Combination Probe KS1D, KS1D-K

LAMTEC

Sensors and systems for combustion engineering

www.lamtec.de

LAMTEC's LT2 family of Lambda Transmitters: a modular O_2 and CO/O_2 measuring system for all applications.

LAMTEC supplies leading technology for measuring exhaust gas in combustion systems. Our comprehensive portfolio of O_2 and CO/H_2 probes, along with transducers, can be combined to meet specifi c requirements and integrated easily into control systems. You get precisely what you need for your combustion system: a solution that both meets your requirements and fi ts your budget.

LAMTEC off ers the LT2 Lambda Transmitter in two basic versions. As a measuring device for O_2 only, the LT2 Lambda Transmitter is combined with the LS2 Lambda Probe. It can also be combined with the KS1D Combination Probe. In this case, it can be used to measure both O_2 and oxidisable emissions (CO_e = CO equivalent).

Since the LT2 Lambda Transmitter system is modular by design, the diff erent sensors can be combined with the various valves and fi ttings with ease. The advantage of this is that the system can be adapted to perform a variety of measuring tasks.

A direct connection between the LT2 Lambda Transmitter and the LAMTEC VMS4/VMS5 fuel/air ratio control management system, the LAMTEC FMS4/FMS5 combustion management system, the LAMTEC ETAMATIC and Burner Tronic BT300 burner controls provides the basis for innovative control processes to optimise oil and gas combustion and for the automatic adaptation combustion systems to changes in combustion conditions.

In addition to O_2 measurement, the Lambda Transmitter supports the following functions when combined with LAMTEC combination probes:

- Measurement of fl ue gas and suction air temperatures and calculation of combustion effi ciency
- Detection of unburned components (CO/H_2), displayed as CO equivalent (CO_e)
- Calculation and display of CO_2 concentration

- Advantages:
- Direct (in situ) measurement of oxygen (O_2) and oxidising exhaust gas components (CO/H_2) in the raw gas up to a temperature of 1,200 °C O_2 measurement, range 0 to 21 vol. % CO_e measurement, range 0 to 10,000 ppm
- Not aff ected by false air (CO_e)
- No gas preparation required, measurement is taken directly in the moist fl ue gas
- Response time set to 60 % (T60)
  O_2 < 10 seconds with standard extraction CO_e ≤ 2 seconds
- Low heating power 20 to 25 W depending on the exhaust gas temperature
- Certifi ed fl ame arrestor
- Universally compatible
- Easy to use – plug-in probe connection
- Low maintenance

Measurement principle

Sensor technology principle for the O_2 electrode: The LAMTEC KS1D Combination Probe is based on a heated electrochemical measuring cell made from zirconium dioxide ceramic (ZrO_2).
It has 3 electrodes:

- O_2 electrode (platinum)
- CO_e electrode (platinum/noble metal)
- Reference electrode (platinum)

The probe is a zirconium dioxide ceramic tube that is sealed on one side. It protrudes into combustion system's emissions channel and divides the reference gas compartment (surrounding area) from the measuring gas compartment (emissions channel) so that no gas can escape. The reference electrode is located on the inner side of the zirconium dioxide ceramic in the reference gas compartment. The two measuring electrodes for O_2 and CO/H_2 are located on the outer side of the ceramic in the measuring gas compartment. An integrated heater warms the probe to a temperature of around 650 °C and controls this temperature. At this temperature, the zirconium dioxide ceramic conducts oxygen ions and the two sensor signal voltages U_{O2} (between the reference and O_2 electrodes) and U_{COe} (between the reference and CO_e electrodes) form accordingly and can be measured.

The sensor voltage U_{O2} [mV] corresponds to the known Nernst voltage, which is dependent on the sensor temperature T [K] and on the logarithm for the O_2 partial

- Firing rate-dependent and fuel-specifi c limit curves/limit values
- Integrated PID/O_2 controller
- Fieldbus connection

pressure ratio between the reference and measuring chambers, with the constants k = 0.21543 [mV/K] and the sensor-specifi c off set voltage U_0 [mV]. as per the formula: $U_{O2} = U_0 + kT\ln(p_{O2,ref}/p_{O2,meas})$.
U_0 is determined by calibrating the probe with the ambient air: With $p_{O2,ref} = p_{O2,meas} = 0.21$, the last part of the equation becomes zero and the off set voltage is measured $U_0 = U_{O2}$ at 21 vol.% O_2. A typical Nernst O_2 characteristic (U_{O2}) at a typical sensor temperature T = 923° [K] with a typical off set voltage of U_0 = -5 [mV] is shown in "Nernst sensor characteristic Us = f (O_2)".

Sensor technology principle for the CO_e electrode: The CO_e electrode is identical to the O_2 electrode apart from the fact that the electro-chemical and catalytic properties in the signal materials are diff erent, thus enabling combustible components such as CO, H_2, to be detected.

For "clean" combustion, the Nernst voltage U_{O2} also forms on the CO_e electrode and the characteristics of both electrodes follow an identical path. In the event of incomplete combustion and in the presence of combustible components, a non-Nernst voltage U_{COe} also forms on the CO electrode and the characteristics for both electrodes move apart (see "Typical signal characteristics for the two KS1D sensor voltages").

The total sensor signal $U_{CO/H2}$ on the CO_e electrode is made up of the total of these two voltages: $U_{CO/H2} = U_{O2} + U_{COe}$. If the oxygen content – measured by the O_2 electrode – is deducted from the total sensor signal, the result $U_{COe} = U_{CO/H2} - U_{O2}$ can be used to generate the concentration of combustible components CO_e in ppm. The "Typical signal characteristics" for the two KS1D sensor voltages shows the typical path for CO_e concentrations (dashed line) when O_2 content reduces gradually. When moving into the defi cient air range, the CO_e concentration increases signifi cantly at the so-called emission edge as a result of the poor/incomplete combustion caused by insuffi cient air for combustion. The resulting signal characteristics U_{O2} (continuous line) and $U_{CO/H2}$ (dotted dashed line) for the KS1D are also shown. In the excess air range with clean CO_e free combustion, the two sensor signals U_{O2} and $U_{CO/H2}$ are identical to one another and show the current oxygen content in the exhaust gas channel in accordance with the Nernst principle. Close to the emission edge, the sensor signal for the CO_e electrode $U_{CO/H2}$ increases at a disproportionate rate due to the additional non-Nernst CO_e signal.

The typical signal characteristics for the two KS1D sensor voltages U_{O2} and $U_{CO/H2}$ in relation to the O_2 content in

the emissions channel. The typical characteristic of combustible components CO_e is also shown.

In addition to the absolute sensor signals $U_{CO/H2}$ and U_{O2}, the relative change to the sensor signals aft er time dU_{O2}/dt and $dU_{CO/H2}$/dt and, in particular, the signal dynamic range for the CO_e electrode can also be used to determine the emission edge (see “Dynamic range of the CO_e electrode signal $U_{CO/H2}$ in the incomplete combustion range”).

oxidising gas components (CO/H_2), displayed as CO_e (CO

Properties:

- Measurements are taken directly in the moist fl ue gas up to 300 °C
- Protection rating IP42, the probe must be protected against water, snow, etc., if installed outside

Applications:

Basic system.

LT2 in IP65 wall-mounting housing.

The LT2 Lambda Transmitter is available in two basic versions:

- Sheet steel housing, lockable door at the front, impact-resistant inspection window, optional display and control unit IP65.

- Natural gas, heating oil (extra light).

LT2K with integrated reference air pump.

- Sheet steel housing, lockable door at the front, impact-resistant inspection window, with integrated reference air pump, optional display and control unit IP65.

Probes.

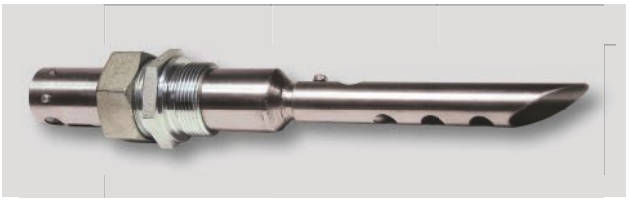
In situ, LAMTEC probes support both O_2 measurement (LS2
Lambda Probe) and simultaneous measurement (KS1D Combination Probe) of O_2 concentration and combustible

equivalent).

Lambda Probe LS2
Combination Probe KS1D

Lambda Probe LS2 in a housing with the GED and PIF
Combination Probe KS1D in a housing with the GED and PIF

Properties:



GED = Gas extraction device
PIF = Probe installation fitting

- Measurements are taken directly in the moist fl ue gas up to 300 °C
- Protection rating IP42, the probe must be protected against water, snow, etc., if installed outside

Applications:

- Natural gas, heating oil (extra light).

Lambda Probe LS2 in HT design Combination Probe KS1D in HT design

Properties:

- Measurements are taken directly in the moist fl ue gas up to 1,200 °C
- Option for semi-automatic calibration during operation with test gas

Properties:

- Measurements are taken directly in the moist fl ue gas up to 450 °C
- On-site customer reference air connection (instrument air); alternatively, an integrated reference air pump can be supplied
- Option for semi-automatic calibration during operation with test gas backfl ushing supported, cyclic regeneration of measuring cell with air
- IP65 protection rating

Applications:

- Natural gas, domestic fuel (extra-light), heating oil (heavy), biomass, non-standard fuels

Lambda Probe LS2-KH with protective tube Combination Probe KS1D-KH with protective tube

Properties:

- Measurements are taken directly in the moist fl ue gas up to 450 °C
- On-site customer reference air connection (instrument air)
- Option for semi-automatic calibration during operation with test gas
- IP65 protection rating
- Includes protective tube for high dust

Applications:

- Natural gas, domestic fuel (extra-light), heating oil (heavy), coal, biomass, particle-laden fuel emissions, non-standard fuels

Lambda probe LS2 and combination probe KS1D with fl

- IP65 protection rating

Applications:

- Natural gas, heating oil (extra-light), coal, particle-laden fuel emissions (available with optional de-dusting cleaning).

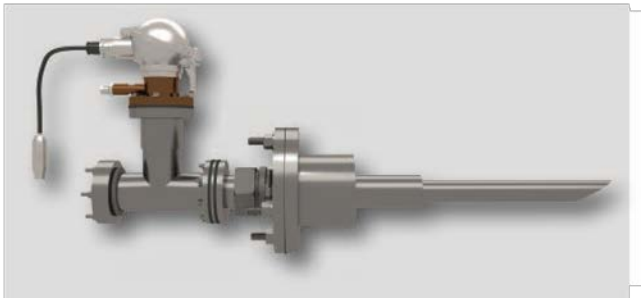
Lambda Probe LS2-K or LS2-KR
Combination Probe KS1D-K or Combination Probe KS1D-KR

ue gas extraction tube

Applications:

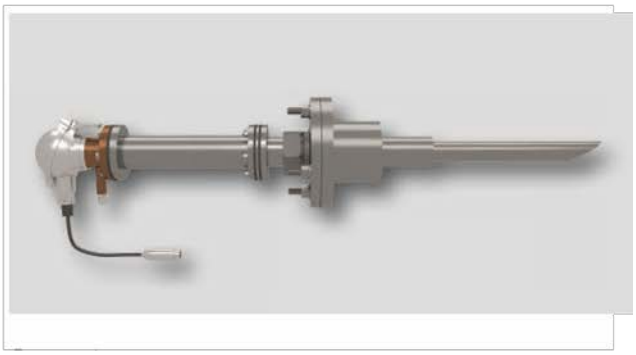
- Natural gas, heating oil EL, HFO, special gases

Lambda probe LS2 and combination probe KS1D with fl ue gas extraction tube and T-adapter



Properties:

- High exhaust gas temperatures up to 1400°C
- T-adapter to protect the probe



- Measurements are taken directly in the moist flue gas up to 1,200 °C
- Option for semi-automatic calibration during operation with test gas
- IP65 protection rating

Applications:

- Dusty and other special fuels

Lambda Probe LS2-KAF with purging clean and fi lter mesh Combination Probe KS1D-KAF with purging and fi lter mesh

Properties:

- Measurements are taken directly in the moist fl ue gas up to 200 °C
- On-site customer reference air connection (instrument air)
- Option for semi-automatic calibration during operation with test gas
- IP65 protection rating
- Includes protective tube for high dust with purging pre-fi lter and additional fi lter mesh

Applications:

- Natural gas, domestic fuel (extra-light), heating oil (heavy), coal dust combustion, biomass, fuel emissions with high dust content, non-standard fuels

Lambda Probe LS2-KA with purging Combination Probe KS1D-KA with purging

Properties:

- Measurements are taken directly in the moist fl ue gas up to 450 °C
- On-site customer reference air connection (instrument air)
- Option for semi-automatic calibration during operation with test gas
- IP65 protection rating
- Includes protective tube for high dust with purging pre-fi lter

Applications:

- Natural gas, domestic fuel (extra-light), heating oil (heavy), coal, biomass, particle-laden fuel emissions, non-standard fuels

Lambda Probe LS2-EX / IIB Combination Probe KS1D-EX / IIB

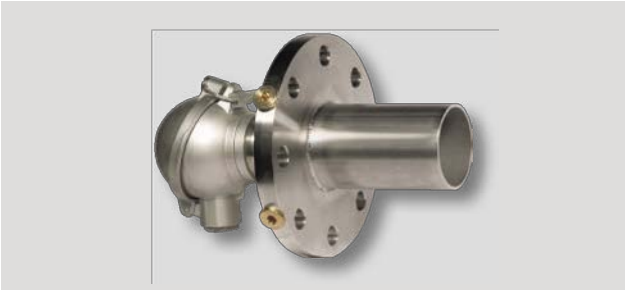
Properties:

- Measurements are taken directly in the moist fl ue gas up to 500 °C
- On-site customer reference air connection (instrument air)
- Option for semi-automatic calibration during operation with test gas
- IP65 protection rating
- Includes ATEX certifi cation: II 2G EEx D IIB +H2T3, Zone 1.

Applications:

- Natural gas, domestic fuel (extra-light), heating oil (heavy), coal, non-standard fuels

Lambda Probe LS2 for manual purging Combination Probe KS1D for manual purging

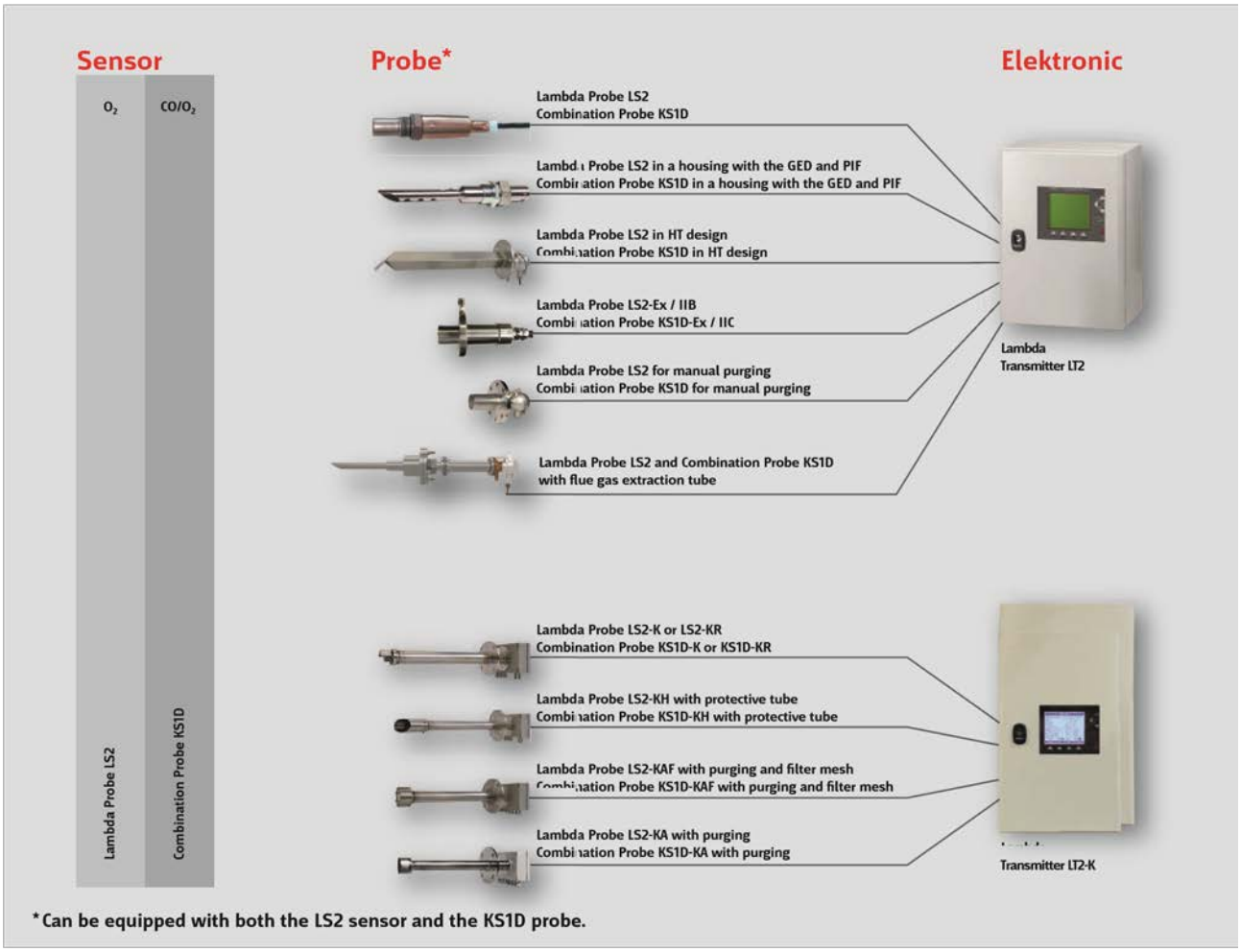


Properties:

- Measurements are taken directly in the moist fl ue gas up to 600 °C
- Includes fi tting for manual purging
- IP65 protection rating

Applications:

- Measurement of very high exhaust gas temperatures. Fuels: Natural gas, domestic fuel (extra-light), heating oil (heavy), coal, biomass, non-standard fuels



Functions in the LT2 with KS1D/LS2.

Optional components.

- Display and control unit
- Remote display soft ware
- Measurement of fl ue gas and suction air temperatures and calculation of combustion effi ciency
- Calculation and display of CO_2 concentration, calculated for specifi c fuel from the O_2 measured value and the CO_2 max. value
- Firing rate-dependent and fuel-specifi c limit values/limit curves
- Integrated PID-O_2 controller
- 4 fl oating analogue outputs (output 1 and 2) max. voltage diff erence 20 V can be set to any value, direct current 0/4 to 20 mA, fi ring rate impedance 0 to 600 Ohm
- 6 digital outputs in connection with relay module 657R0857 Fieldbus
- connection
- Housing heating
- Purge unit

Options for LAMTEC probes

- Semi-automatic calibration (available for probes with attribute “K”)
- Fully automatic calibration (available for probes with attribute “KV”)
- Reference air pump (available for probes with attribute “K” and “Ex”)
- Purge unit with an exhaust gas defl ection pipe (available for probes with attribute “HT”)
- Purging the pre-fi lter (available for KS1D-KA, LS2-KA, KS1D-KAF and LS2-KAF)
- Automatic regeneration of ZrO_2 measuring cell with short application of air for biomass

Accessories

- Mating fl ange
- Flange seal
- Probes in various lengths

Inputs.

Outputs.

Analogue outputs

Output 1 0 ...10%

Probe connection

Relay output

LAMTEC SYSTEM BUS (CAN BUS)

Digital inputs

O_2 = 4 ... 20 mA

Output 2 0 ... 1,000 ppm

CO_e = 4 ... 20 mA

Output 3 n ot assigned

Output 4 n ot assigned

Special input

Output 1 relay output: Group fault message

LSB input

Reset fault/warning

Reset GW message

Offset calibration

PID controller OFF

Maintenance ON/OFF

Fuel 2

Fuel 3

Fuel 4

Monitor

Monitor output: e.g. to connect a multimeter for service purposes Ri >

10 kOhm

Interface
RS232 only in combination with remote display soft ware type 657R1101 RS422 type 663P0503

Digital outputs
Relay outputs 2 – 7
Max. 230 VAC / 4 A
or 48 VDC / 3 A

Input

Output 2 W arning and

Output 6 Limit value 3

Output 7 Limit value 4

Input 1

Input 2

Input 3

Input 4

Analogue measuring inputs

- **CO/H_2 signal**
- **Pressure sensors**
- **Standard signal (4 ... 20 mA) active/passive for pressure, temperature, etc.**
- **Pt100**
- **Potentiometer 1 ... 5 kOhm**

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maintenance

Output 3 Measuring

Output 4 Limit value 1

Output 5 Limit value 2