

ICAD NO₂ / NO_x / NO Analyzer

High Grade Version

NO_x / NO MEASUREMENT VIA O₃ TITRATION CONVERTER (OPTIONAL)

PATENTED, DIRECT NO₂ DETECTION



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

The ICAD (*I*terative *C*avity enhanced *D*OAS) NO₂/NO_x/NO measurement system uses direct optical absorption spectroscopy in the spectral range between 430 to 465 nm. In contrast to the ICAD 200 series, the "L" series features an enhanced sensitivity by using a longer absorption cell and increased reflectivity mirrors. By measuring the absorption spectrum and applying the ICAD algorithm, the unique and characteristic absorption structure of NO₂ is directly identified and separated from other overlapping absorptions like water vapour (H₂O) or Glyoxal (C₂H₂O₂). This gives the advantage of direct NO₂ 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. An internal converter for NO to NO₂ (optional) based on gas phase titration (GPT) with a NO_x free O₃ 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 - 2000 ppb	Power consumption	Less than 30 W at 12 V (typ.)
Time resolution	2s to 60s (1s with post processing possible)	Dimensions	19" Rack housing 13.4 x 48.3 x 65.6 cm
Limit of Detection (at 2 s) * ¹	0.2 ppb, 12 ppt at 1800 s	Start-up time	Less than 1 min (typ.)
Precision (1σ at 2 s)	0.1 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 11.7 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	NO ₂ 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 NO_x is used for gas quantification.

*⁵ No significant spectroscopic cross sensitivity with respect to: Carbon oxides, Methane, H₂CO, Hydrogen, Sulfide, Sulfur Dioxide, Chlorine, Chlorine Dioxide, Hydrogen Cyanide, Hydrogen Chloride, Phosphine, Hydrogen, Ammonia, Acetylene, Nitromethane, Ethylene, Ethanol, Methyl Mercaptan, Ethyl Mercaptan

APPLICATIONS

- High precision NO₂ / 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
- Quick & precise NO₂ / NO_x pollution study, personal exposure studies e.g., for workspace, pedestrians etc.
- Emission monitoring (e.g., stacks)
- Real Driving Emission Measurement of vehicles (RDE): requires extra CO₂ option to derive NO_x / NO₂ per km or kWh

THEORY OF OPERATION

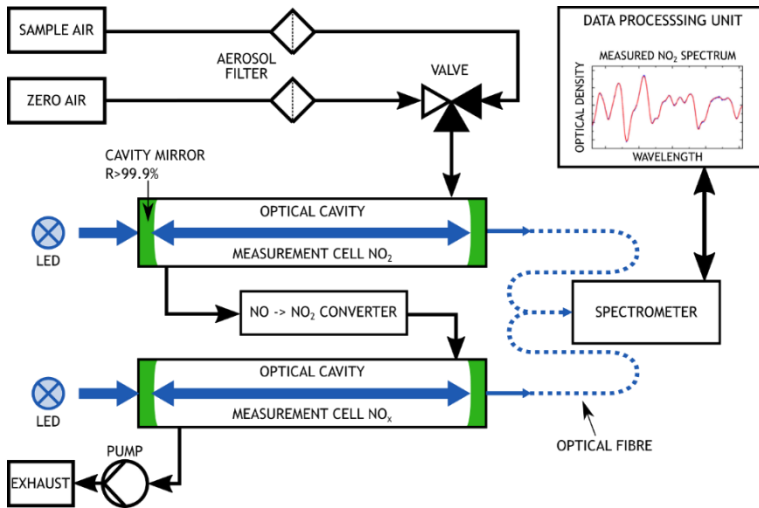


Figure 2: Flow scheme and Measurement Principle of the ICAD NO₂ / NO_x / NO measurement system (incl. additional NO to NO₂ converter for NO_x measurement).

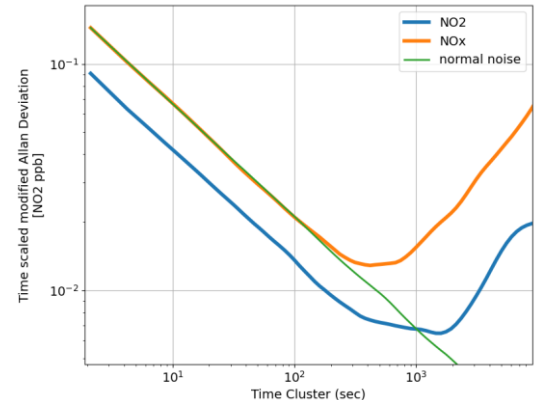


Figure 3: Time scaled modified Allan deviation for NO₂ and NO_x measurements.

ADVANTAGES

BENEFITS

High measurement accuracy

INNOVATION

- Direct NO₂ 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 NO₂ 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.

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