System overview

Lambda transmitter LT3-Ex
Combination probe KS1D-Ex

LAMTEC

Sensors and systems for combustion engineering

www.lamtec.de

LAMTEC Measuring System LT3-Ex KS1D-Ex.

With the LT3-Ex lambda transmitter, LAMTEC provides customers with a simple device for the simultaneous measurement of oxygen (O_2) and oxidising gas components (CO_e) in an explosion-protected (Ex) design.

Together with the KS1D-Ex combination probe, the lambda transmitter is a system for the measurement of oxygen (O_2) and the detection of oxidising gas components (CO/H_2, etc.). The probe is installed directly into the process and does not require a gas treatment unit. Both the transmitter and the probe are designed in "flameproof enclosure" (Ex d) type of explosion protection. This makes it possible to use the entire system in explosive atmospheres, both in Zone 1 and Zone 2. Due to the design of the probe and the materials used, such as ceramics and stainless steel, it is very robust and can be used for all kinds of measuring tasks.

Due to the magnetic keyboard, the device can be operated through the closed disc using a magnetic pin. Explosion protection (Ex) is thus always guaranteed, even during maintenance.

Through the use of an exhaust gas deflection tube made of Kanthal, it is possible to use the KS1D probe up to exhaust gas temperatures of 1,200°C.

Operation using magnetic pin.

Advantages:

- O_2 measurement range: 0 - 21 vol. %
- CO_e measurement range: 0 – 1,000 ppm
- Use in explosive atmospheres, approval according to ATEX and IEC
- Handling during operation when the housing is closed
- Not affected by false air (CO_e)
- No gas preparation required, measurement directly in the moist flue gas
- Adjustment time to 60 %/90% value (T60): O_2 ca. 50 s, CO_e ca. 60 s (T90): O_2 ca. 130 s, CO_e ca. 140 s
- Low heating power with LT3-Ex 15 – 23 W depending on the exhaust gas temperature
- Low-maintenance

Measurement principle

Measurement principle for KS1D-Ex :
The basis of the KS1D-Ex combination probe is a heated electrochemical measuring cell made of zirconium dioxide ceramics.
It has 3 electrodes:

- O_2-sensitive platinum electrode
- CO/H_2-sensitive electrode made from a platinum/gold alloy
- Platinum reference electrode

Functional principle O_2 Measurement (short)
The O_2 measuring cell works as an electrochemical concentration chain and generates a direct voltage. Supplying the external electrode with a sample gas and the internal electrode with a reference gas of a familiar O_2 concentration, e. g., air (20.96 % O_2), with a continuous constant temperature between 700 and 800 °C, results according to Nernst in the logarithmic association between the probe voltage U and the oxygen concentration on the sample gas.

Functional principle CO_e Measurement (short)
Alongside Nernst voltage U_{O2} which is determined by the oxygen content, the combustible components in the sample gas generate an auxiliary direct voltage $U_{CO/H2}$. The sensor voltage is the sum of both voltages $U_S = U_{O2} + U_{CO/H2}$ (see “Sensor characteristic curve”). As already in the case of low concentrations of oxidising gases, such as H_2 or CO, the mixed potential is considerably higher than the O_2 signal.

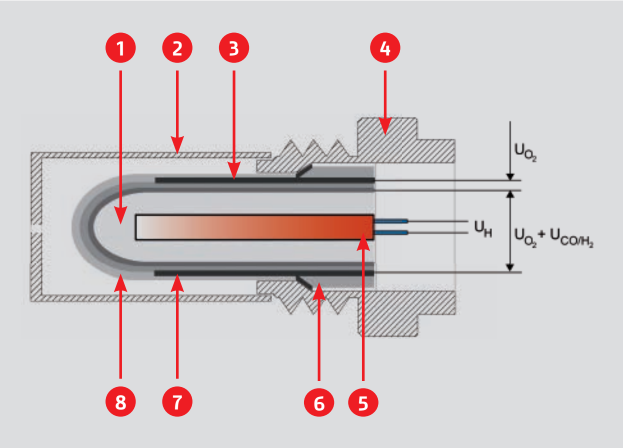
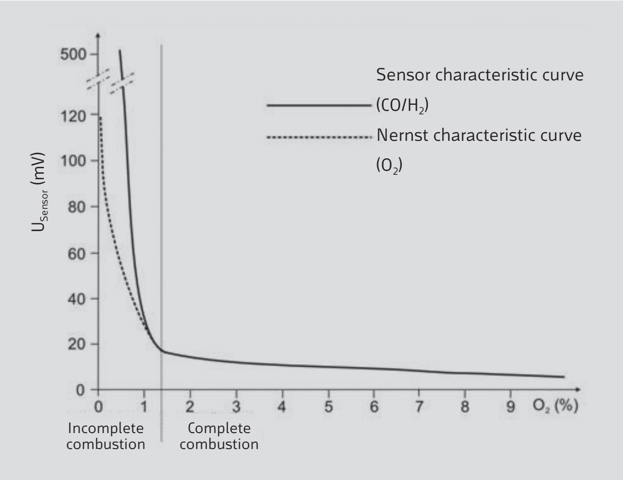


Diagram of the combination probe KS1D-Ex.

1 Reference electrode
2 Sensor cap with gas inlet
3 O_2-sensitive electrode
4 Housing
5 Heater
6 Functional ceramics
7 CO/H_e sensitive electrode
8 Protective coating



Sensor characteristic curve.

Functional principle O_2 Measurement (detailed)

The principle of oxygen measurement is really simple and was already described by W. H. Nernst at the end of the nineteenth century. The voltage U between the two electrodes is composed of a constant offset voltage U_0 and a variable voltage, which, on the one hand, depends on the sensor temperature and, on the other hand, on the ratio of oxygen content to the reference and measurement side:

$U = U_0 + k * T * \ln (p_{02,meas}/p_{02,ref})$.

k is a natural constant. This formula (Nernst formula) explains that the larger the difference between the oxygen fractions in the sample gas and in the reference gas, the greater the sensor voltage is. The offset voltage generally arises as a result of temperature differences between the reference electrode and the electrode in the sample gas.

On both electrodes, the conversion of oxygen to ions takes place (O_2 + 4e < > $2O^{2-}$). The back reaction takes place to the same degree in the chemical balance. The difference in the concentration of oxygen on both sides, however, results in more oxygen being converted than on the sample side when all the framework conditions are met on the reference side. This results in different potentials on both sides. The potential difference produces the measured voltage depending on the oxygen fraction in the sample gas (the reference side is always constant 21%).

Functional principle CO_e measurement (detailed)

If the sample gas does not comprise pure air or nitrogen and oxygen, but also contains a fraction of combustible gases (CO, H_2, CH_4, etc. → CO_e), several effects are responsible for the occurrence of the measured voltage.

The first voltage fraction U_{02} is the same as in oxygen measurement. The difference between the oxygen fractions also exists in this case. The second voltage fraction is the so-called CO_e voltage. This is added to U_{02} to the overall voltage measured between the electrodes U_{CO}/H_2 according to $U_{CO/H2} = U_{02} + U_{COe}$.

The mechanisms which contribute to the formation of the U_{COe} voltage are far more complex than the operation of oxygen measurement. Therefore only the most important points should be mentioned here in brief.

- The sensor. To measure CO_e, it is necessary to alter the material of the sensing electrode as a pure platinum electrode does not respond to CO_e as desired. As a rule, in CO_e sensors the sensing electrode is “passivated” with other metals.
- Platinum has the property of binding many gases including O_2 and CO_e to the surface in an active state. The CO_e bound to the surface reacts spontaneously with the bound oxygen as platinum is a very good catalyst.
- Gold does not have this property of platinum described. However, it binds CO_e molecules to its surface very well. Oxygen, which was there previously, is therefore displaced. In the end, this results in no more oxygen being present anywhere where there is gold is on the surface. Therefore the desired balance of the oxygen fractions between both electrodes (see O_2 measurement) is shifted further towards an imbalance.

The catalytic reactions, the oxygen imbalance and additional processes not described here altogether form the sensor voltage which is determined when measuring CO_e. If the known fraction of oxygen is deducted from this total voltage, the pure voltage which arises as a result of the CO_e processes is obtained.

Exhaust gas deflection tube

The exhaust gas deflection tube was developed to cool off hot combustion system flue gases and to control the probe. The hot flue gas is trapped in the flue gas duct and conducted to the probe through the bottom part of the deflection tube. In the process, the flue gas cools off. After the probe, the cooled flue gas is conducted back to the flue gas duct through the top part of the deflection tube.

1 Combination probe KS1D-Ex **2** Exhaust gas deflection tube **3** Counterflange DN65 PN6 **4** Flange seal **5** Graphite seal

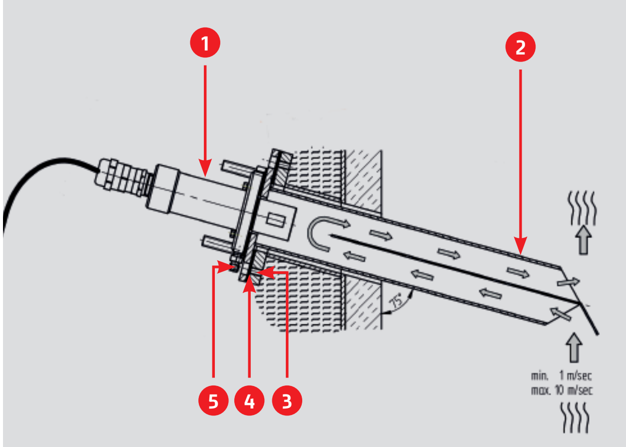
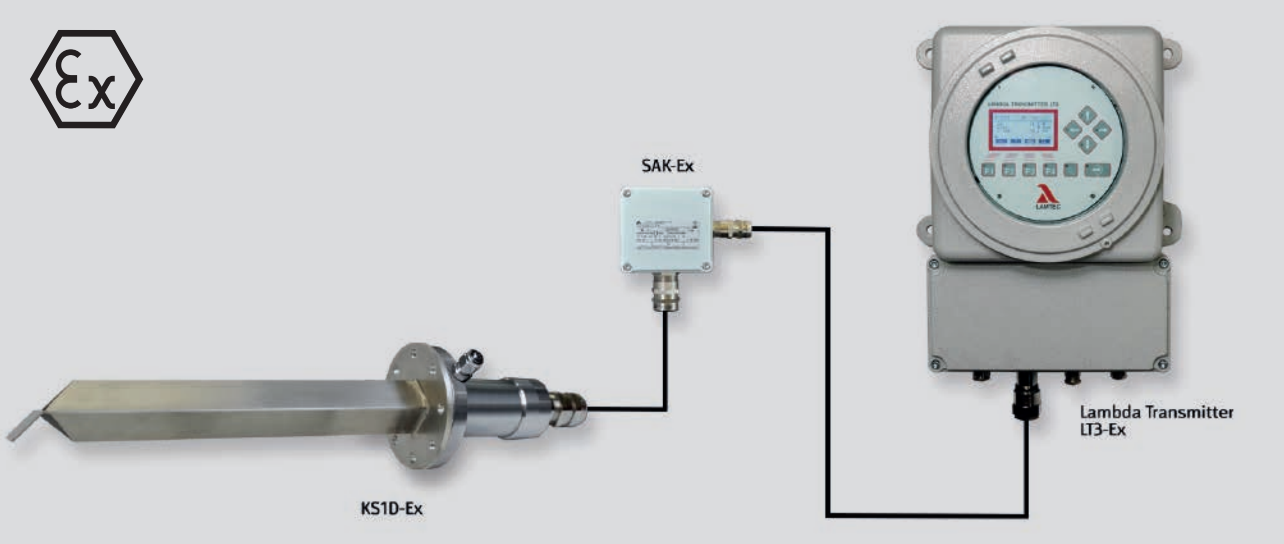


Diagram of the combination probe KS1D-Ex.



Functional overview LT3-Ex with KS1D-Ex, as well as otional probe connection box SAK for extension.

Basic system.


Lambda transmitter LT3-Ex with SAK and main switch.

The LT3-Ex lambda transmitter is a microprocessor-based measuring transducer with diagnosis function.

Specification:

Ex d IIC T5 Gb (-20°C <Ta< + 55°C)
LCIE 13 ATEX 3066 X

The device is operated using a magnetic pin with the housing closed so that no special measures are required during operation in explosive atmospheres.


Combination probe KS1D-Ex.

Combination probe KS1D-Ex

Specification:

II2G Ex d II2B+H2 T3 (Ta: -20 °C bis 60 °C)
LCIE 13 ATEX 3045X
IECEx LCIE 13.0027X

For the first time, the combination probe KS1D-Ex enables the simultaneous measurement of oxygen (O_2) and oxidising exhaust gas components (CO/H_2) using a ZrO_2 sensor. For the KS1D-Ex, the measuring principles of the proven lambda probe LS2 and combination probe KS1 is combined in a ZrO_2 sensor.

Optional components.

PCB probe connection box

Specification:

II 2GD Ex e IIC T5 Gb (-20°C <Ta< + 55°C)
Ex tb IIIC T100 Gb IP66
CESI 03 ATEX 333

The LAMTEC PCB probe connection box has been designed to bridge longer distances between the LT3 and the probe without need for an extension cable (> 2 metres).


PCB probe connection box

Optional components.

T-adapter

The T-adapter protects the probe from solid particles, chemical deposits and condensation. Recommended for dusty and/or corrosive applications.
Recommendation: To prevent the extension from condensation thermally insulate the T-adapter.

T-adapter for vertical mounting of the Kombisonde KS1D-Ex.

ATEX connection cable/extension for combination probe KS1D-Ex

An additional connecting cable/extension is available for connecting the combination probe KS1D-Ex to the probe connection box SAK.

Notes.

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