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# Gas concentrations in the air



## Why is the Measurement of Room Air Quality So Important?

An unsatisfactory room air quality of indoor rooms (e.g. in offices) can easily cause tiredness, poor powers of concentration and even diseases to people. Indicator for the room air quality is the concentration

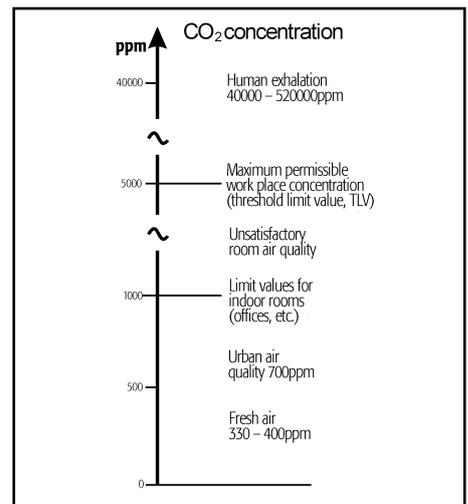
of specific gases in air. The most important ones include:

- Carbon dioxide (CO<sub>2</sub>)
- Carbon monoxide (CO)
- Oxygen (O<sub>2</sub>)
- Ozone (O<sub>3</sub>)

## CO<sub>2</sub>-Concentration

An important criterion for the evaluation of the room air quality is the CO<sub>2</sub> concentration. A CO<sub>2</sub> concentration, which is too high due to insufficient ventilation, is experienced as stale or stagnant air. The illustration above shows the range of CO<sub>2</sub> concentrations that are relevant to a human.

perceived as stale or stagnant air. The illustration above shows the range of CO<sub>2</sub> concentrations that are relevant to a human.



## CO-Concentration

CO is produced when carbon is only partially combusted (fuel). CO is very dangerous for humans because it is at the

same time highly toxic - but invisible and odorless. Reasons for the production of CO in various combustion processes:

- deficiency of air
- too high excess of air
- too early cooling down of flame

### Effects of CO in the ambient air on the human body

CO concentration	Inhalation period and consequences
30 ppm    0.0003%	Maximum concentration in the workplace per 8-hour shift (German MAK value)
200 ppm    0.02%	Slight headache within 2 to 3 hours
400 ppm    0.04%	Headache within 1 to 2 hours, first in the forehead and temples, then spreading to the whole head
800 ppm    0.08%	Dizziness, nausea, and twitching limbs within 45 minutes, unconsciousness within 2 hours
1600 ppm    0.16%	Headache, dizziness, nausea within 20 minutes, death within 2 hours
3200 ppm    0.32%	Headache, dizziness, nausea within 5 to 10 minutes, death within 30 minutes
6400 ppm    0.64%	Headache and dizziness within 1 to 2 minutes, death within 10 to 15 minutes
12800 ppm    1.28%	Death within 1 to 3 minutes

### Applications

- measurement, control, and warning system in garages,
- monitoring of room air quality with respect to maximum permissible workplace concentration (MAK value)
- monitoring of outside air or of protected air systems in domestic and large public shelters.

# Gas concentrations in the air

## O<sub>2</sub>-Concentration

The inhaled air consists of vital oxygen at a ratio of 1:5. Oxygen is required for all oxidation processes; for combustion processes, as well as for silent oxidations. Examples include the rusting of iron, oxidations, which occur in living processes, or the decomposition of organic material. Additionally, all combustion processes that release energy require this gas, for example, heating systems or

aircraft engines. However, oxygen is also bound with any type of noxious fires such as forest and heath fires. Due to the permanent cycle of assimilation and photosynthesis in green plants when they are subject to sunshine, oxygen is continuously re-formed from carbon dioxide. The balance between oxygen consumption and oxygen production is disturbed by the continuously increasing

combustion of fossil combustibles. Therefore, many areas require control measurements of the oxygen content in the air, e.g. in air condition systems, air purifiers, oxygen rectifiers, greenhouses and oxygen incubators, as well as for exhaust emission tests, e.g. in the automotive industry.

## O<sub>3</sub>-Concentration

The ozone contained in the earth's atmosphere forms at altitudes of approximately 30km. It provides a protective shield around the earth and filters out approximately 50% of the solar UV radiation, particularly the short-wave range, which is dangerous for living organisms. However, ozone is toxic and an extremely aggressive trace gas that can cause major burns in human mucous

membranes when breathed in high concentrations. Therefore, control measurements for the ozone content in air must be performed in many areas, e.g. leakage tests in industry, protection of health and safety standards at work, mobile-based air quality measurements or for providing environmental data on advertising displays etc.

### Calculation Formulae

The following formulae are used for converting the O<sub>3</sub> measured value from ppb to µg/m<sup>3</sup>, depending on the current atm. pressure and the temperature.

Example:

20°C and 1013 hPa = factor 2

Ozone (µg/m<sup>3</sup>) = 2 x Ozone (ppb)

This is the nominal value for conversion from ppb to µg/m<sup>3</sup>.

$$\text{Ozone (g/m}^3\text{)} = \frac{0,57 \times \text{Atm. Press. [hPa]}}{\text{Temperature [K]}} \times \text{Ozone (ppb)}$$

## Digital carbon dioxide sensor FYAD 00 CO2B10 with grip, integrated atmospheric pressure sensor for automatic atmospheric pressure compensation, and ALMEMO® D6 plug



- Digital CO<sub>2</sub> sensor with integrated signal processor
- All sensor characteristics and adjustment data are stored in the CO<sub>2</sub> sensor itself.
- The unique automatic calibration procedure (without fresh air intake) automatically compensates any natural ageing effects.
- The sensor is very well protected against the effects of pollution by means of replaceable PTFE filter caps. Long-term stability is outstanding.
- **new:** Automatic atmospheric pressure compensation is provided for pressure-dependent CO<sub>2</sub> concentrations by means of a digital atmospheric pressure sensor integrated in the grip.
- The relevant ambient parameter, atmospheric pressure, is measured using the same sensor.
- **new:** Long-term measuring operations can be performed with an ALMEMO® data logger in sleep mode; this applies only to current device types with sleep delay (180 seconds).
- 2 primary measuring channels (real measurable variables) CO<sub>2</sub> concentration and atmospheric pressure
- Freely selectable measurable variables Two measuring channels are programmed (at our factory). CO<sub>2</sub> concentration, average value (ppm), Atmospheric pressure (mbar, AP, p). Alternatively a further variable can be selected. CO<sub>2</sub> concentration, current value (ppm) This device can be configured on a PC using USB adapter cable ZA 1919 AKUV. (see "General accessories for ALMEMO® D6 sensors" page 04.05).

**General features and accessories, ALMEMO® D6 sensors:**  
see page 01.08

### Technical Data

Digital carbon dioxide (CO <sub>2</sub> ) sensor (including A/D converter)		Sensor connector	Plug connection
Measuring principle	non-dispersive infrared (NDIR) technology	Grip	with socket, integrated electronics
Sensor	2-beam infrared measuring cell	Dimensions:	Diameter 20 mm Total length including the sensor 245 mm
Measuring range	0 to 10,000 ppm	ALMEMO® connecting cable	fitted cable, 2 meters With ALMEMO® D6 plug
Accuracy	±(100 ppm + 5 % of meas. value)	<b>Digital atmospheric pressure sensor (integrated in grip)</b>	
Nominal conditions	+25 °C, 1013 mbar	Measuring range	700 to 1100 mbar
Temperature dependence	typical 2 ppm CO <sub>2</sub> / K in range 0 to +50 °C	Accuracy	±2.5 mbar (at 0 to +65 °C)
Response time	<195 seconds	<b>ALMEMO® D6 plug</b>	
Operative range	-40 to +60 °C / 0 to 95 % RH (non-condensing)	Refresh rate	1 second for all four channels
Measuring interval	Moving average 165 seconds (= 11 current values of 15 sec.)	Supply voltage	6 to 13 VDC
Filter cap	PTFE Diameter 18 mm Length appr. 41 mm	Current consumption	25 mA

### Type (including factory test certificate)

Digital CO<sub>2</sub> sensor with grip, fitted cable with ALMEMO® D6 plug, and integrated digital atmospheric pressure sensor

Factory calibration KY96xx carbon dioxide concentration for digital sensor (see chapter Calibration certificates)

### Order no.

**FYAD00CO2B10**

## Carbon Dioxide Probe FYA600CO2



- Since the gas is supplied by means of free convection, this is especially suitable for climatology measurements.
- Various measuring ranges up to 25%.

### Technical Data

Gas:	CO <sub>2</sub>	Power supply:	6.5 to 12VDC from the ALMEMO® device Operation with mains supply unit recommended !
Measuring principle:	IR optics	Current consumpt.	eff. 50mA/ max. 70mA
Measuring ranges:	nominal (% CO <sub>2</sub> ): 0 ... 2.5%, 0 ... 10%, 0 ... 25%	Settling time t90:	< 60s
Accuracy:	±2% of final value	Temperature coefficient:	typical -0.4% signal/K
Reproducibility:	±1% of final value	Temperature range:	5 to +40°C
Resolution:	(depending on measuring range) <200ppm at 2.5%	Relative humidity:	0 to 95%, noncondensing
Output:	0 ... 2V on ALMEMO® connector Linearization in ALMEMO® device	Dimensions:	W 96mm x H 36mm x D 64mm
Current output:	referred to GND	Weight:	241g
max. burden (load resist.):	400W	Connecting cable:	1.5m long, ALMEMO® connector

! Operation with the device in SLEEP mode is not possible!  
When operating more than one CO<sub>2</sub> probe on a single ALMEMO® device, these CO<sub>2</sub> probes will need their own external power supply ! On request we can offer a wide variety of power supply options to suit your particular measuring setup.

### Type

Carbon dioxide sensor including connecting cable 1.5m long for CO<sub>2</sub> measurements in air  
(Please specify measuring range !)

Factory calibration KY96xx carbon dioxide concentration for measuring chain (sensor + device) (see chapter Calibration certificates)

**Order no.**  
**FYA600CO2**

# Gas concentrations in the air

## Carbon Monoxide Probe FYA600CO



- Applications:  
For measurement, control and warnings in garages, for monitoring the air quality with respect to the maximum allowable concentration at work places (MAC value, e.g. in laboratories and engine test benches)

! Operation with the device in SLEEP mode is not possible!

### Technical Data

Gas:	CO	Transverse sensitivity:	< 2% by integrated filter
Measuring principle:	electrochemical reaction	Output:	4 ... 20 mA on ALMEMO® connector
Measuring range:	see types	Supply voltage:	from the ALMEMO® measuring instrument
Zero point error:	< 10 ppm CO	Ambient temperature:	-10 to +40°C, sensor temperature compensated in range
Gauge reading balance:	< 3 ppm CO	Air humidity:	0 to 90% non-condensing
Error of meas. value:	±3% of full scale value	Life span of the meas. cell:	approx. 2 years typical
Zero point drift:	< 2% (1 year)	Dimensions of meas. head:	Ø 80mm, height 80mm
Reproducibility:	< 2% (1 year)	Weight:	600g
Linearity:	< 2% of full scale value	Connecting cable:	1.5m, with ALMEMO® connector
Settling time $t_{90}$ :	< 60s		

### Ausführung (incl. factory test certificate) Order no.

Carbon monoxide sensor including connecting cable 1.5m long for CO measurements in air  
range: 0 ... 150 ppm

**FYA600COB1**

range: 0 ... 300 ppm  
range: 0 ... 5000 ppm  
range: 0 ... 5 Vol.%

**FYA600COB2**  
**FYA600COB3**  
**FYA600COB4**

## Oxygen Probe FYA600O2



- Examples from the range of applications:  
Measurements in air conditioning systems, air purifiers, oxygen rectifiers, greenhouses and oxygen incubators.
- Approved by PTB and approved for exhaust emission measurements in the automotive industry.

! A correction value can be stored in the ALMEMO® connector plug to compensate for the natural ageing of the probes, so optimum output characteristics can be ensured for the whole operating life.

### Technical Data

Gas:	O <sub>2</sub>	Operating life:	2 years, if operated in 20.9% O <sub>2</sub>
Measuring principle:	electrochemical cell	Nominal conditions:	20°C, 50% rH, 1013mbar
Measuring range:	1 ... 100% O <sub>2</sub> , linear	Temperature range:	-20 to +50°C
Accuracy :	1% O <sub>2</sub>	Temperature compensation:	effective in range -10 to +40°C
Resolution :	0.01% O <sub>2</sub>	Pressure range:	atm. pressure ±10%
Response time:	< 40s	Relative humidity:	0 to 99% non-condensing
Signal drift:	< 2% signal/month (typ. < 5% over operating life)	Connecting cable:	adapter cable 1.5m long
Offset voltage at 20°C:	< 20mV	Dimensions:	H 43 mm x Ø 29,3 mm

### Types

Oxygen sensor including connecting cable 1.5m long for O<sub>2</sub> measurements in air

### Order no.

**FYA600O2**

### For Reordering:

Oxygen sensor  
ALMEMO® connecting cable

**FY9600O2**  
**ZA9600AKO2**

## Ozone Measuring Transducer FYA600O3



- Suitable for many measuring tasks where ozone measurements for control purposes were too expensive to date, e.g. for leakage tests in industry, for protection of health and safety standards at work, for mobile air quality measurements etc.
- Each ozone sensor is supplied with a manufacturer's test certificate.
- As a result of the high long-term stability, only small maintenance costs.

### Technical Data

Gas:	O <sub>3</sub> (ozone)	Power supply:	6 to 14V, stable
Measuring principle:	electrochemical three-electrode sensor	Current consumption:	pump on : 50 mA, typical pump off : 25 mA, typical pump blocked : 180 mA, typical
Measuring range:	0 ... 300 ppb	Overload capacity:	1 ppm
Detection limit	20 ppb	Expected useful life :	Sensor, typically 24 months (at 20 °C) pump, typically 6000 hours
Accuracy:	typically 5% of final value under nominal conditions (for intermittent operation)	Nominal conditions:	20°C, 30% r.H., 1013 mbar, no contaminations of the contact surfaces
Long term accuracy:	after 12 months under nominal conditions typically 5% of final value (for intermittent operation)	Operating range :	-20 to +40 °C / 30 to 80 % RH
Exposure period :	until specification is reached, at least 2 hours (at 200 ppb); for a prolonged period the device was in an ozone-free environment	Storage temperature:	0 to 20°C, at 30 to 80% RH non-condensing
Meas. interval:	pump on: 5min pump off: 10min	Dimensions:	L 180mm x W 125mm x H 90mm
Pump flow rate:	500ml/min	Connecting cable:	1.5m long with ALMEMO® connector programmed in ppb
Signal output:	0 ... 2V, load resistance > 100kΩ		

#### Type (including manufacturer's test certificate)

Ozone sensor including connecting cable 1.5m long for O<sub>3</sub> measurements in air

**Order no.**

**FYA600O3**

#### Option:

Pump in continuous operation (fixed factory setting)

**OY9600O3D**

Maintenance set :

new electro-chemical measuring cell, pump replacement, readjustment, including calibration certificate

**ZB9600O3S**

# Gas concentrations in the air

## Gas probe for various gases FYA600A



- Range:  
Measurement of gas concentration in air
- multiple ranges / Modelvariants

! Operation with the device in SLEEP mode is not possible!

### Technical Data

Gas:	see model variants	Output:	4 ... 20 mA on ALMEMO® connector
Measuring principle:	electrochemical reaction	Supply voltage:	from the ALMEMO® measuring instrument
Measuring range:	see model variants	Ambient temperature:	-10 to +40°C, sensor temperature compensated in range
Error of meas. value:	±3% of full scale value	Air humidity:	0 to 90% non-condensing
Zero point drift:	< 2% (1 year)	Life span of the meas. cell:	approx. 2 years typical
Reproducibility:	< 2% (1 year)	Dimensions of meas. head:	Ø 80mm, height 80mm
Linearity:	< 2% of full scale value	Weight:	600g
Settling time $t_{90}$ :	< 60s	Connecting cable:	1.5m, with ALMEMO® connector
Transverse sensitivity:	< 2% by integrated filter		

### Model variants (including factory test certificate)

### Order no.

Gas probe, including connecting cable, 1.5 meters, for measuring gas in air

#### Ammonia $\text{NH}_3$

Range: 0 ... 250 ppm

FYA600ANH3

#### Nitrogen dioxide $\text{NO}_2$

Range: 0 ... 30 ppm

FYA600ANO2

#### Nitrogen oxide $\text{NO}$

Range: 0 ... 50 ppm

FYA600ANO

#### Chlorine gas $\text{Cl}_2$

Range: 0 ... 50 ppm

FYA600ACL2

#### Sulfur dioxide $\text{SO}_2$

Range: 0 ... 20 ppm

FYA600ASO2B1

Range: 0 ... 50 ppm

FYA600ASO2B2

Range: 0 ... 250 ppm

FYA600ASO2B3

#### Hydrogen sulfide $\text{H}_2\text{S}$

Range: 0 ... 50 ppm

FYA600AH2SB2

Range: 0 ... 250 ppm

FYA600AH2SB3

#### Ethylene oxide $\text{C}_2\text{H}_4\text{O}$

Range: 0 ... 20 ppm

FYA600AC2H4OB1

Range: 0 ... 50 ppm

FYA600AC2H4OB2

Range: 0 ... 100 ppm

FYA600AC2H4OB4