DIFFERENT THINKING.
BETTER MEASURING.

A SPIN-OFF FROM THE UNIVERSITY OF HEIDELBERG
INSTITUTE OF ENVIRONMENTAL PHYSICS

ICAD NO_2 / NO_x / NO Analyzer

PATENTED, FAST, ACCURATE AND DIRECT NITROGEN DIOXIDE DETECTION
ADDITIONAL NOX / NO MEASUREMENT WITH CONVERTER (OPTIONAL)

Figure 1 ICAD 200-D series featuring 19" rack housing and OLED display.

Figure 2 ICAD 200-DM series features compact, waterproof housing for mobile field measurements.

The ICAD *(Iterative CAvity enhanced DOAS)* $NO_2/NO_x/NO$ 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_2 is directly identified and separated from other overlapping absorptions like water vapour (H_2O) or Glyoxal ($C_2H_2O_2$). This gives the advantage of direct NO_2 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 like other optical instruments. It is thus the perfect tool for accurate and precise long-term measurements, but also for mobile applications requiring a wide measurement range, high precision and fast response times. An internal converter for NO to NO_2 (optional) based on gas phase titration (GPT) with a NO_x free O_3 source allows measuring also NO_x/NO with the same system (patented). The operation is simple as no consumable gases are required. Data display is directly available with any WiFi or LAN device or over the RS232 interface. Patents: DE102015000423; EP3329251; US15/748,923; China ZL201680057099.6

SPECIFICATIONS

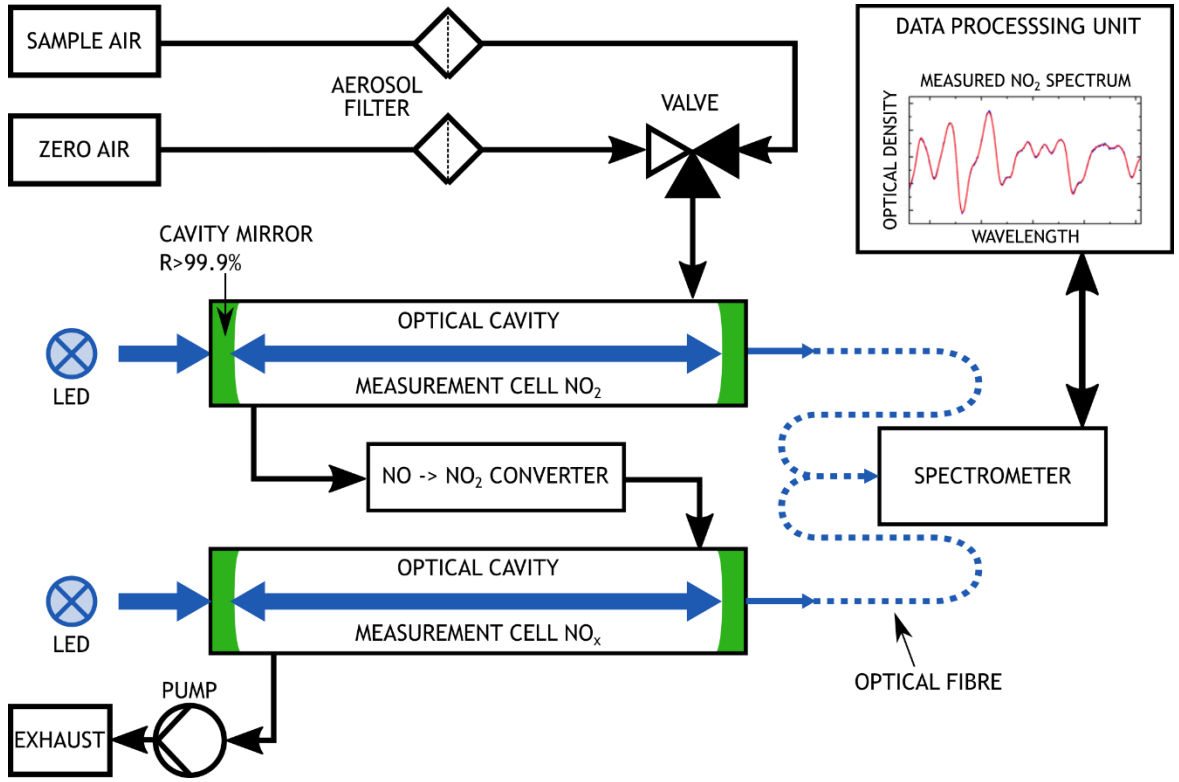
Measurement range[*1]	0 – 5000 ppb	**Power consumption**	Less than 30 W at 12 V (typ.)
Time resolution	2s to 60s (1s with post processing possible)	**Dimensions**	IP64 housing 40.0 x 37.0 x 13.0 cm 19" Rack housing 13.4 x 48.3 x 44.6 cm
Limit of Detection (at 30 s) [*1]	0.3 ppb	**Start-up time**	Less than 1 min (typ.)
Precision (1σ at 30 s)	0.15 ppb or 2%	**Temp. range of operation**	-10 to +25°C (+40°C with cooling option)
Detection of NO_2	Direct spectroscopic measurement	**Temperature sensitivity**	Less than 0.01 ppb/°C
Detection of NO_x / NO	By conversion to NO_2 (GPT)	**Cross sensitivity**	No significant cross sensitivity[*5]
Response Time (10% to 90%)[*2]	2s at 1 l/min or 1s at 2 l/min	**Weight**	Less than 10 kg (depending on config)
Zero Drift	Less than 0.1 ppb/month[*3]	**Consumable gases**	No gases needed for operation
Sample flow	1 to 2.5 l/min	**Other detectable gases**	Glyoxal, CO_2 (optional NDIR sensor)
Calibration	NO2 calibration gas not needed[*4]; NO gas for converter calibration (only for high NO_x measurements)	**Processing unit**	Internal embedded PC, with data analysis and measurement software
Path length characterization	Helium gas (1 to 2 years interval)	**Data communication**	LAN/WiFi/RS232/M2M/OPCUA;Bayern-Hessen Protocol; Voltage/Current Output
Mechanical stability	Insensitive to vibrations		

*1 Custom specifications with different measurement range are possible. By reducing the measurement range better precision and LOD can be achieved.
*2 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.
*3 Upper limit. Drift is negligible due to regularly automated reference measurements.
*4 Literature absorption data for NOx is used for gas quantification.
*5 No significant spectroscopic cross sensitivity with respect to: Carbon oxides, Formaldehyde, Ozone, Methane, Hydrogen, Sulfide, Sulfur Dioxide, Chlorine, Chlorine Dioxide, Hydrogen Cyanide, Hydrogene Chloride, Phosphine, Hydrogen, Ammonia, Acetylene, Nitromethane, Ethylene, Ethanol, Methyl Mercaptan, Ethyl Mercaptan

APPLICATIONS

- High precision NO_2 / NO_x measurements (science, research, background air pollution monitoring)
- Urban air quality monitoring (outdoor, streets, tunnels, street canyons, mobile measurements)
- Indoor air quality and workplace monitoring
- Mobile, quick & precise NO_2 / NO_x pollution study, mobile personal exposure studies e.g., for workspace, pedestrians etc.
- Emission monitoring (e.g., stacks)
- Real Driving Emission Measurement of vehicles (RDE): requires extra CO_2 option to derive NO_x / NO_2 per km or kWh

THEORY OF OPERATION



Flow scheme and Measurement Principle of the ICAD NO_2 / NO_x / NO measurement system (incl. additional NO to NO_2 converter for NO_x measurement).

ADVANTAGES

BENEFITS	INNOVATION
High measurement accuracy	• Direct NO_2 measurement • High sensitivity, low measurement error • No zero-point or calibration drift, 100% reproducibility • No interferences • No water dryer needed
Favourable initial and operating costs	• Parallel NO-Measurement (with converter) • Simple and robust setup • No consumable gases needed • Long lifetime • Fast response within seconds
Simple operation	• No calibration with NO_2 gas required • High stability (not sensitive to shocks, vibration, temperature) • Light weight • Low power consumption and 12V operation • Multiple Interfaces: WiFi, LAN, Machine2Machine, RS232, Analogue Volt./Cur.