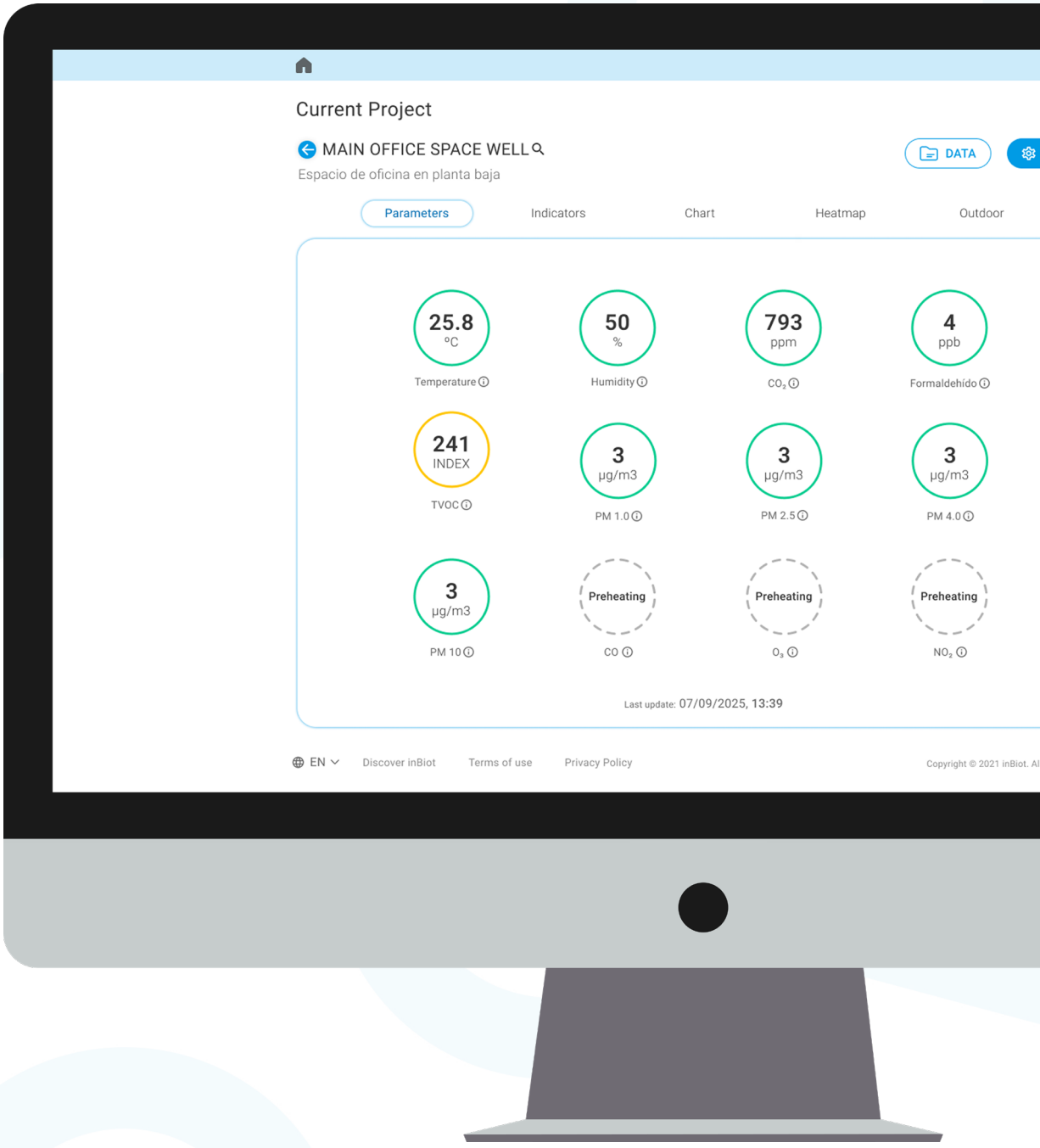
Electrochemical sensors preheating



Electrochemical sensors: why preheating is necessary

Introduction

The electrochemical gas sensors included in the MICA WELL devices (CO, NO_2, and O_3) require an initial period after being turned on before providing reliable data. This process, called the preheating period, is essential to ensure that the measurements shown to the user accurately reflect the environmental concentration of each gas.

The purpose of this document is to explain why this period is necessary, how it is managed, and what happens in the event of a device restart.

What is the preheating period?

The preheating period is the time interval necessary for the sensor:

1. Adjust the signal with respect to the reference gas (physical phase).
2. Be evaluated by the calibration algorithm (software phase).

Only when both stages have been completed is it possible to guarantee quality data.

1. Sensor accommodation (physical component)

Electrochemical sensors require continuous electrical polarization to function properly. After receiving this polarization, the sensor needs time to stabilize its signal. During this initial phase, the readings may be erratic or not representative of the environment, as the sensor has not yet reached its normal operating state.

2. Sensor Evaluation (software component)

The automatic calibration algorithm (called ABC) needs to collect a certain amount of data to adequately characterize the behavior of each individual sensor. Only after this evaluation can the algorithm correctly apply the calibration parameters.

Why is this process important?

The combination of both factors—physical stabilization and algorithmic evaluation—improves the stability of the readings. For this reason, the data provided by the device during the warm-up period should not be considered representative nor used for validation or regulatory compliance purposes.

What to expect and what not to expect from the preheating period?

The preheating period allows for the stabilization of each sensor's measurements. However, the sensors exhibit cross-sensitivity with multiple factors (environmental conditions and the concentration of other gases, among others), which could result in peaks that do not correspond with the reference gas. This effect is not mitigated by preheating.

Contaminants that can produce cross-sensitivity

O_3 sensor

Gas/Vapor	Concentration	Typical Response as PPM O_3
Ozone	0.82 ppm	0.82
Hydrogen	200 ppm	0
Nitrogen Dioxide	5 ppm	4.2
Carbon Monoxide	400 ppm	0
Sulfur Dioxide	10 ppm	0.05
Hydrogen Sulfide	25 ppm	0
Ethanol	200 ppm	0
Formaldehyde	10 ppm	0
Ethylene	50 ppm	0.02
Chlorine	10 ppm	4.0
Nitric Oxide	10 ppm	0.2
Ammonia	100 ppm	-0.3

NO_2 sensor

Gas/Vapor	Concentration	Typical Response as PPM NO_2
Nitrogen Dioxide	5 ppm	5
Hydrogen	200 ppm	0
Ozone	0.82 ppm	0
Carbon Monoxide	400 ppm	0
Sulfur Dioxide	10 ppm	0
Hydrogen Sulfide	25 ppm	0
Ethanol	200 ppm	0
Formaldehyde	10 ppm	0
Ethylene	50 ppm	0
Chlorine	10 ppm	1.3
Nitric Oxide	10 ppm	0
Ammonia	100 ppm	0

CO sensor

Gas/Vapor	Concentration	Typical Response as PPM CO
Carbon Monoxide	400 ppm	400
Hydrogen	200 ppm	150.7
Nitrogen Dioxide	5 ppm	0
Ozone	0.82 ppm	0
Sulfur Dioxide	10 ppm	0
Hydrogen Sulfide	25 ppm	< 1
Ethanol	200 ppm	0.2
Formaldehyde	10 ppm	0.3
Ethylene	50 ppm	78.7
Chlorine	10 ppm	-0.2
Nitric Oxide	10 ppm	3.4
Ammonia	100 ppm	0
Carbon Dioxide	5,000 ppm	< 1
n-Heptane	500 ppm	< 1
Toluene	200 ppm	< 1
Isopropyl Alcohol	200 ppm	1.3
Acetone	200 ppm	< 1
Methane	3,000 ppm	< 1

What happens if the device restarts?

If the sensor loses the bias voltage, for example, after a device reset or a power disconnection, it requires a new preheating process.

Although the ABC algorithm is capable of managing slight variations in sensor behavior, it is necessary to carry out the evaluation process again. Therefore, after each restart, the device will automatically repeat the preheating period to ensure the quality of the data.

Duration of the preheating period by sensor

Sensor	Time
CO	Up to 12 hours
O_3	Up to 12 hours
NO_2	Up to 12 hours