Measurement made easy

Highest precision under harshest conditions

**High precision**
- Lowest detection limits, highly accurate measurements
- Highly selective, virtually cross interference free

**Suitable for harsh process conditions**
- In-situ, direct measurement of hazardous gas streams
- For high pressure, high temperature applications

**Fast and direct**
- In-situ, no sample transport or conditioning
- Fast response

**Safe, compact and easy**
- Flameproof housing (Ex-d), no purging
- No nitrogen purging for oxygen measurement
- Compact and lightweight, insensitive to vibrations
- Ease of maintenance
Introduction

Application and design
The LS4000 is an in situ cross-duct analyzer for measuring gas component concentrations. It applies the highly selective optical measuring principle of tunable diode laser (TDL) absorption spectroscopy. The LS4000 is a stand-alone system and is approved for use in hazardous areas according to international standards.

The analyzer consists of a transmitter unit with a laser light source and a receiver unit with a photodetector. Both units are mounted opposite each other on the process pipe or stack and are connected by a junction box.

Measurement principle – TDLAS
The LS4000 employs the optical measuring technique of absorption spectroscopy, which utilizes the fact that a specific gas absorbs specific light wavelengths.

The light beam is emitted from a tunable laser diode located in the transmitter unit. The laser light passes through the process gas and strikes the photodetector in the receiver unit. The measured gas component present in the optical path absorbs the laser light, attenuating the light received.

A sophisticated signal algorithm processes the amount of light attenuation and calculates the gas concentration on the basis of the Beer-Lambert law. The influence of temperature and pressure variations is eliminated by dynamic automatic correction.

Technical data

Sample components and measurement ranges
Sample component
\( \text{O}_2 \)

Min./max. measurement range
0–1/100 vol.%

Max. abs. pressure
2 bar (29 psi)
2 to 20 bar (29 to 290 psi) on request

Max. temperature
1500 °C (2732 °F)

Measurement range quantity
1 physical measurement range per sample component,
1 x transmission

Optical path lengths (OPL)
Standard optical path lengths
0.5 to 20 m. Other optical path lengths on request.

Remarks
– The analyzer performance characteristics have been determined according to IEC 61207-1:2010 “Expression of performance of gas analyzers – Part 1: General”. They are based on nitrogen as the associated gas. Compliance with these characteristics when measuring other gas mixtures can only be assured if their composition is known.
– All specifications refer to an optical path length (OPL) of 1 meter, tested in ABB’s test and calibration jig. However, application-dependent variations may occur. The specific detection limit, minimum and maximum measurement range for a specific application will depend on the gas conditions (pressure, temperature and gas composition) and optical path length. Minimum measurement range, maximum pressure and maximum temperature cannot necessarily be realized simultaneously under all conditions.
– The maximum pressure and maximum temperature given are physical (spectroscopic) limits.
– Applications exceeding the above given spectroscopic limitation might be possible on request.
Stability
Performance data below is given at standard conditions. Data may vary depending on the specific application.

Linearity deviation
≤ 1% of span

Repeatability
< 0.2% of reading

Zero drift
No zero drift due to the measuring principle

Span drift
< 1% of smallest measuring range per week

Output fluctuation (2σ)
≤ 0.5% of smallest measurement range

Detection limit (4σ)
≤ 1% of smallest measurement range

Influence effects
For large variations of process temperature and pressure, LS4000 applies an automatic dynamic correction which requires 4–20 mA inputs. Influence effects and necessity for temperature or pressure sensor depend on the specific application and are defined by ABB.

Process temperature
< 1% of measuring range per 100 K

Process pressure
< 0.0001% of reading per hPa

Dust load
Instrument remains operable if transmission loss < 97%.

Accompanying gases/cross sensitivity
No cross sensitivity within normal operation conditions

Flow effect
No effect on the measurement, but the flow will determine the amount of gas needed for process purging.

Ambient temperature
In permissible range: no effect

Dynamic response
Warm-up time
< 5 min

Response time
Typically 5 sec

Maintenance interval and calibration/validation
Maintenance interval
Depending on application and dust load

Calibration
Single point calibration with test gas and an external off-line calibration cell (see “Accessories” on page 5)

Calibration/validation interval
Depending on application, typically once a year

Housing

<table>
<thead>
<tr>
<th>Transmitter and receiver unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection class</td>
</tr>
<tr>
<td>Material</td>
</tr>
<tr>
<td>Weight</td>
</tr>
<tr>
<td>Color</td>
</tr>
<tr>
<td>Dimensions</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Junction boxes</th>
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<tr>
<td>General purpose</td>
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<tr>
<td>Protection class</td>
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<tr>
<td>Material</td>
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<tr>
<td>Weight</td>
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<td>Color</td>
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<tr>
<td>Dimensions</td>
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<table>
<thead>
<tr>
<th>ATEX, IECEx</th>
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<tr>
<td>Protection class</td>
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<tr>
<td>Material</td>
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<tr>
<td>Weight</td>
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<tr>
<td>Color</td>
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<tr>
<td>Dimensions</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>CSA Class I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection class</td>
</tr>
<tr>
<td>Material</td>
</tr>
<tr>
<td>Weight</td>
</tr>
<tr>
<td>Dimensions</td>
</tr>
</tbody>
</table>
**Process purging**
Depending on the application, purging on the process side is typically necessary. It is not required to purge the instrument housing.

**Available flange size**
DN50/PN10, ANSI 2 inch-150 lb

<table>
<thead>
<tr>
<th>Material</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Flanges</td>
<td>AISI 316L (1.4404)</td>
</tr>
<tr>
<td>O-rings (process)</td>
<td>FPM (standard), FFKM</td>
</tr>
</tbody>
</table>

**Weight**
3.1 kg

**Gas port for purging**
¼ inch Swagelok® connectors for tubes with 8 mm outer diameter

**Purging medium**
Instrument air, dry and oil-free (compliant with standard ISO 8573.1, Class 2–3)
Nitrogen (required only for low level O₂ measurements)

**Electrical interfaces**

**Analog outputs**
Up to three 4–20 mA outputs (one for each measuring component and transmission), working resistance max. 500 Ω, not isolated

**Analog inputs**
Up to two 4–20 mA inputs for dynamic process temperature and pressure correction, working resistance max. 100 Ω, not isolated

**Digital outputs**
Up to two digital outputs, 1 A at 30 V DC/AC, NO, for error and gas alarm

**Service port**
Ethernet

See pages 6 to 9 for connection drawings

**Connections**

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<th>Signal</th>
<th>Function</th>
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<tr>
<td>13</td>
<td>AO2 (4–20 mA)</td>
<td>Analog output 2</td>
</tr>
<tr>
<td>14</td>
<td>AO3 (4–20 mA)</td>
<td>Analog output 3</td>
</tr>
<tr>
<td>15</td>
<td>AO GND</td>
<td>Analog outputs GND</td>
</tr>
<tr>
<td>16</td>
<td>DO1_A</td>
<td>Digital output 1</td>
</tr>
<tr>
<td>17</td>
<td>DO1_B</td>
<td>Digital output 2</td>
</tr>
<tr>
<td>18</td>
<td>DO2_A</td>
<td>Digital output 2</td>
</tr>
<tr>
<td>19</td>
<td>DO2_B</td>
<td>Digital output 2</td>
</tr>
<tr>
<td>27</td>
<td>T probe in (4–20 mA)</td>
<td>Analog input for dynamic temperature correction</td>
</tr>
<tr>
<td>28</td>
<td>T probe out (4–20 mA)</td>
<td>Analog input for dynamic temperature correction</td>
</tr>
<tr>
<td>29</td>
<td>P probe in (4–20 mA)</td>
<td>Analog input for dynamic pressure correction</td>
</tr>
<tr>
<td>30</td>
<td>P probe out (4–20 mA)</td>
<td>Analog input for dynamic pressure correction</td>
</tr>
</tbody>
</table>

**Power supply**

**Without power supply**
- Input voltage: DC 24 V nominal (DC 18 to 32 V)
- Power consumption: <10 W

**With power supply (integrated in the junction box)**
- Input voltage: AC 100 to 240 V, ±10 %, 50 to 60 Hz
- Output voltage: DC 24 V
- Power consumption: 30 VA

**Installation site requirements**

**Ambient temperature in operation**
- Transmitter and receiver unit, General purpose junction box: -20 to +55 °C (-4 to 131 °F) (no direct solar radiation)
- ATEX, IECEX junction box ¹: -20 to +55 °C (-4 to 131 °F)
- CSA Class I junction box ¹: -25 to +50 °C (-13 to 122 °F)

**Ambient temperature during storage and transport**
- Transmitter and receiver unit: -40 to +70 °C (-40 to 158 °F)

¹) The temperature data is given only for information. The documentation of the junction box manufacturer is relevant.

**Installation location**
The measurement gas must be well stirred at the selected location to produce a representative measurement result. Stratification in the measurement gas path results in erroneous measurement.

**Alignment tolerances**
Flanges parallel within 1.5°
**Explosion-proof versions**
The type LS4060 gas analyzer is suitable for use in hazardous areas:

**Explosion protection to European standards – ATEX**
- Transmitter and receiver unit (Zone 1): II 2(1)G Ex d [op is Ga] IIC T6 Gb
- Transmitter and receiver unit (Zone 2): II 3(1)G Ex d [op is Ga] IIC T6 Gc
- Junction box without power supply: II 2G Ex e IIC T6 Gb
- Junction box with built-in power supply: II 2G Ex d IIC T6

**Explosion protection to international standards – IECEx**
- Transmitter and receiver unit: Ex d [op is] IIC T4 Gb
- Junction box without power supply: Ex e IIC T6 Gb
- Junction box with built-in power supply: Ex de IIC T6 Gb

**Explosion protection to U.S. and Canadian standards – UL, CSA**
- Transmitter and receiver unit: Class I, Div. 1, Groups B, C, D; Class I, Div. 2, Groups A, B, C, D; T4A
- Junction box with built-in power supply: Class I, Div. 1, Groups B, C, D

1) The data regarding the explosion protection of the junction boxes is given only for information. The documentation of the junction box manufacturer is relevant.

**Accessories**

**Calibration cell**
The calibration cell is used for calibrating the instrument.

**Material**
Aluminum (6082-T6) or AISI 316L (1.4404)

**Validation cell**
The validation cell is permanently mounted between the process pipe and the transmitter/receiver unit and is used for a validation of the instrument.

**Material**
AISI 316L (1.4404)

**Gas ports**
¼ inch Swagelok® connectors for tubes with 8 mm outer diameter

**Isolation flanges**
For applications with high pressure or toxic or flammable gas, isolation flanges may be used to seal the process. The isolation flanges are compliant with PED 97/23/EC.

**Available flange size**
DN50/PN16, ANSI 2 inch-150 lb

**Material**
- Flanges: AISI 316L (1.4404)
- Window: Pre-stressed hardened borosilicate to DIN 7080 with antireflex-coating
- Flat gaskets (process): Graphite

**Gas port for purging**
¼ inch Swagelok® connector for tubes with 8 mm outer diameter

**Limitation**
- Temperature: Max. 300°C (572 °F)
- Pressure: Max. 16 bar (232 psi) absolute

**Insertion tubes**
Insertion tubes (length 1 meter) may be used to shorten the optical path length for high dust applications.

**Material**
AISI 316L (1.4404)
LS4000 with junction box in general purpose version

Dimensions in mm (inch)
LS4060 with junction box in ATEX/IECEx version without power supply

Dimensions in mm (inch)
LS4000 Tunable diode laser analyzer

LS4060 with junction box in ATEX/IECEx version with power supply

Dimensions in mm (inch)
LS4060 with junction box in CSA Class I version

Dimensions in mm (inch)
Certifications

CE conformity
The LS4000 and LS4060 gas analyzers satisfy the requirements of the European directives 2006/95/EC Low voltage directive, 2004/108/EC EMC directive and 94/9/EC ATEX directive.

Compliance with the requirements of directive 2006/95/EC is evidenced by full compliance with European standard EN 61010-1:2010.


Compliance of the explosion protected versions type LS4060 with the requirements of directive 94/9/EC is evidenced by full compliance with the European standards listed in the “Explosion protection to European standards – ATEX” section.

Electrical safety to IECEx CB scheme
The LS4000 and LS4060 gas analyzers are certified to the „IEC system for mutual recognition of test certificates for electrical equipment“, evidenced by full compliance with standard IEC 61010-1 (Ed. 3).

CB Test Certificate No. DE1-52306

Electrical safety to U.S. and Canadian standards – UL, CSA
The LS4000 and LS4060 gas analyzers are certified for use in general purpose environment, evidenced by full compliance with standards CAN/CSA-C22.2 No. 61010-1-12 and UL Std. No. 61010-1 (3rd Edition).

Certificate No. 70001037

Explosion protection to European standards – ATEX

Designation:
- II 2(1)G Ex d [op is Ga] IIC T6 Gb
- II 2D Ex tb IIC T88°C Db

EC-Type examination certificate No. BVS 13 ATEX E 008 X

Designation:
- II 3(1)G Ex d [op is Ga] IIC T6 Gc
- II 3D Ex tc IIC T88°C Dc

Certification by manufacturer’s declaration

Explosion protection to international standards – IECEx

Designation:
- Ex d [op is] IIC T4 Gb
- Ex tb IIC T88°C Db

Certificate No. IECEx BVS 13.0013X

Explosion protection to U.S. and Canadian standards – UL, CSA
The LS4060 gas analyzer (transmitter and receiver unit) is certified for use in explosion hazard areas Class I, Div. 1, Groups B, C, D; Class I, Div. 2, Groups A, B, C, D; T4A; Class I, Zone 1, AEx d, IIIB+H2 T4

Certificate No. 12.2589676X

Remark
Information regarding the explosion protection of the junction boxes can be found in the documentation of the junction box manufacturer.
Notes
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