

# ICAD NO<sub>2</sub> / NO<sub>x</sub> / NO Monitor

**Fast, accurate and direct  
Nitrogen Dioxide Detection**

**Additional NO<sub>x</sub> / NO measurement  
with converter**



The ICAD (Iterative Cavity enhanced DOAS) NO<sub>2</sub> / NO<sub>x</sub> / NO measurement system uses direct optical absorption spectroscopy in the spectral range between ~ 430 to 465 nm. By measuring the absorption spectrum and applying the ICAD algorithm, the unique and characteristic absorption structure of NO<sub>2</sub> is directly identified and separated from other overlapping absorptions like water vapour (H<sub>2</sub>O) or Glyoxal (CHOCHO) (patent pending). This gives the advantage of direct NO<sub>2</sub> measurements (in comparison to CLD) without interferences to other substances or the need of drying mechanism which introduce new interferences (e.g. CLD, CRD, CAPS) As the ICAD system relies not on absolute intensities, but rather characteristic differential absorption structures, it has no absolute zero point drift and is insensitive to temperature variations, vibrations and light source degradation. It is thus the perfect tool for accurate and precise long term measurements, but also for mobile applications, especially where high precision and fast response times are required. An internal converter for NO to NO<sub>2</sub> allows measuring also NO<sub>x</sub> / NO with the same system (patent pending). The operation is simple as no consumable gases are required.

## PROPERTIES (TYPICALLY)

<b>Measurement range</b> * <sup>1)</sup>	0 – 5000 ppb	<b>Cross sensitivity</b>	None (from physical principle)
<b>LOD (@ 2 s)</b> * <sup>1)</sup>	0.2 ppb	<b>Power consumption</b>	< 30 W, 12 V
<b>Precision (1σ @2 s)</b> * <sup>1)</sup>	0.1 ppb or 2%	<b>Start-up time</b>	< 1 min
<b>Detection of NO<sub>2</sub></b>	Direct (without converter)	<b>Temperature range</b> * <sup>4)</sup>	-10 – 45° C
<b>Detection of NO<sub>x</sub> / NO</b>	By conversion to NO <sub>2</sub>	<b>Temperature Sensitivity</b>	None
<b>Response Time NO<sub>2</sub> / NO<sub>x</sub> (10% - 90%)</b> * <sup>2)</sup>	2 s @ 1 l / min / 1 s @ 2 l / min	<b>Weight</b>	< 10 kg (adjustable)
<b>Zero Drift</b>	None (from physical principle) <0.1 ppb / month	<b>Size</b>	waterproof PC: 12" x 16" x 5" Rackhousing: 6.7" x 19" x 24"
<b>Sample flow</b>	1 – 3 l/min	<b>Consumable gases</b>	None
<b>Calibration</b>	„Intrinsically“ calibrated, no calibration gas needed, only characterization of absorption path	<b>Dryer</b>	Not required
<b>Characterization of absorption path</b> * <sup>3)</sup>	With Helium gas or optical methods (ICOM, IOK, NB-CRD)	<b>Other Gases</b> * <sup>5)</sup>	H <sub>2</sub> O, CO <sub>2</sub>
<b>Calibration Drift</b>	< 1% month	<b>Computer system</b>	Internal Embedded PC, with data analysis & measurement software
<b>Mechanical stability</b>	Insensitive to vibrations	<b>Data communication</b> * <sup>6)</sup>	LAN / WLAN

Comments:

\*<sup>1)</sup> Custom specifications with different measurement range are possible. By reducing the measurement range better precision and LOD can be achieved. Measurement range can also be increased with slightly lower precision and LOD.

\*<sup>2)</sup> Response: Different measurement cell types are available, allowing different response times. Smaller measurement cells allow a much faster response time, but result typically in a lower precision.

\*<sup>3)</sup> Depends on the system which method is applied (patents pending)

\*<sup>4)</sup> Adaptable, if measurement requires different temperatures. Hot gas measurements possible with modifications.

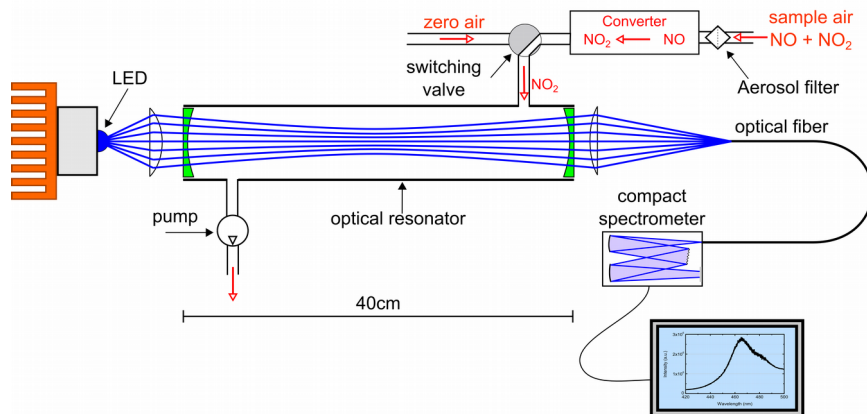
\*<sup>5)</sup> System measures also humidity (H<sub>2</sub>O). System can be added with a CO<sub>2</sub> Sensor. ICAD instruments for other gases are under development.

\*<sup>6)</sup> Other data transmission is in principle possible (RS 232)

## APPLICATIONS

- High precision NO<sub>2</sub> / NO<sub>x</sub> measurements (science, research, background air pollution monitoring)
- Urban air quality monitoring (outdoor, streets, tunnels, street canyons)
- Indoor air quality monitoring
- Mobile, quick and precise NO<sub>2</sub> / NO<sub>x</sub> pollution study
- Mobile personal exposure studies for pedestrians, cyclists, etc.
- Emission monitoring (e.g. stacks)
- Real Driving Emission Measurement of vehicles (RDE): requires addit. CO<sub>2</sub> option to derive NO<sub>x</sub> / NO<sub>2</sub> per km or kWh
- Emission studies of diffuse sources
- Medical inhalant purity measurement

## EXAMPLE MEASUREMENTS



Flow scheme and spectral data principle of the ICAD NO<sub>2</sub> / NO<sub>x</sub> / NO measurement system (incl. additional NO converter for NO<sub>x</sub> measurement).

## ADVANTAGES

Benefits	Innovation
<b>High measurement accuracy</b>	<ul style="list-style-type: none"> <li>• Direct NO<sub>2</sub> measurement</li> <li>• Low measurement error</li> <li>• Measurement range adaptable</li> <li>• No zero-point or calibration drift, 100% reproducibility</li> <li>• No interferences</li> </ul>
<b>Favorable initial and operating costs</b>	<ul style="list-style-type: none"> <li>• Parallel NO-Measurement (with converter)</li> <li>• Simple and robust setup</li> <li>• No consumables (e.g. gases)</li> <li>• Long lifetime</li> <li>• Fast response within seconds</li> </ul>
<b>Simple operation</b>	<ul style="list-style-type: none"> <li>• No heating time</li> <li>• No calibration with gases</li> <li>• High stability (not sensitive to shocks, vibration, temperature)</li> <li>• Light weight</li> </ul>

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