

Oxygen Sensor QGO20.000D27

Basic Documentation

The QGO20... and this Basic Documentation are intended for use by OEMs which integrate the oxygen sensor in their products!

Contents

1	Safety notes.....	5
1.1	Warning notes	5
1.2	Engineering notes.....	5
1.3	Installation and mounting notes.....	6
1.4	Electrical connection of the oxygen sensor	6
1.5	Commissioning notes	7
1.6	Standards and certificates	8
1.7	Service notes.....	8
1.8	Disposal notes	8
2	Overview.....	9
3	Type summary.....	10
4	Technical data	11
5	Description of functions	12
5.1	Functioning principle of the measuring cell	12
5.2	Impact of the cell's temperature	14
5.3	Impact of the reference gas.....	15
5.4	Switching on and switching off	16
5.5	Aging	16
6	Mechanical design of the sensor	17
7	Mounting and connecting the sensor.....	18
7.1	Mounting.....	18
7.2	Electrical connections.....	19
8	Connection diagram	20
9	Dimensions.....	21
10	List of figures	22
11	Index.....	23
12	Addendum	24

1 Safety notes

1.1 Warning notes



To avoid injury to persons, damage to property or the environment, the following warning notes should be observed!

Do not open, interfere with or modify the oxygen sensor!

- All activities (mounting, installation, service, etc.) must be performed by qualified staff
- Before performing any wiring changes in the connection area of the QGO20..., completely isolate the sensor from the mains supply (all-polar disconnection). Ensure that the sensor cannot be inadvertently switched on again and check this by making a voltage test
- Ensure protection against electric shock hazard by providing adequate protection for the connection terminals
- During operation, the sensor's connecting head must be kept closed; all 3 screws must be securely tightened
- Ensure that wiring is in an orderly state and keep hot plant or sensor components away from the cables
- Ensure that the hot QGO20... does not get into contact with explosive or inflammable gases
- There is a risk of burning since the measuring cell works at an operating temperature of 700 °C and other accessible parts can get very hot too (> 60 °C)
- To prevent injury caused by the hot immersion tube, remove the QGO20... from the AGO20... only after the equipment has cooled down
- Fall or shock can adversely affect the safety functions. Such sensors must not be put into operation. The measuring cell might no longer function, even without exhibiting any damage, so that dangerous situations could occur
- Make certain that the sensor's inlet and outlet are always kept free from dirt
- Before cleaning the inlet and outlet, allow the QGO20... to cool down for at least 1 hour. When using compressed air for cooling (only after the sensor has completely cooled down), pressures up to 0.5 bar are permitted. If this is not observed, the sensor can be damaged in a way that inadmissibly high CO levels in the flue gases can occur
- Air must not be allowed to join the flue gases between the burner and the measuring equipment. Ensure that the sensor's mounting flange is completely tight
- Mount the sensor such that the connecting part (head to flange) is free so that the exchange of air is ensured. Otherwise, measurements might get distorted, possibly leading to dangerous situations
- Ensure that there are no chemicals, such as solvent vapors, near the sensor

1.2 Engineering notes

- If the burner is shut down for no more than 1 or 2 weeks, do not switch off the QGO20... and the associated control unit (RPO25..., LMV52..., PLL52)
- To ensure a good response, always use the QGO20... together with the AGO20...
- Flue gas temperatures at the QGO20... must not exceed 300 °C, since higher temperatures can destroy the sensor
- Use the QGO20... only with natural gas or light oil since other types of fuel can destroy the sensor, resulting from aggressive substances in the flue gases

1.3 Installation and mounting notes

- Ensure that the relevant national safety regulations are complied with
- To facilitate mounting, both the QGO20... and AGO20... carry markings (refer to Mounting Instructions M7842)
- The flue gas flow passing the measuring cell must be homogeneous, with no or only little turbulence. When mounted too close to air dampers or pipe bends, faulty measurements can occur
- The exchange of fresh air in the connection area of the sensor with the reference air slots must be ensured and may never be covered up (by insulation or similar)
- On both the gas and air side, the sensor should not be exposed to corrosive gases (NO_x, etc.) since these can drastically reduce the sensor's service life
- A number of faults can distort the measurements (this can lead to dangerous situations in connection with oxygen trim control):
 - If the stack is not tight, false air can join the flue gases. In that case, the residual oxygen content indicated by the sensor is higher than it actually is
 - If the flue gas velocity is low, the sensor's response is slower, since the flue gases take more time to pass the measuring cell. In that case, it is recommended to mount the sensor in an inclined position (refer to «Mounting»)
 - The greater the sensor's distance from the flame, the longer the dead time

Note

For detailed information on mounting, refer to Mounting Instructions M7842.

1.4 Electrical connection of the oxygen sensor

It is important to achieve practically disturbance- and loss-free signal transmission:

- Do not run the sensor cable together with other cables, use a separate cable
- Observe the permissible length and specification of the sensor cables (refer to «Technical data»)

1.5 Commissioning notes

- Prior to commissioning, check to ensure that wiring is in an orderly state
- To prevent the collection of condensate inside the QGO20..., do not put the burner into operation before the sensor's heating up phase is completed
- To avoid incorrect measurements, observe a heating up time of at least 2 hours when first commissioning the plant, otherwise at least 1 hour

During the sensor's heating up phase, temperature differences between the inner and outer electrode generate thermo-electric voltages which, in that phase, falsify the acquired oxygen value.

When commissioning the control system, the heating up times specified in «Engineering notes» must therefore be observed.

It is also recommended to keep the sensor activated during short burner off periods (1 to 2 days).

Prior to commissioning, make the following final checks:

- Check to ensure that the sensor is correctly fitted to the flange
- Ensure that the signal and power supply lines are correctly connected

Electronic circuit

- Activate the electronic circuit
- Wait until the sensor has reached its normal operating temperature, the residual oxygen content is displayed on the associated control unit (RPO25..., LMV52..., PLL52) and has stabilized. For more details, refer to the Basic Documentation of the associated control unit (RPO25..., LMV52..., PLL52)

After the final mounting check, a first functional check can be made:

Functional check

During the prepurge phase, the actual O₂ value must be at a level of about 20.9 %. It can be read off with the help of the handheld terminal AZW20.20 / AZL52...

Only with RPO25...: If set to measuring mode, the actual O₂ value is also displayed directly by the RPO25...

It is also possible to make a functional check of the QGO20... based on a comparative measurement.

Comparative measurement means that, during burner operation, the actual oxygen value is measured with a flue gas analyzer and will then be compared with the value acquired by the QGO20...

Note

Flue gas analyzers measure «dry», the QGO20... measures «wet».

The conversion is made with the help of the conversion table contained in the Addendum to this Basic Documentation.

1.6 Standards and certificates



ISO 9001: 2000
Cert. 00739



ISO 14001: 1996
Cert. 38233

Only in connection with
RPO25...



Conformity to EEC directives
- Electromagnetic compatibility EMC (immunity)
- Directive for gas appliances

89 / 336 EEC
90 / 396 EEC

Only in connection with
LMV52... / PLL52



Conformity to EEC directives
- Electromagnetic compatibility EMC (immunity)
- Directive for gas appliances

89 / 336 EEC
0085BL0373

1.7 Service notes

Plants using the QGO20... must be serviced once a year. After no more than 3 months of operation following commissioning, check the sensor's internal resistance. If it exceeds 50 Ω , shorten the service interval to 3 months. Sensors having an internal resistance of > 150 Ω should no longer be used for control tasks since their response is too slow. For this reason, to ensure proper functioning, sensors with a resistance of > 100 Ω should be replaced.

- Each time a sensor has been replaced, check wiring to ensure it is in an orderly state
- Make certain that the sensor's inlet and outlet are always kept free from dirt
- Check flange gasket on each service visit and replace if necessary
- Before cleaning, allow the QGO20... to cool down for at least 1 hour
- Check the flue gas collector AGO20... at regular intervals and clean if necessary
- After cleaning and heating up, check the O₂ measurement and the proper functioning of the entire control equipment used in connection with the burner

1.8 Disposal notes



The oxygen sensor contains electrical and electronic components and may not be disposed of together with household waste.
Local and currently valid legislation must be observed.

2 Overview

The QGO20... is an oxygen sensor that is used to acquire the residual oxygen content of flue gases in heat generating plants that burn natural gas or light fuel oil. In connection with the control unit (RPO25..., LMV52..., PLL52), QGO20... monitors and controls the combustion process. For mounting the QGO20..., flue gas collectors type AGO20... are available. They can be welded directly into the stack. The QGO20... in connection with the AGO20... is suited for use on all types of heat generating plant which burn natural gas or light fuel oil with flue gas temperatures up to 300 °C at the test point. The units of the ECOGYR range or LMV52...-systems – especially when used in connection with oxygen trim control – are designed to minimize emissions and to optimize the efficiency of the combustion process, also on retrofit projects.

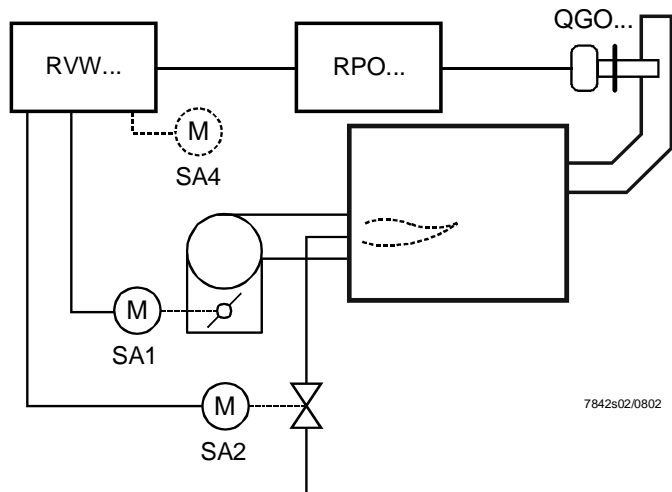


Figure 1: General overview with a modulating burner as an example

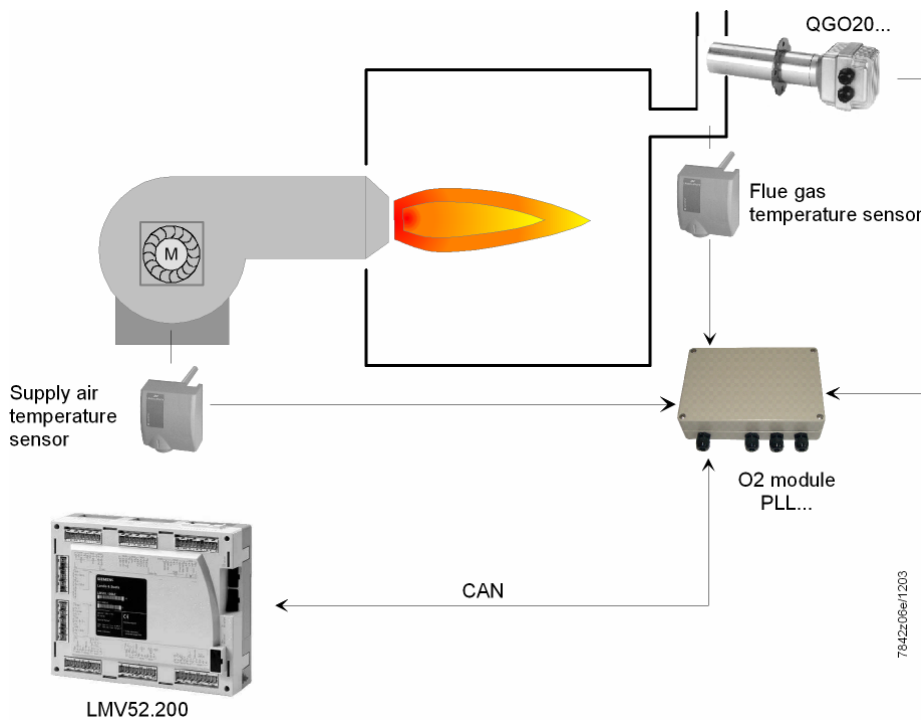


Figure 2: General overview of a dual-fuel burner

3 Type summary

Oxygen sensor **QGO20.000D27**
- Complete with flange gasket

Flange gasket for service **5 759 2021 0**

Control unit for oxygen trim control **RPO25.000B27**
- Refer to Data Sheet 7847 and Basic Documentation P7847
- Refer to Basic Documentation P7550 **LMV52... with PLL52**

Flue gas collectors **AGO20.001A**
- For stack diameters up to 400 mm
- For stack diameters above 400 mm **AGO20.002A**

4 Technical data

General unit data

Operating voltage of measuring cell's	AC 230 V \pm 15 % AC 120 V \pm 15 % (only with LMV52... / PLL52)
Mains frequency	50...60 Hz \pm 6 %
Power consumption	max. 90 W, typically 35 W (controlled)
Perm. mounting position	refer to Mounting Instructions M7842
Degree of protection	IP 40, to be ensured through installation
Weight (net)	approx. 0.9 kg
Signal lines	
- Shielded 6-core cable	twisted pairs
- Shielding connected to terminal GND of the RPO25... / LMV52...	
- Wire dia.	min. 0.25 mm ² (e.g. LiYCY 6 x 2 x 0.2 / 22 or LiYCY 6 x 2 x 0.2)
Measuring system	zirconium dioxide measuring cell as an oxygen ion conductor
Perm. flue gas velocity (only with AGO20...)	1...10 m / s
Types of fuel	fuel oil «EL» or natural gas «H»
Measuring range	0.2...20.9 % O ₂
Perm. cable length	max. 100 m
Power supply lines (Sensor heating)	
- Wire dia.	min. 1 mm ² (e.g. NYM3 x 1.5)
Required operating temperature of measuring cell	700 °C \pm 50 °C

Environmental conditions

Transport	DIN EN 60 721-3-2
Climatic conditions	class 2K2
Mechanical conditions	class 2M2
Temperature range	-25...+70 °C
Humidity	< 95 % r.h.
Operation	DIN EN 60 721-3-3
Climatic conditions	class 3K5
Mechanical conditions	class 3M2
Temperature range	
- Flange	max. 250 °C
- Connecting head	max. 70 °C
- Flue gas	\leq 300 °C
Humidity	< 95 % r.h.



Condensation, formation of ice and ingress of water are not permitted!

AGO20...

Tube	DN50, steel X5 CrNi 18 9
Tube length	
- For AGO20.001A	180 mm
- For AGO20.002A	260 mm
Flange	DN50, steel X5 CrNi 18 9

5 Description of functions

5.1 Functioning principle of the measuring cell

The measuring cell of the QGO20... is made of ceramics (ZrO_2), stabilized with Y_2O_3 . At temperatures above $500\text{ }^\circ\text{C}$, oxygen ions can diffuse through the ceramics material. It carries a porous platinum layer on both sides, which serve as electrodes.

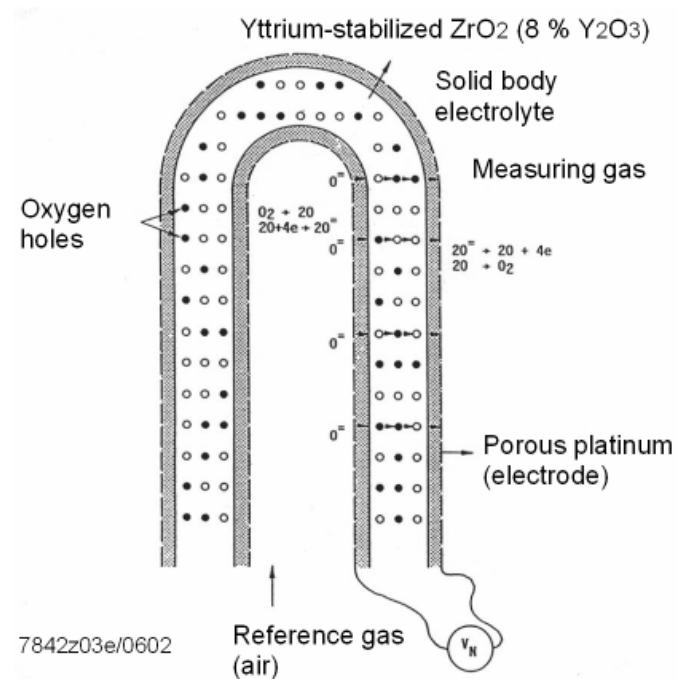


Figure 3: Functioning principle of the measuring cell

The diffusion of ions starts when concentrations on both sides of the cell differ. The diffusion of oxygen ions carries electrical charges that generate an electrical field across the platinum electrodes. When in equilibrium, the diffusion force compensates the force of the electrical field. On the one hand, the porous platinum electrodes serve for the catalytic conversion of the molecules into ions, and vice versa ($O_2 \leftrightarrow 2O + 2e^-$), on the other, for the acquisition of voltage. The voltage across the electrodes is the so-called Nernst voltage. The magnitude of this voltage is dependent on the difference in oxygen concentration and the cell's temperature.

$$V_N = \frac{R \times T}{4 \times F} \ln \frac{O_2\text{-Ref.}}{O_2}$$

where V_N = Nernst voltage
 R = gas constant 8.3 J / K
 F = Faraday constant 96.486 As
 T = absolute cell temperature (K)
 $O_2\text{-Ref.}$ = oxygen content of reference gas (air: 20.9 %)
 O_2 = oxygen content of measured gas

$$\text{that is } = \frac{R}{4 \times F} = 21.5 \frac{\mu V}{K} \text{ or}$$

$$\frac{R \times T}{4 \times F} = 20.9 \text{ mV at } T = 700 \text{ }^\circ\text{C} = 973 \text{ K}$$

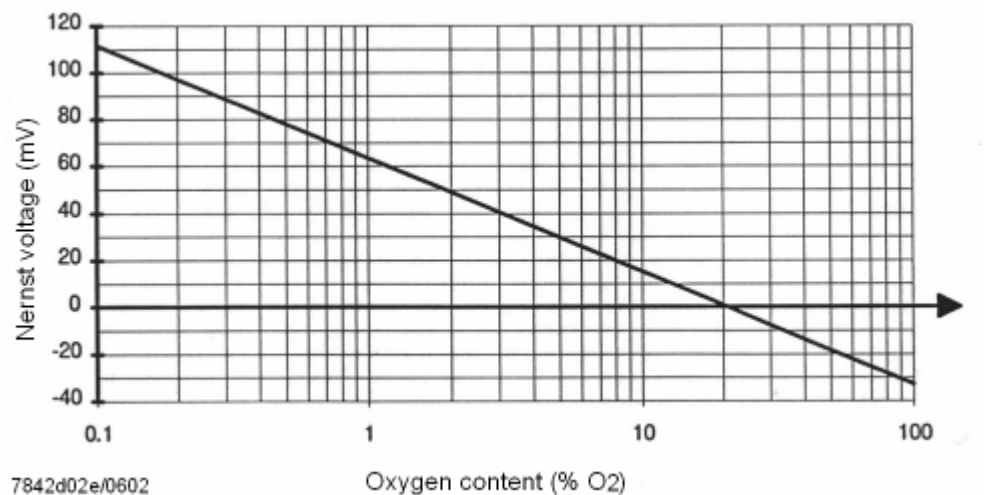


Figure 4: Nernst voltage as a function of the oxygen concentration at a cell temperature of 700 °C

5.2 Impact of the cell's temperature

The slope of the curve changes on a change of cell temperature.

The lower the temperature, the lower the Nernst voltage and the higher the displayed oxygen concentration.

The higher the temperature, the higher the Nernst voltage and the lower the displayed oxygen concentration.

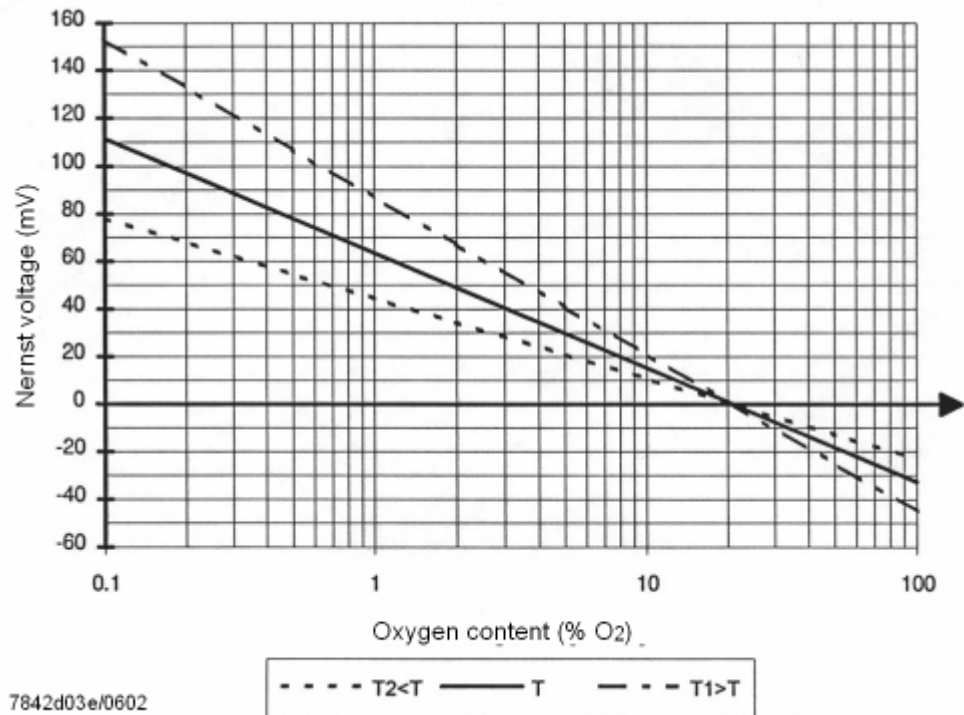


Figure 5: Impact of the cell's temperature on the oxygen value

To limit the error, the temperature in the RPO25... / PLL52 is also considered when calculating the oxygen value and monitored for a minimum temperature.

The actual temperature is continuously acquired and serves as an input variable for controlling the cell's temperature and for calculating the actual oxygen content.

5.3 Impact of the reference gas

When the oxygen concentration of the reference gas changes, the point of intersection of the straight line with the abscissa will change (20.9 %).

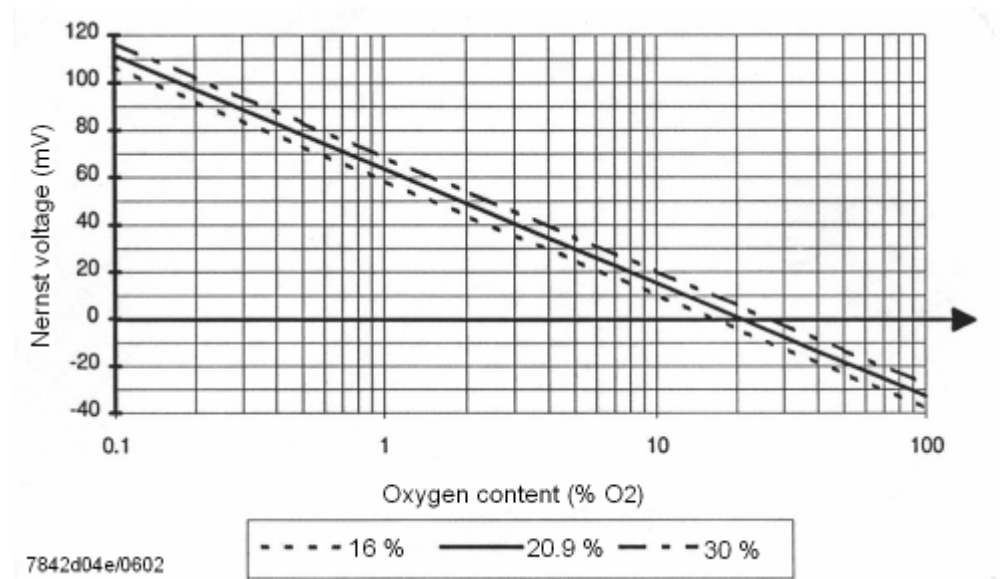


Figure 6: Nernst voltage as a function of the reference gas

Note

The QGO20... is a device that does not measure the absolute but the relative oxygen value.
The result is calculated based solely on the ratio of the partial pressures of the reference gas (ambient air) and the measuring gas.

5.4 Switching on and switching off

When switching the sensor on or off, temperature differences generate thermo-electric voltages of up to 100 mV (both positive and negative).

These can produce erroneous measurements during the heating up phase .

It is recommended to observe the heating up times specified in «Engineering notes».

5.5 Aging

Due to aging, the characteristics “internal resistance“ and “response time“ may change. The RPO25..., LMV52..., PLL52 measures these characteristics at regular intervals and triggers an alarm should programmable limits be exceeded.

Assessment of aging with
the help of the RPO25... /
LMV52... / PLL52 /
AZL52... / AZW20.20

On the display, the following 2 values can be checked:

- Internal resistance: Max. 150 Ω
- Response time: Max. 25 seconds

If one of these 2 limits is exceeded, the QGO20... must be replaced.

6 Mechanical design of the sensor

The function of the oxygen sensor is ensured by the following components:

- 1) **Measuring cell**
The measuring cell acquires differences in oxygen concentrations and delivers a Nernst voltage.
- 2) **Gas routing**
Ensures exchange of the measuring gases in the vicinity of the measuring cell.
- 3) **Heating element**
The heating element maintains the cell's temperature at 700 °C.
- 4) **Thermocouple**
The thermocouple acquires the temperature in the cell and delivers a signal of about 40 $\mu\text{V} / \text{K}$, which is used for temperature control.
- 5) **Connecting head**
The connecting head contains the sensor's connection terminals and the temperature compensation element. The compensation element delivers a current of about 1 $\mu\text{A} / \text{K}$ which represents the temperature inside the head. The sum of head temperature and thermocouple temperature gives the absolute temperature in the measuring zone (normally 973 K).

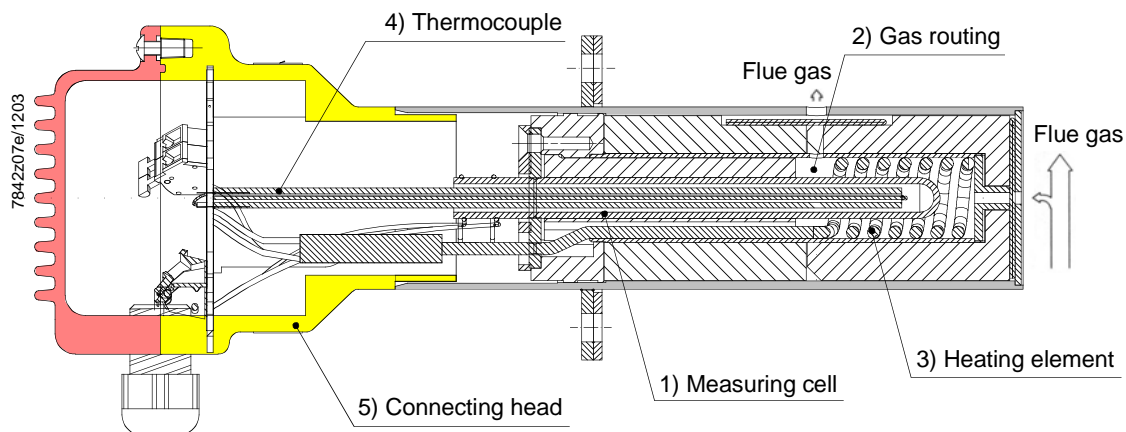


Figure 7: Mechanical design of the oxygen sensor

7 Mounting and connecting the sensor

7.1 Mounting

To simplify mounting in the stack, different types of AGO20... flue gas collectors are available.

The AGO20... provides 2 functions:

1. Collection of flue gases and passing them to the sensor (Figure 8), adapting the sensor to the stack.
2. Serving as a flange for accepting and mounting the QGO20... It is welded gas-tight directly into the end section of the flue gas pipe.

For mounting position, refer to Mounting Instructions M7842.

To reduce the response time in the case of low flow velocities, the AGO20... can also be mounted in an inclined position (Figure 8).

It must be ensured that the hole closest to the sensor head protrudes into the stack.

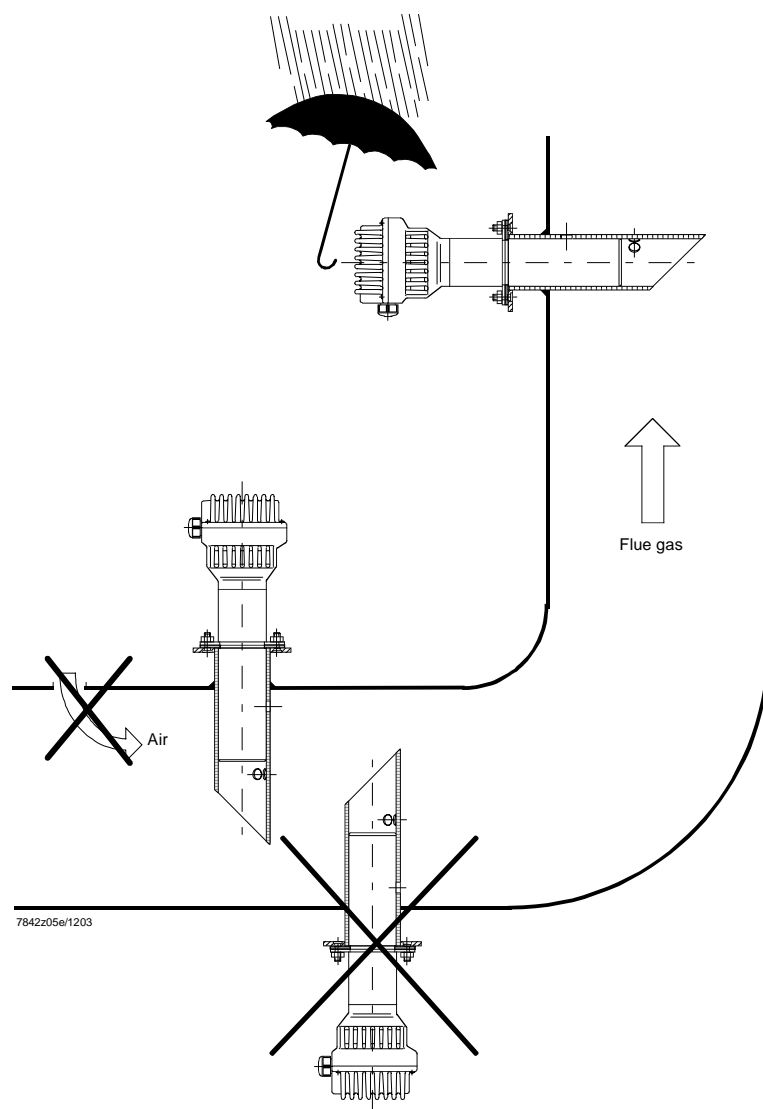


Figure 8: Mounting position of QGO20...

7.2 Electrical connections

Figure 10 shows the connection of the QGO20... to the control unit RPO25... / PLL52.

Note

The signal lines require shielded 6-core cables with twisted pairs.
The shielding is to be connected to terminal GND of the RPO25... / PLL52.
Recommended cross-sectional area: Min. 0.6 mm²

- Open the cover only when the main switch is off so that both live and neutral conductors are disconnected
- There is a risk of burning since the measuring cell works at an operating temperature of 700 °C

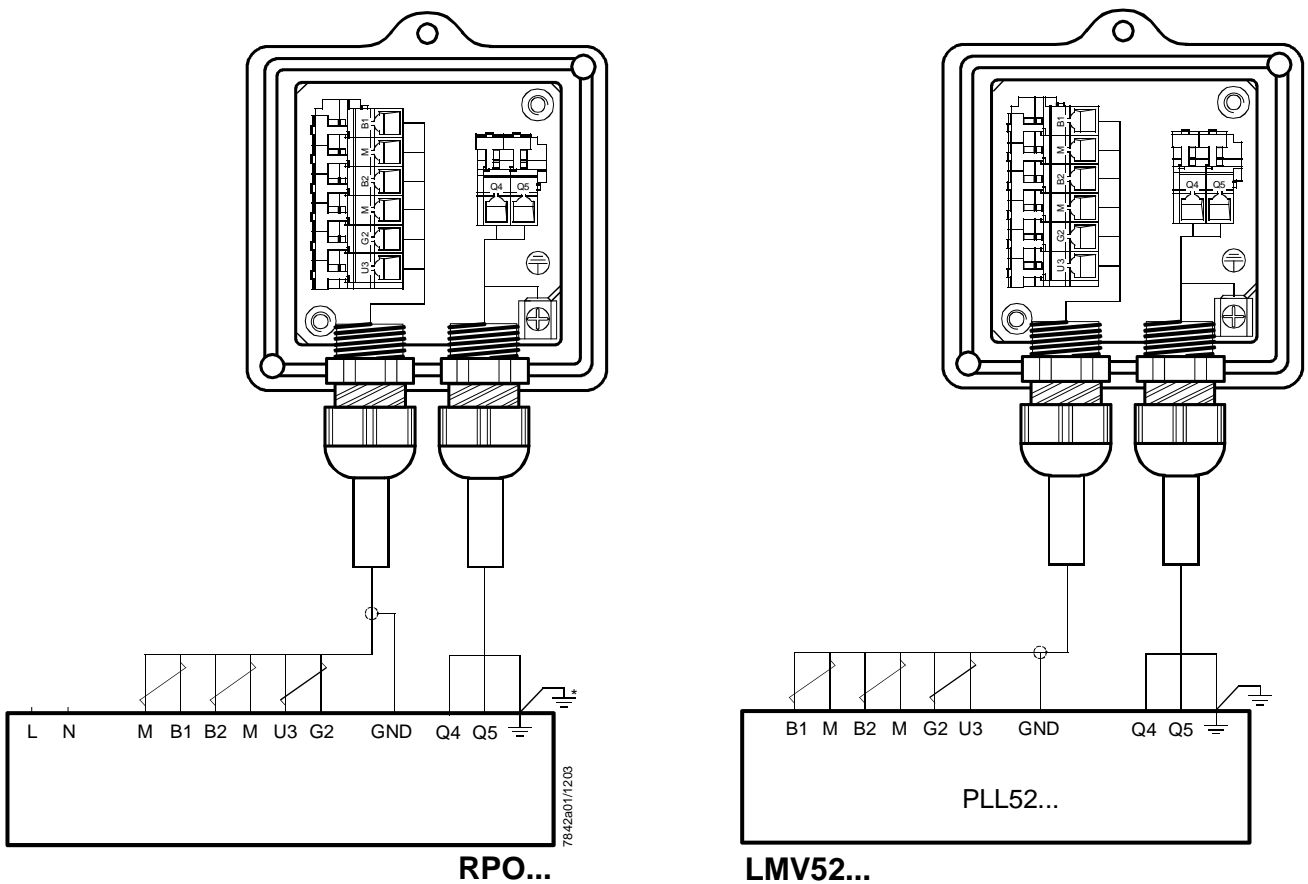
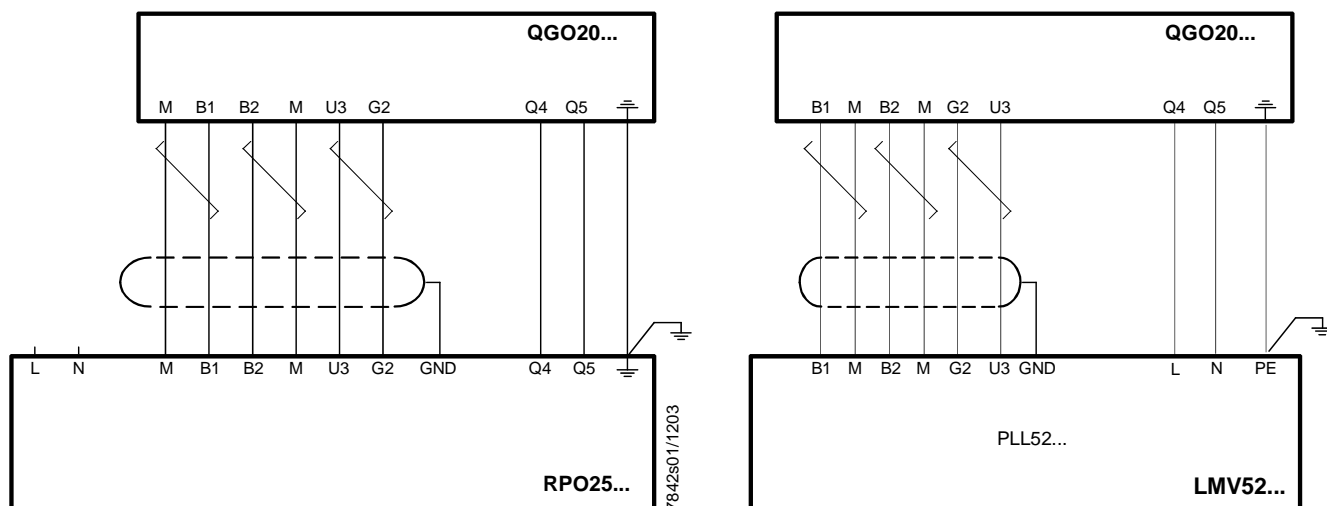


Figure 9: Electrical connections

8 Connection diagram



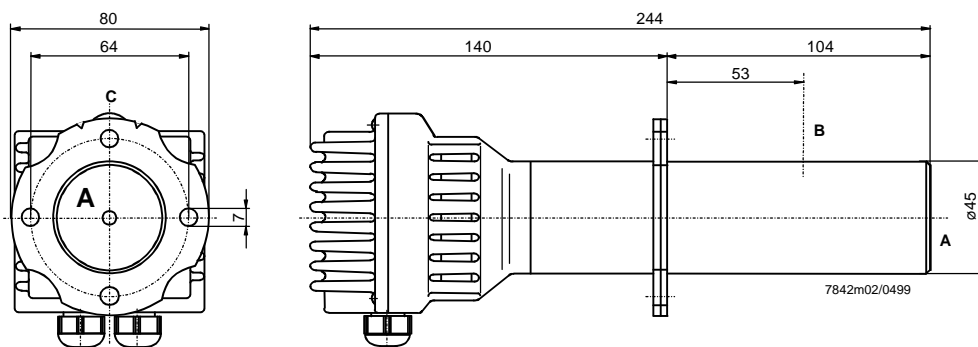
Legend

B1	(+)	Signal of oxygen measuring cell
B2	(+)	Thermocouple voltage
G2	(-)	Power supply temperature compensation element
GND		Electrical ground for shielding
L		Live conductor
M	(-)	Electrical ground for «B1» and «B2»
M	(-)	
N		Neutral conductor
Q4		Sensor heating element (AC 230 V)
Q5		Sensor heating element (AC 230 V)
U3	(+)	Signal of temperature compensation element
⏏		Protective earth (PE)

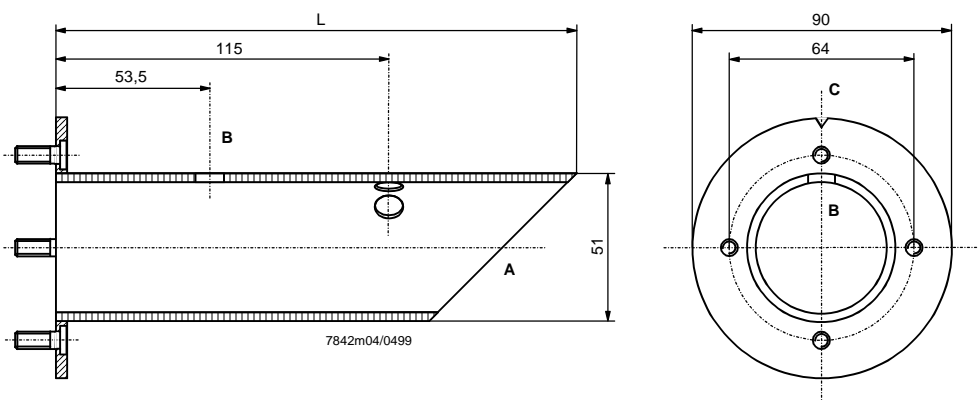
9 Dimensions

Dimensions in mm

QGO20...



AGO20...



Legend

- A Flue gas inlet
- B Flue gas outlet
- C Notch on the flange marking the flue gas outlet side
- L 180 mm for AGO20.001A
260 mm for AGO20.002A

10 List of figures

Figure 1: General overview with a modulating burner as an example	9
Figure 2: General overview of a dual-fuel burner.....	9
Figure 3: Functioning principle of the measuring cell.....	12
Figure 4: Nernst voltage as a function of the oxygen concentration at a cell temperature of 700 °C.....	13
Figure 5: Impact of the cell's temperature on the oxygen value	14
Figure 6: Nernst voltage as a function of the reference gas	15
Figure 7: Mechanical design of the oxygen sensor.....	17
Figure 8: Mounting position of QGO20... ..	18
Figure 9: Electrical connections	19
Figure 10: Table with the different types of flue gas analyzers (figures in %).....	24

11 Index

C	
cell temperature	14, 15, 18
cell temperature control	15
ceramic cell	14
commissioning	5
commissioning notes	8
comparative measurement	8
connecting	19
connecting head	18
connection	7
control unit	10, 11, 21
conversion table	8
cross-sectional area	21
D	
dead time	7
diffusion force	14
E	
electrical connections	21
F	
false air	7
false air entry	7
Faraday constant	14
faults	7
flange	19
flange gasket	9, 11
flue gas analyzer	8
flue gas collector	9
flue gas collectors	10, 11, 19
flue gas velocity	7
functional check	8
G	
gas constant	14
gas routing	18
H	
heating element	18
heating-up phase	5, 17
I	
inclined position	7
installing	7
ions starts	14
L	
life expectancy	17
M	
measuring cell	5, 7, 12, 13, 18, 21
measuring range	12
modulating burner	7, 8, 19
Montage	7
mounting	8, 10, 19
mounting instructions	7, 12, 19
mounting position	12, 19
N	
Nernst voltage	14, 15, 16, 18
O	
operating temperature	5, 8, 12, 21
operating voltage	12
oxygen sensor	7, 9, 10, 11, 13
P	
platinum layer	13
porous platinum electrodes	14
R	
reference gas	14, 16
residual oxygen content	7, 8, 10
response time	17, 19
S	
sensor	5, 7, 8, 17, 18, 19
shielding	21
signal lines	21
storage	12
T	
table with the different types	26
temperature compensation	18
temperature compensation element	18
temperature control	18
terminal	21
thermocouple	18
transducer	15, 16
W	
weight	12

12 Addendum

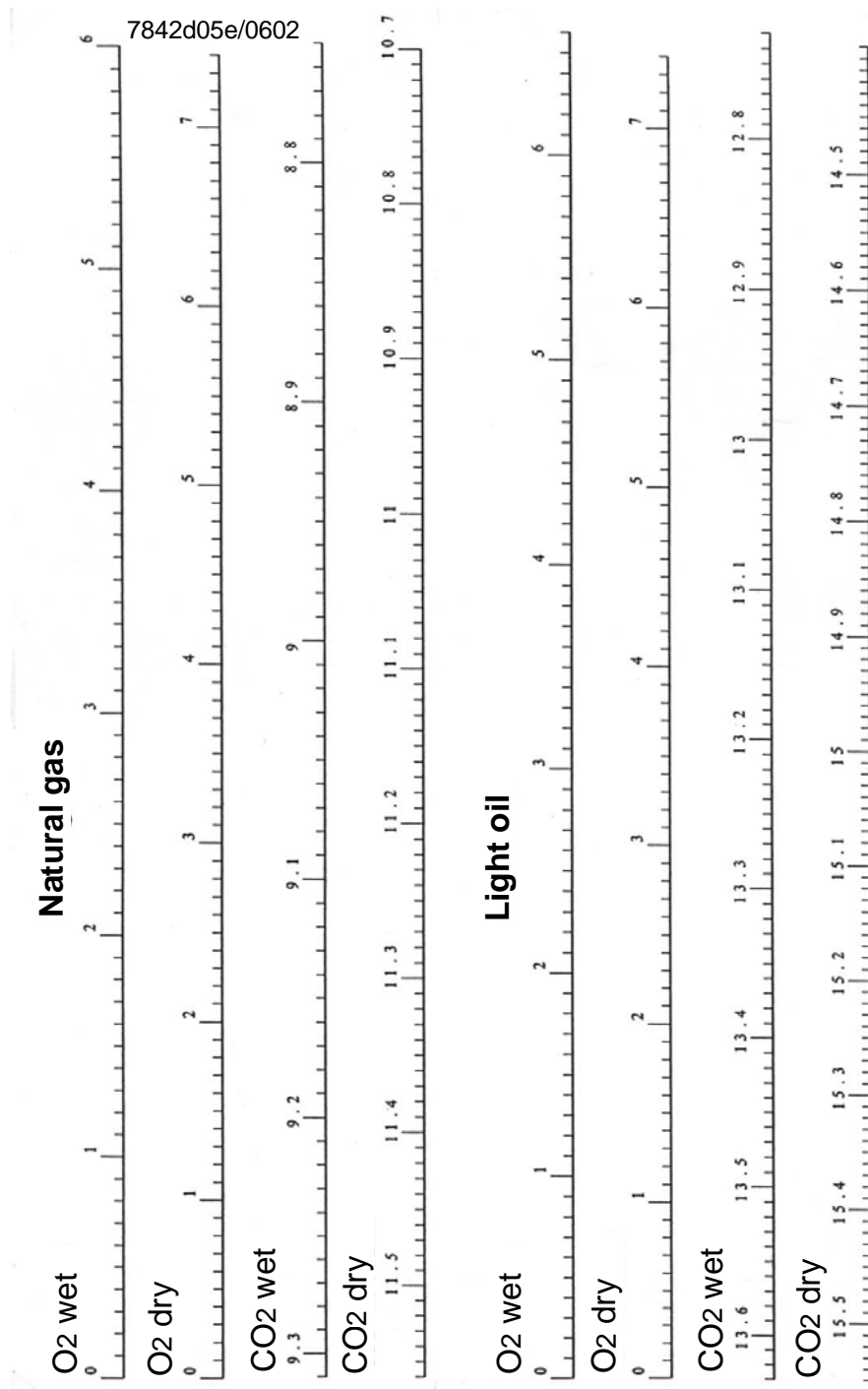


Figure 10: Table with the different types of flue gas analyzers (figures in %)