

# Optimizing Performance: Leveraging Custom Calibration Techniques



## AirAssure™ Model 8144 and BlueSky™ Models 8143/8145 Air Quality Monitors

Application Note TSI-170 (US)

Embracing the advancements in low-cost sensor technology for air quality monitoring is key to overcoming challenges such as variability, calibration drift and environmental influences. Rather than discouraging their use, these challenges underscore the significance of harnessing custom calibration techniques. The utilization of multiplication factors and offsets becomes pivotal in addressing these challenges by standardizing sensor readings and compensating for differences.

Multiplication factors and offsets play a crucial role in enabling users to fully unlock the capabilities of their low-cost sensors. Multiplication factors standardize sensor readings, while offsets correct for calibration drift, ensuring accurate baseline measurements. Here's more on how multiplication factors and offsets contribute to the accuracy of air quality measurements:

- **Sensor Calibration & Sensitivity**

**Compensation:** Sensors may have different sensitivities or response curves. Multiplication factors are often used to calibrate sensors by adjusting their sensitivity. Each sensor type may have a unique response to different concentrations of pollutants. A multiplication factor helps align sensor readings with known reference values or standard concentrations.

- **Zero Calibration & Environmental**

**Compensation:** Offsets are used to calibrate sensors at zero concentration levels. Over time, sensors may drift and produce non-zero readings—even in clean air. An offset compensates for this baseline drift, ensuring that a sensor's zero-point corresponds to the absence of the target pollutants. Additionally, offsets can be used to account for environmental factors that may influence sensor readings. For example, changes in temperature or humidity can impact sensor performance. An offset helps correct for these environmental influences and maintain measurement accuracy.

- **Tailoring to Specific Applications or**

**Environmental Changes:** Multiplication factors and offsets provide users with the flexibility to customize the device for specific applications or environmental conditions like altitude, temperature, humidity or seasonal variability. Users can dynamically adjust these parameters based on their knowledge of the local air quality characteristics or specific requirements.

## Why You Will Love the Benefits of Custom Calibrations

- **Match Data to Reference Monitors:**  
Align your device's data with established reference monitors for accurate and reliable measurements.
  - **Customize to Specific Needs:** Tailor the solution to meet your unique requirements, ensuring relevance and precision.
  - **Remote Data Adjustments:** Enjoy the convenience of making adjustments to your device's data remotely for seamless monitoring.
- **Site-Specific Aerosol Calibration:** Fine-tune the device to capture site-specific aerosols, enhancing the relevance of your air quality data.
  - **Temperature and Humidity Response:** Adjust the instrument's response to account for fluctuations in temperature and humidity, maintaining accuracy.
  - **Increased Confidence in Data:** Custom calibrations boost confidence in the accuracy of your reported air quality data, supporting informed decision-making.

These calibration techniques enable real-time adaptation to changing environmental conditions, making low-cost sensor devices like AirAssure™ and BlueSky™ more versatile. Given cost constraints and inherent technology limitations, the use of multiplication factors and offsets becomes essential in enhancing data quality and providing users with the flexibility to customize devices for specific applications and local conditions. Found on TSI Link™ under **Device Settings**, the Calibration tab is used to adjust sensor measurements using a multiplication factor or offset. Both can be used together or individually.

The formulas look like this:

$\text{Multiplication Factor} = \text{Reference\_Value} / \text{Raw\_Sensor\_Data}$ <p>(scales to measure the desired unit of measurement)</p>
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$\text{Offset} = \text{Reference\_Value} - \text{Raw\_Sensor\_Data}$ <p>(corrects any biases or baseline shifts)</p>
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Each sensor has a multiplication factor range (default is 1) and an offset range (default is 0). See tables below for more information.

AirAssure 8144-2, 8144-4 & 8144-6					
Parameter	Units	Multiplication Factor Range	Multiplication Factor Precision	Offset Range	Offset Precision
CO <sub>2</sub>	ppm	0.1 to 10	0.1	-1000 to 1000	1
CO	ppm	0.1 to 10	0.1	-100 to 100	0.1
NO <sub>2</sub>	ppb	0.1 to 10	0.1	-1000 to 1000	1
SO <sub>2</sub>	ppb	0.1 to 10	0.1	-1000 to 1000	1
O <sub>3</sub>	ppb	0.1 to 10	0.1	-1000 to 1000	1
VOC	mg/m <sup>3</sup>	0.1 to 10	0.1	-100 to 100	0.001
Formaldehyde	ppb	0.1 to 10	0.1	-1000 to 1000	1
BP	inHg	N/A	N/A	-10 to 10	0.01
Temperature	C	N/A	N/A	-10 to 10	0.1
Relative Humidity	%	N/A	N/A	-10 to 10	1
PM	µg/m <sup>3</sup>	0.01 to 10	0.01	-100 to 100	1

BlueSky 8143 & 8145					
Parameter	Units	Multiplication Factor Range	Multiplication Factor Precision	Offset Range	Offset Precision
CO <sub>2</sub>	ppm	0.1 to 10	0.1	-1000 to 1000	1
CO	ppm	0.1 to 10	0.1	-100 to 100	0.001
NO <sub>2</sub>	ppb	0.1 to 10	0.1	-1000 to 1000	1
SO <sub>2</sub>	ppb	0.1 to 10	0.1	-1000 to 1000	1
O <sub>3</sub>	ppb	0.1 to 10	0.1	-1000 to 1000	1
BP	inHg	N/A	N/A	-10 to 10	0.01
Temperature	C	N/A	N/A	-10 to 10	0.1
Relative Humidity	%	N/A	N/A	-10 to 10	1
PM	µg/m <sup>3</sup>	0.01 to 10	0.01	-100 to 100	1

## How to Create Custom Calibrations

Custom calibrations can be done in a few simple steps using ZERO calibration gas:

1. Set any previous custom calibrations to zero in TSI Link™
2. Apply ZERO calibration gas (Reference\_Value now equals 0)
3. Wait for stable values (stabilized Raw\_Sensor\_Data)
4. Calculate custom calibrations using formulas mentioned earlier

In addition to using ZERO calibration gas, collocation is another effective method to derive calibration factors. Collocating is the process by which a reference instrument is operated alongside the AirAssure™ or BlueSky™ device at the same time and place under real world conditions for a defined evaluation period. Derived calibration factors are then applied to the device, which is done via TSI Link™ for AirAssure™ and BlueSky air quality monitors. Choose a well-calibrated reference instrument with a known and reliable measurement accuracy for the specific parameter you are monitoring. This instrument should be considered a reliable standard for comparison.

## How to Set Custom Calibrations in TSI Link™

Here are simplified steps to guide you through applying custom calibration numbers to raw sensor data:

1. On TSI Link™, locate the device you want to update on the Map or under **Devices**.
2. Click on the three vertical dots (⋮) and select **Settings**.
3. Find and open the **Calibration** tab.
4. Find the sensor type and enter a custom calibration number under **Mult Factor** and/or **Offset**.
5. Click **Save** to apply the new calibration settings.

The changes take effect immediately. You can update the calibration settings anytime by repeating these steps. By following these simple instructions, users can easily customize calibration settings and optimize the performance of their AirAssure™ and BlueSky™ Air Quality Monitors for more accurate and reliable measurements.

	Mult Factor	Offset	Auto Cal	Zero
PM2.5	1.1	0		
PM10	3	0		
Temp		0		
RH		0		
BP		0		
CO <sub>2</sub>	1	3	<input checked="" type="checkbox"/>	
TVOC	1	0		

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