

1 System Overview

The LT2 Lambda Transmitter is a universal, microprocessor based O₂ measuring instrument for the direct measurement of O₂ concentration in exhaust gases from oil and gas combustion facilities in the superstoichiometric domain ($\lambda > 1$), in conjunction with the LS 2 Lambda Probe.

Optionally, the KS1 Combination Probe can be activated to record combustible gas components (CO/H₂) - see separate publication. It is possible to set up direct coupling with the compound/firing management system and ETAMATIC. This allows the implementation of an improved control procedure for optimising oil and gas combustion facilities, and for automatic combustion system tuning to variable combustion conditions.

In addition to O₂ measurement, the LT2 Lambda Transmitter also offers the following functions:

- Measurement of flue gas and air temperature intake, and calculation of combustion efficiency.
- Detection of unburned residue (CO/H₂), shown as CO equivalent (CO_e)
- Calculation and display of CO₂ concentration
- Load-dependent and fuel-specific boundary curves / limit values
- O₂-regulation
- Combustion chamber pressure regulation
- Field bus connection

Advantages:

- No gas purification necessary, measurement directly in humid flue gas
- Settling time to 90% value (T₉₀) <15 seconds with standard extraction
- Gas temperature up to 300°C / 572°F
- No calibration gas required
- No reference gas pump required
- No temperature regulation of the measuring cell required
- Low heating power 15...25 watt depending on the zirconium dioxide cell's ageing
- Universally applicable
- Simple handling
Probe connected via plug
- Low maintenance

The LT2 Lambda Transmitter is a universal, microprocessor-based measuring device for directly measuring the O₂ concentration in the super-stoichiometric range ($\lambda > 1$) in combination with the proven Lambda probe .

The Combination Probe KS 1 can be connected for measuring combustible gas constituents (CO/H₂).

1 System Overview

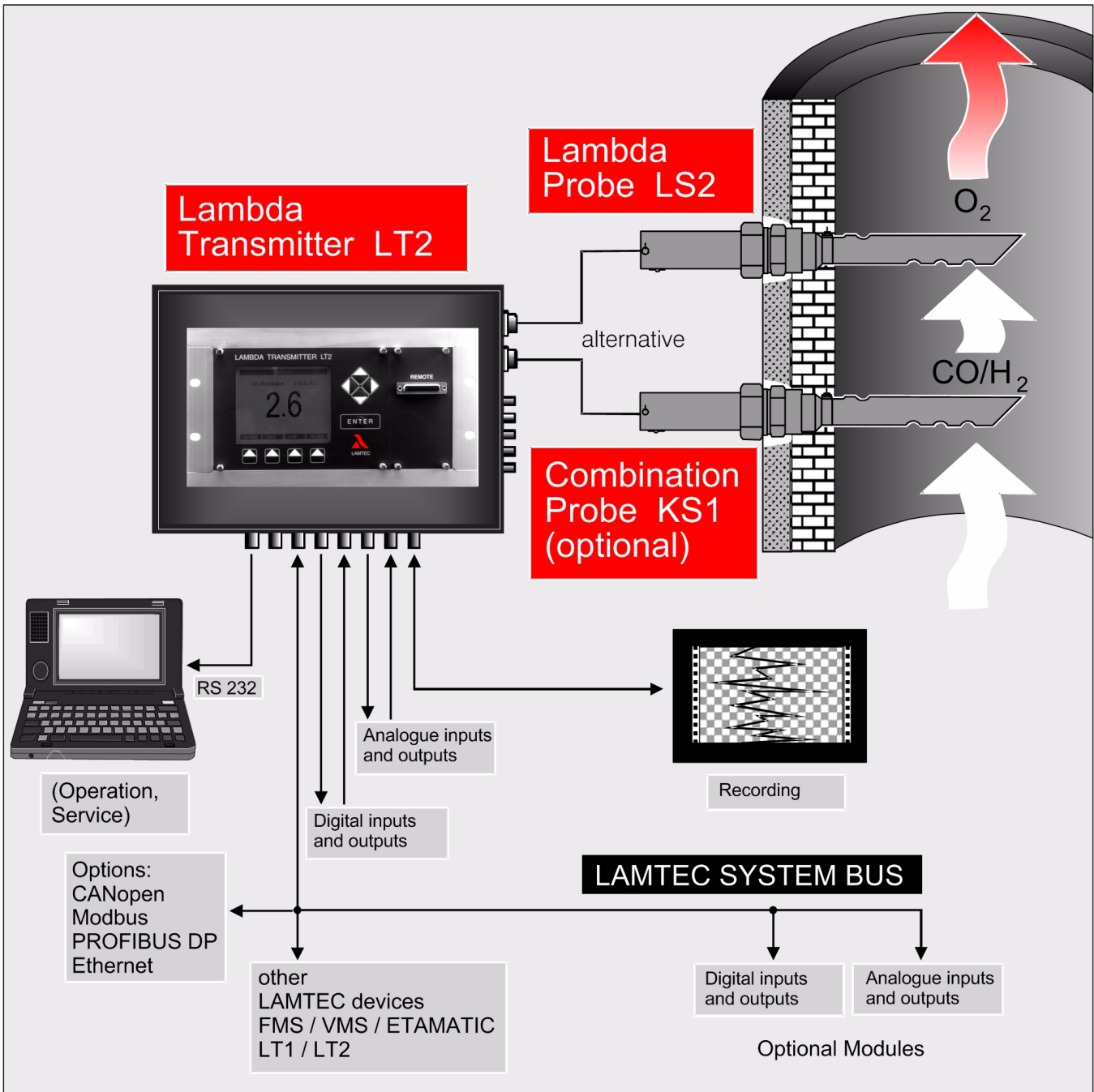


Fig. 1-1 System overview LT2 Lambda Transmitter

1 System Overview

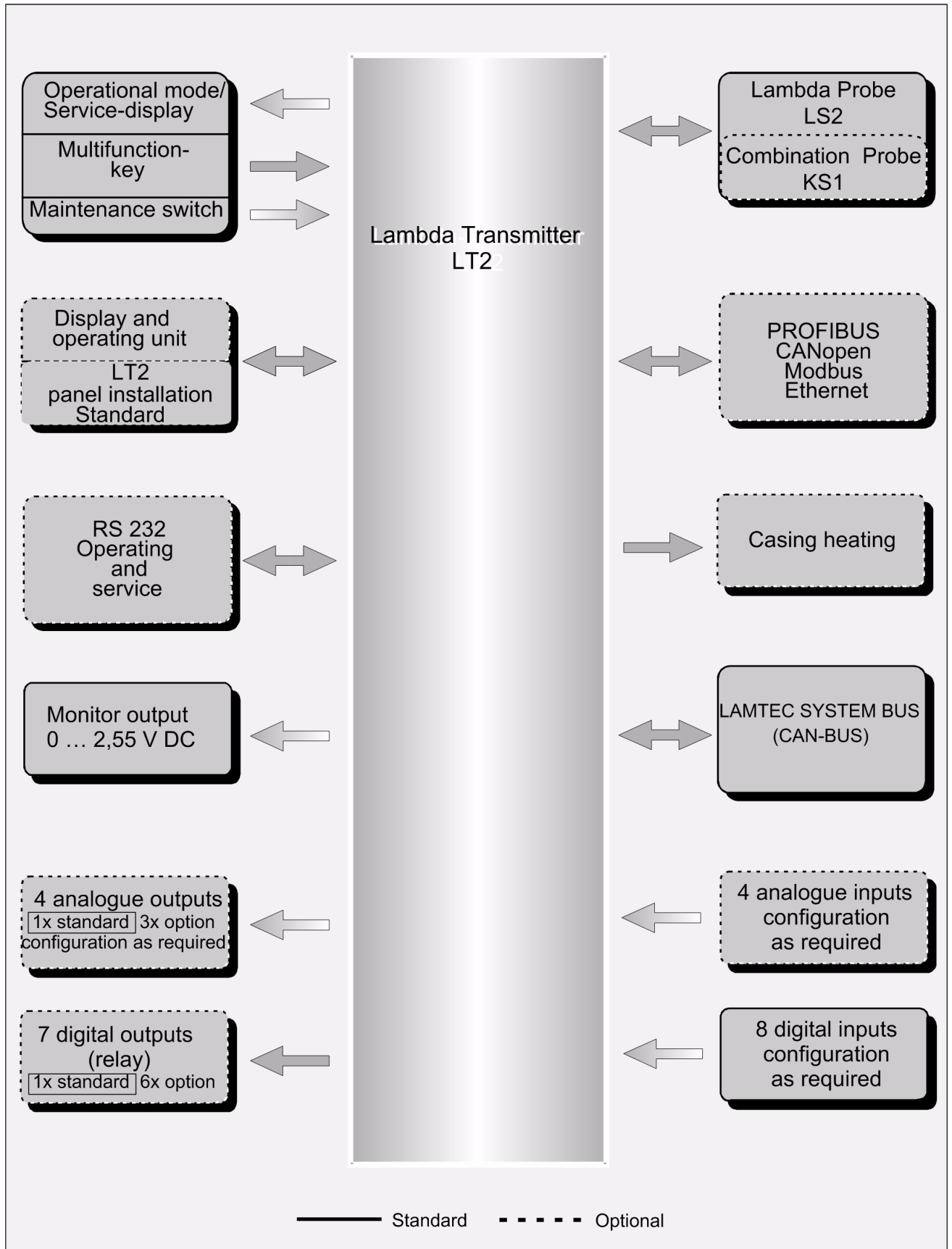


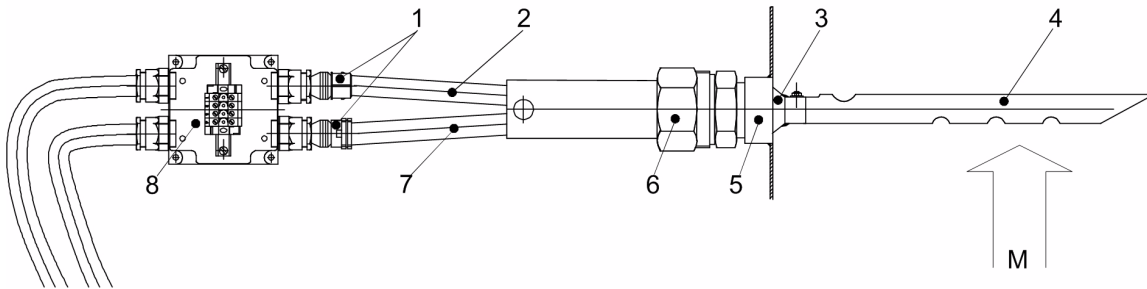
Fig. 1-2 System overview - LT2 Lambda Transmitter input / output modules

2 System Components

2 System Components

The O₂ measurement system is available in various versions. It consists of the following components:

- LT2 Lambda probe
- Gas extraction device (GED)
- Probe installation fitting (PIF)
- Probe connection box (PCB)
- LT2 Lambda Transmitter in IP 54 wall-mounted housing alternatively
 - on mounting plate
 - panel installation housing including display and operating unit



M measuring gas 300°C max.

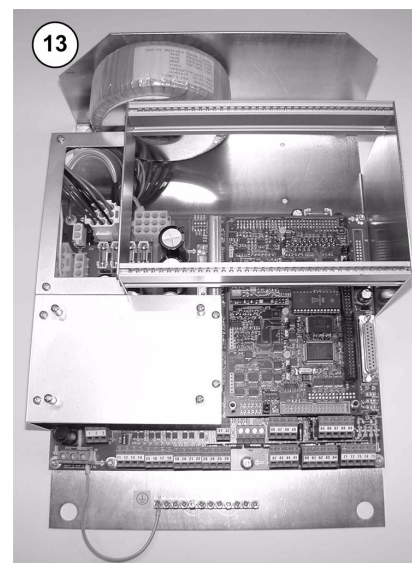
- 1 plug
- 2 probe signal
- 3 Lambda Probe , Type 6 50 R 1000
- 4 gas extraction device (GED)
- 5 half-collar R11/4", type 6 55 R 1012
- 6 probe installation fitting (PIF), Type 6 55 R 1010
- 7 probe heater
- 8 probe connection box (PCB), Type 6 55 R 1025 (optional)
- 9 display and operating unit, Type 6 57 R 0831



10 LT2 Lambda Transmitter panel installation
3 HE, 50 TE
173 x 310 x 280 mm (h x w x d)
type 657 R 1040

11 LT2 Lambda Transmitter in IP 54
wall-mounted housing type 657 R 1025,
sheet steel, 400 x 300 x 150 mm (h x w x d)
with display and operating unit

13 LT2 Lambda Transmitter on
mounting plate
350x258x132 (HxBxT)
type 657 R 1030



3 Measuring Principle

Fundamentally, the Lambda probe consists of a zirconium dioxide-ceramic electrochemical cell. The cell operates as an electrochemical concentration chain, and generates direct voltage that depends on the absolute temperature T and the logarithm of the O_2 concentration or the O_2 partial pressure ratio at the inner and outer electrodes.

If the outer electrode is supplied with the test gas and the inner electrode is supplied with a reference gas with a known O_2 concentration e.g. air (20.96%), then assuming the temperature is held constant, we obtain the logarithmic relationship between probe voltage U_{O_2} and the oxygen concentration of the test gas as shown below.

The characteristic curves for two different temperatures T_1 and T_2 show clearly that when using the voltage probe, the temperature affects the measured value in the cell's active part. In addition, the curves show that the probe is preferentially suitable for measuring low oxygen concentrations, since sensitivity and accuracy increase with decreasing O_2 concentration because of the logarithmic relationship.

Since the measurement of high O_2 concentrations is subject to high error due to the low voltage dependence, it is not possible to use, for example, air (20.96% O_2) to calibrate or tune the probe. Each Lambda Probe is factory-tested under real-life conditions, in a gas-combustion system with an exhaust temperature of approx. 150°C / 302°F. The test protocol is enclosed with each probe. The sensor temperature recorded in the protocol should be input into the LT2 during commissioning. Calibration with test gases is not required. During operation it is possible to check and compensate for the measured values through counter measurement.

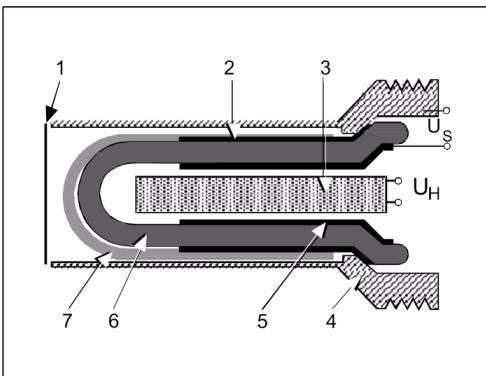


Fig. 3-1 Schematic construction of the oxygen probe

- 1 Gas intake
- 2 Working electrode
- 3 Probe heating
- 4 Housing

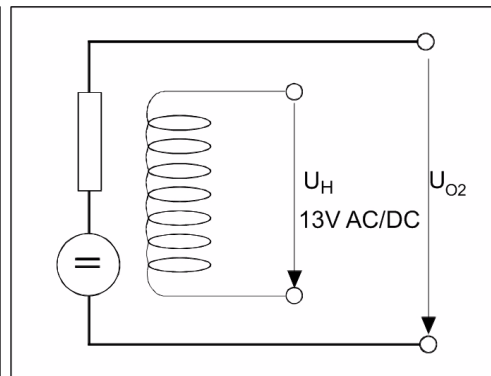


Fig. 3-2 The voltage probe's equivalent electric circuit diagram and working principle

- 5 Reference electrode (Pt)
- 6 Zirconium oxide ceramic
- 7 Protective layer

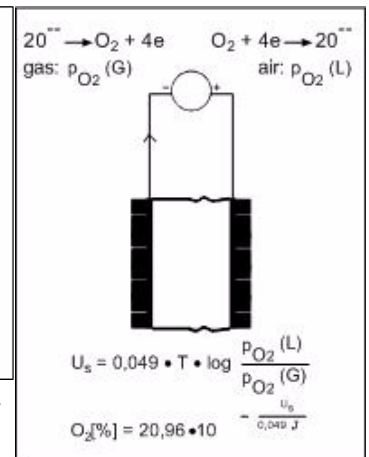


Fig. 3-3 The voltage probe's working principle



Fig. 3-4 Lambda Probe with GED and PIF, standard version

3 Measuring Principle

The curve shown below demonstrates that oxygen measurements require knowledge of the proportionality factor and the probe's temperature. In practice this means adjusting the probe during commissioning with LT2 is possible simply through air voltage compensation (offset compensation) and entering the cell temperature which was obtained during final testing in accordance with the test protocol enclosed with the probe (usually approx. 1000 K). The probe's logarithmic characteristic depends on the cell's temperature and on each probe's curves individually. The temperature of the solid electrolyte and of the electrodes affects the probe's signal, however the probe is heated with constant current to approx. 730°C / 1346°F. The temperature of the measured gas and the installation site affect the cell's temperature slightly. Hence, probe temperature does not need to be measured or regulated. Individual deviations are compensated for during commissioning by adjusting the air voltage (offset compensation) and entering the sensor temperature which was obtained during the final testing and recorded in the test protocol.

The probe can only be used in a gas temperature up to 300°C / 572°F. Probe ageing in long-term operation leads to stretching of the characteristic curve. However, this can be recognised from the fact that the internal resistance increases.

The probe should be replaced every 2 heating periods, no later than after 10,000 hours in operation.



NOTICE!

Calibration of the Lambda Probe with test gases has been abandoned for the sake of simple handling and low maintenance. The probes are measured in the factory under operational conditions (gas combustion, exhaust gas temperature 150°C / 302°F).

Individual deviation is taken into account by adjusting the air voltage (offset compensation) and entering the obtained sensor temperature obtained during commissioning.

Measurement accuracy is + 10% of reading, at best ± 0,3 by vol.% O₂.

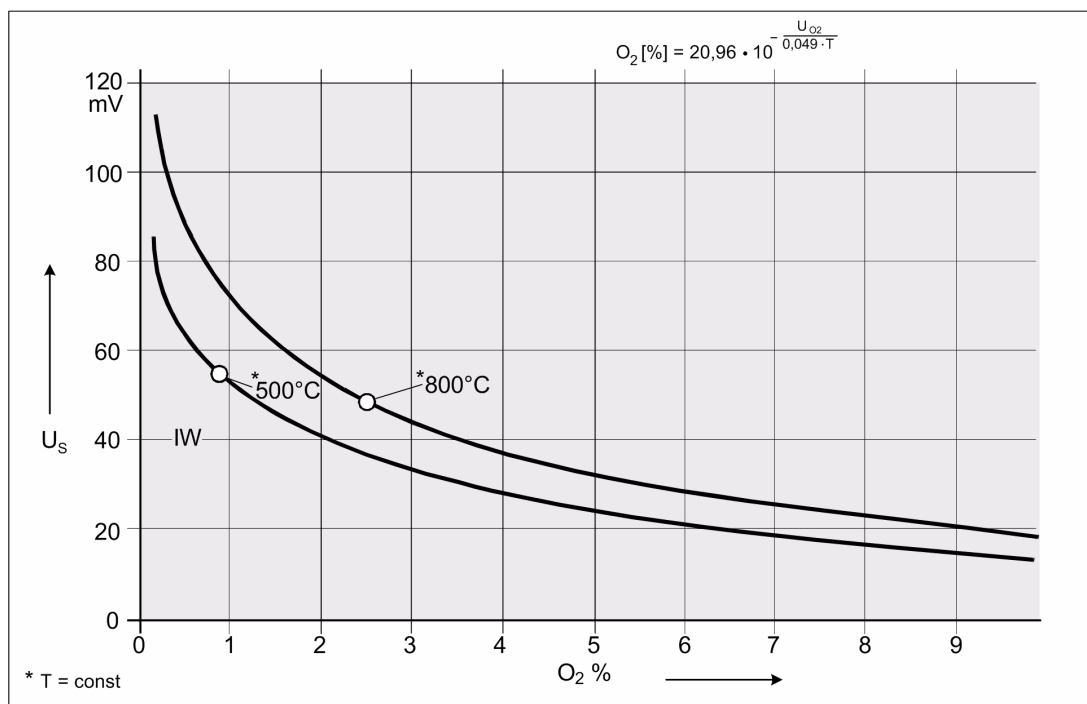
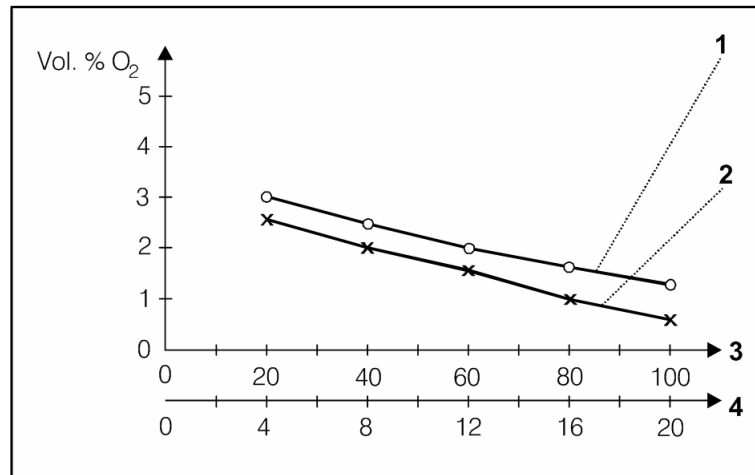


Fig. 3-5 Measurement and calibration diagram of the oxygen probe. The effect of temperature on the probe's characteristic curve.

4 Options

- Display and operating unit
- Measurement of flue gas and intake air temperature and calculation of combustion efficiency
- Calculation and display of CO₂ concentration, fuel-referenced, computed from the measured O₂ value and the CO₂ max. value
- Load-dependent and fuel-specific limit values/boundary curves



- 1 Boundary curve 1 Fuel 1 (curve 5)
- 2 Boundary curve 2 Fuel 1 (curve 7)
- 3 Burner load [%]
- 4 Specified load [mA]

Fig. 4-1 Boundary curves (factory settings), parameters adjusted to values below threshold.

Possible combinations:

- 2 fuels per 4 boundary curves / boundary values per fuel
- 4 fuels per 2 boundary curves / boundary values per fuel
- KS1 combined probe for detecting combustible components (CO/H₂) displayed as CO equivalent (CO_e)
- PID controller
- 1...4 analogue outputs (0/4...20 mA, 0...10 V), max. 2 floating/isolated (outputs 1 and 2), max. potential difference ±20 V, arbitrary configuration
 - Direct current 0/4...20 mA, burden 0...600Ω
 - Direct voltage 0...10 V, burden > 10kΩ
- electrically isolated outputs
- Relay module for digital outputs with 6 relays (1 change-over switch) for the output of operational and status messages, switching capability 230 V AC, 4A / 48 V DC, 3A
- 1...4 analogue inputs via measurement cards, arbitrary configuration, e.g. for temperature sensor, further pressure sensors, KS1 Combination Probe, standard signals etc; max. 2 of these floating, common mode voltage max. ±20 V
- Fieldbus-interface for:
 - PROFIBUS DP
 - Modbus
 - CANopen
 - Ethernet
- Remote Display Software for PC, Windows-based
- electrical casing heating

5 Technical Data

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Technical Data Lambda Transmitter LT2			
Version	Wall-mounted housing	Panel installation	Mounting plate
Type	657 R 1025 / 657 R 1025OEM	657 R 1040	657 R 1030
Housing	Housing in sheet steel, powder-coated	3 HE / 50 TE control panel housing	plate in sheet steel
Protection class to DIN 40050	IP 54	IP 20 Front panel IP 40	IP 00
Dimensions (h x w x d), mm	400x300x150	173x310x270	350x258x132
Colour	Grey RAL 7032	Metallic silver (alum. anodised), control elements brown	
Weight	10 kg	5 kg	6 kg
plus display and operating unit	0,5 kg	---	0,5 kg
Ambient temperature			
Operation	-20°C...+60°C		
Transport and storage	-40°C...+85°C		
Power supply	230 V AC and 115 V AC +10% / -15%, 48 Hz...62Hz To be used only in grounded power line networks!		
Power consumption	Typically 50 VA, short-term 150 VA (probe heating-up phase)		
Display *	LCD graphic display 100 x 80 mm (w x h) - in LT2 wall-mounted housing, optional - in panel installation case, standard Display and operating unit (version installation in a case) Display and operating unit (version panel installation for LT2 on installation plate)		
Resolution	0,1% by vol. O ₂ in the range 0...18% by vol. O ₂ 1% by vol.O ₂ in the range 18...30% by vol. O ₂		
Measuring accuracy (with Lambda probe)	+/- 10% of measured value not more than +/-0,3% by vol. O ₂		
Settling time (90% time)	T ₉₀ < 15s		
Time for operational status to be achieved with	approx. 10 minutes after "POWER ON"		

* For LT2 OEM not available

5 Technical Data

Technical data Lambda Transmitter LT2	
Analog outputs	
Monitor output	0...2,55 V DC, burden >10 kΩ, <100 nF
Accuracy	2% measured value, not more than 0,2 Vol.% O ₂
Resolution	10 mV
Factory settings	0...2,55 V DC ⇔ 0...25,5 Vol.% O ₂ Can be switched via micro switches Probe voltage U _{O₂} 0...2500 mV DC ⇔ 0...250 mV Probe (cell) internal resistance R _I 0...2500 mV ⇔ 0...250 Ω
1...4 current/voltage outputs*	1 Standard, 2...4 Option <ul style="list-style-type: none"> – DC current 0/4...20 mA <li style="padding-left: 20px;">Burden 0...600 Ω – DC voltage 0...10 V <li style="padding-left: 20px;">Burden ≥ 10 kΩ not floating (potential isolation optional)
Factory settings	0...10% by vol. O ₂ ⇔ 4...20 mA
Analogue inputs*	optional 1...4 via mini plug-in card to LT2 power-pack electronics <ul style="list-style-type: none"> – Universal module for potentiometer, 0...5 kΩ type 6 57 P 6000 – Universal module for current 0/4...20 mA type 6 57 P 6001 – Universal module for voltage 0/2...10V type 6 57 P 6005 – Temperature input for PT 100 sensor type 6 57 R 0890
Accuracy	0,05% of measured value, not better than 0,1% by vol.O ₂
Resolution	0,1% by vol.O ₂ Measurement range and physical unit configurable
Operating elements	Wall-mounted housing: <ul style="list-style-type: none"> – Multifunction key maintenance switch and 2 LED rows of 6 LEDs each. – Optional display and operating unit with LCD graphic display. Panel installation housing <ul style="list-style-type: none"> – Display and operating unit with LCD graphic display
Interfaces	LAMTEC SYSTEM BUS RS232 only in combination with remote display software type 6 57 R 1101
BUS-Connection	Optional for the systems: <ul style="list-style-type: none"> – PROFIBUS DP (Siemens) – Modbus – CANopen – Ethernet

* not available with LT2 OEM

5 Technical Data

Technical Data Lambda Transmitter LT2

Digital outputs	1 standard + 6 optional
	1 relay output 0...230 V AC, 2A 0...42 V DC, 3A
	Accumulated error message (fault)
	optional: Relay card with 6 relays (1 change-over contact) Switching capability 0...230 V AC, 4A 0...48 V DC, 3A Type 6 57 R 0857 (built in LT2) Type 6 60 R 0017 (spare part)
Digital inputs	8 inputs - configurable (any) Factory settings: 24 V DC, referenced to instrument potential Can be switched via jumper to floating, for external voltage source.
Cold-start delay	Automatic cold-start delay 10 Min.
Conforms to the following European Directives:	2004/10 /EG Electromagnetic Interference 2006/95/EG Low Voltage Directive

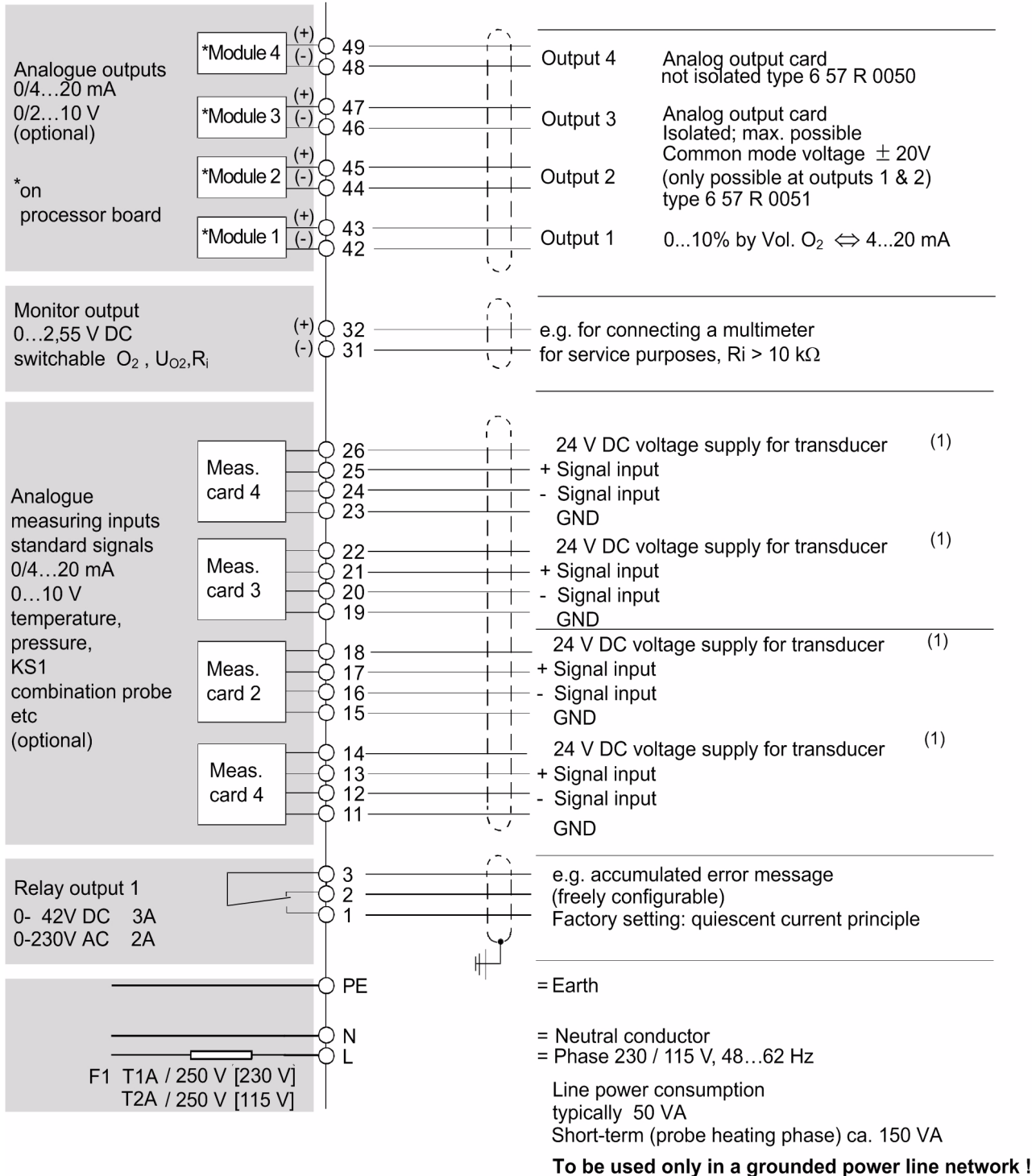
5 Technical Data

Technical Data Lambda Probe LS2	
Protection class to DIN 40050	IP 42
Measurement range	0...18% by vol. O ₂ with restriction 0...21% by vol. O ₂
Measurement accuracy	± 10% of measured value not more than ± 0,3% by vol.
Effect of measured gas pressure	-1,6 mV / 100 mbar change
Permissible fuels	Residue-free gaseous hydrocarbons and light heating oil
Permissible continuous exhaust gas temperature	≤ 300°C / 572°F
Useful life	≥ 2 years with heating oil EL and natural gas
Probe output voltage 0,01...21% by vol. O₂	150...0 mV
Probe internal resistance R in air 20° C and 13 V heating voltage	≤ 150 Ω
Probe voltage in air 20°C when new and 13 V heating voltage	-5...-15 mV
Supply voltage in plug	11...16 V DC; polarity cyclically reversed
Heat output at 13 V steady state	ca. 18 W
Heating current at 13 V steady state	ca. 1,4 A
Isolation resistance between heating and probe connections	> 30 MΩ

6 Connection Diagrams

6 Connection Diagrams

Lambda Transmitter LT2



* Other level/signal inputs possible, depending on meas. card.

Max. 2 of these floating (meas. card 1 and 2); max. possible potential difference $\pm 20\text{ V}$.

⁽¹⁾ Max. total current drawn by all 4 meas. cards together = 80mA

Fig. 6-1 Wiring diagram Lambda Transmitter LT2

6 Connection Diagrams

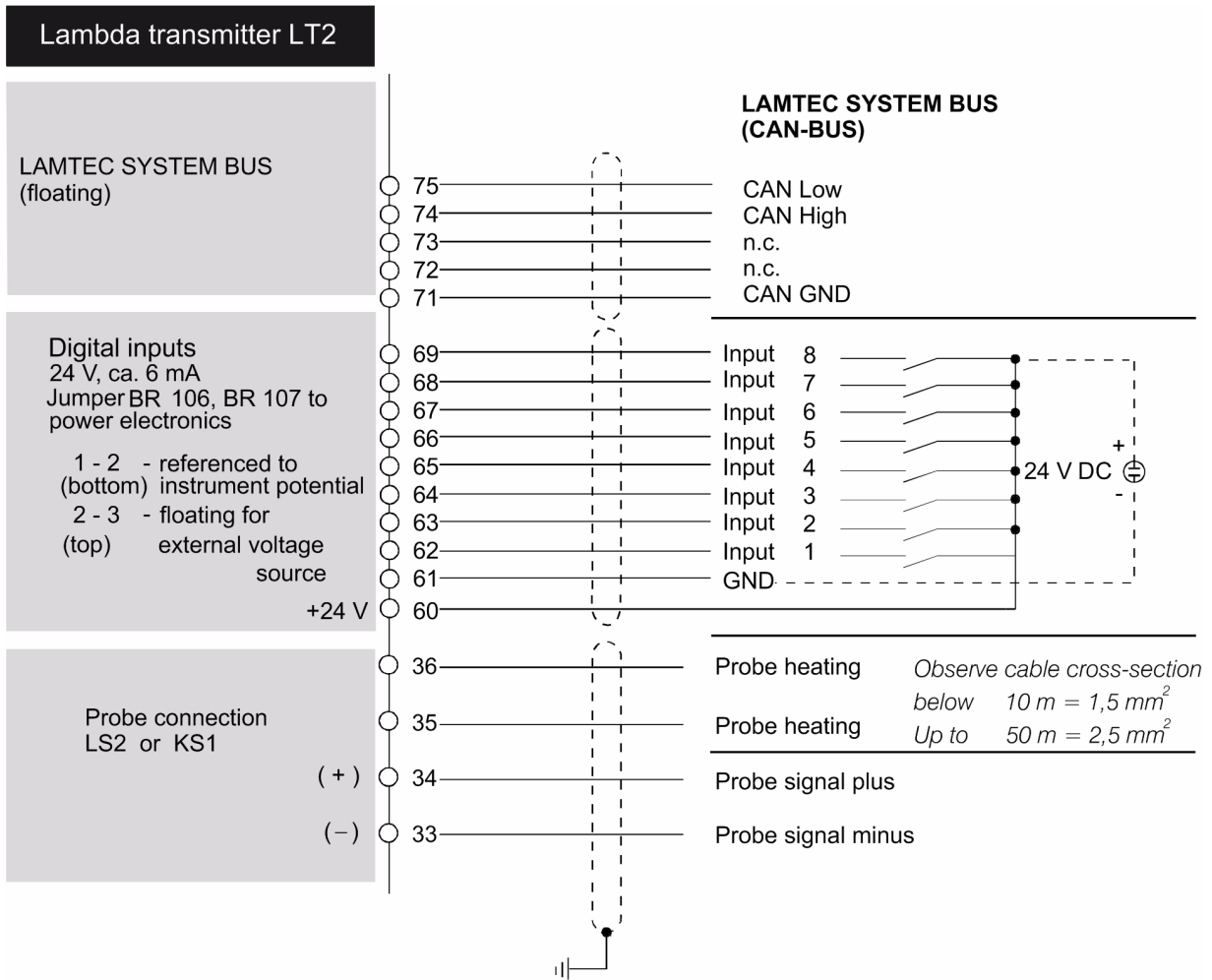


Fig. 6-2 Wiring diagram Lambda Transmitter LT2 - inputs and probe connection

- 33** Probe signal-
- 34** Probe signal +
- 35** Probe heating
- 36** Probe heating

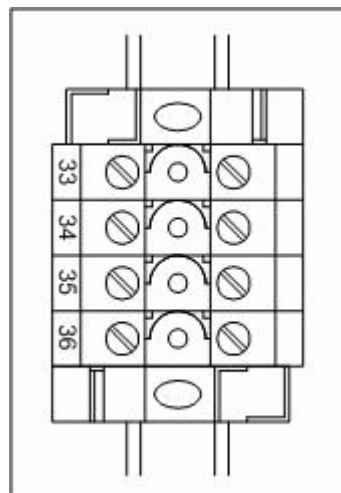


Fig. 6-3 SAK wiring diagram
 type 6 55 R 1025

6 Connection Diagrams

Lambda Transmitter LT2

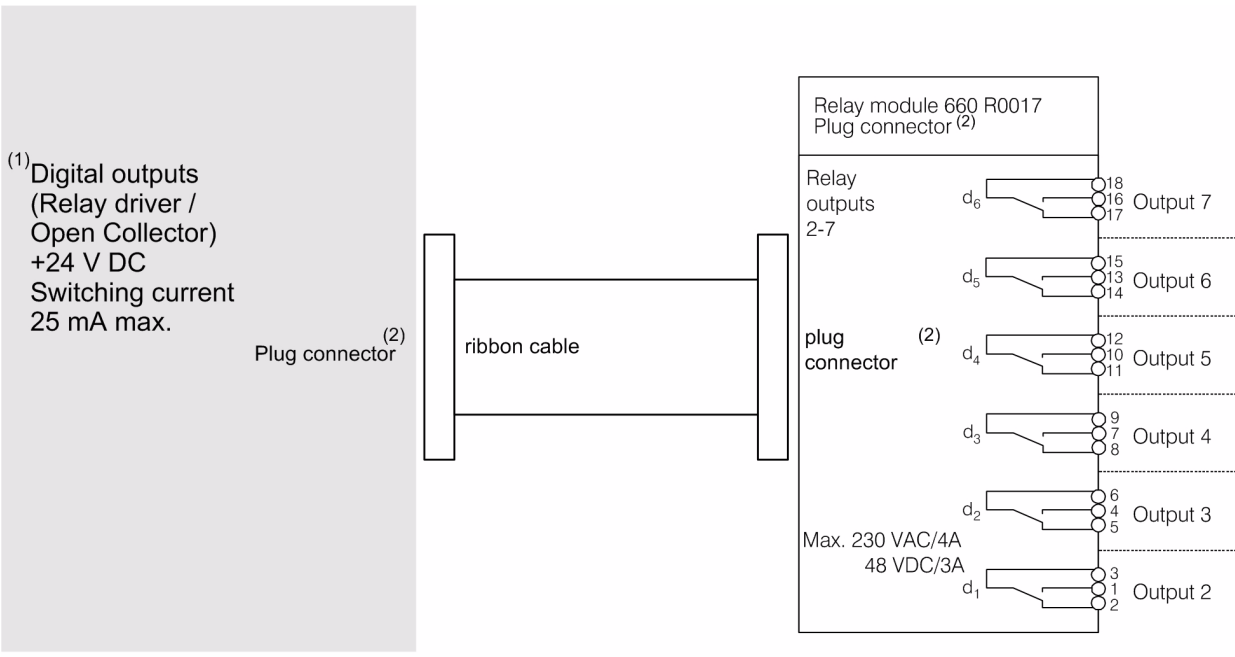


Fig. 6-4 Relay module for digital outputs

(1) not available for OEM
(2) Plug connector X211

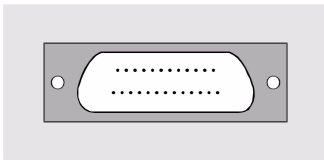


Fig. 6-5 25-pin plug for interface module

Interface Module:

- RS232 only in combination with Remote-Display-Software
- RS422 / 485 at terminals

7 Dimensions

7 Dimensions

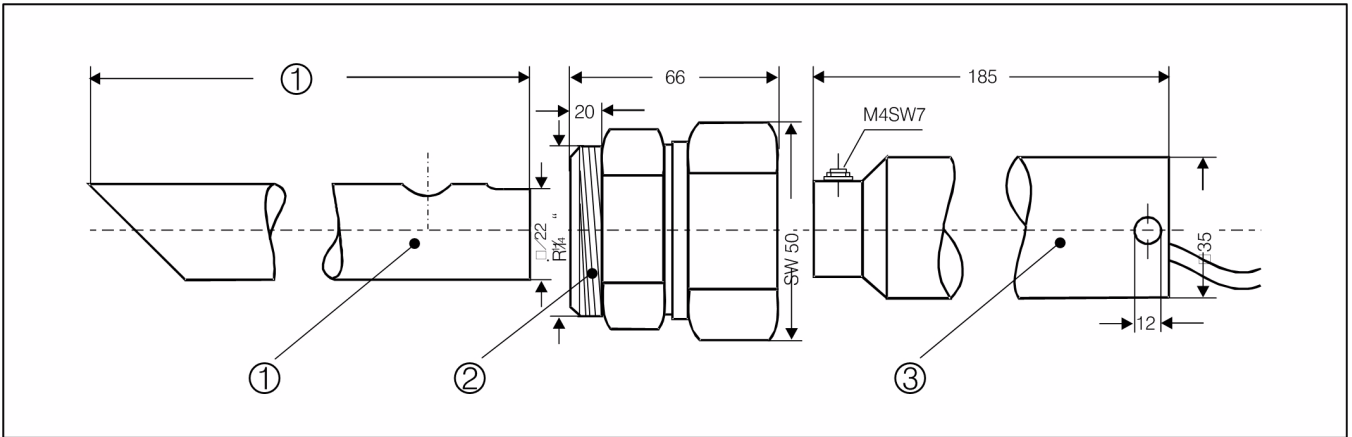


Fig. 7-1 dimensional drawing

No.	Description
1	gas extraction device (GED) for , length: 150 mm
	gas extraction device (GED) for , length:300 mm
	gas extraction device (GED) for , length:450 mm
	gas extraction device (GED) for , length: 1000 mm
2	probe installation fitting (PIF) for male coupling R 1 1/4"
3	Lambda Probe

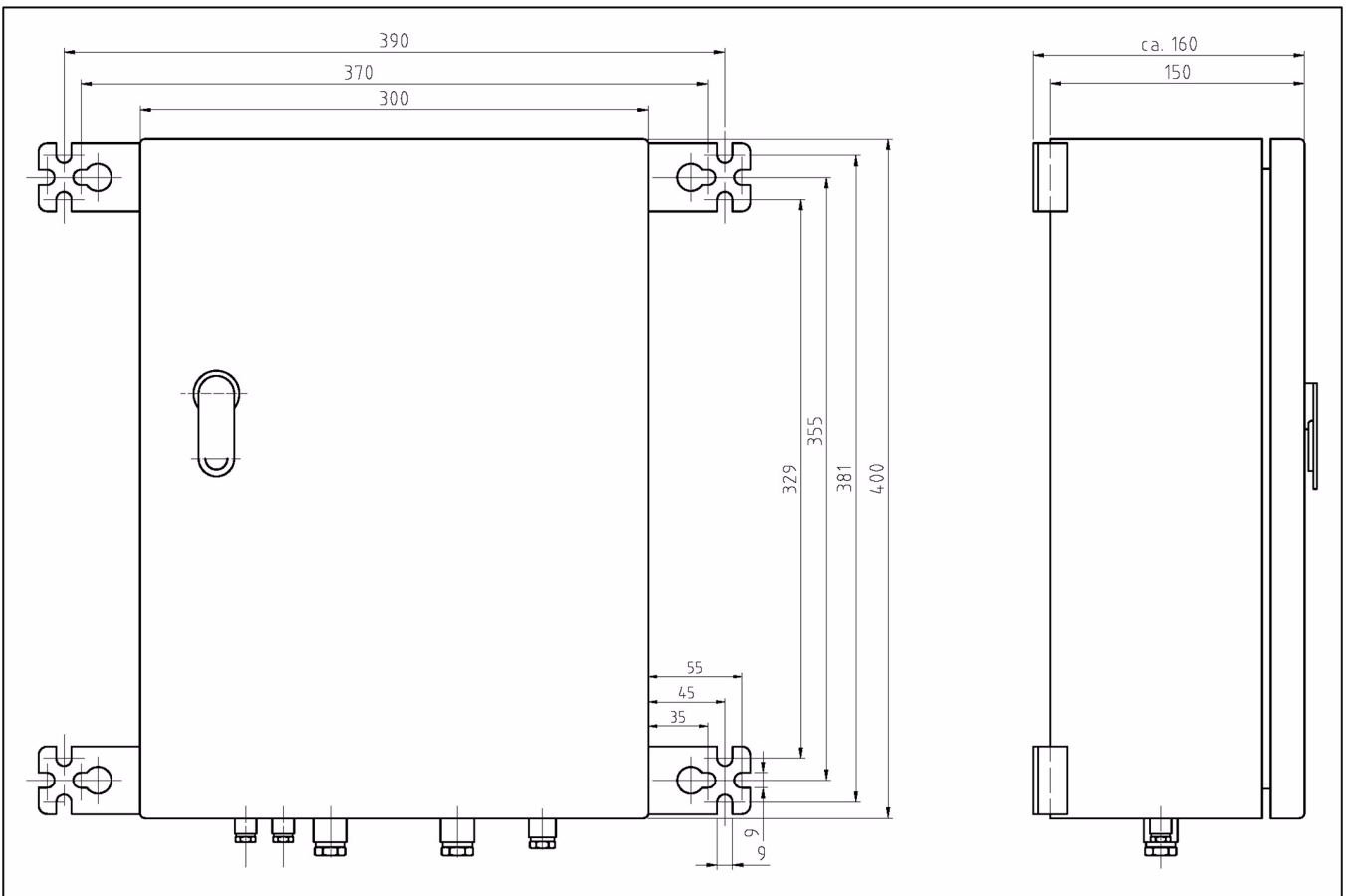


Fig. 7-2 LT2 Wall-mounted housing dimensional diagram

7 Dimensions

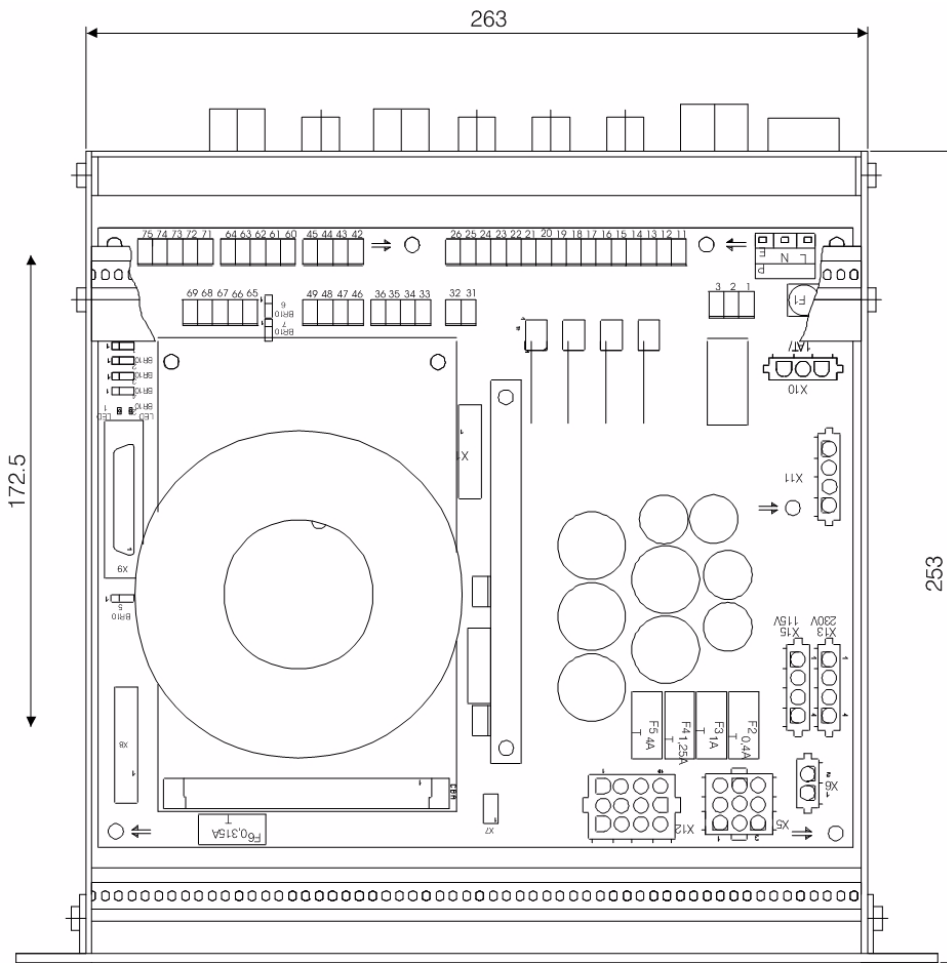


Fig. 7-3 Dimensional diagram: LT2 panel installation top view

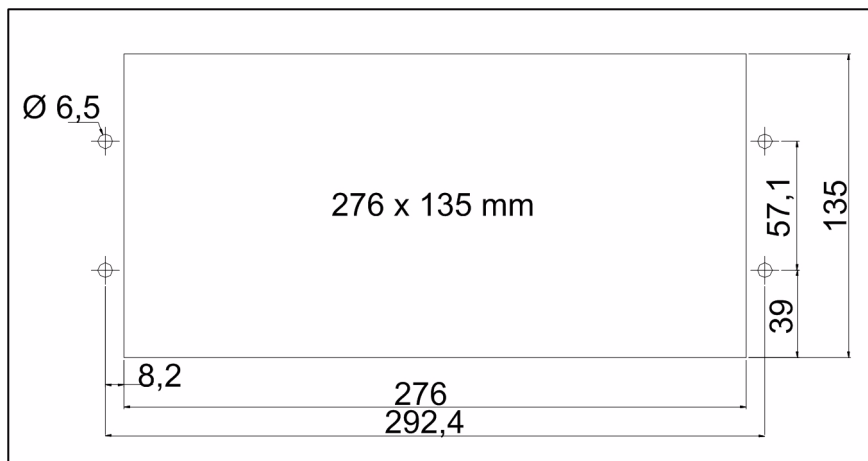


Fig. 7-4 Dimensional diagram: LT2 panel assembly dimension

7 Dimensions

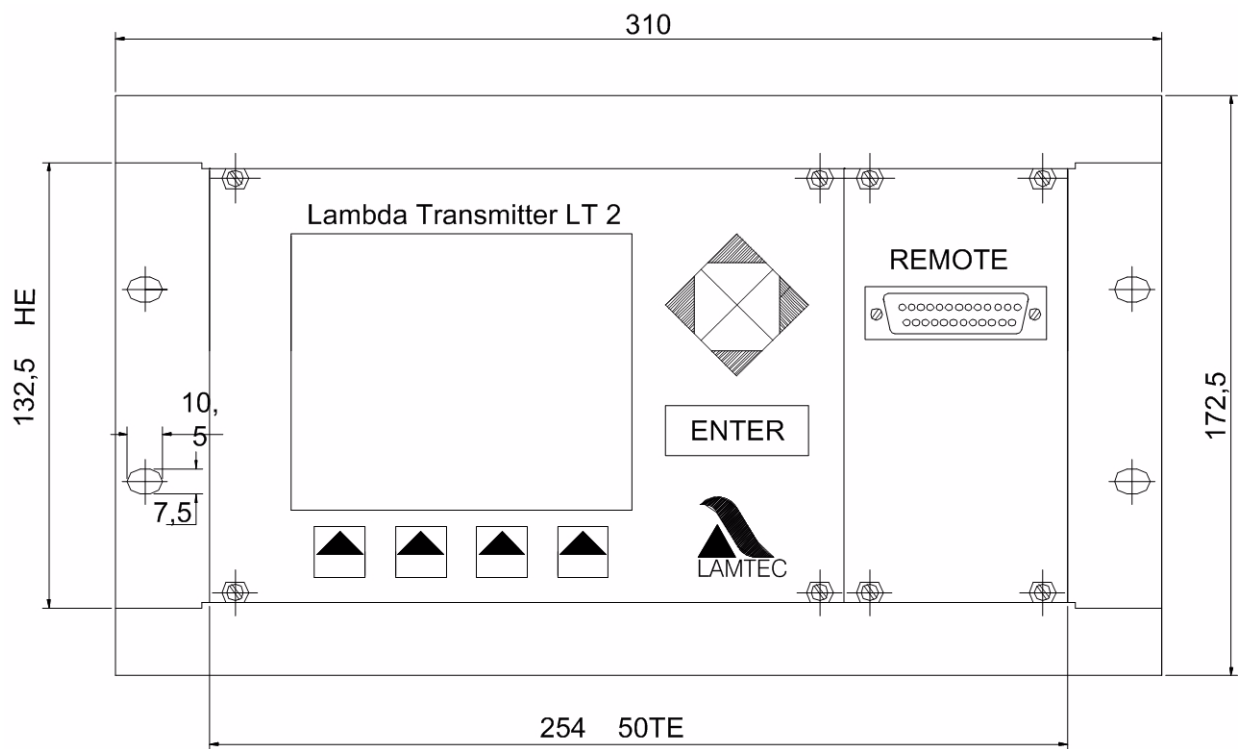


Fig. 7-5 Dimensional diagram: LT2 panel installation front

7 Dimensions

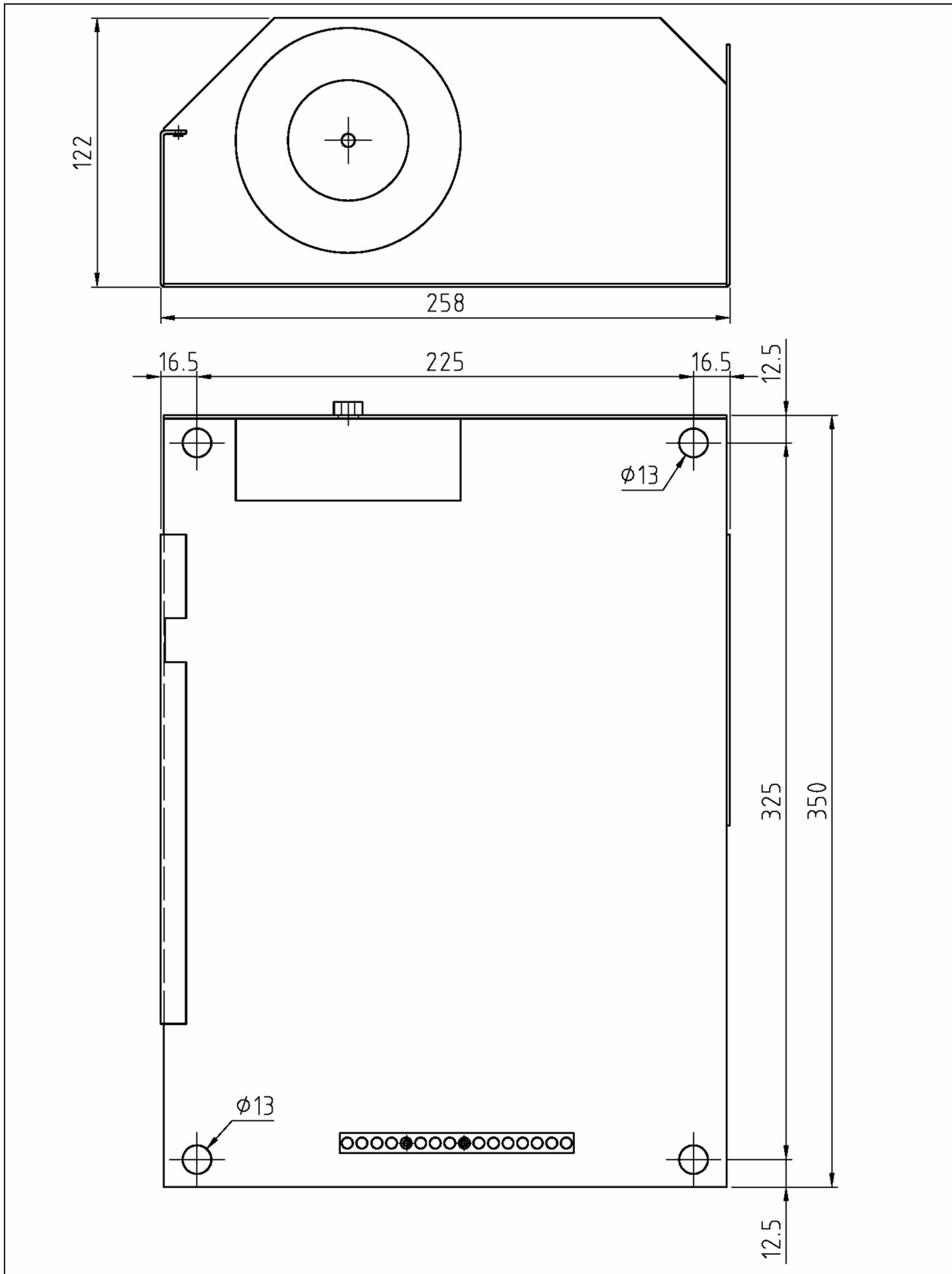


Fig. 7-6 Dimensional diagram LT2 on mounting plate

8 Ordering Information

8 Ordering Information

8.1 Ordering Information O₂-measurement

Product / Type	Order No.
Lambda Probe LS2 with connecting cable, length 2,5 m	6 50 R 1000
Gas extraction device, length 150 mm	6 55 R 1001
Gas extraction device, length 300 mm	6 55 R 1002
Gas extraction device, length 450 mm	6 55 R 1003
Gas extraction device, length 1,000 m	6 55 R 1004
probe installation fitting - male coupling R 1¼"	6 55 R 1010
Half sleeve fitting, pipe screwing R 1¼" DIN 2986 for PIF 655 R 1010	6 55 R 1012
Probe installation fitting - flange mounting DN32PN6 material: chromadid yellow steel	6 55 R 1040
Flange gasket DN32PN6, material: Graphite 3mm	6 55 P 4212
Extension cable for probe-connecting-cable 2 m long	6 55 R 1006
Extension cable for probe-connecting-cable, 5 m long	6 55 R 1007
Extension cable for probe-connecting-cable, 10 m long	6 55 R 1008
Extension cable for probe-connecting-cable, 20 m long	6 55 R 1009
Probe connection box for LS2	6 55 R 1025
Lambda Transmitter LT2 OEM, in a wall mounting housing 300x400x150, IP66, exclusive to connect the ETAMATIC via LAMTEC SYSTEM BUS (LSB) for the O ₂ -regulation without LCD-Display and manual control panel, without analogue output Attention: A refitting of the LCD-Display and manual control panel is not possible!	6 57 R 1020
Lambda Transmitter LT2, in a wall mounting housing 300x400x150, IP54, without LCD-Display and manual control panel, analogue output 0/4-20mA or 0/2-10V	6 57 R 1025
Lambda Transmitter LT2, on mounting plate, prepare for control cabinet without LCD-Display and manual control panel, analogue output 0/4-20mA or 0/2-10V	6 57 R 1030
Lambda Transmitter LT2, prepares for panel mounting cabinet, analogue output 0/4-20mA or 0/2-10V	6 57 R 1040

8.2 Detection of Combustibles (CO/H) - Option

Product / Type	Order no.
Combination Probe KS1 with PTFE-connecting cable (up to 250°C), length: 2 m	6 56 R 0000 T
Combination Probe KS1 with glass-silk insulated connecting cable (up to 400°C), length: 1,5 m	6 56 R 0001 T
Probe connection box for KS1	6 56 R 1025
Lambda Transmitter LT2, in wall-mounting housing 300x400x150, IP54, to connect the Combination Probe KS1 directly, without display and operating unit, analogue output 0/4-20mA or 0/2-10V	6 57 R 1025KS1
Software upgrade for LT2/LT2 for CO-detection with the Combination Probe KS1, incl. remote-connection to one LT (master) with O ₂ -measurement	6 57 R 0601
Software upgrade for LT2/LT2 for CO-control by the Combination Probe KS1, incl. remote-connection to one LT (master) with O ₂ -measurement only in combination with FMS/ETAMATIC)	6 57 R 0602

8 Ordering Information

8.3 Options

Product / Type	Order No:
Display and operating unit (design: housing for LT2 in wall-mounted housing)	6 57 R 0831
Display and operating unit, cable length 1,5m (design: panel installation for LT2 on mounting plate)	6 57 R 0831T
Calculation of the combustion efficiency, incl. 2 input cards for PT100 temperature sensors	6 57 R 0895
Temperature input for PT 100, e.g. to measure flue gas temperature	6 57 R 0890
Temperature sensor PT-100, 250 mm length, -50°C...+400°C	6 57 R 0891
Temperature sensor PT-100, 150 mm length, -50°C...+400°C	6 57 R 0897
Calculation of the CO ₂ concentration	6 57 R 0910
Integrated PID-controller for O ₂ control, temperature control, pressure control etc.	6 57 R 1120
Firing rate and fuel specific related limit curves/limit values, incl. analogue input PCB-card (alternatively: current, potentiometer or LSB) and 1 relay module 657 R 0017	6 57 R 0922
Relay module R 0017 with 6 relays for output of operating and status, mounted in LT2	6 57 R 0857
Analogue output 0/4...20 mA, 0...10 V	6 57 R 0050
Analogue output 0/4...20 mA, 0...10 V isolated, +20 V max. potential difference (only output 1 + 2)	6 57 R 0051
Isolated analogue output 1, +20 V max. potential difference VMS /FMS 4...20 mA ↔ 0...25% by vol.O ₂	6 57 R 0054REG
Analogue input 0/4...20mA	6 63 R 6001
Analogue input 0/4...20mA with feeding 24V DC for transmitter	6 63 P 6002
Analogue input 0/2...10V	657P 6000
Analogue input for LT1 / LT2 potentiometer 1...5 kΩ	657P 6005
BUS-Interface PCB for PROFIBUS DP	6 63 R 0401LT
BUS-interface PCB for CANopen	6 63 R 0402LT
BUS-Interface PCB for Modbus	6 63 R 0403LT
BUS-Interface PCB for Ethernet (Modbus TCP)	6 63 R 0406LT
Remote-Display-Software incl. interface-module RS 232	6 57 R 1101
Interface-module RS 422/485 on terminals	6 63 P 0503
Electric casing heating 230 V, 120 W, mounted in LT2, switching point > +15 °C	6 57 R 0367

8 Ordering Information

8.4 Ordering Examples

O2-Measurement LT2 / LS2-KV – fully automated calibration in wall mounting housing IP 54

Product/ Type		Order-No.
1	Lambda Probe LS2	6 50 R 1000
1	Gas extraction device, length 300 mm	6 55 R 1002
1	Probe installation fitting, pipe support 1/4"	6 55 R 1010
1	LT2 Lambda Transmitter in wall-mounting housing IP54	6 57 R 1025
1	Display and operating unit	6 57 R 0831
1	Relay module for operational, status and limit value messages outputs	6 57 R 0857

O2-Measurement LT2/ LS2 for measuring gas temperatures up to 300 °C /572°F, wall mounting housing IP 54 in combination with VMS / FMS / ETAMATIC

Product / Type		Order-No.
1	Lambda Probe LS2	6 50 R 1000
1	Gas extraction device, length 300 mm	6 55 R 1002
1	Probe installation fitting, pipe support 1/4"	6 55 R 1010
1	LT2 Lambda Transmitter in wall-mounted housing IP5	6 57 R 1025
1	Isolated analogue output 1, configured for connecting VMS / FMS	6 57 R 0054REG

O2- Measuring LT2 / LS 2 panel installation housing 3HE/50TE

Product / Type		Order-No.
1	Lambda Probe LS2	6 50 R 1000
1	Gas extraction device (GED), length 150 mm	6 55 R 1001
1	Probe installation fitting (PIF), pipe support R 1 ¼ "	6 55 R 1010
1	Probe junction box (SAK)	6 55 R 1025
1	Lambda Transmitter LT2 (prepares for panel mounting cabinet) incl. operating keypad and display	6 57 R 1040

O2- Measurement in combination with the detection of combustibles (CO/H), indicated as CO-equivalent (COe) [ppm]

Product / Type		Order-No.
1	Lambda Probe LS2	6 50 R 1000
1	Combination Probe KS 1 with PTFE-connection cable (to 200 °C), length 2 m	6 56 R 0000T
2	Flue gas intake (GED), length 300 mm	6 55 R 1002
2	Probe installation fitting (PIF), pipe support R 1 ¼ "	6 55 R 1010
1	Probe connection box (SAK)	6 55 R 1025
1	Lambda Transmitter LT2 in wall mounting cabinet IP 54 KS1	6 57 R 1025 / KS1
1	Lambda Transmitter LT2 in wall mounting cabinet IP 54	6 57 R 1025
1	Software-extension for LT 1 / LT2 for CO-detection with the combination-probe KS1 incl. REMOTE connection to LT (master) with O ₂ -measurement	6 57 R 0601



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