Simultaneous Gas Analysis with »RI.sens Multiline«

The Gas Analysis Solution by RITTER with multiple Sensors for up to 4 different Gases, Pressure and Humidity
Analyse simultaneously up to 4 different gases plus pressure & humidity in one tabletop casing

<table>
<thead>
<tr>
<th>Arrangement</th>
<th>Line 1*</th>
<th>Line 2*</th>
<th>Line 3*</th>
<th>Options / Additional sensors **</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI sens mono 1 line + options</td>
<td>CO₂ / CO / NO / N₂O / CH₄ / C₇H₈</td>
<td>CO₂ / CO / NO / N₂O / CH₄ / C₇H₈</td>
<td>O₂</td>
<td>P</td>
</tr>
<tr>
<td>1.1</td>
<td>NO / NO₂ / SO₂ / H₂S / O₃ / Cl₂</td>
<td>NO / NO₂ / SO₂ / H₂S / O₃ / Cl₂</td>
<td>O₂</td>
<td>P</td>
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<tr>
<td>1.2</td>
<td>CO₂ / CO / NO / N₂O / CH₄ / C₇H₈</td>
<td>NO / SO₂ / O₂ / Cl₂</td>
<td>O₂</td>
<td>P</td>
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<tr>
<td>2.1</td>
<td>CO₂ / CO / NO / N₂O / CH₄ / C₇H₈</td>
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<td>O₂</td>
<td>P</td>
</tr>
<tr>
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<td>NO / NO₂ / SO₂ / H₂S / O₃ / Cl₂</td>
<td>NO / SO₂ / O₂ / Cl₂</td>
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<td>P</td>
</tr>
<tr>
<td>2.3</td>
<td>CO₂ / CO / NO / N₂O / CH₄ / C₇H₈</td>
<td>NO / SO₂ / O₂ / Cl₂</td>
<td>O₂</td>
<td>P</td>
</tr>
<tr>
<td>RI sens duo 2 lines + options</td>
<td>CO₂ / CO / NO / N₂O / CH₄ / C₇H₈</td>
<td>CO₂ / CO / NO / N₂O / CH₄ / C₇H₈</td>
<td>O₂</td>
<td>P</td>
</tr>
<tr>
<td>3.1</td>
<td>NO / NO₂ / SO₂ / H₂S / O₃ / Cl₂</td>
<td>NO / SO₂ / O₂ / Cl₂</td>
<td>O₂</td>
<td>P</td>
</tr>
<tr>
<td>3.2</td>
<td>CO₂ / CO / NO / N₂O / CH₄ / C₇H₈</td>
<td>NO / SO₂ / O₂ / Cl₂</td>
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<td>P</td>
</tr>
<tr>
<td>3.3</td>
<td>NO</td>
<td>NO₂</td>
<td>SO₂</td>
<td>O₂</td>
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</table>

* Only one gas selectable per line / ** P = pressure, H = humidity

Modular sensor design

In order to adapt gas analyses as flexibly as possible to individual measurement tasks, the single components were designed modularly. This resulted in a »modular system« in which the various photometric components such as detectors, emitters, measuring sample cell, etc. can be assembled user-specifically.

With this sophisticated sensor design, customer-specific applications can be realized without needing a completely new development. The modularity makes replacement and maintenance considerably easier when servicing is required. In contrast to this design, common completely glued gas sensors can only be replaced as a complete unit thus generating high follow-up costs (total cost of ownership) in case of maintenance.

Optionally, the various gas measurement modules can also be equipped with sensors for oxygen, pressure and humidity measurements.

List of measurement ranges

<table>
<thead>
<tr>
<th>Measuring range*</th>
<th>CO₂</th>
<th>CO</th>
<th>NO</th>
<th>CH₄</th>
<th>C₇H₈</th>
<th>N₂O</th>
<th>SO₃</th>
<th>NO₂</th>
<th>O₃</th>
<th>Cl₂</th>
<th>H₂S</th>
<th>NO</th>
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<tbody>
<tr>
<td>100 Vol.-%</td>
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<td>10 Vol.-%</td>
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</tbody>
</table>

* = Full scale value (F.S.) / ** = up to 300 ppm

Subject to alteration.
»RI.sens Multiline« Infrared Sensor NDIR (non-dispersive IR sensor)

The »RI.sens Multiline« NDIR Module has been specially developed for use in high-quality gas analysis. In the design phase special emphasis was placed on high stability and a low detection limit. These goals could be fully achieved by using high-performance light-emitting diodes (IR-LED) and thermal micro-radiators which were adapted to the requirements of gas detection. In the spectral range from 2 μm to 12 μm, carbon dioxide, carbon monoxide, hydrocarbons, water vapor and sulfur hexafluoride can be safely detected down to the ppm range with this innovative sensor platform.

Applications
› Biogas research
› Environmental and process measuring technology
› Elemental analysis
› TOC-analyzers
› Industrial gas analysis
› Natural gas analysis

Features & Benefits
› Measurement accuracy ±2 % of span (full scale)
› Operating temperature: 5-45 °C
› Operating pressure: 800-1200 mbar (hPa) abs.
› Warm-up time: 2 min
› Response time (t90): ≈ 3 sec
› Interface: USB, on request RS232
› Sensor cuvette: Aluminum, gold plated for sensor length ≥ 100 mm
› Incl. temperature compensation
› Incl. data acquisition software

In contrast to photometric NDUV sensors the lifetime of electrochemical sensors for measurement of H$_2$S is limited. Please note that lifetime data for such sensors are given for air and not for measurement of H$_2$S. For H$_2$S concentrations > 200 ppm the lifetime is reduced, for concentrations > 1000 ppm critical. While the measurement performance of UV-LED is constant, EC sensors are becoming »deaf«.

»RI.sens Multiline« Ultraviolet Sensor NDUV (non-dispersive UV sensor)

The »RI.sens Multiline« NDUV Module has also been specially developed for use in high-quality gas analysis. In the design phase special emphasis was placed on high stability and a low detection limit. These goals could be fully achieved by using high-performance light-emitting diodes (UV-LED) and gas discharge lamps (EDL) which were adapted to the requirements of gas detection technology. In the spectral range from 200 nm to 405 nm, nitrogen oxides, aromatic hydrocarbons, ketones, ozone, sulfur dioxide and halogens can be used with this novel sensor platform, partly detected reliably in the ppb range.

Applications
› Biogas research
› Environmental measuring technology
› Elemental analysis
› Process measuring technology

Features & Benefits
› Measurement accuracy ±2 % of span (full scale)
› Operating temperature: 5-45 °C
› Operating pressure: 800-1200 mbar (hPa) abs.
› Warm-up time: 1 min
› Response time (t90): ≈ 1-2 sec depending on gas
› Interface: USB, on request RS232
› Sensor cuvette: Aluminum, gold plated for sensor length ≥ 100 mm
› Incl. temperature compensation
› Incl. data acquisition software

Options, built-in as supplement in »RI.sens Multiline« tabletop casing

Oxygen sensor
› Electrochemical sensor
› Measurement range: 0-100 %
› Measurement accuracy ±2 % of span (full scale)
› Resolution: < 0.5 % of span (full scale)
› Response time (t90): ≈ 15 sec; automotive version ≈ 5 sec
› Lifetime: approx. 5 years

Pressure sensor
› Pressure compensation of measured gas concentrations
› Measuring range: 800-1,200 mbar abs.
› Measurement accuracy ±1 % of span (full scale)
› Resolution: 1 mbar
› Response time (t90): 1 s
› Incl. temperature compensation

Humidity sensor
› Polymer humidity sensor
› Measuring range: 0-100 % RH
› Measurement accuracy ±2 % RH of span (full scale)
› Resolution: ±1 % RH
› Response time (t90): 12 s
› Incl. temperature compensation
› Indicated values: relative humidity in % RH
»RI.sens Multiline« Infrared plus Ultraviolet Sensor

The third »RI.sens Multiline« module is a combination of both NDIR and NDUV Module on a common board. With this unit, up to 3 gas components can be measured simultaneously. The basic electronics can supply IR and UV radiation sources with different frequencies for 0 Hz (DC) to 100 Hz (AC). This system is an ideal tool for detecting multi-component gas at low ppm levels.

Applications
- Biogas research
- Environmental and process measuring technology
- Elemental analysis
- TOC-analyzers
- Industrial gas analysis
- Natural gas analysis

Features & Benefits
- Measurement accuracy ±2 % of span (full scale)
- Operating temperature: 5-45 °C
- Operating pressure: 800-1200 mbar (hPa) abs.
- Warm-up time: IR 2 min / UV 1 min
- Response time (t90): ≈ IR 3 sec / UV 1-2 sec depending on gas
- Interface: USB, on request RS232
- IR Sensor cuvette: Aluminum, gold plated for sensor length ≥ 100 mm
- UV Sensor cuvette: Stainless steel with inert coating inside and outside; PEEK for corrosive gases (H₂S, chlorine) on request
- Incl. temperature compensation
- Incl. data acquisition software

»RI.sens Multiline« Ultraviolet Sensor NDUV / UVRAS

For the detection of NO and H₂S an EDL (electrodeless gas discharge lamp) is used. A combination of both technologies (UVRAS & UVLEDs) allows simultaneous gas analysis of NO, NO₂, and SO₂ in the lower ppm range, which is particularly important in flue gas analysis (CEM, Continuous Emission Monitoring).

Measurement technology: In the EDL, N₂ and O₂ are converted to NO and produce selective UV radiation. With this radiation a cross sensitivity free NO measurement is made possible. This method is called UV resonance spectroscopy (UVRAS).

Applications
- Exhaust gas monitoring (CEM, Continuous Emission Monitoring)
- Laboratory area
- Biogas research
- Industrial gas analysis
- Engine test benches
- Portable gas analysis (PEMS, Portable Emission Monitoring System)

Features & Benefits
- Measurement accuracy ±2 % of span (full scale)
- Simultaneous NO x and SO₂ analysis
- Temperature controlled up to 55 °C
- Fast response time < 3 seconds
- Durable EDL (> 16000 h)
- Flow-independent measurement 0-2 L/min
- No influence of gas humidity
- No NO x converter required
- Compact size
- In "Thermobox" as standard for stable measurement conditions

Options, built-in as supplement in »Ri.sens Multiline« tabletop casing

Analog Output
- Analog Voltage Output for max. 4 separate gas concentrations
- Alternatively 0-2 V / 0-5 V / 0-10 V
- 16 bit resolution,
- 1 sec update rate

PEEK Cuvette
- For corrosive gases (e.g. Chlorine)
- O-ring seal
- Pressure-resistant

Thermobox
- For thermal insulation
- Temperature controlled up to 55 °C
- Optional casing for NDIR & NDUV sensors
- With dust filter
- Temperature range 5-45 °C
From »Multiline« to »Multiplex«
A brief story of measurement efficiency and cost reduction

With a sensor of the »RI.sens Multiline« series, up to four different gases can be analyzed and gas pressure and humidity can be measured optionally. Only by this fact, these sensors are superior to other conventional sensors, with each of which the concentration of only one gas can be measured.

However, by combining the Multiline sensors with the »RITTER Multiplexer« for gas analysis, the efficiency can even be multiplied and costs drastically reduced!

“RITTER Multiplexer” allows ...

... the measurement of up to 4 gas concentrations from up to 18 gas sources

Here are two possible configurations:

»Operation principle in configuration A:«
Controlled by the software and electromagnetic valves, the gas from up to 18 gas sources is directed via 1 or 2 multiplexer units (depending on the number of gas lines) into the »RI.sens Multiline« sensor. The gas lines are “multiplexed” which means that the single lines are selected sequentially by the software and directed into the sensor one after the other. The measured gas concentrations are indicated by the software for each gas line and its gas components. After having passed the sensor all gas lines are flowing into one common gas outlet line.

»Operation principle in configuration B:«
In addition to the operation in configuration A the gas of each gas line is directed into 1 or 2 additional multiplexer units (depending on the number of gas lines). Once again controlled by the software and electromagnetic valves, the gas of each line continues flowing in its original line for further measurements and/or processing.

Extensive measurements of the entire »RITTER Multiplexer« system are currently being carried out for release for use in practice. Once these are completed, availability will be announced on the RITTER website www.ritter.de

Multiplexer processing times per gas line [min]

<table>
<thead>
<tr>
<th>No. of Gas Lines</th>
<th>Flow Rate [ml/h]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>9</td>
<td>13.5</td>
</tr>
<tr>
<td>18</td>
<td>26.9</td>
</tr>
</tbody>
</table>

Patent pending
"In everyday use clever solutions are simply desirable. The RITTER company is a solid partner in this respect, shaping my everyday life pleasantly again and again."