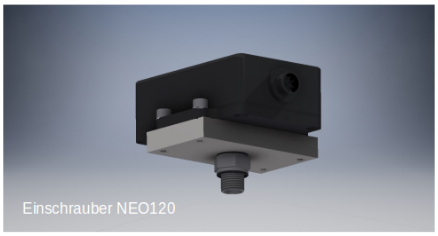
It contains further information on the sensor and on initial commissioning.

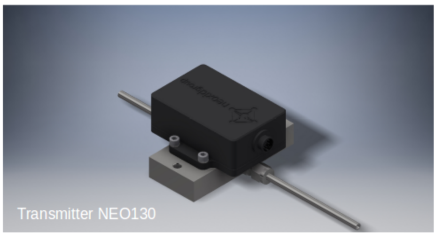
Mounting the sensor:
The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO9XXHT-M12-Modell-und-Zeichnung.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request (see https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf). To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a spatial direction other than horizontally, a small offset[143] occurs; this must be corrected via a specific CAN message on ID 0x680 (zero point adjustment, see page). 14

Scope of delivery:
In addition to the sensor unit, 4x M5 screws are supplied for mounting the sensor, as well as a 3 m connection cable with cable end sleeves.

139 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar
140 For 0-5 vol.-% and 0-10 vol.-% H_2systems
141 For 100 vol% H_2systems
142 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber
143 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.







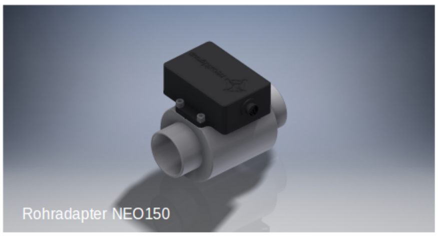


Figure 2a: Mounting the H_2sensor system

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The above-mentioned adapters (with the exception of the NEO160) can also be fitted with heating cartridges, which are also available on request. As a further protective measure against small amounts of splash water, the sensor is fitted with a ribbed plug. Care must be taken to ensure that the sensor is installed in such a way that this plug functions properly if an installation with a passing gas is used.

Fig. 2b: NEO9XXHT-M12 O-ring and ribbed plug

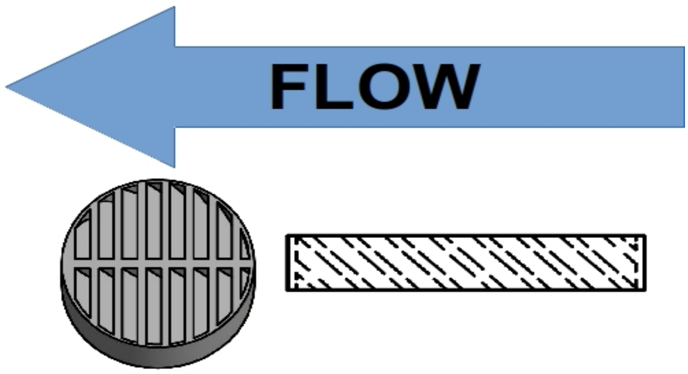


Figure 2c: Fitting ribbed plugs against the direction of flow

Hole pattern:

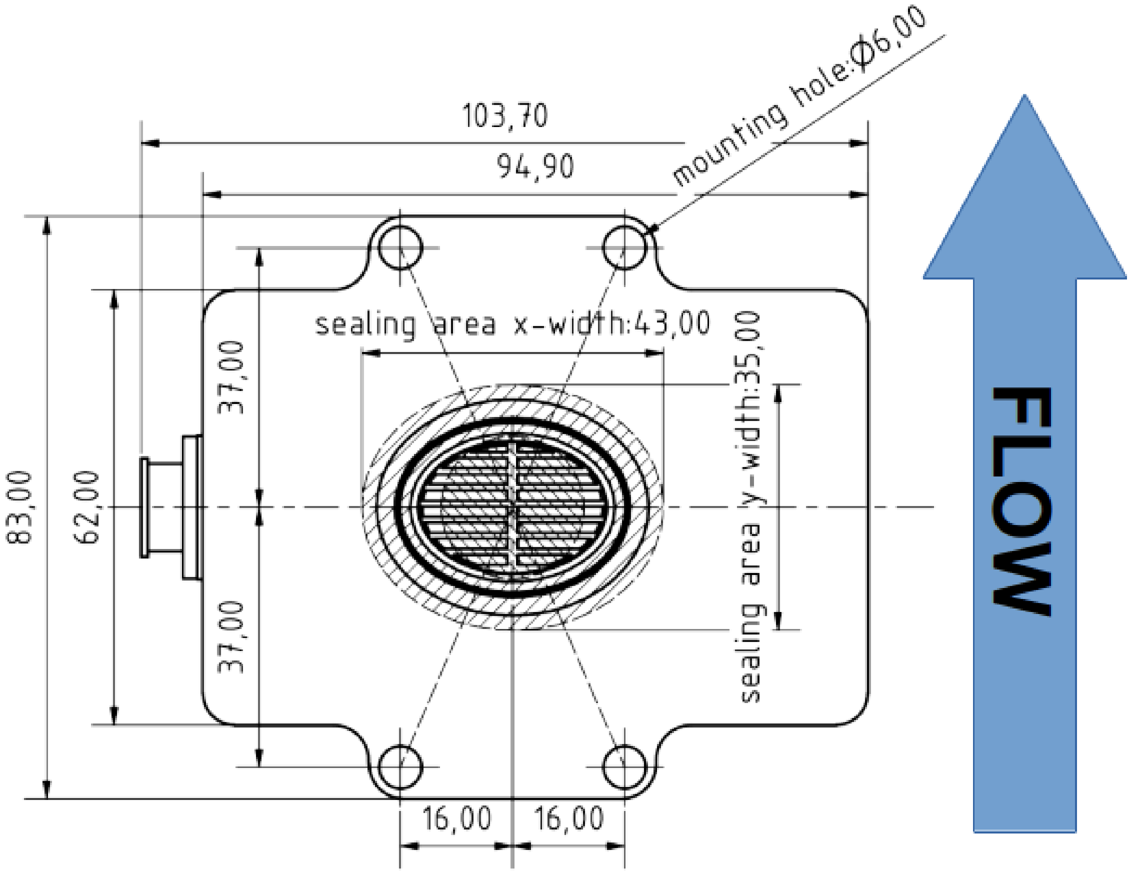


Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

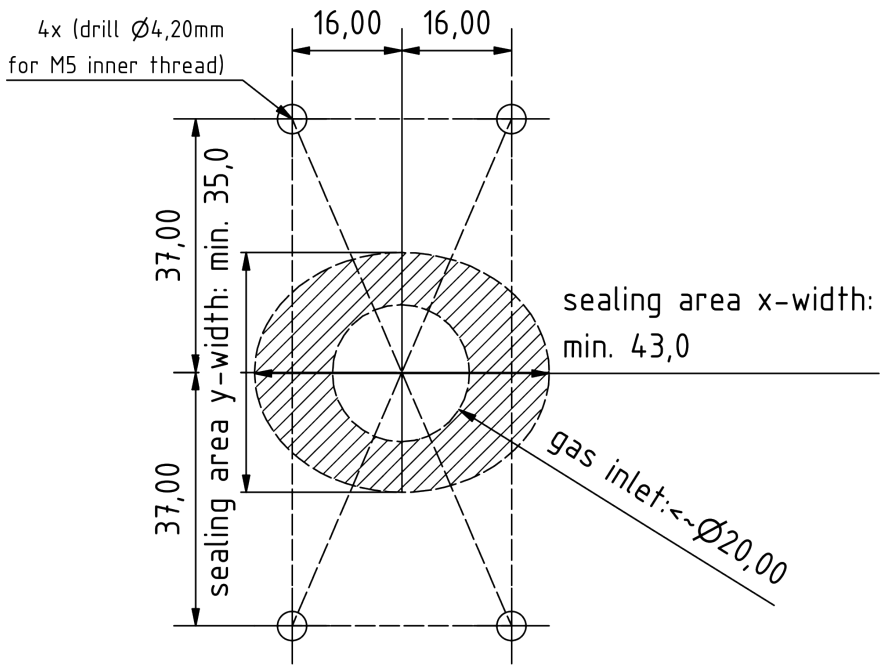
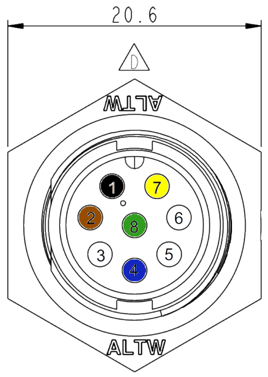


Figure 3b: Drilling template

Electrical PIN assignment



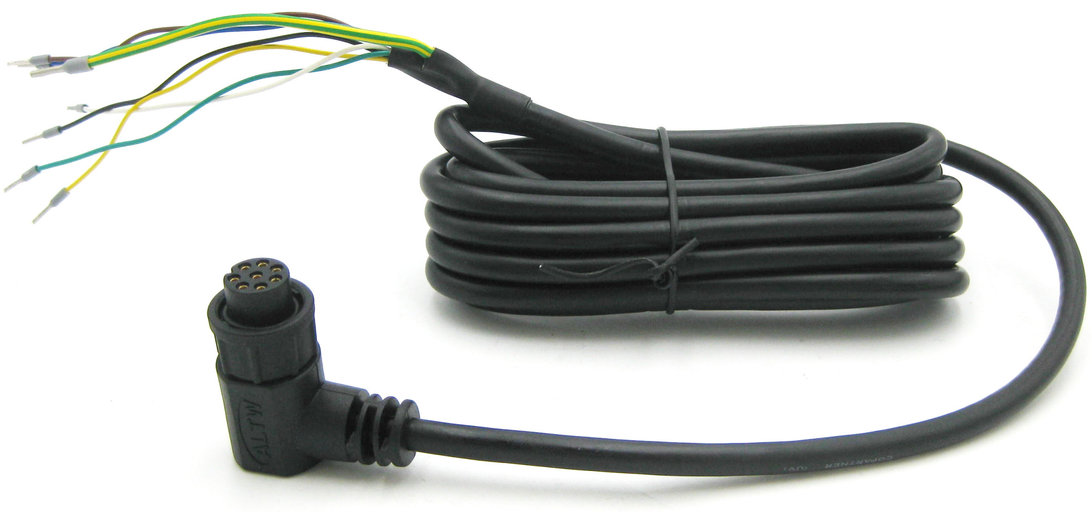
Housing plug

PIN no.	Description of the	Colour
1	VCC+ 12 ... 30V DC (min.: 2.4W)	black
2	GND 0V DC	brown
3	CAN-High (opt. DAC)+	white
4	CAN-Low (opt. DAC-)	blue
5	*service port A*	-
6	*service port B*	-
7	DAC + / RS485 A	yellow
8	DAC - / RS485 B	green
	Shielding (optional GND)	green/yellow

8-pin housing connector: Amphenol LTW: ABD-08RMMS-LC7001
8-pin cable socket: Amphenol LTW: BD-08BFFA-LL7001

Figure 3c below shows the enclosed connection cable with angled socket:

Figure 3c: Connection cable with angled socket



Simultaneous signal output via CAN bus and an analogue interface
If required, the sensor's measurement data can be output simultaneously via the CAN bus interface and an analogue interface (4-20 mA, 0-10V). If an analogue interface (4-20 mA, 0-10V) is selected in addition to the CAN bus, the analogue signal is output via PIN 7 & 8. CAN addressing via the connector is then no longer possible!

Information on hydrogen ignition by the NEO974HT/NEO983HT/ NEO986HT from neo hydrogen sensors GmbH in accordance with J2578 SAE international:
The H_2sensor NEO974HT/NEO983HT/NEO986HT uses a heating element that is heated with 5 V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the NEO974HT (a Zener diode prevents excessively high operating voltages). In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm^3 measuring cavity.

Catalytic materials are not installed in the H_2sensor NEO974HT/NEO983HT/NEO986HT, so there is no risk of spontaneous combustion.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors NEO974HT/NEO983HT/NEO986HT. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

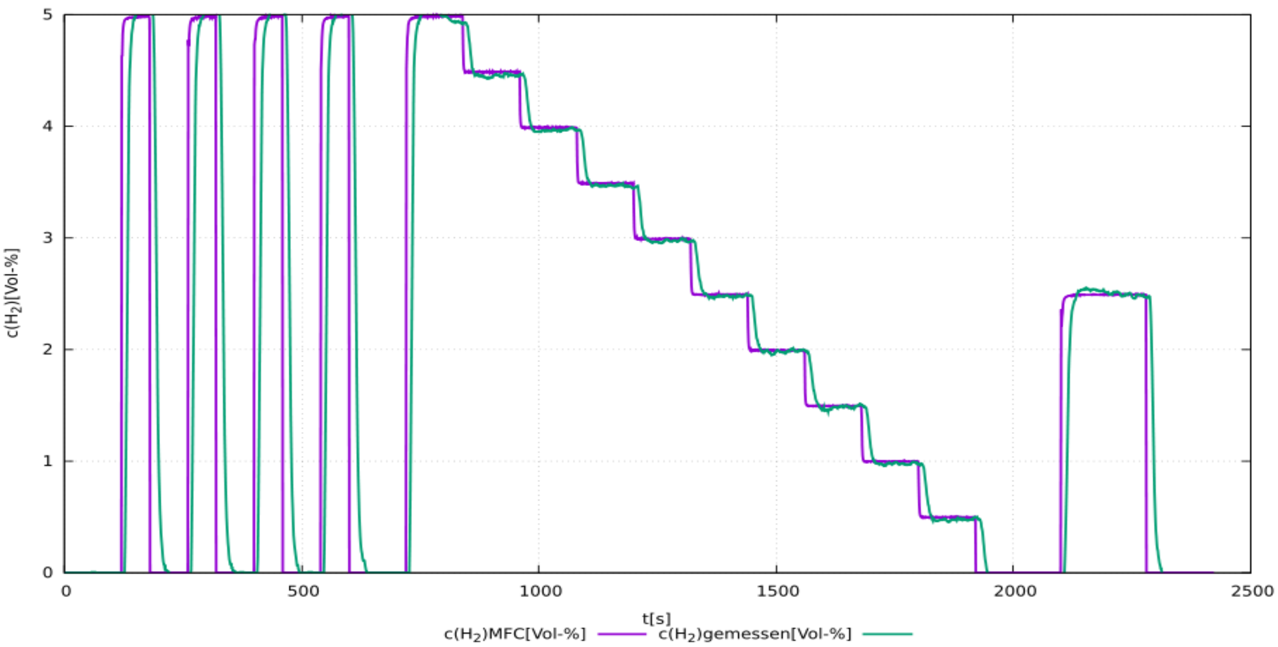


Figure 4a: Test of a sensor system NEO974HT 0 - 5 vol.-% H_2 in 21 vol.-% O_2. Measured with a total flow of 1,000 sccm.

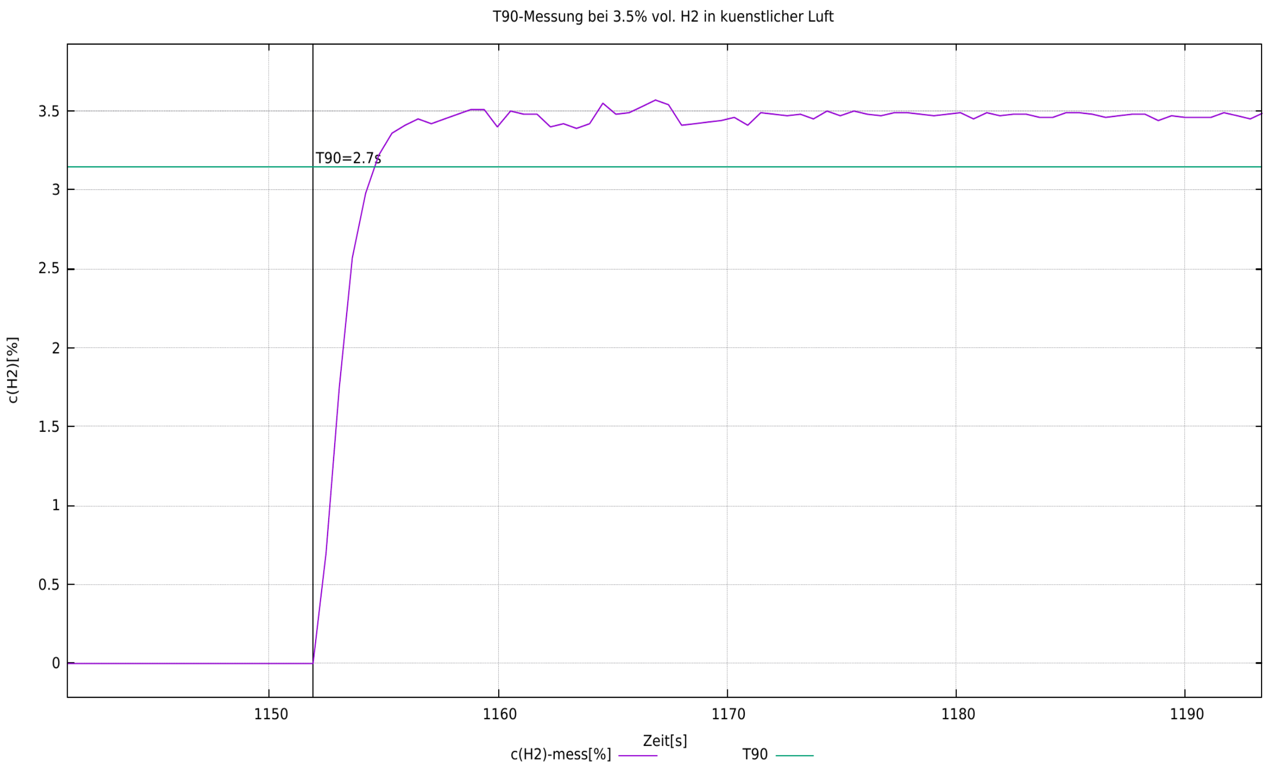


Figure 4b: t_{90} time determination with a sensor system by switching from 0 vol.-% H_2 to 3.5 vol.-% H_2. Measured with a total flow of 1,000 sccm.

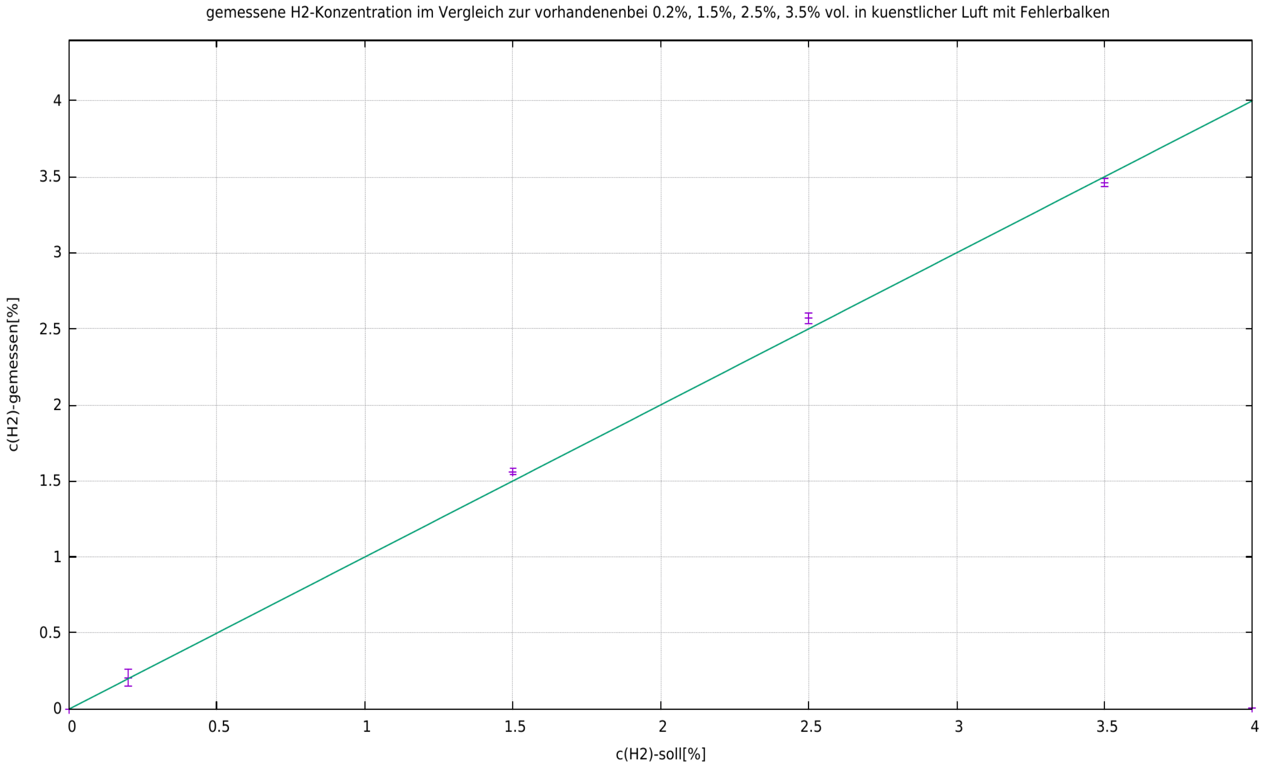


Figure 4c: Comparative measurement of the set hydrogen concentration and the measured hydrogen concentration with an error bar of three standard deviations of the measurement signal.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO974HTA (0-5 vol.-% H_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319
NEO983HTA (0-10 vol.-% H_2)	0x320 & 0x321	0x328 & 0x329	0x330 & 0x331	0x338 & 0x339
NEO986HTA (0-100 vol.-% H_2)	0x340 & 0x341	0x348 & 0x349	0x350 & 0x351	0x358 & 0x359

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment.
must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [144]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[145]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To set the CAN ID, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message after 5s at system start.

144 Details can be found in the operating instructions under chapter: "Maintenance and service"
145 0xYY describes a measure for the set zero point adjustment

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO974HTA (0-5 vol.-% H_2)	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359
NEO983HTA (0-10 vol.-% H_2)	0x0CFF1459 & 0x0CFF1559	0x0CFF1659 & 0x0CFF1759	0x0CFF1859 & 0x0CFF1959	0x0CFF1A59 & 0x0CFF1B59
NEO986HTA (0-100 vol.-% H_2)	0x0CFF1C59 & 0x0CFF1D59	0x0CFF1E59 & 0x0CFF1F59	0x0CFF2059 & 0x0CFF2159	0x0CFF2259 & 0x0CFF2359

Set CAN ID (CAN2.0B):
To set the CAN ID, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):
A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make an adjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [146]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[147]
*corresponds to the serial number of the individual sensor system.
CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured hydrogen concentration exceeds the 0.5 % by volume limit (c(H_2) from <0.5 % by volume to >= 0.5 % by volume).

The following message is sent:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = *(Msg0-20)/100*
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with the defined carrier gas, without humidity, normal pressure and in the absence of H_2, the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

146 Details can be found in the operating instructions under chapter: "Maintenance and service"
147 0xYY describes a measure for the set zero point adjustment

Further CAN commands (CAN2.0A):

Adjust baud rate:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Change CAN2.0 A/B:
0x680 0xA0 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Zero point adjustment:
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Further CAN commands (CAN2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/H2-Sensor_NEO9XX_V146.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = (Msg0-20)/100
Msg 1(Bit 16-31): Water concentration [vol.-%]: c($H_{(2)}O$) = (Msg1-20)/100
Msg 2(bit 32-47): Pressure [mbar]: p = Msg2
Msg 3(Bit 48-55): Temperature [°C]: *T = (Msg3-60)*
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration_RAW[vol.-%]: c(H_2) = (Msg0-20)/100
Measurement of the hydrogen content, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with the defined carrier gas, without humidity, normal pressure and in the absence of H_2, the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

Example for the interpretation of CAN messages:
Hex message from Sensor:
CAN Msg1: CAN ID1 320 00 14 00 CE 03 ED 68 D8
CAN Msg2: CAN ID2 321 00 0A 63 00 50 D 92 CA

Decimal translation:
CAN Msg1: Byte0+1: 20, Byte 2+3: 206, Byte 4+5: 1005 Byte 6: 104, Byte 7: 216
CAN Msg2: Byte0+1: 10, Byte 2: 99, Byte 3: 0, Byte 4+5:1293 Byte 6: 146, Byte 7: 202

Sensor translation:
CAN Msg1: c(H_2) [vol.-%]: 0, c($H_{(2)}O$)[vol.-%]: 1.86, p[mbar]: 1005, T[°C]: 44, CRC: 216
CAN Msg2: c(H_2) _raw[vol.-%]: -0.1, raw: 99, status: 0, serial#: 1293, SV: 14.6 Counter: 202

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait

Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

Example:

"Sensor running; no $H_{(2)}$ .." → Status byte = 00000000 binary → 0 hexadecimal, 0 decimal
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal[148]
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal[149]
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

148 If the supply voltage is not sufficient, status byte 2 is output and a full signal is output at the H2 concentration.

149 Status byte 32 is set if the temperature (T > 120°C && T less than -40°C), the relative humidity (r.h. > 99%), the pressure (p > 6000 mbara && less than 600 mbara) are outside the defined range or 5,000 operating hours. The status byte is only reset with a zero point adjustment!

Analogue 4-20mA - Series I

I[mA]	c($H_{2)}$ [vol.-%]	Comment
4 - 20 mA[150]	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration. This means that 2.5 vol-% $H_{(2)}$,for example, is then output as 12mA with a 5 vol-% H_2sensor system. In the heat-up phase and during a critical fault, a current <4mA is output (usually approx. 3mA)

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The maximum permissible load is 450 Ohm.

Analogue 0-10V - Series I

U[V]	c($H_{2)}$ [vol.-%]	Comment
0 - 10 V	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration in a range from 1V to 9V. This means that 5 vol-% $H_{(2)}$,for example, is then output as 5V for a 10 vol-% H_2sensor system. Values less than 1V indicate an error.

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The minimum measuring resistance is 10 kOhm.

The following diagram shows a connection diagram:

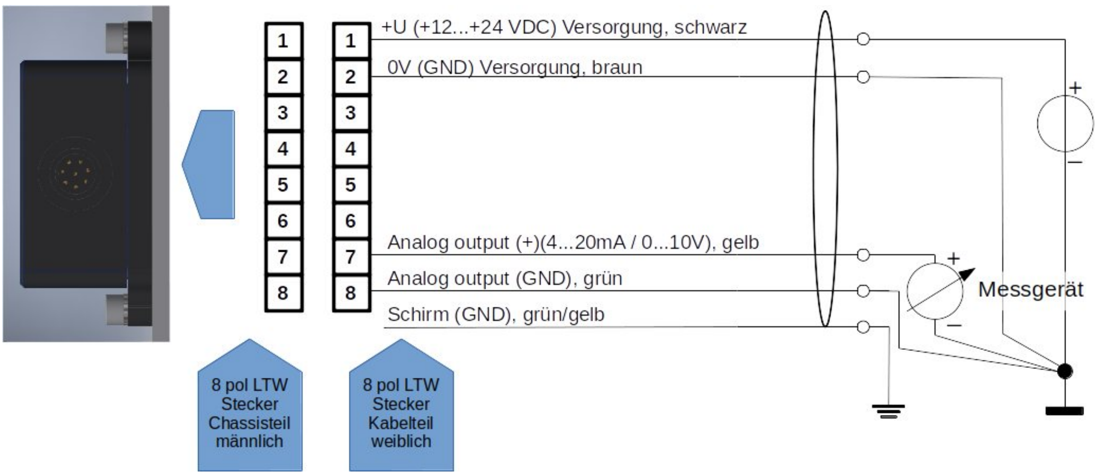


Figure 5: Wiring diagram

150 In earlier versions of this sensor, 7.2 to 20mA was given as the measuring range.

Digital Modbus via RS485 or EIA/TIA-485 - NEO series M

In serial master-slave communication, our NEO sensors function as slaves with the start slave ID 1 and a baud rate of 9,600 in 8N1, i.e. data bits: 8, parity: none, stop bits: 1. The 16-bit registers are defined as signed integers in big-endian, i.e. values in the range -32,768 to 32,767. The Modbus lines are not terminated.

Input register:

Name	Description of the	Scaling[151]	Unit	Register addresses	INPUT register address (hex / dec)
Hydrogen concentration	H_2Volume concentration (Example: 2030 = 20.3 vol.-%)	100	Vol.-%	3x257	0x100 / 256_{dec}
Water concentration	H_2O Volume concentration (Example: 2330 = 23.3 vol.-%)	100	Vol.-%	3x258	0x101 / 257_{dec}
Pressure	Pressure as absolute pressure (Example: 1033 = 1033 mbar)	1	mbar a	3x259	0x102 / 258_{dec}
Temperature	Temperature in measuring cavern (Example: 6250 = 62.5°C)	100	°C	3x260	0x103 / 259_{dec}
Hydrogen concentration _RAW	Hydrogen concentration (Example: 2750 = 27.5 vol.-%)	100	Vol.-%	3x261	0x104 / 260_{dec}
Gross value	Raw value = 100 in the absence of water and hydrogen and otherwise normal air.	1	-	3x262	0x105 / 261_{dec}
Status byte	See "Explanations on the status byte" in the "Signal explanation" section: "CAN".	1	-	3x263	0x106 / 262_{dec}
Serial number	S/N: P number, which is noted on the outside of the device. (Example: 3626 = P-3626)	1	-	3x264	0x107 / 263_{dec}
Software version	Version of the sensor software (Example: 156 = version 15.6)	10	-	3x265	0x108 / 264_{dec}
Message counter	High running counter 0-255	1	-	3x266	0x109 / 265_{dec}
Check value	00000000 01010101 value is 85, which can be used to check the byte order	1	-	3x267	0x10A / 266_{dec}

Holding register:

151 When reading with a PLC, make sure that the data type is set to "Real" so that the signed integer can also be displayed as a comma number.

Name	**Description of the**	**Register addresses**	**HOLDING Register address (hex / dec)**
Baud rate	default: 9,600 Specifying the baud rate of the Modbus RTU interface: 4,800, 9,600 or 19,200	4x001	0x00 / 0_{dec}
Slave ID	default: 1 Possible slave IDs of the sensor 1-247	4x002	0x01 / 1_{dec}
Mode parity	default: 0 = parity: none, stop bit: 1 0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2	4x003	0x02 / 2_{dec}
Zero point adjustment	default: 0 If a 1 is written to the register, a zero point adjustment is carried out here and then changed the register to 2.	4x004	0x03 / 3_{dec}

Changes to the factory settings are only applied after restarting the sensor.

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapters and heaters:
Various adapters are available for mounting the sensor. For use in very humid environments or environments with liquid water or the risk of icing, there are heating cartridges that can be operated at a constant voltage. These can be fitted in the adapters. You can find the corresponding products under:
https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for the fine purification of gases by removing minimal impurities.

FAQ:
The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Hydrogen concentration sensor data sheet

NEO974HT, NEO983HT and NEO986HT, version 15.6

Product description:

Sensor system for measuring the hydrogen concentration in air, oxygen, nitrogen or oxygen-depleted air with temperature-, pressure- and humidity-compensated signal evaluation for automotive or industrial applications. Applicable in the range: 0.6 - 5 bara, 0 - 100% r.h. (non-condensing) and 40°C - 120°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measuring ranges: 0-5 vol.-% $H_{(2)\,(}$**NEO974HT**), 0-10 vol.-% $H_{(2)\,(}$**NEO983HT**) or 0-100 vol.-% $H_{(2)\,(}$**NEO986HT**)
- Carrier gases air, N_2, O_2, oxygen-depleted air, methane, synthetic natural gas are possible
- Measuring signal independent of pressure, temperature and humidity
- Signal output via CAN 2.0, Modbus RTU via RS485, 0-10V or 4-20mA
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement. No sample extraction necessary.
- Can also be used in the intake manifold with H_2direct injection
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Factory calibrated and ready for immediate use
- Suitable for concentration measurement in the ventilation of the crankcase or in the recirculation of the fuel cell (recirculation sensor; for controlling the purge valve)
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary
- CAN WakeUp function implemented
- Encrypted CAN communication on demand

Figure 1: H_2concentration sensor version NEO9XXHT


...go to English version

Sensor system characteristics:

Supply voltage: 12 - 32 V DC[152]

Energy consumption: < 2,4 W

Possible H_2sensitivity: 0 - 100 vol.-% H_2 **NEO986HT**
0 - 10 vol.-% H_2 **NEO983HT**
0 - 5 vol.-% H_2 **NEO974HT**

Accuracy: ± 0.3 vol.-% H_2[153] or ± 2 vol.-% H_2[154]

Detection limit: < 0.3 vol.-% $H_{(2)}$ ([1])or < 0.5 vol.-% $H_{(2)}$ ([2])

Response time t_{90}: < 5 s

Decay time t_{10}: < 5 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[155]

Media temperature: - 40°C - 120°C
(can also be calibrated down to -60°C)

Ambient temperature: - 40°C - 100°C
The cold start at -40°C was tested.

Pressure range: 0.6 - 6 bar absolute, i.e. 60 - 600 kPa
(can also be calibrated up to 0.25 bar a)

Air humidity: 0 - 100 % r.h. (non-condensing)[156]

Carrier gas: Air, N_2, O_2, Oxygen from air, CH_4,
synthetic natural gas, also as O_2 in H_2variant
available[157] (see data sheet
Sensor system_NEO4XXHT_V146_EN_EN)

Cross-sensitivities: Helium, tbd

Signal :[158] CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on
page13 Modbus RTU via RS485 interface on page 18
4-20 mA on page 112

152 For analogue 0-10V output, please apply more than 15 VDC.
153 For 0-5 vol.-% and 0-10 vol.-% H_2systems
154 For 100 vol.-% H_2systems
155 The system is designed for continuous operation
156 In particular, splash water must be kept away from the sensor opening
157 Info for electrolysis gases: If you flush this 0-5% H_2sensor in the carrier gas oxygen with nitrogen (even without hydrogen content), the H_2measurement will be falsified by a few volume per cent with a negative offset!
158 Signals are described in the "Explanation of signals" section

0-10 V on page 132

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm for CAN bus and Modbus RTU
250 ppm at 4-20 mA or 0-10V

Housing: Size: 95 x 83 x 48 mm³, housing cover made of
EN AW 6060 and media-contacting base plate made of
316L or 1.4404, tighten M5 screws to the measuring
chamber with 3Nm.

Long-term stability/drift: Deviation <0.1 vol.-% in the first 5000h
Operating time

Leakage rate: $<10^{-5}$mbar l / s [159]

IP code: IP6K7

Weight: < 810 g

SIL: -

ATEX: Zone I available on request (see data sheet
Sensor system_NEO9XXHT_ATEX_V149_EN_EN)

Service life: IP6K7 enclosure qualified with an expected
Service life of 5 years.[160] The system has been tested
with 100,000 switch-on and switch-off cycles.

Maintenance interval : We recommend checking the H_2sensor every
6 months. check.

Measuring behaviour: The gas to be tested may have a maximum
have a maximum velocity of 25m/s. In
addition, a laminar flow is recommended. If the
specification differs specification, the sensor
must be tested for tested for functionality.

Connection cable: 3 m enclosed; more detailed information on
page 185

RoHS compliant: Yes https://neoxid-cloud.de/Konformitaetserklaerung-
RoHS_DE_EN_V02_scan.pdf

Customs tariff number: 90271010

COO: Germany / NRW

159 Measured with forming gas 90/10, 1.5 bar absolute, room temperature
160 Measuring components are purely inorganic and are not consumed during measurement

ECCN:	EAR99
EC-79/2009	Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

Accuracy of the measured values:[161]

Size	Accuracy
Hydrogen concentration	*± 0.3 vol.-% H_2*[162] *or ± 2 vol.-% H_2*[163]
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[164]	*± 0,3 °C*
Pressure	*± 20 mbar*

Table8 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO9XXHT-V08_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Mounting the sensor:
The stepfile and 2D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO9XXHT-Modell-und-Zeichnung.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request (see https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf). To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a spatial direction other than horizontally, a small offset[165] occurs, which must be corrected via a specific CAN message on ID 0x680 (zero point adjustment, see page). 14

Scope of delivery:
In addition to the sensor unit, 4x M5 screws are supplied for mounting the sensor, as well as a 3 m connection cable with cable end sleeves.

161 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar
162 For 0-5 vol.-% and 0-10 vol.-% H_2systems
163 For 100 vol% H_2systems
164 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber
165 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.

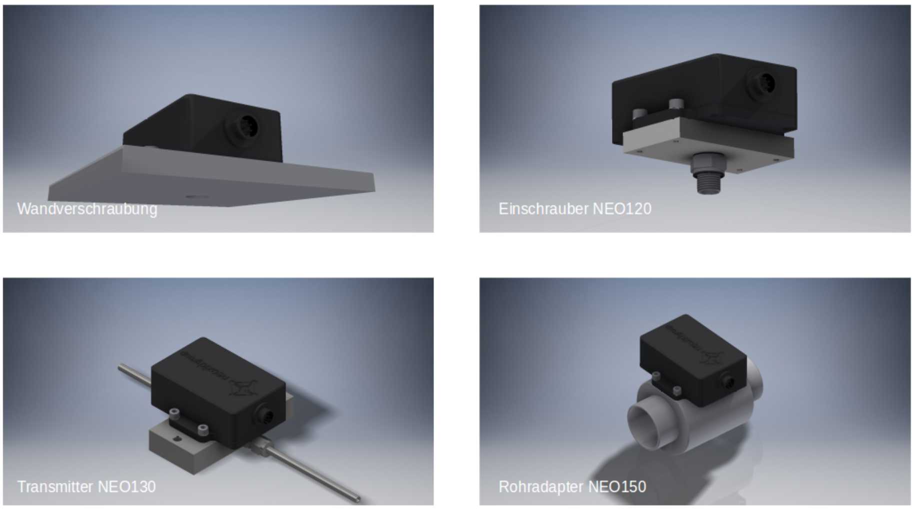


Figure 2a: Mounting the H_2sensor system

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The above-mentioned adapters (with the exception of the NEO160) can also be fitted with heating cartridges, which are also available on request. As a further protective measure against small amounts of splash water, the sensor is fitted with a ribbed plug. Care must be taken to ensure that the sensor is installed in such a way that this plug functions properly if an installation with a passing gas is used.

Fig. 2b: NEO9XXHT O-ring and ribbed plug

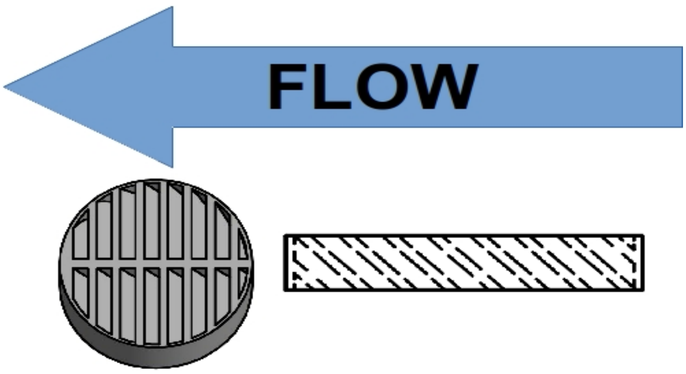


Figure 2c: Fitting ribbed plugs against the direction of flow

Hole pattern:

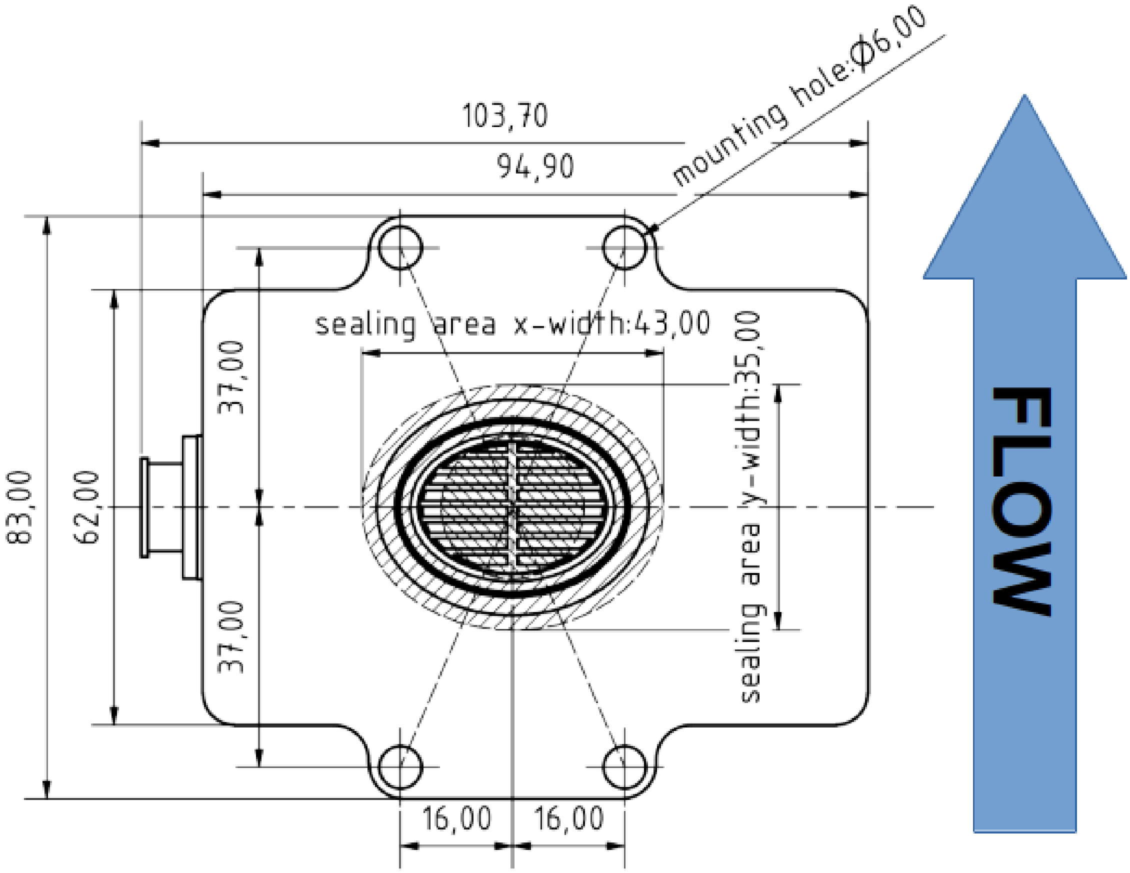


Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

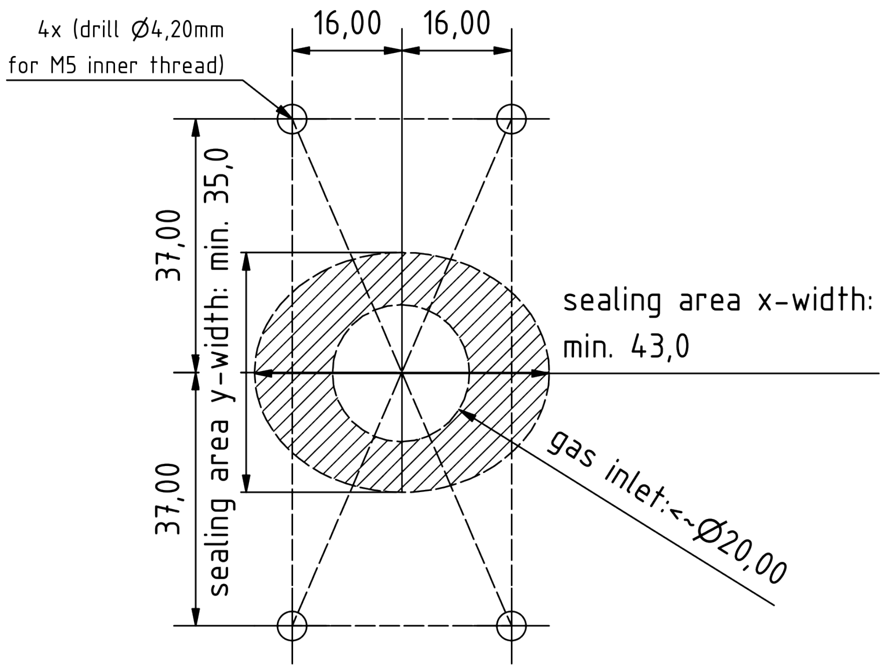
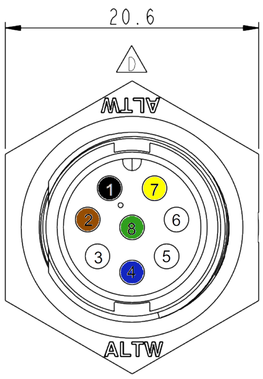


Figure 3b: Drilling template

Electrical PIN assignment



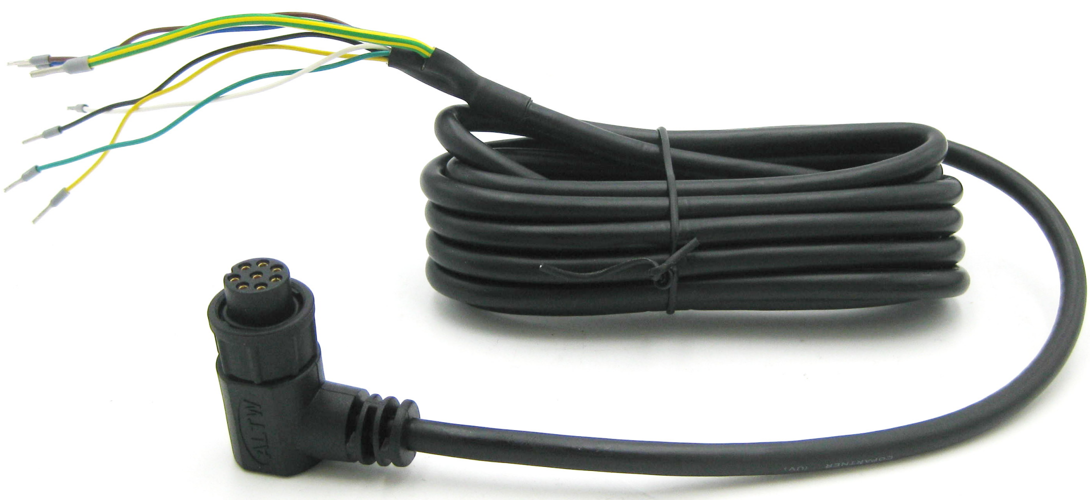
Housing plug

PIN no.	Description of the	Colour
1	VCC+ 12 ... 30V DC (min.: 2.4W)	black
2	GND 0V DC	brown
3	CAN-High (opt. DAC)+	white
4	CAN-Low (opt. DAC-)	blue
5	*service port A*	-
6	*service port B*	-
7	DAC + / RS485 A	yellow
8	DAC - / RS485 B	green
	Shielding (optional GND)	green/yellow

8-pin housing connector: Amphenol LTW: ABD-08RMMS-LC7001
8-pin cable socket: Amphenol LTW: BD-08BFFA-LL7001

Figure 3c below shows the enclosed connection cable with angled socket:

Figure 3c: Connection cable with angled socket



Simultaneous signal output via CAN bus and an analogue interface
If required, the sensor's measurement data can be output simultaneously via the CAN bus interface and an analogue interface (4-20 mA, 0-10V). If an analogue interface (4-20 mA, 0-10V) is selected in addition to the CAN bus, the analogue signal is output via PIN 7 & 8. CAN addressing via the connector is then no longer possible!

Information on hydrogen ignition by the NEO974HT/NEO983HT/ NEO986HT from neo hydrogen sensors GmbH in accordance with J2578 SAE international:
The H_2sensor NEO974HT/NEO983HT/NEO986HT uses a heating element that is heated with 5 V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the NEO974HT (a Zener diode prevents excessively high operating voltages). In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavity.

Catalytic materials are not installed in the H_2sensor NEO974HT/NEO983HT/NEO986HT, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors NEO974HT/NEO983HT/NEO986HT. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

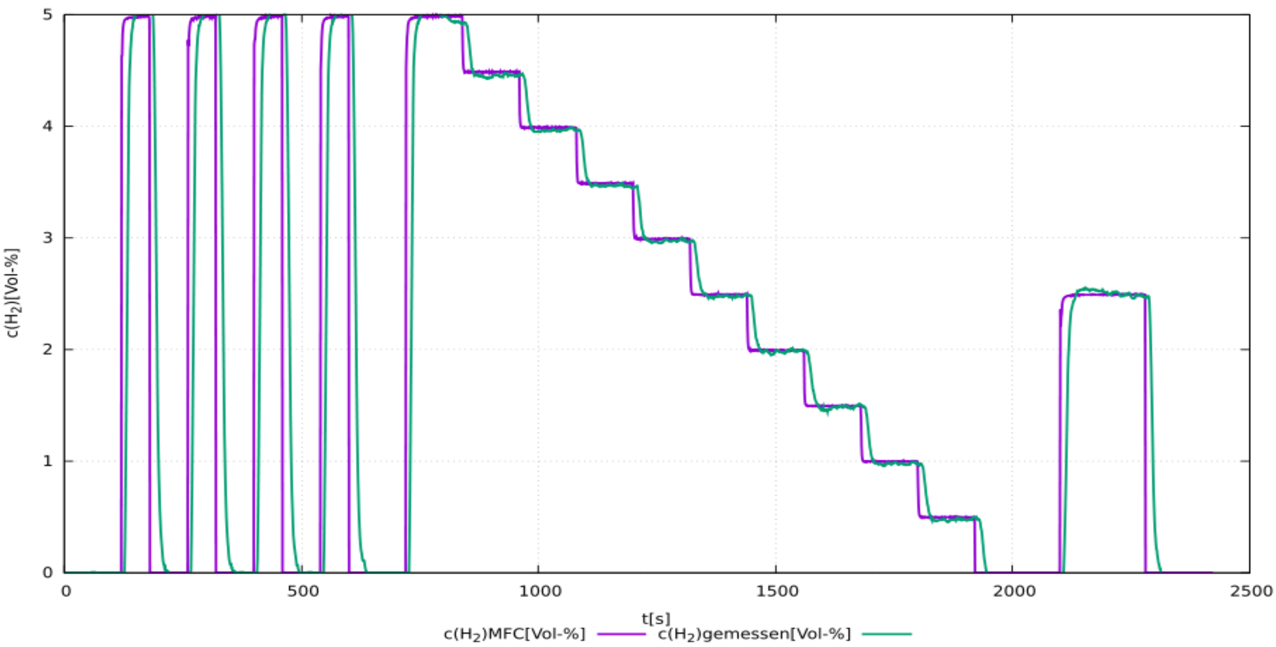


Figure 4a: Test of a sensor system NEO974HT 0 - 5 vol.-% H_2in 21 vol.-% O_2. Measured with a total flow of 1,000 sccm.

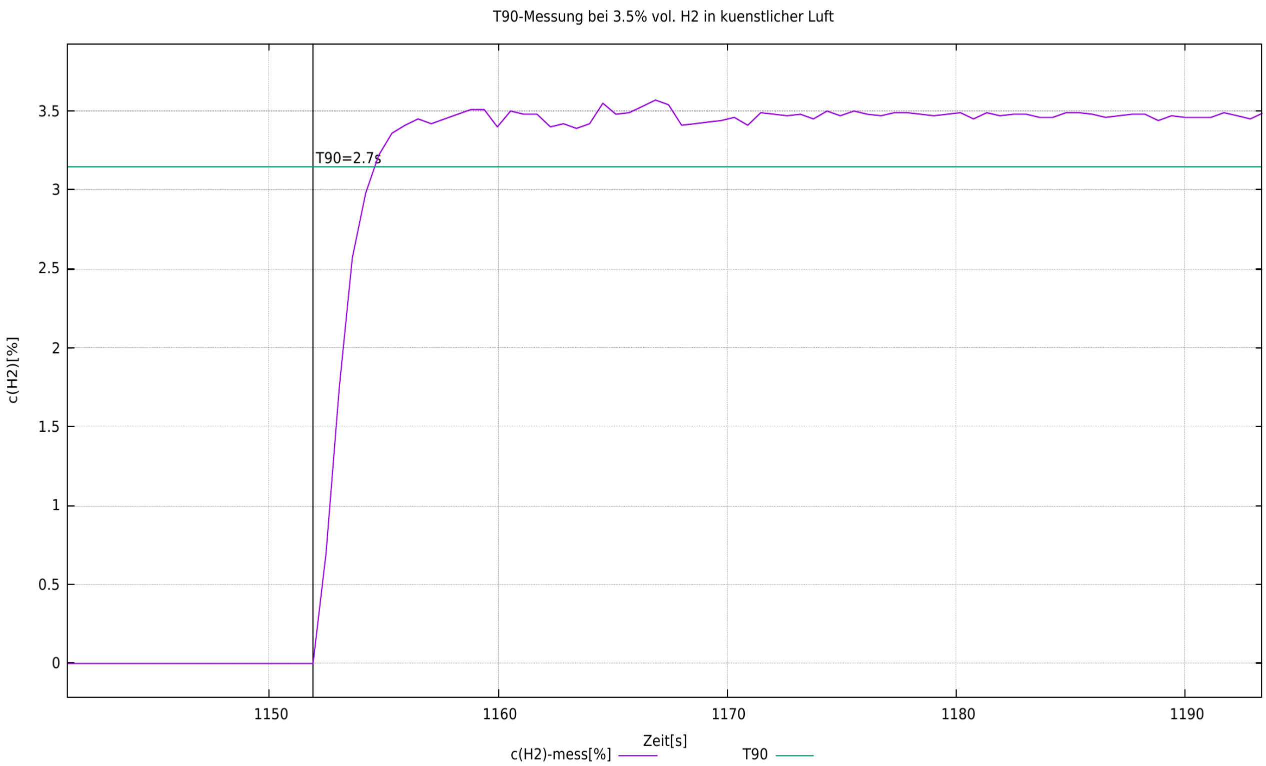


Figure 4b: t_{90}time determination with a sensor system by switching from 0 vol.-% $H_2$to 3.5 vol.-% H_2. Measured with a total flow of 1,000 sccm.

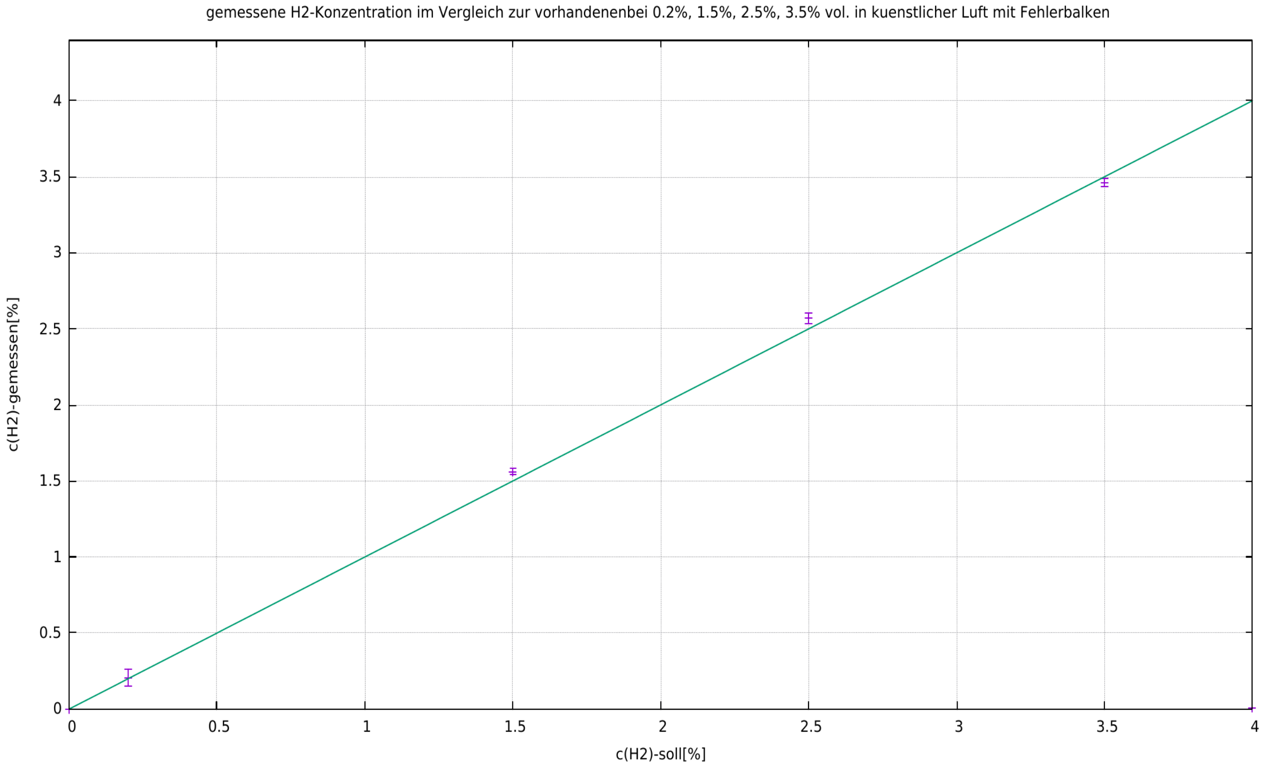


Figure 4c: Comparative measurement of the set hydrogen concentration and the measured hydrogen concentration with an error bar of three standard deviations of the measurement signal.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO974HTA (0-5 vol.-% H_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319
NEO983HTA (0-10 vol.-% H_2)	0x320 & 0x321	0x328 & 0x329	0x330 & 0x331	0x338 & 0x339
NEO986HTA (0-100 vol.-% H_2)	0x340 & 0x341	0x348 & 0x349	0x350 & 0x351	0x358 & 0x359

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment.
must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [166]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[167]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To set the CAN ID, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message after 5s at system start.

166 Details can be found in the operating instructions under chapter: "Maintenance and service"
167 0xYY describes a measure for the set zero point adjustment

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO974HTA (0-5 vol.-% H_2)	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359
NEO983HTA (0-10 vol.-% H_2)	0x0CFF1459 & 0x0CFF1559	0x0CFF1659 & 0x0CFF1759	0x0CFF1859 & 0x0CFF1959	0x0CFF1A59 & 0x0CFF1B59
NEO986HTA (0-100 vol.-% H_2)	0x0CFF1C59 & 0x0CFF1D59	0x0CFF1E59 & 0x0CFF1F59	0x0CFF2059 & 0x0CFF2159	0x0CFF2259 & 0x0CFF2359

Set CAN ID (CAN2.0B):
To set the CAN ID, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):
A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make an adjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [168]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[169]
*corresponds to the serial number of the individual sensor system.
CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured hydrogen concentration exceeds the 0.5 % by volume limit (c(H_2) from <0.5 % by volume to >= 0.5 % by volume).

The following message is sent:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = *(Msg0-20)/100*
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with the defined carrier gas, without humidity, normal pressure and in the absence of H_2, the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

168 Details can be found in the operating instructions under chapter: "Maintenance and service"
169 0xYY describes a measure for the set zero point adjustment

Further CAN commands (CAN2.0A):

Adjust baud rate:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Change CAN2.0 A/B:
0x680 0xA0 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Zero point adjustment:
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Further CAN commands (CAN2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/H2-Sensor_NEO9XX_V146.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = (Msg0-20)/100
Msg 1(Bit 16-31): Water concentration [vol.-%]: c($H_{(2)}O$) = (Msg1-20)/100
Msg 2(bit 32-47): Pressure [mbar]: p = Msg2
Msg 3(Bit 48-55): Temperature [°C]: *T = (Msg3-60)*
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration_RAW[vol.-%]: c(H_2) = (Msg0-20)/100
Measurement of the hydrogen content, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with the defined carrier gas, without humidity, normal pressure and in the absence of H_2, the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

Example for the interpretation of CAN messages:
Hex message from Sensor:
CAN Msg1: CAN ID1 320 00 14 00 CE 03 ED 68 D8
CAN Msg2: CAN ID2 321 00 0A 63 00 50 D 92 CA

Decimal translation:
CAN Msg1: Byte0+1: 20, Byte 2+3: 206, Byte 4+5: 1005 Byte 6: 104, Byte 7: 216
CAN Msg2: Byte0+1: 10, Byte 2: 99, Byte 3: 0, Byte 4+5:1293 Byte 6: 146, Byte 7: 202

Sensor translation:
CAN Msg1: c(H_2) [vol.-%]: 0, c($H_{(2)}O$)[vol.-%]: 1.86, p[mbar]: 1005, T[°C]: 44, CRC: 216
CAN Msg2: c(H_2) _raw[vol.-%]: -0.1, raw: 99, status: 0, serial#: 1293, SV: 14.6 Counter: 202

Explanation of the status byte:

Bit 24	0: there is currently no H_2O condensation	1: if H_2O condensation is present (acute)
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume

Bit 29	0: No maintenance required	1: Sensor please wait
Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	0: there has never been H_2O condensation	1: if H_2O condensation ever occurred.

Example:

"Sensor running; no $H_{(2)}$ .." → Status byte = 00000000 binary → 0 hexadecimal, 0 decimal
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal[170]
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal[171]
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

170 If the supply voltage is not sufficient, status byte 2 is output and a full signal is output at the H2 concentration.

171 Status byte 32 is set if the temperature (T > 120°C && T less than -40°C), the relative humidity (r.h. > 99%), the pressure (p > 6000 mbara && less than 600 mbara) are outside the defined range or 5,000 operating hours. The status byte is only reset with a zero point adjustment!

Analogue 4-20mA - Series I

I[mA]	c(H_2) [vol.-%]	Comment
4 - 20 mA[172]	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration. This means that 2.5 vol-% $H_{(2)}$,for example, is then output as 12mA with a 5 vol-% H_2sensor system. In the heat-up phase and during a critical fault, a current <4mA is output (usually approx. 3mA)

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The maximum permissible load is 450 Ohm.

Analogue 0-10V - Series I

U[V]	c(H_2) [vol.-%]	Comment
0 - 10 V	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration in a range from 1V to 9V. This means that 5 vol-% $H_{(2)}$,for example, is then output as 5V for a 10 vol-% H_2sensor system. Values less than 1V indicate an error.

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The minimum measuring resistance is 10 kOhm.

The following diagram shows a connection diagram:

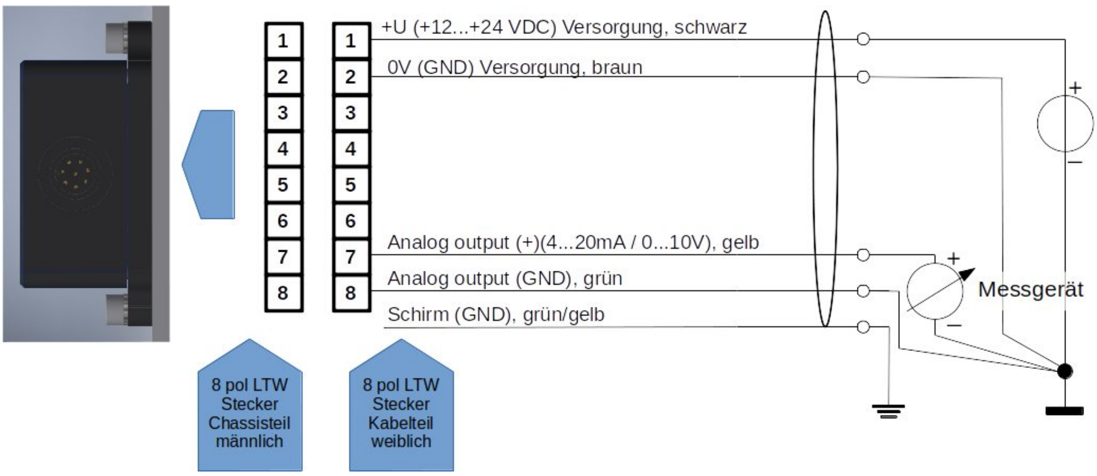


Figure 5: Wiring diagram

172 In earlier versions of this sensor, 7.2 to 20mA was given as the measuring range.

Digital Modbus via RS485 or EIA/TIA-485 - NEO series M

In serial master-slave communication, our NEO sensors function as slaves with the start slave ID 1 and a baud rate of 9,600 in 8N1, i.e. data bits: 8, parity: none, stop bits: 1. The 16-bit registers are defined as signed integers in big-endian, i.e. values in the range -32,768 to 32,767. The Modbus lines are not terminated.

Input register:

Name	Description of the	Scaling[173]	Unit	Register addresses	INPUT register address (hex / dec)
Hydrogen concentration	H_2Volume concentration (Example: 2030 = 20.3 vol.-%)	100	Vol.-%	3x257	0x100 / 256_{dec}
Water concentration	H_2O Volume concentration (Example: 2330 = 23.3 vol.-%)	100	Vol.-%	3x258	0x101 / 257_{dec}
Pressure	Pressure as absolute pressure (Example: 1033 = 1033 mbar)	1	mbar a	3x259	0x102 / 258_{dec}
Temperature	Temperature in measuring cavern (Example: 6250 = 62.5°C)	100	°C	3x260	0x103 / 259_{dec}
Hydrogen concentration _RAW	Hydrogen concentration (Example: 2750 = 27.5 vol.-%)	100	Vol.-%	3x261	0x104 / 260_{dec}
Gross value	Raw value = 100 in the absence of water and hydrogen and otherwise normal air.	1	-	3x262	0x105 / 261_{dec}
Status byte	See "Explanations on the status byte" in the "Signal explanation" section: "CAN".	1	-	3x263	0x106 / 262_{dec}
Serial number	S/N: P number, which is noted on the outside of the device. (Example: 3626 = P-3626)	1	-	3x264	0x107 / 263_{dec}
Software version	Version of the sensor software (Example: 156 = version 15.6)	10	-	3x265	0x108 / 264_{dec}
Message counter	High running counter 0-255	1	-	3x266	0x109 / 265_{dec}
Check value	00000000 01010101 value is 85, which can be used to check the byte order	1	-	3x267	0x10A / 266_{dec}

Holding register:

173 When reading with a PLC, make sure that the data type is set to "Real" so that the signed integer can also be displayed as a comma number.

Name	**Description of the**	**Register addresses**	**HOLDING Register address (hex / dec)**
Baud rate	default: 9,600 Specifying the baud rate of the Modbus RTU interface: 4,800, 9,600 or 19,200	4x001	0x00 / 0_{dec}
Slave ID	default: 1 Possible slave IDs of the sensor 1-247	4x002	0x01 / 1_{dec}
Mode parity	default: 0 = parity: none, stop bit: 1 0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2	4x003	0x02 / 2_{dec}
Zero point adjustment	default: 0 If a 1 is written to the register, a zero point adjustment is carried out here and then changed the register to 2.	4x004	0x03 / 3_{dec}

Changes to the factory settings are only applied after restarting the sensor.

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapters and heaters:
Various adapters are available for mounting the sensor. For use in very humid environments or environments with liquid water or the risk of icing, there are heating cartridges that can be operated at a constant voltage. These can be fitted in the adapters. You can find the corresponding products under:
https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for the fine purification of gases by removing minimal impurities.

FAQ:
The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Hydrogen concentration sensor data sheet

NEO974, NEO983 and NEO986, version 15.6

Product description:

Sensor system for measuring the hydrogen concentration in air, oxygen, nitrogen or oxygen-depleted air with temperature-, pressure- and humidity-compensated signal evaluation for automotive or industrial applications. Applicable in the range: 0.6 - 6 bara, 0 - 100% r.h. (non-condensing) and -40°C - 85°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measuring ranges: 0-5 vol.-% $H_{(2)}$ (**NEO974**), 0-10 vol.-% $H_{(2)}$ (**NEO983**) or 0-100 vol.-% $H_{(2)}$ (**NEO986**)
- Carrier gases air, N_2, O_2, oxygen depleted air possible
- Measuring signal independent of pressure, temperature and humidity
- Signal output via CAN 2.0, Modbus RTU via RS485, 0-10V or 4-20mA
- Replacement system for the AMS HLS-442, HLS-440P and the HPS-100
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Can also be used in the intake manifold with H_2direct injection.
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Factory calibrated and ready for immediate use
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary.
- Encrypted CAN communication on demand

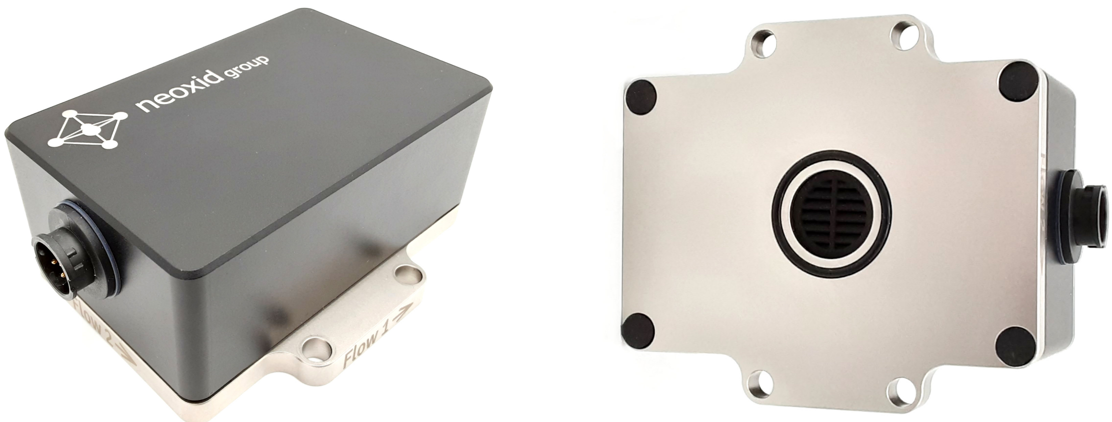


Figure 1: H_2concentration sensor version NEO9XX

...go to English version

Sensor system characteristics:

Supply voltage: 12 - 32 V DC[174]

Energy consumption: < 2,4 W

Possible H_2sensitivity: 0 - 100 vol.-% H_2 **NEO986**
0 - 10 vol.-% H_2 **NEO983**
0 - 5 vol.-% H_2 **NEO974**

Accuracy: ± 0.3 vol.-% H_2[175] or ± 2 vol.-% H_2[176]

Detection limit: < 0.3 vol.-% $H_{(2)}$ (1)or < 0.5 vol.-% $H_{(2)}$ (2)

Response time t_{90}: < 3 s[1], < 5 s[2]

Decay time t_{10}: < 3 s[1], < 5 s[2]

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[177]

Media temperature: - 40°C - 85°C

Ambient temperature: - 40°C - 85°C
The cold start at -40°C was tested.

Pressure range: 0.6 - 6 bar absolute, i.e. 60 - 600 kPa

Humidity: 0 - 100 % r.h. (non-condensing)[178]

Carrier gas: Air, N_2, O_2, oxygen depleted air, also available as $O_{(2)}$)
available as H_2variant[179] (see data sheet
data_sheet_Sensor_system_NEO445_V146_EN)

Cross-sensitivities: Helium, tbd

Signal :[180] CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on
page25 Modbus RTU via RS485 interface on page 16
4-20 mA on page 28
0-10 V on page 28

174 For analogue 0-10V output, please apply more than 15 VDC.
175 For 0-5 vol.% and 0-10 vol.% H_2systems
176 For 100 vol% H_2systems
177 The system is designed for continuous operation
178 In particular, splash water must be kept away from the sensor opening
179 Info for electrolysis gases: If you flush this 0-5% H_2sensor in the carrier gas oxygen with nitrogen (even without hydrogen content), the H_2measurement will be falsified by a few volume per cent with a negative offset!
180 Signals are described in the "Explanation of signals" section

Output/measurement interval:	100 ms / 10 Hz
Resolution:	100 ppm for CAN bus and Modbus RTU 250 ppm at 4-20 mA or 0-10V
Housing: with	Size: 95 x 83 x 41 mm³, housing cover made of EN AW 6060 and media-contacting base plate made of 316L or 1.4404, M5 screws to the measuring chamber 3Nm.
Leakage rate:	10^{-5}mbar l / s [181]
Long-term stability:	Deviation <0.1 vol.-% in the first 5000h Operating time
IP code:	IP6K7
Weight:	< 570 g
SIL:	-
ATEX:	Zone I available on request (see data sheet Sensor system_NEO9XXHT_ATEX_V146_EN_EN)
Service life:	IP6K7 enclosure qualified with an expected Service life of 5 years[182] . The system was tested with 100,000 switch-on and switch-off cycles.
Maintenance interval : 6 months.	We recommend checking the H_2sensor every check.
Measuring behaviour: addition, a specification differs must be tested for	The gas to be tested may have a maximum have a maximum velocity of 25m/s. In laminar flow is recommended. If the specification, the sensor tested for functionality.
Connection cable: page 123	3 m enclosed; more detailed information on
RoHS compliant: RoHS_DE_EN_V02_scan.pdf	Yes https://neoxid-cloud.de/Konformitaetserklaerung-
Customs tariff number:	90271010
COO:	Germany / NRW
ECCN:	EAR99

181 Measured with forming gas 90/10, 1.5 bar absolute, room temperature

182 Measuring components are purely inorganic and are not consumed during measurement

EC-79/2009 | Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

Accuracy of the measured values:[183]

Size	**Accuracy**
Hydrogen concentration	± 0.3 vol.-% H_2[184] or ± 2 vol.-% H_2[185]
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[186]	± 0,3 °C
Pressure	± 20 mbar

Table9 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO9XX-V08_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Scope of delivery:

In addition to the sensor unit, 4x M5 screws are supplied for mounting the sensor, as well as a 3 m connection cable with cable end sleeves.

Mounting the sensor:

The stepfile and a 2D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO9XX.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request (see data sheet_Adapter_NEO1XX_V146_EN_EN). To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a spatial direction other than horizontally, a small offset[187] occurs; this must be corrected via a specific CAN message on ID 0x680 (zero point adjustment, see page). 14

183 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar
184 For 0-5 vol.-% and 0-10 vol.-% H_2systems
185 For 100 vol.-% H_2systems
186 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber
187 When tilted by± 40° in all directions, the error is less than± 0.05 vol.-%.

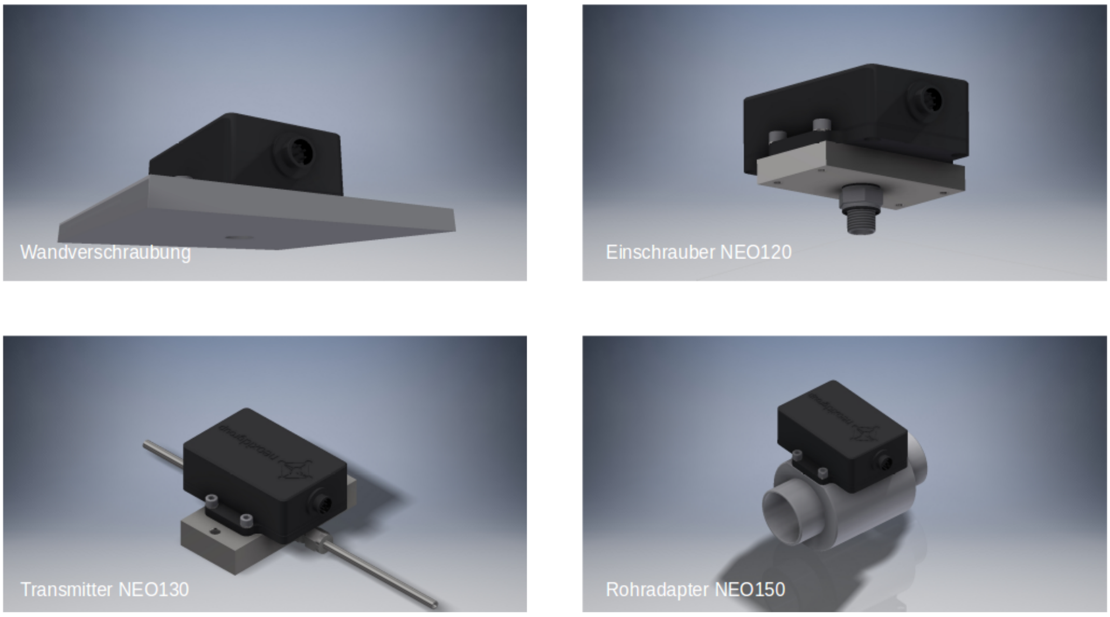


Figure 2a: Mounting the H_2sensor system

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation (standstill condensation) can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The above-mentioned adapters (with the exception of the NEO160) can also be fitted with heating cartridges, which are also available on request. As a further protective measure against small amounts of splash water, the sensor is fitted with a ribbed plug. Care must be taken to ensure that the sensor is installed in such a way that this plug functions properly if an installation with a passing gas is used.

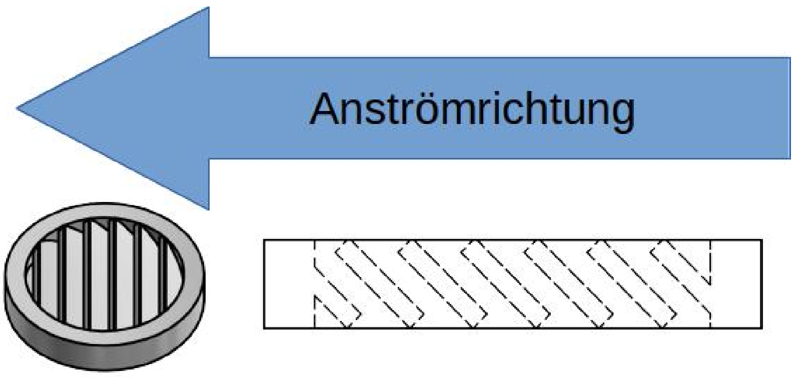


Figure 2b: Fitting ribbed plugs against the direction of flow

Hole pattern:

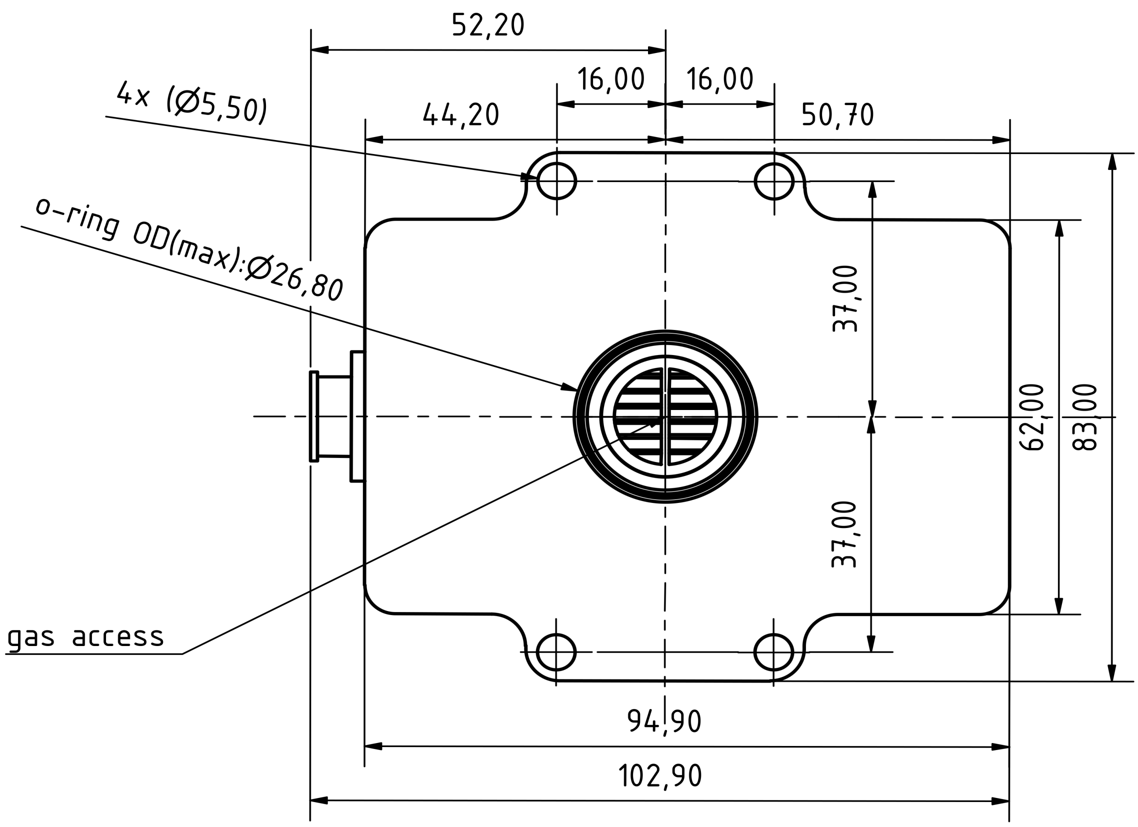


Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

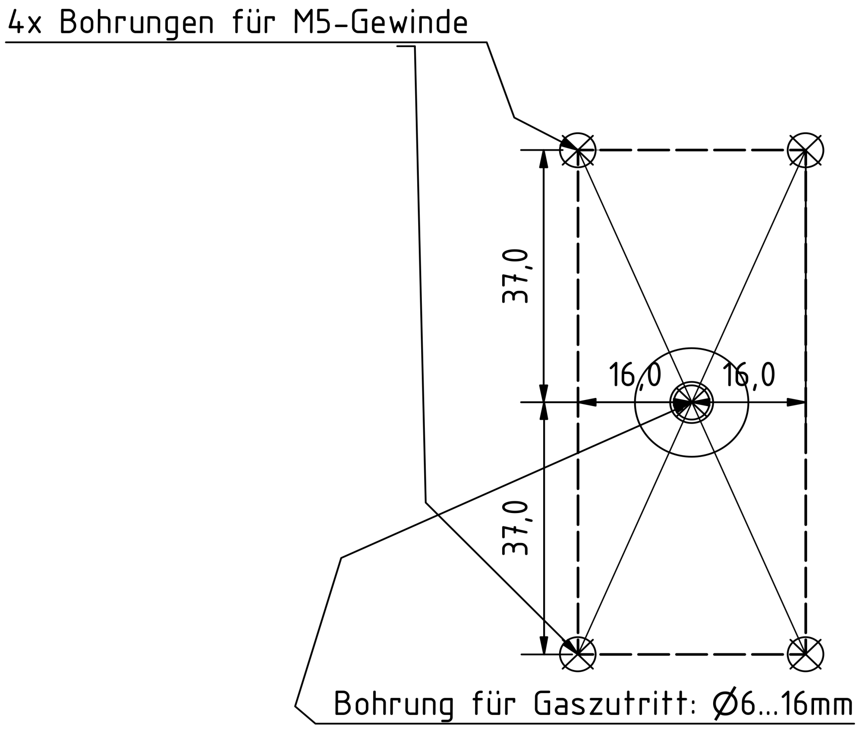
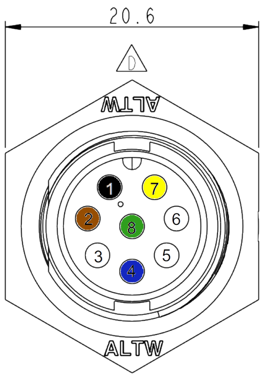


Figure 3b: Drilling template

Electrical PIN assignment



Housing plug

PIN no.	Description of the	Colour
1	VCC+ 12 ...+30 V DC (min.: 2.4W)	black
2	GND 0V DC	brown
3	CAN-High (opt. DAC+)	white
4	CAN-Low(opt. DAC-)	blue
5	*service port A*	-
6	*service port B*	-
7	DAC + / RS485 A	yellow
8	DAC - / RS485 B	green
	Shielding (optional GND)	green/yellow

8-pin housing connector: Amphenol LTW: ABD-08RMMS-LC7001
8-pin cable socket: Amphenol LTW: BD-08BFFA-LL7001

Figure 3c below shows the enclosed connection cable with angled socket:

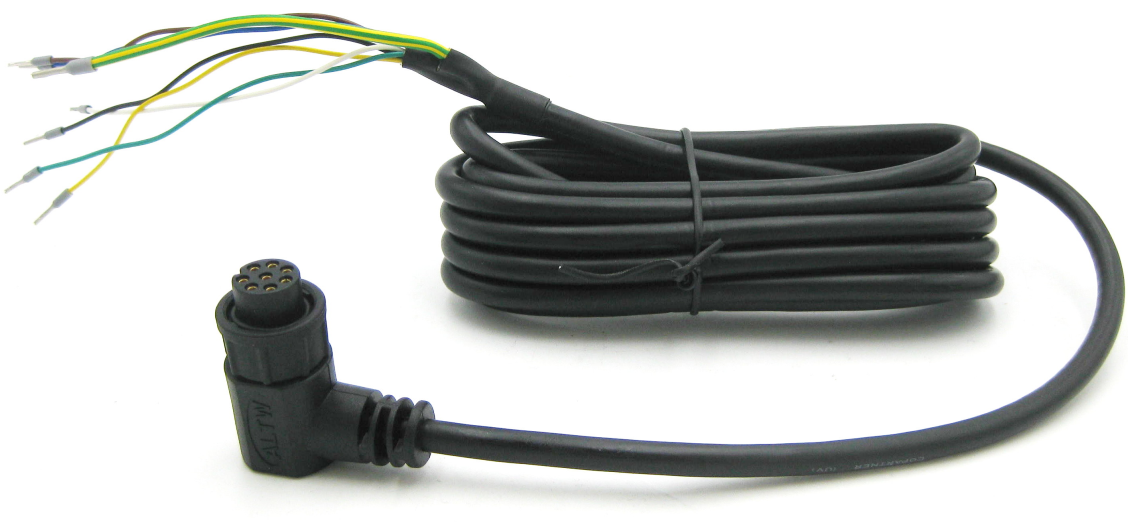


Figure 3c: Connection cable with angled socket

Simultaneous signal output via CAN bus and an analogue interface

If required, the sensor's measurement data can be output simultaneously via the CAN bus interface and an analogue interface (4-20 mA, 0-10V). If an analogue interface (4-20 mA, 0-10V) is selected in addition to the CAN bus, the analogue signal is output via PIN 7 & 8. CAN addressing via the connector is then no longer possible!

Information on hydrogen ignition by the NEO974/NEO983/NEO986 from neo hydrogen sensors GmbH in accordance with J2578 SAE international:
The H_2sensor NEO974/NEO983/NEO986 uses a heating element that is heated with 5 V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the NEO974/NEO983/NEO986 (a Zener diode prevents the operating voltage from being too high). In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is issued via the status byte if the heating current is outside the normal range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavity.

Catalytic materials are not installed in the H_2sensor NEO974/NEO983/NEO986, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors NEO974/NEO983/NEO986. Neither an explosion nor a detonation could be caused during normal operation, even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

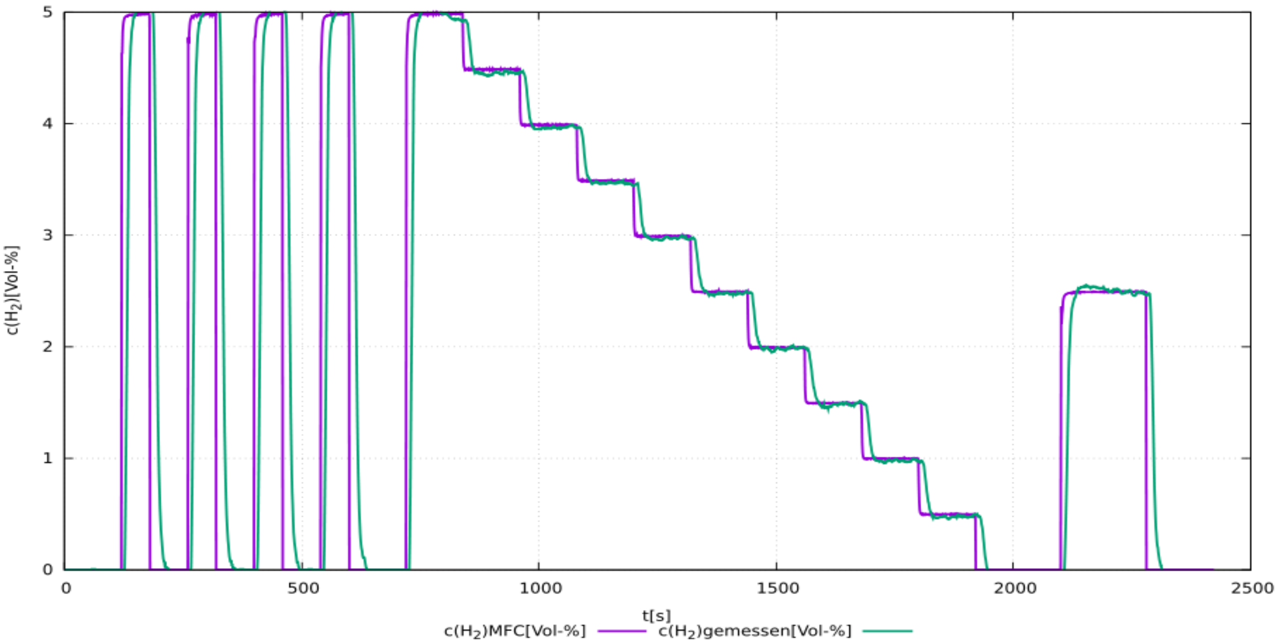


Figure 4a: Test of a sensor system NEO974 0 - 5 vol.-% H_2in 21 vol.-% O_2. Measured with a total flow of 1,000 sccm.

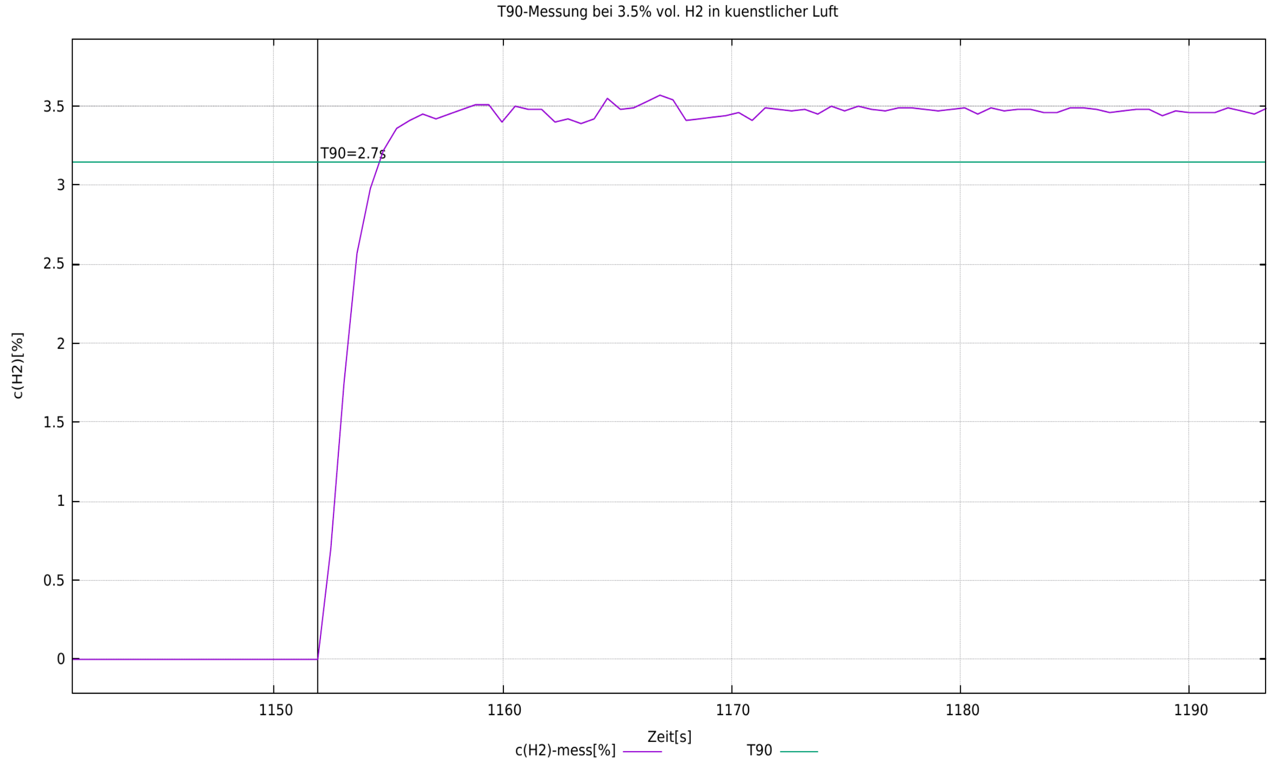


Figure 4b: t_{90}time determination with a sensor system by switching from 0 vol.-% $H_2$to 3.5 vol.-% H_2. Measured with a total flow of 1,000 sccm.

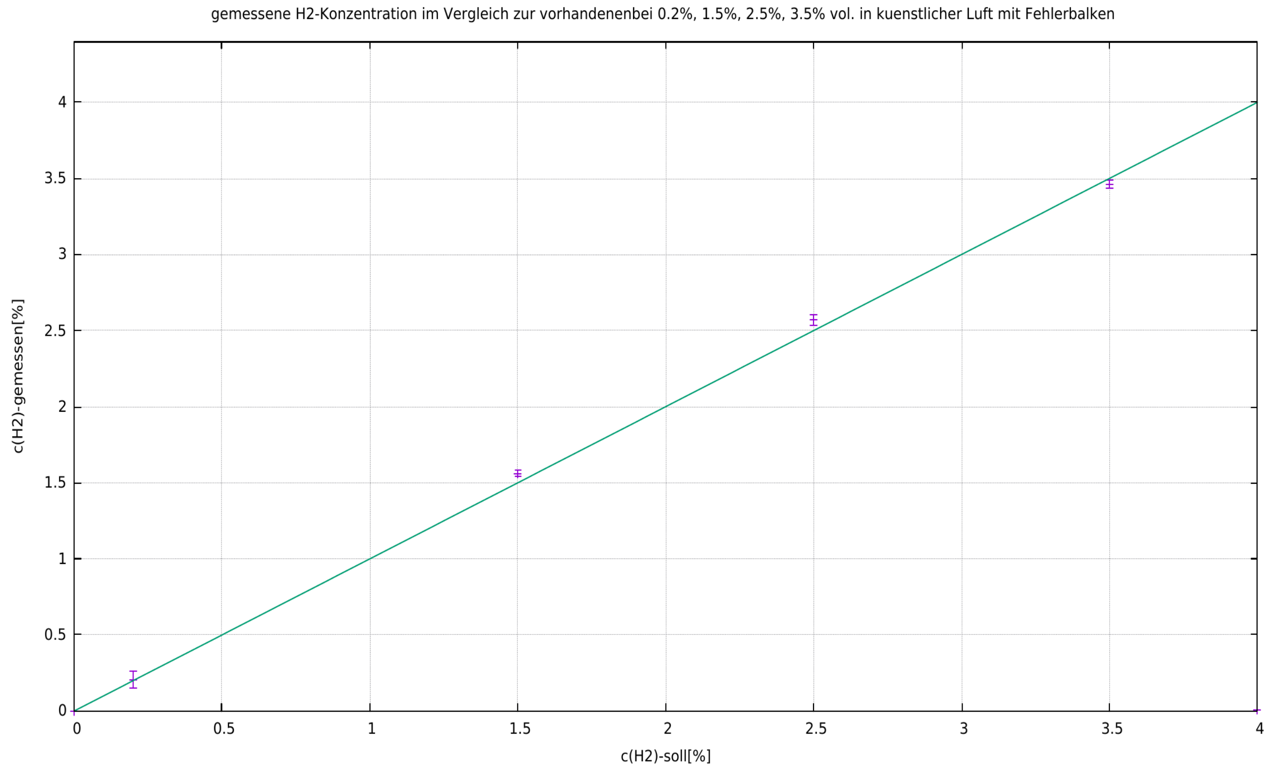


Figure 4c: Comparative measurement of the set hydrogen concentration and the measured hydrogen concentration with an error bar of three standard deviations of the measurement signal.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Explanations on starting the sensor and using the sensor at cold temperatures

The heating phase of the sensor takes up to 70s. This time depends on how warm the environment is, how long the sensor has been switched off and how much heat is dissipated from the sensor into the environment. However, the sensor recognises when it has finished heating up and then simply starts regular operation. The user can recognise this from the status byte. This indicates when the heating phase is over (status not equal to 8).
If the sensor is operated in a cold environment <0°C, there are a few things to consider. A cold start at -40°C is unproblematic and has been tested with the sensor. However, care must be taken to ensure that no ice forms in the sensor or at the sensor opening if an immediate measurement is required within the normal heating phase. A layer of ice on the membrane physically prevents the gas to be measured from entering. This problem can be solved by either drying the system with dry gas after using the sensor in a very humid environment, or by additionally heating the sensor during and before each use.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO974A (0-5 vol.-% H_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319
NEO983A (0-10 vol.-% H_2)	0x320 & 0x321	0x328 & 0x329	0x330 & 0x331	0x338 & 0x339
NEO986A (0-100 vol.-% H_2)	0x340 & 0x341	0x348 & 0x349	0x350 & 0x351	0x358 & 0x359

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to carry out a readjustment.
must be made. This is permanent and affects all outgoing H_2signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To make an adjustment, the system should be free of hydrogen and with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [188]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[189]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To set the CAN ID, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

188 Details can be found in the operating instructions under chapter: "Maintenance and service"
189 0xYY describes a measure for the set zero point adjustment

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO974A (0-5 vol.-% H_2)	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359
NEO983A (0-10 vol.-% H_2)	0x0CFF1459 & 0x0CFF1559	0x0CFF1659 & 0x0CFF1759	0x0CFF1859 & 0x0CFF1959	0x0CFF1A59 & 0x0CFF1B59
NEO986A (0-100 vol.-% H_2)	0x0CFF1C59 & 0x0CFF1D59	0x0CFF1E59 & 0x0CFF1F59	0x0CFF2059 & 0x0CFF2159	0x0CFF2259 & 0x0CFF2359

Set CAN ID (CAN2.0B):
To set the CAN ID, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x200
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x200, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):
A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make a readjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To make an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [190]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[191]
*corresponds to the serial number of the individual sensor system.

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/H2-Sensor_NEO9XX_V146.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: $c(H_2) = (Msg0-20)/100$
Msg 1(Bit 16-31): *Water concentration [vol.-%]:* $c(H_{(2)}O) = (Msg1-20)/100$
Msg 2(bit 32-47): Pressure [mbar]: $p = Msg2$
Msg 3(Bit 48-55): Temperature [°C]: $T = (Msg3-60)$
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0D59:
Msg 0(bit 0-15): Hydrogen concentration_RAW[vol.-%]: $c(H_2) = (Msg0-20)/100$
Measurement of the hydrogen content, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the

190 Details can be found in the operating instructions under chapter: "Maintenance and service"
191 0xYY describes a measure for the set zero point adjustment

absence of $H_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): *Version = (Msg4 / 10)*
Msg 5(Bit 56-63): Continuous message counter

CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured hydrogen concentration exceeds the 0.5 % by volume limit (c(H_2) from <0.5 % by volume to >= 0.5 % by volume).

The following message is sent:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(*H_2*) *= (Msg0-20)/100*
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $H_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

Example for the interpretation of CAN messages:

Hex message from Sensor:
CAN Msg1: CAN ID1 320 00 14 00 CE 03 ED 68 D8
CAN Msg2: CAN ID2 321 00 0A 63 00 50 D 92 CA

Decimal translation:
CAN Msg1: Byte0+1: 20, Byte 2+3: 206, Byte 4+5: 1005 Byte 6: 104, Byte 7: 216
CAN Msg2: Byte0+1: 10, Byte 2: 99, Byte 3: 0, Byte 4+5:1293 Byte 6: 146, Byte 7: 202

Sensor translation:
CAN Msg1: c($H_{2)}$ [vol.-%]: 0, c($H_{(2)}O$)[vol.-%]: 1.86, p[mbar]: 1005, T[°C]: 44, CRC: 216
CAN Msg2: c($H_{2)}$_raw[vol.-%]: -0.1, raw: 99, status: 0, serial#: 1293, SV: 14.6 Counter: 202

Explanation of the status byte:

Bit 24	0: there is currently no H_2O condensation	1: if H_2O condensation is present (acute)
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait
Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	0: there has never been H_2O condensation	1: if H_2O condensation ever occurred.

Example:

"Parameter outside ..." -> Status byte = 00000010 binary -> 2 hexadecimal, 2 decimal
"Sensor defective" -> Status byte = 00000100 binary -> 4 hexadecimal, 4 decimal
"Sensor in heating phase" -> Status byte = 00001000 binary -> 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 vol.-%" -> Status byte = 00010000 binary -> 10 hexadecimal, 16 decimal
"Sensor please wait" -> Status byte = 00100000 binary -> 20 hexadecimal, 32 decimal[192]
"Recalibrate sensor" -> Status byte = 01000000 binary -> 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Set the baud rate to 500 kbit/s or 250 kbit/s:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H2 in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Initiate maintenance:
0x680 0x00 0x77 0x61 0x72 0x74 0x75 0x6E 0x67

Further CAN commands (CAN2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

192 Status byte 32 is set if the temperature (T > 120°C && T less than -40°C), the relative humidity (r.h. > 99%), the pressure (p > 6000 mbara && less than 600 mbara) are outside the defined range or 5,000 operating hours. The status byte is only reset with a zero point adjustment!

Analogue 4-20mA - Series I

I[mA]	c(H_2) [vol.-%]	Comment
4 - 20 mA[193]	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration. This means that 2.5 vol-% $H_{(2)}$,for example, is then output as 12mA with a 5 vol-% H_2sensor system. In the heat-up phase and during a critical fault, a current <4mA is output (usually approx. 3mA)

It should be noted that the analogue output of the sensors is subject to an additional error of 2% FS. The maximum permissible load is 450 Ohm.

Analogue 0-10V - Series I

U[V]	c(H_2) [vol.-%]	Comment
0 - 10 V	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration in a range from 1V to 9V. This means that 5 vol-% $H_{(2)}$,for example, is then output as 5V for a 10 vol-% H_2sensor system. Values less than 1V indicate an error.

It should be noted that the analogue output of the sensors is subject to an additional error of 2% FS. The minimum measuring resistance is 10 kOhm.

The following diagram 5 shows a connection diagram:

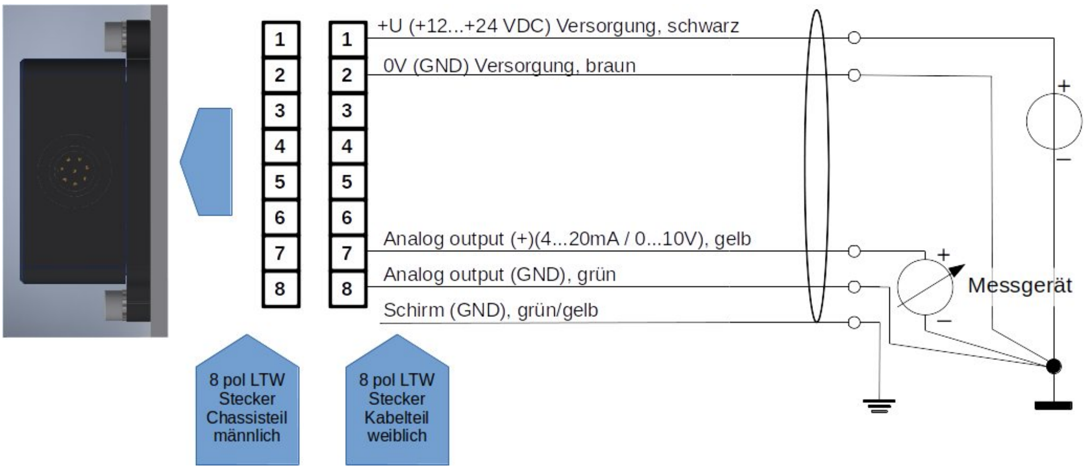


Figure 5: Wiring diagram

193 In earlier versions of this sensor, 7.2 to 20mA was given as the measuring range.

Digital Modbus via RS485 or EIA/TIA-485 - NEO series M

In serial master-slave communication, our NEO sensors function as slaves with the start slave ID 1 and a baud rate of 9,600 in 8N1, i.e. data bits: 8, parity: none, stop bits: 1. The 16-bit registers are defined as signed integers in big-endian, i.e. values in the range -32,768 to 32,767. The Modbus lines are not terminated.

Input register:

Name	Description of the	Scaling[194]	Unit	Register addresses	INPUT register address (hex / dec)
Hydrogen concentration	H_2Volume concentration (Example: 2030 = 20.3 vol.-%)	100	Vol.-%	3x257	0x100 / 256_{dec}
Water concentration	H_2O Volume concentration (Example: 2330 = 23.3 vol.-%)	100	Vol.-%	3x258	0x101 / 257_{dec}
Pressure	Pressure as absolute pressure (Example: 1033 = 1033 mbar)	1	mbar a	3x259	0x102 / 258_{dec}
Temperature	Temperature in measuring cavern (Example: 6250 = 62.5°C)	100	°C	3x260	0x103 / 259_{dec}
Hydrogen concentration _RAW	Hydrogen concentration (Example: 2750 = 27.5 vol.-%)	100	Vol.-%	3x261	0x104 / 260_{dec}
Gross value	Raw value = 100 in the absence of water and hydrogen and otherwise normal air.	1	-	3x262	0x105 / 261_{dec}
Status byte	See "Explanations on the status byte" in the "Signal explanation" section: "CAN".	1	-	3x263	0x106 / 262_{dec}
Serial number	S/N: P number, which is noted on the outside of the device. (Example: 3626 = P-3626)	1	-	3x264	0x107 / 263_{dec}
Software version	Version of the sensor software (Example: 156 = version 15.6)	10	-	3x265	0x108 / 264_{dec}
Message counter	High running counter 0-255	1	-	3x266	0x109 / 265_{dec}
Check value	00000000 01010101 value is 85, which can be used to check the byte order	1	-	3x267	0x10A / 266_{dec}

194 When reading with a PLC, make sure that the data type is set to "Real" so that the signed integer can also be displayed as a comma number.

Holding register:

Name	Description of the	Register addresses	HOLDING Register address (hex / dec)
Baud rate	default: 9,600 Specifying the baud rate of the Modbus RTU interface: 4,800, 9,600 or 19,200	4x001	0x00 / 0_{dec}
Slave ID	default: 1 Possible slave IDs of the sensor 1-247	4x002	0x01 / 1_{dec}
Mode parity	default: 0 = parity: none, stop bit: 1 0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2	4x003	0x02 / 2_{dec}
Zero point adjustment	default: 0 If a 1 is written to the register, a zero point adjustment is carried out here and then changed the register to 2.	4x004	0x03 / 3_{dec}

Changes to the factory settings are only applied after restarting the sensor.

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapters and heaters:
Various adapters are available for mounting the sensor. For use in very humid environments or environments with liquid water or the risk of icing, there are heating cartridges that can be operated at a constant voltage. These can be fitted in the adapters. You can find the corresponding products under:
https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for the fine purification of gases by removing minimal impurities.

FAQ:

The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Hydrogen concentration sensor data sheet

NEO9005, NEO9010 and NEO9100, version 16.0

Product description:

Sensor system for measuring the hydrogen concentration in air, oxygen, nitrogen or oxygen-depleted air with temperature-, pressure- and humidity-compensated signal evaluation for automotive or industrial applications. Applicable in the range: 0.6 - 5 bara, 0 - 100% r.h. (non-condensing) and 40°C - 120°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measuring ranges: 0-5 vol.-% $H_{(2)}$ (**NEO9005**), 0-10 vol.-% $H_{(2)}$ (**NEO9010**) or 0-100 vol.-% $H_{(2)}$ (**NEO9100**)
- Carrier gases air, N_2, O_2, oxygen-depleted air, methane, synthetic natural gas are possible
- Measuring signal independent of pressure, temperature and humidity
- Signal output via CAN 2.0, Modbus RTU via RS485, 0-10V or 4-20mA
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement. No sample extraction necessary.
- Can also be used in the intake manifold with H_2direct injection
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Factory calibrated and ready for immediate use
- Suitable for concentration measurement in the ventilation of the crankcase or in the recirculation of the fuel cell (recirculation sensor; for controlling the purge valve)
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary
- CAN WakeUp function implemented
- Encrypted CAN communication on demand

Figure 1: H_2concentration sensor version NEO9XXX

...go to English version

Sensor system characteristics:

Supply voltage: 12 - 32 V DC[195]

Energy consumption: < 2,4 W

Possible H_2sensitivity: 0 - 100 vol.-% H_2 **NEO9100**
0 - 10 vol.-% H_2 **NEO9010**
0 - 5 vol.-% H_2 **NEO9005**

Accuracy: ± 0.3 vol.-% H_2[196] or ± 2 vol.-% H_2[197]

Detection limit: < 0.3 vol.-% $H_{(2)}$ ([1])or < 0.5 vol.-% $H_{(2)}$ ([2])

Response time t_{90}: < 5 s

Decay time t_{10}: < 5 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[198]

Media temperature: - 40°C - 120°C
(can also be calibrated down to -60°C)

Ambient temperature: - 40°C - 100°C
The cold start at -40°C was tested.

Pressure range: 0.6 - 6 bar absolute, i.e. 60 - 600 kPa
(can also be calibrated up to 0.25 bar a)

Air humidity: 0 - 100 % r.h. (non-condensing)[199]

Carrier gas: Air, N_2, O_2, Oxygen from air, Ar, CH_4,
synthetic natural gas, also as O_2 in H_2variant
available[200] (see data sheet
Sensor system_NEO4XXHT_V146_EN_EN)

Cross-sensitivities: Helium, tbd

Signal :[201] CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on
page13 Modbus RTU via RS485 interface on page 18
4-20 mA on page 112

195 For analogue 0-10V output, please apply more than 15 VDC.
196 For 0-5 vol.-% and 0-10 vol.-% H_2systems
197 For 100 vol.-% H_2systems
198 The system is designed for continuous operation
199 In particular, splash water must be kept away from the sensor opening
200 Info for electrolysis gases: If you flush this 0-5% H_2sensor in the carrier gas oxygen with nitrogen (even without hydrogen content), the H_2measurement will be falsified by a few volume per cent with a negative offset!
201 Signals are described in the "Explanation of signals" section

0-10 V on page 132

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm for CAN bus and Modbus RTU
250 ppm at 4-20 mA or 0-10V

Housing: Size: 95 x 83 x 48 mm³, housing cover made of
EN AW 6060 and media-contacting base plate made of
316L or 1.4404, tighten M5 screws to the measuring
chamber with 3Nm.

Long-term stability/drift: Deviation <0.1 vol.-% in the first 5000h
Operating time

Leakage rate: $<10^{-5}$mbar l / s [202]

IP code: IP6K7

Weight: < 810 g

Probability of default: FIT: 85.00
MTBF: 1,343 years
PFH: 8.50E-08
PFD: 8.5E-04

ASIL/SIL: in preparation

ATEX: Zone I available on request (see data sheet:
https://neoxid-cloud.de/Datenblatt_H2-Sensor_NEO9XXHT_ATEX_V156.pdf

Service life: IP6K7 enclosure qualified with an expected
Service life of 5 years.[203] The system has been tested
with 100,000 switch-on and switch-off cycles.

Maintenance interval : We recommend checking the H_2sensor every
6 months. check.

Measuring behaviour: The gas to be tested may have a maximum
have a maximum velocity of 25m/s. In
addition, a laminar flow is recommended. If the
specification differs specification, the sensor
must be tested for tested for functionality.

Connection cable: Must be purchased separately

RoHS compliant: Yes https://neoxid-cloud.de/Konformitaetserklaerung-
RoHS_DE_EN_V02_scan.pdf

202 Measured with forming gas 90/10, 1.5 bar absolute, room temperature
203 Measuring components are purely inorganic and are not consumed during measurement

EMC compliant: Yes https://neoxid-cloud.de/EMV-NEO9XXX_neohysens.pdf

Customs tariff number: 90271010

COO: Germany / NRW

ECCN: EAR99

EC-79/2009 Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

Accuracy of the measured values:[204]

Size	Accuracy
Hydrogen concentration	*± 0.3 vol.-% H_2*[205] *or ± 2 vol.-% H_2*[206]
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[207]	*± 0,3 °C*
Pressure	*± 20 mbar*

Table10 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO9XXX-V08_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Mounting the sensor:
The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO9XXX-Modell-und-Zeichnung.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request (see https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf). To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a spatial direction other than horizontally, a small offset[208] occurs, which must be corrected via a specific CAN message

204 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar

205 For 0-5 vol.-% and 0-10 vol.-% H_2systems

206 For 100 vol% H_2systems

207 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber

208 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.

on ID 0x680 (zero point adjustment, see page). 14

Scope of delivery:
In addition to the sensor unit, 4x M5 screws are supplied for mounting the sensor.

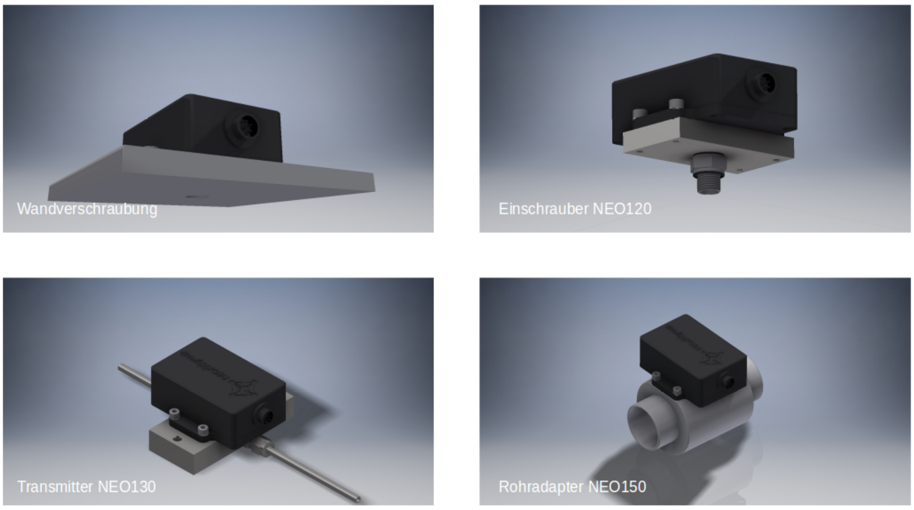


Figure 2a: Mounting the H_2sensor system

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The above-mentioned adapters (with the exception of the NEO160) can also be fitted with heating cartridges, which are also available on request. As a further protective measure against small amounts of splash water, the sensor is fitted with a ribbed plug. Care must be taken to ensure that the sensor is installed in such a way that this plug functions properly if an installation with a passing gas is used.

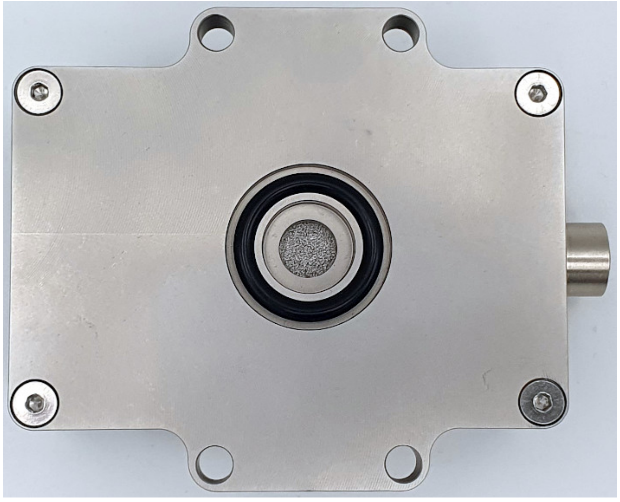


Figure 2b: Assembly

Hole pattern:

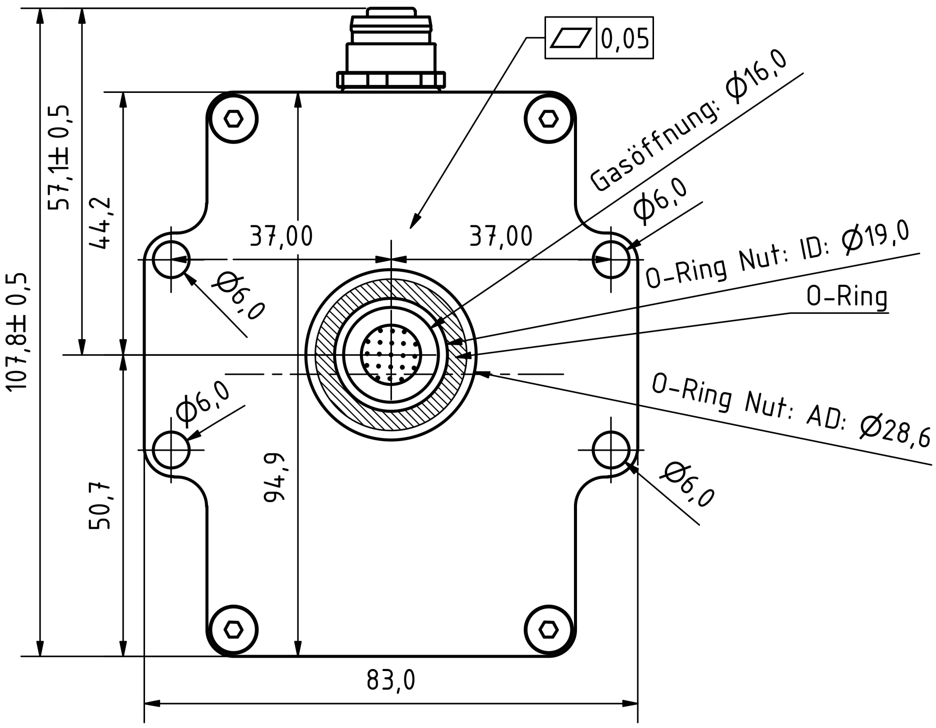


Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

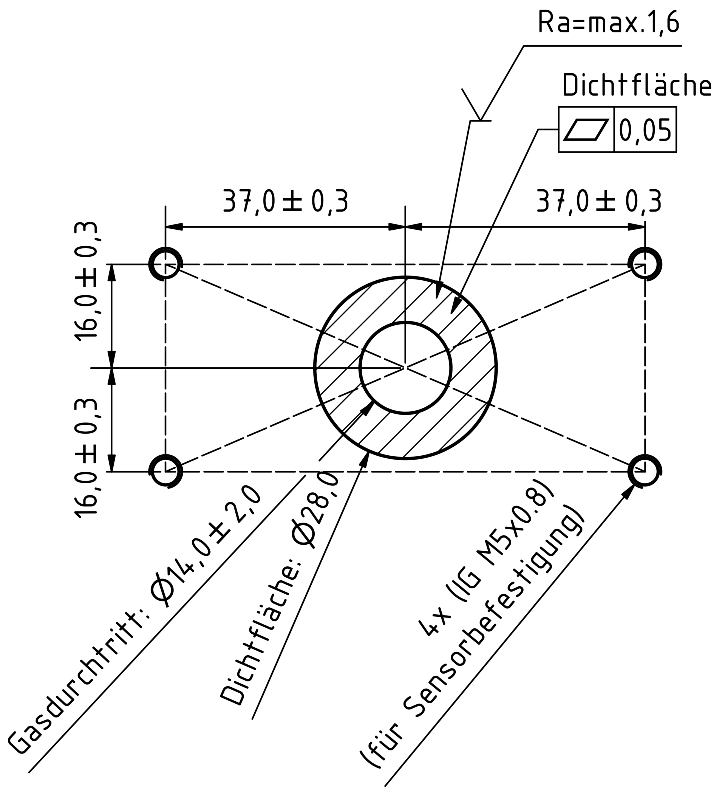
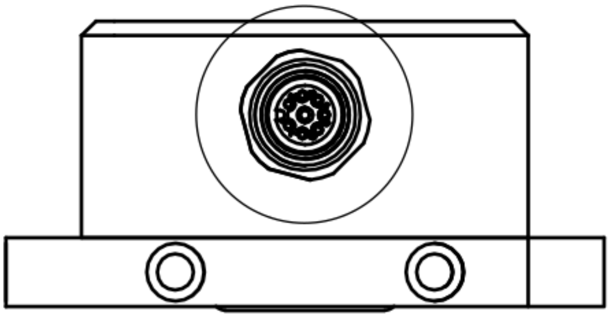
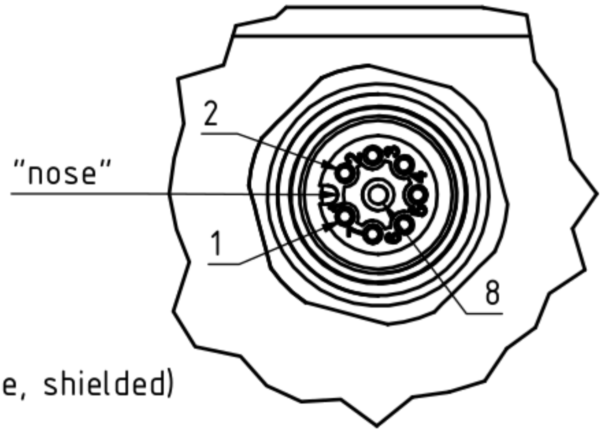


Figure 3b: Drilling template

Electrical PIN assignment
PANEL CABLE M12 COD.A FEMEA
Part number 21 03 317 6805

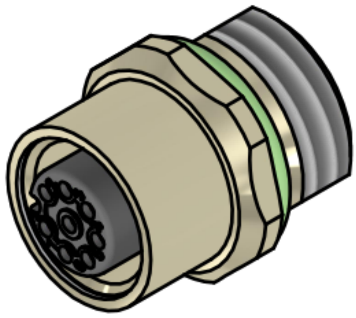




Pin-Assignment for

Connector (M12, a-coded, 8-pole, female, shielded)

1: V+ (+12...30V(DC))
2. GND (0V)
3. CAN-High
4. CAN-Low
5. analog-out(+)
6. analog-out(-)
7. Opt. or Service (delivery standard: nc)
8. Opt. or Service (delivery standard: nc)
9./housing: shield



Information on hydrogen ignition by the NEO9005/NEO9010/ NEO9100 from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

The H_2sensor NEO9005/NEO9010/NEO9100 uses a heating element that is heated with 5 V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the NEO9005 (a Zener diode prevents excessively high operating voltages). In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm^3 measuring cavity.

Catalytic materials are not installed in the H_2sensor NEO9005/NEO9010/NEO9100, so there is no risk of spontaneous combustion.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors NEO9005/NEO9010/NEO9100. Neither an explosion nor a detonation could be caused during normal operation, even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

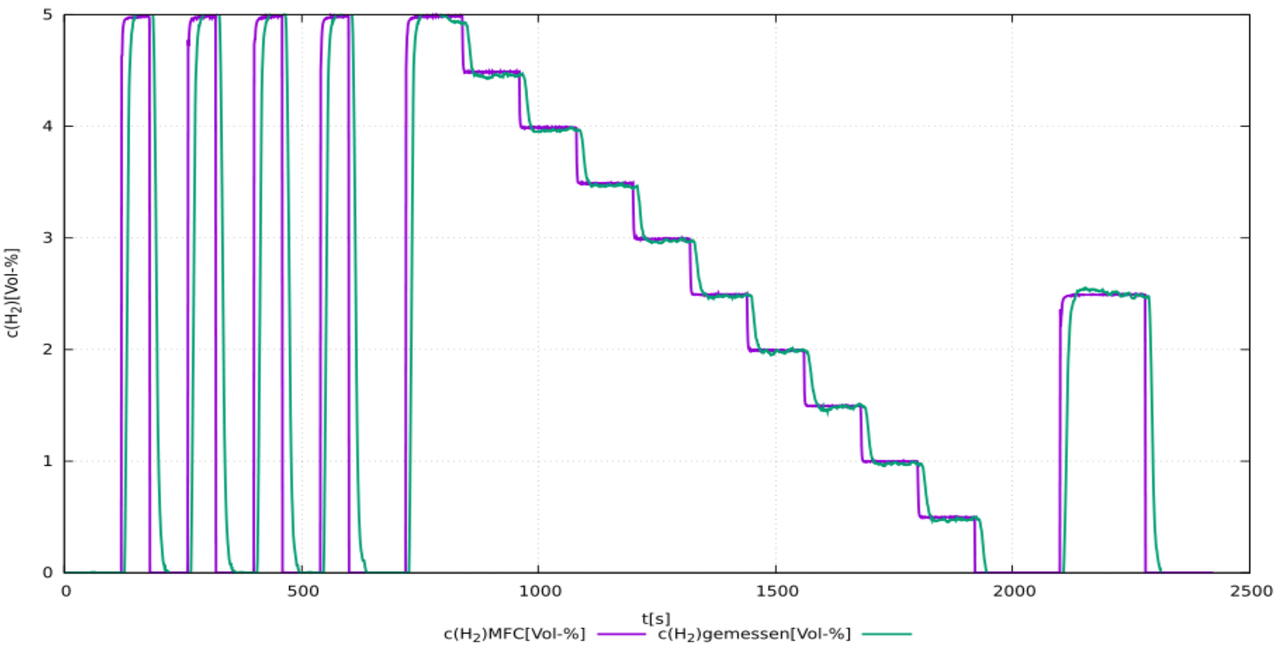


Figure 4a: Test of a sensor system NEO9005 0 - 5 vol.-% H_2in 21 vol.-% O_2. Measured with a total flow of 1,000 sccm.

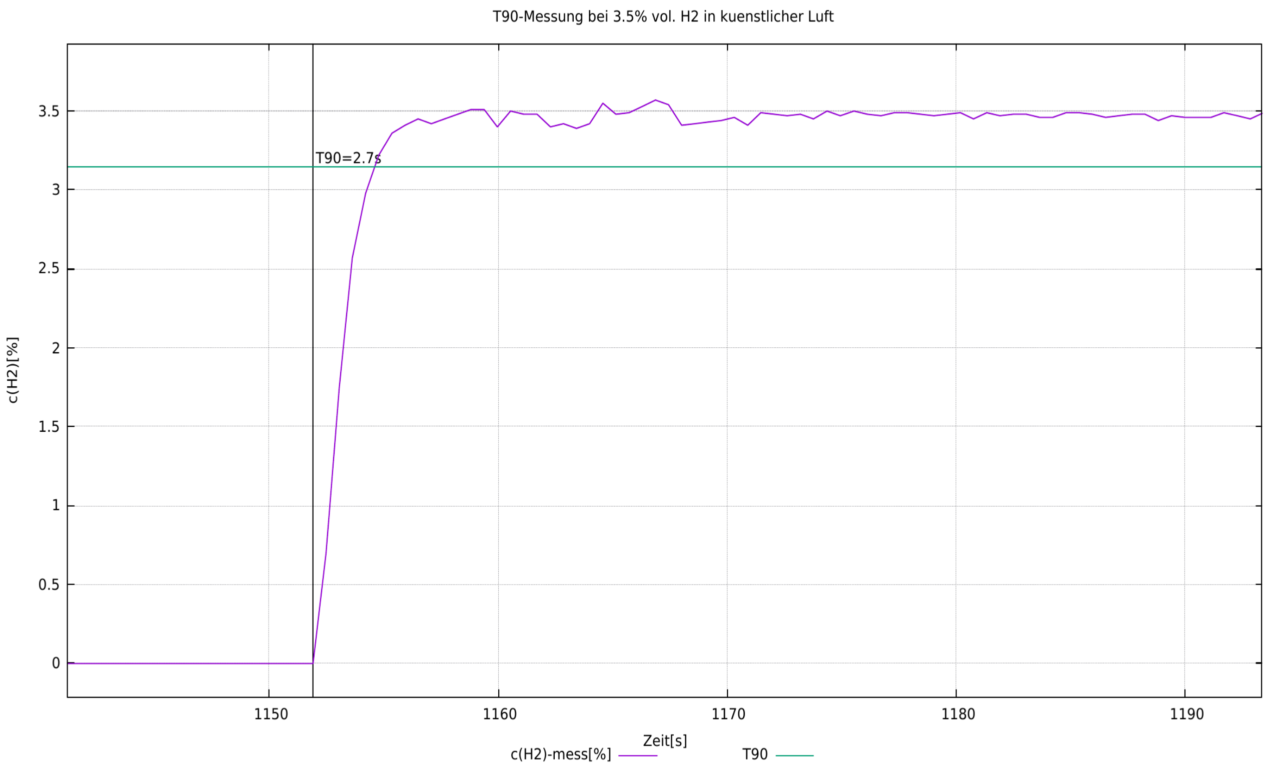


Figure 4b: t_{90}time determination with a sensor system by switching from 0 vol.-% $H_2$to 3.5 vol.-% H_2. Measured with a total flow of 1,000 sccm.

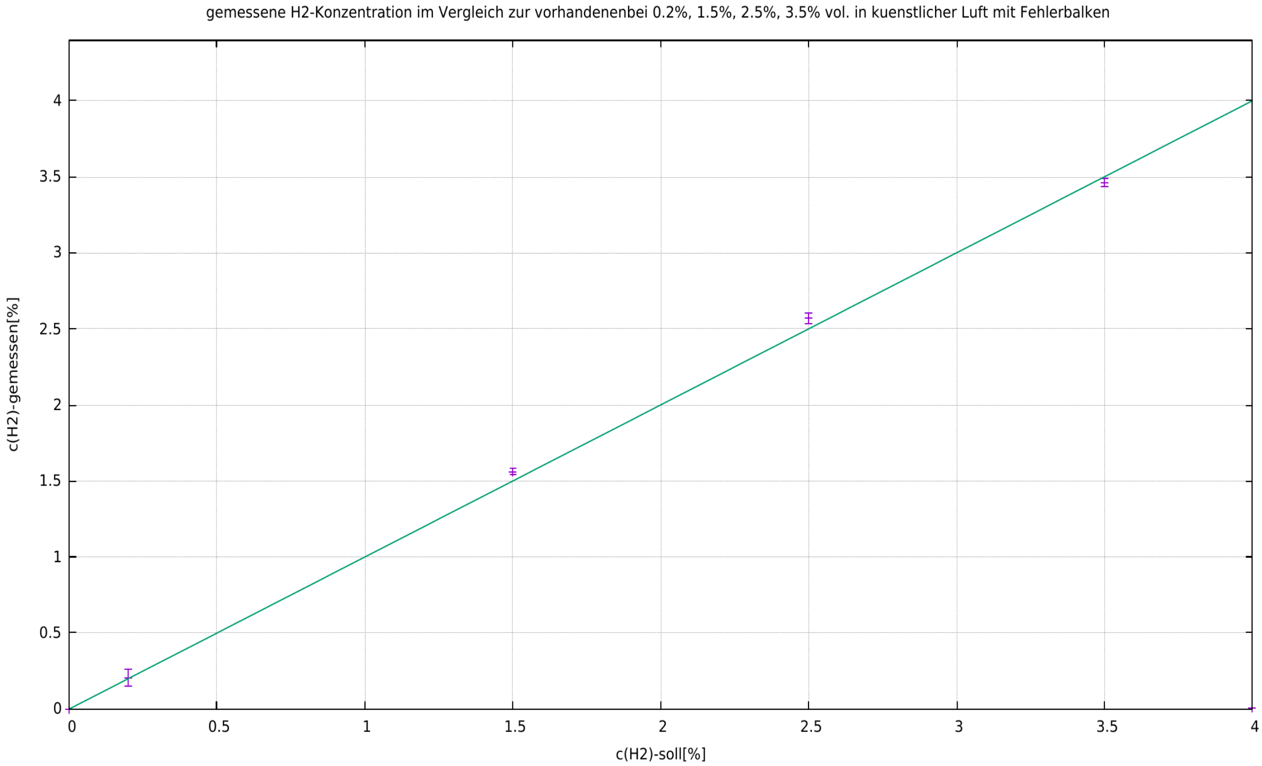


Figure 4c: Comparative measurement of the set hydrogen concentration and the measured hydrogen concentration with an error bar of three standard deviations of the measurement signal.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO9005A (0-5 vol.-% H_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319
NEO9010A (0-10 vol.-% H_2)	0x320 & 0x321	0x328 & 0x329	0x330 & 0x331	0x338 & 0x339
NEO9100A (0-100 vol.-% H_2)	0x340 & 0x341	0x348 & 0x349	0x350 & 0x351	0x358 & 0x359

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment.
must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [209]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[210]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To set the CAN ID, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message after 5s at system start.

209 Details can be found in the operating instructions under chapter: "Maintenance and service"
210 0xYY describes a measure for the set zero point adjustment

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO9005A (0-5 vol.-% H_2)	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359
NEO9010A (0-10 vol.-% H_2)	0x0CFF1459 & 0x0CFF1559	0x0CFF1659 & 0x0CFF1759	0x0CFF1859 & 0x0CFF1959	0x0CFF1A59 & 0x0CFF1B59
NEO9100A (0-100 vol.-% H_2)	0x0CFF1C59 & 0x0CFF1D59	0x0CFF1E59 & 0x0CFF1F59	0x0CFF2059 & 0x0CFF2159	0x0CFF2259 & 0x0CFF2359

Set CAN ID (CAN2.0B):
To set the CAN ID, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):
A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make an adjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [211]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[212]
*corresponds to the serial number of the individual sensor system.
CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured hydrogen concentration exceeds the 0.5 % by volume limit (c(H_2) from <0.5 % by volume to >= 0.5 % by volume).

The following message is sent:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = *(Msg0-20)/100*
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with the defined carrier gas, without humidity, normal pressure and in the absence of H_2, the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

211 Details can be found in the operating instructions under chapter: "Maintenance and service"
212 0xYY describes a measure for the set zero point adjustment

Further CAN commands (CAN2.0A):

Adjust baud rate:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Change CAN2.0 A/B:
0x680 0xA0 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Zero point adjustment:
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Further CAN commands (CAN2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/H2-Sensor_NEO9XXX_V160.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = (Msg0-20)/100
Msg 1(Bit 16-31): Water concentration [vol.-%]: c($H_{(2)}O$) = (Msg1-20)/100
Msg 2(bit 32-47): Pressure [mbar]: p = Msg2
Msg 3(Bit 48-55): Temperature [°C]: *T = (Msg3-60)*
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration_RAW[vol.-%]: c(H_2) = (Msg0-20)/100
Measurement of the hydrogen content, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with the defined carrier gas, without humidity, normal pressure and in the absence of H_2, the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

Example for the interpretation of CAN messages:
Hex message from Sensor:
CAN Msg1: CAN ID1 320 00 14 00 CE 03 ED 68 D8
CAN Msg2: CAN ID2 321 00 0A 63 00 50 D 92 CA

Decimal translation:
CAN Msg1: Byte0+1: 20, Byte 2+3: 206, Byte 4+5: 1005 Byte 6: 104, Byte 7: 216
CAN Msg2: Byte0+1: 10, Byte 2: 99, Byte 3: 0, Byte 4+5:1293 Byte 6: 146, Byte 7: 202

Sensor translation:
CAN Msg1: c(H_2) [vol.-%]: 0, c($H_{(2)}O$)[vol.-%]: 1.86, p[mbar]: 1005, T[°C]: 44, CRC: 216
CAN Msg2: c(H_2) _raw[vol.-%]: -0.1, raw: 99, status: 0, serial#: 1293, SV: 14.6 Counter: 202

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait
Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

Example:
"Sensor running; no $H_{(2)}$ .." → Status byte = 00000000 binary → 0 hexadecimal, 0 decimal
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal[213]
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal[214]
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

213 If the supply voltage is not sufficient, status byte 2 is output and a full signal is output at the H2 concentration.

214 Status byte 32 is set if the temperature (T > 120°C && T less than -40°C), the relative humidity (r.h. > 99%), the pressure (p > 6000 mbara && less than 600 mbara) are outside the defined range or 5,000 operating hours. The status byte is only reset with a zero point adjustment!

Analogue 4-20mA - Series I

I[mA]	c(H_2) [vol.-%]	Comment
4 - 20 mA[215]	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration. This means that 2.5 vol-% $H_{(2)}$, for example, is then output as 12mA with a 5 vol-% H_2 sensor system. In the heat-up phase and during a critical fault, a current <4 mA is output (usually approx. 3.6 mA)

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The maximum permissible load is 450 Ohm.

Analogue 0-10V - Series I

U[V]	c(H_2) [vol.-%]	Comment
0 - 10 V	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration in a range from 1V to 9V. This means that 5 vol-% $H_{(2)}$, for example, is then output as 5V for a 10 vol-% H_2 sensor system. Values less than 1V indicate an error.

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The minimum measuring resistance is 10 kOhm.

215 In earlier versions of this sensor, 7.2 to 20mA was given as the measuring range.

Digital Modbus via RS485 or EIA/TIA-485 - NEO series M

In serial master-slave communication, our NEO sensors function as slaves with the start slave ID 1 and a baud rate of 9,600 in 8N1, i.e. data bits: 8, parity: none, stop bits: 1. The 16-bit registers are defined as signed integers in big-endian, i.e. values in the range -32,768 to 32,767. The Modbus lines are not terminated.

Input register:

Name	Description of the	Scaling[216]	Unit	Register addresses	INPUT register address (hex / dec)
Hydrogen concentration	H_2Volume concentration (Example: 2030 = 20.3 vol.-%)	100	Vol.-%	3x257	0x100 / 256_{dec}
Water concentration	H_2O Volume concentration (Example: 2330 = 23.3 vol.-%)	100	Vol.-%	3x258	0x101 / 257_{dec}
Pressure	Pressure as absolute pressure (Example: 1033 = 1033 mbar)	1	mbar a	3x259	0x102 / 258_{dec}
Temperature	Temperature in measuring cavern (Example: 6250 = 62.5°C)	100	°C	3x260	0x103 / 259_{dec}
Hydrogen concentration _RAW	Hydrogen concentration (Example: 2750 = 27.5 vol.-%)	100	Vol.-%	3x261	0x104 / 260_{dec}
Gross value	Raw value = 100 in the absence of water and hydrogen and otherwise normal air.	1	-	3x262	0x105 / 261_{dec}
Status byte	See "Explanations on the status byte" in the "Signal explanation" section: "CAN".	1	-	3x263	0x106 / 262_{dec}
Serial number	S/N: P number, which is noted on the outside of the device. (Example: 3626 = P-3626)	1	-	3x264	0x107 / 263_{dec}
Software version	Version of the sensor software (Example: 156 = version 15.6)	10	-	3x265	0x108 / 264_{dec}
Message counter	High running counter 0-255	1	-	3x266	0x109 / 265_{dec}
Check value	00000000 01010101 value is 85, which can be used to check the byte order	1	-	3x267	0x10A / 266_{dec}

Holding register:

Name	Description of the	Regist	HOLDING

216 When reading with a PLC, make sure that the data type is set to "Real" so that the signed integer can also be displayed as a comma number.

		er addresses	Register address (hex / dec)
Baud rate	default: 9,600 Specifying the baud rate of the Modbus RTU interface: 4,800, 9,600 or 19,200	4x001	0x00 / 0_{dec}
Slave ID	default: 1 Possible slave IDs of the sensor 1-247	4x002	0x01 / 1_{dec}
Mode parity	default: 0 = parity: none, stop bit: 1 0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2	4x003	0x02 / 2_{dec}
Zero point adjustment	default: 0 If a 1 is written to the register, a zero point adjustment is carried out here and then changed the register to 2.	4x004	0x03 / 3_{dec}

Changes to the factory settings are only applied after restarting the sensor.

FAQ:
The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Data sheet hydrogen concentration sensor NEO974HT-ATEX, NEO983HT-ATEX and NEO986HT-ATEX, version 15.6

Product description:

Sensor system for measuring the hydrogen concentration in air, oxygen, nitrogen or oxygen-depleted air with temperature-, pressure- and humidity-compensated signal evaluation for automotive or industrial applications. Applicable in the range: 0.6 - 5 bara, 0 - 100% r.h. (non-condensing) and -40°C - 120°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measuring ranges: 0-5 vol.-% $H_{(2)}$ (**NEO974HT-ATEX**), 0-10 vol.-% $H_{(2)}$ (**NEO983HT-ATEX**) or 0-100 vol.-% $H_{(2)}$ (**NEO986HT-ATEX**)
- Carrier gases air, N_2, oxygen from enriched air are possible
- Measuring signal independent of pressure, temperature and humidity
- Signal output via CAN 2.0, Modbus RTU via RS485, 0-10V or 4-20mA
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Factory calibrated and ready for immediate use
- Suitable for crankcase ventilation
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary
- CAN WakeUp function implemented
- Encrypted CAN communication on demand

Figure 1a: H_2concentration sensor version NEO9XXHT-ATEX

...go to English version

Sensor system characteristics:

Supply voltage: 12 - 30 V DC[217]

Energy consumption: < 2,4 W

Possible H_2sensitivity: 0 - 100 vol.-% H_2 **NEO986HT-ATEX**
0 - 10 vol.-% H_2 **NEO983HT-ATEX**
0 - 5 vol.-% H_2 **NEO974HT-ATEX**

Accuracy: ± 0.3 vol.-% H_2[218] or ± 2 vol.-% H_2[219]

Detection limit: < 0.3 vol.-% $H_{(2)}$ (1)or < 0.5 vol.-% $H_{(2)}$ (2)

Response time t_{90}: < 5 s

Decay time t_{10}: < 5 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[220]

Media temperature: - 40°C - 120°C
(can also be calibrated down to -60°C)

Ambient temperature: - 40°C - 100°C
The cold start at -40°C was tested.

Pressure range: 0.6 - 6 bar absolute, i.e. 60 - 600 kPa
(can also be calibrated up to 0.25 bar a, i.e. 25 kPa)

Air humidity: 0 - 100 % r.h. (non-condensing)[221]

Carrier gas: Air, N_2, oxygen depleted air

Cross-sensitivities: Helium, tbd

Signal :[222] CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on
page13 Modbus RTU via RS485 interface on page
17

4-20 mA on page 112
0-10 V on page 132

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm for CAN bus and Modbus RTU

217 For analogue 0-10V output, please apply more than 15 VDC.
218 For 0-5 vol.-% and 0-10 vol.-% H_2systems
219 For 100 vol% H_2systems
220 The system is designed for continuous operation
221 In particular, splash water must be kept away from the sensor opening
222 Signals are described in the "Explanation of signals" section

250 ppm at 4-20 mA or 0-10V

Housing: Size: 95 x 83 x 48 mm³, housing cover made of EN AW 6060 and media-contacting base plate made of 316L or 1.4404, tighten M5 screws to the measuring chamber with 3Nm.

Leakage rate: <10^{-5}mbar l / s [223]

Long-term stability/drift: Deviation <0.1 vol.-% in the first 5000h Operating time

IP code: IP6K7

Weight: < 810 g

SIL: -

ATEX: **II 2G/- Ex db IIB+H2 T1 Gb/- at -40°C < $_{T(a)}$< 100°C**
https://neoxid-cloud.de/Konformitaetserklaerung_Muster_scan.pdf

Type of protection: Flameproof Ex D

Service life: IP6K7 enclosure qualified with an expected Service life of 5 years.[224] The system has been tested with 100,000 switch-on and switch-off cycles.

Maintenance interval : We recommend checking the H_2sensor every 6 months. check.

Measuring behaviour: The gas to be tested may have a maximum have a maximum velocity of 25m/s. In addition, a laminar flow is recommended. If the specification differs specification, the sensor must be tested for tested for functionality.

Connection cable: 3 m enclosed;

RoHS compliant: Yes https://neoxid-cloud.de/Konformitaetserklaerung-RoHS_DE_EN_V02_scan.pdf

Customs tariff number: 90271010

COO: Germany / NRW

ECCN: EAR99

EC-79/2009 Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

223 Measured with forming gas 90/10, 1.5 bar absolute, room temperature
224 Measuring components are purely inorganic and are not consumed during measurement

Accuracy of the measured values:[225]

Size	Accuracy
Hydrogen concentration	*± 0.3 vol.-% H_2*[226] *or ± 2 vol.-% H_2*[227]
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[228]	*± 0,3 °C*
Pressure	*± 20 mbar*

Table11 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO9XXATEX-V011_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Mounting the sensor:
The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO9XXHT-ATEX-Modell-und-Zeichnung.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request (see data sheet_Adapter_NEO1XX_V146_EN_EN). To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a spatial direction other than horizontally, a small offset[229] occurs; this must be corrected via a specific CAN message on ID 0x680 (zero point adjustment, see page). 14

Scope of delivery:
In addition to the sensor unit, 4x M5 screws are supplied for mounting the sensor, as well as a 3 m connection cable with cable end sleeves.

225 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar
226 For 0-5 vol.-% and 0-10 vol.-% H_2 systems
227 For 100 vol.-% H_2 systems
228 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber
229 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.

ATEX area:

The sensor as such is not suitable for installation in an explosive atmosphere. It should be connected to an explosive atmosphere. The resulting ATEX Zone 1 area can be seen here:

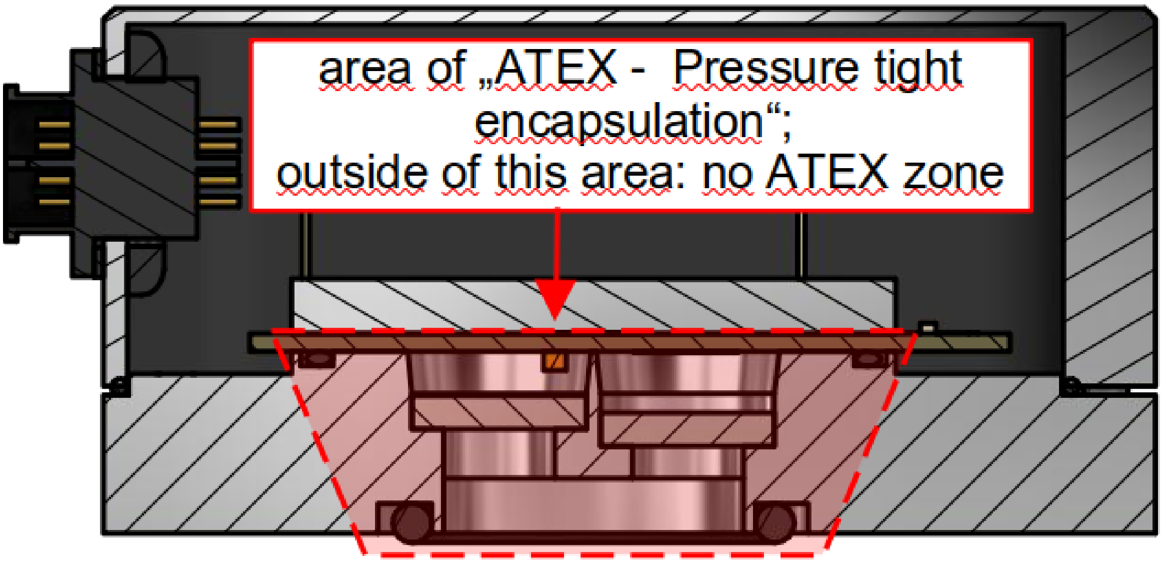


Figure 2a: Flameproof enclosure area

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The sensor can be fitted with heating cartridges, which are also available on request. In particular, standstill condensation can be effectively avoided in this way. As a further protective measure against small amounts of splash water, the sensor is fitted with two sintered metal discs.

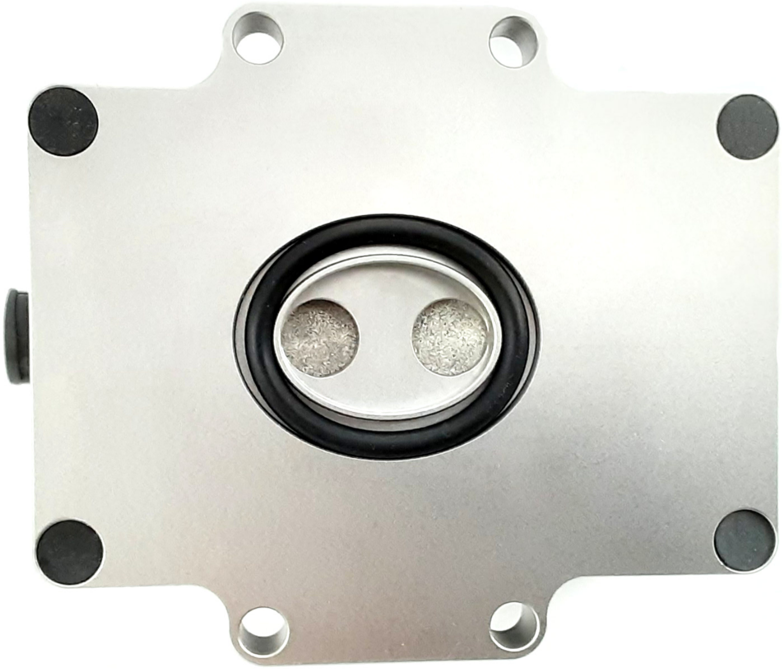


Figure 2b: NEO9XXHT-ATEX O-ring and sintered metal discs

Hole pattern:

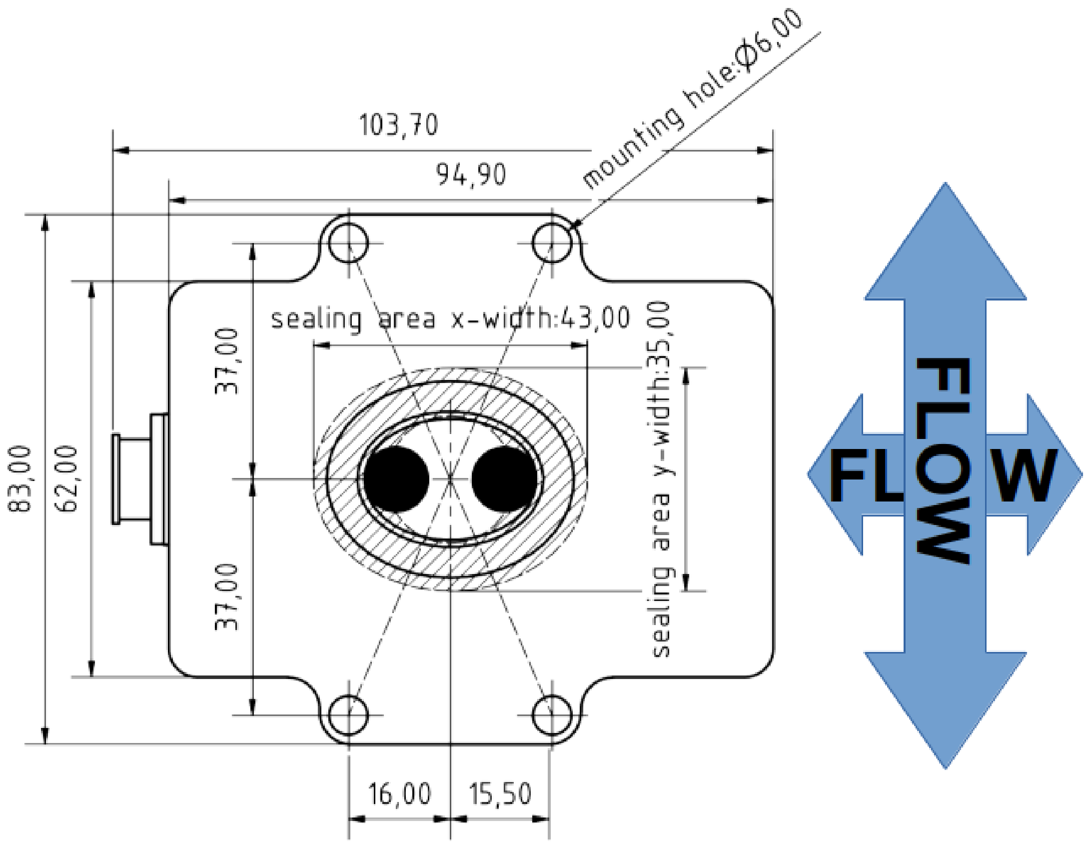


Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

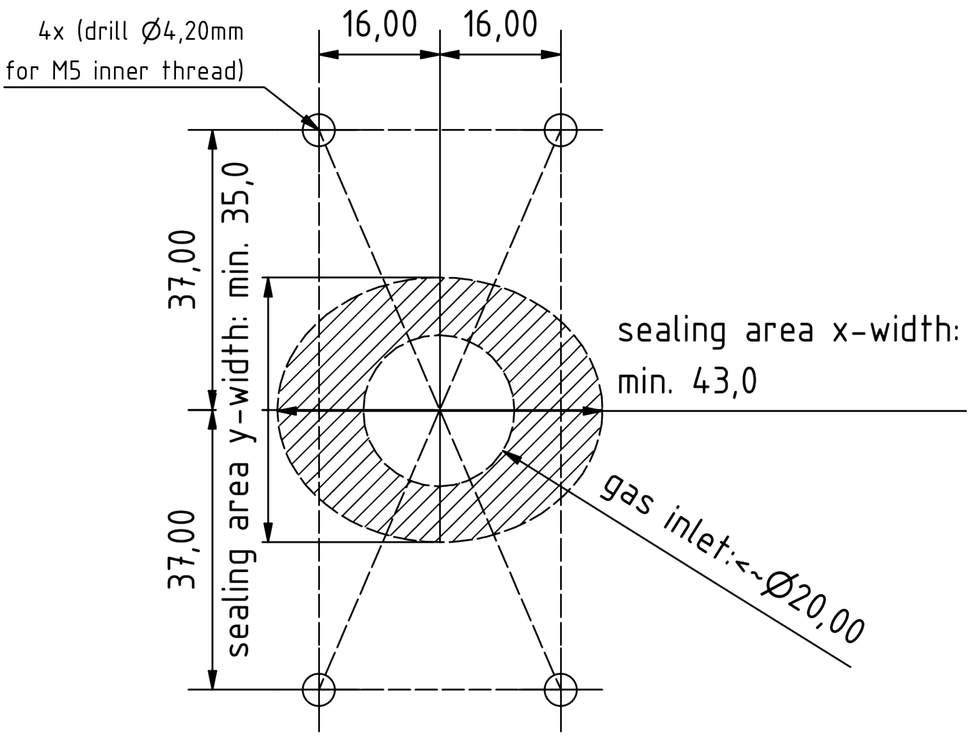
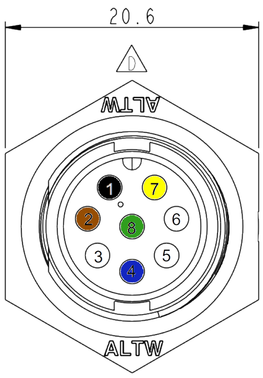


Figure 3b: Drilling template

Electrical PIN assignment



Housing plug

PIN no.	Description of the	Colour
1	VCC+ 12 ... 30V DC (min.: 2.4W)	black
2	GND 0V DC	brown
3	CAN-High (opt. DAC)+	white
4	CAN-Low (opt. DAC-)	blue
5	*service port A*	-
6	*service port B*	-
7	DAC + / RS485 A	yellow
8	DAC - / RS485 B	green
	Shielding (optional GND)	green/yellow

8-pin housing connector: Amphenol LTW: ABD-08RMMS-LC7001
8-pin cable socket: Amphenol LTW: BD-08BFFA-LL7001

Figure 3c below shows the enclosed connection cable with angled socket:

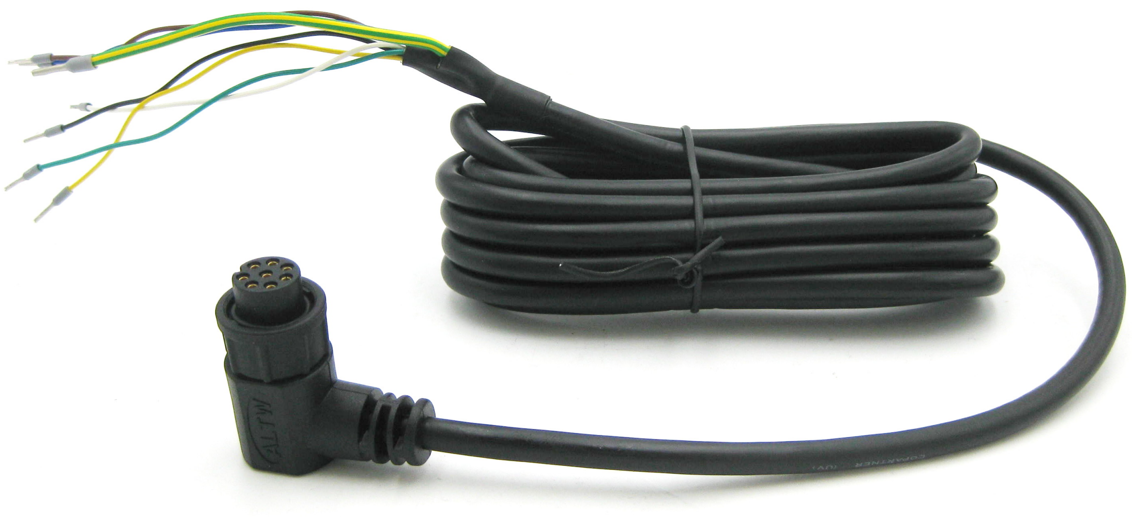


Figure *3c*: *Connection cable with angled socket*

Simultaneous signal output via CAN bus and an analogue interface
If required, the sensor's measurement data can be output simultaneously via the CAN bus interface and an analogue interface (4-20 mA, 0-10V). If an analogue interface (4-20 mA, 0-10V) is selected in addition to the CAN bus, the analogue signal is output via PIN 7 & 8. CAN addressing via the connector is then no longer possible!

Information on hydrogen ignition by the NEO974HT-ATEX/NEO983HT-ATEX/ NEO986HT-ATEX from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

The H_2sensor NEO974HT-ATEX/NEO983HT-ATEX/NEO986HT-ATEX uses a heating element that is heated with 5 V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the NEO974HT-ATEX (a Zener diode prevents excessively high operating voltages). In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavity.

Catalytic materials are not installed in the H_2sensor NEO974HT-ATEX/NEO983HT-ATEX/NEO986HT-ATEX, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors NEO974HT-ATEX/NEO983HT-ATEX/NEO986HT-ATEX. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

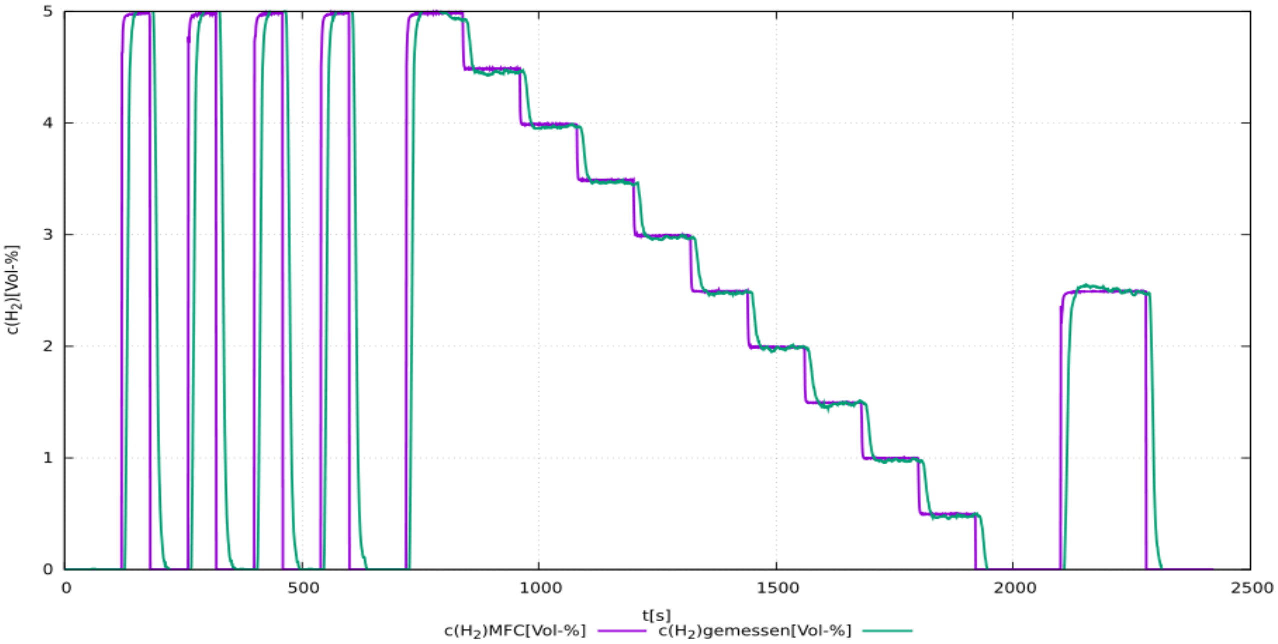


Figure 4a: Test of a sensor system NEO974HT-ATEX 0 - 5 vol.-% H_2in 21 vol.-% O_2. Measured with a total flow of 1,000 sccm.

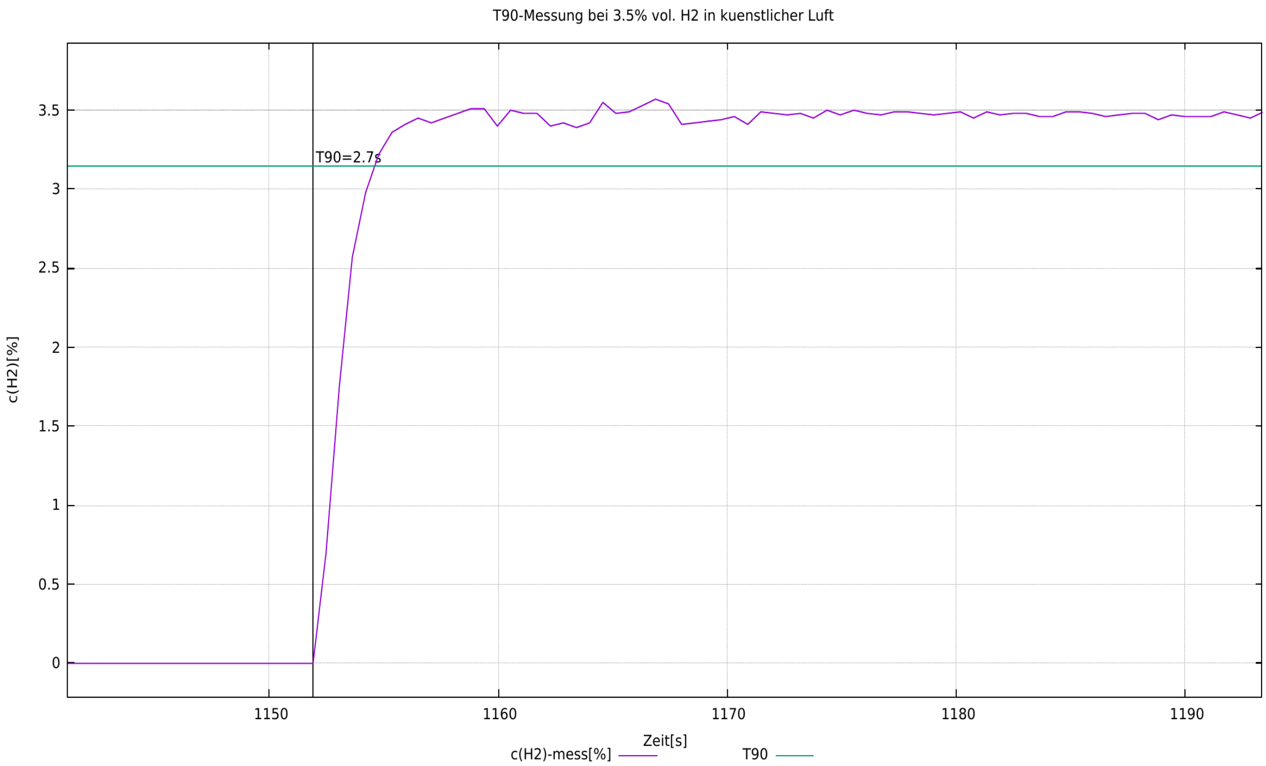


Figure 4b: t_{90}time determination with a sensor system by switching from 0 vol.-% $H_2$to 3.5 vol.-% H_2. Measured with a total flow of 1,000 sccm.

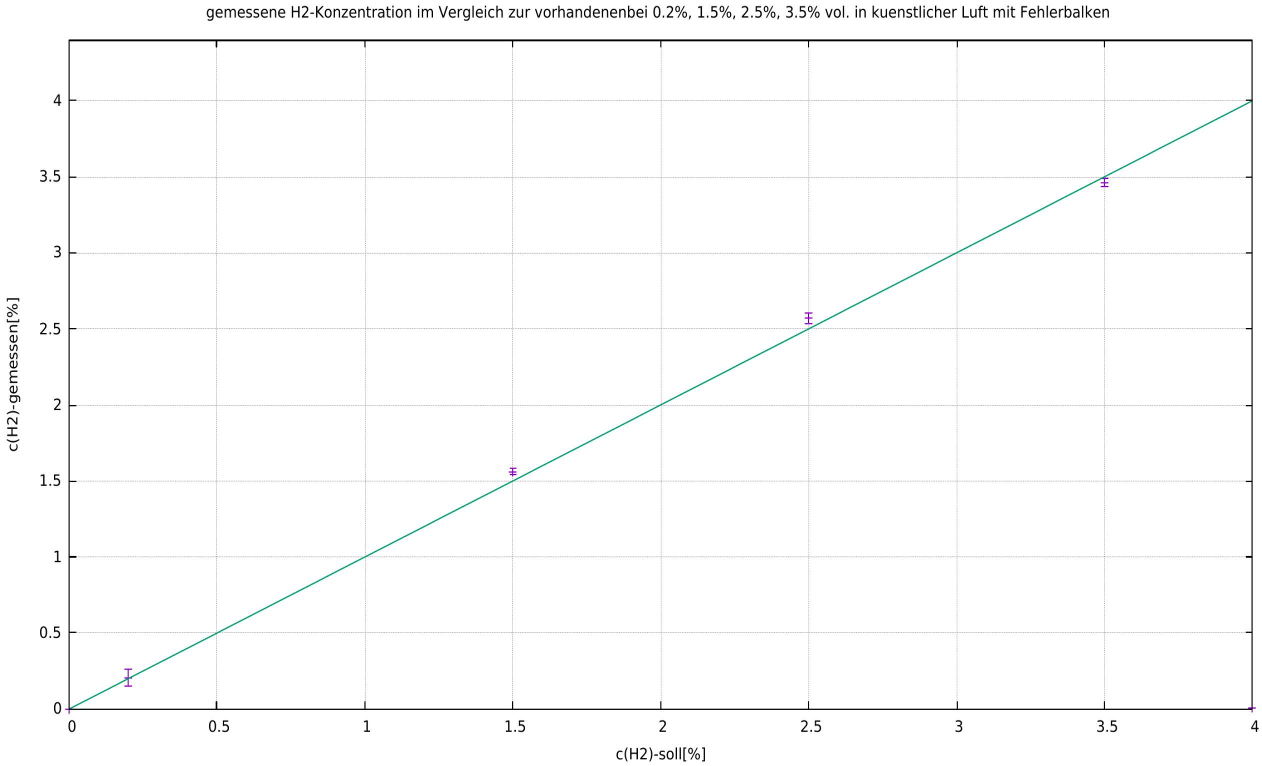


Figure 4c: Comparative measurement of the set hydrogen concentration and the measured hydrogen concentration with an error bar of three standard deviations of the measurement signal.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO974HTA (0-5 vol.-% H_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319
NEO983HTA (0-10 vol.-% H_2)	0x320 & 0x321	0x328 & 0x329	0x330 & 0x331	0x338 & 0x339
NEO986HTA (0-100 vol.-% H_2)	0x340 & 0x341	0x348 & 0x349	0x350 & 0x351	0x358 & 0x359

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment.
must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [230]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[231]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To set the CAN ID, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message after 5s at system start.

230 Details can be found in the operating instructions under chapter: "Maintenance and service"
231 0xYY describes a measure for the set zero point adjustment

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO974HTA (0-5 vol.-% H_2)	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359
NEO983HTA (0-10 vol.-% H_2)	0x0CFF1459 & 0x0CFF1559	0x0CFF1659 & 0x0CFF1759	0x0CFF1859 & 0x0CFF1959	0x0CFF1A59 & 0x0CFF1B59
NEO986HTA (0-100 vol.-% H_2)	0x0CFF1C59 & 0x0CFF1D59	0x0CFF1E59 & 0x0CFF1F59	0x0CFF2059 & 0x0CFF2159	0x0CFF2259 & 0x0CFF2359

Set CAN ID (CAN2.0B):
To set the CAN ID, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):
A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make an adjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [232]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[233]
*corresponds to the serial number of the individual sensor system.

CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured hydrogen concentration exceeds the 0.5 % by volume limit (c(H_2) from <0.5 % by volume to >= 0.5 % by volume).

The following message is sent:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = *(Msg0-20)/100*
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with the defined carrier gas, without humidity, normal pressure and in the absence of H_2, the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

232 Details can be found in the operating instructions under chapter: "Maintenance and service"
233 0xYY describes a measure for the set zero point adjustment

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/H2-Sensor_NEO9XX_V146.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = (Msg0-20)/100
Msg 1(Bit 16-31): Water concentration [vol.-%]: c($H_{(2)}O$) = (Msg1-20)/100
Msg 2(bit 32-47): Pressure [mbar]: p = Msg2
Msg 3(Bit 48-55): Temperature [°C]: *T = (Msg3-60)*
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0C59:
Msg 0(Bit 0-15): Hydrogen concentration_RAW[vol.-%]: c(H_2) = (Msg0-20)/100
Measurement of the hydrogen content, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with the defined carrier gas, without humidity, normal pressure and in the absence of H_2, the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

Example for the interpretation of CAN messages:
Hex message from Sensor:
CAN Msg1: CAN ID1 320 00 14 00 CE 03 ED 68 D8
CAN Msg2: CAN ID2 321 00 0A 63 00 50 D 92 CA

Decimal translation:
CAN Msg1: Byte0+1: 20, Byte 2+3: 206, Byte 4+5: 1005 Byte 6: 104, Byte 7: 216
CAN Msg2: Byte0+1: 10, Byte 2: 99, Byte 3: 0, Byte 4+5:1293 Byte 6: 146, Byte 7: 202

Sensor translation:
CAN Msg1: c(H_2) [vol.-%]: 0, c($H_{(2)}O$)[vol.-%]: 1.86, p[mbar]: 1005, T[°C]: 44, CRC: 216
CAN Msg2: c(H_2) _raw[vol.-%]: -0.1, raw: 99, status: 0, serial#: 1293, SV: 14.6 Counter: 202

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait

Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

Example:
"Sensor running; no $H_{(2)}$ .." → Status byte = 00000000 binary → 0 hexadecimal, 0 decimal
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal[234]
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal[235]
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN 2.0A):

Adjust baud rate:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Change CAN2.0 A/B:
0x680 0xA0 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Zero point adjustment:
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Further CAN commands (CAN 2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

234 If the supply voltage is not sufficient, status byte 2 is output and a full signal is output at the H2 concentration.

235 Status byte 32 is set if the temperature (T > 120°C && T less than -40°C), the relative humidity (r.h. > 99%), the pressure (p > 6000 mbara && less than 600 mbara) are outside the defined range or 5,000 operating hours. The status byte is only reset with a zero point adjustment!

Analogue 4-20mA - Series I

I[mA]	c($H_{2)}$ [vol.-%]	Comment
4 - 20 mA[236]	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration. This means that 2.5 vol-% $H_{(2)}$,for example, is then output as 12mA with a 5 vol-% H_2sensor system. In the heat-up phase and during a critical fault, a current <4mA is output (usually approx. 3mA)

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The maximum permissible load is 450 Ohm.

Analogue 0-10V - Series I

U[V]	c($H_{2)}$ [vol.-%]	Comment
0 - 10 V	0 - 5 vol.-% 0 - 10 vol.-% 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration in a range from 1V to 9V. This means that 5 vol-% $H_{(2)}$,for example, is then output as 5V for a 10 vol-% H_2sensor system. Values less than 1V indicate an error.

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The minimum measuring resistance is 10 kOhm.

The following diagram shows a connection diagram:

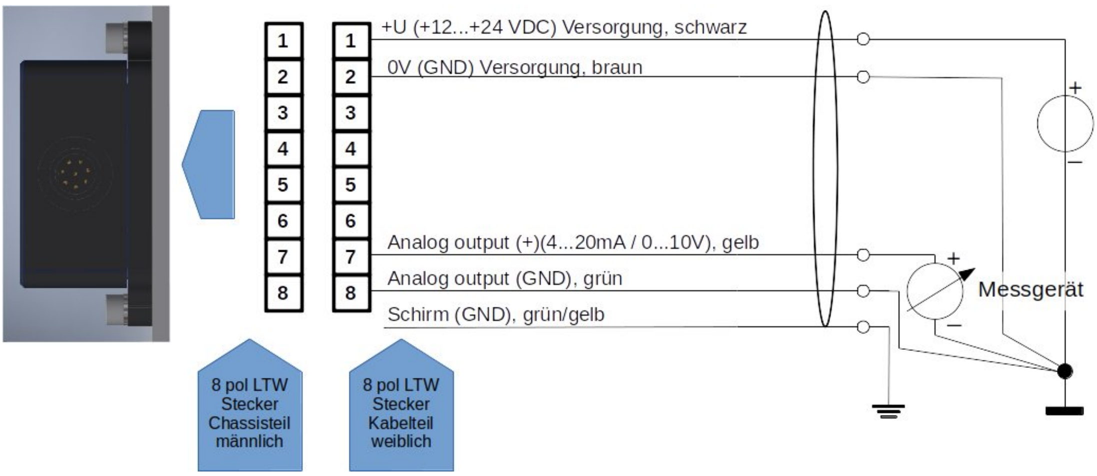


Figure 5: Wiring diagram

236 In earlier versions of this sensor, 7.2 to 20mA was given as the measuring range.

Digital Modbus via RS485 or EIA/TIA-485 - NEO series M

In serial master-slave communication, our NEO sensors function as slaves with the start slave ID 1 and a baud rate of 9,600 in 8N1, i.e. data bits: 8, parity: none, stop bits: 1. The 16-bit registers are defined as signed integers in big-endian, i.e. values in the range -32,768 to 32,767. The Modbus lines are not terminated.

Input register:

Name	Description of the	Scaling[237]	Unit	Register addresses	INPUT register address (hex / dec)
Hydrogen concentration	H_2Volume concentration (Example: 2030 = 20.3 vol.-%)	100	Vol.-%	3x257	0x100 / 256_{dec}
Water concentration	H_2O Volume concentration (Example: 2330 = 23.3 vol.-%)	100	Vol.-%	3x258	0x101 / 257_{dec}
Pressure	Pressure as absolute pressure (Example: 1033 = 1033 mbar)	1	mbar a	3x259	0x102 / 258_{dec}
Temperature	Temperature in measuring cavern (Example: 6250 = 62.5°C)	100	°C	3x260	0x103 / 259_{dec}
Hydrogen concentration _RAW	Hydrogen concentration (Example: 2750 = 27.5 vol.-%)	100	Vol.-%	3x261	0x104 / 260_{dec}
Gross value	Raw value = 100 in the absence of water and hydrogen and otherwise normal air.	1	-	3x262	0x105 / 261_{dec}
Status byte	See "Explanations on the status byte" in the "Signal explanation" section: "CAN".	1	-	3x263	0x106 / 262_{dec}
Serial number	S/N: P number, which is noted on the outside of the device. (Example: 3626 = P-3626)	1	-	3x264	0x107 / 263_{dec}
Software version	Version of the sensor software (Example: 156 = version 15.6)	10	-	3x265	0x108 / 264_{dec}
Message counter	High running counter 0-255	1	-	3x266	0x109 / 265_{dec}
Check value	00000000 01010101 value is 85, which can be used to check the byte order	1	-	3x267	0x10A / 266_{dec}

Holding register:

Name	Description of the	Regist	HOLDING

237 When reading with a PLC, make sure that the data type is set to "Real" so that the signed integer can also be displayed as a comma number.

		er addresses	Register address (hex / dec)
Baud rate	default: 9,600 Specifying the baud rate of the Modbus RTU interface: 4,800, 9,600 or 19,200	4x001	0x00 / 0_{dec}
Slave ID	default: 1 Possible slave IDs of the sensor 1-247	4x002	0x01 / 1_{dec}
Mode parity	default: 0 = parity: none, stop bit: 1 0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2	4x003	0x02 / 2_{dec}
Zero point adjustment	default: 0 If a 1 is written to the register, a zero point adjustment is carried out here and then changed the register to 2.	4x004	0x03 / 3_{dec}

Changes to the factory settings are only applied after restarting the sensor.

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapters and heaters:
Various adapters are available for mounting the sensor. For use in very humid environments or environments with liquid water or the risk of icing, there are heating cartridges that can be operated at a constant voltage. These can be fitted in the adapters. You can find the corresponding products under:
https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for fine purification of gases by removing minimal impurities.

FAQ:
The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Data sheet H_2sensor system NEO952 for high temperature applications, version 15.6

Product description:

Hydrogen measuring system with temperature compensated output for determining the H_2concentration in hot media.

Typical application:

- Detection of hydrogen in the exhaust gas of hydrogen combustion engines / H_2-powered petrol engines or solid oxide fuel cells (SOFC)

Properties:

- Measurements to just above the lower explosion limit, i.e. 0 - 5 vol.-% H_2
- Minor cross-sensitivities to oxygen
- No sample extraction necessary for exhaust gases up to 400°C.
- Signal output via CAN 2.0 - Alternatively also available as Modbus RTU, 4-20mA or 0-10V variant
- Factory calibrated and ready for immediate use
- Sensor must be operated with at least 4nL/min of passing gas

Figure 1: H_2sensor system version NEO952A

Sensor system characteristics - Sensor:

Supply voltage: 12 - 32 V DC

Energy consumption: < 3 W

H_2sensitivity: 0 - 5 % by volume H_2

Accuracy: ~ ± 0.5 % by volume H_2

Detection limit: < 0.5 vol% H_2in air at 0% r.h., RT, normal pressure

Response time t_{90}: < 10 s

Decay time t_{10}: < 10 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[238]

Media temperature: -40°C - 400°C

Ambient temperature: The measuring electronics must be operated at temperatures below 100°C

Pressure range: 0.6 - 1.5 bar absolute[239]

Humidity: 0 to 95% r.h. (non-condensing)[240]

Carrier gas: depleted air (lambda of the previous combustion combustion >1.5); $O_2$is required.

Cross-sensitivities: low oxygen[241] , tbd

Harmful gases: tbd

Signal: CAN 2.0A/B (125, 250, 500, 1000 kbit/s)
CAN lines are not terminated!
CAN ID: Standard 0x630 or 1584
2nd CAN message for CAN ID: 0x631 or 1585
Alternatively on request: 4 - 20mA, 0-10V or
ModbusRTU via RS485

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm

238 The system is designed for continuous operation
239 The accuracy of the hydrogen measurement cannot be guaranteed with alternative pressures
240 Dew point < 60°C
241 Sensor signal remains within the accuracy at 6 to 20.9 vol.% O_2, there is no signal with no oxygen, lambda > 1.5 is recommended

Material:	Electronic unit is made of EN AW 6060 Media-contacting sensor probe made of 1.4301
Weight:	approx. 1050 g (670 g for sensor probe incl. cable and heating tape, 380g for evaluation unit)
Length of connecting cable:	3,000 mm
RoHS compliant:	Yes
Customs tariff number:	90271010
COO:	Germany / NRW
EC-79/2009	Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

Operating instructions:

The operating instructions can be downloaded from the following link:

https://neoxid-cloud.de/Betriebsanleitung-NEO952-V01_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Assembly:

The screwed-in sensor should be screwed vertically into the flue gas pipe from above. During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (soot[242] , rust). The system has an M18x1.5 thread and a spanner size of 30 and is sealed with a copper sealing ring (18.2 x 23.9 x 1.5 mm).

The electronics housing should be installed in such a way that it does not become hotter than 100°C. The spatial direction is irrelevant for the electronics. The retaining pins or screws of the electronics housing may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 1 Nm. The sensor is also supplied with a heating tape, which is tightened with 3 Nm. The measuring probe should not be cooled by cold (travelling) air, as this can lead to slight deviations in the measured values.

The measuring probe must be handled with care. We recommend using an open-end spanner to screw on the probe. As the entire probe consists of several elements screwed together, care must be taken when unscrewing the probe from a measuring stand to ensure that the entire element is unscrewed and not just individual components. This is important as otherwise damage to the inner workings of the probe cannot be ruled out.

242 Sooty exhaust fumes from combustion engines running on petrol/diesel can block the sensor input.

Scope of delivery:

The scope of delivery includes:

- Sensor unit with connection cable to the evaluation electronics,
- Evaluation electronics with customer cable
- Copper sealing ring (18.2 x 23.9 x 1.5 mm)

Drilling template - electronics housing:

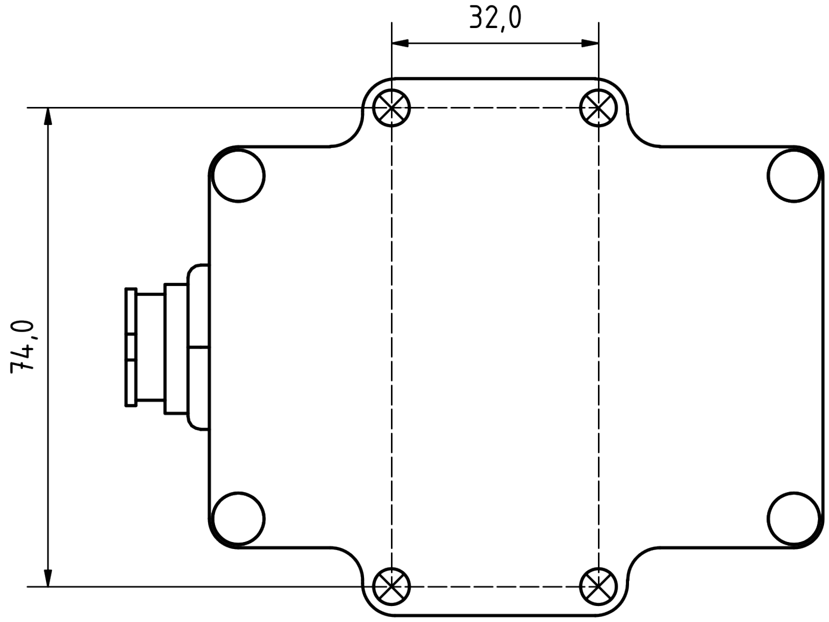
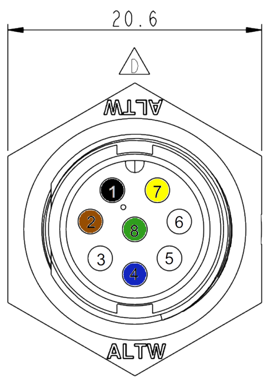


Figure 3b: Drilling template

Here is a 3D step file and a 2D drawing:

https://neoxid-cloud.de/NEO952_2D_und_3D.zip

Electrical PIN assignment



Housing plug

PIN no.	Description of the	Colour
1	VCC+ 12 ...+30 V DC (min.: 2.4W)	black
2	GND 0V DC	brown
3	CAN-High (opt. DAC+)	white
4	CAN-Low (opt. DAC-)	blue
5	*service port A*	-
6	*service port B*	-
7	DAC + / RS485 A	yellow
8	DAC - / RS485 B	green
	Shielding (optional GND)	green/yellow

8-pin housing connector: Amphenol LTW: ABD-08RMMS-LC7001
8-pin cable socket: Amphenol LTW: BD-08BFFA-LL7001

Figure 3c below shows the enclosed connection cable with angled socket:

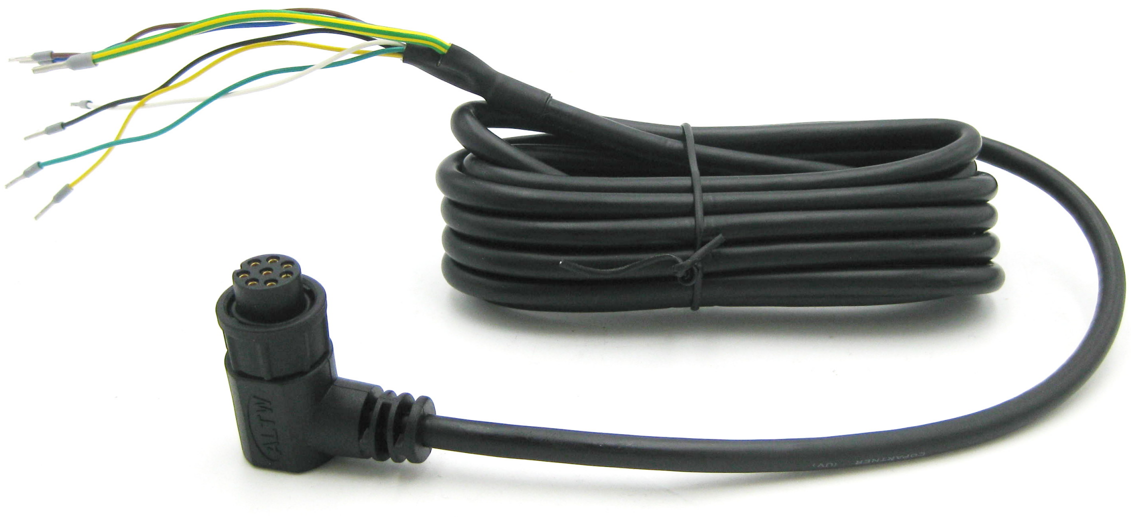


Figure 3c: Connection cable with angled socket

Simultaneous signal output via CAN bus and an analogue interface

If required, the sensor's measurement data can be output simultaneously via the CAN bus interface and an analogue interface (4-20 mA, 0-10V). If an analogue interface (4-20 mA, 0-10V) is selected in addition to the CAN bus, the analogue signal is output via PIN 7 & 8. CAN addressing via the connector is then no longer possible!

Signal explanation

CAN 2.0 - Series A (11-bit identifier / "Base frame format"):

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

Set CAN ID (CAN2.0A):

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO952A (0-5 vol.-% H_2)	0x630 & 0x631	0x638 & 0x639	0x640 & 0x641	0x648 & 0x649

A specific CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to carry out a readjustment.
must be made. This is permanent and affects all outgoing H_2signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To make an adjustment, the system should be free of hydrogen and with the correct carrier gas (air). [243]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[244]
*corresponds to the serial number of the individual sensor system.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message is delivered 5s after system start.

Set CAN ID (CAN2.0B):
The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4

243 Details can be found in the operating instructions under chapter: "Maintenance and service"
244 0xYY describes a measure for the set zero point adjustment

NEO952A (0-5 vol.-% H_2)	0x0CFF3D59 & 0x0CFF3E59	0x0CFF3F59 & 0x0CFF4059	0x0CFF4159 & 0x0CFF4259	0x0CFF4359 & 0x0CFF4459

A CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x200
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x200, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):

A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make a readjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To make an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (air). [245]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[246]
*corresponds to the serial number of the individual sensor system.

Matrix message layout (CAN 2.0A & CAN2.0B):

A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/NEO952_V148.dbc.zip

CAN ID: Standard 0x630 or 0x0CFF3D59 :[247]

Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = *(Msg0-1000)/100* [248]
Msg 1(Bit 16-23): Measuring chamber sensor signal through PT100 equivalent [Ohm]: *R= Msg1+100*
Msg 2(Bit 24-31): Measuring chamber reference measurement by PT100 Ref[Ohm]: *R= Msg2+100* [249]
Msg 3(Bit 32-39): Lambda expected by the sensor: *Lambda= Msg3/10*
Msg 4(bit 40-47): Oxygen concentration: expected oxygen concentration: *c(O_2) = Msg4/10*
Msg 5(Bit 48-55): *CRC - SAE J1850 ZERO*[250] *: Msg5*
Msg 6(Bit 56-63): Continuous message counter *Msg6*

2nd CAN message for CAN ID: 0x631 or 0x0CFF3E59:

Msg 0(bit 0-15): Hydrogen concentration_RAW [vol.-%]: c(H_2) = *(Msg0-20)/100*
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $H_2$the following applies: Raw value = 100±1 *Msg1*
Msg 2(Bit 24-31): Status byte: see below. *Msg2*
Msg 3(Bit 32-47): Serial number *Msg3*
Msg 4(Bit 48-55): Version = *(Msg4 / 10)*

245 Details can be found in the operating instructions under chapter: "Maintenance and service"
246 0xYY describes a measure for the set zero point adjustment
247 Sample CAN IDs, others are possible (please note the type plate on your sensor)
248 The H_2concentration is output from -10 to 100% in order to map possible error cases
249 The measured temperature in the measuring chamber is higher than the medium temperature
250 Example: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

Msg 5(Bit 56-63): Continuous message counter *Msg5*

Hex message from Sensor:
CAN Msg1: CAN ID1 0x630 04 E2 70 CE 20 CC 00 D8

Decimal translation:
CAN Msg1: Byte0+1: 1250, Byte 2: 112, Byte 3: 206, Byte 4: 32 Byte 5: 204, Byte 6: 0, Byte 7: 216

Sensor translation:
CAN Msg1: c(H_2) [vol.-%]: 2.5, R-Pt[Ohm]: 212, Ref-PT[]: 306, Lambda1: 3.2, c(O_2) [vol.-%]: 20.4, CRC: 0, Counter: 216

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait
Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

Example:
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Set the baud rate to 500 kbit/s or 250 kbit/s:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H2 in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Initiate maintenance:
0x680 0x00 0x77 0x61 0x72 0x74 0x75 0x6E 0x67

Further CAN commands (CAN2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

Analogue 4-20mA - Series I

I[mA]	c(H_2) [vol.-%]	Comment
4 - 20 mA	0 - 5 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration. This means that 2.5 vol-% H_2, for example, is then output as 12mA. Values less than 4mA indicate a fault or that the measuring probe is not connected.

It should be noted that the analogue output of the sensors is subject to an additional error of 2% FS. The maximum permissible load is 450 Ohm.

Analogue 0-10V - Series I

U[V]	c(H_2) [vol.-%]	Comment
0 - 10 V	0 - 5 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration in a range from 1V to 9V. This means that 2.5 vol-% H_2, for example, is then output as 5V. Values less than 1V indicate an error. On request, it is also possible to output 0V and 5V at 40% LEL, so that you can switch a relay, for example!

It should be noted that the analogue output of the sensors is subject to an additional error of 2% FS. The minimum measuring resistance is 10 kOhm.

Digital Modbus via RS485 or EIA/TIA-485 - NEO series M

In serial master-slave communication, our NEO sensors function as slaves with the start slave ID 1 and a baud rate of 9,600 in 8N1, i.e. data bits: 8, parity: none, stop bits: 1. The 16-bit registers are defined as unsigned integers in the big endian, i.e. values in the range 0 to 65535. The Modbus lines are not terminated.

Input register:

Name	**Description of the**	**Scaling[251]**	**Unit**	**Register addresses**	**INPUT register address (hex / dec)**
Hydrogen concentration	H_2Volume concentration = x / 100 - 20 vol.-% (Example: 2330 = 2.3 vol.-%)	100	Vol.-%	3x001	0x00 / 0_{dec}
Sensor signal equivalent to PT100	PT100_SENS = x / 10 (Example: 2250 = 225.0 Ohm)	10	Ohm	3x002	0x02 / 2_{dec}
Reference signal with PT100	PT100_REF = x / 10 (Example: 2250 = 225.0Ohm)	10	Ohm	3x003	0x03 / 3_{dec}
Lambda expected value	Lambda, which the sensor expects: (Example: 25 = 2.5)	100	-	3x004	0x04 / 4_{dec}
Oxygen concentration	O_2Volume concentration = x / 10 vol.-% (Example: 203 = 20.3 vol.-%)	10	Vol.-%	3x005	0x05 / 5_{dec}
Hydrogen concentration _RAW	Hydrogen concentration (Example: 2750 = 27.50 vol.-%)	100	Vol.-%	3x006	0x06 / 6_{dec}
Gross value	Raw value = 100 in the absence of water and hydrogen and otherwise normal air.	-	-	3x007	0x07 / 7_{dec}
Status byte	See "Explanations on the status byte" in the "Signal explanation" section: "CAN".	-	-	3x008	0x08 / 8_{dec}
Serial number	S/N: P number, which is noted on the outside of the device. (Example: 626 = P-0626)	-	-	3x009	0x09 / 9_{dec}
Software version	Software version = x / 10 (156 = 15.6)	10	-	3x010	0x0A / 10_{dec}
Message counter	High running counter	-	-	3x011	0x0B / 11_{dec}
Empty byte	No relevant information	-	-	3x012	0x0C / 12_{dec}

251 When reading with a PLC, make sure that the data type is set to "Real" so that the unsigned integer can also be displayed as a comma number.

Holding register:

Name	Description of the	Register addresses	HOLDING Register address (hex / dec)
Baud rate	default: 9,600 Specifying the baud rate of the Modbus RTU interface: 4,800, 9,600 or 19,200	4x001	0x00 / 0_{dec}
Slave ID	default: 1 Possible slave IDs of the sensor 1-247	4x002	0x01 / 1_{dec}
Mode parity	default: 0 = parity: none, stop bit: 1 0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2	4x003	0x02 / 2_{dec}
Zero point adjustment	default: 0 If a 1 is written to the register, a zero point adjustment is carried out here and then changed the register to 2.	4x004	0x03 / 3_{dec}

Changes to the factory settings are only applied after restarting the sensor.

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for the fine purification of gases by removing minimal impurities.

FAQ:

The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Hydrogen concentration sensor data sheet

NEO962A Version 15.6

Product description:

Sensor system for measuring the hydrogen concentration in nitrogen for industrial applications.

Properties:

- Measuring ranges: 0-5,000 ppm $H_{(2)}$ (**NEO962**)
- Carrier gases N_2
- Signal output via CAN 2.0A or CAN 2.0B
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Factory calibrated and ready for immediate use
- Encrypted CAN communication on demand

Figure 1: H_2concentration sensor version NEO962

...go to English version

Sensor system characteristics:

Supply voltage: 12 - 32 V DC

Energy consumption: < 2,4 W

Possible H_2sensitivity: 0 to 5,000 ppm

Accuracy: ± 100 ppm[252]

Detection limit: < 100 ppm

Response time t_{90}: < 5 s

Decay time t_{10}: < 5 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[253]

Media temperature: 10°C - 50°C

Ambient temperature: 10°C - 50°C

Pressure range: 0.8 - 1.2 bar absolute

Air humidity: 0 - 100 % r.h. (non-condensing)[254]

Carrier gas: N_2

Cross-sensitivities: Helium, tbd

Signal :[255] CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on
page 25

Output/measurement interval: 100 ms / 10 Hz

Resolution: 1 ppm

Long-term stability/drift: < 0.1 vol.-% in the first 5,000h operating time

252 Provided the system is readjusted before each measurement (zero point adjustment, see page) 14

253 The system is designed for continuous operation

254 In particular, splash water must be kept away from the sensor opening

255 Signals are described in the "Explanation of signals" section

Housing: with	Size: 95 x 83 x 41 mm³, housing cover made of EN AW 6060 and media-contacting base plate made of 316L or 1.4404, M5 screws to the measuring chamber 3Nm.
Leakage rate:	10^{-5}mbar l / s [256]
IP code:	IP6K7
Weight:	< 570 g
SIL:	-
ATEX:	-
Service life:	IP6K7 enclosure qualified with an expected Service life of 5 years[257] . The system was tested with 100,000 switch-on and switch-off cycles.
Measuring behaviour: addition, a specification differs must be tested for	The gas to be tested may have a maximum have a maximum velocity of 25m/s. In laminar flow is recommended. If the specification, the sensor tested for functionality.
Connection cable: page 123	3 m enclosed; more detailed information on
RoHS compliant:	Yes
Customs tariff number:	90271010
COO:	Germany / NRW

Mounting the sensor:

The stepfile and a 2D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO9XX.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request. To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is

256 Measured with forming gas 90/10, 1.5 bar absolute, room temperature
257 Measuring components are purely inorganic and are not consumed during measurement

mounted in a room direction other than horizontal, a small offset occurs; this must be corrected via a specific CAN message on ID 0x680 (zero point adjustment, see page14).

Figure 2a: Mounting the H_2sensor system

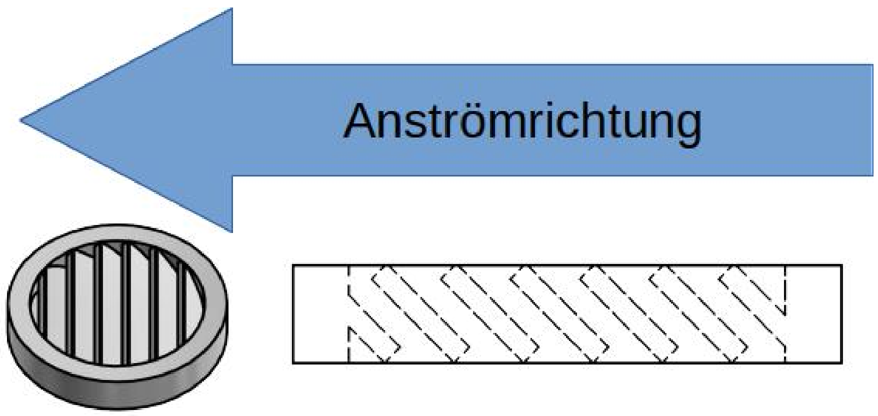


Figure 2b: Fitting ribbed plugs against the direction of flow

Hole pattern:

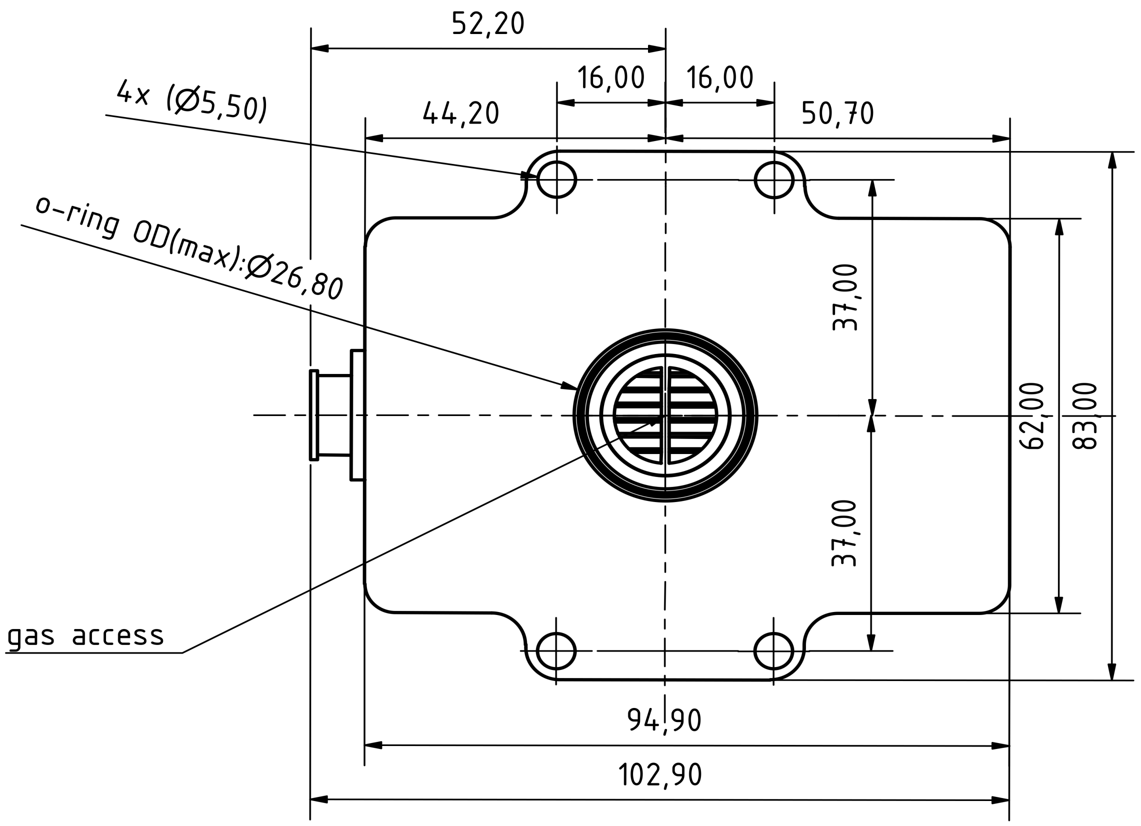


Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

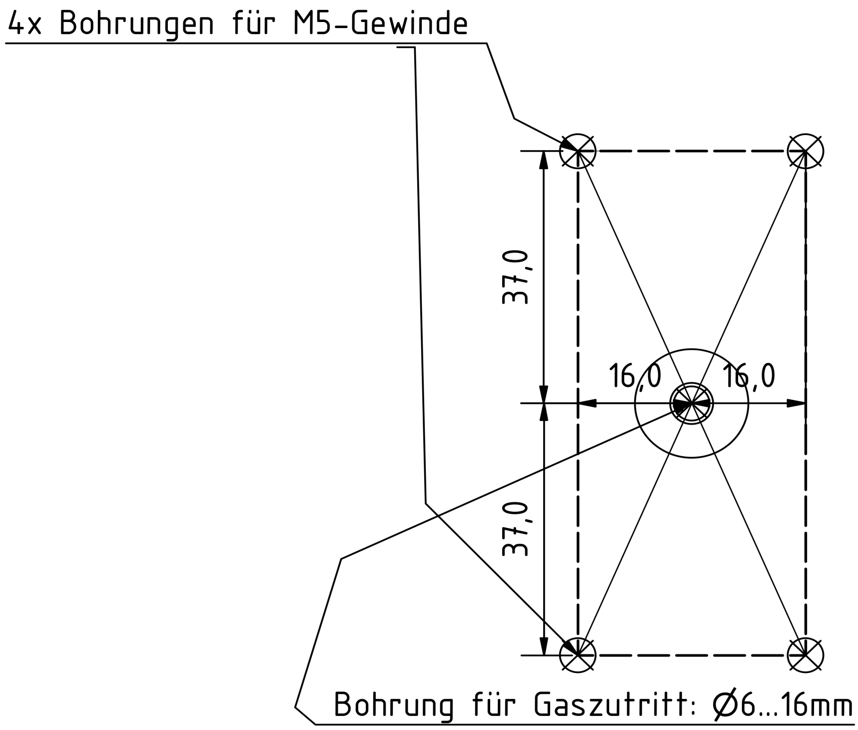
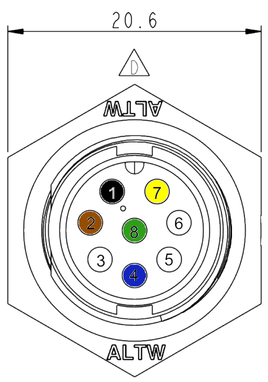


Figure 3b: Drilling template

Electrical PIN assignment



Housing plug

PIN no.	Description of the	Colour
1	VCC +12 ...+30 V DC (min.: 2.4W)	black
2	GND 0V DC	brown
3	CAN-High (opt. DAC+)	white
4	CAN-Low(opt. DAC-)	blue
5	*service port A*	-
6	*service port B*	-
7		yellow
8		green
	Shielding (optional GND)	green/yellow

8-pin housing connector: Amphenol LTW: ABD-08RMMS-LC7001
8-pin cable socket: Amphenol LTW: BD-08BFFA-LL7001

The following figure 3c shows the enclosed connection cable with angled socket :

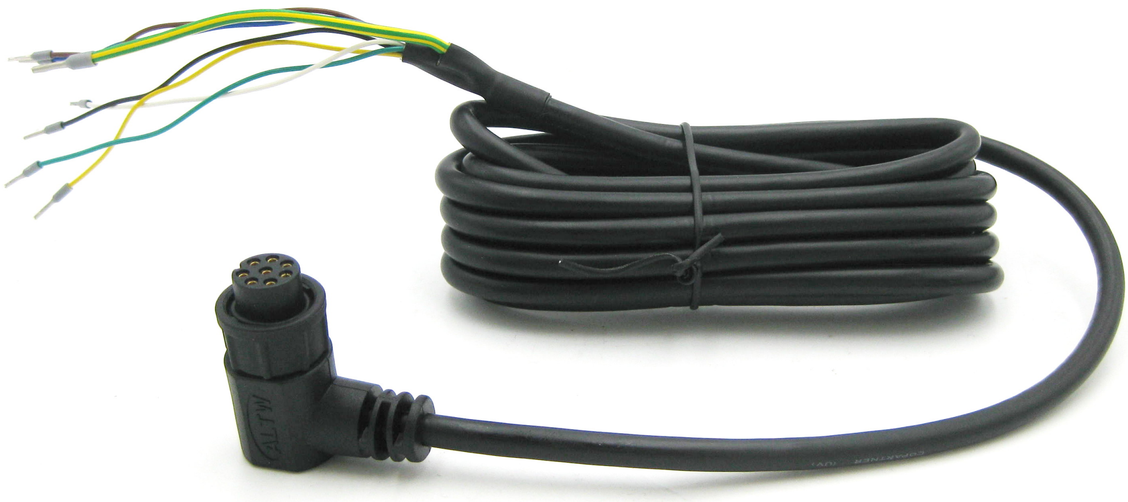


Figure 3c: Connection cable with angled socket

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO962A (0-5,000 ppm H_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment. must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [258]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[259]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To set the CAN ID, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.

CAN2.0B - Series A

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
First CAN message after 5s at system startup

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO962A (0-5,000 ppm H_2)	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359

Set CAN ID (CAN2.0B):
To set the CAN ID, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

258 Details can be found in the operating instructions under chapter: "Maintenance and service"
259 0xYY describes a measure for the set zero point adjustment

increases the address by 0x08
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.

Zero point adjustment (CAN2.0B):
A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make an adjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [260]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[261]
*corresponds to the serial number of the individual sensor system.

CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured hydrogen concentration exceeds the 0.5 vol.-% limit ($c(H_2)$ from <0.5 vol.-% to >=0.5 vol.-%).

The following message is sent:
Msg 0(bit 0-15): Hydrogen concentration [ppm]: $c(H_2) = Msg0$
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $H_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/H2-Sensor_NEO9XX_V146.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration [ppm]: $c(H_2) = Msg0$
Msg 1(Bit 16-31): *Water concentration [vol.-%]:* $c(H_{(2)}O) = (Msg1-20)/100$
Msg 2(bit 32-47): Pressure [mbar]: $p = Msg2$
Msg 3(Bit 48-55): Temperature [°C]: $T = (Msg3-60)$
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0D59:
Msg 0(Bit 0-15): Hydrogen concentration_RAW[ppm]: $c(H_2) = Msg0$
Measurement of the hydrogen content, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $H_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.

260 Details can be found in the operating instructions under chapter: "Maintenance and service"
261 0xYY describes a measure for the set zero point adjustment

<u>Msg 3(Bit 32-47)</u>: *Serial* number
<u>Msg 4(Bit 48-55):</u> Software version (Msg 4 / 10)
<u>Msg 6(Bit 56-63)</u>: Continuous message counter

Example for the interpretation of CAN messages:

Hex message from Sensor:
CAN Msg1: CAN ID1 320 00 14 00 CE 03 ED 68 D8
CAN Msg2: CAN ID2 321 00 0A 63 00 50 D 92 CA

Decimal translation:
CAN Msg1: Byte0+1: 20, Byte 2+3: 206, Byte 4+5: 1005 Byte 6: 104, Byte 7: 216
CAN Msg2: Byte0+1: 10, Byte 2: 99, Byte 3: 0, Byte 4+5:1293 Byte 6: 146, Byte 7: 202

Sensor translation:
CAN Msg1: c($H_{2)}$ [vol.-%]: 0, c($H_{(2)}$ $_O$)[vol.-%]: 1.86, p[mbar]: 1005, T[°C]: 44, CRC: 216
CAN Msg2: c($H_{2)}$_raw[vol.-%]: -0.1, raw: 99, status: 0, serial#: 1293, SV: 14.6 Counter: 202

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >= 0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait
Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

<u>Example:</u>
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

<u>Set the baud rate to 500 kbit/s or 250 kbit/s:</u>
<u>0x680</u> 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

<u>Recalibrate hydrogen slope at 2% H_2in carrier gas:</u>
<u>0x680</u> 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

<u>Speed up the prediction algorithm:</u>
<u>0x680</u> 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

<u>Slowing down the prediction algorithm:</u>
<u>0x680</u> 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Initiate maintenance:
0x680 0x00 0x77 0x61 0x72 0x74 0x75 0x6E 0x67

Further CAN commands (CAN2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

Hydrogen concentration sensor data sheet

NEO986NG30 and NG100 for natural gas, version 15.6

Product description:

Sensor system for measuring the hydrogen concentration in natural gas with temperature-, pressure- and humidity-compensated signal evaluation for industrial applications. Applicable in the range: 0.6 - 1.5 bara, 0 - 100% r.h. (non-condensing) and 40°C - 85°C. A mathematical prediction algorithm ensures very short on and off times.

Properties:

- 0 - 30 vol.-% H_2or 0 - 100 vol.-% H_2
- Carrier gas: Natural gas (CH4/C2H6/C3H8/CO2 = 92.5vol.-%/2.5vol.-%/4vol.-%/1vol.-%)
- Measuring signal independent of pressure, temperature and humidity
- Signal output via CAN 2.0, Modbus RTU via RS485, 0-10V or 4-20mA
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Factory calibrated and ready for immediate use
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary.
- Encrypted CAN communication on demand

Figure 1: H_2concentration sensor version NEO986NG

Sensor system characteristics:

Supply voltage: 12 - 32 V DC

Energy consumption: < 2,4 W

Possible H_2sensitivity: 0 - 30 vol.-% H_2 **NEO986NG30**
0 - 100 vol.-% H_2 **NEO986NG100**

Accuracy: < ± 2 vol.-% H_2[262]

Detection limit: < 0.5 vol.-% H_2

Response time t_{90}: < 5 s

Decay time t_{10}: < 5 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[263]

Media temperature: - 40°C - 85°C

Ambient temperature: - 40°C - 85°C
The cold start at -40°C was tested.

Pressure range: 0.6 - 1.5 bar absolute, i.e. 60 - 150 kPa

Carrier gas: Natural gas (CH4/C2H6/C3H8/CO2 =
92.5vol.-%/2.5vol.-% /4vol.-%/1vol.-%)

Cross-sensitivities: Helium, tbd

Signal :[264] CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on
page25
Modbus RTU via RS485 interface on page
4-20 mA on page 28
0-10 V on page 28

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm for CAN bus and Modbus RTU
250 ppm at 4-20 mA or 0-10V

Housing: Size: 95 x 83 x 41 mm³, housing cover made of
EN AW 6060 and media-contacting base plate made of
316L or 1.4404, tighten M5 screws to the measuring
chamber with 3 Nm.

Leakage rate: 10^{-5}mbar l / s [265]

262 Deviation is largely due to changing methane content in the natural gas
263 The system is designed for continuous operation
264 Signals are described in the "Explanation of signals" section
265 Measured with forming gas 90/10, 1.5 bar absolute, room temperature

Long-term stability/drift: <0.1 vol.-% in the first 5,000h operating time

IP code: IP6K9K from all sides except the sensor opening, there only IP6K4

Weight: < 570 g

Service life: Expected service life of 5 years[266] . The system has been tested with 100,000 switch-on and switch-off cycles.

Maintenance interval : We recommend checking the H_2sensor every 6 months. check.

Measuring behaviour: The gas to be tested may have a maximum have a maximum velocity of 25m/s. In addition, a laminar flow is recommended. If the specification differs specification, the sensor must be tested for tested for functionality.

Connection cable: 3 m enclosed; more detailed information on page 123

RoHS compliant: Yes

Customs tariff number: 90271010

COO: Germany / NRW

EC-79/2009 Not subject to type-approval according to Annex I b), Only components that come into contact with liquid hydrogen or have an operating pressure greater than 30 bar are subject to type approval.

Accuracy of the measured values:[267]

Size	**Accuracy**
Hydrogen concentration	± 2 vol.-% H_2
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[268]	± 0,3 °C
Pressure	± 20 mbar

Table12 : Statistical errors for individual measured variables

266 Measuring components are purely inorganic and are not consumed during measurement
267 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar
268 The temperature in the measuring chamber is always measured too high as the sensor elements heat up the measuring chamber

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO9XX-v007.pdf

It contains further information on the sensor and on initial commissioning.

Mounting the sensor:

The stepfile and a 2D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO9XX.zip

During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request (see data sheet_Adapter_NEO1XX_V146_EN_EN). To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a spatial direction other than horizontally, a small offset[269] occurs; this must be corrected via a specific CAN message on ID 0x680 (zero point adjustment, see page). 14

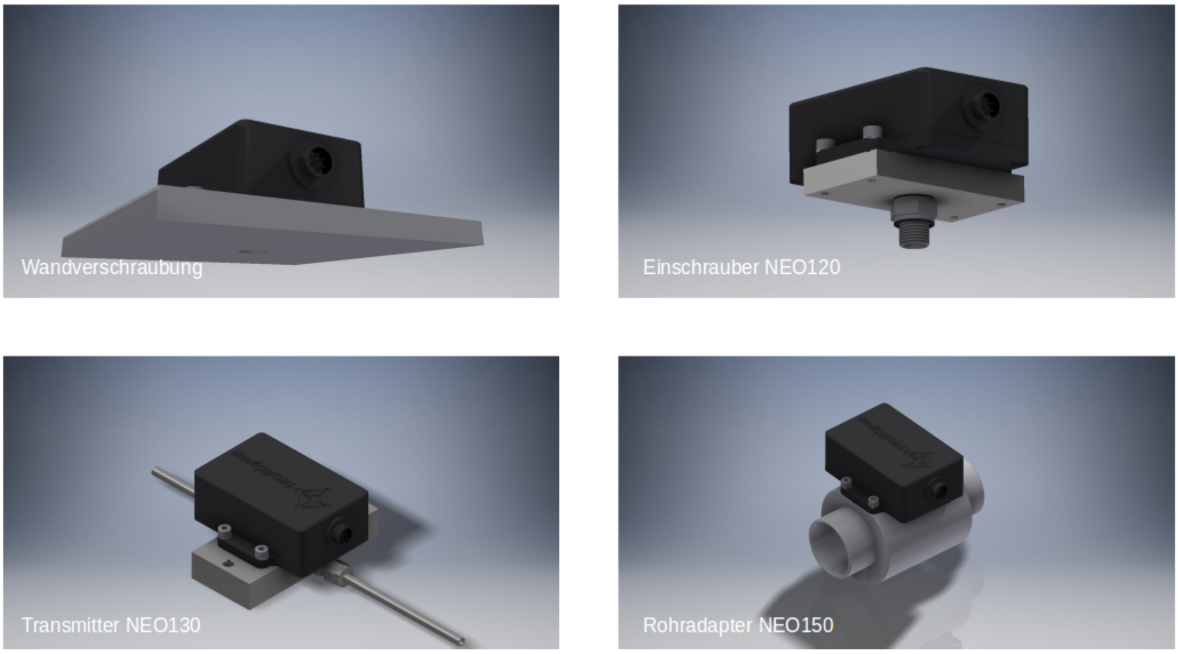


Figure 2a: Mounting the H_2sensor system

269 When tilted by± 40° in all directions, the error is less than± 0.05 vol.-%.

Hole pattern:

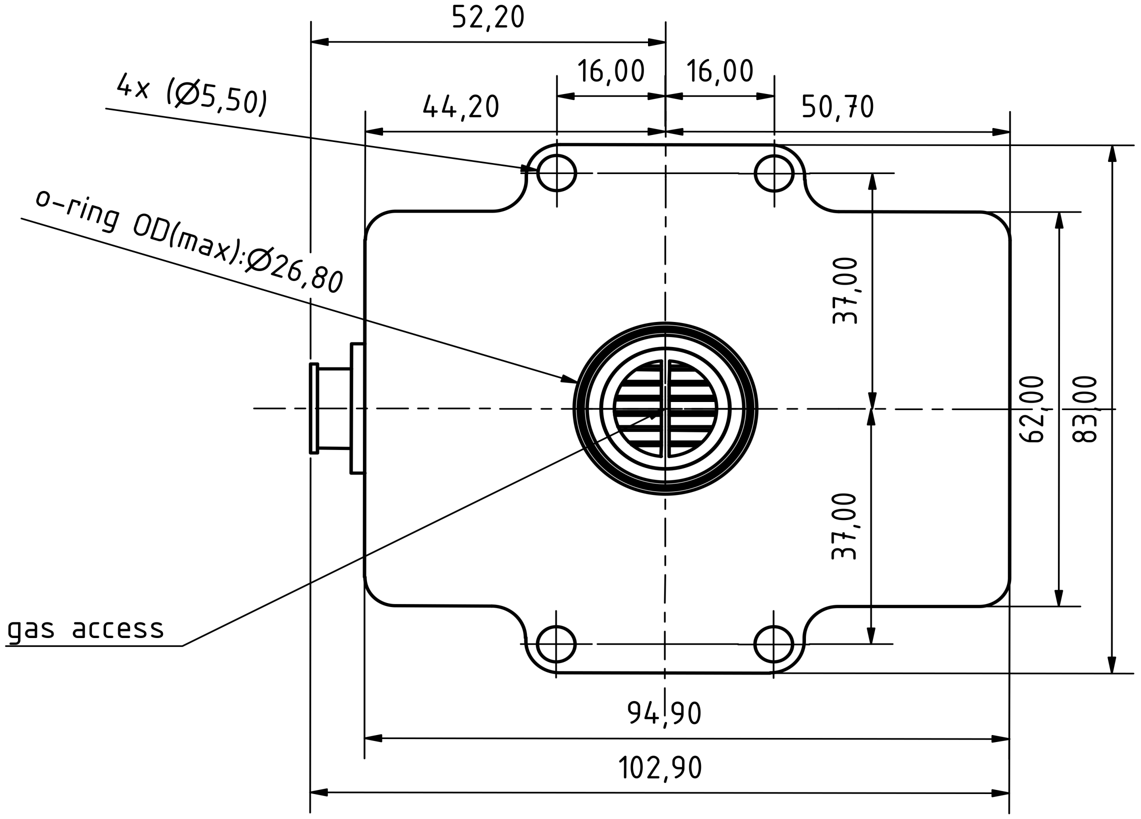


Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

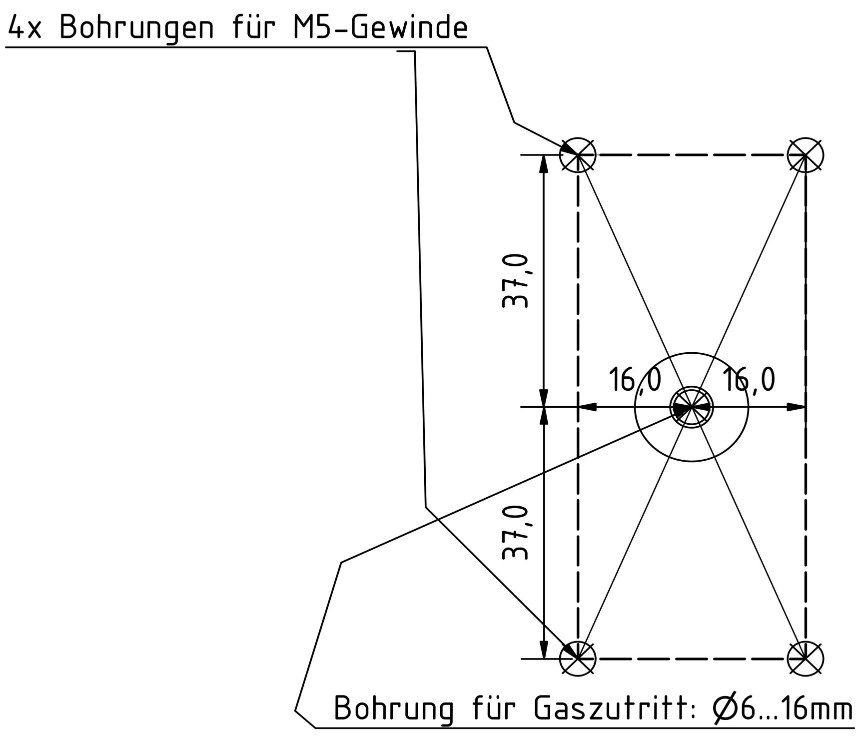
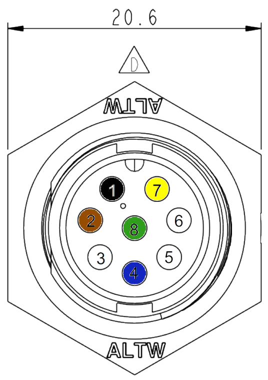


Figure 3b: Drilling template

Electrical PIN assignment



Housing plug

PIN no.	Description of the	Colour
1	VCC+ 12 ...+30 V DC (min.: 2.4W)	black
2	GND 0V DC	brown
3	CAN-High (opt. DAC+)	white
4	CAN-Low(opt. DAC-)	blue
5	*service port A*	-
6	*service port B*	-
7	DAC + / RS485 A	yellow
8	DAC - / RS485 B	green
	Shielding (optional GND)	green/yellow

8-pin housing connector: Amphenol LTW: ABD-08RMMS-LC7001
8-pin cable socket: Amphenol LTW: BD-08BFFA-LL7001

Figure 3c below shows the enclosed connection cable with angled socket:

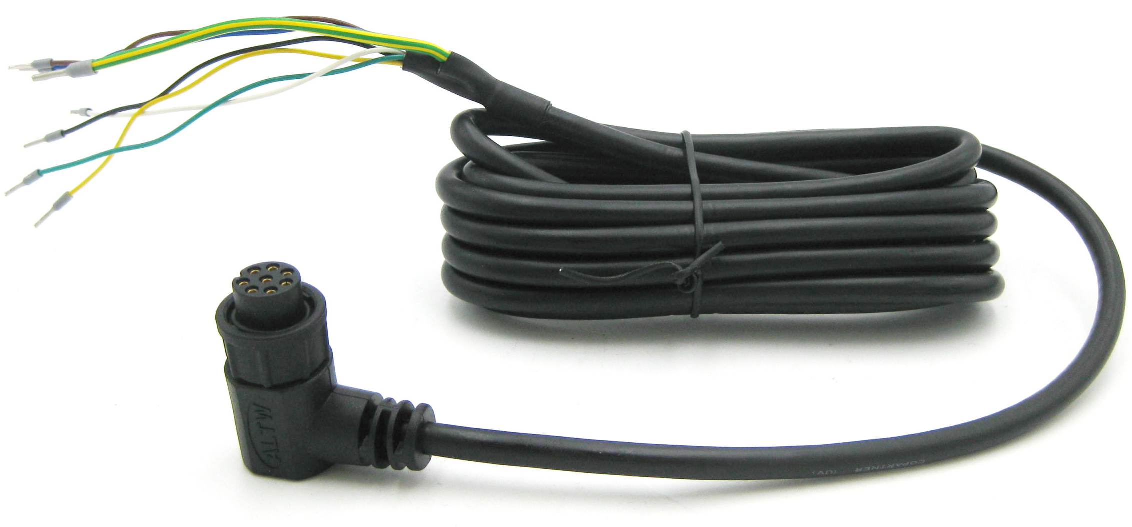


Figure 3c: Connection cable with angled socket

Simultaneous signal output via CAN bus and an analogue interface

If required, the sensor's measurement data can be output simultaneously via the CAN bus interface and an analogue interface (4-20 mA, 0-10V). If an analogue interface (4-20 mA, 0-10V) is selected in addition to the CAN bus, the analogue signal is output via PIN 7 & 8. CAN addressing via the connector is then no longer possible!

Information on hydrogen ignition by the NEO986NG from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

The NEO986NG H_2sensor uses a heating element that is heated with 5 V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the NEO986NG (a Zener diode prevents the operating voltage from being too high). In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavity.

Catalytic materials are not installed in the H_2sensor NEO986NG, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the NEO986NG H_2sensors. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

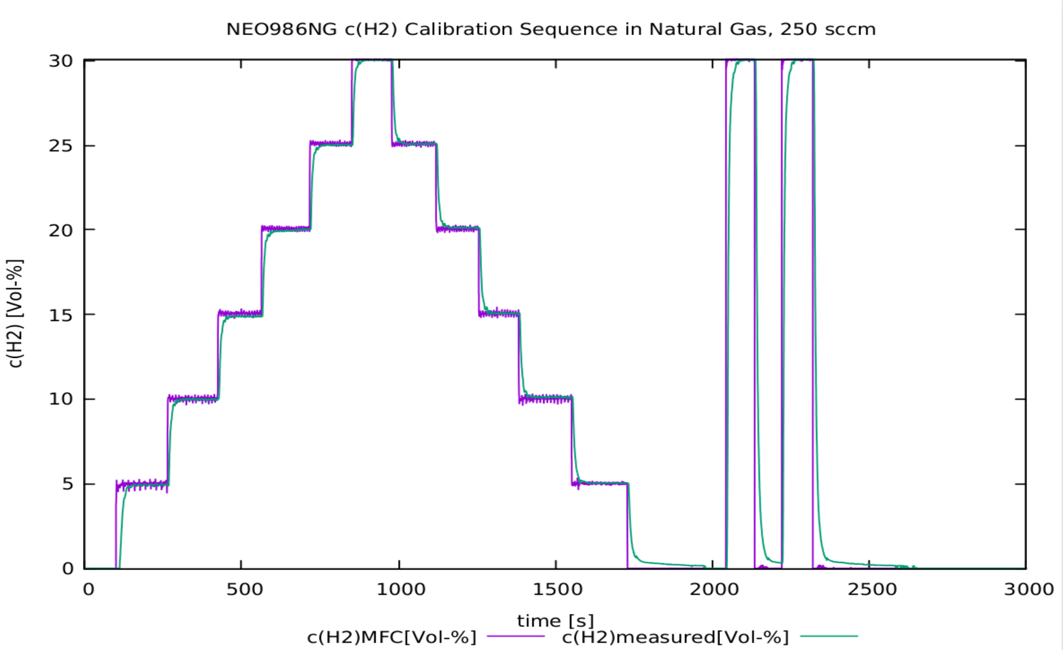


Figure 4a: Test of a sensor system NEO986 0 - 30 vol.-% H_2in natural gas. Measured with a total flow of 250 sccm.

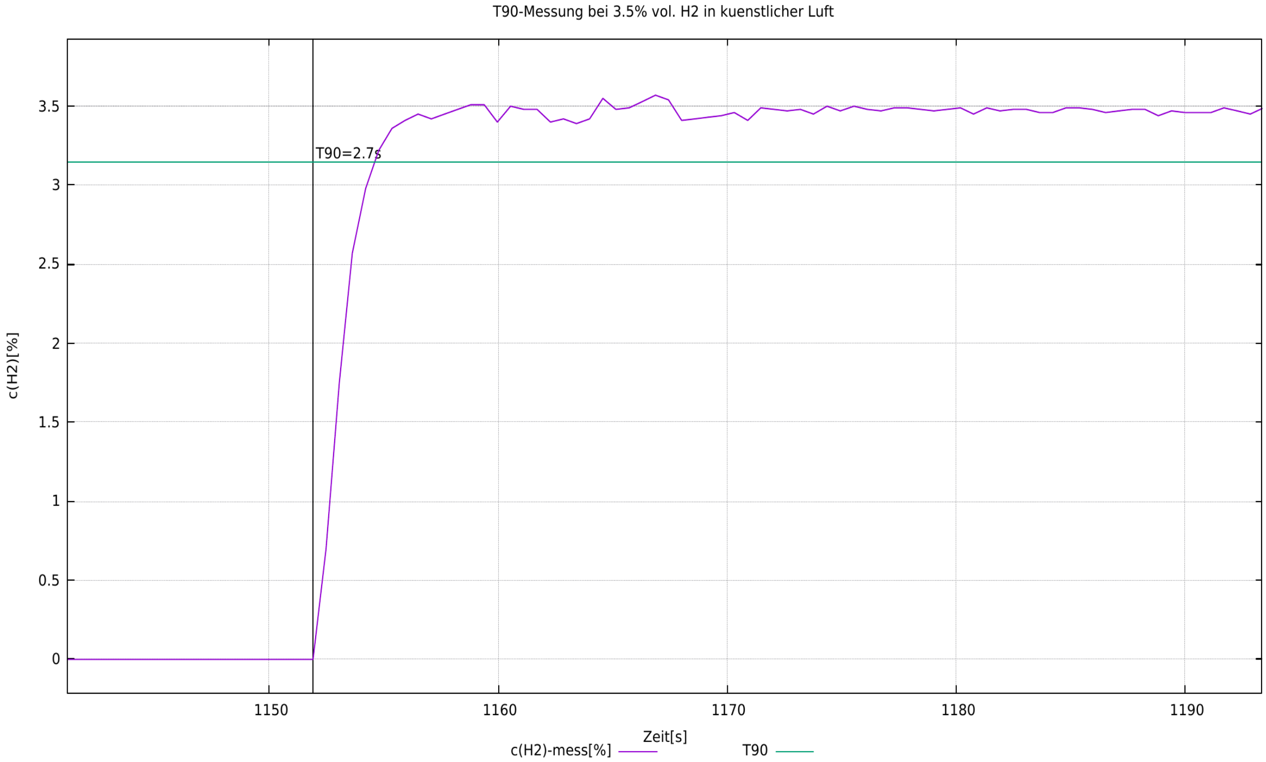


Figure 4b: t_{90}time determination with a sensor system by switching from 0 vol.-% $H_2$to 3.5 vol.-% H_2. Measured with a total flow of 1,000 sccm.

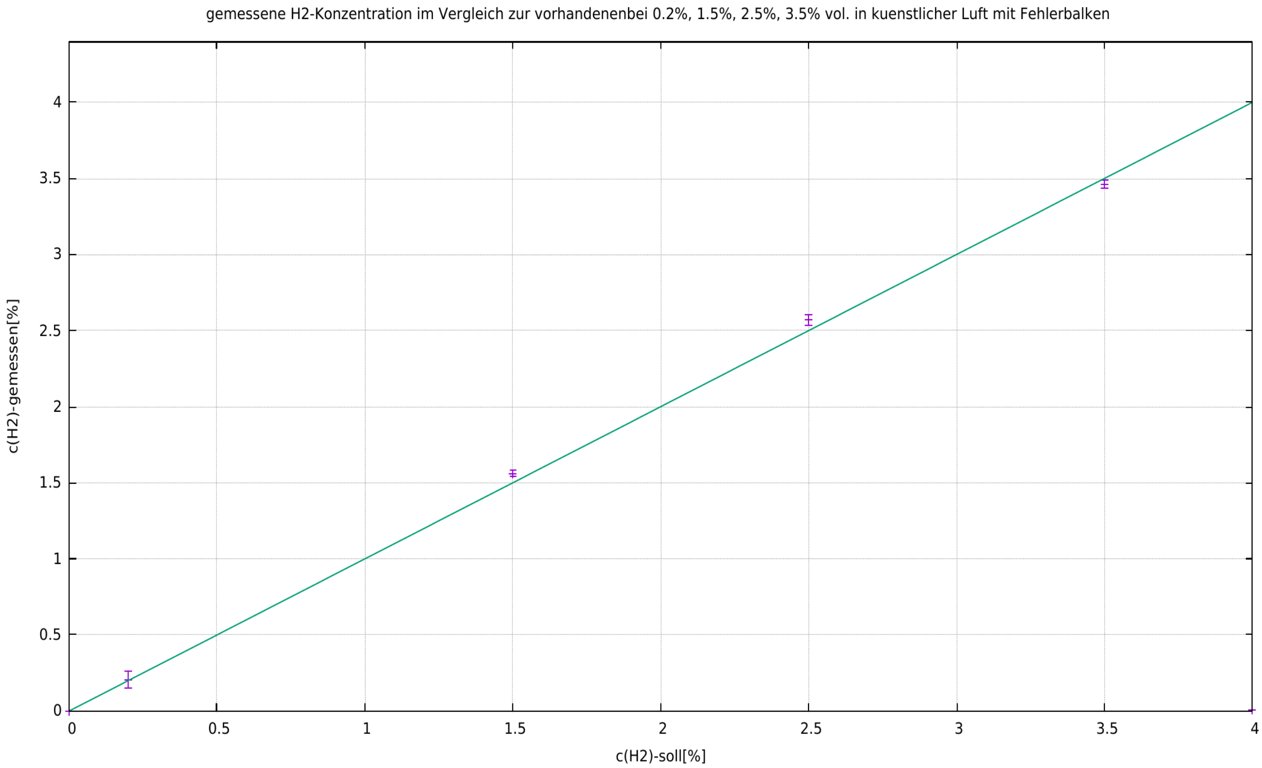


Figure 4c: Comparative measurement of the set hydrogen concentration and the measured hydrogen concentration with an error bar of three standard deviations of the measurement signal.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO986NGA (0-30 vol.-% H_2)	0x340 & 0x341	0x348 & 0x349	0x350 & 0x351	0x358 & 0x359

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to carry out a readjustment.
must be made. This is permanent and affects all outgoing H_2signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To make an adjustment, the system should be free of hydrogen and purged with the desired carrier gas. [270]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[271]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To set the CAN ID, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO986A (0-30 vol.-% H_2)	0x0CFF1C59 & 0x0CFF1D59	0x0CFF1E59 & 0x0CFF1F59	0x0CFF2059 & 0x0CFF2159	0x0CFF2259 & 0x0CFF2359

Set CAN ID (CAN2.0B):

270 Details can be found in the operating instructions under chapter: "Maintenance and service"
271 0xYY describes a measure for the set zero point adjustment

To set the CAN ID, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x200
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x200, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):

A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make a readjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To make an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (natural gas). [272]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[273]
*corresponds to the serial number of the individual sensor system.

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):

A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/H2-Sensor_NEOXXX_V146.dbc.zip

1st CAN message e.g. 0x320 or 0x0CFF1C59:

Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = *(Msg0-20)/100*
Msg 1(Bit 16-31): *Water concentration [vol.-%]: c($H_{(2)}O$) = (Msg1-20)/100*
Msg 2(bit 32-47): Pressure [mbar]: *p = Msg2*
Msg 3(Bit 48-55): Temperature [°C]: *T = (Msg3-60)*
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x321 or 0x0CFF1D59:

Msg 0(bit 0-15): Hydrogen concentration_RAW[vol.-%]: c(H_2) = *(Msg0-20)/100*
Measurement of the hydrogen content, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $H_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): *Version = (Msg4 / 10)*
Msg 5(Bit 56-63): Continuous message counter

272 Details can be found in the operating instructions under chapter: "Maintenance and service"
273 0xYY describes a measure for the set zero point adjustment

Example for the interpretation of CAN messages:

Hex message from Sensor:
CAN Msg1: CAN ID1 320 00 14 00 CE 03 ED 68 D8
CAN Msg2: CAN ID2 321 00 0A 63 00 50 D 92 CA

Decimal translation:
CAN Msg1: Byte0+1: 20, Byte 2+3: 206, Byte 4+5: 1005 Byte 6: 104, Byte 7: 216
CAN Msg2: Byte0+1: 10, Byte 2: 99, Byte 3: 0, Byte 4+5:1293 Byte 6: 146, Byte 7: 202

Sensor translation:
CAN Msg1: c($H_{2)}$ [vol.-%]: 0, c($H_{(2)}$ $_O$)[vol.-%]: 1.86, p[mbar]: 1005, T[°C]: 44, CRC: 216
CAN Msg2: c($H_{2)}$ _raw[vol.-%]: -0.1, raw: 99, status: 0, serial#: 1293, SV: 14.6 Counter: 202

CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured hydrogen concentration exceeds the 0.5 % by volume limit (c(H_2) from <0.5 % by volume to >= 0.5 % by volume).

The following message is sent:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = *(Msg0-20)/100*
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $H_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 5(Bit 56-63): Continuous message counter

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait
Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

Example:
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Set the baud rate to 500 kbit/s or 250 kbit/s:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H2 in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Initiate maintenance:
0x680 0x00 0x77 0x61 0x72 0x74 0x75 0x6E 0x67

Analogue 4-20mA - Series I

I[mA]	c(H_2) [vol.-%]	Comment
4 - 20 mA[274]	0 - 30 vol.-% resp. 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration. This means that 15 vol-% H_2, for example, is then output as a 12mA sensor system. In the heat-up phase and during a critical fault, a current <4mA is output (usually approx. 3mA)

It should be noted that the analogue output of the sensors is subject to an additional error of 2% FS. The maximum permissible load is 450 Ohm.

Analogue 0-10V - Series I

U[V]	c(H_2) [vol.-%]	Comment
0 - 10 V	0 - 30 vol.-% resp. 0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum hydrogen volume concentration in a range from 1V to 9V. This means that 15 vol-% $H_{(2)}$,for example, is then output as 5V with a 0-30% H2 sensor. Values less than 1V indicate an error. On request, it is also possible to output 0V and 5V at 40% LEL, so that you can switch a relay, for example!

It should be noted that the analogue output of the sensors is subject to an additional error of 2% FS. The minimum measuring resistance is 10 kOhm.

The following diagram 5 shows a connection diagram:

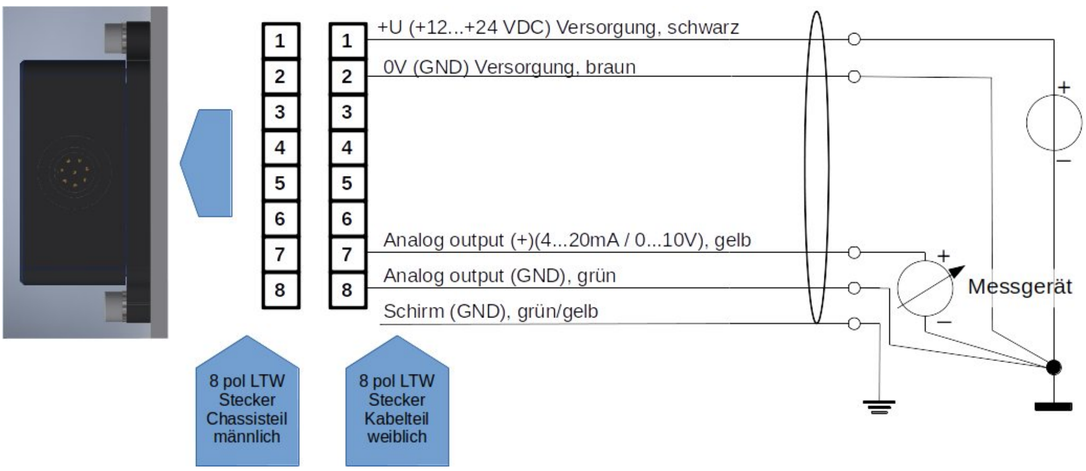


Figure 5: Wiring diagram

274 In earlier versions of this sensor, 7.2 to 20mA was given as the measuring range.

Digital Modbus via RS485 or EIA/TIA-485 - NEO series M

In serial master-slave communication, our NEO sensors function as slaves with the start slave ID 1 and a baud rate of 9,600 in 8N1, i.e. data bits: 8, parity: none, stop bits: 1. The 16-bit registers are defined as signed integers in big-endian, i.e. values in the range -32,768 to 32,767. The Modbus lines are not terminated.

Input register:

Name	Description of the	Scaling[275]	Unit	Register addresses	INPUT register address (hex / dec)
Hydrogen concentration	H_2Volume concentration (Example: 2030 = 20.3 vol.-%)	100	Vol.-%	3x257	0x100 / 256_{dec}
Water concentration	H_2O Volume concentration (Example: 2330 = 23.3 vol.-%)	100	Vol.-%	3x258	0x101 / 257_{dec}
Pressure	Pressure as absolute pressure (Example: 1033 = 1033 mbar)	1	mbar a	3x259	0x102 / 258_{dec}
Temperature	Temperature in measuring cavern (Example: 6250 = 62.5°C)	100	°C	3x260	0x103 / 259_{dec}
Hydrogen concentration _RAW	Hydrogen concentration (Example: 2750 = 27.5 vol.-%)	100	Vol.-%	3x261	0x104 / 260_{dec}
Gross value	Raw value = 100 in the absence of water and hydrogen and otherwise normal air.	1	-	3x262	0x105 / 261_{dec}
Status byte	See "Explanations on the status byte" in the "Signal explanation" section: "CAN".	1	-	3x263	0x106 / 262_{dec}
Serial number	S/N: P number, which is noted on the outside of the device. (Example: 3626 = P-3626)	1	-	3x264	0x107 / 263_{dec}
Software version	Version of the sensor software (Example: 156 = version 15.6)	10	-	3x265	0x108 / 264_{dec}
Message counter	High running counter 0-255	1	-	3x266	0x109 / 265_{dec}
Check value	00000000 01010101 value is 85, which can be used to check the byte order	1	-	3x267	0x10A / 266_{dec}

Holding register:

275 When reading with a PLC, make sure that the data type is set to "Real" so that the signed integer can also be displayed as a comma number.

Name	Description of the	Register addresses	HOLDING Register address (hex / dec)
Baud rate	default: 9,600 Specifying the baud rate of the Modbus RTU interface: 4,800, 9,600 or 19,200	4x001	0x00 / 0_{dec}
Slave ID	default: 1 Possible slave IDs of the sensor 1-247	4x002	0x01 / 1_{dec}
Mode parity	default: 0 = parity: none, stop bit: 1 0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2	4x003	0x02 / 2_{dec}
Zero point adjustment	default: 0 If a 1 is written to the register, a zero point adjustment is carried out here and then changed the register to 2.	4x004	0x03 / 3_{dec}

Changes to the factory settings are only applied after restarting the sensor.

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapters and heaters:
Various adapters are available for mounting the sensor. For use in very humid environments or environments with liquid water or the risk of icing, there are heating cartridges that can be operated at a constant voltage. These can be fitted in the adapters. You can find the corresponding products under:
https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt_neoCANLogger_V146_DE_EN.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for the fine purification of gases by removing minimal impurities.

FAQ:

The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Data sheet hydrogen concentration sensor NEO1005, version 16.0, BMW part numbers: 4B08802, 4B087F6, 4B087F7 and 4B087F9

Product description:

Sensor system for measuring the hydrogen concentration in air with temperature-, pressure- and humidity-compensated signal evaluation for automotive applications. Applicable in the range: 0.6 - 1.5 bara, 0 - 100% r.h. (non-condensing) and -40°C - 85°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measurements in the range of 0-5 vol.-% H_2
- Carrier gases Air
- Encrypted CAN communication on demand
- Measuring signal independent of pressure, temperature and humidity
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Signal output via CAN 2.0A
- Connectors and contacts for crimping are included
- Factory calibrated and ready for immediate use
- CAN wake-up function when a certain H_2concentration is detected
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary.

Figure 1a: H_2sensor system NEO1005A

Sensor system characteristics:

Supply voltage: 9 - 30V DC

Energy consumption: < 2,4 W

H_2sensitivity: 0 - 5 % by volume H_2

Accuracy: ± 0.3 % by volume H_2[276]

Detection limit: < 0.2% by volume $H_{(2)}$ ([1])

Response time t_{90}: < 3 s

Decay time t_{10}: < 3 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[277]

Media temperature: - 40°C - 85°C/105°C[278]

Ambient temperature: - 40°C - 85°C/105°C[4]
The cold start at -40°C was tested.

Pressure range: 0.6 - 1.5 bar absolute

Humidity: 0 - 100 % r.h. (non-condensing)

Carrier gas: Air

Cross-sensitivities: Helium, tbd

CAN signal: CAN 2.0A (125, 250, 500, 1000 kbit/s) on page 13

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm

Housing: Size: 84 x 82 x 29 mm³
Material: polyamide 6, 10% glass fibres, 20% mineral

Leakage rate: 10^{-5}mbar l / s [279]

Long-term stability/drift: <0.1 vol.-% in the first 5,000h operating time

IP code: IP6K7

276
277 The system is designed for continuous operation
278 105°C are not suitable for continuous operation
279 Measured with forming gas 90/10, 1.5 bar absolute, room temperature

Weight:	80 g
ASIL:	ASIL B is aimed for
Probability of default:	FIT: 63.00 MTBF: 1,812 years PFH: 6.30E-08 PFD: 6.3E-04
ATEX:	-
Service life: with	IP6K7 enclosure qualified with an expected Service life of 5 years.[280] The system has been tested 100,000 switch-on and switch-off cycles.
Long-term stability:	Deviation <0.1 vol.-% in the first 5000h Operating time
Maintenance interval : 6 months.	We recommend checking the H_2sensor every check.
Measuring behaviour: addition, a specification differs must be tested for	The gas to be tested may have a maximum have a maximum velocity of 25m/s. In laminar flow is recommended. If the specification, the sensor tested for functionality.
Connection: request	Connector plug and 8x contacts for crimping are included. A cable can also be manufactured on can also be manufactured.
RoHS compliant:	Yes https://neoxid-cloud.de/Konformitaetserklaerung-RoHS_DE_EN_V02_scan.pdf
EMC compliant:	Yes https://neoxid-cloud.de/EMV_NEO1XXX_neoxid-group.pdf
Customs tariff number:	90271010[281]
COO:	Germany / NRW
EC-79/2009	Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

280 Measuring components are purely inorganic and are not consumed during measurement

281 This product is not assigned to an ECCN. It therefore belongs to the EAR99 classification and can be traded freely.

Accuracy of the measured values:[282]

Size	Accuracy
Hydrogen concentration	± *0.3 vol.-% H_2*
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[283]	± *0,3 °C*
Pressure	± *20 mbar*

Table13 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO1XXX-V09_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Assembly:

The stepfile and 2D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO1XXX-Spritzguss.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system as shown in Figure 1a. If the sensor is mounted in a different spatial direction, there will be a small offset[284] , which must be corrected via a specific CAN message on ID 0x680[285] . The retaining pins or screws may have a maximum diameter of 5.5 mm. We recommend a tightening torque of 2.3 Nm.

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The sensor is fitted with a ribbed plug as a protective measure against small amounts of splash water. It must be ensured that the sensor is installed in such a way that this plug functions properly if an installation with a gas flowing past is used.

282 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar

283 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber

284 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.

285 See CAN Matrix Message Layout

Figure 1b: H_2sensor system NEO1005 from below

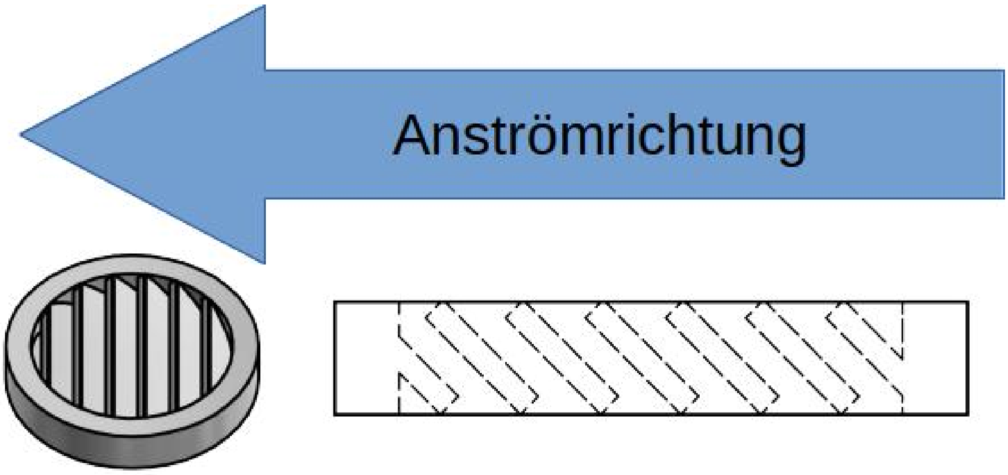


Figure 2a: Fitting ribbed plugs against the direction of flow

Hole pattern:

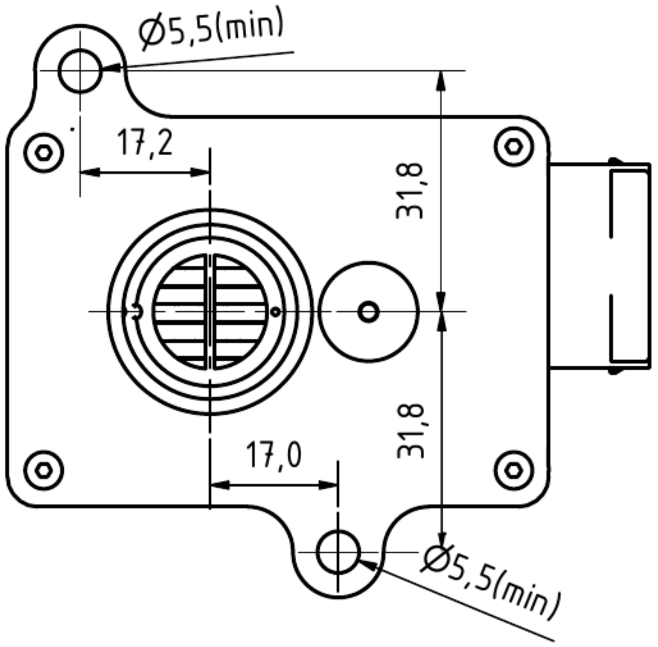


Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

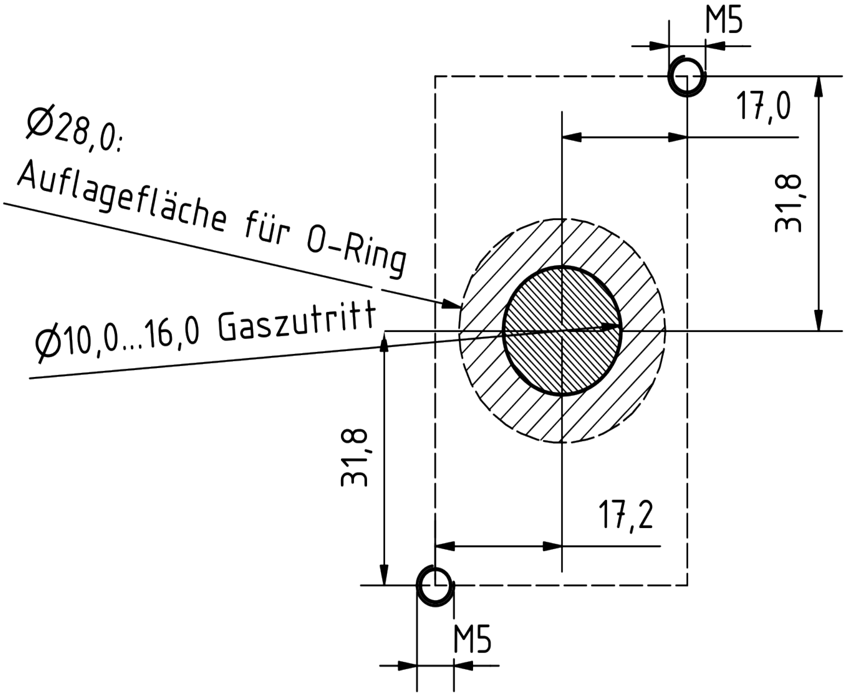
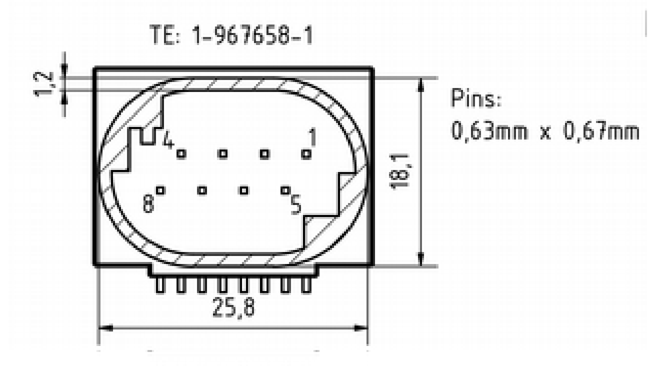


Figure 3b: Drilling template

	**PIN assignment** Pin 1: 9...+30V DC (min.: 2.4W) Pin 2: 0V DC (GND) Pin 3: CAN-High Pin 4: CAN-Low Pin 5: Termination 1a* Pin 6: Termination 1b* Pin 7: Termination 2a* Pin 8: Termination 2b* ***) Short-circuiting 1a with 1b and 2a with 2b terminates the CAN line.**
8-pole housing socket: TE Connectivity MQS 1-967658-1	

Information on hydrogen ignition by the NEO1005 from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

A heating element is used in the H_2sensor, which is heated with 5V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the sensor (a Zener diode prevents operating voltages > 15 V). At 32 V, the heating element burnt out and still did not cause the explosive stoichiometric gas mixture to explode. In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavern. The sample gas must diffuse through a membrane.

Catalytic materials are not installed in the H_2sensor, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

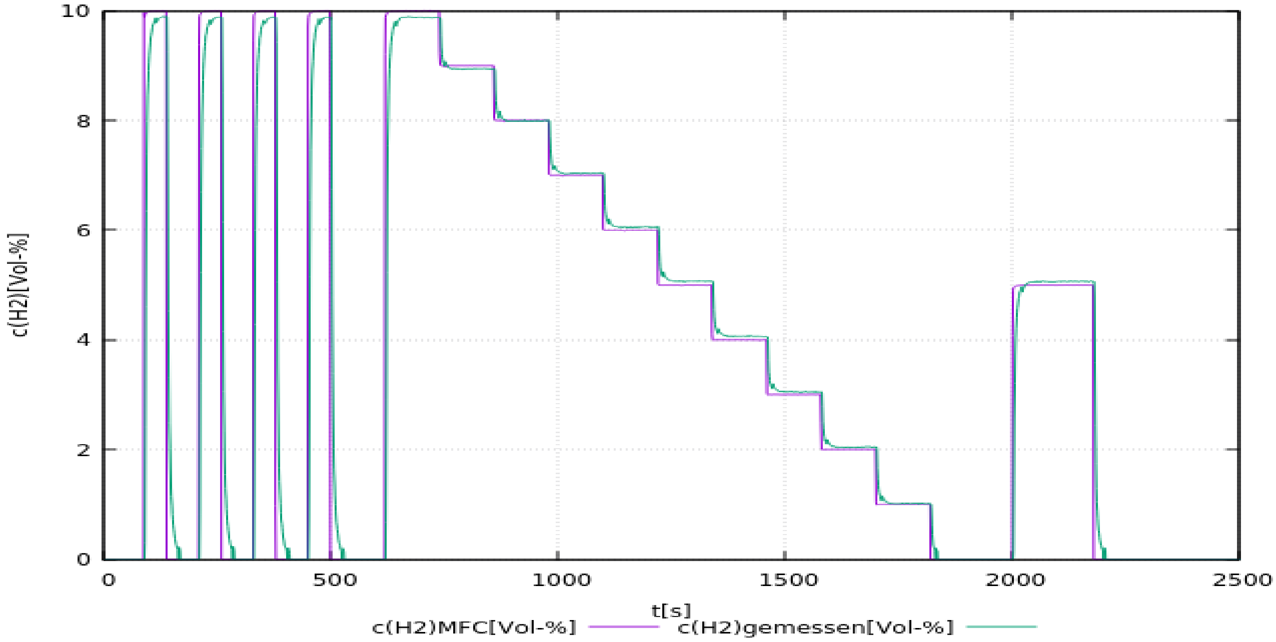


Figure 5a: Test of a NEO1010 sensor system up to 10 vol.-% H_2in 13 vol.-% O_2. Measured with a total flow of 2,000 sccm.

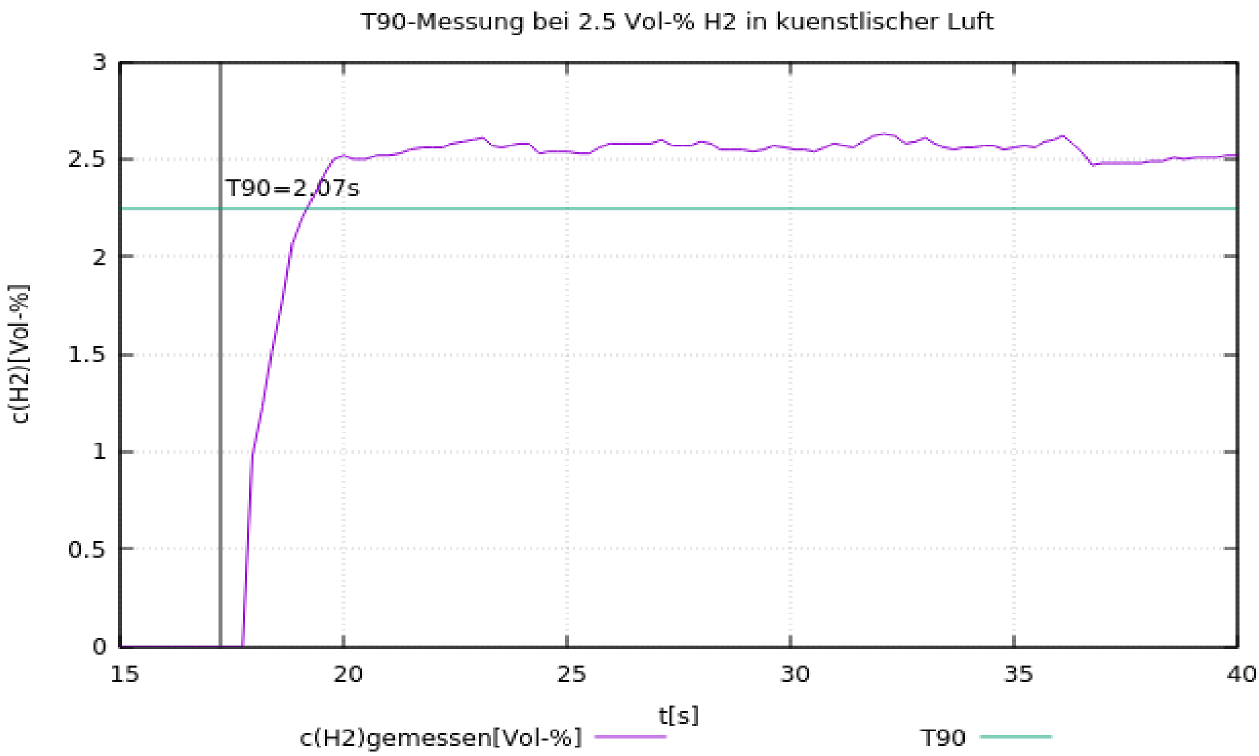


Figure 5b: t_{90}time determination with a NEO1005 sensor system by switching from 0 vol.-% $H_2$to 2.5 vol.-% H_2. Measured with a total flow of 4,000 sccm.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. However, the sensors can be ordered with 120 Ohm termination.
The first CAN message is delivered 5s after system start. It is possible for the sensor to send a predefined message on a desired ID at a certain hydrogen concentration (CAN wake-up). This could be used to wake up other devices in the network from sleep mode.

The CAN IDs of the sensor are as follows:

	CAN ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO1005A (0-5 vol.-% H_2)	155 & 595	170 & 610	180 & 620	190 & 630
BMW part number	4B087F9	4B08802	4B087F7	4B087F6
NEO article number	200284	200285	200283	200281

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment. must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air). [286]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[287]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To change the ID on which the NEO1005A transmits, a CAN message can be sent:
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address

and

0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

286 Details can be found in the operating instructions under chapter: "Maintenance and service"
287 0xYY describes a measure for the set zero point adjustment

CAN Matrix Message Layout (CAN 2.0A):
The corresponding DBC file is available at the following link:
https://neoxid-cloud.de/H2-Sensor_NEO11XX_V160-BMW.dbc.zip

1st CAN message dec155:
Msg 1 (bit 56-63): Sensor status [a.u.]
Msg 2 (bit 48-55): Relative humidity [%]
Msg 3 (bit 40-47): Temperature [°C]
Msg 4 (bit 28-39): Pressure [mbar a]
Msg 5 (bit 16-27): H_2concentration [0-100% FS]
Msg 6 (bit 12-15): CHL
Msg 7 (Bit 8-11): ALV
Msg 8 (Bit 0-7): CRC

2nd CAN message dec595:
Msg 1 (bit 56-63): Empty
Msg 2 (bit 48-55): ERR_ResetCounter
Msg 3 (Bit 32-47): ERR_InternalError_Detail
Msg 4 (bit 28-29): ERR_OverUndervoltage
Msg 5 (bit 26-27): ERR_Overtemperature
Msg 6 (Bit 24-25): ERR_InternalError
Msg 7 (bit 16-23): Voltage [V]
Msg 8 (bit 12-15): CHL
Msg 9 (Bit 8-11): ALV
Msg 10 (Bit 0-7): CRC

Further CAN commands (CAN2.0A):

Adjust baud rate:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Zero point adjustment:
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

FAQ:

The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Data sheet hydrogen concentration sensor NEO1005, version 16.2, BMW part numbers: 4B12407, 4B12408, 4B12409, 4B12410

Product description:

Sensor system for measuring the hydrogen concentration in air with temperature-, pressure- and humidity-compensated signal evaluation for automotive applications. Applicable in the range: 0.6 - 1.5 bara, 0 - 100% r.h. (non-condensing) and -40°C - 85°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measurements in the range of 0-5 vol.-% H_2
- Carrier gases Air
- Encrypted CAN communication on demand
- Measuring signal independent of pressure, temperature and humidity
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Signal output via CAN 2.0A
- Connectors and contacts for crimping are included
- Factory calibrated and ready for immediate use
- CAN wake-up function when a certain H_2concentration is detected
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary.

Figure 1a: H_2sensor system NEO1005A

Sensor system characteristics:

Supply voltage:	9 - 30V DC
Energy consumption:	< 2,4 W
H_2sensitivity:	0 - 5 % by volume H_2
Accuracy:	± 0.3 % by volume H_2[288]
Detection limit:	< 0.2% by volume $H_{(2)}$ ([1])
Response time t_{90}:	< 3 s
Decay time t_{10}:	< 3 s
Start-up time after cold start:	< 5 s until the first message < 70 s until quantification of the H_2concentration[289]
Media temperature:	- 40°C - 85°C/105°C[290]
Ambient temperature:	- 40°C - 85°C/105°C[4] The cold start at -40°C was tested.
Pressure range:	0.6 - 1.5 bar absolute
Air humidity:	0 - 100 % r.h. (non-condensing)
Carrier gas:	Air
Cross-sensitivities:	Helium, tbd
CAN signal:	CAN 2.0A (125, 250, 500, 1000 kbit/s) on page 13
Output/measurement interval:	100 ms / 10 Hz
Resolution:	100 ppm
Housing:	Size: 84 x 82 x 29 mm³ Material: polyamide 6, 10% glass fibres, 20% mineral
Leakage rate:	10^{-5}mbar l / s [291]
Long-term stability/drift:	<0.1 vol.-% in the first 5,000h operating time
IP code:	IP6K7

288
289 The system is designed for continuous operation
290 105°C are not suitable for continuous operation
291 Measured with forming gas 90/10, 1.5 bar absolute, room temperature

Weight:	80 g
ASIL:	ASIL B is aimed for
Probability of default:	FIT: 63.00 MTBF: 1,812 years PFH: 6.30E-08 PFD: 6.3E-04
ATEX:	-
Service life: with	IP6K7 enclosure qualified with an expected Service life of 5 years.[292] The system has been tested 100,000 switch-on and switch-off cycles.
Long-term stability:	Deviation <0.1 vol.-% in the first 5000h Operating time
Maintenance interval : 6 months.	We recommend checking the H_2sensor every check.
Measuring behaviour: addition, a specification differs must be tested for	The gas to be tested may have a maximum have a maximum velocity of 25m/s. In laminar flow is recommended. If the specification, the sensor tested for functionality.
Connection: request	Connector plug and 8x contacts for crimping are included. A cable can also be manufactured on can also be manufactured.
RoHS compliant: RoHS_DE_EN_V02_scan.pdf	Yes https://neoxid-cloud.de/Konformitaetserklaerung-
EMC compliant:	Yes https://neoxid-cloud.de/EMV_NEO1XXX_neoxid-group.pdf
Customs tariff number:	90271010[293]
COO:	Germany / NRW
EC-79/2009	Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

292 Measuring components are purely inorganic and are not consumed during measurement
293 This product is not assigned to an ECCN. It therefore belongs to the EAR99 classification and can be traded freely.

Accuracy of the measured values:[294]

Size	Accuracy
Hydrogen concentration	*± 0.3 vol.-% H_2*
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[295]	*± 0,3 °C*
Pressure	*± 20 mbar*

Table14 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO1XXX-V09_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Assembly:
The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO1XXX-Spritzguss.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system as shown in Figure 1a. If the sensor is mounted in a different spatial direction, there will be a small offset[296] , which must be corrected via a specific CAN message on ID 0x680[297] . The retaining pins or screws may have a maximum diameter of 5.5 mm. We recommend a tightening torque of 2.3 Nm.

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The sensor is fitted with a ribbed plug as a protective measure against small amounts of splash water. It must be ensured that the sensor is installed in such a way that this plug functions properly if an installation with a gas flowing past is used.

294 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar
295 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber
296 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.
297 See CAN Matrix Message Layout

Figure 1b: H_2sensor system NEO1005 from below

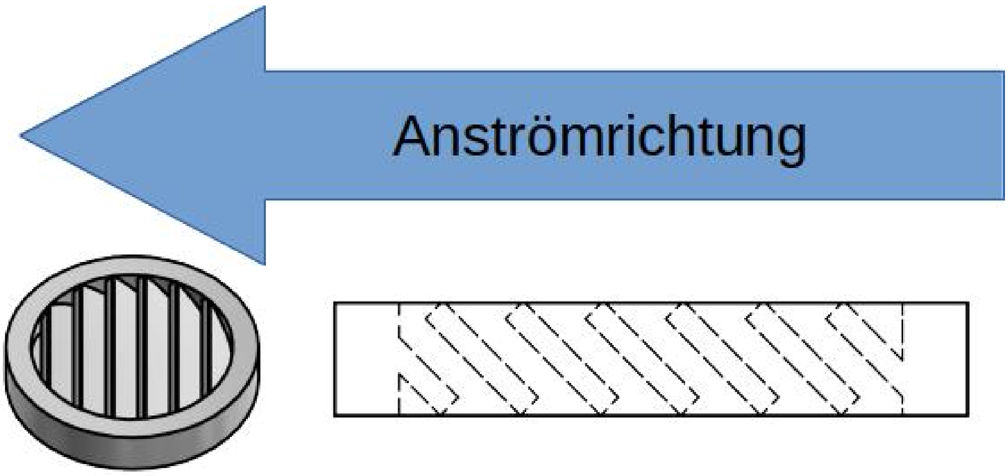


Figure 2a: Fitting ribbed plugs against the direction of flow

Hole pattern:

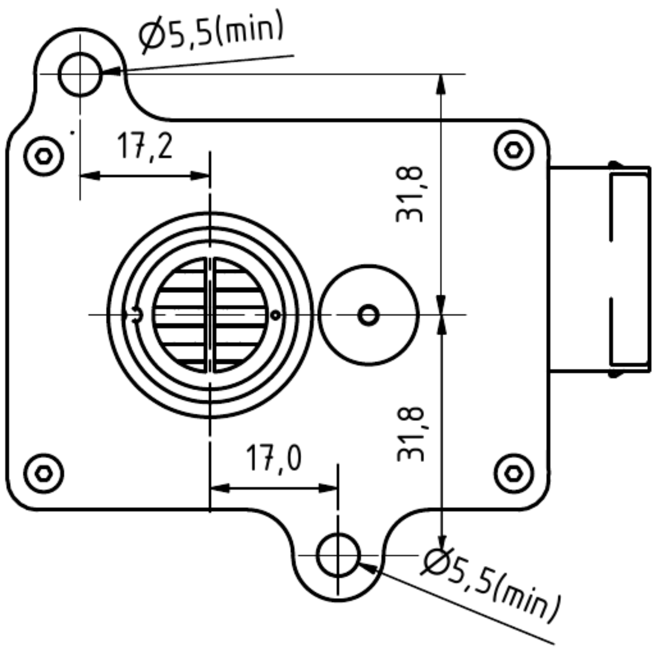


Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

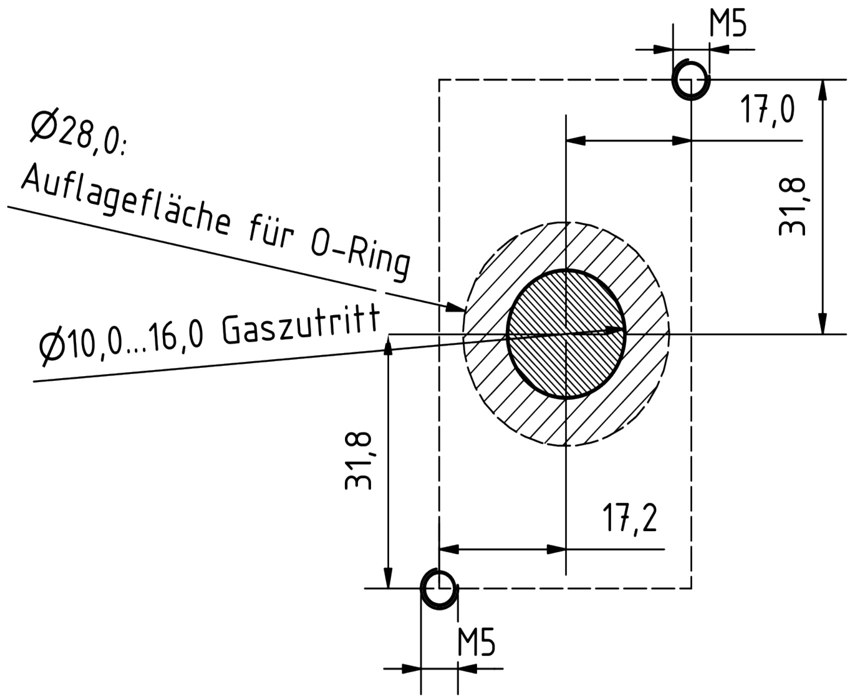
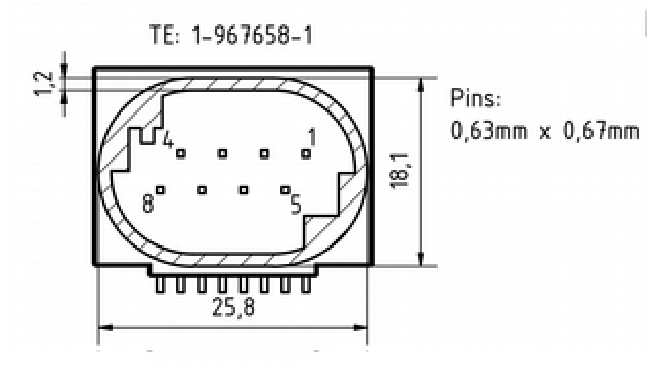


Figure 3b: Drilling template

	**PIN assignment** Pin 1: 9...+30V DC (< 2.4W) Pin 2: 0V DC (GND) Pin 3: CAN-High Pin 4: CAN-Low Pin 5: CAN-High loop-through Pin 6: CAN-Low loop through Pin 7: NC Pin 8: NC
8-pole housing socket: TE Connectivity MQS 1-967658-1	

Information on hydrogen ignition by the NEO1005 from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

A heating element is used in the H_2sensor, which is heated with 5V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the sensor (a Zener diode prevents operating voltages > 15 V). At 32 V, the heating element burnt out and still did not cause the explosive stoichiometric gas mixture to explode. In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavern. The sample gas must diffuse through a membrane.

Catalytic materials are not installed in the H_2sensor, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

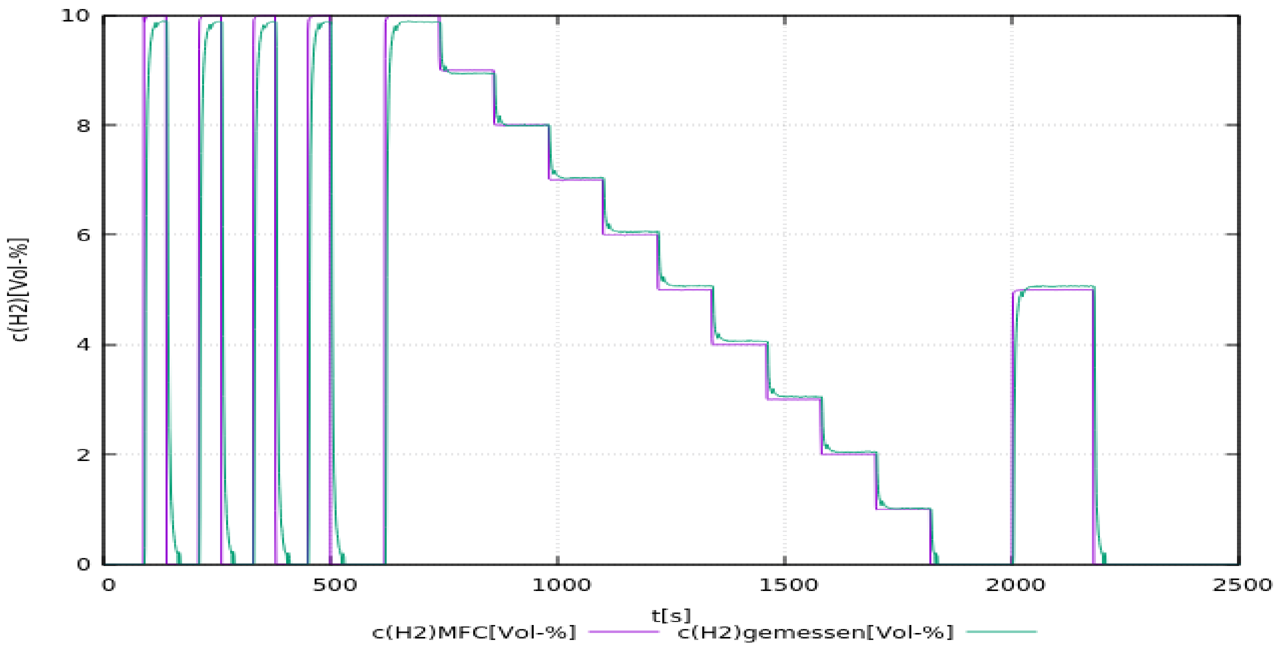


Figure 5a: Test of a NEO1010 sensor system up to 10 vol.-% H_2in 13 vol.-% O_2. Measured with a total flow of 2,000 sccm.

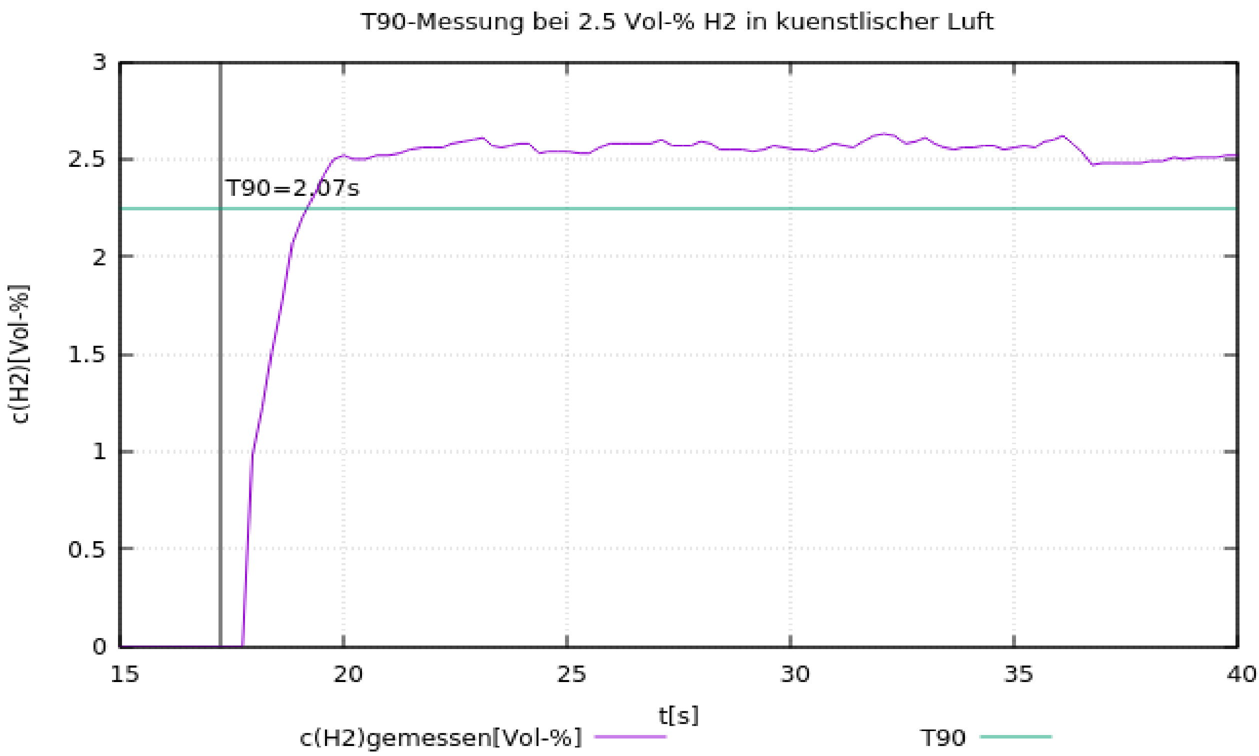


Figure 5b: t_{90}time determination with a NEO1005 sensor system by switching from 0 vol.-% $H_2$to 2.5 vol.-% H_2. Measured with a total flow of 4,000 sccm.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. However, the sensors can be ordered with 120 Ohm termination.
The first CAN message is delivered 5s after system start. It is possible for the sensor to send a predefined message on a desired ID at a certain hydrogen concentration (CAN wake-up). This could be used to wake up other devices in the network from sleep mode.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	**CAN-ID 2**	**CAN-ID 3**	**CAN-ID 4**
NEO1005A (0-5 vol.-% H_2)	155 & 595	170 & 610	180 & 620	190 & 630
Scheduling	-	-	120 Ohm	120 Ohm
BMW part number	4B12409	4B12410	4B12408	4B12407
NEO article number	200442	200443	200441	200440

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment. must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air). [298]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[299]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To change the ID on which the NEO1005A transmits, a CAN message can be sent:
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address

and

0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

298 Details can be found in the operating instructions under chapter: "Maintenance and service"
299 0xYY describes a measure for the set zero point adjustment

CAN Matrix Message Layout (CAN 2.0A):
The corresponding DBC file is available at the following link:
https://neoxid-cloud.de/H2-Sensor_NEO11XX_V160-BMW.dbc.zip

1st CAN message dec155:
Msg 1 (bit 56-63): Sensor status [a.u.]
Msg 2 (bit 48-55): Relative humidity [%]
Msg 3 (bit 40-47): Temperature [°C]
Msg 4 (bit 28-39): Pressure [mbar a]
Msg 5 (bit 16-27): H_2concentration [0-100% FS]
Msg 6 (bit 12-15): CHL
Msg 7 (Bit 8-11): ALV
Msg 8 (Bit 0-7): CRC

2nd CAN message dec595:
Msg 1 (bit 56-63): Empty
Msg 2 (bit 48-55): ERR_ResetCounter
Msg 3 (Bit 32-47): ERR_InternalError_Detail
Msg 4 (bit 28-29): ERR_OverUndervoltage
Msg 5 (bit 26-27): ERR_Overtemperature
Msg 6 (Bit 24-25): ERR_InternalError
Msg 7 (bit 16-23): Voltage [V]
Msg 8 (bit 12-15): CHL
Msg 9 (Bit 8-11): ALV
Msg 10 (Bit 0-7): CRC

Further CAN commands (CAN2.0A):

Adjust baud rate:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Zero point adjustment:
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

FAQ:

The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Data sheet hydrogen concentration sensor NEO1010, version 16.0, BMW part number: 4A1F701

Product description:

Sensor system for measuring the hydrogen concentration in air with temperature-, pressure- and humidity-compensated signal evaluation for automotive applications. Applicable in the range: 0.6 - 1.5 bara, 0 - 100% r.h. (non-condensing) and -40°C - 85°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measurements in the range of 0-10 vol.% H_2
- Carrier gases Air
- Encrypted CAN communication on demand
- Measuring signal independent of pressure, temperature and humidity
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Signal output via CAN 2.0A
- Connectors and contacts for crimping are included
- Factory calibrated and ready for immediate use
- CAN wake-up function when a certain H_2concentration is detected
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary.

Figure 1a: H_2sensor system NEO1010A

Sensor system characteristics:

Supply voltage: 9 - 30V DC

Energy consumption: < 2,4 W

H_2sensitivity: 0 - 10 % by volume H_2

Accuracy: ± 0.3 % by volume H_2[300]

Detection limit: < 0.2% by volume $H_{(2)}$ ([1)]

Response time t_{90}: < 3 s

Decay time t_{10}: < 3 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[301]

Media temperature: - 40°C - 85°C/105°C[302]

Ambient temperature: - 40°C - 85°C/105°C[4]
The cold start at -40°C was tested.

Pressure range: 0.6 - 1.5 bar absolute

Air humidity: 0 - 100 % r.h. (non-condensing)

Carrier gas: Air

Cross-sensitivities: Helium, tbd

CAN signal: CAN 2.0A (125, 250, 500, 1000 kbit/s) on page 13

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm

Housing: Size: 84 x 82 x 29 mm³
Material: polyamide 6, 10% glass fibres, 20% mineral

Leakage rate: 10^{-5}mbar l / s [303]

Long-term stability/drift: <0.1 vol.-% in the first 5,000h operating time

IP code: IP6K7

300
301 The system is designed for continuous operation
302 105°C are not suitable for continuous operation
303 Measured with forming gas 90/10, 1.5 bar absolute, room temperature

Weight:	80 g
ASIL:	ASIL B is aimed for
Probability of default:	FIT: 63.00 MTBF: 1,812 years PFH: 6.30E-08 PFD: 6.3E-04
ATEX:	-
Service life: with	IP6K7 enclosure qualified with an expected Service life of 5 years.[304] The system has been tested 100,000 switch-on and switch-off cycles.
Long-term stability:	Deviation <0.1 vol.-% in the first 5000h Operating time
Maintenance interval : 6 months.	We recommend checking the H_2sensor every check.
Measuring behaviour: addition, a specification differs must be tested for	The gas to be tested may have a maximum have a maximum velocity of 25m/s. In laminar flow is recommended. If the specification, the sensor tested for functionality.
Connection: request	Connector plug and 8x contacts for crimping are included. A cable can also be manufactured on can also be manufactured.
RoHS compliant: RoHS_DE_EN_V02_scan.pdf	Yes https://neoxid-cloud.de/Konformitaetserklaerung-
EMC compliant:	Yes https://neoxid-cloud.de/EMV_NEO1XXX_neoxid-group.pdf
Customs tariff number:	90271010[305]
COO:	Germany / NRW
EC-79/2009	Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

304 Measuring components are purely inorganic and are not consumed during measurement

305 This product is not assigned to an ECCN. It therefore belongs to the EAR99 classification and can be traded freely.

Accuracy of the measured values:[306]

Size	Accuracy
Hydrogen concentration	*± 0.3 vol.-% H_2*
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[307]	*± 0,3 °C*
Pressure	*± 20 mbar*

Table15 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO1XXX-V09_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Assembly:
The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO1XXX-Spritzguss.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system as shown in Figure 1a. If the sensor is mounted in a different spatial direction, there will be a small offset[308] , which must be corrected via a specific CAN message on ID 0x680[309] . The retaining pins or screws may have a maximum diameter of 5.5 mm. We recommend a tightening torque of 2.3 Nm.

Use in very humid gas / risk of condensate formation

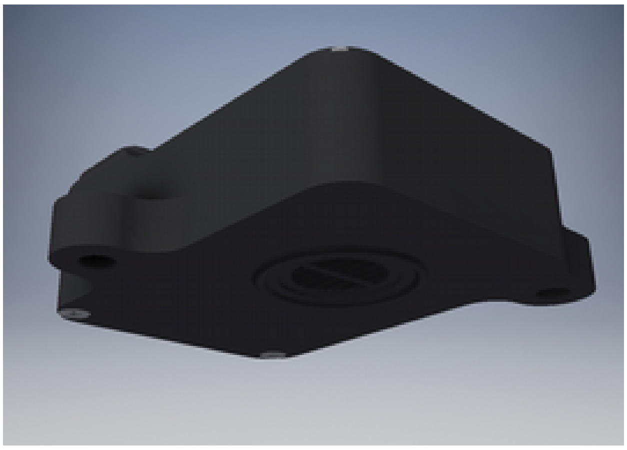
When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The sensor is fitted with a ribbed plug as a protective measure against small amounts of splash water. It must be ensured that the sensor is installed in such a way that this plug functions properly if an installation with a gas flowing past is used.

306 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar

307 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber

308 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.

309 See CAN Matrix Message Layout



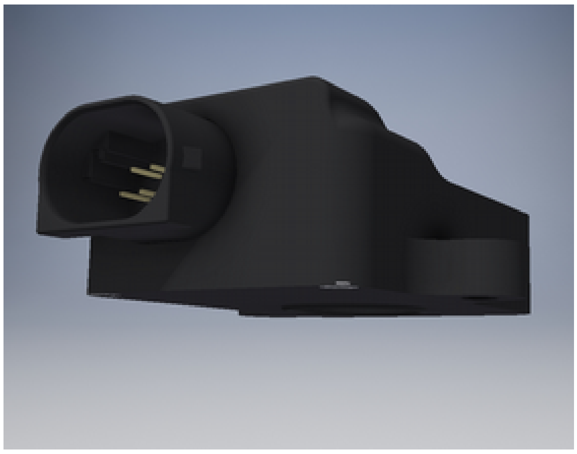


Figure 1b: H_2sensor system NEO1005 from below

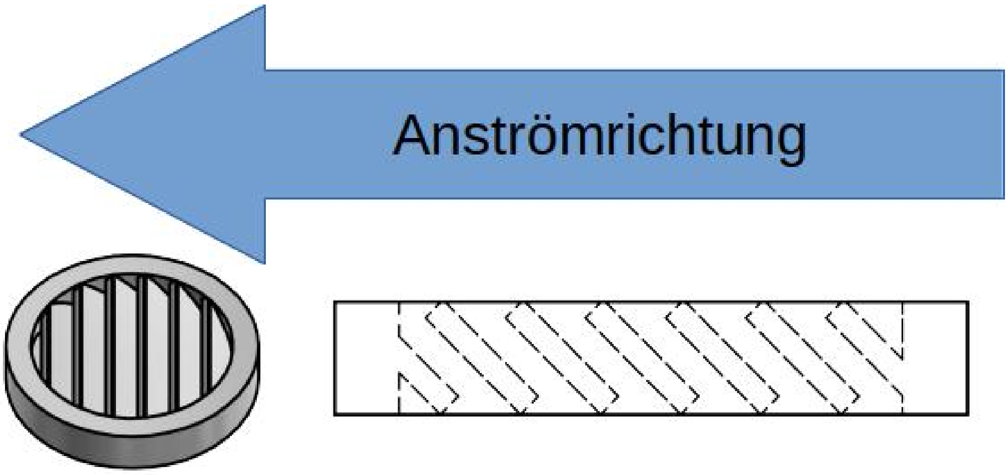


Figure 2a: Fitting ribbed plugs against the direction of flow

Hole pattern:

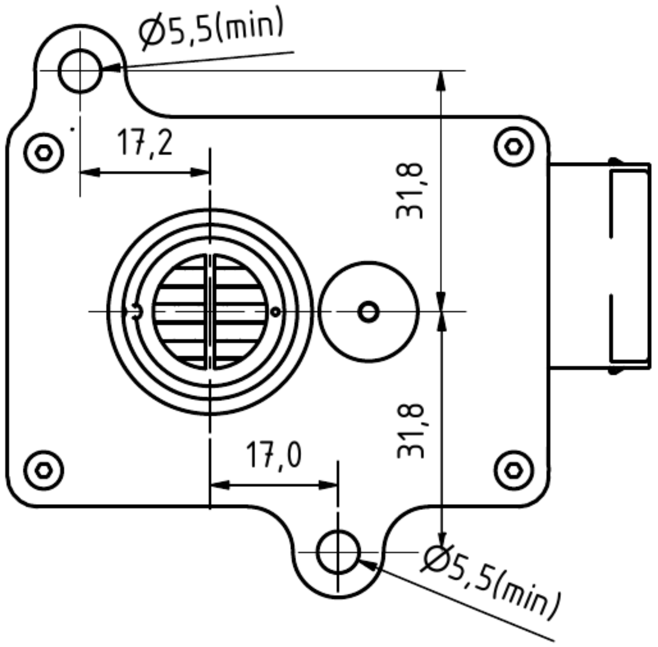


Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

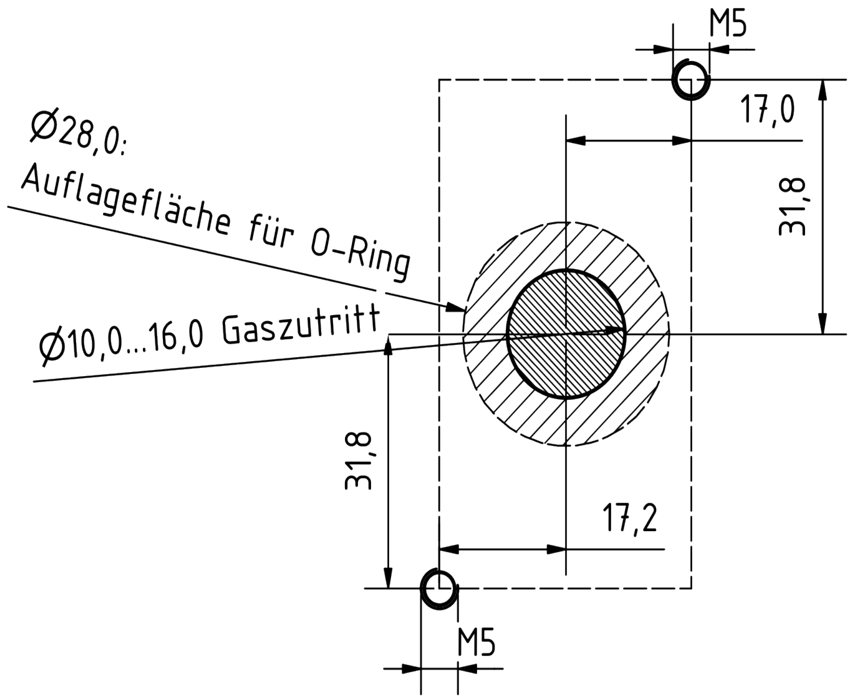
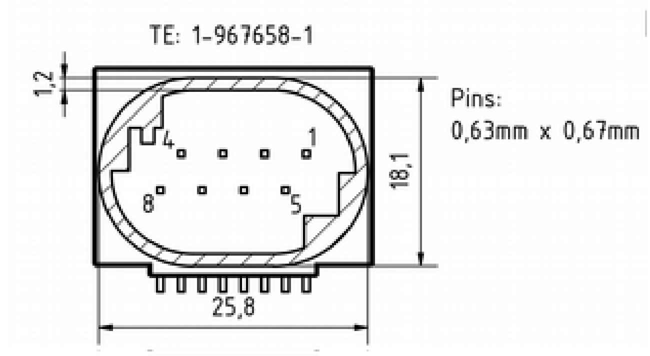


Figure 3b: Drilling template

	**PIN assignment** Pin 1: 9...+30V DC (< 2.4W) Pin 2: 0V DC (GND) Pin 3: CAN-High Pin 4: CAN-Low Pin 5: CAN-High loop-through Pin 6: CAN-Low loop through Pin 7: NC Pin 8: NC
8-pole housing socket: TE Connectivity MQS 1-967658-1	

Information on hydrogen ignition by the NEO1005 from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

A heating element is used in the H_2sensor, which is heated with 5V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the sensor (a Zener diode prevents operating voltages > 15 V). At 32 V, the heating element burnt out and still did not cause the explosive stoichiometric gas mixture to explode. In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavern. The sample gas must diffuse through a membrane.

Catalytic materials are not installed in the H_2sensor, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

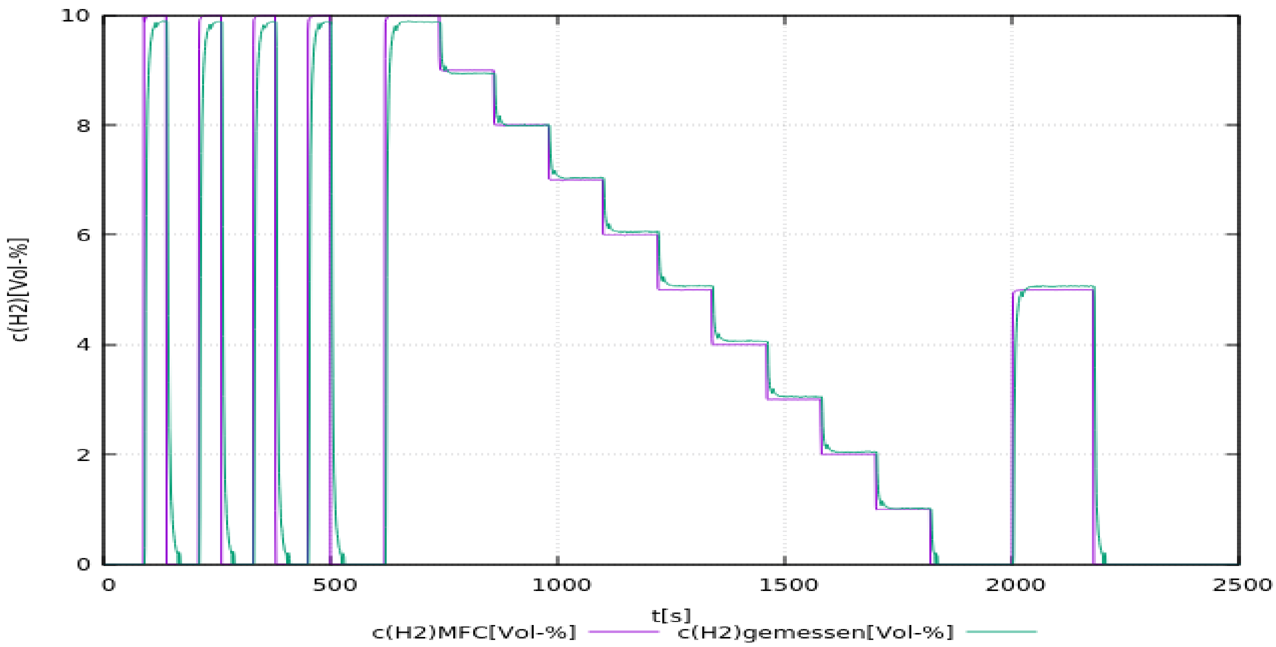


Figure 5a: Test of a NEO1010 sensor system up to 10 vol.-% H_2in 13 vol.-% O_2. Measured with a total flow of 2,000 sccm.

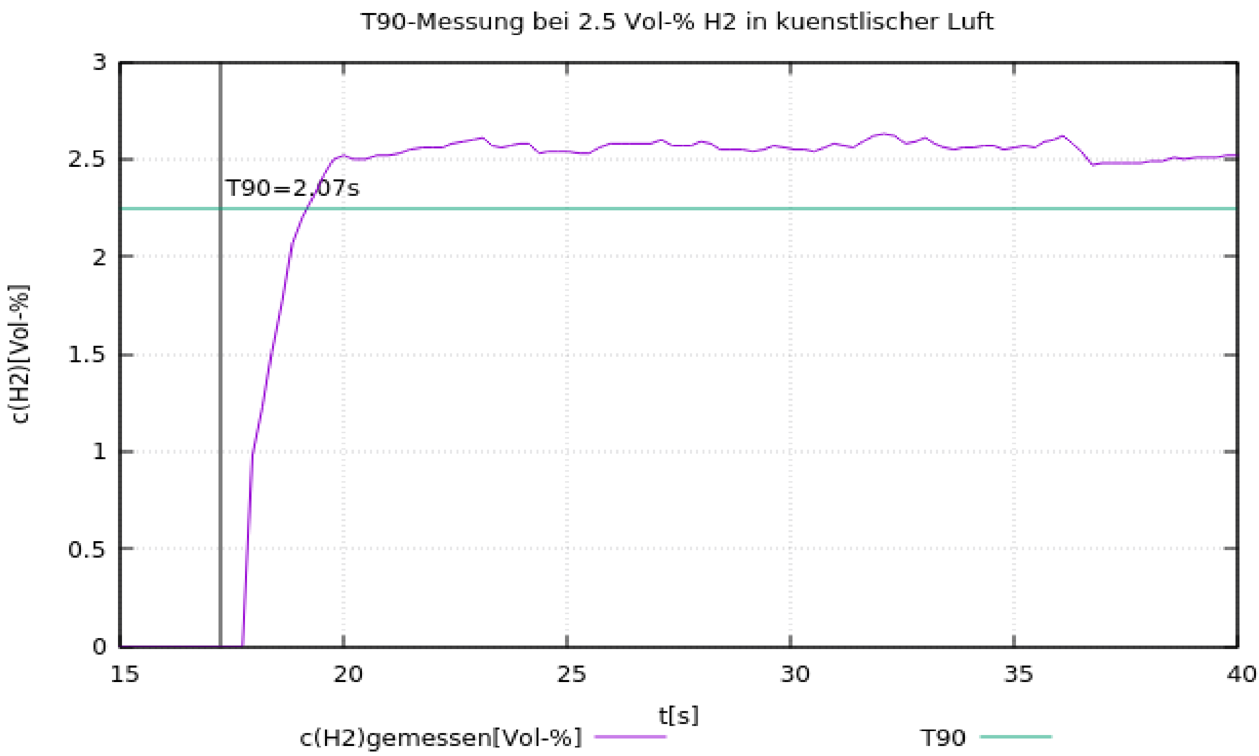


Figure 5b: t_{90}time determination with a NEO1005 sensor system by switching from 0 vol.-% $H_2$to 2.5 vol.-% H_2. Measured with a total flow of 4,000 sccm.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. However, the sensors can be ordered with 120 Ohm termination.
The first CAN message is delivered 5s after system start. It is possible for the sensor to send a predefined message on a desired ID at a certain hydrogen concentration (CAN wake-up). This could be used to wake up other devices in the network from sleep mode.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	**CAN-ID 2**
NEO1005A (0-5 vol.-% H_2)	160 & 600	165 & 605
Scheduling	-	-
BMW part number	4A1F701	tbd
NEO article number	100268	tbd

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment. must be made. This is permanent and affects all outgoing H2 signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and with the correct carrier gas (air). [310]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[311]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To change the ID on which the NEO1005A transmits, a CAN message can be sent:
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address

and

0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

310 Details can be found in the operating instructions under chapter: "Maintenance and service"
311 0xYY describes a measure for the set zero point adjustment

CAN Matrix Message Layout (CAN 2.0A):
The corresponding DBC file is available at the following link:
https://neoxid-cloud.de/H2-Sensor_NEO11XX_V160-BMW.dbc.zip

1st CAN message dec155:
Msg 1 (bit 56-63): Sensor status [a.u.]
Msg 2 (bit 48-55): Relative humidity [%]
Msg 3 (bit 40-47): Temperature [°C]
Msg 4 (bit 28-39): Pressure [mbar a]
Msg 5 (bit 16-27): H_2concentration [0-100% FS]
Msg 6 (bit 12-15): CHL
Msg 7 (Bit 8-11): ALV
Msg 8 (Bit 0-7): CRC

2nd CAN message dec595:
Msg 1 (bit 56-63): Empty
Msg 2 (bit 48-55): ERR_ResetCounter
Msg 3 (Bit 32-47): ERR_InternalError_Detail
Msg 4 (bit 28-29): ERR_OverUndervoltage
Msg 5 (bit 26-27): ERR_Overtemperature
Msg 6 (Bit 24-25): ERR_InternalError
Msg 7 (bit 16-23): Voltage [V]
Msg 8 (bit 12-15): CHL
Msg 9 (Bit 8-11): ALV
Msg 10 (Bit 0-7): CRC

Further CAN commands (CAN2.0A):

Adjust baud rate:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Zero point adjustment:
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

FAQ:

The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Data sheet hydrogen concentration sensor NEO1100R recirculation sensor radial sealing, V16.0

Product description:

Sensor system for measuring the hydrogen concentration in nitrogen with temperature-, pressure- and humidity-compensated signal evaluation for automotive applications. Applicable in the range: 0.6 - 6 bar a, 0 - 100% r.h. (non-condensing) and -40°C - 85°C. A mathematical prediction algorithm ensures very short on and off times.

Properties:

- Measurements in the range of 0-100 vol.-% H_2
- Carrier gases Nitrogen
- Encrypted CAN communication on demand
- Measuring signal independent of pressure, temperature and humidity
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Signal output via CAN 2.0A
- Connectors and contacts for crimping are included
- Factory calibrated and ready for immediate use

Figure 1: H_2sensor system NEO1100R series

Sensor system characteristics:

Supply voltage: 9 - 32V DC

Energy consumption: < 2,4 W

Possible H_2sensitivity: 0 - 100 % by volume H_2

Accuracy: ± 1.5 % by volume H_2

Detection limit: < 0.5 % by volume H_2

Response time t_{90}: < 5 s

Decay time t_{10}: < 5 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[312]

Media temperature: - 40°C - 85°C/105°C[313]

Ambient temperature: - 40°C - 85°C/105°C[2]

Pressure range: 0.5 - 6 bar absolute

Burst pressure: > 8 bar absolute

Humidity: 0 - 100 % r.h. (non-condensing)

Carrier gas: Nitrogen

Cross-sensitivities: Helium, tbd

CAN signal: CAN 2.0A (125, 250, 500, 1000 kbit/s) on page 13

Output/measurement interval: 100 ms / 10 Hz

Resolution: 250 ppm

Dimensions: 85 x 73 x 29 mm³,

Material: Base plate: 1.4404, cap: PET (black)

Leakage rate: < 1.0 - $10^{(-)\,(3)}$mbar l / s [314]

IP code: IP6K7

Weight: 275 g

312 The system is designed for continuous operation
313 105°C are not suitable for continuous operation
314 Measured with 100% H_2, 6 bar absolute, room temperature

ASIL: -

ATEX: -

Service life: IP6K7 enclosure qualified with an expected Service life of 5 years.[315] The system has been tested with 100,000 switch-on and switch-off cycles.

Long-term stability: Deviation <0.1 vol.-% in the first 5,000 h Operating time

Maintenance interval : We recommend checking the H_2sensor every 6 months. check.

Measuring behaviour: The gas to be tested may have a maximum have a maximum velocity of 25m/s. In addition, a laminar flow is recommended. If the specification differs specification, the sensor must be tested for tested for functionality.

Connection: Connector plug and 8x contacts for crimping are included. A cable can also be manufactured on request can also be manufactured.

RoHS compliant: Yes https://neoxid-cloud.de/Konformitaetserklaerung-RoHS_DE_EN_V02_scan.pdf

EMC compliant: Yes https://neoxid-cloud.de/EMV_NEO1XXX_neoxid-group.pdf

Customs tariff number: 90271010[316]

COO: Germany / NRW

EC-79/2009 Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

Accuracy of the measured values:[317]

315 Measuring components are purely inorganic and are not consumed during measurement

316 This product is not assigned to an ECCN. It therefore belongs to the EAR99 classification and can be traded freely.

317 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar

Size	Accuracy
Hydrogen concentration	*± 1.5 % by volume H_2*
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[318]	*± 0,3 °C*
Pressure	*± 50 mbar, T > 65 °C± 100 mbar*

Table16 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO1XXX-V08_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Assembly:
The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO1100R-Edelstahl-radialdichtend.zip

During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system as shown in Figure 1a. If the sensor is mounted in a different spatial direction, there will be a small offset[319] , which must be corrected via a specific CAN message on ID 0x680[320] . The retaining pins or screws may have a maximum diameter of 5.5 mm. We recommend a tightening torque of 5 Nm.

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The sensor is fitted with a ribbed plug as a protective measure against small amounts of splash water. It must be ensured that the sensor is installed in such a way that this plug functions properly if an installation with a gas flowing past is used.

318 The temperature in the measuring chamber is always measured too high as the sensor elements heat up the measuring chamber
319 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.
320 See CAN Matrix Message Layout

Hole pattern:

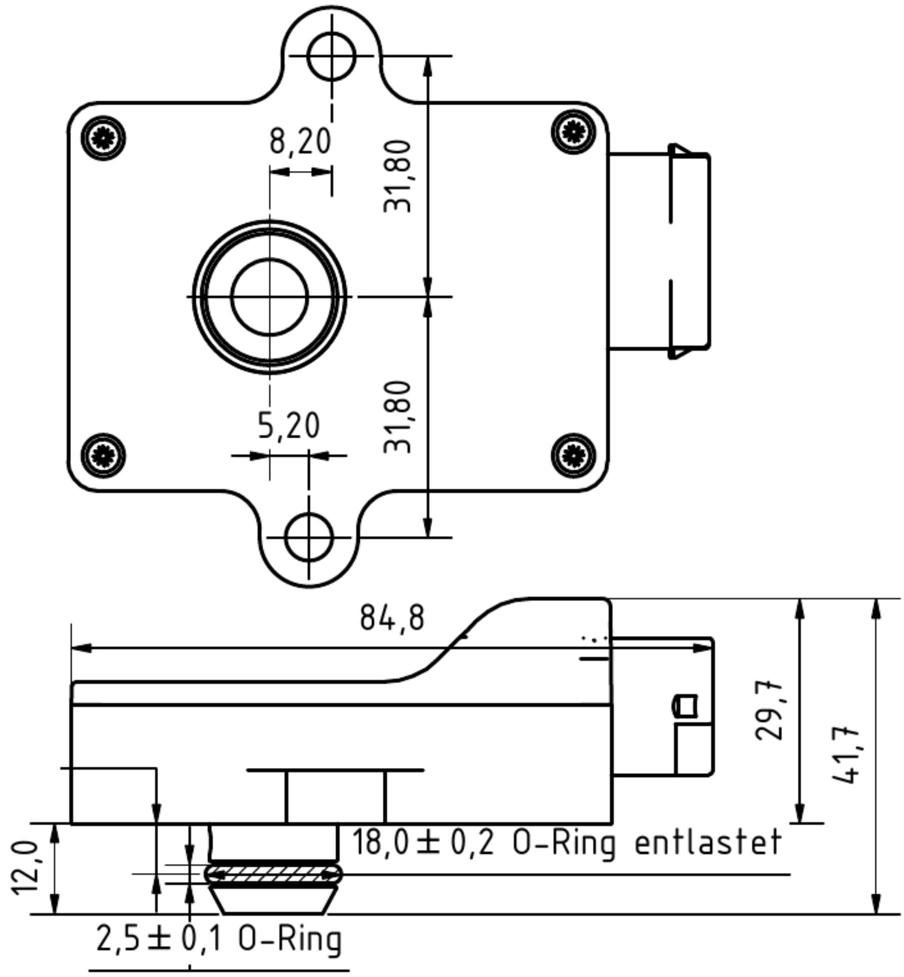


Figure 3a: Hole pattern of the H_2sensor system from below and from the side

Drilling template:

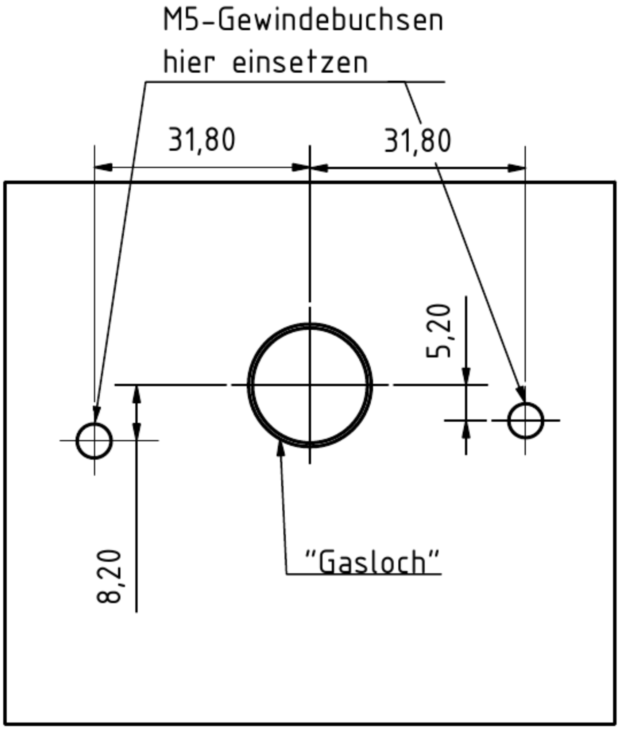
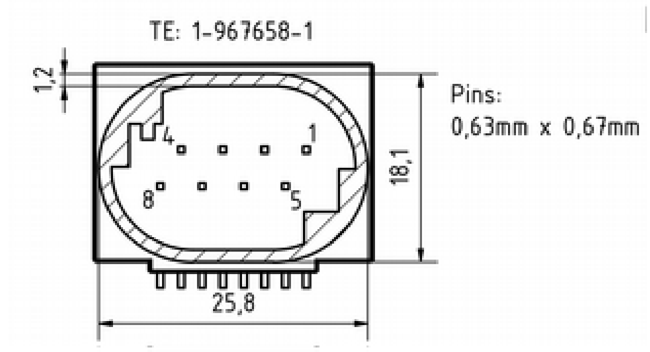


Figure 3b: Drilling template

	**PIN assignment** Pin 1: 9...+30V DC (min.: 2.4W) Pin 2: 0V DC (GND) Pin 3: CAN-High Pin 4: CAN-Low Pin 5: CAN-High loop-through Pin 6: CAN-Low loop through Pin 7: NC Pin 8: NC
8-pole housing socket: TE Connectivity MQS 1-967658-1	

Information on hydrogen ignition by the NEO1100R series from neo hydrogen

sensors GmbH in accordance with J2578 SAE international:

A heating element is used in the H_2sensor, which is heated with 5V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the sensor (a Zener diode prevents operating voltages > 15 V). At 32 V, the heating element burnt out and still did not cause the explosive stoichiometric gas mixture to explode. In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavern. The sample gas must diffuse through a membrane.

Catalytic materials are not installed in the H_2sensor, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard.
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN ID
NEO1100A (0-100 vol.-% H_2)	dec200 & dec640 or 0xC8 & 0x280

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to make an adjustment. This is permanent and affects all outgoing H_2signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (nitrogen). [321]
The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[322]
*corresponds to the serial number of the individual sensor system.

CAN Matrix Message Layout (CAN 2.0A):
The corresponding DBC file is available at the following link:
https://neoxid-cloud.de/H2-Sensor_NEO11XX_V160-BMW.dbc.zip

1st CAN message dec200, 0xC8:
Msg 1 (bit 56-63): Sensor status [a.u.]
Msg 2 (bit 48-55): Relative humidity [%]
Msg 3 (bit 40-47): Temperature [°C]
Msg 4 (bit 28-39): Pressure [mbar a]
Msg 5 (bit 16-27): H_2concentration [0-100% FS]
Msg 6 (bit 12-15): CHL
Msg 7 (Bit 8-11): ALV
Msg 8 (Bit 0-7): CRC - SAE J1850 ZERO

2nd CAN message dec640, 0x280:
Msg 1 (bit 56-63): Empty
Msg 2 (bit 48-55): ERR_ResetCounter
Msg 3 (Bit 32-47): ERR_InternalError_Detail
Msg 4 (bit 28-29): ERR_OverUndervoltage
Msg 5 (bit 26-27): ERR_Overtemperature
Msg 6 (Bit 24-25): ERR_InternalError
Msg 7 (bit 16-23): Voltage [V]
Msg 8 (bit 12-15): CHL
Msg 9 (Bit 8-11): ALV
Msg 10 (Bit 0-7): CRC- SAE J1850 ZERO

321 Details can be found in the operating instructions under chapter: "Maintenance and service"
322 0xYY describes a measure for the set zero point adjustment

Further CAN commands (CAN2.0A):

Zero point adjustment:
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Data sheet hydrogen concentration sensor NEO1100R recirculation sensor, version 16.0

Product description:

Sensor system for measuring the hydrogen concentration in nitrogen with temperature-, pressure- and humidity-compensated signal evaluation for automotive applications. Applicable in the range: 0.6 - 6 bar a, 0 - 100% r.h. (non-condensing) and -40°C - 85°C. A mathematical prediction algorithm ensures very short on and off times.

Properties:

- Measurements in the range of 0-100 vol.-% H_2
- Carrier gases Nitrogen
- Encrypted CAN communication on demand
- Measuring signal independent of pressure, temperature and humidity
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Signal output via CAN 2.0A
- Connectors and contacts for crimping are included
- Factory calibrated and ready for immediate use

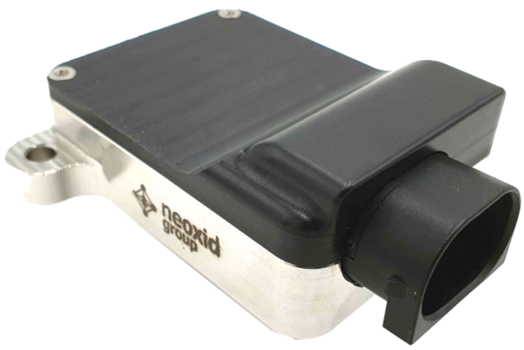


Figure 1: H_2sensor system NEO1100R series

Sensor system characteristics:

Supply voltage:	9 - 32V DC
Energy consumption:	< 2,4 W
Possible H_2sensitivity:	0 - 100 % by volume H_2
Accuracy:	± 1.5 % by volume H_2
Detection limit:	< 0.5 % by volume H_2
Response time t_{90}:	< 5 s
Decay time t_{10}:	< 5 s
Start-up time after cold start:	< 5 s until the first message < 70 s until quantification of the H_2concentration[323]
Media temperature:	- 40°C - 85°C/105°C[324]
Ambient temperature:	- 40°C - 85°C/105°C[2]
Pressure range:	0.5 - 6 bar absolute
Burst pressure:	> 8 bar absolute
Humidity:	0 - 100 % r.h. (non-condensing)
Carrier gas:	Nitrogen
Cross-sensitivities:	Helium, tbd
CAN signal:	CAN 2.0A (125, 250, 500, 1000 kbit/s) on page 13
Output/measurement interval:	100 ms / 10 Hz
Resolution:	250 ppm
Dimensions:	85 x 73 x 29 mm³,
Material:	Base plate: 1.4404, cap: PET (black)
Leakage rate:	< 1.0 - $10^{(-)(3)}$mbar l / s [325]
IP code:	IP6K7
Weight:	285 g

323 The system is designed for continuous operation
324 105°C are not suitable for continuous operation
325 Measured with 100% H_2, 6 bar absolute, room temperature

ASIL: -

ATEX: -

Service life: IP6K7 enclosure qualified with an expected Service life of 5 years.[326] The system has been tested with 100,000 switch-on and switch-off cycles.

Long-term stability: Deviation <0.1 vol.-% in the first 5000h Operating time

Maintenance interval : We recommend checking the H_2sensor every 6 months. check.

Measuring behaviour: The gas to be tested may have a maximum have a maximum velocity of 25m/s. In addition, a laminar flow is recommended. If the specification differs specification, the sensor must be tested for tested for functionality.

Connection: Connector plug and 8x contacts for crimping are included. A cable can also be manufactured on request can also be manufactured.

RoHS compliant: Yes https://neoxid-cloud.de/Konformitaetserklaerung-RoHS_DE_EN_V02_scan.pdf

Customs tariff number: 90271010[327]

COO: Germany / NRW

EC-79/2009 Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

Accuracy of the measured values:[328]

326 Measuring components are purely inorganic and are not consumed during measurement

327 This product is not assigned to an ECCN. It therefore belongs to the EAR99 classification and can be traded freely.

328 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar

Size	Accuracy
Hydrogen concentration	*± 2 vol.-% H_2*
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[329]	*± 0,3 °C*
Pressure	*± 50 mbar, T > 65 °C± 100 mbar*

Table17 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO1100-V08_DE_EN.pdf

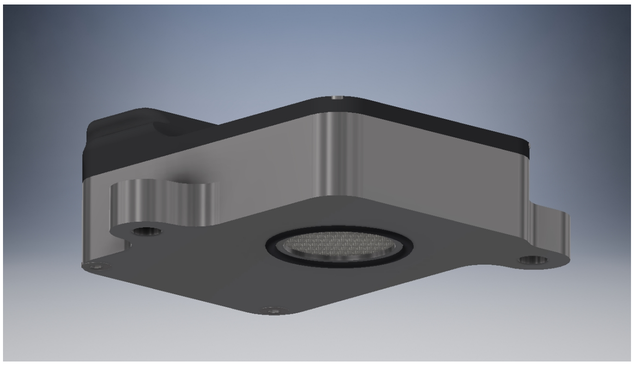
It contains further information on the sensor and on initial commissioning.

Assembly:
The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO1100R-Edelstahl-achsialdichtend.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system as shown in Figure 1a. If the sensor is mounted in a different spatial direction, there will be a small offset[330] , which must be corrected via a specific CAN message on ID 0x680[331] . The retaining pins or screws may have a maximum diameter of 5.5 mm. We recommend a tightening torque of 5 Nm.

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The sensor is fitted with a ribbed plug as a protective measure against small amounts of splash water. It must be ensured that the sensor is installed in such a way that this plug functions properly if an installation with a passing gas is used.

329 The temperature in the measuring chamber is always measured too high as the sensor elements heat up the measuring chamber
330 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.
331 See CAN Matrix Message Layout



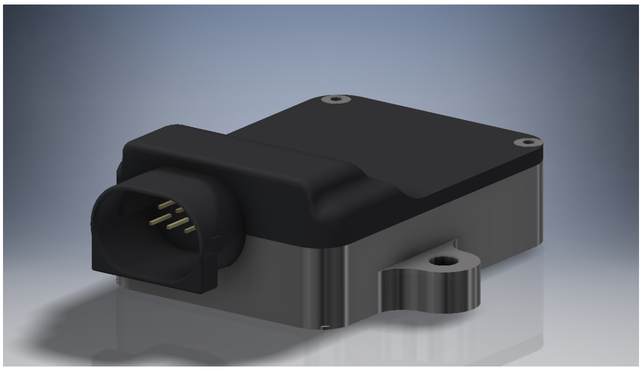


Figure 1b: H_2sensor system NEO1100R series from below

Hole pattern:

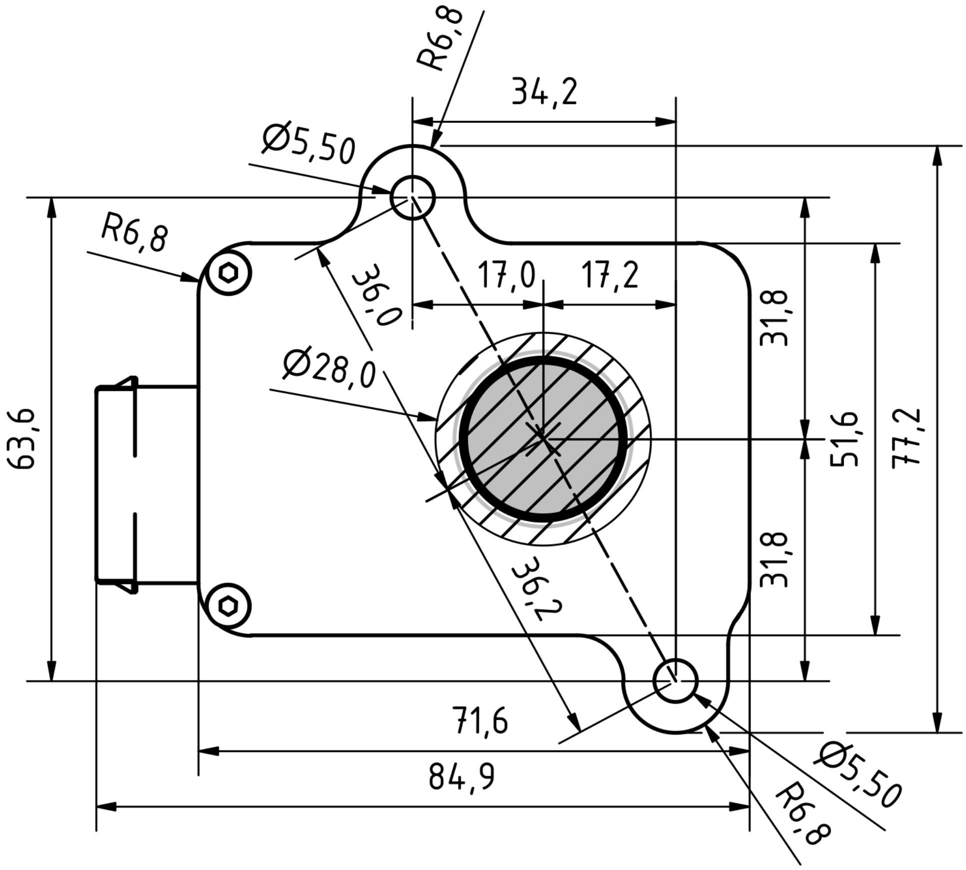


Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

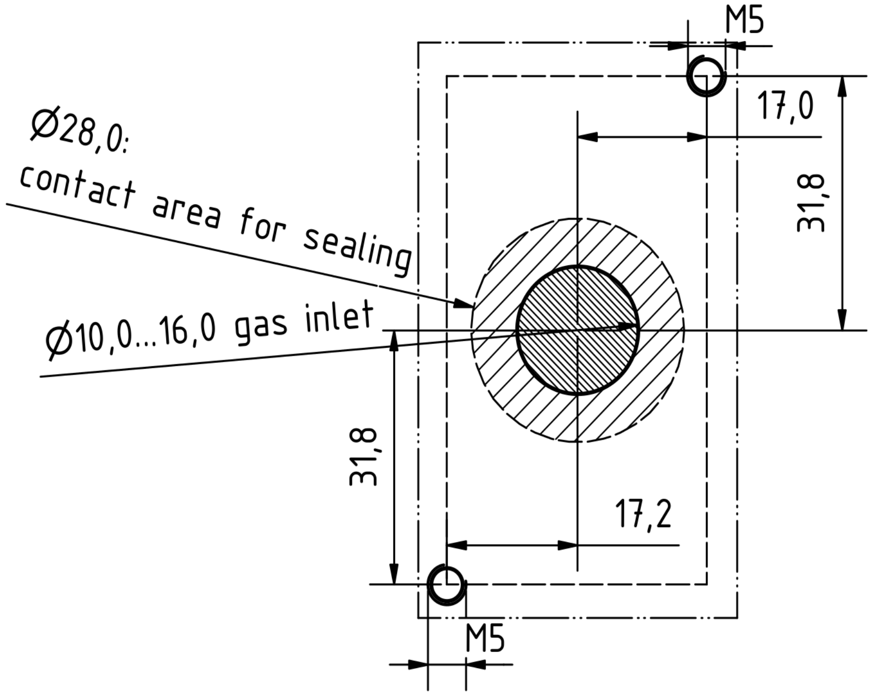
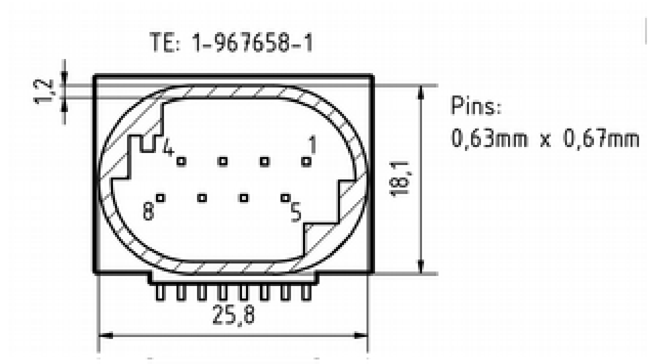


Figure 3b: Drilling template

	**PIN assignment** Pin 1: 9...+30V DC (min.: 2.4W) Pin 2: 0V DC (GND) Pin 3: CAN-High Pin 4: CAN-Low Pin 5: CAN-High loop-through Pin 6: CAN-Low loop through Pin 7: NC Pin 8: NC
8-pole housing socket: TE Connectivity MQS 1-967658-1	

Information on hydrogen ignition by the NEO1100R series from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

A heating element is used in the H_2sensor, which is heated with 5V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the sensor (a Zener diode prevents operating voltages > 15 V). At 32 V, the heating element burnt out and still did not cause the explosive stoichiometric gas mixture to explode. In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm^3 measuring cavern. The sample gas must diffuse through a membrane.

Catalytic materials are not installed in the H_2sensor, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard.
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN ID 1
NEO1100A **(0-100 vol.-% H_2)**	dec200 & dec640 or 0xC8 & 0x280

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to make an adjustment. This is permanent and affects all outgoing H_2signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (nitrogen). [332]
The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[333]
*corresponds to the serial number of the individual sensor system.

CAN Matrix Message Layout (CAN 2.0A):
The corresponding DBC file is available at the following link:
https://neoxid-cloud.de/H2-Sensor_NEO11XX_V160-BMW.dbc.zip

1st CAN message dec200, 0xC8:
Msg 1 (bit 56-63): Sensor status [a.u.]
Msg 2 (bit 48-55): Relative humidity [%]
Msg 3 (bit 40-47): Temperature [°C]
Msg 4 (bit 28-39): Pressure [mbar a]
Msg 5 (bit 16-27): H_2concentration [0-100% FS]
Msg 6 (bit 12-15): CHL
Msg 7 (Bit 8-11): ALV
Msg 8 (Bit 0-7): CRC

2nd CAN message dec640, 0x280:
Msg 1 (bit 56-63): Empty
Msg 2 (bit 48-55): ERR_ResetCounter
Msg 3 (Bit 32-47): ERR_InternalError_Detail
Msg 4 (bit 28-29): ERR_OverUndervoltage
Msg 5 (bit 26-27): ERR_Overtemperature
Msg 6 (Bit 24-25): ERR_InternalError
Msg 7 (bit 16-23): Voltage [V]
Msg 8 (bit 12-15): CHL
Msg 9 (Bit 8-11): ALV
Msg 10 (Bit 0-7): CRC

332 Details can be found in the operating instructions under chapter: "Maintenance and service"
333 0xYY describes a measure for the set zero point adjustment

Further CAN commands (CAN2.0A):

Zero point adjustment:
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Data sheet hydrogen concentration sensor NEO1441-R unit sensor, version 16.0

Product description:

Sensor system for measuring impurities in hydrogen gas with temperature and pressure-compensated signal evaluation for automotive applications. Applicable in the range: 0.6 - 5 bar a and -40°C - 85°C.

Properties:

- Measurements in the range of 0-10,000 ppmv Impurities in the H_2
- Carrier gas hydrogen
- Encrypted CAN communication on demand
- Measuring signal independent of pressure, temperature and humidity
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Signal output via CAN 2.0A
- Connectors and contacts for crimping are included
- Factory calibrated and ready for immediate use

Figure 1: H_2sensor system NEO1441 series

Sensor system characteristics:

Supply voltage: 9 - 32V DC

Energy consumption: < 2,4 W

Possible X-sensitivity: 0 - 10,000 ppmv

Response time t_{90}: < 5 s

Decay time t_{10}: < 5 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[334]

Media temperature: - 40°C - 85°C

Ambient temperature: - 40°C - 85°C

Pressure range: 0.5 - 5 bar absolute

Burst pressure: > 8 bar absolute

Humidity: 0 - 10,000 ppmv

Carrier gas: Hydrogen

Cross sensitivities: He

CAN signal: CAN 2.0A (125, 250, 500, 1000 kbit/s) on page 13

Output/measurement interval: 100 ms / 10 Hz

Resolution: 1 ppm

Dimensions: 85 x 73 x 29 mm³,

Material: Base plate: 1.4404, cap: PET (black)

Leakage rate: $< 1.0 - 10^{(-)\,(3)}$mbar l / s [335]

IP code: IP6K7

Weight: 285 g

ASIL: -

ATEX: -

334 The system is designed for continuous operation
335 Measured with 100% H_2, 6 bar absolute, room temperature

Service life: IP6K7 enclosure qualified with an expected Service life of 5 years.[336] The system has been tested with 100,000 switch-on and switch-off cycles.

Maintenance interval : We recommend checking the H_2sensor every 6 months. check.

Measuring behaviour: The gas to be tested may have a maximum have a maximum velocity of 25m/s. In addition, a laminar flow is recommended. If the specification differs specification, the sensor must be tested for tested for functionality.

Connection: Connector plug and 8x contacts for crimping are included. A cable can also be manufactured on request can also be manufactured.

RoHS compliant: Yes https://neoxid-cloud.de/Konformitaetserklaerung-RoHS_DE_EN_V02_scan.pdf

EMC compliant: Yes https://neoxid-cloud.de/EMV_NEO1XXX_neoxid-group.pdf

Customs tariff number: 90271010[337]

COO: Germany / NRW

EC-79/2009 Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

Operating instructions:

The operating instructions can be downloaded from the following link: https://neoxid-cloud.de/Betriebsanleitung-NEO1100-V08_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Assembly:
The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO1100.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system as shown in Figure 1a. If the sensor is mounted in a different spatial direction, there will be a small offset[338] , which must be corrected via a specific CAN

336 Measuring components are purely inorganic and are not consumed during measurement

337 This product is not assigned to an ECCN. It therefore belongs to the EAR99 classification and can be traded freely.

338 For tilting by ± 40° in all directions, the error is less than ± X ppmv

message on ID 0x680[339] . The retaining pins or screws may have a maximum diameter of 5.5 mm. We recommend a tightening torque of 5 Nm.

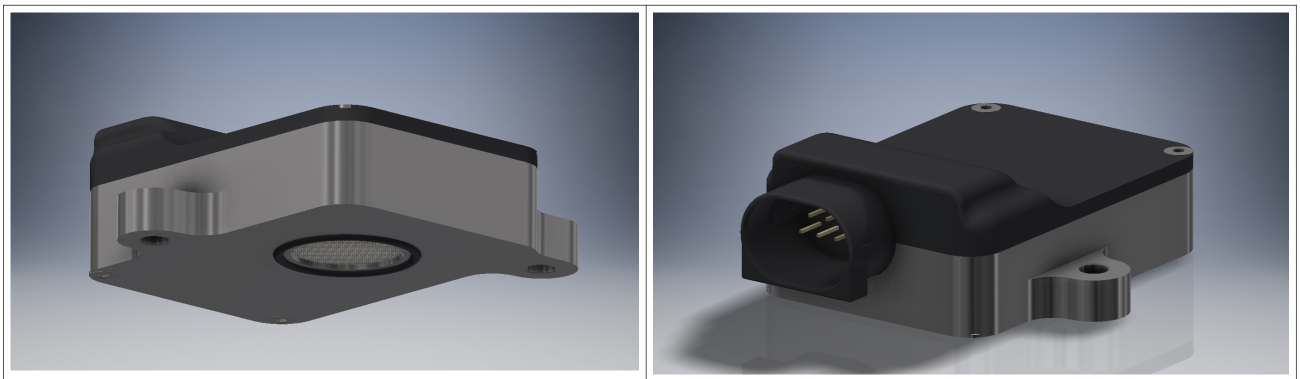


Figure 1b: H_2sensor system NEO1441 series from below

Hole pattern:

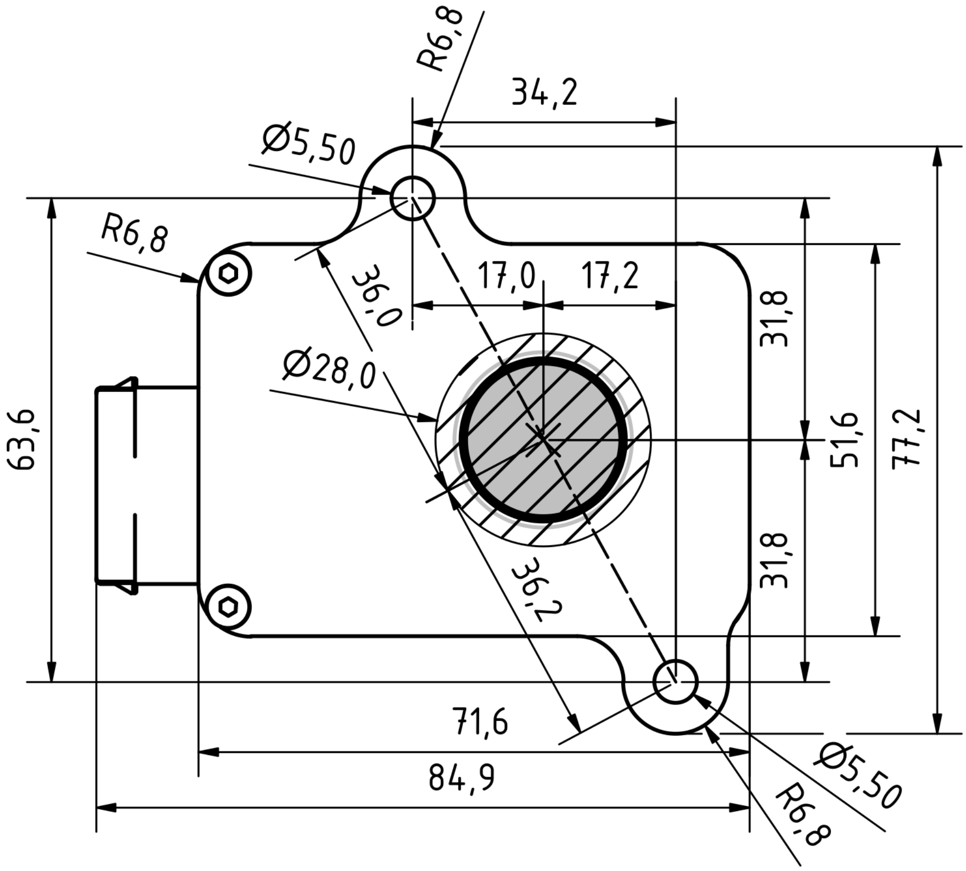


Figure 3a: Hole pattern of the H_2sensor system from below

339 See CAN Matrix Message Layout

Drilling template:

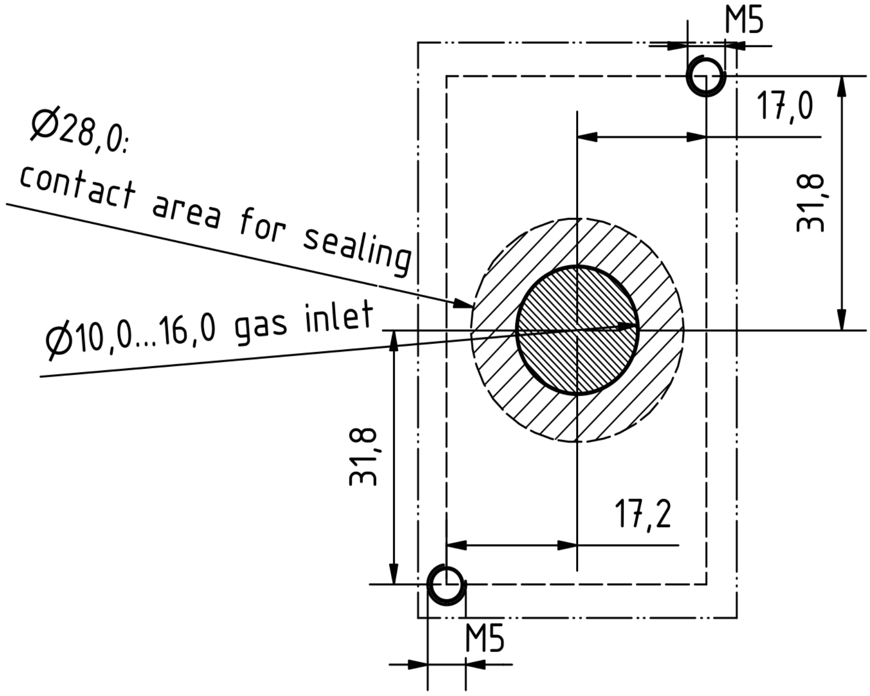
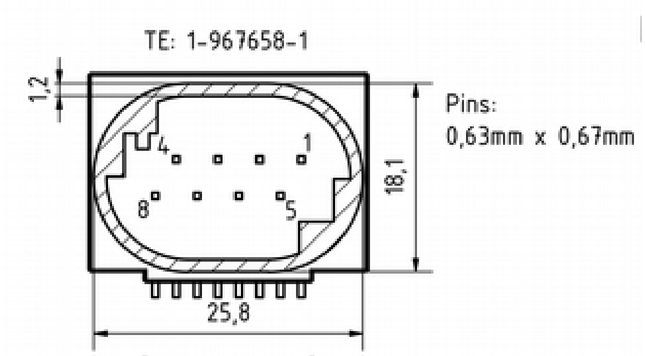


Figure 3b: Drilling template

<table>
<tr><td>
</td><td>

PIN assignment

Pin 1: 9...+30V DC (min.: 2.4W)
Pin 2: 0V DC (GND)
Pin 3: CAN-High
Pin 4: CAN-Low
Pin 5: CAN-High loop-through
Pin 6: CAN-Low loop through
Pin 7: NC
Pin 8: NC</td></tr>
<tr><td colspan="2">8-pole housing socket:
TE Connectivity MQS 1-967658-1</td></tr>
</table>

Information on hydrogen ignition by the NEO1441 series from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

A heating element is used in the H_2sensor, which is heated with 5V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the sensor (a Zener diode prevents operating voltages > 15 V). At 32 V, the heating element burnt out and still did not cause the explosive stoichiometric gas mixture to explode. In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavern. The sample gas must diffuse through a membrane.

Catalytic materials are not installed in the H_2sensor, so there is no risk of spontaneous combustion.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard.
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1
NEO1441A **(0-100 vol.-% H_2)**	dec200 & dec640 or 0xC8 & 0x280

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to make an adjustment. This is permanent and affects all outgoing H_2signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (nitrogen). [340]
The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[341]
*corresponds to the serial number of the individual sensor system.

CAN Matrix Message Layout (CAN 2.0A):
The corresponding DBC file is available at the following link:
https://neoxid-cloud.de/H2-Sensor_NEO1441_V156.dbc.zip

1st CAN message dec180, 0xB4:
Msg 0(Bit 0-15): Impurity concentration [ppmv]: c(X) = Msg0
Msg 1(bit 16-31): Water vapour concentration [ppmv]: c($H_{(2)}$ O) = Msg1
Msg 2(bit 32-47): Pressure [mbar a]: p = Msg2
Msg 3(Bit 48-55): Temperature [°C]: T = (Msg3-60)
Temperature of the measuring chamber, usually higher than in the medium[342]
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message dec181, 0xB5:
Msg 0(Bit 0-15): Impurity concentration raw [ppmv]: c(X) = Msg0
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of X the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 5(Bit 56-63): Continuous message counter

340 Details can be found in the operating instructions under chapter: "Maintenance and service"
341 0xYY describes a measure for the set zero point adjustment
342 temperature deviates significantly from the gas temperature, especially when the gas is stationary. A direct correlation with the outside temperature is not possible.

Hydrogen concentration sensor data sheet

NEOGuardian, Version 15.6

Product description:

Sensor and warning system for monitoring the hydrogen concentration in air, with temperature-, pressure- and humidity-compensated signal evaluation for automotive or industrial applications. Applicable in ambient pressure, 0 - 100% r.h. (non-condensing) and -40°C - 85°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Warning signal at 40% LEL (others on customer request)
- Room monitoring of H_2 in air
- Measuring signal independent of pressure, temperature and humidity
- Signal output optionally via CAN 2.0
- The gas concentration is not changed by the measurement.
- Oxygen is not required for the measurement.
- Sensor and signalling device suitable for wall mounting.
- Factory calibrated and ready for immediate use

Figure 1: Complete set of sensor and signalling device with connection cable and power supply unit

*...go to English version*

Sensor system characteristics:

Power supply: 12V 0.5 Ampere, power supply unit included in the scope of delivery

Energy consumption: < 2,8 W

Warning signal at: 40% LEL, deviating on customer request

Volume of the warning signal: 105 dB

Accuracy: ± 0.3 vol.-% H_2

Detection limit: < 0.3 vol.-% H_2

Response time t_{90}: < 3 s[1]

Decay time t_{10}: < 3 s[1]

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the H_2concentration[343]

Media temperature: - 40°C - 85°C

Ambient temperature: - 40°C - 85°C
The cold start at -40°C was tested.

Pressure range: Ambient pressure

Humidity: 0 - 100 % r.h. (non-condensing)[344]

Carrier gas: Air

Cross-sensitivities: Helium, tbd

Signal :[345] optional CAN 2.0A / B (500kbit/s or 250kbit/s)
on page 25

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm via CAN bus

343 The system is designed for continuous operation
344 In particular, splash water must be kept away from the sensor opening
345 Signals are described in the "Explanation of signals" section

Sensor housing:	Size: 95 x 83 x 50 mm³, housing cover made of EN AW 6060, base plate made of 316L or 1.4404
IP Code Sensor:	IP6K7
Sensor weight:	< 570 g
Housing signalling device:	Size: 89 x 80 x 47 mm³, housing made of ABS
IP code signalling device:	IP66
Signal transmitter weight:	300 g
Long-term stability:	Deviation <0.1 vol.-% in the first 5000h Operating time
SIL:	-
ATEX:	-
Service life:	IP6K7 enclosure qualified with an expected Service life of 5 years[346] . The system was tested with 100,000 switch-on and switch-off cycles.
Maintenance interval : 6 months.	We recommend checking the H_2sensor every check.
Connection cable: requirements; more detailed	enclosed, length 10m or according to customer information on page 123
RoHS compliant:	Yes
Customs tariff number:	90271010
COO:	Germany / NRW
EC-79/2009	Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

346 Measuring components are purely inorganic and are not consumed during measurement

Accuracy of the measured values:[347]

Size	Accuracy
Hydrogen concentration	± 0.3 vol.-% H_2[348] or ± 2 vol.-% H_2[349]
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[350]	± 0,3 °C
Pressure	± 20 mbar

Table18 : Statistical errors for individual measured variables

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEOGuardian-V08_DE_EN.pdf

It contains further information on the sensor and on initial commissioning.

Scope of delivery:

In addition to the sensor unit and signalling device, a suitable power supply unit is supplied, as well as a connection cable for the sensor and signalling device.

Mounting the sensor:

The stepfile and a 2D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO9XX.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend using the sensor system. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a spatial direction other than horizontally, a small offset[351] occurs, which must be corrected via a specific CAN message on ID 0x680 (zero point adjustment, see page). 14

347 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar
348 For 0-5 vol.-% and 0-10 vol.-% H_2systems
349 For 100 vol.-% H_2systems
350 The temperature in the measuring chamber is always measured too high as the sensor elements heat up the measuring chamber
351 When tilted by± 40° in all directions, the error is less than± 0.05 vol.-%.

Figure 2a: H_2sensor system with adapter

Hole pattern:

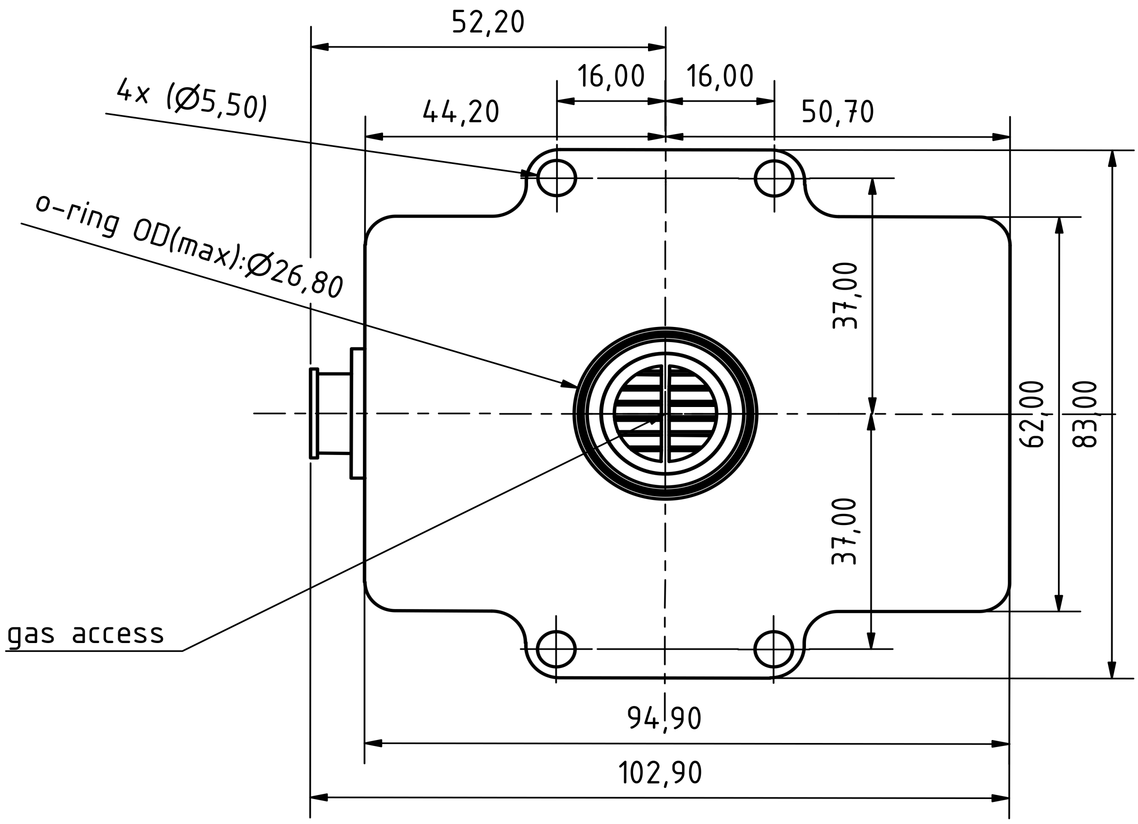


Figure 3a: Hole pattern of the H_2sensor system from below, adapter has identical screw holes

Figure 3c: Connecting cable in 30m version

Information on hydrogen ignition by the NEOGuardian from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

The NEOGuardian H_2sensor uses a heating element that is heated with 5 V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the NEOGuardian (a Zener diode prevents the operating voltage from being too high). In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm³ measuring cavity.

Catalytic materials are not installed in the NEOGuardian H_2sensor, so that spontaneous combustion and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the NEOGuardian H_2sensors. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Resolution and response behaviour:

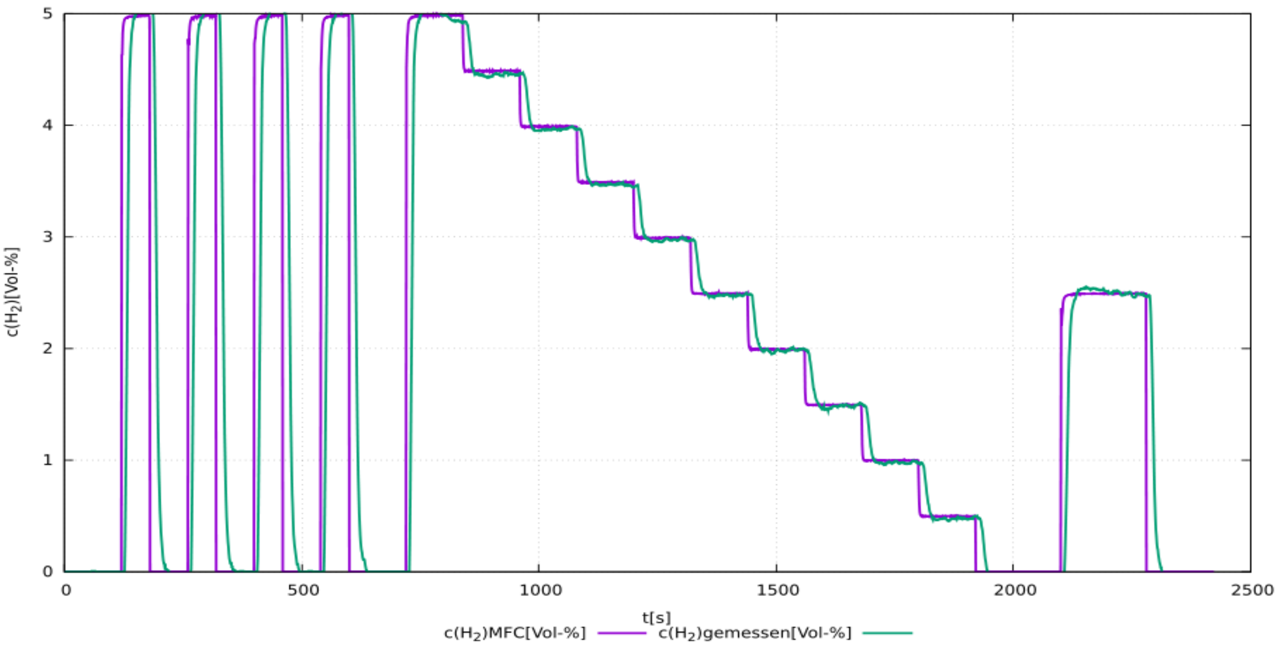


Figure 4a: Test of a sensor system NEO974 0 - 5 vol.-% H_2in 21 vol.-% O_2. Measured with a total flow of 1,000 sccm.

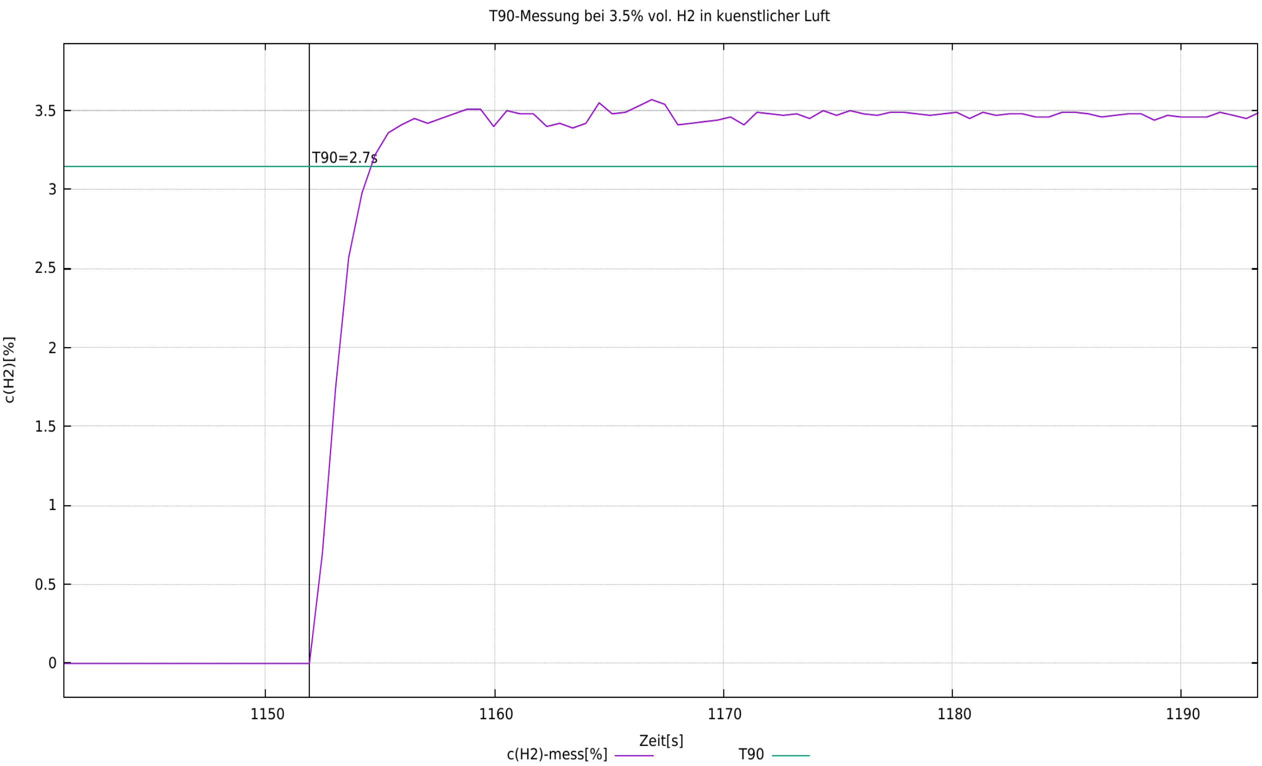


Figure 4b: t_{90}time determination with a sensor system by switching from 0 vol.-% $H_2$to 3.5 vol.-% H_2. Measured with a total flow of 1,000 sccm.

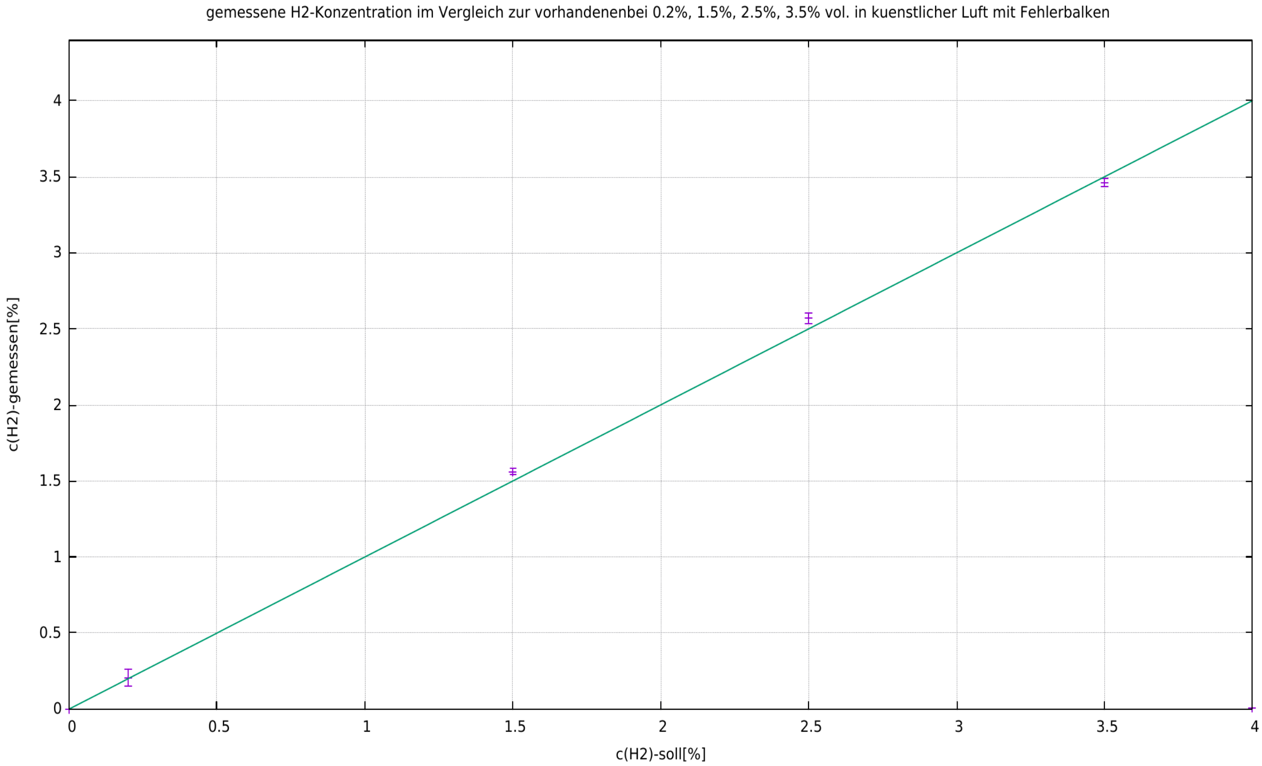


Figure 4c: Comparative measurement of the set hydrogen concentration and the measured hydrogen concentration with an error bar of three standard deviations of the measurement signal.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Explanations on starting the sensor and using the sensor at cold temperatures

The heating phase of the sensor takes up to 70s. This time depends on how warm the environment is, how long the sensor has been switched off and how much heat is dissipated from the sensor into the environment. However, the sensor recognises when it has finished heating up and then simply starts regular operation. The user can recognise this from the status byte. This indicates when the heating phase is over (status not equal to 8).
If the sensor is operated in a cold environment <0°C, there are a few things to consider. A cold start at -40°C is unproblematic and has been tested with the sensor. However, care must be taken to ensure that no ice forms in the sensor or at the sensor opening if an immediate measurement is required within the normal heating phase. A layer of ice on the membrane physically prevents the gas to be measured from entering. This problem can be solved by either drying the system with dry gas after using the sensor in a very humid environment, or by additionally heating the sensor during and before each use.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is optionally sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO974A (0-5 vol.-% H_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319
NEO983A (0-10 vol.-% H_2)	0x320 & 0x321	0x328 & 0x329	0x330 & 0x331	0x338 & 0x339
NEO986A (0-100 vol.-% H_2)	0x340 & 0x341	0x348 & 0x349	0x350 & 0x351	0x358 & 0x359

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to carry out a readjustment.
must be made. This is permanent and affects all outgoing H_2signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To make an adjustment, the system should be free of hydrogen and with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [352]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[353]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
There are two additional cable ends on the supplied cable for setting the CAN ID. These are called Add.1 and Add.2. Both should float for the standard ID. To change the CAN ID, these should then each be connected to GND so that 4 different IDs can be set. The names of the lines can be found in the cable assignment supplied.

Standard ID:	→	ID: 0x300 or 0x320 or 0x340 [354]
CAN-Addr 1 to GND:	→	ID is increased by 0x08
CAN-Addr 2 to GND:	→	ID is increased by 0x10
CAN-Addr 1 and 2 to GND:	→	ID is increased by 0x18

The cable designations can be found in the enclosed cable assignment.

Alternatively, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and

352 Details can be found in the operating instructions under chapter: "Maintenance and service"
353 0xYY describes a measure for the set zero point adjustment
354 0x300 corresponds to NEO974, 0x320 to NEO983 and 0x340 to NEO986 as default ID

0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO974A (0-5 vol.-% H_2)	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359
NEO983A (0-10 vol.-% H_2)	0x0CFF1459 & 0x0CFF1559	0x0CFF1659 & 0x0CFF1759	0x0CFF1859 & 0x0CFF1959	0x0CFF1A59 & 0x0CFF1B59
NEO986A (0-100 vol.-% H_2)	0x0CFF1C59 & 0x0CFF1D59	0x0CFF1E59 & 0x0CFF1F59	0x0CFF2059 & 0x0CFF2159	0x0CFF2259 & 0x0CFF2359

Set CAN ID (CAN2.0B):

There are two additional cable ends on the supplied cable for setting the CAN ID. These are called Add.1 and Add.2. Both should float for the standard ID. To change the CAN ID, these should then be connected to GND so that 4 different IDs can be set. The names of the lines can be found in the enclosed cable assignment.

Standard ID: → ID: 0x0CFF0C59 or 0x0CFF1459 or 0x0CFF1C59
CAN-Addr 1 to GND → ID is increased by 0x200
CAN-Addr 2 to GND: → ID is increased by 0x400
CAN-Addr 1 and 2 on GND: → ID is increased by 0x600

Alternatively, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):

A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make a readjustment. This is permanent and affects all outgoing H2 signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To make an adjustment, the system should be free of hydrogen and flushed with the correct carrier gas (air, oxygen, nitrogen or oxygen-depleted air). [355]

355 Details can be found in the operating instructions under chapter: "Maintenance and service"

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[356]
*corresponds to the serial number of the individual sensor system.

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/H2-Sensor_NEO9XX_V146.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = *(Msg0-20)/100*
Msg 1(Bit 16-31): *Water concentration [vol.-%]: c($H_{(2)\,O}$) = (Msg1-20)/100*
Msg 2(bit 32-47): Pressure [mbar]: *p = Msg2*
Msg 3(Bit 48-55): Temperature [°C]: *T = (Msg3-60)*
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0D59:
Msg 0(Bit 0-15): Hydrogen concentration_RAW[vol.-%]: c(H_2) = *(Msg0-20)/100*
Measurement of the hydrogen content, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $H_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured hydrogen concentration exceeds the 0.5 % by volume limit (c(H_2) from <0.5 % by volume to >= 0.5 % by volume).

The following message is sent:
Msg 0(bit 0-15): Hydrogen concentration [vol.-%]: c(H_2) = *(Msg0-20)/100*
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $H_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

Example for the interpretation of CAN messages:

Hex message from Sensor:
CAN Msg1: CAN ID1 320 00 14 00 CE 03 ED 68 D8
CAN Msg2: CAN ID2 321 00 0A 63 00 50 D 92 CA

Decimal translation:
CAN Msg1: Byte0+1: 20, Byte 2+3: 206, Byte 4+5: 1005 Byte 6: 104, Byte 7: 216
CAN Msg2: Byte0+1: 10, Byte 2: 99, Byte 3: 0, Byte 4+5:1293 Byte 6: 146, Byte 7: 202

356 0xYY describes a measure for the set zero point adjustment

Sensor translation:
CAN Msg1: c(H_2) [vol.-%]: 0, c(H_2O)[vol.-%]: 1.86, p[mbar]: 1005, T[°C]: 44, CRC: 216
CAN Msg2: c(H_2)_raw[vol.-%]: -0.1, raw: 99, status: 0, serial#: 1293, SV: 14.6 Counter: 202

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait
Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

Example:
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Set the baud rate to 500 kbit/s or 250 kbit/s:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H_2in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Initiate maintenance:
0x680 0x00 0x77 0x61 0x72 0x74 0x75 0x6E 0x67

Further CAN commands (CAN2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapter
The NEO160 adapter is recommended for mounting the sensor on a wall or ceiling:
https://neoxid-cloud.de/
Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf

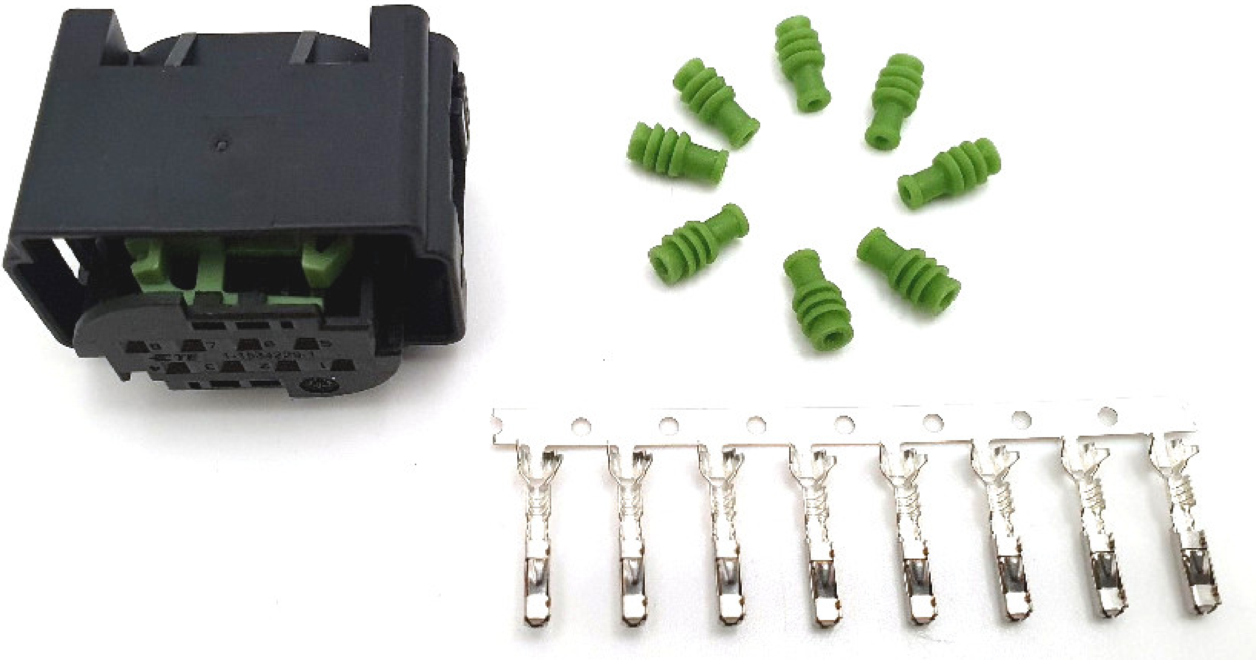
neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

FAQ:

The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Data sheet MQS connector set, version 16.0
Item number 200.496

Consisting of MQS connector, 6 pins and 6 insulators



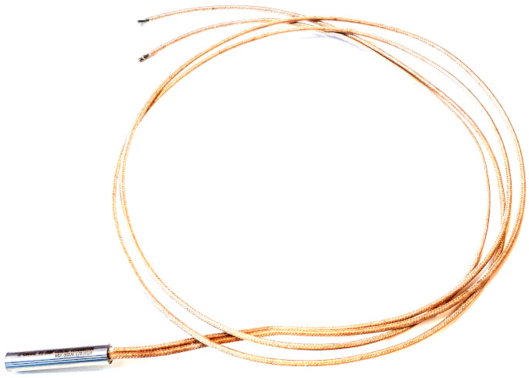
Data sheet NEO203 heating cartridges
Version 15.6

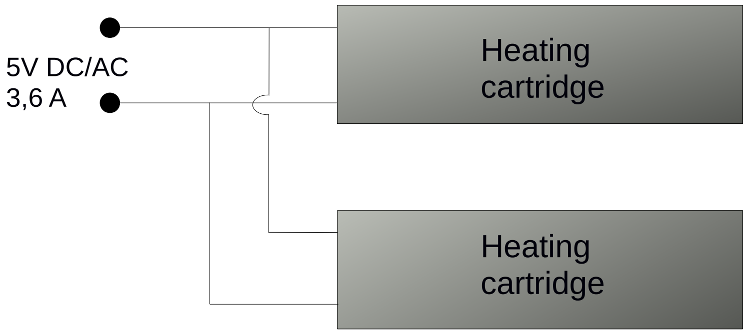
Technical data

Voltage:	5V (DC)
max. power:	8.7W± 10%
Rated current at 5V :[357]	1,8A
Diameter:	8mm -0.02mm to -0.07mm
Bore fit:	H7
Sheath length:	40mm +1% to -3%
Connection cable:	Length: 1000 mm
	Cross-section: 1.75mm²,
AWG13	
Sheath material:	Stainless steel 1.4541
Max. Operating temperature heater:	+600°C, pipe +250°C
	(line 350°C for a short time)
Final inspection:	Unit test according to
EN60335-1	or VDE0721
Leakage current:	< 0.5mA
Weight:	~ 45 g
RoHS compliant:	Yes
Customs tariff number (HS Code):	85168080
COO:	Germany

The resistance-temperature curve of the heating cartridge is not linear and it is not a PTC heater. The resistance of the supply cable is not taken into account in the performance data; the operating voltage must be adjusted according to the cable length.

357 Power for 1 pc. heating cartridge. At 5V, the sensors reach 75 - 85°C, depending on where they are used. The sensor can be destroyed if the heating temperature is too high!





3D CAD file:

https://neoxid-cloud.de/neo203-Heater-8x40.stp.zip

Assembly:

The installation instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung_NEO20X-V160_DE_EN.pdf

The heating cartridge can be used in various adapters (NEO120, NEO130, NEO150 and NEO170) to prevent condensation (including standstill condensation). To do this, 2 cartridges are inserted into the 8 mm fitting provided for this purpose and each is fixed in place with an M4 grub screw. A tightening torque of 1 Nm is recommended. If the cartridges are ordered together with adapters, these are already installed so that no further assembly work is required.

If it is necessary to regulate the cartridge heaters to the temperature of the sensor, ensure that the distance to the dew point temperature or freezing point is at least 15°C.

The mounted H_2sensor may only be pressurised with gas when the desired sensor temperature (usually 85°C) is reached. For rapid heating, the sensor can be heated with a voltage of up to 24V. The delayed heat dissipation to the sensor must be taken into account and the voltage must be reduced at an early stage! The sensor temperature must be monitored continuously. At room temperature, 5V heating voltage is normally sufficient to prevent condensation in the sensor.

Caution: Failure to comply may result in damage to the sensor and heating cartridge!

Data sheet NEO204 heating cartridge
Version 15.6

Technical data

Voltage (maximum): 24V (AC/DC)

max. power: 8.7W± 10%

Rated current at 24V :[358] 0.36A± 10%

Diameter: 8.00 -0.02mm to -0.2mm

Bore fit: 8.00 -0.00mm to +0.01mm

Sheath length: 40mm± 2.0mm

Connection cable :[359] Length: 1000 mm
Cross-section: 1.75mm^2, AWG13

Sheath material: Stainless steel 1.4541

Max. Operating temperature heater: +600°C, cable +250°C
(line 350°C for a short time)

Final inspection: Unit test according to EN60335-1 or VDE0700/0721

Leakage current: <0.5mA

Weight: ~45 g

RoHS compliant: Yes

Customs tariff number: 85168080

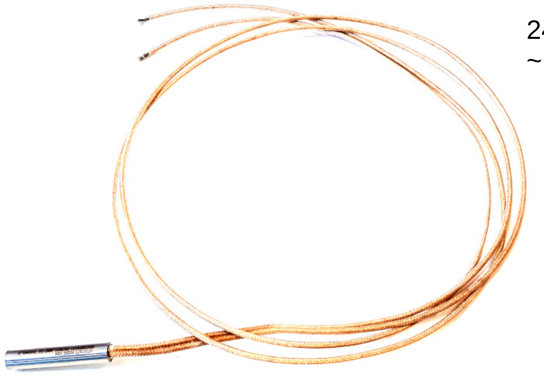
COO: Germany

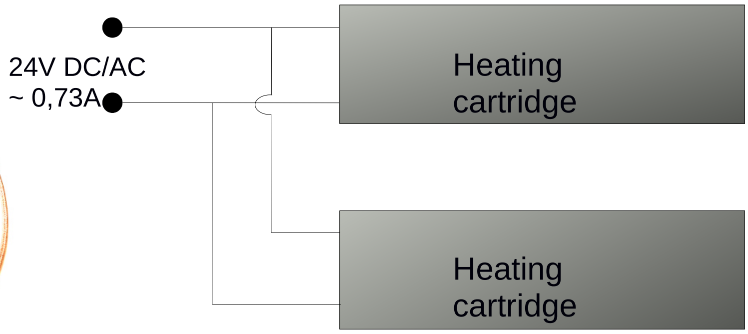
The resistance - temperature curve of the heating cartridge is not linear and it is not a PTC

358 Power for 1 pc. heating cartridge. At 24V, the sensors receive 75 - 85°C, depending on the Place of use. The sensor can be destroyed if the heating temperature is too high!
359 Other lengths optionally available.

heater. The resistance of the supply cable is not included in the performance data.

The operating voltage must be adjusted according to the cable length.





3D CAD file:

https://neoxid-cloud.de/neo203-Heater-8x40.stp.zip

Assembly:

The installation instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung_NEO20X-V160_DE_EN.pdf

The heating cartridge can be used in various adapters (NEO120, NEO130, NEO150 and NEO170). To do this, 2 cartridges are inserted into the 8 mm fitting provided and each fixed in place with an M4 grub screw. A tightening torque of 1 Nm is recommended. If the cartridges are ordered together with adapters, these are already installed so that no further assembly work is required.

The installed H_2sensor may only be pressurised with gas when the desired sensor temperature (usually 85°C) is reached. The temperature in the hydrogen sensor is optionally output via CAN bus. Condensation must not form in the sensor. The sensor temperature must be monitored continuously. At room temperature, sensor temperatures of 75 - 85°C are normally achieved with 24V (8.7W) heating voltage (depending on the sensor variant).

In difficult cases (i.e. hot, humid gas enters a cold sensor after a short gas line), the heating cartridge must be adjusted and possibly regulated. When regulating the temperature of the sensor, ensure that the distance to the dew point temperature or the freezing point is at least 15°C.

Caution: Failure to comply may result in damage to the sensor and heating cartridge!

Data sheet NEO205 heating cartridge
Version 15.6

Technical data

Voltage (maximum): 28V (AC/DC)

max. power: 8.7W± 10%

Rated current at 28V :[360] 0.32A± 10%

Diameter: 8.00 -0.02mm to -0.2mm

Bore fit: 8.00 -0.00mm to +0.01mm

Sheath length: 40mm± 2.0mm

Connection cable :[361] Length: 1000 mm
Cross-section: 1.75mm^2, AWG13

Sheath material: Stainless steel 1.4541

Max. Operating temperature heater: +600°C, cable +250°C (line 350°C for a short time)

Final inspection: Unit test according to EN60335-1 or VDE0700/0721

Leakage current: <0.5mA

Weight: ~45 g

RoHS compliant: Yes

Customs tariff number: 85168080

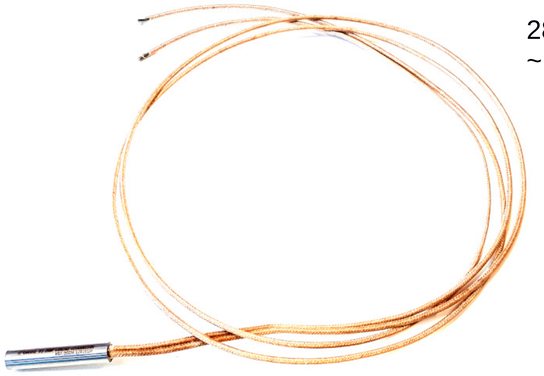
COO: Germany

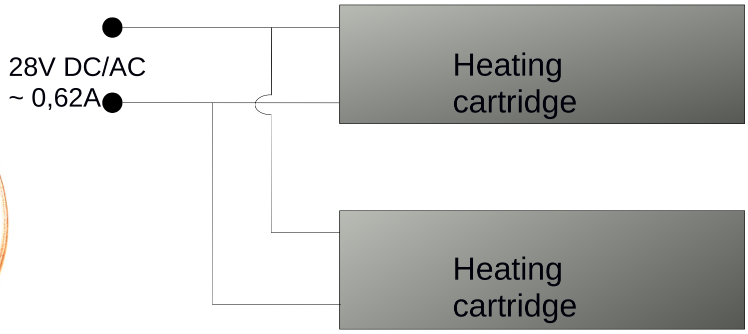
The resistance - temperature curve of the heating cartridge is not linear and it is not a PTC

360 Power for 1 pc. heating cartridge. At 28V, the sensors receive 75 - 85°C, depending on the Place of use. The sensor can be destroyed if the heating temperature is too high!
361 Other lengths optionally available.

heater. The resistance of the supply cable is not included in the performance data.

The operating voltage must be adjusted according to the cable length.





3D CAD file:

https://neoxid-cloud.de/neo203-Heater-8x40.stp.zip

Assembly:

The installation instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung_NEO20X-V160_DE_EN.pdf

The heating cartridge can be used in various adapters (NEO120, NEO130, NEO150 and NEO170). To do this, 2 cartridges are inserted into the 8 mm fitting provided and each fixed in place with an M4 grub screw. A tightening torque of 1 Nm is recommended. If the cartridges are ordered together with adapters, these are already installed so that no further assembly work is required.

The installed H_2sensor may only be pressurised with gas when the desired sensor temperature (usually 85°C) is reached. The temperature in the hydrogen sensor is optionally output via CAN bus. Condensation must not form in the sensor. The sensor temperature must be monitored continuously. At room temperature, sensor temperatures of 75 - 85°C are normally achieved with 28V (8.7W) heating voltage (depending on the sensor variant).

In difficult cases (i.e. hot, moist gas enters a cold sensor after a short gas line), the heating cartridge must be adjusted and possibly regulated. When regulating the temperature of the sensor, ensure that the distance to the dew point temperature or the freezing point is at least 15°C.

Caution: Failure to comply may result in damage to the sensor and heating cartridge!

Data sheet H_2-OxiKat NEO308

Product description:

System for flameless hydrogen combustion in a wide concentration range, especially for gas purification in the ppm range. Only permitted outside the ignition limits (in the non-explosive range). Emission-free conversion of hydrogen into usable heat energy and water by catalytic reaction with oxygen.

Typical application:

- Catalytic, flameless, thermal combustion of H_2/air-gas mixtures for heat recovery and/or exhaust gas purification on an industrial scale
- Fine purification of gases by removing minimal impurities
- Combustion of hydrocarbon gas mixtures (at elevated starting temperature)
- Catalytic post-combustion of fuel cell exhaust gases or electrolysis gas
- Removal of oxygen or hydrogen residues from electrolysis gas
  z. e.g. purification of air or helium
- Gas treatment, gas purification, depletion of oxygen or hydrogen in chemical processes
- Safety technology, explosion prevention, fire prevention (through O_2discharge)
- NOx reduction possible by means of H_2(SCR catalytic converter)
- TNV, thermal post-combustion
- Fuel cell applications, purge pulse gases

Structure:

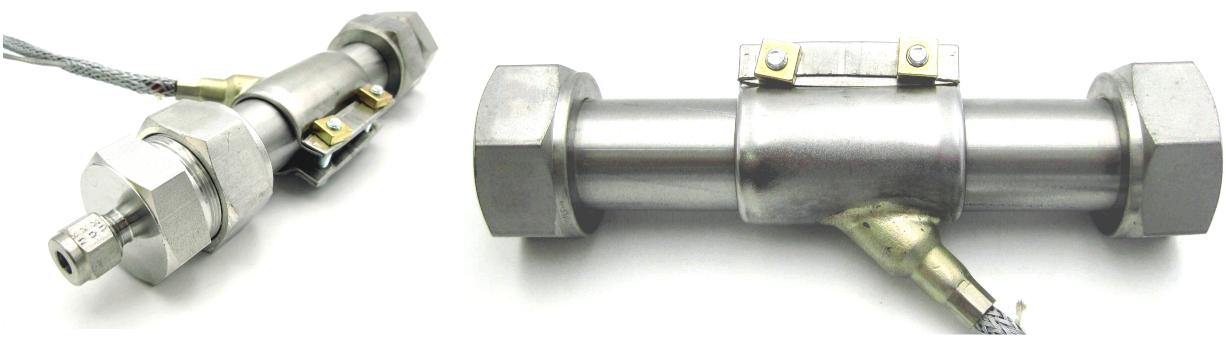


Figure 1: H_2burner version NEO308 with heating tape + optional adapter to 6.35mm or 6.00mm compression fitting

Properties:

- Suitable for generating process heat or converting large quantities of hydrogen with a non-hazardous gas composition
- Exhaust gas free of pollutants compared to flame combustion, contains no NO_x, CO, CO_2
- High efficiency with H_2conversion, H_2residue <500 ppm (>99.95 % efficiency), also with gassing with H_2up to 39,000 ppm, total conversion tested up to 8,000 litres/h H_2, catalysis can be started at room temperature with dry gas
- Regulation of concentration, pressure and gas flow velocity not absolutely necessary
- High moisture tolerance, condensing moisture at elevated temperatures and 100 % RH can be processed with the appropriate structure
- Corrosion-resistant substrate, no carbon corrosion, not as mechanically sensitive as aluminium oxide due to elastic carrier grid (no shrinkage or breakage)
- Dust-free disassembly/assembly possible for easy maintenance or cleaning
- Deposits can usually be removed easily
- Suitable for removing hydrocarbons (99.9 %), methane, CO (efficiency depends on temperature)
- Cost-effective and environmentally friendly production
- Low use of precious metals
- Recycling or regeneration mostly possible
- Modular design for easy adaptation to different systems
- Thermal output up to 1 kW

Safety note:

4.0 vol-% H_2in air (under standard conditions) is the lower explosion limit, 77 vol-% H_2in air is the upper explosion limit. These are dependent on temperature, oxygen content, humidity and pressure, among other things (e.g. 2.9 vol-% at 200 °C / 1 bar - 2.1 vol-% at 300 °C / 1 bar). The temperature increase due to the reaction must be taken into account. Operation close to the explosion limit is not recommended.

There is a risk of burns on the catalytic converter housing; installation is only permitted with sufficiently temperature-resistant materials!

System characteristics:

Design: 1" tube, material 1.4435, TP316/TP316L

Catalyst: Titanium support grid with nanostructured metal oxide
platinum catalyst.

Coating

Weight: < 350 g

Outer diameter: 25.4 mm

Inner diameter: 21.18 mm

Length: 150 mm

Connection: Smooth pipes for compression fitting

Cat grille: 10 pieces

H_2range[362] : 0 - 4.0 % by volume H_2

Response time[363] : 1 - 900 seconds

Operating temperature :[364] 20 °C - 400 °C

Pressure range: 0 - 100 bar

Air humidity: 0 - 100 % r.h.

Carrier gas :[365] oxygen-containing gas

ATEX: Not applicable, device only approved outside
hazardous area

CE mark Not available as Pressure Equipment Directive
2014/68/EU

The 3D stepfile and 2D drawings are available here:
https://neoxid-cloud.de/NEO308.zip

This article is not a hazardous substance and does not contain any hazardous components or substances with
European Community occupational exposure limit values or particularly
substances of very high concern (SVHC) above their respective legal nominal limits.
Consequently, according to Regulation (EC) No. 1907/2006 (REACH), no safety data sheet is required.

362 under standard conditions, with a conversion corresponding to the O_2content; with < 6% O_2any H_2concentration possible

363 dependent on temperature, concentration, density, humidity values and volume flow rate

364 higher temperature (up to 400°C) possible, note the strength of the housing

365 Oxygen is required for the catalytic reaction with hydrogen

necessary and not available in this case.

Operating data at maximum flow rate:

The values are dependent on temperature, pressure, humidity, concentration and flow!

Flow speed: 7.5 m/s

Total volume flow: 9500 ltr/h

Volume fraction H_2at 4 vol.% 380 litres/h or 34g/h

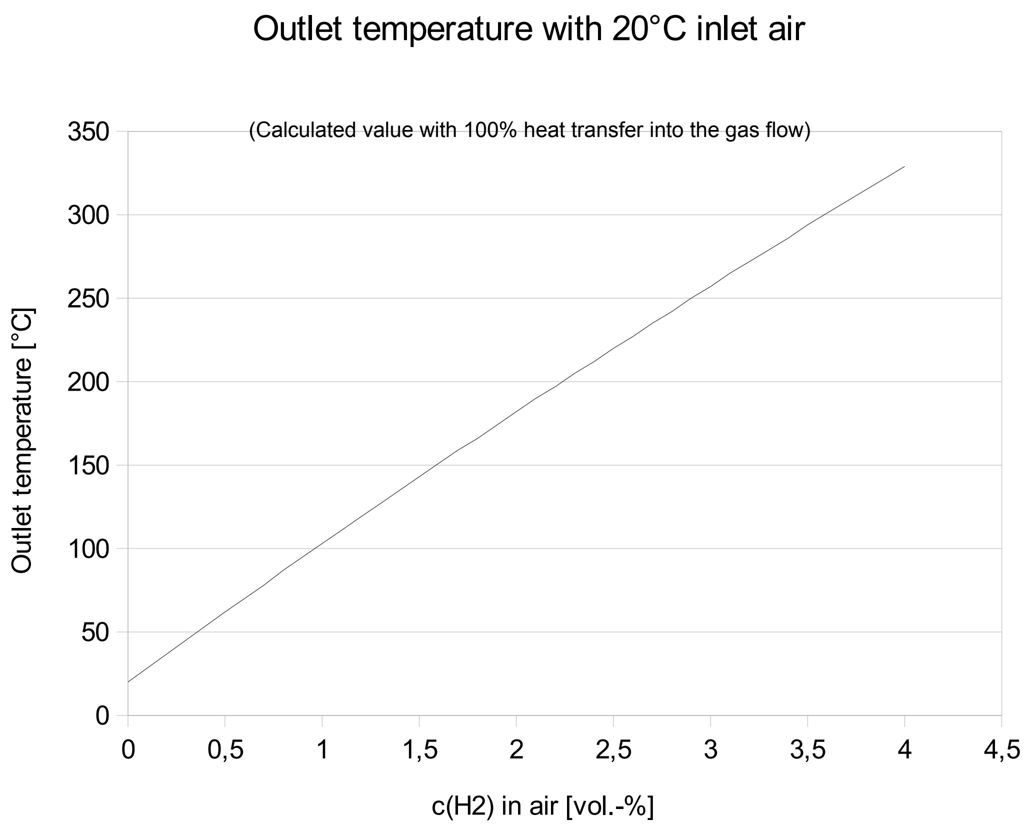
enthalpy of formation H_2O (liquid): 1.3 kWh

Thermal output: 1 kW

Exhaust gas temperature at 20 °C Start
and complete heat transfer
into the exhaust gas ~330 °C

Amount of water produced: 0.3 litres/hour

When used for gas purification in the ppm range, the flow velocity of the gas must be reduced. The maximum possible velocity depends on the gas composition, temperature and pressure and must be determined on a case-by-case basis.



Handling instructions:

- Store in a dry and closed place when not in use
- Avoid contamination by long-chain hydrocarbons, greases, oils, hand perspiration, sulphur compounds, halogens, silicones, phosphorus and heavy metal compounds, formation of deposits due to aerosols or particles
- Clean with oil-free compressed air, brush, do not use solvents, consult the manufacturer if necessary
- Water accumulation in the catalyser must be avoided by suitable pipe routing
- the ignition of a hydrogen mixture and the formation of a flame must be avoided

To ensure safety, observe the Pressure Equipment Directive 2014/68EU, German Statutory Accident Insurance (DGUV), Technical Rules for Operational Safety (TRBS), Technical Rules for Hazardous Substances (TRGS), Technical Regulations for Pipeline Construction and other safety regulations before commissioning. As the catalytic converter can be used under a wide variety of operating conditions, a decision on its suitability for a specific application may only be made after precise analysis and/or tests have been carried out to check that the specific requirements are met. Commissioning of the components is prohibited until it has been established that the machine or system in which the components are installed complies with the regulations. Hydrogen can be dangerous if an operator is not familiar with its handling. Installation, commissioning and maintenance of the catalyser should only be carried out by trained and experienced personnel.

Please contact neo hydrogen sensors GmbH if the product is to be used under one of the following conditions:

- Operating or environmental conditions that deviate from the specified technical data or when using the product outdoors.
- Installation within machinery and equipment used in connection with nuclear power, railways, aviation, motor vehicles, medical equipment, food and beverage, leisure and recreational equipment, emergency stop circuits or safety equipment.
- Applications where there is a possibility of damage to persons, property or animals and which require a special safety analysis.

Operation with additional heating

Moisture deposits may be present on the hydrophilic catalyst, which must be removed for a safe start. Preheating with the supplied jacket heater should ensure a reliable start of the reaction even under unfavourable conditions. A temperature rise can be measured after the catalytic converter has been started if the appropriate quantities of hydrogen are converted. If the hydrogen conversion is sufficient, the temperature continues to rise and the heating band can optionally be switched off. Continuous operation of the heater with reduced voltage increases the service life compared to frequent switching on and off.

During continuous operation of the heater, the maximum permissible temperature of 400 °C in the heating element must be observed! Continuous operation without sufficient heat dissipation will damage the heater. We recommend operation with our heating controller H-Tronic (article number 100198).

Technical data of the cylinder heating tape as auxiliary heating

Diameter :	25.4 mm with intermediate layer
Width:	48 mm
Performance:	400 W
Operating voltage:	0 - 230 V AC/DC
Connection:	radial/180°/centre
Supply line length:	2000 mm
Miscellaneous:	Stainless steel version
Temperature measurement:	PT-1000
Permissible temperature:	350 - 400 °C
Tightening torque:	3 - 3.5 Nm, retighten after initial heating

The specified operating temperature of the heating elements does not apply to the connecting cable. The connecting cable may need to be adapted to the application.
This product is electrical equipment. Correct functioning and operational safety can only be guaranteed if the general safety regulations for electrical installations and the special safety and installation instructions in this manual are observed during installation.
be used. The heating element may only be used in accordance with the instructions. neo hydrogen sensors GmbH accepts no liability for damage caused by non-compliance with the instructions.

Safety instructions for the auxiliary heater

The heating element is not intended for use in Ex systems. Please note when handling electrical equipment:
Installation, maintenance and servicing of the heating element is the responsibility of a qualified electrician. In the event of faults in the power supply and/or damage to the electrical equipment, the heating element must be switched off immediately. Safety devices must not be bypassed, dismantled, altered in their function or bypassed in any other way. Before carrying out any work on the heating element, switch it off and secure it against being switched on again. The user's accident prevention regulations must be observed. Persons who are not authorised or who are under the influence of alcohol, other drugs or medication that affect reaction time must not operate or maintain heating elements.

Installation - Assembly

The heating element may only be used if it is in perfect technical condition and in accordance with its intended use and in a safe and hazard-conscious manner. As heat is transferred from the heating elements to the body to be heated by contact heat, the heating element must be in firm and even contact with the body to be heated. If the heat absorption is too low, a heat build-up occurs in the heating element, which can destroy the heating element.
heating element.

The following points must be observed:

- The entire inner surface of the heating element must be in firm contact with the body to be heated
- The clamping screws must be tightened firmly and evenly
  One-piece cylinder heating elements without hinge with 3 to max. 3.5 Nm
- Cables with sufficient heat resistance of the conductor and insulation must be provided for the electrical supply line.

Commissioning - Operation

The heating element may only be handled by trained and authorised persons. The heating element may only be put into operation after it has been fully assembled. During initial commissioning until the operating temperature is reached, the tight fit of the heating element must be checked at several intervals. If necessary, retighten the clamping screws.

Maintenance

Regular testing by a qualified electrician is mandatory. The period depends on the operational conditions and must be determined and carried out by the user on their own responsibility.

In addition to these instructions and the binding accident prevention regulations applicable in the country of use and at the place of use, the recognised technical rules for safe and professional work must also be observed.
We reserve the right to make changes in the interest of technical progress.

Connection dimensions:

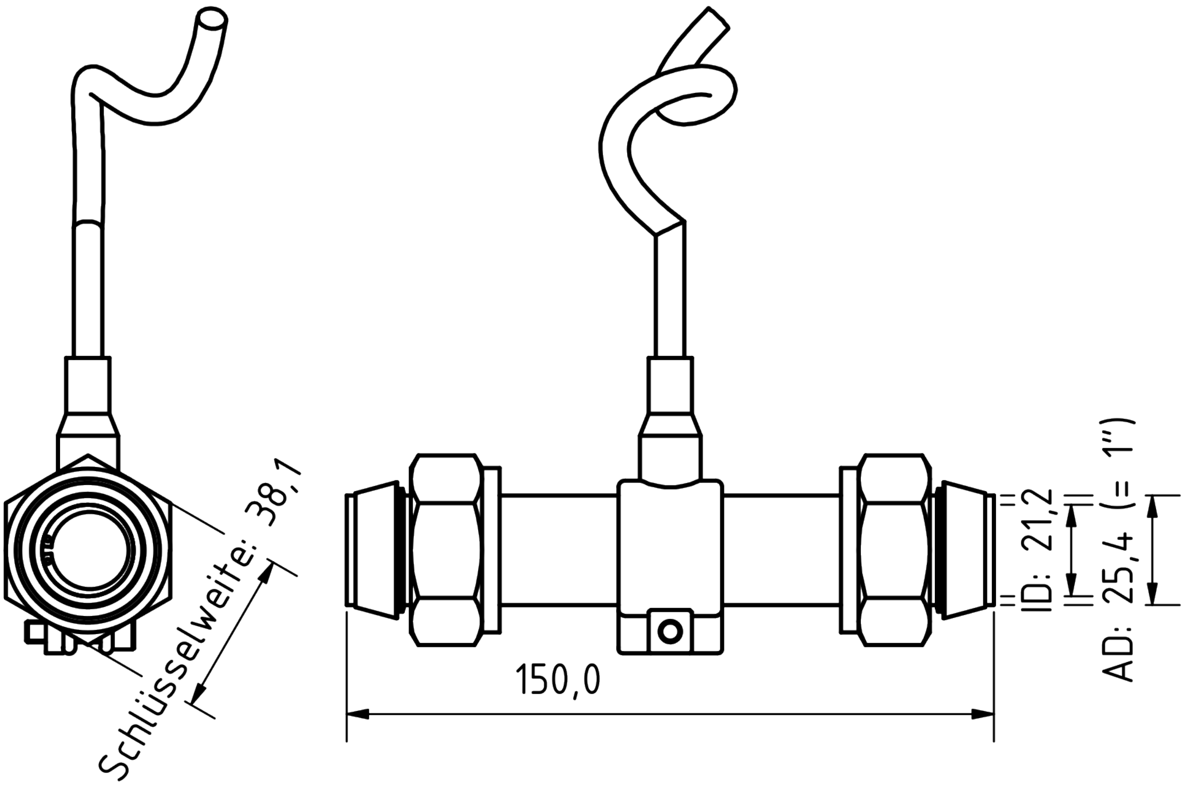


Figure 2: Connection dimensions of the housing with heater (symbol image) and 1" compression fitting

Data sheet neoCANLogger as an accessory for neoxid group sensors, article no.: 100.234

Product description:

The neoCANLogger can be used to read out and adjust sensors from the neoxid group from software version 14.8. Automatic translation of the CAN signal into human-readable form and simultaneous output via a TFT display. Saving of data with date and time on SD card.

Properties:

- Simple readout of the CAN sensors on a TFT display
- Translate signal output into human-readable format
- Zero point adjustments and CAN ID modification possible via neoCANLogger
- Power supply via supplied 230 V plug-in power supply unit
- The scope of delivery includes: neoCANLogger, 12V plug-in power supply, 2x spring clamp plugs, 32GB SD card
- Translation option for: NEO974A / NEO974HTA / NEO983A / NEO983HTA / NEO986A / NEO986HTA / NEO951A / NEO480A / NEO440A / NEO445A / NEO445HTA

Figure 1: neoCANLogger display

Sensor system characteristics:

Supply voltage:	230 V AC
Energy consumption:	< 1,5 W
Start time:	< 20 s until the first message
Ambient temperature:	15 - 50°C
Print area:	Environment
Air humidity:	5 - 95 % r.h. (non-condensing)
Signal translation:	CAN 2.0 A/B with baud rate 500 kbit/s[366] CAN lines are terminated! CAN-ID: 0x100 - 0xFF000000 are read in
Housing:	Size: 200 x 110 x 60 mm^3
Weight:	< 225 g
SIL:	-
ATEX:	-
RoHS compliant:	Yes
Customs tariff number:	90271010
COO:	Germany

General function and commissioning:

Commissioning:

The neoCANLogger is connected to a 230V socket using the power supply unit supplied. The socket for this is located on the back on the left. This neoCANLogger starts automatically. After the neoCANLogger has started (approx. 20 sec.), it displays "No CAN IDs ... reconnecting...". Connect a sensor using the spring clamp connectors supplied. The colours of the terminal plugs match both the cable colours of the sensor cable and the safety sockets in the logger.

366 Other baud rates on request

Figure 2: Spring clamp plug

As soon as a sensor is connected, it is logged in; if no sensor logs in, please ensure that CAN High and CAN Low are connected correctly. The neoCANLogger starts on the overview page and displays all connected sensors.

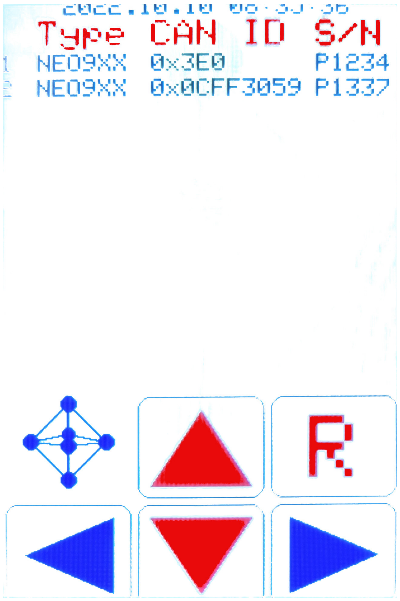


Figure 3: Overview page

The right arrow can now be used to switch to the individual sensors. If the sensor has been connected correctly, the H2 value of the sensor can be set to zero by pressing the "R" button for 3 seconds. Details can be found in the
section "Adjusting a sensor".
Press the up/down arrow buttons for approx. 3 seconds to increase/decrease the CAN ID of the individual sensor. In the overview page, all commands sent apply to all sensors. When viewing the individual sensor, the executed command only applies to the sensor.

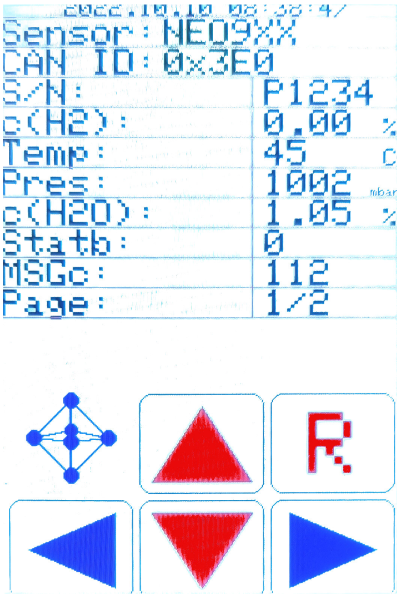


Figure 4: Sensor side

The settings are located before the overview page (button on the left of the overview page). The following functions can be set on this page:
- The time of the RTC can be adjusted in 10 second steps.
- The write frequency to the SD card can be set in 1 second increments.
- You can set whether the runtime of the device is also written to the SD card in milliseconds.

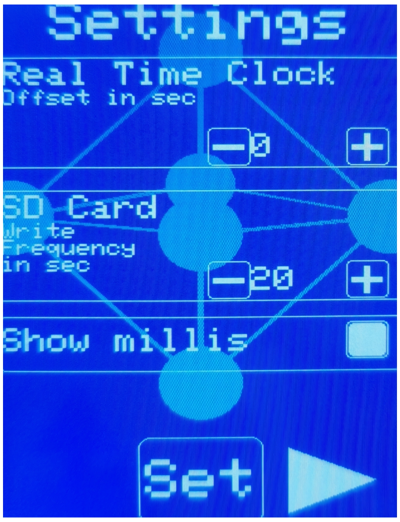


Figure 5: Settings page

Read out the SD card:

A microSDHC UHS-I card is used as the SD card. This SD card may have a maximum size of 32 GB and be formatted in FAT32 format. The card can be inserted into the neoCANLogger using an SD card adapter. If a sensor is recorded every 100ms, the 32GB memory card is sufficient for around 100 days.
If the file is renamed, the neoCANLogger creates a file with the original name again the next time it records and writes to it.

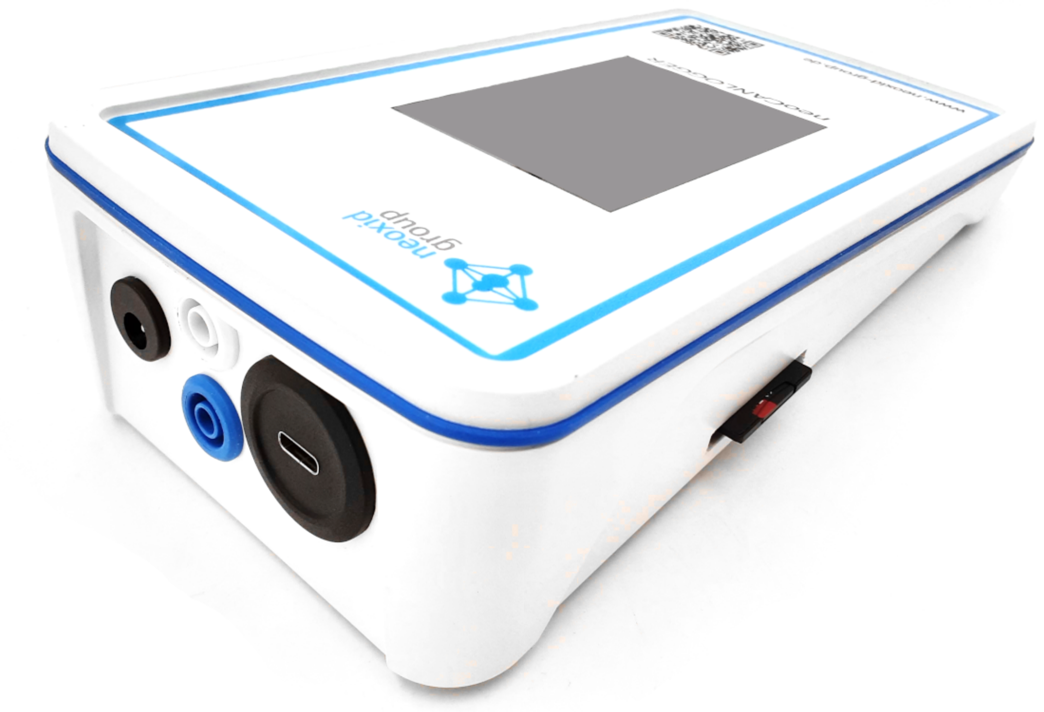


Figure 6: neoCANLogger view SD card slot

Adjustment of a sensor:

A specific CAN message can be used to zero the NEO9XXA sensors. This is permanent and affects all outgoing H2 signals.

Before this adjustment of the sensor, it should be in contact exclusively with its carrier gas for at least five minutes. The relative humidity should be kept between 0 and 1% and the temperature between 10 and 50°C. The accuracy of the adjustment is± 0.05Vol.-% H2. The neoCANLogger confirms the adjustment with a green dot above the "R" button.

The red buttons "R", "^" and "v" must each be held for three seconds until they execute the command.

To apply the commands (reset, CAN ID up, CAN ID down) only for one sensor, the pages of the individual sensors are used.

Data sheet O_2 sensor system NEO440 for the measurement of 0 to 100 vol.-% O_2, Version 15.6

Product description:

O_2 measuring system based on ZrO_2 with digital or analogue output. A mathematical prediction algorithm ensures very short rise and decay times.

Typical application:

- Detection of O_2 in industrial processes
- Detection of O_2 in the automobile
- Room air monitoring

Properties:

- Measuring range from 0-100 vol.-% O_2 under atmospheric conditions
- Output of the O_2 concentration
- The gas concentration is not changed by the measurement.
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Signal output via CAN 2.0 A/B, 0-10V or 4-20mA
- Gas adapter available for measuring gas in a pipe (see Figure 2)
- Encrypted CAN communication on demand

Figure 1: O_2 sensor system version NEO440 with customer cable

Sensor system characteristics:

Supply voltage: 12 - 28 V DC

Energy consumption: < 15 W

O_2 sensitivity: 0.1 - 100 % by volume O_2[367]

Accuracy: < ± 1Vol.-% O_2[368]

Response time t_{63}: < 5s

Start-up time after cold start: < 5s until the first CAN message
Stable O_2 signal after less than 80s

Media temperature: - 40°C - 85°C

Ambient temperature: - 30°C - 70°C

Pressure: atmospheric

Air humidity: 0 - 95 % r.h. (non-condensing)

Carrier gas: Air, nitrogen

Cross-sensitivities: Hydrogen

Signal: CAN 2.0A/B (125, 250, 500, 1000 kbit/s)
0-10V, 4-20mA

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm with CAN bus
250 ppm at 4-20 mA or 0-10V

SIL: -

ATEX: -

Maintenance interval : We recommend checking the O_2 sensor every
6 months. check.

Measuring behaviour: The gas to be tested may have a maximum
have a maximum velocity of 25m/s. In
addition, a laminar flow is recommended. If the
specification differs specification, the sensor
must be tested for tested for functionality.

367 The sensor element should not be operated in a reducing atmosphere for long periods of time.
368 In the range of 0 - 25 vol.-% O_2

Connection cable:	3 m enclosed or 1m from sensor unit to control unit
IP Code:	IP6K6 (dustproof & protection against water in the mounted condition
Weight:	< 700 g (incl. evaluation electronics)
RoHS compliant:	Yes
Customs tariff number:	90271010
COO:	Germany / NRW

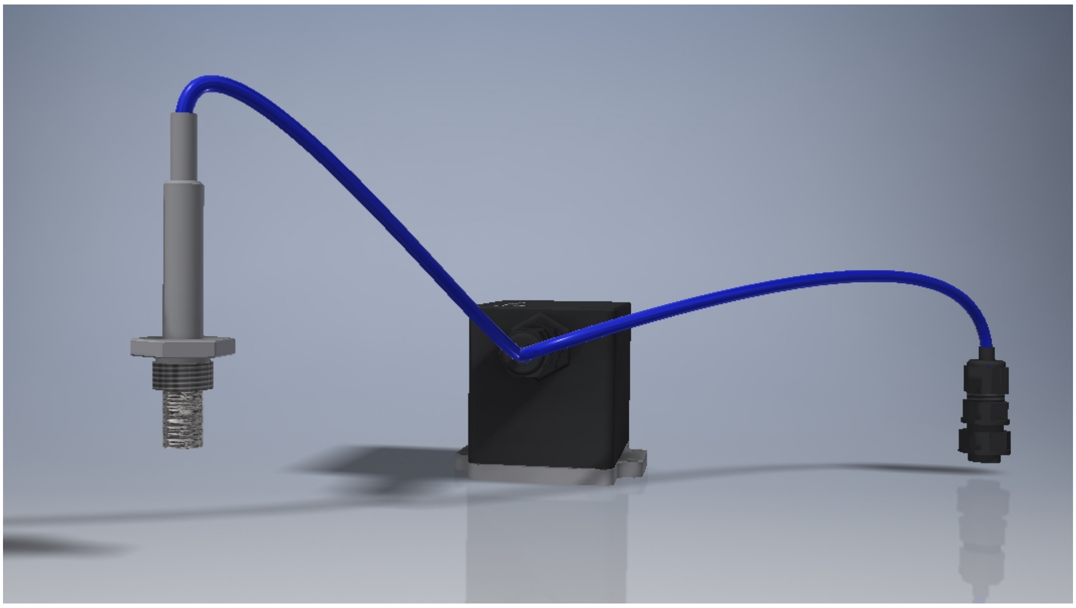


Figure 2: O_2sensor system version NEO440 without housing

Mounting the sensor:

The stepfile and a 2D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO440.zip
NEO440A is for screwing in with an M18x1.5 thread. During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). A tightening torque of 3 Nm is recommended. An additional housing (see Fig. 1 or Fig. 3) and the matching NEO120, NEO130 and NEO150 adapters can be purchased (see data sheet_Adapter_NEO1XX_V146_EN_EN). To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed.

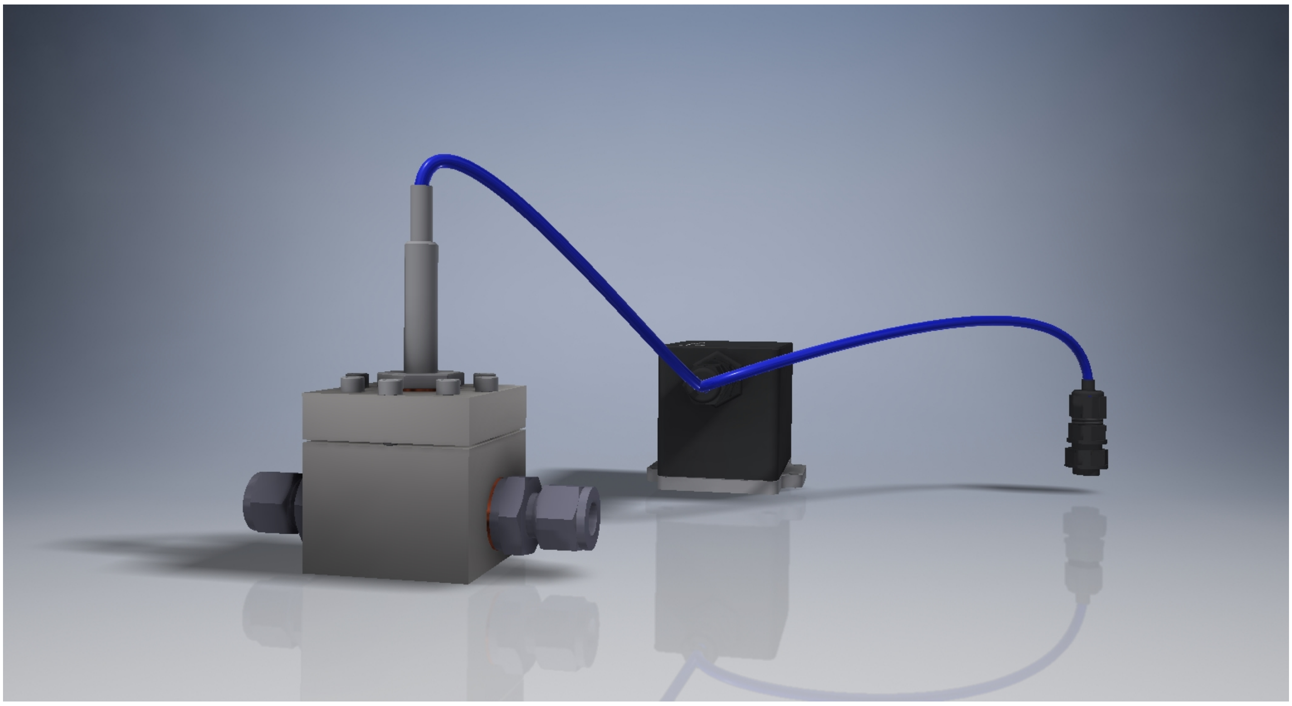


Figure 3a: Example of mounting O_2sensor system with housing for pipe connections

Drilling template - electronics housing:

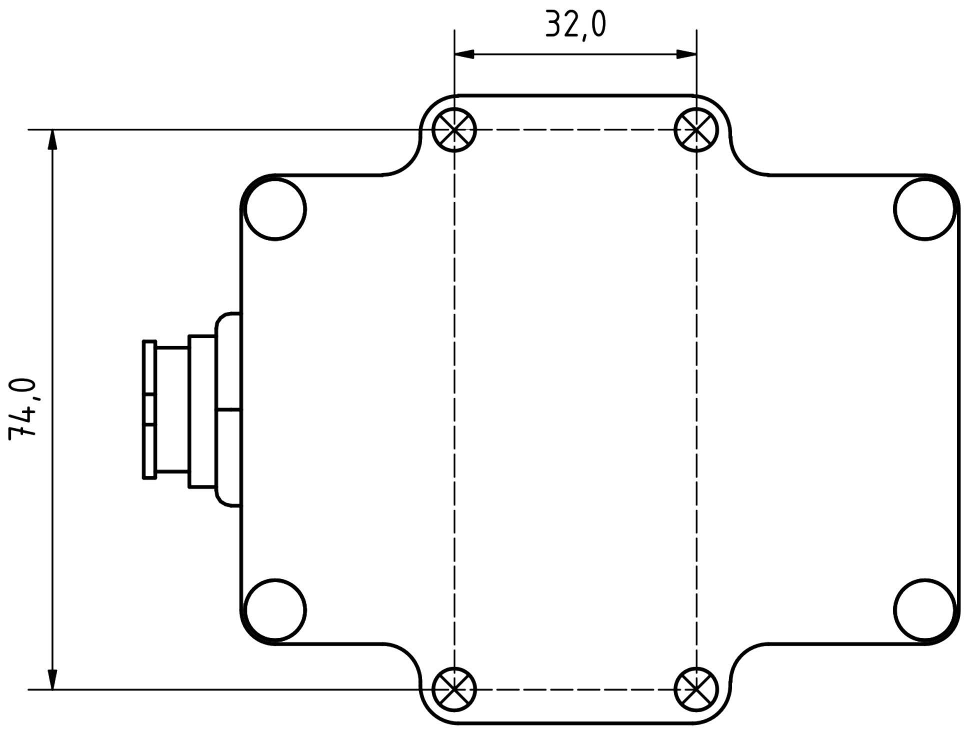
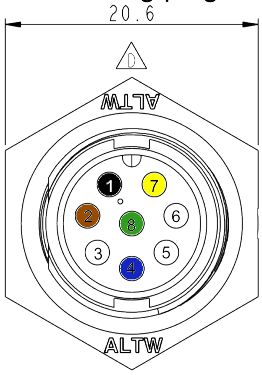


Figure 3b: Drilling template

Electrical PIN assignment



PIN no.	Description of the	Colour
1	VCC 12-28 VDC (<15W)	black
2	GND 0V DC	brown
3	CAN-High or DAC+	white
4	CAN-Low or DAC-	blue
5	*Service port A*	-
6	*Service port B*	-
7	*Connection to sensor unit*	yellow
8	*Connection to sensor unit*	green
	Shielding (optional GND)	green/yellow

8-pin housing connector: Amphenol LTW: ABD-08RMMS-LC7001
8-pin cable socket: Amphenol LTW: BD-08BFFA-LL7001

The following figure 3c shows the connection cable and sensor cable:

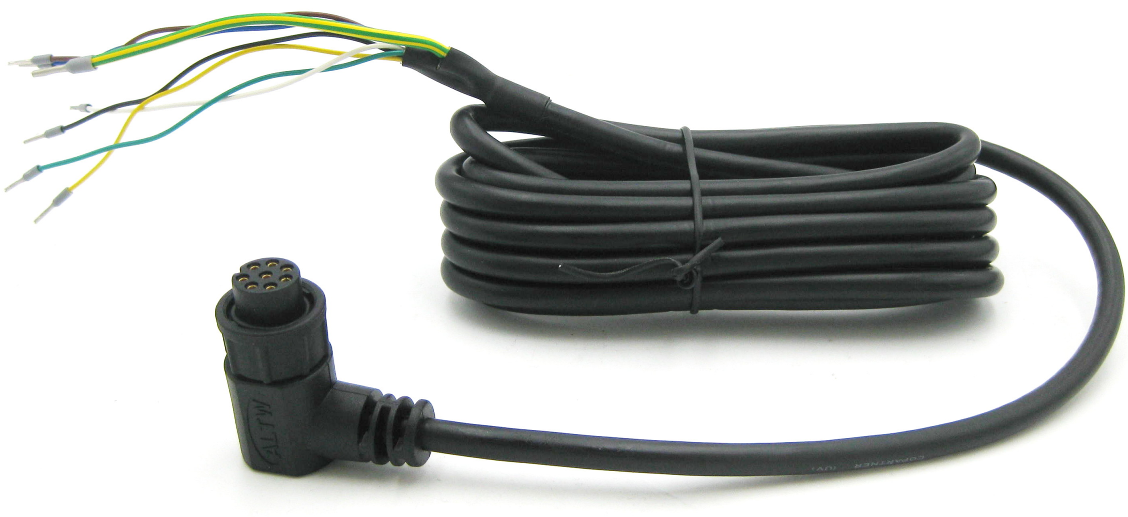


Figure 3c: Connection cable with angled socket

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 ohms on request)! The data type of the CAN data is defined as an unsigned integer in the big endian.

The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO440A	0x440	0x448	0x450	0x458

Set CAN ID (CAN2.0A):
To set the CAN ID, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO440A	0x0CFF1C59	0x0CFF1E59	0x0CFF2059	0x0CFF2259

Set CAN ID (CAN2.0B):
To set the CAN ID, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/O2-Sensor_NEO440_V154.dbc.zip

CAN ID 0x440 or 0x0CFF1C59:
Msg 0 (bit 0-15): Oxygen concentration [Vol.-%] $c(O_2) = (Msg0-20)/100$
Msg 1 (bit 16-23): Pressure [mbar] $p = (Msg1-20)*3+600$[369]
Msg 2 (bit 24-31): Temperature [°C] $T = Msg2-60$[370]
Msg 3 (bit 32-39): Supply voltage [V]: $U=(Msg3-20)/5$
Msg 4 (bit 40-47): CRC 1
Msg 5 (bit 48-55): CRC 0
Msg 6 (Bit 56-63): continuous message counter

369 Only used to measure the ambient pressure and not the media pressure
370 Only measures the temperature of the electrical components

Analogue 4-20mA - Series I

I[mA]	$c(O_2)$ [vol.-%]	Comment
4 - 20 mA[371]	0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum oxygen volume concentration. This means that 25 vol-% $O_{(2)}$, for example, is then output as 8mA for a 100 vol-% O_2 sensor system. In the heat-up phase and during a critical fault, a current <4mA is output (usually approx. 3mA)

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The maximum permissible load is 450 Ohm.

Analogue 0-10V - Series I

U[V]	$c(O_2)$ [vol.-%]	Comment
0 - 10 V	0 - 100 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum oxygen volume concentration in a range from 1V to 9V. This means that 50 vol-% $O_{(2)}$, for example, is then output as 5V for a 100 vol-% O_2 sensor system. Values less than 1V indicate an error.

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The minimum measuring resistance is 10 kOhm.

371 In earlier versions of this sensor, 7.2 to 20mA was given as the measuring range.

Data sheet oxygen concentration sensor NEO445HT-ATEX, Version 15.6

Product description:

Sensor system for measuring the oxygen concentration in hydrogen with temperature-, pressure- and humidity-compensated signal evaluation for automotive or industrial applications with ATEX Zone I. Applicable in the range: 0.6 - 5 bara, 0 - 100% r.h. (non-condensing) and 40°C - 120°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measuring ranges: 0-5 vol.-% O_2
- Carrier gas: Hydrogen
- Measurement of electrolysis gases (O_2in H_2) , installation in test benches
- Measuring signal independent of pressure, temperature and humidity
- Signal output via CAN 2.0, Modbus RTU via RS485, 0-10V or 4-20mA
- The gas concentration is not changed by the measurement.
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Factory calibrated and ready for immediate use
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary.
- Encrypted CAN communication on demand

Figure 1: O2 concentration sensor version NEO445HT-ATEX

...go to English version

Sensor system characteristics:

Supply voltage: 12 - 32 V DC

Energy consumption: < 2,4 W

O_2sensitivity: 0 - 5 vol.-% O_2

Accuracy: ± 0.5 vol.-% O_2

Detection limit: < 0.5 vol.-% O_2

Response time t_{90}: < 5 s

Decay time t_{10}: < 5 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the O_2concentration[372]

Media temperature: - 40°C - 120°C

Ambient temperature: - 40°C - 100°C
The cold start at -40°C was tested.

Pressure range: 0.6 - 5 bar absolute, i.e. 60 - 500 kPa

Air humidity: 0 - 100 % r.h. (non-condensing)[373]

Carrier gas: Hydrogen

Signal :[374] CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on
page25 Modbus RTU via RS485 interface on page 29
4-20 mA on page 28
0-10 V on page 28

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm for CAN bus and Modbus RTU
250 ppm at 4-20 mA or 0-10V

Housing: Size: 95 x 83 x 49 mm³, housing cover made of
EN AW 6060 and media-contacting base plate made of
316L or 1.4404, M5 screws to the measuring chamber
with 3Nm.

372 The system is designed for continuous operation
373 In particular, splash water must be kept away from the sensor opening
374 Signals are described in the "Explanation of signals" section

Leakage rate: 10^{-5}mbar l / s [375]

IP code: IP6K7

Weight: < 810 g

SIL: -

ATEX: **II 2G/- Ex db IIB+H2 T1 Gb/- at -40°C < $_{T(a)}$< 100°C**
https://neoxid-cloud.de/Konformitaetserklaerung_Muster_scan.pdf

Type of protection: Flameproof Ex D

Service life: IP6K7 enclosure qualified with an expected Service life of 5 years[376] . The system was tested with 100,000 switch-on and switch-off cycles.

Long-term stability/drift: < 0.1 vol.-% in the first 5,000h operating time

Maintenance interval : We recommend checking the O_2sensor every
6 months. check.

Measuring behaviour: The gas to be tested may have a maximum have a maximum velocity of 25m/s. In
addition, a laminar flow is recommended. If the
specification differs specification, the sensor
must be tested for tested for functionality.

Connection cable: 3 m enclosed; more detailed information on
page 123

RoHS compliant: Yes

Customs tariff number: 90271010

COO: Germany / NRW

EC-79/2009 Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

375 Measured with forming gas 90/10, 1.5 bar absolute, room temperature
376 Measuring components are purely inorganic and are not consumed during measurement

Accuracy of the measured values:[377]

Size	Accuracy
Oxygen concentration	± 0.5 vol.-% O_2
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[378]	± 0,3 °C
Pressure	± 20 mbar

Table19 : Statistical errors for individual measured variables

Mounting the sensor:

The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO445HT.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request (see data sheet_Adapter_NEO1XX_V146_EN_EN). To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a spatial direction other than horizontally, a small offset[379] occurs; this must be corrected via a specific CAN message on ID 0x680 (zero point adjustment, see page). 14

ATEX area:

The sensor as such is not suitable for installation in an explosive atmosphere. It should be connected to an explosive atmosphere. The resulting ATEX Zone 1 area can be seen here:

377 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar

378 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber

379 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.

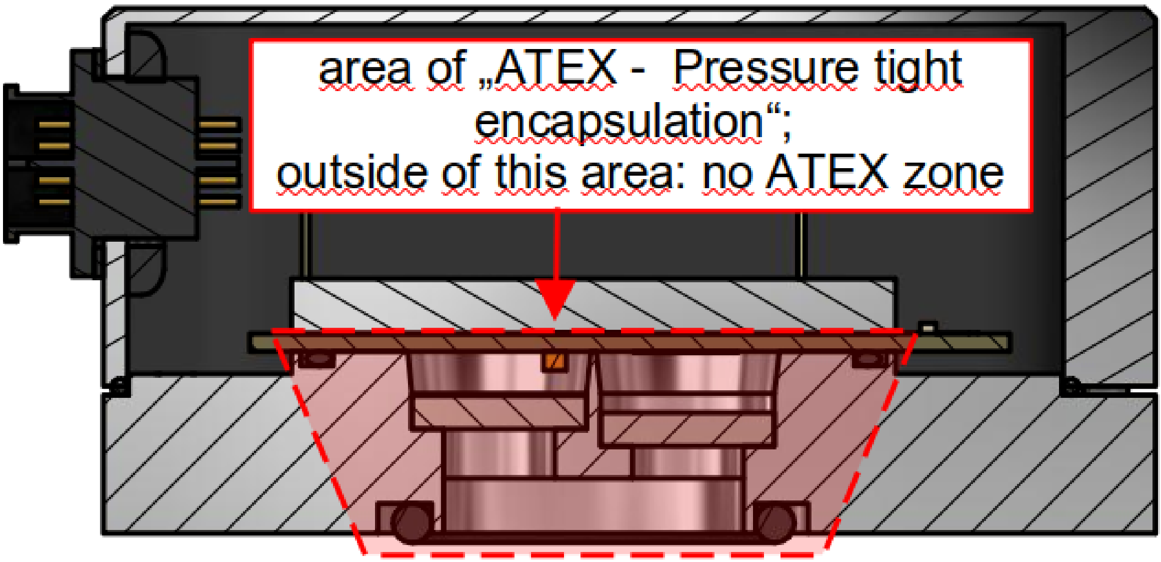


Figure 2a: Flameproof enclosure area

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The above-mentioned adapters (with the exception of the NEO160) can also be fitted with heating cartridges, which are also available on request. As a further protective measure against small amounts of splash water, the sensor is fitted with a ribbed plug. Care must be taken to ensure that the sensor is installed in such a way that this plug functions properly if an installation with a passing gas is used.

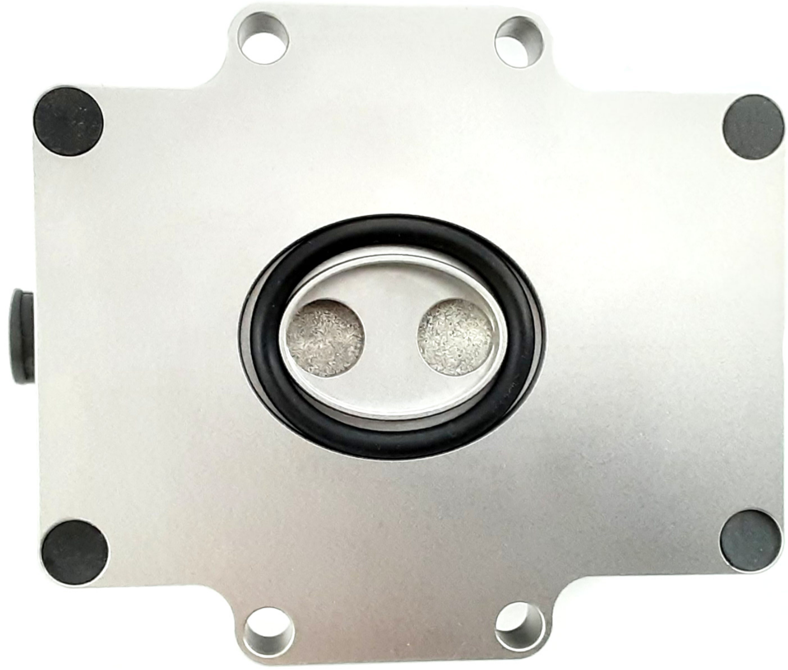


Figure 2b: NEO9XXHT-ATEX O-ring and sintered metal discs

Hole pattern:

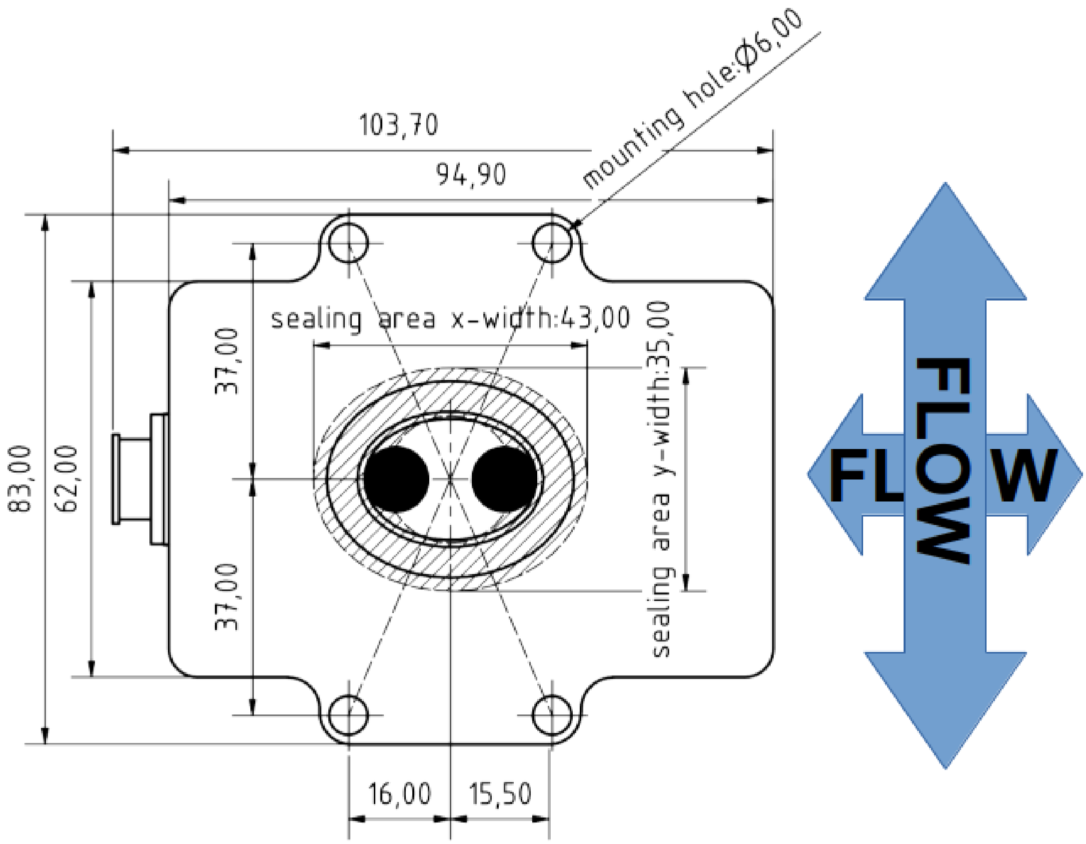


Figure 3a: Hole pattern of the H_2sensor system from below

Drilling template:

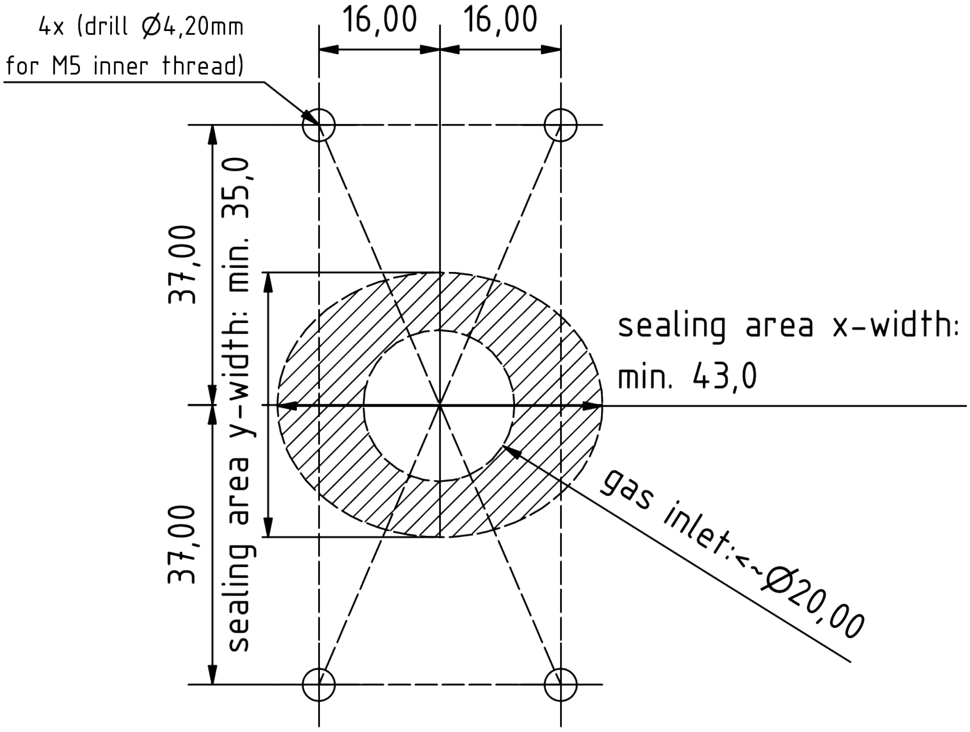
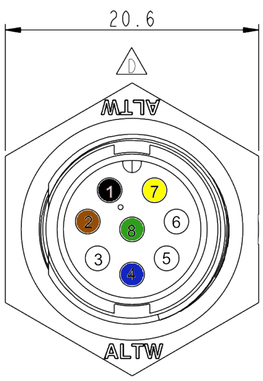


Figure 3b: Drilling template

Electrical PIN assignment



Housing plug

PIN no.	Description of the	Colour
1	VCC+ 12 ... 30V DC (min.: 2.4W)	black
2	GND 0V DC	brown
3	CAN-High (opt. DAC)+	white
4	CAN-Low (opt. DAC-)	blue
5	*service port A*	-
6	*service port B*	-
7	DAC + / RS485 A	yellow
8	DAC - / RS485 B	green
	Shielding (optional GND)	green/yellow

8-pin housing connector: Amphenol LTW: ABD-08RMMS-LC7001
8-pin cable socket: Amphenol LTW: BD-08BFFA-LL7001

Figure 3c below shows the enclosed connection cable with angled socket:

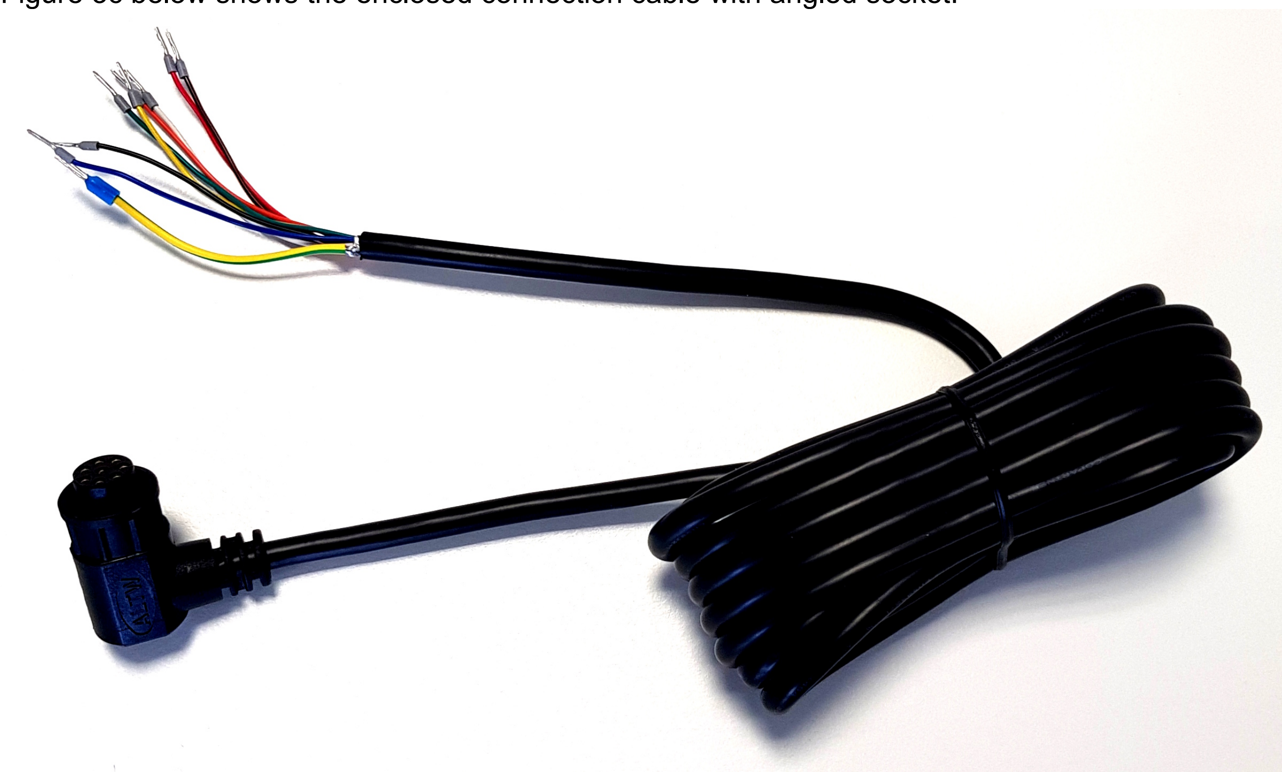


Figure 3c: Connection cable with angled socket

Simultaneous signal output via CAN bus and an analogue interface

If required, the sensor's measurement data can be output simultaneously via the CAN bus interface and an analogue interface (4-20 mA, 0-10V). If an analogue interface (4-20 mA, 0-10V) is selected in addition to the CAN bus, the analogue signal is output via PIN 7 & 8. CAN addressing via the connector is then no longer possible!

Information on hydrogen ignition by the NEO974HT-ATEX/NEO983HT-ATEX/

NEO986HT-ATEX from neo hydrogen sensors GmbH in accordance with J2578 SAE international:

The H_2sensor NEO974HT-ATEX/NEO983HT-ATEX/NEO986HT-ATEX uses a heating element that is heated with 5 V from a fixed-voltage component. During the explosion and detonation tests carried out, the supply voltage of the heater was successively increased, which is not possible with the fixed-voltage component installed in the NEO974HT-ATEX (a Zener diode prevents excessively high operating voltages). In the current sensor version, the current flowing through the heating element is monitored by the microcontroller and an error is signalled via the status byte if the heating current is outside the standard range. The heating temperature is 320°C and is therefore 265°C below the hydrogen ignition temperature of 585°C. The heating element is located in a small 120 mm^3 measuring cavity.

Catalytic materials are not installed in the H_2sensor NEO974HT-ATEX/NEO983HT-ATEX/NEO986HT-ATEX, so that self-ignition and thus a hazard cannot occur.

Extensive in-house explosion and detonation tests were carried out with the H_2sensors NEO974HT-ATEX/NEO983HT-ATEX/NEO986HT-ATEX. Neither an explosion nor a detonation could be caused during normal operation, not even with a stoichiometric H_2/O_2mixture.

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO445HTA (0-5 vol.-% O_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment.
must be made. This is permanent and affects all outgoing O_2signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be oxygen-free and flushed with hydrogen. [380]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[381]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To set the CAN ID, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

380 Details can be found in the operating instructions under chapter: "Maintenance and service"
381 0xYY describes a measure for the set zero point adjustment

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message is delivered after 5 seconds at system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO445HTA (0-5 vol.-% O2)	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359

Set CAN ID (CAN2.0B):
To set the CAN ID, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x200
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x200, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):
A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make an adjustment. This is permanent and affects all outgoing O_2signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be oxygen-free and flushed with hydrogen. [382]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[383]
*corresponds to the serial number of the individual sensor system.

382 Details can be found in the operating instructions under chapter: "Maintenance and service"
383 0xYY describes a measure for the set zero point adjustment

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/O2-Sensor_NEO445HT_V146.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Oxygen concentration [vol.-%]: c(*O2) = (Msg0-20)/100*
Msg 1(Bit 16-31): *Water concentration [vol.-%]: c(O2O) = (Msg1-20)/100*
Msg 2(bit 32-47): Pressure [mbar]: *p = Msg2*
Msg 3(Bit 48-55): Temperature [°C]: *T = (Msg3-60)*
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0D59:
Msg 0(Bit 0-15): Oxygen concentration_RAW[vol.-%]: c(O2) = (Msg0-20)/100
Measurement of the oxygen content, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $O_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured oxygen concentration exceeds the 0.5 vol.-% limit (c(O_2) from <0.5 vol.-% to >= 0.5 vol.-%).

The following message is sent:
Msg 0(bit 0-15): Oxygen concentration [vol.-%]: c(O_2) = (Msg0-20)/100
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $O_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait
Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

Example:

"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Set the baud rate to 500 kbit/s or 250 kbit/s:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H2 in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Initiate maintenance:
0x680 0x00 0x77 0x61 0x72 0x74 0x75 0x6E 0x67

Analogue 4-20mA - Series I

I[mA]	c($O_{2)}$ [vol.-%]	Comment
4 - 20 mA[384]	0 - 5 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum oxygen volume concentration. This means that 2.5 vol-% $O_{(2)}$,for example, is then output as 12 mA for a 5 vol-% O_2sensor system. In the heat-up phase and during a critical fault, a current < 4mA is output (usually approx. 3mA)

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The maximum permissible load is 450 Ohm.

Analogue 0-10V - Series I

U[V]	c($O_{2)}$ [vol.-%]	Comment
0 - 10 V	0 - 5 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum oxygen volume concentration in a range from 1V to 9V. This means that 2.5 vol-% $O_{(2)}$,for example, is then output as 5V for a 5 vol-% O_2sensor system. Values less than 1V indicate an error.

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The minimum measuring resistance is 10 kOhm.

The following diagram 5 shows a connection diagram:

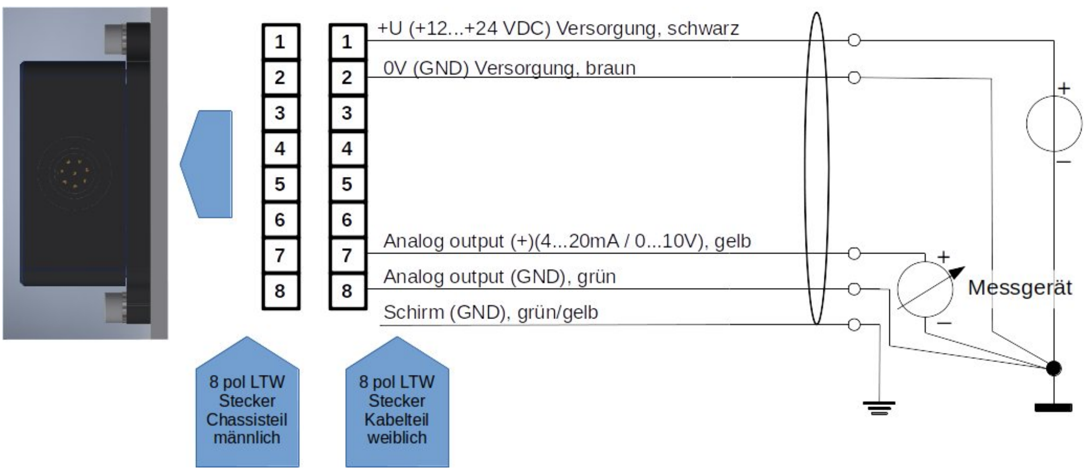


Figure 5: Wiring diagram

384 In earlier versions of this sensor, 7.2 to 20mA was given as the measuring range.

Digital Modbus via RS485 - Series M

RS485 (Modbus RTU) Factory settings:

Slave ID: 1
Baud rate: 9600
Parity: none
Stop Bits: 1
CRC: 16bit

Name	**Description of the**	**Register addresses (hex / dec)**
Oxygen concentration	O_2Volume concentration = x / 100 - 20 vol.-% (Example: 2330 = 3.3 vol.-%)	0x7531 / 30001
Water concentration	H_2O volume concentration = x / 100 - 20 vol.-% (Example: 2330 = 3.3 vol.-%)	0x7532 / 30002
Pressure	Pressure = x - 20 mbar (Example: 1033 = 1013 mbar)	0x7533 / 30003
Temperature	Temperature = x / 100 - 40 °C (Example: 6250 = 22.5°C)	0x7534 / 30004
CRC	According to: SAE J1850 ZERO (Example: CRC 0x00 0x14 0x00 0x14 0x20 0x34 0x5A = 0xAA)	0x7535 / 30005
Oxygen concentration_RAW	Oxygen concentration = x / 100 - 20 vol.-% (Example: 2750 = 7.50 vol.-%)	0x7536 / 30006
Gross value	Raw value = 100 in the absence of water and oxygen in pure hydrogen	0x7537 / 30007
Status byte	32: Sensor maintenance required 16: Oxygen present 8: Sensor in heating phase +0: Sensor fully functional +2: A parameter outside the defined Area +4: Error: Sensor defective +6: Error: Measuring time defective	0x7538 / 30008
Serial number	S/N: P number, which is noted on the outside of the device. (Example: 626 = P-0626)	0x7539 / 30009
Software version	Software version = x / 10 (146 = 14.6)	0x753A / 30010
Continuous message counter	High running counter	0x753B / 30011
Empty byte	No relevant information	0x753C / 30012

Holding register:

Name	Description of the	Register address
Baud rate	Set the baud rate of the Modbus RTU interface: 4800 9600 19200 default: 9600 Changes to the baud rate are only accepted after the sensor is restarted	0x9C41
Slave ID	Slave ID of the sensor 1-200 default: 1 Changes to the slave ID are only applied after the sensor is restarted	0x9C42
Mode	0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2 default: Parity: none, stop bit: 1 Mode change is only applied after restarting the sensor	0x9C43
Zero point adjustment	Default: 0 If a 1 is written to the register, a zero point adjustment is carried out here (see page:14) and the register is then changed to 2.	0x9C44

Information on the registers:

The registers are defined as unsigned 16-bit integers. So they have a range from 0 to 65535. When reading out with a PLC, make sure that the data type is set to "Real" so that the unsigned integer can also be displayed as a comma number.

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapters and heaters:
Various adapters are available for mounting the sensor. For use in very humid environments or environments with liquid water or the risk of icing, there are heating cartridges that can be operated at a constant voltage. These can be fitted in the adapters. You can find the corresponding products under:
https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for the fine purification of gases by removing minimal impurities.

FAQ:
The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Data sheet oxygen concentration sensor NEO445HT, Version 15.6

Product description:

Sensor system for measuring the oxygen concentration in hydrogen with temperature-, pressure- and humidity-compensated signal evaluation for automotive or industrial applications. Applicable in the range: 0.6 - 5 bara, 0 - 100% r.h. (non-condensing) and 40°C - 120°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measuring ranges: 0-5 vol.-% O_2
- Carrier gas: Hydrogen
- Measurement of electrolysis gases (O_2in $H_{2)}$, installation in test benches
- Measuring signal independent of pressure, temperature and humidity
- Signal output via CAN 2.0, Modbus RTU via RS485, 0-10V or 4-20mA
- The gas concentration is not changed by the measurement.
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Factory calibrated and ready for immediate use
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary.
- Encrypted CAN communication on demand

Figure 1: O2 concentration sensor version NEO445HT

...go to English version

Sensor system characteristics:

Supply voltage:	12 - 32 V DC
Energy consumption:	< 2,4 W
O_2sensitivity:	0 - 5 vol.-% O_2
Accuracy:	± 0.5 vol.-% O_2
Detection limit:	< 0.5 vol.-% O_2
Response time t_{90}:	< 5 s
Decay time t_{10}:	< 5 s
Start-up time after cold start:	< 5 s until the first message < 70 s until quantification of the O_2concentration[385]
Media temperature:	- 40°C - 120°C
Ambient temperature:	- 40°C - 100°C The cold start at -40°C was tested.
Pressure range:	0.6 - 5 bar absolute, i.e. 60 - 500 kPa
Humidity:	0 - 100 % r.h. (non-condensing)[386]
Carrier gas:	Hydrogen
Signal :[387]	CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on page25 Modbus RTU via RS485 interface on page 29 4-20 mA on page 28 0-10 V on page 28
Output/measurement interval:	100 ms / 10 Hz
Resolution:	100 ppm for CAN bus and Modbus RTU 250 ppm at 4-20 mA or 0-10V
Housing:	Size: 95 x 83 x 49 mm³, housing cover made of EN AW 6060 and media-contacting base plate made of 316L or 1.4404, M5 screws to the measuring chamber with 3Nm.

385 The system is designed for continuous operation
386 In particular, splash water must be kept away from the sensor opening
387 Signals are described in the "Explanation of signals" section

Leakage rate:	10^{-5}mbar l / s [388]
IP code:	IP6K7
Weight:	< 810 g
SIL:	-
ATEX:	Zone I available on request (see data sheet Sensor system_NEO9XXHT_ATEX_V146_EN_EN)
Service life:	IP6K7 enclosure qualified with an expected Service life of 5 years[389] . The system was tested with 100,000 switch-on and switch-off cycles.
Long-term stability/drift:	< 0.1 vol.-% in the first 5,000h operating time
Maintenance interval :	We recommend checking the O_2sensor every 6 months. check.
Measuring behaviour:	The gas to be tested may have a maximum have a maximum velocity of 25m/s. In addition, a laminar flow is recommended. If the specification differs specification, the sensor must be tested for tested for functionality.
Connection cable:	3 m enclosed; more detailed information on page 123
RoHS compliant:	Yes
Customs tariff number:	90271010
COO:	Germany / NRW
EC-79/2009	Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

Accuracy of the measured values:[390]

388 Measured with forming gas 90/10, 1.5 bar absolute, room temperature
389 Measuring components are purely inorganic and are not consumed during measurement
390 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar

Size	Accuracy
Oxygen concentration	± 0.5 vol.-% O_2
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[391]	± 0,3 °C
Pressure	± 20 mbar

Table20 : Statistical errors for individual measured variables

Mounting the sensor:

The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO445HT.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request (see data sheet_Adapter_NEO1XX_V146_EN_EN). To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a spatial direction other than horizontally, a small offset[392] occurs; this must be corrected via a specific CAN message on ID 0x680 (zero point adjustment, see page). 14

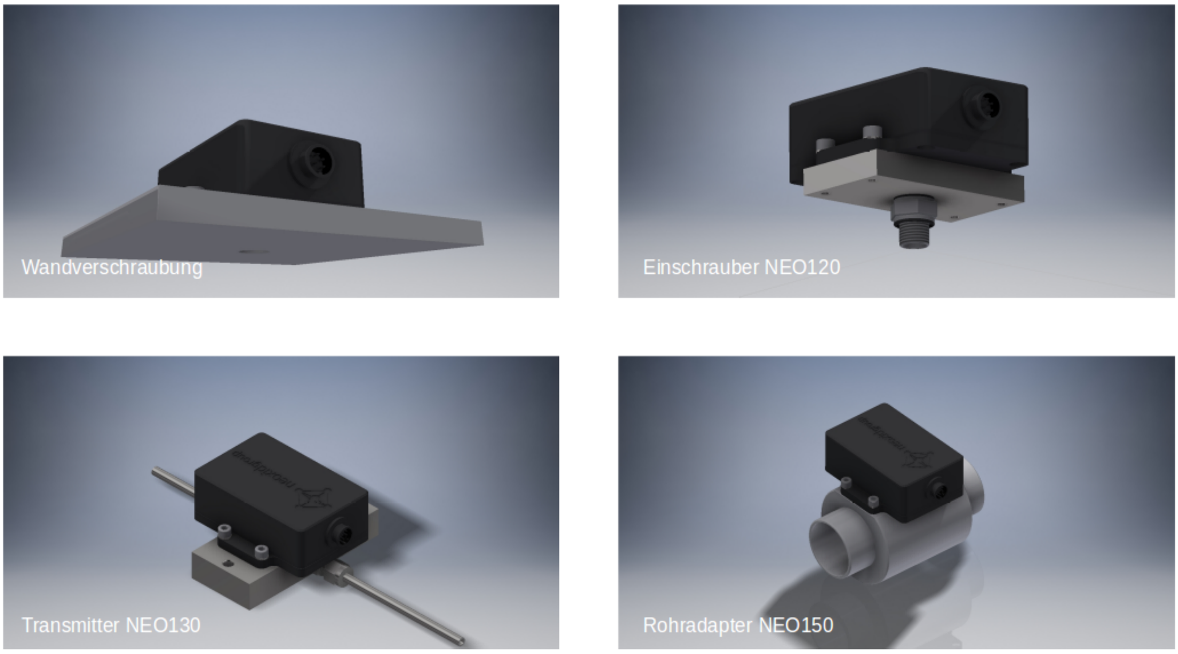


Figure 2a: Mounting the O_2sensor system

391 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber
392 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The above-mentioned adapters (with the exception of the NEO160) can also be fitted with heating cartridges, which are also available on request. As a further protective measure against small amounts of splash water, the sensor is fitted with a ribbed plug. Care must be taken to ensure that the sensor is installed in such a way that this plug functions properly if an installation with a passing gas is used.

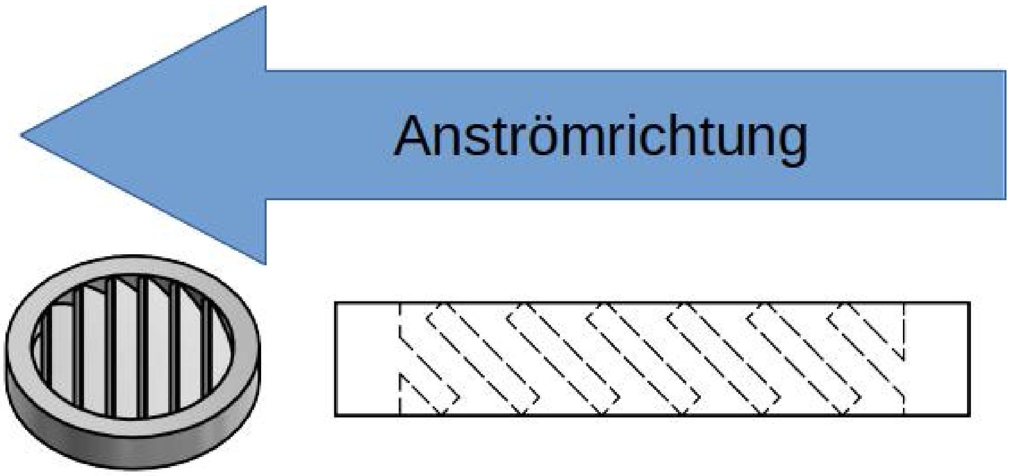


Figure 2b: Fitting ribbed plugs against the direction of flow

Hole pattern:

Figure 3a: Hole pattern of the O_2sensor system from below

Drilling template:

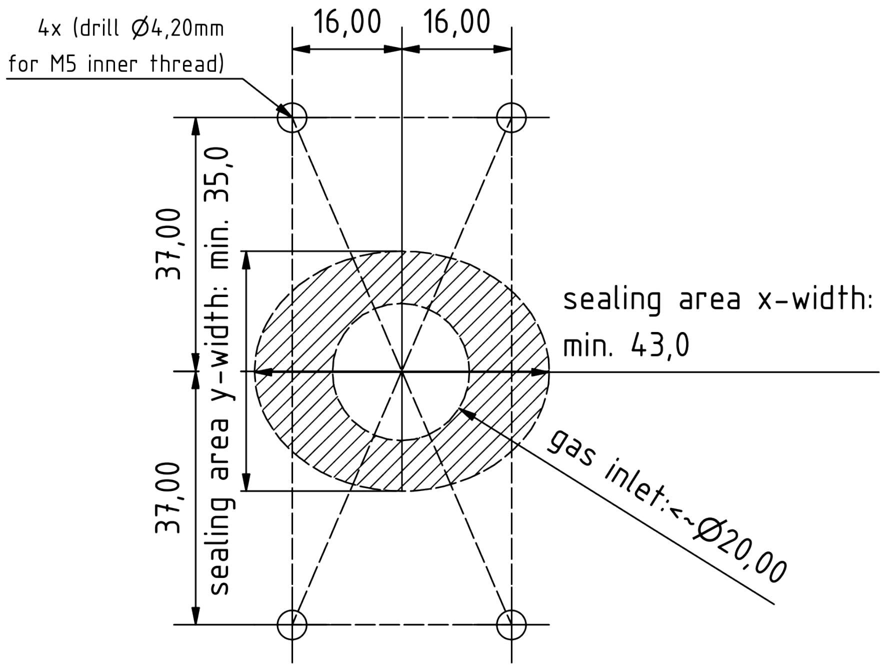
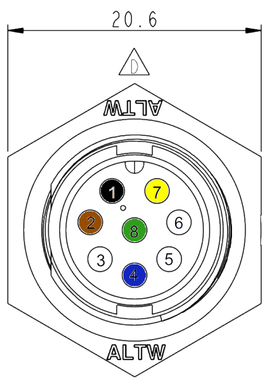


Figure 3b: Drilling template

Electrical PIN assignment



Housing plug

PIN no.	Description of the	Colour
1	VCC+ 12 ...+30 V DC (min.: 2.4W)	black
2	GND 0V DC	brown
3	CAN-High (opt. DAC+)	white
4	CAN-Low(opt. DAC-)	blue
5	*service port A*	-
6	*service port B*	-
7	DAC + / RS485 A	yellow
8	DAC - / RS485 B	green
	Shielding (optional GND)	green/yellow

8-pin housing connector: Amphenol LTW: ABD-08PMMS-LC7001
8-pin cable socket: Amphenol LTW: BD-08BFFA-LL7001

Figure 3c below shows the enclosed connection cable with angled socket:

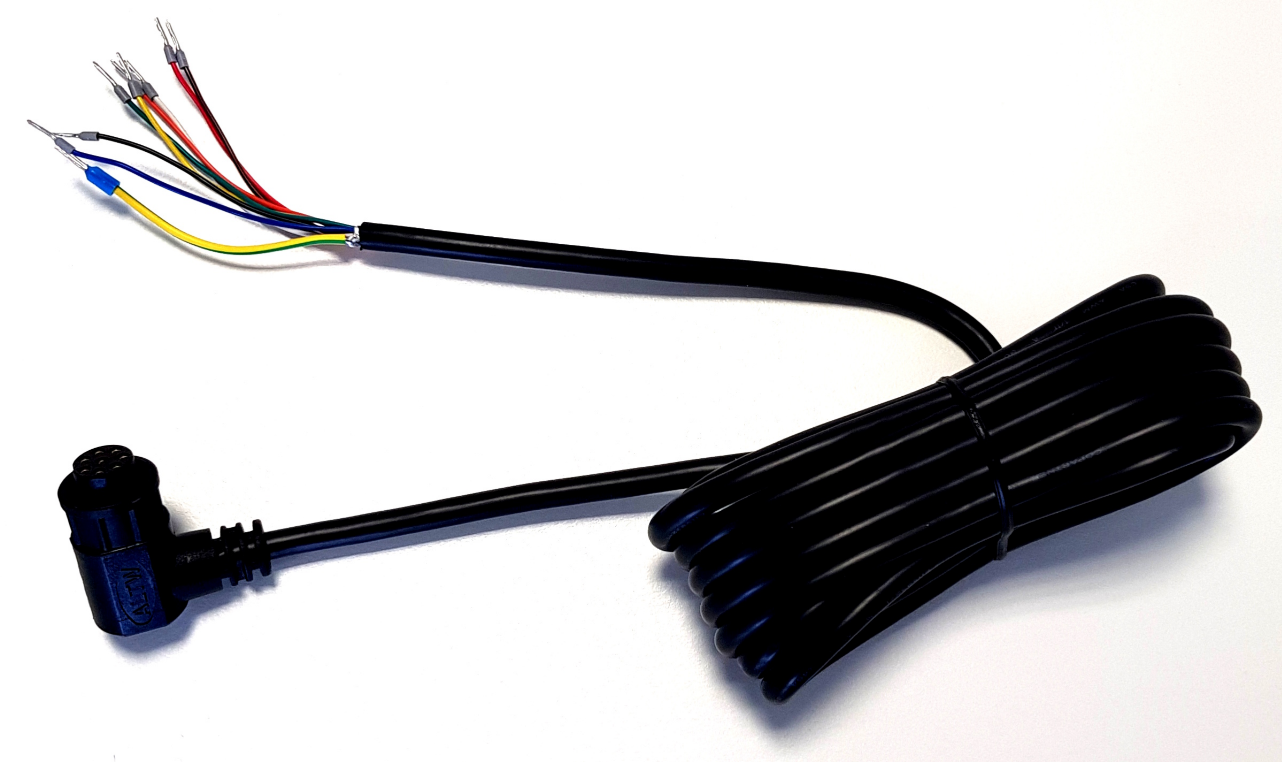


Figure 3c: Connection cable with angled socket

Simultaneous signal output via CAN bus and an analogue interface

If required, the sensor's measurement data can be output simultaneously via the CAN bus interface and an analogue interface (4-20 mA, 0-10V). If an analogue interface (4-20 mA, 0-10V) is selected in addition to the CAN bus, the analogue signal is output via PIN 7 & 8. CAN addressing via the connector is then no longer possible!

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO445HTA (0-5 vol.-% O_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to set the CAN ID after adjustment. must be made. This is permanent and affects all outgoing O_2signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be oxygen-free and flushed with hydrogen. [393]

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[394]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
To set the CAN ID, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

393 Details can be found in the operating instructions under chapter: "Maintenance and service"
394 0xYY describes a measure for the set zero point adjustment

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message is delivered after 5 seconds at system start.

The CAN IDs of the sensor are as follows:

	CAN ID 1	**CAN-ID 2**	**CAN-ID 3**	**CAN-ID 4**
NEO445HTA (0-5 vol.-% O2)	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359

Set CAN ID (CAN2.0B):

To set the CAN ID, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x200
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x200, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):

A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make an adjustment. This is permanent and affects all outgoing O_2signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be oxygen-free and flushed with hydrogen. [395]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[396]
*corresponds to the serial number of the individual sensor system.

395 Details can be found in the operating instructions under chapter: "Maintenance and service"
396 0xYY describes a measure for the set zero point adjustment

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/O2-Sensor_NEO445HT_V146.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Oxygen concentration [vol.-%]: c(*O2) = (Msg0-20)/100*
Msg 1(Bit 16-31): *Water concentration [vol.-%]: c(O2O) = (Msg1-20)/100*
Msg 2(bit 32-47): Pressure [mbar]: *p = Msg2*
Msg 3(Bit 48-55): Temperature [°C]: *T = (Msg3-60)*
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0D59:
Msg 0(Bit 0-15): Oxygen concentration_RAW[vol.-%]: c(O2) = (Msg0-20)/100
Measurement of the oxygen content, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $O_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured oxygen concentration exceeds the 0.5 vol.-% limit (c(O_2) from <0.5 vol.-% to >= 0.5 vol.-%).

The following message is sent:
Msg 0(bit 0-15): Oxygen concentration [vol.-%]: c(O_2) = (Msg0-20)/100
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $O_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No hydrogen	1: Hydrogen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait
Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

Example:

"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Set the baud rate to 500 kbit/s or 250 kbit/s:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H2 in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Initiate maintenance:
0x680 0x00 0x77 0x61 0x72 0x74 0x75 0x6E 0x67

Analogue 4-20mA - Series I

I[mA]	c(O_2) [vol.-%]	Comment
4 - 20 mA[397]	0 - 5 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum oxygen volume concentration. This means that 2.5 vol-% $O_{(2)}$,for example, is then output as 12 mA for a 5 vol-% O_2sensor system. In the heat-up phase and during a critical fault, a current < 4mA is output (usually approx. 3mA)

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The maximum permissible load is 450 Ohm.

Analogue 0-10V - Series I

U[V]	c(O_2) [vol.-%]	Comment
0 - 10 V	0 - 5 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum oxygen volume concentration in a range from 1V to 9V. This means that 2.5 vol-% $O_{(2)}$,for example, is then output as 5V for a 5 vol-% O_2sensor system. Values less than 1V indicate an error.

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The minimum measuring resistance is 10 kOhm.

The following diagram 5 shows a connection diagram:

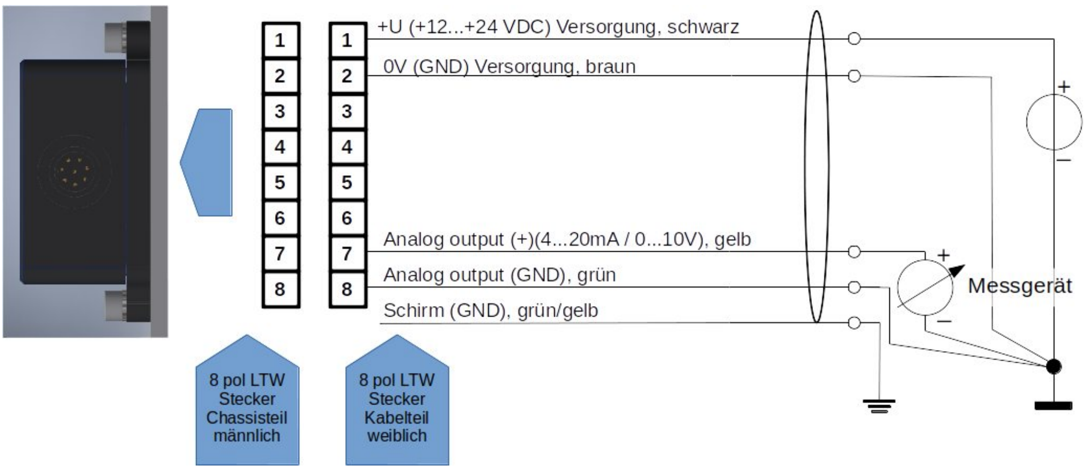


Figure 5: Wiring diagram

397 In earlier versions of this sensor, 7.2 to 20mA was given as the measuring range.

Digital Modbus via RS485 - Series M

RS485 (Modbus RTU) Factory settings:

Slave ID: 1
Baud rate: 9600
Parity: none
Stop Bits: 1
CRC: 16bit

Name	**Description of the**	**Register addresses (hex / dec)**
Oxygen concentration	O_2Volume concentration = x / 100 - 20 vol.-% (Example: 2330 = 3.3 vol.-%)	0x7531 / 30001
Water concentration	H_2O volume concentration = x / 100 - 20 vol.-% (Example: 2330 = 3.3 vol.-%)	0x7532 / 30002
Pressure	Pressure = x - 20 mbar (Example: 1033 = 1013 mbar)	0x7533 / 30003
Temperature	Temperature = x / 100 - 40 °C (Example: 6250 = 22.5°C)	0x7534 / 30004
CRC	According to: SAE J1850 ZERO (Example: CRC 0x00 0x14 0x00 0x14 0x20 0x34 0x5A = 0xAA)	0x7535 / 30005
Oxygen concentration_RAW	Oxygen concentration = x / 100 - 20 vol.-% (Example: 2750 = 7.50 vol.-%)	0x7536 / 30006
Gross value	Raw value = 100 in the absence of water and oxygen in pure hydrogen	0x7537 / 30007
Status byte	32: Sensor maintenance required 16: Oxygen present 8: Sensor in heating phase +0: Sensor fully functional +2: A parameter outside the defined Area +4: Error: Sensor defective +6: Error: Measuring time defective	0x7538 / 30008
Serial number	S/N: P number, which is noted on the outside of the device. (Example: 626 = P-0626)	0x7539 / 30009
Software version	Software version = x / 10 (146 = 14.6)	0x753A / 30010
Continuous message counter	High running counter	0x753B / 30011
Empty byte	No relevant information	0x753C / 30012

Holding register:

Name	Description of the	Register address
Baud rate	Set the baud rate of the Modbus RTU interface: 4800 9600 19200 default: 9600 Changes to the baud rate are only accepted after the sensor is restarted	0x9C41
Slave ID	Slave ID of the sensor 1-200 default: 1 Changes to the slave ID are only applied after the sensor is restarted	0x9C42
Mode	0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2 default: Parity: none, stop bit: 1 Mode change is only applied after restarting the sensor	0x9C43
Zero point adjustment	Default: 0 If a 1 is written to the register, a zero point adjustment is carried out here (see page:14) and the register is then changed to 2.	0x9C44

Information on the registers:

The registers are defined as unsigned 16-bit integers. So they have a range from 0 to 65535. When reading out with a PLC, make sure that the data type is set to "Real" so that the unsigned integer can also be displayed as a comma number.

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapters and heaters:
Various adapters are available for mounting the sensor. For use in very humid environments or environments with liquid water or the risk of icing, there are heating cartridges that can be operated at a constant voltage. These can be fitted in the adapters. You can find the corresponding products under:
https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for the fine purification of gases by removing minimal impurities.

FAQ:
The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Data sheet oxygen concentration sensor NEO445,

Version 15.6

Product description:

Sensor system for measuring the oxygen concentration in hydrogen with temperature-, pressure- and humidity-compensated signal evaluation for automotive or industrial applications. Applicable in the range: 0.6 - 5 bara, 0 - 100% r.h. (non-condensing) and -40°C - 85°C. A mathematical prediction algorithm ensures very short response and decay times.

Properties:

- Measuring range: 0-5 vol.-% O_2in $H_{(2)}$ (0-5 vol.-% H_2sensor in O_2would be the NEO974)
- Measurement of electrolysis gases (O_2in H_2) , installation in test benches / electrolysers
- Measuring signal independent of pressure, temperature and humidity
- Signal output via CAN 2.0, Modbus RTU via RS485, 0-10V or 4-20mA
- The gas concentration is not changed by the measurement.
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Factory calibrated and ready for immediate use
- Due to the wide variety of possible operating conditions, sample extraction is rarely necessary.
- Encrypted CAN communication on demand

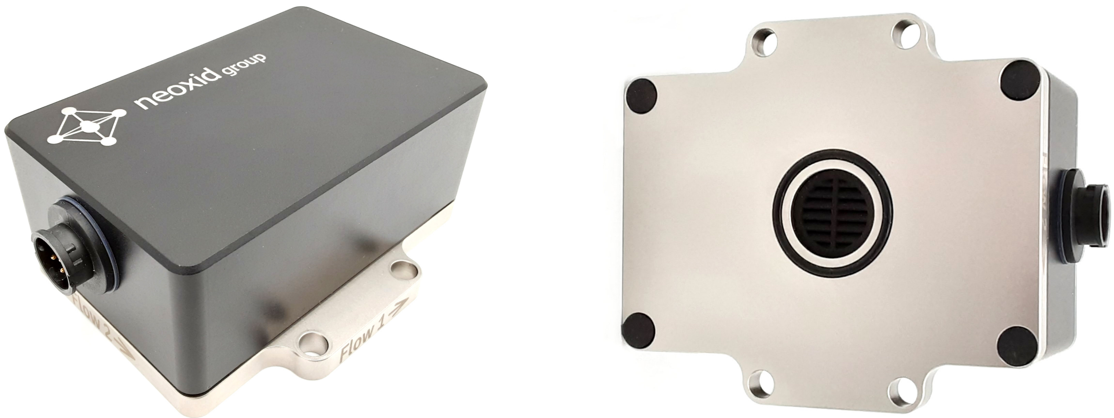


Figure 1: O_2concentration sensor version NEO445

...go to English version

Sensor system characteristics:

Supply voltage: 12 - 32 V DC

Energy consumption: < 2,4 W

O_2sensitivity: 0 - 5 vol.-% O_2

Accuracy: ± 0.3 vol.-% O_2

Detection limit: < 0.3 vol.-% O_2

Response time t_{90}: < 3 s

Decay time t_{10}: < 3 s

Start-up time after cold start: < 5 s until the first message
< 70 s until quantification of the O_2concentration[398]

Media temperature: - 40°C - 85°C

Ambient temperature: - 40°C - 85°C
The cold start at -40°C was tested.

Pressure range: 0.6 - 5 bar absolute, i.e. 60 - 500 kPa

Air humidity: 0 - 100 % r.h. (non-condensing)[399]

Carrier gas: Hydrogen[400]

Signal :[401] CAN 2.0A/B (125, 250, 500, 1000 kbit/s) on page25
Modbus RTU via RS485 interface on page 29
4-20 mA on page 28
0-10 V on page 28

Output/measurement interval: 100 ms / 10 Hz

Resolution: 100 ppm for CAN bus and Modbus RTU
250 ppm at 4-20 mA or 0-10V

398 The system is designed for continuous operation
399 In particular, splash water must be kept away from the sensor opening
400 If you flush this 0-5% O_2sensor with nitrogen (even without hydrogen content), a full signal (i.e. 5% O_2) is measured!
401 Signals are described in the "Explanation of signals" section

Housing: with	Size: 95 x 83 x 41 mm³, housing cover made of EN AW 6060 and media-contacting base plate made of 316L or 1.4454, M5 screws to the measuring chamber 3Nm.
Leakage rate:	10^{-5}mbar l / s [402]
IP code:	IP6K7
Weight:	< 570 g
SIL:	-
ATEX:	-
Service life:	IP6K7 enclosure qualified with an expected Service life of 5 years[403] . The system was tested with 100,000 switch-on and switch-off cycles.
Long-term stability/drift:	< 0.1 vol.-% in the first 5,000h operating time
Maintenance interval : 6 months.	We recommend checking the O_2sensor every check.
Measuring behaviour: addition, a specification differs must be tested for	The gas to be tested may have a maximum have a maximum velocity of 25m/s. In laminar flow is recommended. If the specification, the sensor tested for functionality.
Connection cable: page 123	3 m enclosed; more detailed information on
RoHS compliant:	Yes
Customs tariff number:	90271010
COO:	Germany / NRW
EC-79/2009	Not subject to type-approval according to Annex I b), Annex I defines the components to be tested only for liquid hydrogen parts and those above 30 bar

402 Measured with forming gas 90/10, 1.5 bar absolute, room temperature
403 Measuring components are purely inorganic and are not consumed during measurement

Accuracy of the measured values:[404]

Size	**Accuracy**
Oxygen concentration	± 0.3 vol.-% O_2
Water vapour concentration	± 0.15 vol.-% H_2O
Temperature[405]	± 0,3 °C
Pressure	± 20 mbar

Table21 : Statistical errors for individual measured variables

Mounting the sensor:

The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO445.zip
During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request (see data sheet_Adapter_NEO1XX_V146_EN_EN). To use the sensor as a room monitoring sensor, there is the NEO160 adapter, which ensures that the sensor can be screwed to any surface without the opening being closed. If the sensor is mounted in a spatial direction other than horizontally, a small offset[406] occurs; this must be corrected via a specific CAN message on ID 0x680 (zero point adjustment, see page). 14
Figure 2a: Mounting the O_2sensor system

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The adapters mentioned above (with the exception of the NEO160) can also be fitted with heating cartridges, which are also available on request. As a further protective measure against small amounts of splash water, the sensor is fitted with a ribbed plug. Care must be taken to ensure that the sensor is installed in such a way that this plug functions properly if an installation with a passing gas is used.

404 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar

405 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber

406 When tilted by ± 40° in all directions, the error is less than ± 0.05 vol.-%.

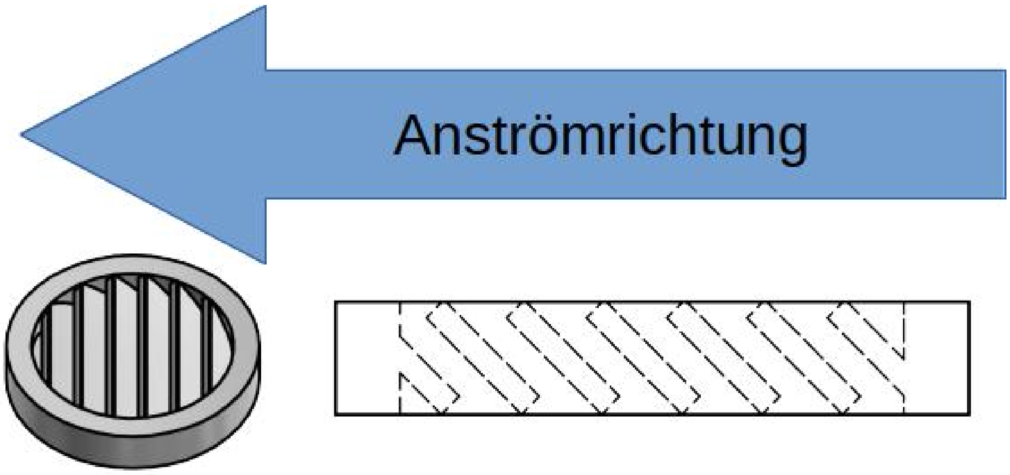


Figure 2b: Fitting ribbed plugs against the direction of flow

Hole pattern:

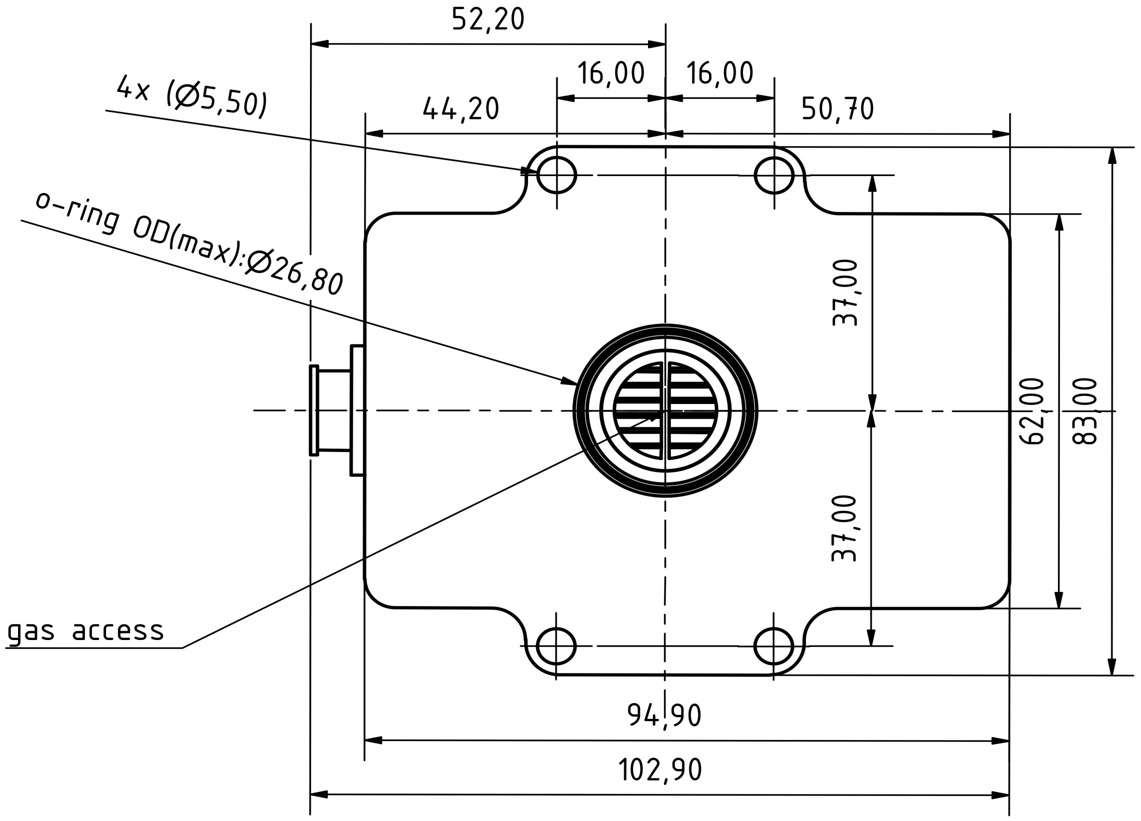


Figure 3a: Hole pattern of the O_2sensor system from below

Drilling template:

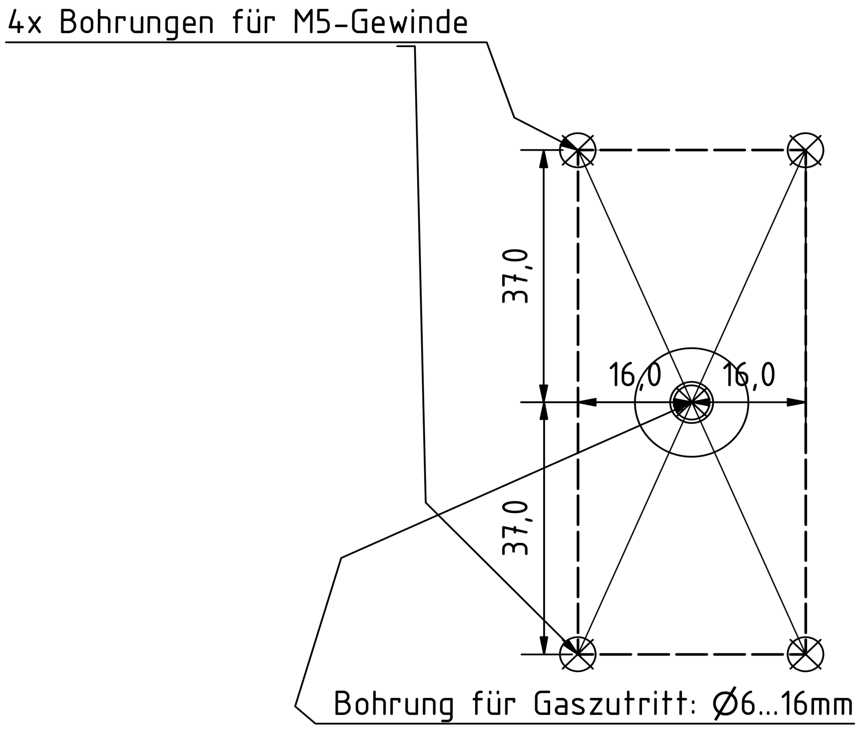
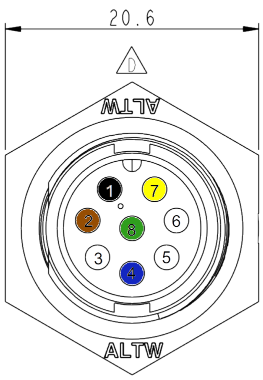


Figure 3b: Drilling template

Electrical PIN assignment



Housing plug

PIN no.	Description of the	Colour
1	VCC+ 12 ...+30 V DC (min.: 2.4W)	black
2	GND 0V DC	brown
3	CAN-High (opt. DAC+)	white
4	CAN-Low(opt. DAC-)	blue
5	*service port A*	-
6	*service port B*	-
7	CAN-Addr 1 / DAC + / RS485 A	yellow
8	CAN-Addr 2 / DAC - / RS485 B	green
	Shielding (optional GND)	green/yellow

8-pin housing connector: Amphenol LTW: ABD-08PMMS-LC7001
8-pin cable socket: Amphenol LTW: BD-08BFFA-LL7001

Figure 3c below shows the enclosed connection cable with angled socket:

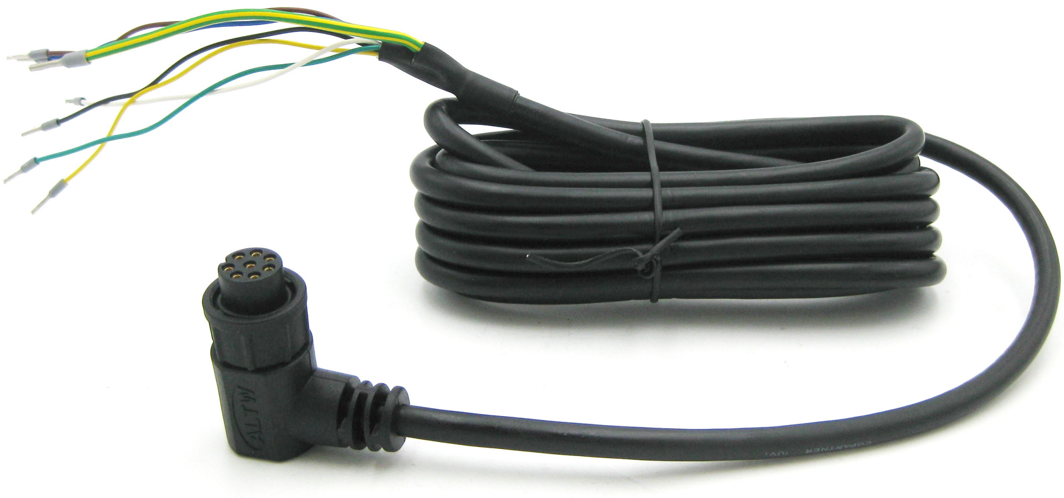


Figure 3c: Connection cable with angled socket

Simultaneous signal output via CAN bus and an analogue interface

If required, the sensor's measurement data can be output simultaneously via the CAN bus interface and an analogue interface (4-20 mA, 0-10V). If an analogue interface (4-20 mA, 0-10V) is selected in addition to the CAN bus, the analogue signal is output via PIN 7 & 8. CAN addressing via the connector is then no longer possible!

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO445A (0-5 vol.-% O_2)	0x300 & 0x301	0x308 & 0x309	0x310 & 0x311	0x318 & 0x319

Zero point adjustment (CAN2.0A):
A specific 8-byte message on the CAN ID 0x680 can be used to perform a zero point adjustment. must be made. This is permanent and affects all outgoing O_2signals.
0x680 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be oxygen-free and flushed with hydrogen.[407] Only the measured values for the oxygen concentration are readjusted.

The sensor returns the following response:
0x361 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[408]

*corresponds to the serial number of the individual sensor system.

Set CAN ID (CAN2.0A):
There are two additional cable ends on the supplied cable for setting the CAN ID. These are called Add.1 and Add.2. Both should float for the standard ID. To change the CAN ID, these should then each be connected to GND so that 4 different IDs can be set. The names of the lines can be found in the cable assignment supplied.

Standard ID:	→	ID: 0x300
CAN-Addr 1 to GND:	→	ID is increased by 0x08
CAN-Addr 2 to GND:	→	ID is increased by 0x10
CAN-Addr 1 and 2 to GND:	→	ID is increased by 0x18

The cable designations can be found in the enclosed cable assignment.

Alternatively, a CAN message can be sent to change the address.
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver

407 Details can be found in the operating instructions under chapter: "Maintenance and service"
408 0xYY describes a measure for the set zero point adjustment

MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
First CAN message after 5s at system startup

The CAN IDs of the sensor are as follows:

	CAN ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO445A (0-5 vol.-% O2)	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359

Set CAN ID (CAN2.0B):
There are two additional cable ends on the supplied cable for setting the CAN ID. These are called Add.1 and Add.2. Both should float for the standard ID. To change the CAN ID, these should then each be connected to GND so that 4 different IDs can be set. The names of the lines can be found in the cable assignment supplied.

Standard ID: → ID: 0x0CFF0C59
CAN-Addr 1 to GND → ID is increased by 0x200
CAN-Addr 2 to GND: → ID is increased by 0x400
CAN-Addr 1 and 2 on GND: → ID is increased by 0x600

Alternatively, a CAN message can be sent to change the address.
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x200
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x200, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

Zero point adjustment (CAN2.0B):

A specific 8-byte message on the CAN ID 0x0CFF6000 can be used to make an adjustment. This is permanent and affects all outgoing O_2signals.
0x0CFF6000 0x14 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

To carry out an adjustment, the system should be oxygen-free and flushed with hydrogen. [409]

The sensor returns the following response:
0x0CFFFF59 0x14 0x97 0xCD 0xE7 0xXX* 0xXX* 0xB3 0xYY[410]
*corresponds to the serial number of the individual sensor system.

CAN wake-up function (CAN 2.0A & CAN2.0B):
The sensor issues a wake-up message on ID: 0x112 or 0x0CFF0059. This is only sent once if the measured oxygen concentration exceeds the 0.5 vol.-% limit (c(O_2) from <0.5 vol.-% to >= 0.5 vol.-%).

The following message is sent:
Msg 0(bit 0-15): Oxygen concentration [vol.-%]: c(O_2) = (Msg0-20)/100
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $O_2$the following applies: Raw value = *100±1*

409 Details can be found in the operating instructions under chapter: "Maintenance and service"
410 0xYY describes a measure for the set zero point adjustment

Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

CAN Matrix Message Layout (CAN 2.0A & CAN2.0B):
A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/O2-Sensor_NEO4XX_V146.dbc.zip

1st CAN message e.g. 0x300 or 0x0CFF0C59:
Msg 0(bit 0-15): Oxygen concentration [vol.-%]: c(O_2) = (Msg0-20)/100
Msg 1(Bit 16-31): Water concentration [vol.-%]: c($H_{(2)}$ O) = (Msg1-20)/100
Msg 2(bit 32-47): Pressure [mbar]: p = Msg2
Msg 3(Bit 48-55): Temperature [°C]: T = (Msg3-60)
Temperature of the measuring chamber, usually higher than in the medium
Msg 4(Bit 56-63): CRC - SAE J1850 ZERO: CRC(0x00 0x14 0x00 0x14 0x20 0x34 0x5A) = 0xAA

2nd CAN message, e.g. CAN ID 0x301 or 0x0CFF0D59:
Msg 0(Bit 0-15): Oxygen concentration_RAW[vol.-%]: c(*O2) = (Msg0-20)/100*
Measurement of the oxygen content, without internal logic
Msg 1(Bit 16-23): Raw value: Output of the raw value for error checking. For measurements with defined carrier gas, without humidity, normal pressure and in the absence of $O_2$the following applies: Raw value = *100±1*
Msg 2(Bit 24-31): Status byte: see below.
Msg 3(Bit 32-47): *Serial* number
Msg 4(Bit 48-55): Software version: *Version = (Msg4 / 10)*
Msg 6(Bit 56-63): Continuous message counter

Explanation of the status byte:

Bit 24	Always 0	
Bit 25	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 26	0: Sensor OK.	1: Sensor defective
Bit 27	0: Sensor in control mode	1: Sensor in heating phase
Bit 28	0: No oxygen	1: Oxygen >0.5 % by volume
Bit 29	0: No maintenance required	1: Sensor please wait
Bit 30	0: Sensor is calibrated	1: Recalibrate sensor
Bit 31	Always 0	

Example:
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Set the baud rate to 500 kbit/s or 250 kbit/s:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Recalibrate hydrogen slope at 2% H2 in carrier gas:
0x680 0x19 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Speed up the prediction algorithm:
0x680 0x82 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Slowing down the prediction algorithm:
0x680 0x8C 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Initiate maintenance:
0x680 0x00 0x77 0x61 0x72 0x74 0x75 0x6E 0x67

Analogue 4-20mA - Series I

I[mA]	c(O_2) [vol.-%]	Comment
4 - 20 mA[411]	0 - 5 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum oxygen volume concentration. This means that 2.5 vol-% $O_{(2)}$,for example, is then output as 12 mA for a 5 vol-% O_2sensor system. In the heat-up phase and during a critical fault, a current < 4mA is output (usually approx. 3mA)

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The maximum permissible load is 450 Ohm.

Analogue 0-10V - Series I

U[V]	c(O_2) [vol.-%]	Comment
0 - 10 V	0 - 5 vol.-%	The concentration is distributed linearly between 0 vol.-% and the maximum oxygen volume concentration in a range from 1V to 9V. This means that 2.5 vol-% $O_{(2)}$,for example, is then output as 5V for a 5 vol-% O_2sensor system. Values less than 1V indicate an error.

It should be noted that the analogue output of the sensors is subject to an additional error of± 2% FS. The minimum measuring resistance is 10 kOhm.

The following diagram 5 shows a connection diagram:

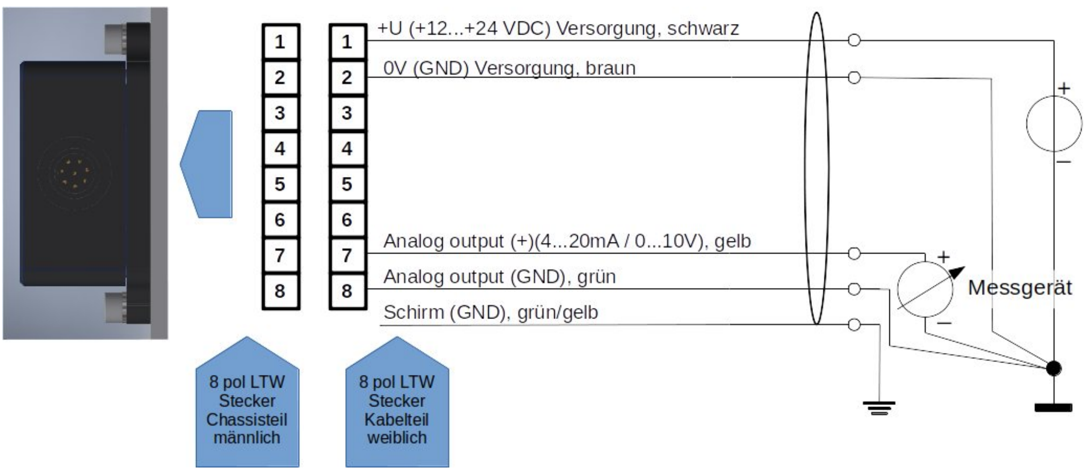


Figure 5: Wiring diagram

411 In earlier versions of this sensor, 7.2 to 20mA was given as the measuring range.

Digital Modbus via RS485 - Series M

RS485 (Modbus RTU) Factory settings:

Slave ID: 1
Baud rate: 9600
Parity: none
Stop Bits: 1
CRC: 16bit

Name	**Description of the**	**Register addresses (hex / dec)**
Oxygen concentration	O_2Volume concentration = x / 100 - 20 vol.-% (Example: 2330 = 3.3 vol.-%)	0x7531 / 30001
Water concentration	H_2O volume concentration = x / 100 - 20 vol.-% (Example: 2330 = 3.3 vol.-%)	0x7532 / 30002
Pressure	Pressure = x - 20 mbar (Example: 1033 = 1013 mbar)	0x7533 / 30003
Temperature	Temperature = x / 100 - 40 °C (Example: 6250 = 22.5°C)	0x7534 / 30004
CRC	According to: SAE J1850 ZERO (Example: CRC 0x00 0x14 0x00 0x14 0x20 0x34 0x5A = 0xAA)	0x7535 / 30005
Oxygen concentration_RAW	Oxygen concentration = x / 100 - 20 vol.-% (Example: 2750 = 7.50 vol.-%)	0x7536 / 30006
Gross value	Raw value = 100 in the absence of water and oxygen in pure hydrogen	0x7537 / 30007
Status byte	32: Sensor maintenance required 16: Oxygen present 8: Sensor in heating phase +0: Sensor fully functional +2: A parameter outside the defined Area +4: Error: Sensor defective +6: Error: Measuring time defective	0x7538 / 30008
Serial number	S/N: P number, which is noted on the outside of the device. (Example: 626 = P-0626)	0x7539 / 30009
Software version	Software version = x / 10 (146 = 14.6)	0x753A / 30010
Continuous message counter	High running counter	0x753B / 30011
Empty byte	No relevant information	0x753C / 30012

Holding register:

Name	Description of the	Register address
Baud rate	Set the baud rate of the Modbus RTU interface: 4800 9600 19200 default: 9600 Changes to the baud rate are only accepted after the sensor is restarted	0x9C41
Slave ID	Slave ID of the sensor 1-200 default: 1 Changes to the slave ID are only applied after the sensor is restarted	0x9C42
Mode	0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2 default: Parity: none, stop bit: 1 Mode change is only applied after restarting the sensor	0x9C43
Zero point adjustment	Default: 0 If a 1 is written to the register, a zero point adjustment is carried out here (see page:14) and the register is then changed to 2.	0x9C44

Information on the registers:

The registers are defined as unsigned 16-bit integers. So they have a range from 0 to 65535. When reading out with a PLC, make sure that the data type is set to "Real" so that the unsigned integer can also be displayed as a comma number.

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapters and heaters:
Various adapters are available for mounting the sensor. For use in very humid environments or environments with liquid water or the risk of icing, there are heating cartridges that can be operated at a constant voltage. These can be fitted in the adapters. You can find the corresponding products under:
https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for the fine purification of gases by removing minimal impurities.

FAQ:

The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Data sheet humidity, temperature and pressure sensor system NEO480HTA ATEX, version 15.6

Product description:

Humidity-measuring triple sensor system with temperature and pressure-compensated signal evaluation with CAN bus interface

Typical application:

- Detection of moisture in fuel cell systems
- Detection of moisture in cars

Properties:

- Measuring range humidity dew point up to +90°C
- Independent of pressure and temperature
- Error control
- Replacement for Vaisalla humidity sensors
- The gas concentration is not changed by the measurement.
- Signal output via CAN 2.0A or CAN2.0B
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Encrypted CAN communication on demand

Figure 1: Humidity sensor system version NEO480HTA

Sensor system characteristics:

Supply voltage: 12 - 32 V DC[412]

Energy consumption: < 1,0 W

Humidity sensitivity: 0 - 100 % r.h. (non-condensing)

Dew point: < 90°C

Humidity accuracy: < ± 0.9 g/m³
< ± 0.09 vol.-%
< ± 1,2 °
< ± 3 % r.h.

Pressure: 0.6 - 5 bar absolute

Response time t_{63}: < 10s

Start-up time after cold start: < 5s until the first CAN message
Stable humidity signal after less than 20s

Media temperature: - 40°C - 120°C

Ambient temperature: - 40°C - 100°C
The cold start at -40°C was tested.

Carrier gas: Air, nitrogen, hydrogen

IP code: IP6K9

Signal: CAN 2.0A / B (500kbit/s or 250kbit/s)
CAN lines are not terminated!
CAN ID: Standard 0x480[413] or 1152

Output/measurement interval: 100 ms / 10 Hz

Housing: Size: 95 x 83 x 48 mm³, housing cover made of EN AW 6060 and media-contacting base plate made of 316L or 1.4404, M5 screws to the measuring chamber with 3Nm.

IP code: IP6K7

Weight: < 810 g

SIL: -

412 For analogue 0-10V output, please apply more than 15 VDC.
413 CAN ID can be set individually, see section "Set CAN ID"

ATEX: Zone I available on request (see data sheet https://neoxid-cloud.de/Datenblatt_Triple-Sensor_NEO480HTA_ATEX_V146_DE_EN.pdf)

Service life: IP6K7 enclosure qualified with an expected Service life of 5 years.[414] The system has been tested with 100,000 switch-on and switch-off cycles.

Measuring behaviour: The gas to be tested may have a maximum have a maximum velocity of 25m/s. In addition, a laminar flow is recommended. If the specification differs specification, the sensor must be tested for tested for functionality.

Connection cable: 3 m enclosed

RoHS compliant: Yes

Customs tariff number: 90271010

COO: Germany / NRW

ECCN: EAR99

Accuracy of the measured values:[415]

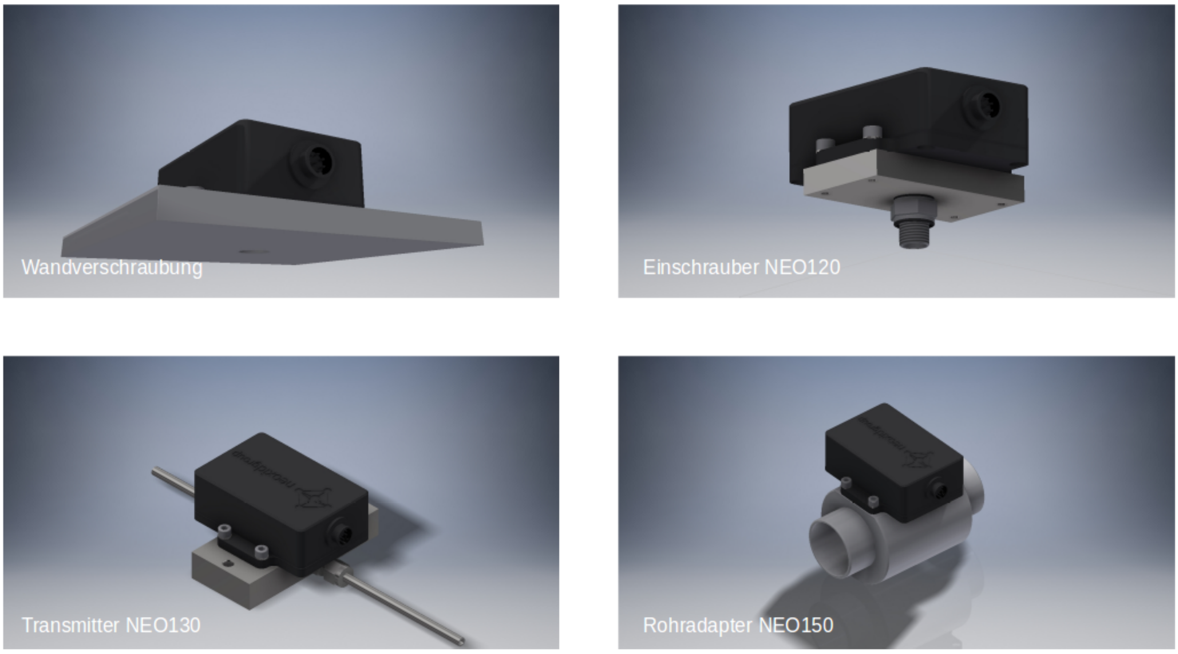
Size	**Accuracy**	**Unit**
Temperature[416]	< ± *0,3*	°C
Pressure	< ± *20*	mbar
Absolute humidity	< ± *0,9*	g/m³
Vol.-% H_2O	< ± *0,09*	Vol.-%
Dew point	< ± *1,2*	°C
Relative humidity	< ± *3*	%

Table22 : Statistical errors for individual measured variables

Assembly:
The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO480HT.zip

414 Measuring components are purely inorganic and are not consumed during measurement
415 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar
416 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber

Figure 2a: Mounting the humidity sensor system



During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request (see data sheet_Adapter_NEO1XX_V146_EN_EN). To use the sensor as a room monitoring sensor, the NEO160 adapter is available, which ensures that the sensor can be screwed to any surface without closing the opening.

ATEX area:

The sensor as such is not suitable for installation in an explosive atmosphere. It should be connected to an explosive atmosphere. The resulting ATEX Zone 1 area can be seen here:

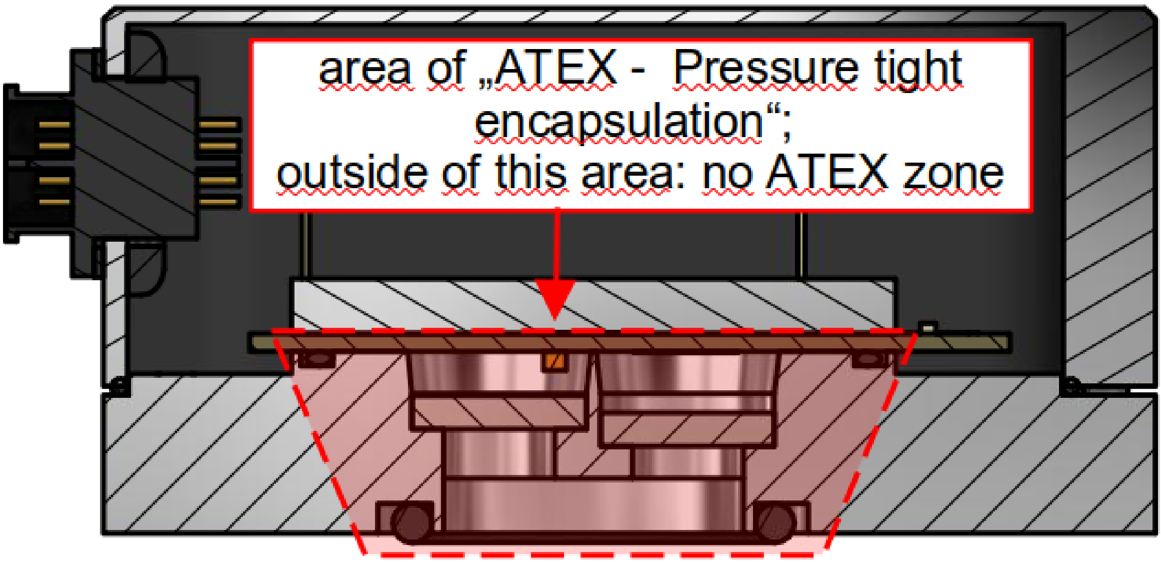


Figure 2a: Flameproof enclosure area

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems in which significant quantities of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The adapters mentioned above (with the exception of the NEO160) can also be fitted with heating cartridges, which are also available on request. Care must be taken to ensure that the sensor is installed in such a way that this plug functions properly if an installation with a passing gas is used.

Figure 2b: NEO480HT-ATEX O-ring and sintered metal discs

Hole pattern:

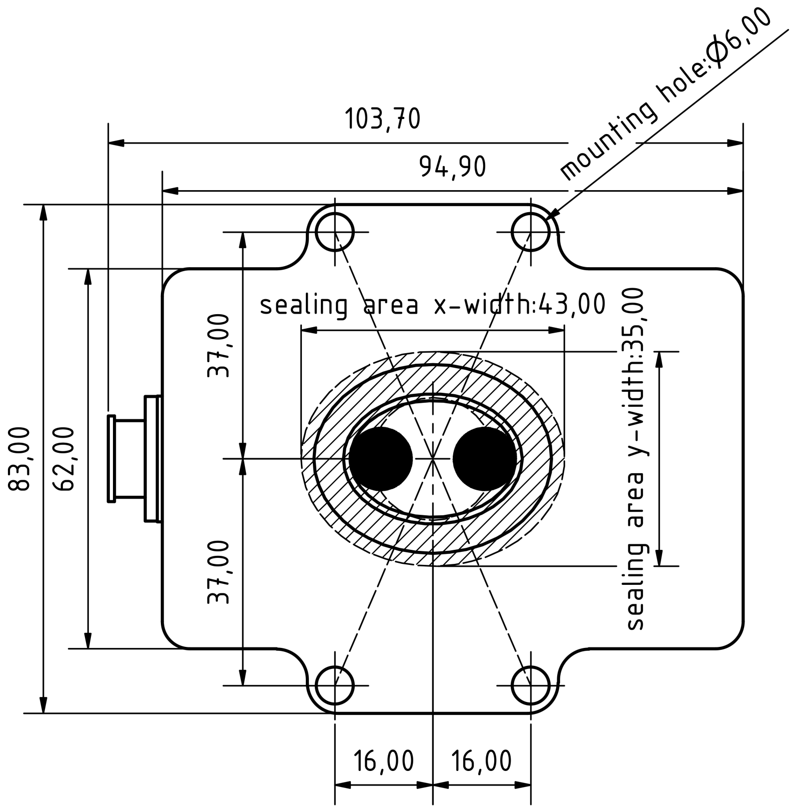


Figure 3a: Hole pattern of the humidity sensor system from below

Drilling template:

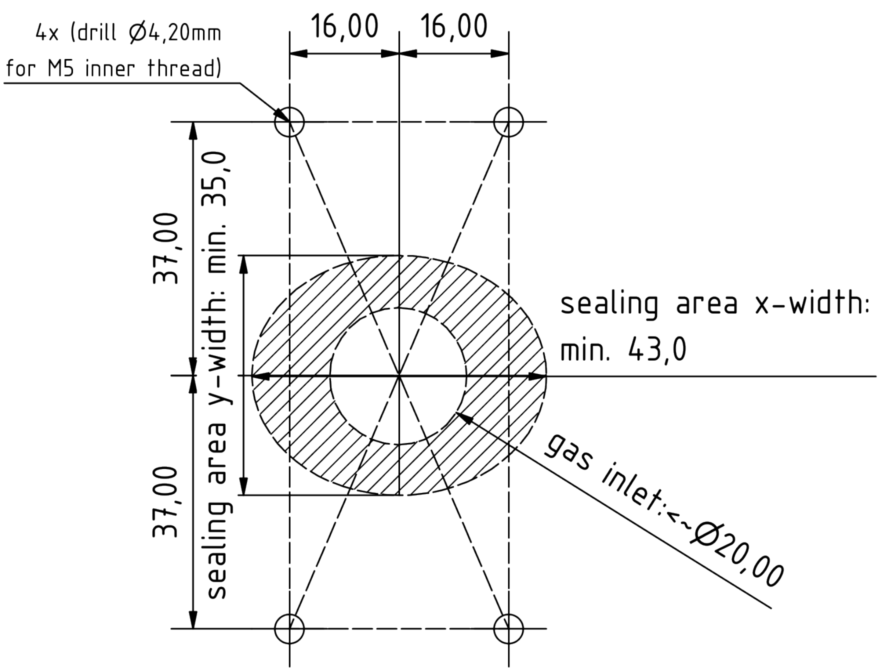
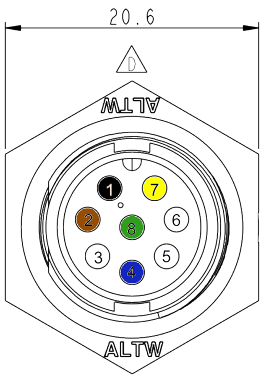


Figure 3b: Drilling template

During installation, it must be ensured that the opening is not blocked, e.g. by a condensing film of water. We recommend mounting the sensor system as shown in Figure

2.
The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm and a maximum of 10 Nm.

Electrical PIN assignment



Housing plug

PIN no.	Description of the	Colour
1	VCC+ 12 ... 30V DC (min.: 1W)	black
2	GND 0V DC	brown
3	CAN-High	white
4	CAN-Low	blue
5	*service port A*	-
6	*service port B*	-
7		yellow
8		green
	Shielding	green/yellow

8-pin housing connector: Amphenol LTW: ABD-08RMMS-LC7001
8-pin cable socket: Amphenol LTW: BD-08BFFA-LL7001

Figure 3c below shows the enclosed connection cable with angled socket:

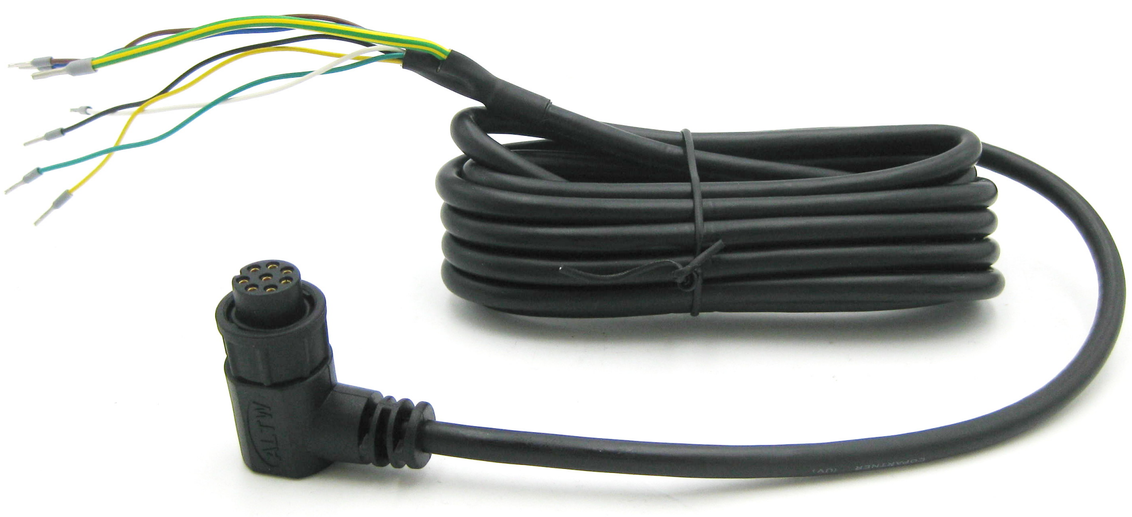


Figure 3c: Connection cable with angled socket

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562.
The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO480HTA	0x480 & 0x481	0x488 & 0x489	0x490 & 0x491	0x498 & 0x499

Set CAN ID (CAN2.0A):

The CAN ID can be changed via a CAN message. This is as follows:
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562. The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO480HTA	0x0CFF1C52 & 0x0CFF1D52	0x0CFF1E52 & 0x0CFF1F52	0x0CFF2052 & 0x0CFF2152	0x0CFF2252 & 0x0CFF2352

Set CAN ID (CAN2.0B):

The CAN ID can be changed via a CAN message. This is as follows:
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x200
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x200, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN matrix and message layout of the NEO480HTA:

A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/Triple-Sensor-NEO480.dbc.zip

CAN ID 0x480 or 0x0CFF0C59:
Msg 0 Bit(0-15): Dew point [°C] *tau = (Msg0- 28020) / 100*
Msg 1 bit(16-31): Pressure [mbar]: *p=(Msg1- 20) / 10)*
Msg 2 Bit(32-47): Temperature [°C]: *T= (Msg2 - 4020) / 100*
Msg 3(Bit 48-55): Status byte: see below.
Msg 4(Bit 56-63): continuous message counter

CAN ID 0x481 or 0x0CFF0D59:
Msg 0 Bit(0-15): Dew point_raw value [°C] tau = *Msg0- 28020) / 100*
Measurement of the dew point, without internal logic
Msg 1 bit(16-31): Absolute humidity [g/m³] *a.H. = (Msg1 - 20) /100*
Msg 2(bit 32-39): Water concentration [vol.-%]: $c(H_{(2)}O)=(Msg2 - 20) / 2$[417]
Msg 3(Bit 40-47): CRC 1
Msg 4(Bit 48-55): CRC 0
Msg 5(Bit 56-63): continuous message counter

Explanation of the status byte:

Bit 48	Always 0	
Bit 49	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 50	0: Sensor OK.	1: Sensor defective

417 Optional output as relative humidity r.h.

Bit 51	0: Sensor in control mode	1: Sensor in heating phase
Bit 52	Always 0	
Bit 53	0: No maintenance required	1: Sensor please wait
Bit 54	Always 0	
Bit 55	Always 0	

Example:
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Hydrogen >=0.5 % by volume" → Status byte = 00010000 binary → 10 hexadecimal, 16 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Set the baud rate to 500 kbit/s or 250 kbit/s:
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Initiate maintenance:
0x680 0x00 0x77 0x61 0x72 0x74 0x75 0x6E 0x67

Further CAN commands (CAN2.0B):

As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

Digital Modbus via RS485 or EIA/TIA-485 - NEO480 series M

In serial master-slave communication, our NEO sensors function as slaves with the start slave ID 1 and a baud rate of 9,600 in 8N1, i.e. data bits: 8, parity: none, stop bits: 1. The 16-bit registers are defined as signed integers in big-endian, i.e. values in the range -32,768 to 32,767. The Modbus lines are not terminated.

Input register:

Name	Description of the	Scaling[418]	Unit	Register addresses	INPUT register address (hex / dec)
Dew point	Dew point of the medium	100	°C	3x513	0x200 / 512_{dec}
Water concentration	H_2O Volume concentration	100	Vol.-%	3x514	0x201 / 513_{dec}
Pressure	Pressure as absolute pressure	1	mbar a	3x515	0x202 / 514_{dec}
Temperature	Temperature in measuring cavern	100	°C	3x516	0x203 / 515_{dec}
Dewpoint_RAW	Unfiltered dew point of the medium	100	°C	3x517	0x204 / 516_{dec}
Absolute humidity	Absolute humidity	100	g/m^3	3x518	0x205 / 517_{dec}
Serial number	S/N: P number, which is noted on the outside of the device. (Example: 3626 = P-3626)	1	-	3x519	0x206 / 518_{dec}
Software version	Version of the sensor software	10	-	3x520	0x207 / 519_{dec}
Message counter	High running counter 0-255	1	-	3x521	0x208 / 520_{dec}
Check value	00000000 01010101 value is 85, which can be used to check the byte order	1	-	3x522	0x209 / 521_{dec}

418 When reading with a PLC, make sure that the data type is set to "Real" so that the signed integer can also be displayed as a comma number.

Holding register:

Name	Description of the	Register addresses	HOLDING Register address (hex / dec)
Baud rate	default: 9,600 Specifying the baud rate of the Modbus RTU interface: 4,800, 9,600 or 19,200	4x001	0x00 / 0_{dec}
Slave ID	default: 1 Possible slave IDs of the sensor 1-247	4x002	0x01 / 1_{dec}
Mode parity	default: 0 = parity: none, stop bit: 1 0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2	4x003	0x02 / 2_{dec}

Changes to the factory settings are only applied after restarting the sensor.

Possible accessories:

Various accessories are available for the sensor. These can be purchased in addition to the sensor.

Adapters and heaters:
Various adapters are available for mounting the sensor. For use in very humid environments or environments with liquid water or the risk of icing, there are heating cartridges that can be operated at a constant voltage. These can be fitted in the adapters. You can find the corresponding products under:
https://neoxid-cloud.de/Datenblatt_Adapter_NEO120_NEO130_NEO150_NEO160_NEO170_NEO203_V146_DE_EN.pdf

neoCANLogger
The neoCANLogger is used to transfer the CAN data from the sensor into human-readable data and to record it:
https://neoxid-cloud.de/Datenblatt-neoCANLogger-Display-V01.pdf

Flameless hydrogen burner:
If, in addition to the detection of hydrogen, it is also to be consumed without a flame in order to either remove the hydrogen and/or utilise the thermal energy of hydrogen, we also offer catalytic burners in various sizes:
For a gas volume flow of up to 7.5m³/h:
https://neoxid-cloud.de/Datenblatt-NEO305_V006_DE_EN.pdf
For a gas volume flow of up to 74m³/h:
https://neoxid-cloud.de/Datenblatt_NEO324_V003_DE_EN.pdf
For a gas volume flow of 205m³/h:
https://neoxid-cloud.de/Datenblatt_NEO342_V004_DE_EN.pdf
Larger gas volume flows on request. The catalytic converters are also suitable for the fine purification of gases by removing minimal impurities.

FAQ:
The FAQs on sensors and possible accessories can be found here:
https://neoxid-cloud.de/FAQ_V01_DE_EN.pdf

Data sheet humidity, temperature and pressure sensor system NEO480HTA, version 16.0

Product description:

Humidity-measuring triple sensor system with temperature and pressure-compensated signal evaluation

Typical application:

- Detection of moisture in fuel cell systems
- Detection of moisture in cars

Properties:

- Measuring range humidity dew point up to +90°C
- Independent of pressure and temperature
- Error control
- Replacement for Vaisalla humidity sensors
- The gas concentration is not changed by the measurement.
- Signal output via CAN 2.0A / B or Modbus RTU/RS485
- Connection adapter available as a transmitter or screw-in version for measuring gas in a housing or pipe with optional external heaters
- Encrypted CAN communication on demand

Figure 1: Humidity sensor system version NEO480HTA

Sensor system characteristics:

Supply voltage: 12 - 32 V DC[419]

Energy consumption: < 1,0 W

Humidity sensitivity: 0 - 100 % r.h. (non-condensing)

Dew point: < 90°C

Humidity accuracy: < ± 0.9 g/m³
< ± 0.09 vol.-%
< ± 1,2 °
< ± 3 % r.h.

Pressure: 0.6 - 5 bar absolute

Response time t_{63}: < 10s

Start-up time after cold start: < 5s until the first CAN message
Stable humidity signal after less than 20s

Media temperature: - 40°C - 120°C

Ambient temperature: - 40°C - 100°C
The cold start at -40°C was tested.

Carrier gas: Air, nitrogen, hydrogen

IP code: IP6K9

Signal: CAN 2.0A / B (125, 250, 500 and 1,000 kbit/s possible)
CAN lines are not terminated!
CAN ID: Standard 0x480 and 0x481[420]

Output/measurement interval: 100 ms / 10 Hz

Housing: Size: 95 x 83 x 48 mm³, housing cover made of EN AW 6060 and media-contacting base plate made of 316L or 1.4404, tighten M5 screws to the measuring chamber with 3Nm.

IP code: IP6K7

Weight: < 810 g

SIL: -

419 For analogue 0-10V output, please apply more than 15 VDC.
420 CAN ID can be set individually, see section "Set CAN ID"

ATEX: Zone I available on request

Service life: IP6K7 enclosure qualified with an expected Service life of 5 years.[421] The system has been tested with 100,000 switch-on and switch-off cycles.

Measuring behaviour: The gas to be tested may have a maximum have a maximum velocity of 25m/s. In addition, a laminar flow is recommended. If the specification differs specification, the sensor must be tested for tested for functionality.

Connection cable: 3 m enclosed

RoHS compliant: Yes

Customs tariff number: 90271010

COO: Germany / NRW

ECCN: EAR99

Accuracy of the measured values:[422]

Size	Accuracy	Unit
Temperature[423]	< ± *0,3*	°C
Pressure	< ± *20*	mbar
Absolute humidity	< ± *0,9*	g/m³
Vol.-% H_2O	< ± *0,09*	Vol.-%
Dew point	< ± *1,2*	°C
Relative humidity	< ± *3*	%

Table23 : Statistical errors for individual measured variables

421 Measuring components are purely inorganic and are not consumed during measurement

422 All specifications of accuracies at 50% r.h., 25°C and a pressure of 1018 mbar

423 The temperature in the measuring chamber is always measured too high, as the sensor elements heat up the measuring chamber

Operating instructions:

The operating instructions can be downloaded from the following link:
https://neoxid-cloud.de/Betriebsanleitung-NEO480-V08_DE_EN.pdf

Assembly:
The stepfile and 2-D drawing of the sensor can be found here:
https://neoxid-cloud.de/NEO480HT.zip

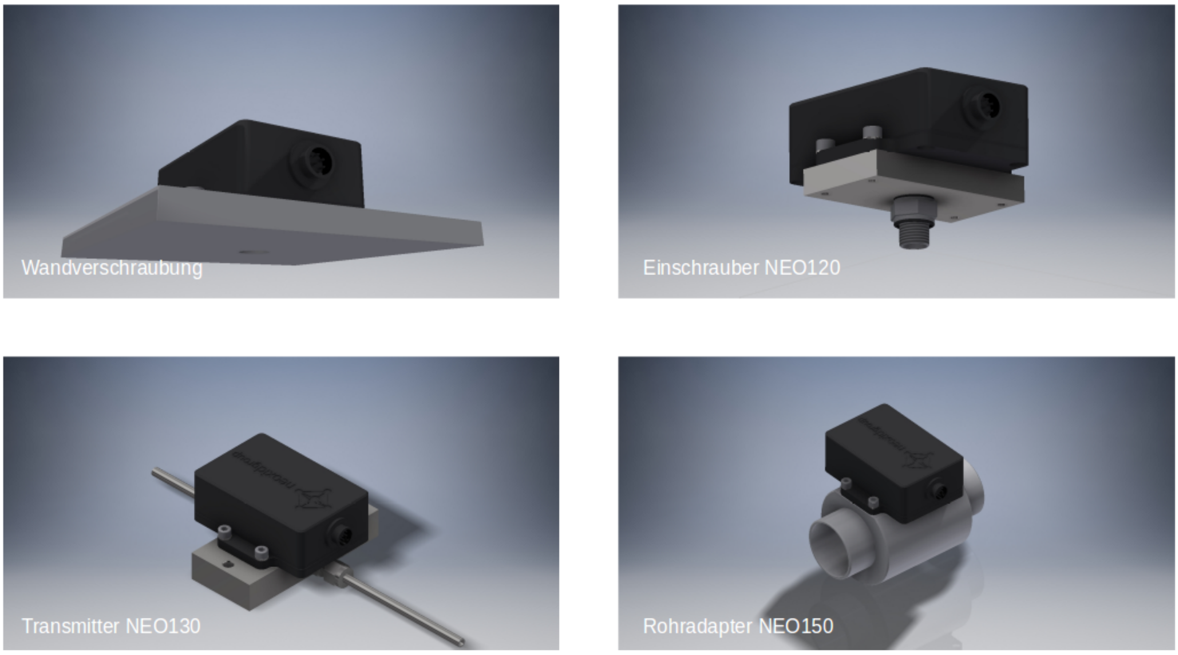


Figure 2a: Mounting the humidity sensor system

During installation, it must be ensured that the opening is not blocked, e.g. by a condensing/liquid/freezing film of water or by dust/particles (rust). We recommend mounting the sensor system horizontally as shown in Figure 2a so that the sensor opening points downwards and the gas flows past the sensor. The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm. The NEO120, NEO130 and NEO150 adapters are available on request (see data sheet_Adapter_NEO1XX_V146_EN_EN). To use the sensor as a room monitoring sensor, the NEO160 adapter is available, which ensures that the sensor can be screwed to any surface without closing the opening.

Use in very humid gas / risk of condensate formation

When using the sensor under condensing conditions or in systems where significant amounts of liquid water are present, care must be taken to ensure that this liquid water is not poured directly onto the sensor and that the sensor is protected from condensation. Please note that even after switching off the fuel/electrolyser/hydrogen burner/... water condensation can occur in the system and also in the sensor! Liquid water in the sensor can lead to corrosion on the sensor elements and thus to damage to the sensor! To protect the sensor from condensation, either the dew point in the medium to be measured must be lowered, for example by using a condensate trap, or the temperature in the sensor must be increased by using additional heat sources. The above-mentioned adapters (with the exception of the NEO160) can also be fitted with heating cartridges, which are also available on request. As a further protective measure against small amounts of splash water, the sensor is fitted with a ribbed plug. Care must be taken to ensure that the sensor is installed in such a way that this plug functions properly if an installation with a passing gas is used.

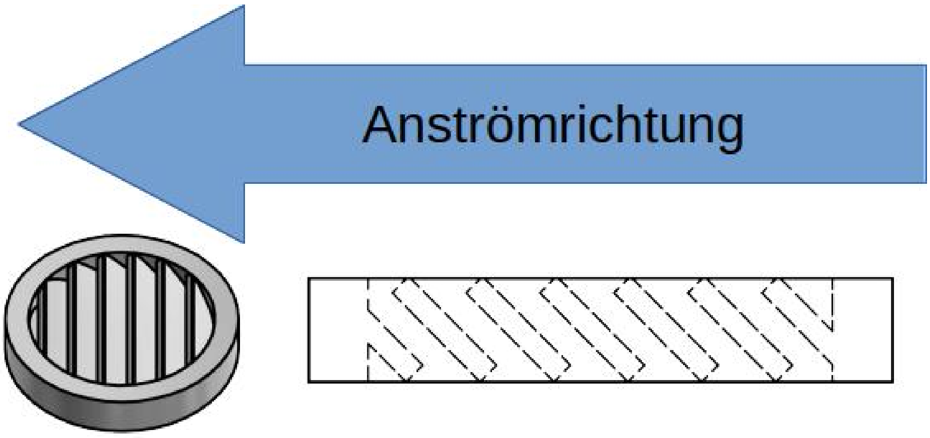


Figure 2b: Fitting ribbed plugs against the direction of flow

Hole pattern:

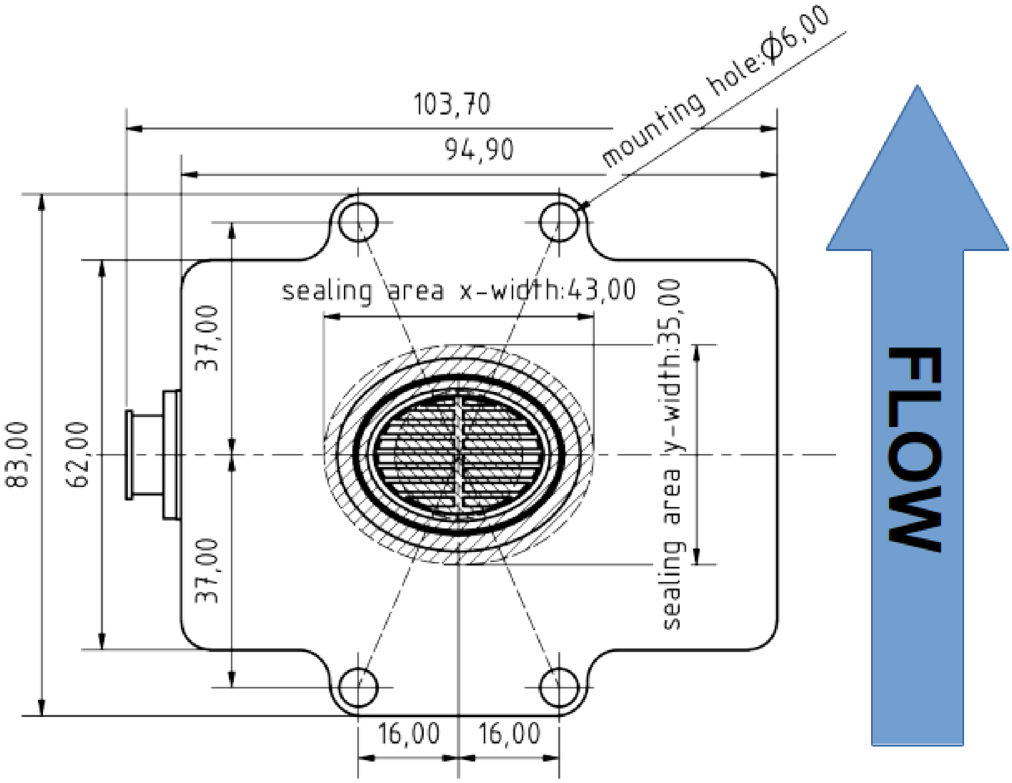


Figure 3a: Hole pattern of the humidity sensor system from below

Drilling template:

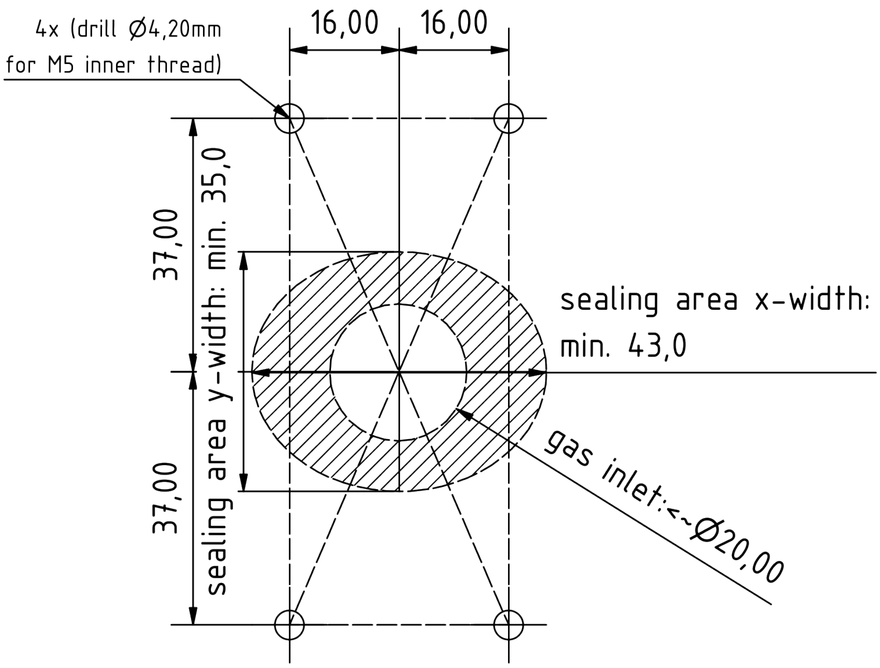
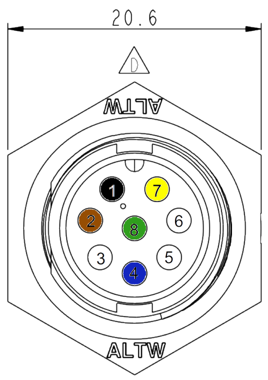


Figure 3b: Drilling template

During installation, it must be ensured that the opening is not blocked, e.g. by a

condensing film of water. We recommend mounting the sensor system as shown in Figure 2.
The retaining pins or screws may have a maximum diameter of 5.5 mm or 6.5 mm. We recommend a tightening torque of 3 Nm and a maximum of 10 Nm.

Electrical PIN assignment



Housing plug

PIN no.	Description of the	Colour
1	VCC+ 12 ... 30V DC (min.: 1W)	black
2	GND 0V DC	brown
3	CAN-High	white
4	CAN-Low	blue
5	*service port A*	-
6	*service port B*	-
7		yellow
8		green
	Shielding	green/yellow

8-pin housing connector: Amphenol LTW: ABD-08RMMS-LC7001
8-pin cable socket: Amphenol LTW: BD-08BFFA-LL7001

Figure 3c below shows the enclosed connection cable with angled socket:

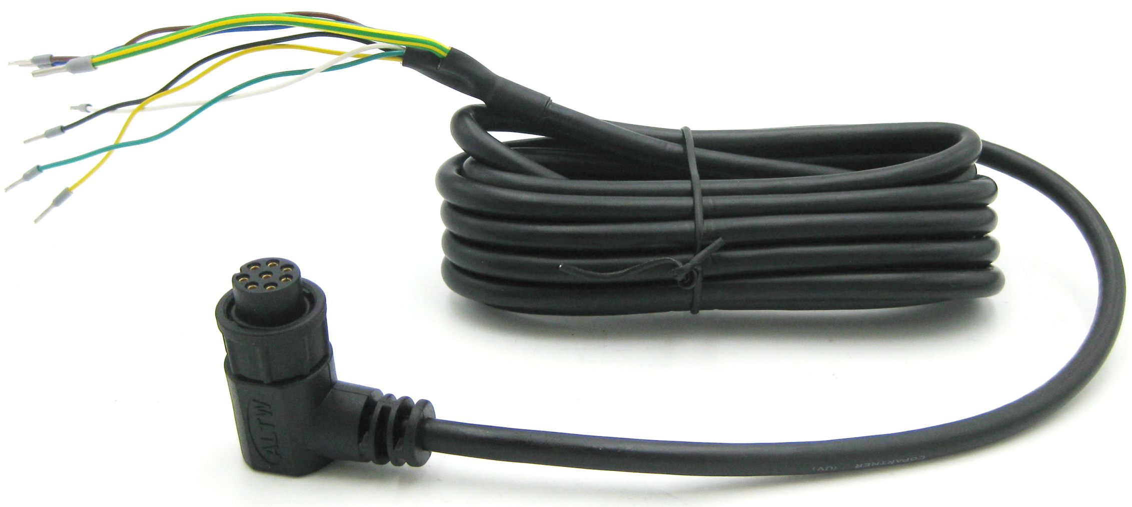


Figure 3c: Connection cable with angled socket

Declaration on "Substances of Very High Concern (SVHC)" according to Article 33 of Regulation (EC) No 1907/2006 (REACH)

SVHC (substances of very high concern) are chemical compounds (or part of a group of chemical compounds) for which the authorisation of use in the EU falls under the REACH Regulation.

The first list of SVHC was published on 28 October 2008. It was last updated on 8 July 2021 and currently contains 219 substances.

Based on the information currently available to us from our material suppliers, we can assure you that none of the substances listed as SVHC according to the above-mentioned issue status are contained in the devices and products placed on the market by the neoxid group in a concentration above 0.1 per cent by mass.

Signal explanation

CAN2.0A - Series A (11-bit identifier / "Base frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562.
The CAN lines are not terminated as standard. On request, we can terminate the lines on the PCB board with 120 Ohm!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	**CAN-ID 2**	**CAN-ID 3**	**CAN-ID 4**
NEO480HTA	0x480 & 0x481	0x488 & 0x489	0x490 & 0x491	0x498 & 0x499

Set CAN ID (CAN2.0A):

The CAN ID can be changed via a CAN message. This is as follows:
0x680 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x08
and
0x680 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x08, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN2.0B - Series A (29-bit identifier / "Extended frame format")

The data is sent via CAN with the CAN controller MCP2515 and the CAN transceiver MCP2562.
The CAN lines are not terminated as standard (the line can be terminated with 120 Ohm on request)! CAN 2.0B with 29 bit CAN ID based on J1939!
The first CAN message is delivered 5s after system start.

The CAN IDs of the sensor are as follows:

	CAN-ID 1	CAN-ID 2	CAN-ID 3	CAN-ID 4
NEO480HTA	0x0CFF0C59 & 0x0CFF0D59	0x0CFF0E59 & 0x0CFF0F59	0x0CFF1059 & 0x0CFF1159	0x0CFF1259 & 0x0CFF1359

Set CAN ID (CAN2.0B):

The CAN ID can be changed via a CAN message. This is as follows:
0x0CFF6000 0x64 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
increases the address by 0x200
and
0x0CFF6000 0x6E 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00
Reduces the address by 0x200, whereby the default ID specifies the minimum.
The digital change to the CAN ID is saved by the sensor and retained even when the system is restarted.

CAN matrix and message layout of the NEO480HTA:
A suitable DBC file is available for download at the following address:
https://neoxid-cloud.de/Triple-Sensor-NEO480.dbc.zip

CAN ID 0x480 or 0x0CFF0C59:
Msg 0 Bit(0-15): Dew point [°C] *tau = (Msg0- 28020) / 100*
Msg 1 Bit(16-31): Pressure [mbar a]: *p = (Msg1- 20) / 10)*
Msg 2 Bit(32-47): Temperature [°C]: *T= (Msg2 - 4020) / 100*
Msg 3(Bit 48-55): Status byte: see below.
Msg 4(Bit 56-63): Message counter[424]

CAN ID 0x481 or 0x0CFF0D59:
Msg 0 Bit(0-15): Dew point_raw value [°C] tau = *Msg0- 28020) / 100*
Measurement of the dew point, without internal logic
Msg 1 bit(16-31): Absolute humidity [g/m³] *a.H. = (Msg1 - 20) /100*
Msg 2(bit 32-39): Water concentration [vol.-%]: $c(H_{(2)}O)=(Msg2 - 20) / 2$[425]
Msg 3(Bit 40-47): CRC 1
Msg 4(Bit 48-55): CRC 0
Msg 5(Bit 56-63): Message counter

Explanation of the status byte:

Bit 48	Always 0	
Bit 49	0: Frame parameter in the defined range	1: A parameter outside the defined range
Bit 50	0: Sensor OK.	1: Sensor defective
Bit 51	0: Sensor in control mode	1: Sensor in heating phase
Bit 52	Always 0	
Bit 53	0: No maintenance required	1: Sensor please wait
Bit 54	Always 0	

424 The message counter counts from 0 - 255 and is incremented by 1 with each CAN message. The message counter of both CAN messages is the same.
425 Optional output as relative humidity r.h.

Bit 55	Always 0	

Example:
"Parameter outside ..." → Status byte = 00000010 binary → 2 hexadecimal, 2 decimal
"Sensor defective" → Status byte = 00000100 binary → 4 hexadecimal, 4 decimal
"Sensor in heating phase" → Status byte = 00001000 binary → 8 hexadecimal, 8 decimal
"Sensor please wait" → Status byte = 00100000 binary → 20 hexadecimal, 32 decimal
"Recalibrate sensor" → Status byte = 01000000 binary → 40 hexadecimal, 64 decimal

Further CAN commands (CAN2.0A):

Change baud rate (125, 250, 500 and 1,000 kbit/s):
0x680 0x78 0xB3 0xE7 0xCD 0x00 0x00 0x97 0x00

Initiate maintenance:
0x680 0x00 0x77 0x61 0x72 0x74 0x75 0x6E 0x67

Further CAN commands (CAN2.0B):
As with CAN2.0A, whereby the CAN ID is not 0x680 but 0x0CFF6000.

Digital Modbus via RS485 or EIA/TIA-485 - NEO480 series M

In serial master-slave communication, our NEO sensors function as slaves with the start slave ID 1 and a baud rate of 9,600 in 8N1, i.e. data bits: 8, parity: none, stop bits: 1. The 16-bit registers are defined as signed integers in big-endian, i.e. values in the range -32,768 to 32,767. The Modbus lines are not terminated.

Input register:

Name	**Description of the**	**Scaling[426]**	**Unit**	**Register addresses**	**INPUT register address (hex / dec)**
Dew point	Dew point of the medium	100	°C	3x513	0x200 / 512_{dec}
Water concentration	H_2O Volume concentration	100	Vol.-%	3x514	0x201 / 513_{dec}
Pressure	Pressure as absolute pressure	1	mbar a	3x515	0x202 / 514_{dec}
Temperature	Temperature in measuring cavern	100	°C	3x516	0x203 / 515_{dec}
Dewpoint_RAW	Unfiltered dew point of the medium	100	°C	3x517	0x204 / 516_{dec}
Absolute humidity	Absolute humidity	100	g/m^3	3x518	0x205 / 517_{dec}
Serial number	S/N: P number, which is noted on the outside of the device. (Example: 3626 = P-3626)	1	-	3x519	0x206 / 518_{dec}
Software version	Version of the sensor software	10	-	3x520	0x207 / 519_{dec}
Message counter	High running counter 0-255	1	-	3x521	0x208 / 520_{dec}
Check value	00000000 01010101 value is 85, which can be used to check the byte order	1	-	3x522	0x209 / 521_{dec}

426 When reading with a PLC, make sure that the data type is set to "Real" so that the signed integer can also be displayed as a comma number.

Holding register:

Name	Description of the	Register addresses	HOLDING Register address (hex / dec)
Baud rate	default: 9,600 Specifying the baud rate of the Modbus RTU interface: 4,800, 9,600 or 19,200	4x001	0x00 / 0_{dec}
Slave ID	default: 1 Possible slave IDs of the sensor 1-247	4x002	0x01 / 1_{dec}
Mode parity	default: 0 = parity: none, stop bit: 1 0 = Parity: none, stop bit: 1 1 = Parity: none, stop bit: 2 2 = Parity: even, stop bit: 1 3 = Parity: even, stop bit: 2 4 = Parity: odd, stop bit: 1 5 = Parity: odd, stop bit: 2	4x003	0x02 / 2_{dec}

Changes to the factory settings are only applied after restarting the sensor.