

# ICAD IN SITU ANALYSERS

PATENTED, DIRECT  $\text{NO}_2$  AND / OR *HONO* DETECTION - NITROGENMONOXIDE (*NO*) MEASUREMENT VIA  $\text{O}_3$  TITRATION CONVERTER - HIGH PRECISION - EASY OPERATION - CALIBRATION NOT REQUIRED



$\text{NO}_2$ /NO/HONO MEASUREMENT - PPT RANGE - HIGH TIME RESOLUTION - LOW POWER CONSUMPTION

## HIGH SENSITIVITY, LARGE DYNAMIC RANGE & MOBILITY

The ICAD features typical advantages of high accuracy, instrumental stability, long maintenance intervals and low consumables. Further, the high dynamic range allows measurements from high polluted conditions e.g., at high traffic roads or industrial monitoring to very low concentrations in clean environments. If even ultra-low  $\text{NO}_x$  concentrations down to 15 ppt are of interest, the special ICAD high-grade versions “\*L” are the perfect tool. The measurement can easily be controlled with a tablet connected to the ICAD via WiFi.



## WORK SPACE $\text{NO}_2$ / $\text{NO}_x$ MONITORING OR INDUSTRIAL MONITORING



The high mobility, rugged design, and low maintenance effort make ICAD instrument the ideal instrumentation for reliable monitoring  $\text{NO}_x$  levels in workplace environments such as mines, constructions site or industrial production places. Further, ICAD instruments can be applied to measure and monitor the  $\text{NO}_x$  emissions of industrial machines. Multiple data interfaces enable optional integration of ICAD instruments with industrial processes.

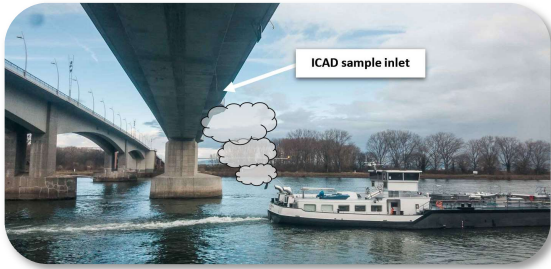
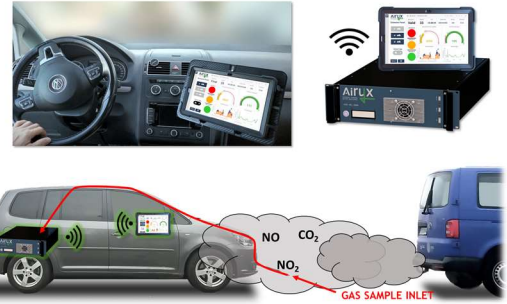
## MOBILE MEASUREMENTS

The low power consumption, compact size, moderate weight and insensitivity to vibrations allow easily mobile measurements at different locations. The short set-up and warm-up time gives a lot of flexibility. Customized, ICAD versions for applications on drones are also available.



## MOBILE APPLICATIONS - ON-ROAD REAL DRIVING EMISSIONS

ICAD for emissions “\*E” (equipped with additional internal CO<sub>2</sub> sensor) allow on-road real driving emissions via the so-called Plume Chasing method. A vehicle with the ICAD, follows target vehicles to measure the gases in the diluted plume. Within seconds the system derives the specific NO<sub>x</sub> emission signature from the vehicle. In short times, high emitting vehicles due to defects or exhaust manipulations are identified. The tool allows authorities to enhance inspection efficiency or researchers to perform a vehicle emission screening.



## FLEXIBLE DEPLOYMENT - EXTENDED APPLICATION

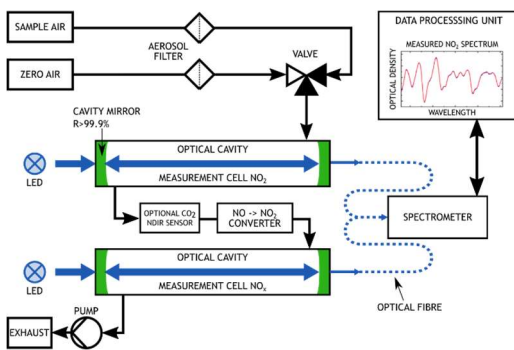
The fast response time of the ICAD instrument enables monitoring and assignment of NO<sub>x</sub> emissions from water vehicles (e.g., at bridges or at the shoreline). With the ICAD emission configuration, NO<sub>x</sub> emission factors (mg NO<sub>x</sub>/kWh) are similar derived like for the real driving application. The calculation is independent from dilution of exhaust gases and thus, influence of meteorology.

## NO DRIFTS, NO CROSS-INTERFERENCES

The selective detection of NO<sub>2</sub>, NO<sub>x</sub> or HONO, high measurement sensitivity and negligible drift makes the ICAD perfectly suitable for stationary air quality monitoring as well as scientific studies of chemical processes, e.g., atmospheric studies or simulation experiments. Further, the absence or cross-interferences to other gas species, enables measurements also of complex mixture (e.g., containing high concentration of CO<sub>2</sub>, N<sub>2</sub>O, H<sub>2</sub>O or hydrocarbons).



## TECHNIQUE AND FEATURES



- ❑ **Direct measurement** by differential absorption spectroscopy
- ❑ **High sensitivity and accuracy** by use of ICAD algorithm (insensitive to intensity variations and aging of light sources)
- ❑ **No cross-interference**, spectral separation from other gases like water vapour (H<sub>2</sub>O), Glyoxal (C<sub>2</sub>H<sub>2</sub>O<sub>2</sub>), oxygen (O<sub>2</sub>)
- ❑ **NO<sub>2</sub> / HONO calibration gases** not required; **no pre-drying** of sample air required
- ❑ High dynamic detection range of **low ppt to ppm**
- ❑ **Fast response** time of 1 seconds
- ❑ Optional internal **CO<sub>2</sub> extension** for combustion emission measurements (e.g., vehicle on-road measurement, Plume Chasing)
- ❑ Remote access with any Wi-Fi device. GUI for easy operation. Multiple data interfaces.
- ❑ **Graphical system health table** for easy and fast on-board diagnosis.

System Health Status Table						
Name	Description	Value	Status	Good Range	Warning Range	
O3_Sen	O3 Conc. from Generator	1621 ppb	0_Too Low	[2500;3400]	[2200;2800]	
CO2_C	Measured CO2 Concentration	1142 ppm	Good	[0;2000]	[0;2000]	
CO2_Present	Status of CO2 Sensor	1	Good	[1;1]	[1;1]	
F1	Total gas flow	2140 sccm	Good	[1900;2400]	[1500;2700]	
F2	O3 gas flow	129.3 sccm	Good	[120.0;140.0]	[110.0;150.0]	
ICCH1	Light Intensity at Channel 1	4930 cts	Good	[4684.5;776]	[3944.5;916]	
ICCH2	Light Intensity at Channel 2	4382 cts	Good	[4163.46;01]	[3506.52;58]	
P	Ambient Pressure	998 hPa	Good	[700;1150]	[-3000;1200]	
PPA0	Pressure Cell 1	954.2 kPa	Good	[800.0;1000.0]	[700.0;1050.0]	
PPA1	Pressure Cell 2	856.1 kPa	Good	[700.0;900.0]	[600.0;950.0]	
SV	Analyser Supply Voltage	11.9 V	Good	[10.0;13.0]	[10.0;13.5]	
T0	Temperature of Resonator (at LED)	35.006 C	Good	[34.000;38.000]	[25.000;39.000]	
T2	Temperature of Resonator (at Spectrometer)	34.9 C	Good	[30.0;41.0]	[21.0;45.0]	
TP	Temperature of Chl. Electronics (MCU)	50 C	Good	[20;70]	[10;75]	
O3_Gen_E	O3 Conc. Uncertainty	3537 ppb	Disabled	[0;1000]	[0;1250]	

## ICAD MODEL OVERVIEW

	NO2-210	NOx-210D	NOx-210DE	NO2-210L	NOx-210DL	HONO/NO2-210L
Detectable gases	NO <sub>2</sub>	NO <sub>2</sub> / NO	NO <sub>2</sub> / NO / CO <sub>2</sub>	NO <sub>2</sub>	NO <sub>2</sub> / NO	HONO / NO <sub>2</sub>
Range	5 ppm	5 / 5 ppm	5 / 5 / 2000 ppm	2 ppm	2 ppm / 2 ppm	0.5 / 2 ppm
Limit of detection at 2s, 30s, 300s in ppt	350,100,30 ppt	350,100,30 ppt	350,100,30 ppt CO <sub>2</sub> : 4 ppm	200,50,15 ppt	200,50,15 ppt	HONO: 500,120,40 ppt NO <sub>2</sub> : 600,150,50 ppt
Precision (1σ) at 2s, 30s, 300s in ppt	175,50,15 ppt	175,50,15 ppt	175,50,15 ppt CO <sub>2</sub> : 2 ppm	100,25,8 ppt	100,25,8 ppt	HONO: 250,60,20 ppt NO <sub>2</sub> : 300,75,25 ppt
Available also as mobile "M"-version	✓	✓	✓	✗	✗	✗

## ICAD SPECIFICATIONS

Detection of NO <sub>2</sub> , HONO	Direct spectroscopic measurement	Weight 19" Rack	< 12 kg (depending on config)
Detection of NO (NO <sub>x</sub> )	By conversion to NO <sub>2</sub>	Weight "M" version	< 10 kg (depending on config)
Response Time (10% to 90%)* <sup>2</sup>	2s at 1 l/min or 1s at 2 l/min	Power consumption	Less than 40 W at 12 V (typ.)
Zero drift	Less than 0.1 ppb/month <sup>3</sup>	Start-up time	Less than 1 min (typ.)
Sample flow	1 to 2 l/min	Temp. range of operation	-10 to +25 °C (+40 °C with cooling option)
Time resolution	1s to 60 s temporal averaging	Temperature sensitivity	Less than 0.01 ppb/ °C
Calibration for NO <sub>2</sub> / HONO	Via spectroscopic data, gas-free <sup>4</sup>	Cross sensitivity	No significant cross sensitivity <sup>5</sup>
Path length characterization	Gas free ICOM method, Helium (optional, every 1 to 2 years)	Mech. stability	Insensitive to vibrations
		Consumable gases	No gases needed for operation
		Other detectable gases	Glyoxal <sup>6</sup> (respected by spectral analysis)
Housing Size 19" Rack	43.8 x 13.3 (3HU) x 43.5 cm <sup>3</sup> (WHD)	Processing unit	Internal embedded PC (WIN10)
Housing Size 19" Rack "L"	43.8 x 13.3 (3HU) x 66.5 cm <sup>3</sup> (WHD)	Data communication	LAN/WiFi/RS232/M2M/OPCUA; Bayern-Hessen Protocol; Voltage/Current Output
Housing Size "M"	40.0 x 13.3 (3HU) x 30.0 cm <sup>3</sup> (WHD)		

[\*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. [\*3] Upper limit. Drift is negligible due to regularly automated reference measurements. [\*4] Literature absorption data for target gas is used for gas quantification. [\*5] No significant spectroscopic cross sensitivity found for: water, ozone, Glyoxal, Carbon Oxides, Methane, Formaldehyde, Hydrogen, Sulphide, Sulphur Dioxide, Chlorine, Chlorine Dioxide, Hydrogen Cyanide, Hydrogen Chloride, Phosphine, Hydrogen, Ammonia, Acetylene, Nitromethane, Ethylene, Ethanol, Methyl Mercaptan, Ethyl Mercaptan. [\*6] For NO2-210 and NOx-210 models.

## ADVANTAGES

### BENEFITS

#### High measurement accuracy

### INNOVATION

- **Series 210 Improvement:** Enhanced accuracy at higher concentrations
- **Series 210 Improvement:** Enhanced time resolution down to 1s
- Direct spectroscopic gas measurement
- High sensitivity, low measurement error
- Fast measurement response
- No zero-point or calibration drift, 100% reproducibility, no interferences
- No sample pre-dryer needed

#### Simple and low costs operation

- NO<sub>2</sub> / HONO calibration gas not required
- Parallel NO measurement (with ozone titration converter)
- No consumable gases needed
- Robust setup, long lifetime

#### Flexible application

- **Series 210 Improvement:** System Health GUI for fast on-board diagnosis
- **Series 210 Improvement:** Easy adjustment of span calibration in GUI
- High stability (not sensitive to shocks, vibration, temperature)
- Compact design, mobile application
- Low power consumption and 12 V operation
- Data Interfaces: WiFi, LAN, Machine2Machine, RS232, Analogue Volt./Cur.
- Internal memory for up to 2 years of data

Patents: DE102015000423; EP3329251; US15/748,923; China ZL201680057099.6