Technical Data

Lambda Transmitter LT3
KS1D Combination probe

Simultaneous measurement of oxygen ($O_2$) and oxidising components (CO/H$_2$)

Sensors and Systems for Combustion Engineering
# Introduction

## 1 Introduction

### 1.1 Use

The Lambda Transmitter LT3 has been developed to use in conjunction with the combination probe KS1D for the simultaneous measurement of the $O_2$ concentration and oxidising components ($CO/H_2$), displayed as CO equivalents ($CO_e$), usually in the flue gases in the superstoichiometric area ($\lambda>1$).

### 1.2 Product Matrix

Suitable for gas measurements with a small proportion of combustible components (< 10,000 ppm), for example in flue gases of combustions systems.

Admissible fuels:
- Non-interacting gaseous hydrocarbons
- Light oil
- Coal
- Biomass (wood)

Direct measurements in "combustion gases" are not possible.

<table>
<thead>
<tr>
<th>Use</th>
<th>Probe installation fitting (PIF)</th>
<th>Gas extraction device (GED)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LT3 in wall mounting housing Type 657R51</strong> ... In conjunction with:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• KS1D combi probe in standard housing, 2 m connecting cable, Type 656R2000</td>
<td>• Male coupling R1¼&quot; Type 655R1010 optionally</td>
<td>• GED 150 mm Type 655R1001</td>
</tr>
<tr>
<td>• Probe installation fitting (PIF)</td>
<td>• Half collar R1¼&quot; will be welded Type 655R1012</td>
<td>• GED 300 mm Type 655R1002</td>
</tr>
<tr>
<td>• Gas extraction device (GED)</td>
<td></td>
<td>• GED 450 mm Type 655R1003</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• GED 1,000 mm Type 655R1004</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>LT3 in wall mounting housing Type 657R51</strong> ... In conjunction with:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• KS1D-HT combi probe „High Temperature“, 2 m connecting cable, Type 656R2015</td>
<td>• Flue gas temperature &gt; 300 °C</td>
<td>• Flue gas bypass tube up to 750 °C Type 656R1014 → 500 mm Type 656R1015 → 750 mm Type 656R1016 → 1,000 mm</td>
</tr>
<tr>
<td>• Counter flange</td>
<td>• Counter flange, tube internal diameter 80 mm, tube length 70 mm, material: steel, black coated hole diameter in accordance to DN65 PN6 Type 655R0179</td>
<td>• Flue gas bypass tube up to 950 °C Type 656R1017 → 500 mm Type 656R1018 → 750 mm Type 656R1019 → 1,000 mm</td>
</tr>
<tr>
<td>• Flange sealing</td>
<td>• Counter flange, tube internal diameter 80 mm, tube length 70 mm, material: stainless steel 1.4571, hole diameter in accordance to DN65 PN6 Type 655R0180</td>
<td>• Flue gas bypass tube up to 1,200 °C Type 656R1021 → 500 mm Type 656R1022 → 750 mm Type 656R1023 → 1,000 mm</td>
</tr>
<tr>
<td>• Flue gas bypass tube</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1.3 Theoretical Foundations of the KS1D

1.3.1 Technical Description

- Direct (in situ) measurement of oxygen (O₂) and oxidising flue gas constituents (CO/H₂) in crude gas
  \[ \text{O}_2 \text{ measuring range: 0 to 21 vol.\%} \]
  \[ \text{CO}_\text{e} \text{ measuring range: 0 ... 1,000 ppm} \]
  \} \text{ in conjunction with LT3 Lambda Transmitter}
- Independent of infiltrated tramp air (COₑ)
- No gas preparation required, measurement performed directly in the moist flue gas
- Setting time to 60 \% value \( (T_{60}) < 10 \text{ s} \)
  \[ \text{CO}_\text{e} < 2 \text{ s} \]
- Low heating power 18 ... 25 W, depending on the flue gas temperature
- Low-maintenance
- Type 656R2000 in housing for flue gas temperatures < 300 °C
  5-wire Teflon cable with circular connector, length 2 m
- Type 656R2015 „high temperature“ for flue gas temperatures > 300 °C
  5-wire Teflon cable with circular connector, length 2 m
  in conjunction with flue gas bypass tube
- In the case of distances >2 m, an extension cable Type 656R3006 (2 m) or type 656R3007 (5 m) or a probe connection box type 656R3025 can be used.

1.3.2 Measuring Principle

The KS1D combination probe is primarily made up of an electrochemical cell made of zirconium dioxide ceramics.

It has 3 electrodes:
- \( \text{O}_2 \)-sensitive platinum electrode
- \( \text{CO}/\text{H}_2 \)-sensitive electrode made of a platinum/noble metal alloy
- Platinum reference electrode
1.3.3 Probe Principle - \( \text{O}_2 \)-sensitive Electrode

The \( \text{O}_2 \) measuring cell works as an electrochemical concentration change and generates a direct voltage which is dependent on the absolute temperature \( T \) and the logarithm of the \( \text{O}_2 \) concentration ratio or the \( \text{O}_2 \) partial pressure ratio on the reference and \( \text{O}_2 \) external electrode.

Supposing the external electrode with a sample gas and the internal electrode with a reference gas of familiar \( \text{O}_2 \) concentration, e.g. air (20.96 %), with a continuous constant temperature, results in the logarithmic association between the probe voltage \( U \) and the oxygen concentration on the sample gas, as shown below.

\[
U_s = 0.049 \cdot T \cdot \log \frac{P_{\text{O}_2}^{(\text{L})}}{P_{\text{O}_2}^{(\text{G})}}
\]

\[
\text{O}_2 [\%] = 20.96 \cdot 10^{- \frac{U_s}{0.049 \cdot T}}
\]

Fig. 1: Schematic diagram of the structure of KS1D combination probe

Fig. 2: Sensor characteristic \( U = f (\text{O}_2) \)
Combustible components will be absorbed like oxygen molecules on the electrode and diffuse to the "three-phase boundary", formed by sample gas, electrode and zirconium dioxide. Alongside Nernst voltage $U_{O_2}$ which is determined by the oxygen content, the combustible components in the sample gas generate an auxiliary direct voltage $U_{CO/H_2}$ via the sensor. The sensor voltage is the total of the two voltages $U_S = U_{O_2} + U_{CO/H_2}$ (see Fig. 3). Even with low concentrations of oxidable gases, like $H_2$ or $CO$, the mixed potential is considerably greater than that of the $O_2$ signal. The formation of the mixed potential takes place very quickly, $t_{60}$-times below 2 s have been achieved.

![Diagram of sensor characteristics](image)

**Fig. 3: Characteristics on a gas burner**

A further indicator for non-burned ($CO/H_2$) on firing systems is the dynamic response of the sensor signal ($U_s$). With an increasing content of non-burned residue, the dynamic increases. The following Fig. 4 shows the increase of the sensor signal via the measuring $O_2$ value on a reference plant (12 MW gas burning system) with a small firing-rate applied.

![Diagram of sensor voltage](image)

**Fig. 4: Sensor voltage $U_{COe}$ plotted versus the $O_2$ value of 12 MW gas combustion**
Introduction

1.4 Designs and Accessories KS1D Combination Probe

1.4.1 Standard

Fig. 5: KS1D combination probe "Standard version"

1 KS1D combination probe in standard housing type 656R2000
Standard cable length 2 m, Teflon, with connector

2 Gas extraction device type 655R1001 ... 1004 (150 ... 1,000mm)

3 Probe installation fitting type 655R1010
For higher distances (no illustration)
Probe connection box (PCB) type 656R3025
See also chapter 1.4.5 Dimensions KS1D-HT "High Temperature"

1.4.2 High Temperature

Fig. 6: KS1D combination probe "High Temperature version"

1 KS1D-HT combination probe „High Temperature“ type 656R2015
Standard cable length 2 m, Teflon, with connector, in conjunction with flue gas bypass tube

2 Flue gas bypass tube Ø 80 mm, material stainless steel 1.4571
Flue gas temperatures up to 750 °C
Type 656R1014 656R1015 656R1016
Length 500 mm length 750 mm length 1,000 mm

Flue gas bypass tube Ø 80 mm, material Inconell 600
Flue gas temperatures up to 950 °C
Type 656R1017 656R1018 656R1019
Length 500 mm length 750 mm length 1,000 mm

Flue gas bypass tube Ø 80 mm, material Kanthal
Flue gas temperatures up to 1,200 °C
Type 656R1021 656R1022 656R1023
Length 500 mm length 750 mm length 1,000 mm
### 1.4.3 Dimensions KS1D in Standard Housing

![Fig.7: Drawing KS1D Standard version]

<table>
<thead>
<tr>
<th>Part no.</th>
<th>item no.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>655R1001</td>
<td>gas extraction device length X = 150mm</td>
</tr>
<tr>
<td></td>
<td>655R1002</td>
<td>gas extraction device length X = 300mm</td>
</tr>
<tr>
<td></td>
<td>655R1003</td>
<td>gas extraction device length X = 450mm</td>
</tr>
<tr>
<td></td>
<td>655R1004</td>
<td>gas extraction device length X = 1,000mm</td>
</tr>
<tr>
<td>2</td>
<td>655R1010</td>
<td>probe installation fitting 1 ¼”</td>
</tr>
<tr>
<td>3</td>
<td>656R2000</td>
<td>KS1D combination probe for flue gas temperatures up to 300 °C</td>
</tr>
</tbody>
</table>

### 1.4.4 Probe Installation Fitting (PIF) for KS1D in Standard Housing

![Fig. 8: Graph PIF Standard version]

- **Half-collar R 1.25” DIN 2986**
  - Type 655 R 1012

- **Probe installation fitting (SEA) type 655 R 1010**

- **Probe installation**
  - Fig. 1: without MEV
  - Fig. 2: with MEV

- **Flue gases**

- **Gas extraction device (MEV)**
  - Type 655 R 1001…1004
1.4.5 Dimensions KS1D-HT „High Temperature“

Fig. 9: Dimensions KS1D HT

1.4.6 Counter Flange for KS1D-HT „High Temperature“

Fig. 10: Dimensions counter flange type 655R0179 and 655R0180
1.4.7 Flue Gas Bypass Tube for KS1D-HT „High Temperature“

Fig. 11: Dimensions flue gas deflecting tube side view type 656R1014 … 656R1023

Fig. 12: Dimensions flue gas deflecting tube front view type 656R1014 … 656R1023
1.4.8 Probe Connection Box (PCB) Type 656R3025

If the distance between the probe Type 656R2000 / R2015 and the LT3 analyser is > 2 m, then a probe connection box can be used.

Therefore the 5-pin connector and the probe M20 blanking plate at the housing of the LT3 must be removed and the included M16 and M20 cable gland must be installed.

Input: Probe connector
Output: Terminal bar
Protection class: IP65

The PCB contains a terminal bar as converter to the plug of the probe.

Height x width x depth [mm]: 40 x 80 x 80

![Fig. 13: Probe Connection box type 656R3025](image)

1.4.9 Plug Assignment

<table>
<thead>
<tr>
<th>Term. 33 (PCB)</th>
<th>sensor O₂</th>
<th>Term. 10 (LT3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Term. 34 (PCB)</td>
<td>sensor GND</td>
<td>Term. 11 (LT3)</td>
</tr>
<tr>
<td>Term. 12 (PCB)</td>
<td>sensor CO</td>
<td>Term. 12 (LT3)</td>
</tr>
<tr>
<td>Term. 35 / 36 (PCB)</td>
<td>probe heater</td>
<td>Term. 13 / 14 (LT3)</td>
</tr>
</tbody>
</table>

Recommended cable cross-sections between probe connection box and LT3

<table>
<thead>
<tr>
<th>Probe heater</th>
<th>Other connecting cables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal 35/36</td>
<td>up to 20 m ≥ 1.5 mm²</td>
</tr>
<tr>
<td></td>
<td>up to 50 m ≥ 2.5 mm²</td>
</tr>
</tbody>
</table>
1.5 Technical Description LT3

Transmitter with microprocessor-based diagnostics.

The regulation of the temperature of the combination probe KS1D is depending on the sensor impedance. The combination probe KS1D will be monitored to fault conditions or lack of connections. Malfunctions will be detected by the electronics and results to a fault/warning message.

1.5.1 Designs LT3 in Wall Mounting Housing

The LT3 in wall unit can be supplied in various designs:
- Basic version
  - without display, without analogue or digital outputs
- without display, with 4 analogue outputs current 0/4 … 20 mA, via LSB module
- without display, with 4 analogue outputs voltage 0/2 … 10 V, via LSB module
- without display, with 4 digital outputs
  - for output of operational, status and limit messages, via LSB module
- without display, with 4 analogue outputs 0/4 … 20 mA and 4 digital outputs, via LSB module
- without display, with 4 analogue outputs 0/2 … 10 V and 4 digital outputs, via LSB module
- with display, without analogue or digital outputs
- with display and with 4 analogue outputs current 0/4 … 20 mA, via LSB module
- with display and with 4 analogue outputs voltage 0/2 … 10 V, via LSB module
- with display and with 4 digital outputs
  - for output of operational, status and limit messages, via LSB module
- with display and with 4 analogue outputs 0/4 … 20 mA and 4 digital outputs, via LSB module
- with display and with 4 analogue outputs 0/2 … 10 V and 4 digital outputs, via LSB module
Introduction

1.5.2 Structure of the LT3

Fig. 15: Assembly LT3

1 Mains connection
2 Probe connection KS1D (probe signal/probe heater)
3 External LSB connection to M12 plug-in connector
4 Internal LSB connection to terminals
5 Plug-in jumper 602 for LAMTEC SYSTEM BUS – termination resistor
6 Main board
7 Processor board
8 LSB module with 4 digital outputs
9 LSB module with 4 analogue outputs
1.6 Display and Operation LT3

1.6.1 User Interface

The display and operation of the LT3 occurs via a User Interface in the front door (included in standard delivery).

Functions:
- Reading of the $O_2$ and CO measuring values
- Password input
- Information about probe and fuel, about warnings and faults, about software version, CRC and serial number
- Calibration of the measurement
- Settings (Maintenance, filter time, analogue output, probe exchange, display)

Fig. 16: LT3 User Interface
1.6.2 External Operation via Programming Unit (Option)

- Operation and parameterization
- Full access via password to the parameter level
- Dataset reading and writing
- Incl. connecting cable, length 4 m, for connection to the existing M12 plug-in connector

Fig. 17: Programming unit type 657R0932

1.6.3 LSB Remote Software (Option)

- Remote Software for PCs, Windows XP or higher
- Full access via password to the parameter level
- Dataset reading and writing
- No operation but fault reset
- Incl. USB/CAN-module
- Incl. connecting cable length 4 m, for connection to the existing M12 plug-in connector

Fig. 18: Start menu Remote Software type 657R9000
1.7 Analogue Outputs via LSB Module Current, alternatively Voltage

1.7.1 Description of Function

- Current module: 4 analogue outputs 0/4 ... 20 mA
- Voltage module: 4 analogue outputs 0/2 ... 10 VDC
- Fast wiring of multiple modules via strapping plug

The field bus modules are universal output modules that are activated via the LAMTEC SYSTEM BUS. The module is addressed via a settable address (1 to 99) and the output states are transferred in the data bytes. If an analog output module with the same address is existing in the system, the voltage and the current measured there is reproduced at the relevant output.

Note:
All outgoing lines from the LSB modules are to be shielded. The shields must be placed shortly as possible to the PE busbar.

Note:
The termination resistor defines the start and the end of the LAMTEC SYSTEM BUS. It is absolutely necessary to enable the termination resistor at the first and last bus user.

Fig. 19: Analogue Outputs LSB module

1 Analogue output module
2 LSB termination resistor 120 Ω
3 Selector switch for setting of the LSB address "factor 10"
4 Selector switch for setting of the LSB address "factor 1"
5 Strapping plug

Fig. 20: Terminal assignment

- 1+/1- Analogue output 1
- 2+/2- Analogue output 2
- 3+/3- Analogue output 3
- 4+/4- Analogue output 4
- 24VDC Line voltage, to LT3 terminals 77 -/78 +
- CAN H/L LAMTEC SYSTEM BUS to LT3 terminals 74 H/75 L
1.7.2 Factory Settings of the Analogue Outputs

The module is enabled by factory side. For retrofitting or replacement only the LSB address “19” on the module have to be setted via 2 selector switches.

Analogue output 1 (O₂ measured value)
- Setting range 0 … 25 % O₂
- Factory setting 0 … 10 Vol.% O₂ → 4 … 20 mA

Analogue output 2 (CO measured value)
- Setting range 0 … 1,000 ppm
- Factory setting 0 … 1,000 ppm → 4 … 20 mA

Analogue output 3 and 4 are disabled by factory side, respectively for other values like flue gas temperature and efficiency reserved (in preparation).
1.8 Digital Outputs via LSB Module

1.8.1 Description of Function

- 4 relay outputs 250 VAC, 6 A
- Fast wiring of multiple modules via strapping plug
- Manual activation of the relay outputs via switch

The field bus modules are universal output modules that are activated via the LAMTEC SYSTEM BUS. The module is addressed via a settable address (1 up to 99) and the output statuses are transferred in the data bytes.

Note:
All outgoing lines from the LSB modules are to be shielded. The shields must be placed shortly as possible to the PE busbar.

Note:
The termination resistor defines the start and the end of the LAMTEC SYSTEM BUS. It is absolutely necessary to enable the termination resistor at the first and last bus user.

Fig. 21: Digital Outputs LSB module

1 Digital output module
2 LSB termination resistor 120 Ω
3 Selector switch for setting of the LSB address “factor 10”
4 Selector switch for setting of the LSB address “factor 1”
5 Strapping plug
6 Manual activation

Fig. 22: Terminal assignment

- 13/14 Digital output 1
- 23/24 Digital output 2
- 33/34 Digital output 3
- 43/44 Digital output 4
- 24VDC Line voltage, to LT3 terminals 77-/78+
- CAN H/L LAMTEC SYSTEM BUS to LT3 terminals 74 H/75 L
### 1.8.2 Factory Settings of the Digital Outputs

The module is enabled by factory side. For retrofitting or replacement only the LSB address "03" on the module have to be setted via 2 selector switches.

- **Digital output 1**  
  FAULT  
  Terminal 13 and 14

- **Digital output 2**  
  WARNING  
  Terminal 23 and 24

- **Digital output 3**  
  LIMIT 1 (exceeding 400 ppm COe, 60 sec.)  
  Terminal 33 and 34

- **Digital output 4**  
  LIMIT 2 (drops below 0.5 vol% O2, 30 sec)  
  Terminal 43 and 44

**Manual activation of the digital outputs:**
- Position „1“ → Output contact always closed
- Position „A“ → Output contact controlled by LSB
- Position „0“ → Output contact always open

### 1.8.3 Diagnosis of the Digital Outputs

4 LEDs above the switch indicate the status of the corresponding digital outputs.
2.1 Dimensions Housing LT3 with Wall Mounting Brackets Vertical/Horizontal

Fig. 23: Dimensions housing LT3
2.2 Technical Data for the Lambda Transmitter LT3

Design: Wall mounting housing

Housing: Steel plate housing

Type of protection in accordance with DIN 40050
- IP66, without display
- IP54, with glued display in the front door

Dimensions (HxWxD) [mm] 300 x 300 x 120

Colour Light grey RAL 7035

Weight approx. 6 kg

Ambient temperature:
- Operation: -5 °C ... +60 °C
- Transport and storage: -20 °C ... +70 °C

Supply voltage: 120 VAC / -30% ... 230 VAC/+10%, 50 ... 60 Hz
ATTENTION: Use in grounded power line networks only!

Power consumption:
- Typical: 30 W
- max: 69 W

Resolution:
- O₂: 0.1 vol. % O₂ in the range 0 ... 18 vol. % O₂
- 1 vol. % O₂ in the range 18 ... 25 vol. % O₂
- CO₂: 1 ppm in the CO range 0 ... 1,000 ppm

Accuracy of measurement:
- O₂: ± 5 % of measured value
  not better than ± 0.3 vol. % O₂
- CO₂: ± 25 % of measured value
  not better than +/- 20 ppm after prior calibration under plant conditions with a CO reference measurement

In the measuring range 0...100 ppm: ≤ 10 ppm

Setting time (60 % time):
- O₂: T₆₀ < 10 s
- CO₂: T₆₀ < 2 s

Time for operational readiness with KS1D (cold start)
At first-time commissioning of the combination probe KS1D 60 minutes after "POWER ON", otherwise 10 minutes after "POWER ON"

Analogue outputs via analogue output module
- Analogue output 1 (O₂ measured value)
  - Setting range 0 ... 25 % O₂
  - Factory setting 0 ... 10 Vol.% O₂ → 4 ... 20 mA
- Analogue output 2 (CO measured value)
  - Setting range 0 ... 1,000 ppm
  - Factory setting 0 ... 1,000 ppm → 4 ... 20 mA

Digital outputs via digital output module optional

Operating elements
- Integrated User Interface with LCD graphic display 45 x 27 mm (W x H)
- External programming unit with LCD graphic display 60 x 32 mm (W x H) (option)

Interface: LAMTEC SYSTEM BUS (LSB)

Conformity with the following European Directives:
- 2004/108/EC Electromagnetic Compatibility
- 2006/95/EC Low Voltage Directive
2.2.1 Technical Data Analogue Output Module

- Rated voltage $U_N$: DC 24 V
- Power consumption: 50 mA
- Power consumption: 1.2 W
- Operating voltage area: 19.2 V ... 26.4 V
- Operating temperature area: -5 °C ... +60 °C
- Storage temperature area: -20 °C ... +70 °C
- Safety circuit: Reverse battery protection for the operating voltage
- Functional display: Green LED for BUS activity and supply voltage
- Status display: Red LED for BUS error message
- Item no. - voltage module: 663R4025
- Item no. - current module: 663R4029

Analogue outputs (voltage)

- Output current (10 VDC) (Analogue output): 5 mA
- Accuracy: 1 %
- Output voltage: 0/2 ... 10 VDC

Analogue outputs (current)

- Output current: 0/4 ... 20 mA
- Accuracy: 1 %
- Burden: max. 300 Ω

Housing

- Inlet cross section device terminals: 2.5 mm²
- Connection cross section screwable push terminal (BUS, supply): 1.5 mm²
- Weight: 95 g
- Housing dimensions WxHxD [mm]: 35 x 68 x 60
### Technical Data Digital Output Module

- **Rated voltage** $U_N$: DC 24V
- **Power consumption** $P$: 100 mA
- **Power consumption** $P$: 2.4 W
- **Operating voltage area**: 19.2 V ... 26.4 V
- **Operating temperature area**: -5 °C ... +60 °C
- **Storage temperature area**: -20 °C ... +70 °C
- **Protective circuit**: Inverse-polarity protection of the operating voltage
- **Operating display**: Green LED for BUS activity and supply voltage
- **Status display**: Red LED for BUS error message
- **Accuracy**: 1 %
- **Response time** (Receiving to sending): 15 ms
- **Recovery time**: 550 ms
- **Item number**: 663R4027

#### Digital outputs

- **Output contact / material**: 4 switches / AgNi
- **Switching voltage**: max. 250 V
- **Inrush / breaking current max.**: 12 A / 4 s at 10 % ED
- **Continuous current**: 6 A / relay however max. 12 A / module
- **Fuse protection for contacts**: 6 A
- **Mechanical life cycle**: $1 \times 10^7$ working cycles
- **Electrical life cycle**: $1 \times 10^5$ working cycles
- **Permissible switching rate**: 360 / h at nominal firing-rate
- **Insulation to VDE 0110**: C
- **Rated voltage**: 250 V
- **Overvoltage category**: II
- **Degree of pollution**: 2
- **Test voltage coil / contact**: 4000 VAC 50 Hz 1 min
- **Test voltage contact / contact**: 1000 VAC 50 Hz 1 min

#### Housing

- **Type of protection** (EN 60529): Housing IP50 terminals IP20
- **Inlet cross section device terminals**: 2.5 mm$^2$
- **Connection cross section screwable push terminal (BUS, supply)**: 1.5 mm$^2$
- **Weight**: 95 g
- **Housing dimensions** WxHxD [mm]: 35 x 68 x 60
### 2.3 Technical Data for the KS1D Combination Probe

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
</table>
| **Measuring range**            | **O<sub>2</sub>**: 0 ... 18 vol. % O<sub>2</sub> with restriction 0 ... 25 vol. % O<sub>2</sub>  
**CO<sub>2</sub>**: 0 ... 1,000ppm CO<sub>e</sub> |
| **Measuring accuracy**         | **O<sub>2</sub>**: ± 5 % of measured value  
not better than ± 0.3 vol. % O<sub>2</sub>  
**CO<sub>2</sub>**: ± 25 % of measured value  
not better than +/- 20 ppm after prior calibration under plant conditions with a CO reference measurement |
|                               | In the measuring range 0 ... 100 ppm: ≤ 10 ppm                        |
| **Sampling**                   | Direct on the flue gas channel (in situ)                               |
| **Probe output voltage**       | **O<sub>2</sub>** electrode: -30 mV ... +800 mV  
Resolution: 0.1 mV  
**CO/H<sub>2</sub>** electrode: -30 ... +800 mV  
Resolution: 1 mV |
| **Sources of error:**          | Temperature  
Other non-burned hydrocarbons                                           |
| **Cross sensitivity:**         | In view of SO<sub>2</sub>, NH<sub>3</sub>, NO, propane, aromatic hydrocarbons |
| **Probe internal resistance of** | 15 ... 25 Ω                                                          |
| the ZrO<sub>2</sub> measuring cell on air and 22W heating power          |                                                                 |
| **Permissible fuels**          | Non-interacting gaseous hydrocarbons  
Domestic fuel  
Coal  
Wood |
| **Weight**                     | 560 g combination probe KS1D in standard housing type 656R2000  
1,300 g combination probe KS1D-HT „High Temperature“ type 656R2015 |
| **Lifetime**                   | ≥ 2 years for natural gas and oil                                       |
| **Heating power**              | 10 ... 25 W, depending on design and measuring gas temperature          |
| **Insulation resistance**      | > 30 MΩ                                                                |
| between heater and probe connection |                                                                 |
| **Mounting position**          | Horizontal to vertical                                                 |
| **Ambient temperature**        | -20 to +60°C                                                           |
| **Permitted continuous flue**  | < 300 °C combination probe KS1D in standard housing type 656R2000  
> 300 °C combination probe KS1D-HT „High Temperature“ type 656R2015 |
| **gas temperature**            |                                                                 |
| **Protection class in accordance with DIN 40050** | IP42 combination probe KS1D in standard housing type 656R2000  
IP65 combination probe KS1D-HT „High Temperature“ type 656R2015 |
## Appendix

### 2.4 Overview Order No.

#### 2.4.1 Lambda Transmitter LT3

<table>
<thead>
<tr>
<th>Description / Type</th>
<th>Order-no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lambda Transmitter LT3 in wall mounting housing in following variants:</td>
<td>657R51 – ...</td>
</tr>
<tr>
<td>LT3, without display, without outputs</td>
<td>657R51 – 00 / 00</td>
</tr>
<tr>
<td>LT3, without display, with 4 analogue output current 0/4 … 20 mA</td>
<td>657R51 – 00 / 05</td>
</tr>
<tr>
<td>LT3, without display, with 4 analogue output voltage 0/2 … 10 V</td>
<td>657R51 – 00 / 10</td>
</tr>
<tr>
<td>LT3, without display, with 4 digital outputs</td>
<td>657R51 – 00 / 20</td>
</tr>
<tr>
<td>LT3, without display, with 4 analogue output current 0/4 … 20 mA and 4 digital outputs</td>
<td>657R51 – 00 / 30</td>
</tr>
<tr>
<td>LT3, without display, with 4 analogue output voltage 0/2 … 10 V and 4 digital outputs</td>
<td>657R51 – 00 / 35</td>
</tr>
<tr>
<td>LT3, with display, without outputs</td>
<td>657R51 – 20 / 00</td>
</tr>
<tr>
<td>LT3, with display with 4 analogue output current 0/4 … 20 mA</td>
<td>657R51 – 20 / 05</td>
</tr>
<tr>
<td>LT3, with display, with 4 analogue output voltage 0/2 … 10 V</td>
<td>657R51 – 20 / 10</td>
</tr>
<tr>
<td>LT3, with display, with 4 digital outputs</td>
<td>657R51 – 20 / 20</td>
</tr>
<tr>
<td>LT3, with display, with 4 analogue output current 0/4 … 20 mA and 4 digital outputs</td>
<td>657R51 – 20 / 30</td>
</tr>
<tr>
<td>LT3, with display, with 4 analogue output voltage 0/2 … 10 V and 4 digital outputs</td>
<td>657R51 – 20 / 35</td>
</tr>
</tbody>
</table>

#### 2.4.2 Accessories for Lambda Transmitter LT3

<table>
<thead>
<tr>
<th>Description / Type</th>
<th>Order-no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming unit, incl. 4 m connecting cable, for external operation in language german/english or french</td>
<td>657R0932</td>
</tr>
<tr>
<td>For ordering please specify language setting!</td>
<td></td>
</tr>
<tr>
<td>LSB Remote Software for PC, incl. USB/CAN-Module and connecting cable, Windows XP or higher</td>
<td>657R9000</td>
</tr>
</tbody>
</table>

#### 2.4.3 KS1D Combination Probe in Standard Housing

<table>
<thead>
<tr>
<th>Description / Type</th>
<th>Order-no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>KS1D combination probe in housing (standard) with PTFE-connecting cable up to 300 °C, cable length 2 m, IP42</td>
<td>656R2000</td>
</tr>
<tr>
<td>Gas extraction device (GED), length 150 mm</td>
<td>655R1001</td>
</tr>
<tr>
<td>Gas extraction device (GED), length 300 mm</td>
<td>655R1002</td>
</tr>
<tr>
<td>Gas extraction device (GED), length 450 mm</td>
<td>655R1003</td>
</tr>
<tr>
<td>Gas extraction device (GED), length 1,000 mm</td>
<td>655R1004</td>
</tr>
<tr>
<td>Probe installation fitting (PIF), screw-in joint R1 ¼&quot;, material: steel</td>
<td>655R1010</td>
</tr>
</tbody>
</table>
### 2.4.4 KS1D-HT Combination Probe „High Temperature“

<table>
<thead>
<tr>
<th>Description / Type</th>
<th>Order-no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>KS1D-HT combination probe “high temperature”, cable length 2 m, IP65, up from 300 °C</td>
<td>656R2015</td>
</tr>
<tr>
<td>Counter flange DN65 PN6, with tube Ø 80 mm, length=70 mm, material: steel, EPD black, int. hole diameter in accordance to DN65 PN6</td>
<td>655R0179</td>
</tr>
<tr>
<td>Counter flange DN65 PN6, with tube Ø 80 mm, special length &lt; 500 mm, material: steel galv., int. hole diameter in accordance to DN65 PN6</td>
<td>655R0179/S</td>
</tr>
<tr>
<td>Counter flange DN65 PN6, with tube Ø 80 mm, length =70 mm, material: stainless steel 1.4571, int. hole diameter in accordance to DN65 PN6</td>
<td>655R0180</td>
</tr>
<tr>
<td>Counter flange DN65 PN6, with tube Ø 80 mm, special length &lt;500 mm, material: stainless steel 1.4571, int. hole diameter in accordance to DN65 PN6</td>
<td>655R0180/S</td>
</tr>
<tr>
<td>Sealing for counter flange DN65 PN6, 3 mm, material: graphite</td>
<td>655P4211</td>
</tr>
<tr>
<td>Flue gas bypass tube, length 500 mm, material: stainless steel 1.4571, for measuring gas temp. up to 750 °C</td>
<td>656R1014</td>
</tr>
<tr>
<td>Flue gas bypass tube, length 750 mm, material: stainless steel 1.4571, for measuring gas temp. up to 750 °C</td>
<td>656R1015</td>
</tr>
<tr>
<td>Flue gas bypass tube, length 1,000 mm, material: stainless steel 1.4571, for measuring gas temp. up to 750 °C</td>
<td>656R1016</td>
</tr>
<tr>
<td>Flue gas bypass tube, length 500 mm, material: INCONELL 600, for measur gas temp. up to 950 °C</td>
<td>656R1017</td>
</tr>
<tr>
<td>Flue gas bypass tube with purge connector, length 500 mm, INCONELL 600, for measuring gas temp. up to 950 °C</td>
<td>656R1017A</td>
</tr>
<tr>
<td>Additionally required: Purge unit type 657R0931</td>
<td></td>
</tr>
<tr>
<td>Flue gas bypass tube, length 750 mm, material: INCONELL 600, for measuring gas temp. up to 950 °C</td>
<td>656R1018</td>
</tr>
<tr>
<td>Flue gas bypass tube, length 1,000 mm, material: INCONELL 600, for measuring gas temp. up to 950 °C</td>
<td>656R1019</td>
</tr>
<tr>
<td>Flue gas bypass tube, length 500 mm, material: KANTHAL, for mea. gas temp. up to 1,200 °C</td>
<td>656R1021</td>
</tr>
<tr>
<td>Flue gas bypass tube with purge connector, length 500 mm, material: KANTHAL, for measuring gas temp. up to 1,200 °C</td>
<td>656R1021A</td>
</tr>
<tr>
<td>Additionally required: Purge unit type 657R0931</td>
<td></td>
</tr>
<tr>
<td>Flue gas bypass tube, length 750 mm, material: KANTHAL, for measuring gas temp. up to 1,200 °C</td>
<td>656R1022</td>
</tr>
<tr>
<td>Flue gas bypass tube, length 1,000 mm, material: KANTHAL, for measuring gas temp. up to 1,200 °C</td>
<td>656R1023</td>
</tr>
<tr>
<td>General overhaul Combi Probe KS1D</td>
<td>656R2010D</td>
</tr>
<tr>
<td>Only possible after returning a used probe KS1D</td>
<td></td>
</tr>
<tr>
<td>Mounting compound - Anti-seize-paste (5 pcs. per pack)</td>
<td>650R1090</td>
</tr>
</tbody>
</table>
2.5 Order examples

2.5.1 Simultaneous measurement of the O\textsubscript{2} concentration and oxidising components (CO/H\textsubscript{2}) in wall mounting housing IP54, for flue gas temperatures up to 300 °C

<table>
<thead>
<tr>
<th>Description / Type</th>
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</tr>
<tr>
<td>1 Programming unit, incl. 4m connecting cable, for external operation in language german / english or french</td>
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</tr>
</tbody>
</table>

2.5.2 Simultaneous measurement of the O\textsubscript{2} concentration and oxidising components (CO/H\textsubscript{2}) in wall mounting housing IP54, for flue gas temperatures up to 750 °C

<table>
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<tbody>
<tr>
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</tr>
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</tr>
<tr>
<td>1 LSB Remote Software for PC, incl. USB/CAN-Module and connecting cable, Windows XP or higher</td>
<td>657R9000</td>
</tr>
</tbody>
</table>

2.6 Spare Parts LT3

| LT3 main board | 657P5000 |
| LT3 processor board | 657R5012 |
| Serial number of the LT3 is necessary | |
| Programming unit | 663R0932V3.0 |
| LSB module with 4 analogue outputs (current) | 663R4029 |
| LSB module with 4 analogue outputs (voltage) | 663R4025 |
| LSB module with 4 digital outputs | 663R4027 |