Air Pollution Sensor

INAIR-NO2

For detection of NO_2 in ambient air

Key features

- **Digital output**
- **Pre-calibrated**
- **Proprietary optical sensor technology**
- **Pumped or Diffusive air flow configuration**
- **Protective case with slim profile**

Detection of NO_2 in ambient air

Insplorion InAir-NO2 is an optochemical sensor based on Insplorion's patented Nanoplasmonic Sensing technology (NPS). The active sensor element is a semi-transparent glass chip covered with plasmonic nanostructures and a functional coating. Readout is accomplished using light-emitting diodes and photosensitive detectors to measure the interaction between the sensor element and NO_2 gas molecules. Concentrations in the range of a few $\mu g/m^3$ (ppb) can be detected.

InAir-NO2 is a miniaturized high performance sensor that enables cost effective detection and measurement of NO_2 levels in ambient air.

The InAir-NO2 is available for both diffusive measurements and with connections for pumped air flow. Both configurations come with a precalibrated sensor element.

The sensor can be calibrated for optimal performance at a certain temperature and humidity. The drift and temperature compensated signal is presented in ppb by volume [1 ppb NO_2 = 1.88 $\mu g/m^3$]. For purposeful and adaptive calibration at a certain location of interest the raw uncalibrated signal is also presented.

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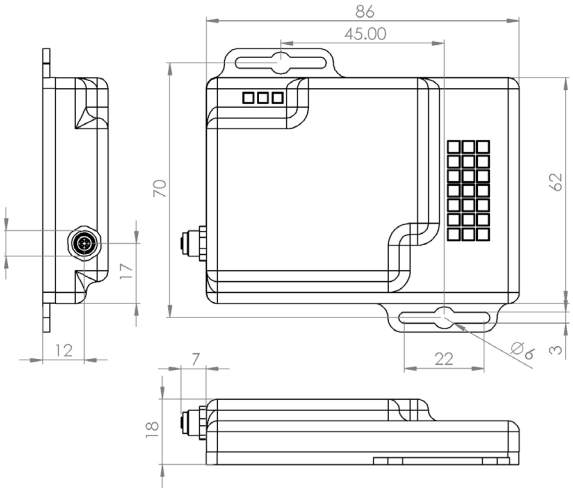
Dimensions

Diffusion measurements (Standard)

Order code: INAIR-NO2-DIF

Size: 86x62x18 mm
Weight: 150 g

Water-proof filters

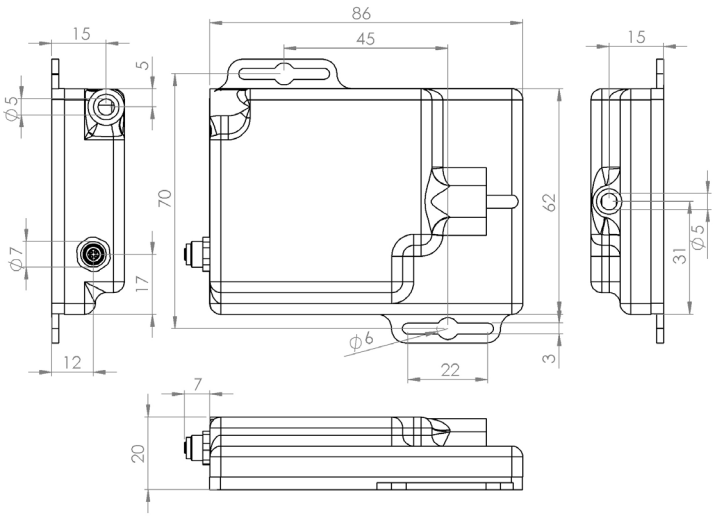


Pumped air flow

Order code: INAIR-NO2-TUB

Size: 86x62x20 mm
Weight: 160 g

Connectors for 5 mm outer diameter soft tubing

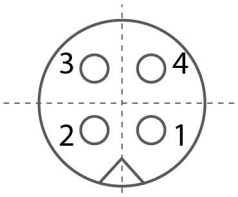


Connection

4-pin connector

Recommended:

0.25 mm² (AWG 24)
binder 707-series M5 connector



Sensor module connector

Corresponding cable with welded plug:
manufacturer order-no: 79-3107-32-04
Length: 2 m
Order code: INAIR-CAB-42S

Optional RS232-USB adapter (for cable mount)
Order code: INAIR-ADA-1

Optional MODBUS adapter (for cable mount)
Order code: INAIR-ADA-2

Pin-out	Colour	
1	Brown	+5 V
2	White	Rx (3.3 V)
3	Blue	Tx (3.3 V)
4	Black	Ground

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Communication protocol (version 1.44.x)

Serial communication interface (standard)

Rx and Tx via connector cable using 3.3V TTL serial.

Baud rate	**115 200**
Databits	**8**
Stop bits	**1**
No parity	
No flow control	

Text string:

"{Time since boot} <TAB> {Signal} <TAB> {Temp} <TAB>{Raw signal}<TAB>{Status} <NL>"

Name	Format	Unit	Resolution	Range	Description
Time since boot	Integer	s	1 s		
Signal	Float	ppb	0.1 ppb		Calibrated and drift compensated signal.
Temp	Float	°C	0.01 °C		Module temperature. (Different from ambient)
Raw signal	Float	a.u.	0.1		Uncalibrated raw signal.
Comp raw	Float	a.u.	0.1		Uncalibrated but temperature compensated raw signal.
Serial number	Integer	-	-	0-65535	
Status	String	-	-		

Available commands:

"log N<CR><NL>"
N=0 Continuos log off.
N=-1 Return one text string.
N>0 Device returns text string every Nth second.

"id<CR><NL>"
Device returns: "{DEVICE-ID}<TAB>{Firmware version}<NL>"

MODBUS via RS485 (as preconfigured)

Baud rate	**19 200**
Databits	**8**
Stop bits	**1**
Even parity	
No flow control	

Slave address: 22 (can be preconfigured as required)

COIL register - read and write
No register exists

DISCRETE input register - only read
No register exists

INPUT register - only read

Name	Register	Format	Unit	Resolution	Range
Signal	0x00	Signed 16-bit	ppb	10 ppb	-32 to +32 ppm
Temperature	0x01	Signed 16-bit	°C	0.01 °C	-320 to +320 °C
Signal_PPB	0x14	Signed 16-bit	ppb	1 ppb	-32 to 32 ppm
Raw signal	0x15	Signed 16-bit	a.u.	1	-32767 to 32767
Comp raw	0x16	Signed 16-bit	a.u.	1	-32767 to 32767

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Name	Register	Format	Unit	Resolution	Range
Time since boot	0x0A	16-bit	minutes	1 min	0-65535
Serial number	0x0B	16-bit	-	-	0-65535
Status	0x0C	bits	-	-	0x0000 to 0xFFFF
Version	0x0D	16-bit	-	0.01	-

HOLDING register - read and write

No register exists

Detailed register description:

Signal (0x00):

Address 0x00		Status	
Bit	Parameter name	Default value	Bit description
15:0	NO2_10PPB	-	Signed 16-bit value represents NO2 conc. rounded to nearest 10 ppb. Signal is calibrated and drift compensated. Range: -32 to 32 ppm. Resolution: 10 ppb.

Temperature (0x01):

Address 0x01		Status	
Bit	Parameter name	Default value	Bit description
15:0	TEMP_MOD	0	Signed operating temperature of the module. Range: -320 to 320 °C. Resolution: 0.01 °C.

Signal_PPB (0x14):

Address 0x14		Status	
Bit	Parameter name	Default value	Bit description
15:0	NO2_PPB	-	Signed 16-bit value represents NO2 conc. in ppb. Signal is calibrated and drift compensated. Range: -32 to 32 ppm. Resolution: 1 ppb.

Raw Signal (0x15):

Address 0x15		Status	
Bit	Parameter name	Default value	Bit description
15:0	Raw signal	-	Signed 16-bit value represents the sensor response. Signal is unfiltered and not calibrated. Range: -32767 to 32767. Resolution: 1 [a.u.]

Comp Raw (0x16):

Address 0x16		Status	
Bit	Parameter name	Default value	Bit description
15:0	Comp Raw	-	Signed 16-bit value represents the sensor response. Signal is not calibrated but temperature compensated. Range: -32767 to 32767. Resolution: 1 [a.u.]

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Time since boot (0x0A):

Address 0x0A		Status	
Bit	Parameter name	Default value	Bit description
15:0	Time since boot	0	Number of minutes since last boot. Useful to detect unknown reboots during run. Range is 0 - 65536. No overflow control. 65536 is 45 days.

Serial number (0x0B):

Address 0x0B		Status	
Bit	Parameter name	Default value	Bit description
15:0	Serial number	-	Device serial number. Range is 0 - 65536.

Status (0x0C):

Address 0x0C		Status	
Bit	Parameter name	Default value	Bit description
15..0		-	Not implemented.

Version (0x0D):

Address 0x0D		Status	
Bit	Parameter name	Default value	Bit description
15:0	Version number	-	Protocol version number. Given as (Major.Minor)

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Test and Calibration

The performance of all sensors is evaluated during a final test in production. The final test parameters in the table below are applied for each INAIR-NO2 module. The calibration test involves determination of a sensitivity factor of the signal response towards a set NO_2 concentration to allow conversion of the raw signal to ppb NO_2 by volume. An additional calibration factor is applied to compensate for temperature dependance. No compensation to account for humidity is applied.

TEST	PARAMETER	OBJECTIVE	PROTOCOL	RESULTS AVAILABLE
Electrical	Voltages, Currents, Signal, Operation temperature	Function test to determine accurate sensor mount and fully functional module.	Not disclosed	No
Gas	Calibration factor - NO2	Determine calibration factor for sensor signal / ppb	Controlled exposure at range 0 ppb NO2 to 100 ppb NO2	No / Special request
Temperature	Temperature calibration coefficient	Determine calibration factor for sensor signal shift due to change in ambient temperature.	Controlled ambient temperature measurements performed at steady-state at a temperature interval ±5 °C.	No

Operation and Signal Processing

The InAir-NO2 sensor module may be operated under ambient conditions. The connectors are IP67 classified and the sensor is splash and dust protected but not IP classified. Care should be taken to install the module under a protective cover. Performance will be influenced by external factors. Adequate protection from the environment will greatly improve results. Temperature fluctuations will affect the performance of the sensor module. While the temperature compensated signal will include compensation for the influence of the current module temperature at steady-state, the compensation may be inadequate for certain unpredictable transient states. For example, a very rapid temperature change could cause a change in the processed signal. As the state is stabilized the signal processing in the device will compensate for the baseline shift. The result will be a gradual recovery to the baseline signal that can last for several hours.

The signal processing algorithm allows for very sensitive detection of shifts in NO_2 concentration, particularly under varying steady state conditions. An effect of the drift compensation is that over time, the baseline response strives towards zero. Under some circumstances, this results in an accuracy error in the form of a deviation from the actual background NO_2 concentration. To account for this the sensor module also presents the raw unprocessed signal. During operation, it is recommended to handle transient conditions by monitoring the module temperature signal. It is also beneficial to monitor the humidity and to apply additional algorithmic compensation to account for large changes in absolute humidity.

Subject to surrounding conditions, the sensor module may require a stabilization period in the order of a few hours after inital power-up. It is recommended to operate the module continously after initial power-up.

Sensor Application

The InAir-NO2 module is suited for detection of ambient levels of NO_2. Application engineers at Insplorion AB can assist you in configuration and integration of the module in customized systems. Insplorion AB can provide additional services for calibration and signal compensation and processing. For contact with an Application Engineer or Customer Support, contact Insplorion AB directly.

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Typical performance

The InAir-NO2 sensor module responds to changes in concentration of NO_2 in ambient air. Internal signal processing algorithms compensates the signal to the surrounding temperature and changes in other conditions. The signal is not compensated for changes in humidity. Figure 1 below shows the typical performance of the sensor in the concentration range 0 to 100 ppb (0 to 55 µg/m3). Figure 2 shows the expected influence of relative humidity at room temperature.

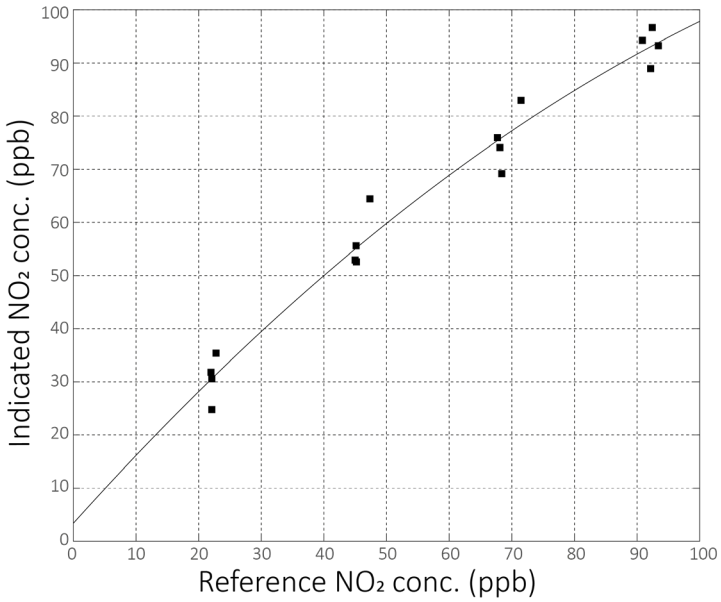

Figure 1: Typical sensor performance at exposure to varying concentrations of NO_2. The reference concentration is determined with an Ecotech Serinus 40 analyser. The analysis was conducted in an ambient of synthetic air at room temperature (25 °C), atmospheric pressure, and under dry conditions. The responses shown are the processed and temperature compensated signal.

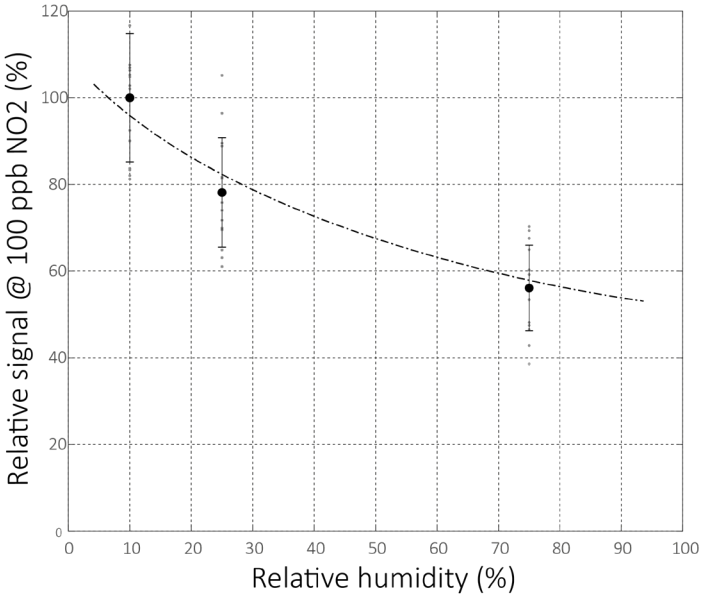

Figure 2: Variation in sensor performance due to humidity. The analysis was performed at room temperature (25 °C) and at atmospheric pressure (1013 mbar). Under those conditions 100% Relative humidity (RH) corresponds to 23 g/m^3 absolute humidity (AH). The graph shows the average performance of 5 individual sensor modules evaluated 3 times at 3 different humidity levels. The response to 100 ppb NO_2 was evaluated. The response shown is the processed and temperature compensated signal.

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