PRODUCT MANUAL

CO2

MICRO-HYBRID

Manual

MicroSENS 180-HS 0-20% CO_2 Gas Sensor

Contents

(Version 1.0, Released 09.07.2026)

1 Legal Information

1.1 Intellectual Property and Usage Restrictions

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1.4 Patent Notice

This product is protected by patents and their corresponding national rights.

2 Introduction

2.1 Purpose of This Manual

This manual provides detailed installation, operation, calibration, and maintenance guidance for the MicroSENS 180-HS 0-20% CO_2 gas sensor. It is intended for qualified personnel in laboratory and industrial environments responsible for installation, commissioning, and service of measurement equipment.

2.2 Product Overview and Key Features

The MicroSENS 180-HS 0-20% CO_2 gas sensor is a robust infrared CO_2 sensor engineered for highly accurate gas concentration measurements in applications requiring high-temperature sterilization and long-term stability. It is specifically optimized for measuring 5-10 Vol.-% CO_2 in cell incubators to support ideal cell and tissue growth.

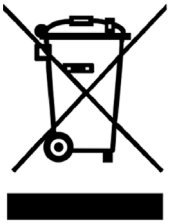
The MicroSENS 180-HS 0-20% CO_2 gas sensor features automatic hardware-based compensation for temperature and pressure variations. The influence of humidity on the measurement signal can be managed and corrected via dedicated software commands, ensuring high data integrity under diverse operating conditions.

A key characteristic of the sensor is its suitability for heat sterilization. It withstands typical decontamination cycles of 180 °C, while the sensor head alone can endure temperatures up to 190 °C. This robust design supports excellent long-term stability and operational lifetime, even after repeated high-temperature exposure.

The sensor is intended exclusively for measuring CO_2 concentrations in clean, dry, non-corrosive gases. Typical applications include cell culture incubators, bioreactors, CO_2 shakers, laboratory climate chambers, and pharmaceutical and biotechnology systems. The MicroSENS 180-HS 0-20% CO_2 gas sensor is designed for straightforward integration with other system components, such as incubator controllers, and provides two output options: an analog 4-20 mA current loop and a digital RS232 serial interface. This gas sensor performs an automatic zero-point correction if it detects slightly negative CO_2 readings, as will be discussed later in this manual.

This sensor has an automatic protection feature and automatically switches to standby mode upon exceeding a sensor head temperature of approximately 85 °C. In standby mode, the sensor sends a message of -3000 (3 mA), meaning no CO_2 reading is available.

2.3 Symbols Used

Symbol	Name	Description
	**Caution**	Ignoring these instructions may damage the device or compromise data integrity. Follow all handling and operating guidelines to protect the product.
	**Hot Surface**	Indicates hot surfaces. Avoid contact with hot surfaces to prevent burns. Allow components to cool before touching or servicing.
	**Electrical Hazard**	Indicates the presence of dangerous voltage. Disconnect power and follow all electrical safety procedures before working on the device.
	**WEEE Compliance**	Information regarding how to dispose of this product.

2.4 Safety Information and Warnings

The sensor must not be used in explosive atmospheres, for monitoring medical breathing gases, or in any safety-critical application where device failure could cause injury or death. Only accessories supplied with the unit or explicitly approved by the manufacturer may be used. Third-party accessories must fully comply with the manufacturer's specifications.

The safety symbols, identification markings, and rating information printed on the product label, housing, or associated product marking are part of this manual and must be observed at all times. Before installation and commissioning, the operator shall ensure that all markings on the device remain legible and undamaged. If markings become unreadable or are missing, the device must not be put into operation until the issue has been resolved.

The type label or product marking may include information such as product identification, electrical ratings, interface designation, serial or batch identification, and applicable warning symbols. These markings must be considered together with the instructions in this manual.

If there is reason to believe that safe operation has been impaired, the device must be switched off or disconnected from the supply by the surrounding system, removed from service, and secured against unintentional operation until it has been inspected by qualified personnel.

Prevent condensation or liquid ingress into the optical path at all times. The device is intended for indoor use only and may be operated at altitudes up to 2000 m.

Symbol	Name	Description
	**Electrical Hazard**	Do not attempt to open the unit. The MicroSENS 180-HS contains no consumables or user-replaceable parts with the exception of the PTFE filter. Only cleaning of external surfaces and the PTFE filter is permitted. All internal repairs must be carried out by Micro-Hybrid or authorized service partners. Operate the sensor strictly within its rated voltage limits. Use only SELV/PELV power supplies, installed according to local electrical safety regulations. Protect all cables from damage: do not kink, over-bend, or strain cables, and do not pinch them with heavy or sharp-edged objects. Before cleaning the housing, switch off the unit and disconnect it from the power supply. Use a slightly damp, well-wrung cloth. Do not use highly flammable or aggressive solvents.
	**Hot Surface**	Despite the safety measures built into this product, residual risks remain, including burn hazards, if the sensor head is touched immediately after a high-temperature sterilization cycle. Other risks are electrical hazards from incorrect wiring or damaged cables, and measurement errors if the sensor is installed incorrectly or exposed to condensation or liquid ingress. During operation or after exposure to elevated process temperatures, accessible parts of the device or adjacent mounting surfaces may become hot. Allow sufficient cooling time before touching, servicing, or removing the device.
	**Caution**	Before returning this product for calibration or repair, the user must ensure that the unit has not been exposed to dangerous contamination and can be handled safely without special protective measures. Unless explicitly specified otherwise, the device is not intended to provide protection against hazardous atmospheres, corrosive media, or chemically aggressive process conditions. Where such conditions may occur in the end application, the system integrator must verify compatibility of all wetted

and exposed materials and must ensure that failure of the device cannot create a hazardous situation.

The unit must not be modified or used in any manner not explicitly described in this documentation. Improper modification or unauthorized use may result in safety hazards, equipment damage, or reduced service life.

The sensor does not contain substances classified as hazardous and does not generate or release hazardous, corrosive, or flammable substances during normal use. If installed in systems handling hazardous gases or incubator media, the operator is responsible for appropriate safety measures and decontamination. The sensor contains no user-replaceable fuses or batteries.

When integrating the MicroSENS 180-HS 0-20% CO_2 gas sensor into a larger system (e.g., cell incubators, climate chambers, bioreactors), the system manufacturer must ensure that the specified environmental limits are not exceeded, all connected devices meet applicable safety and EMC standards, and special operating conditions (e.g., disinfectants, incubator gases) do not impair electrical safety or sensor performance.

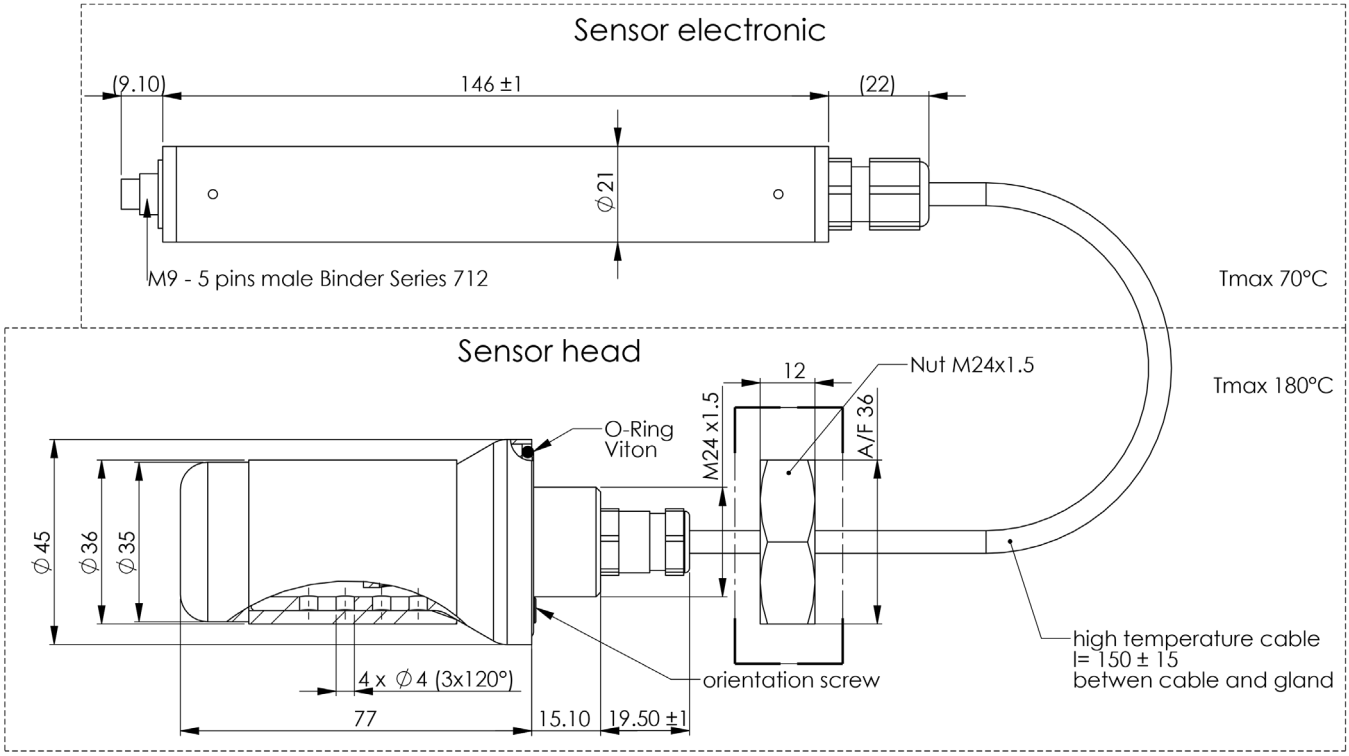
The sensor assembly is lightweight and can be safely lifted and carried by one person. No special lifting equipment is required.

The sensor is designed for continuous operation in incubators. No special duty-cycle limits apply within the specified environmental conditions.

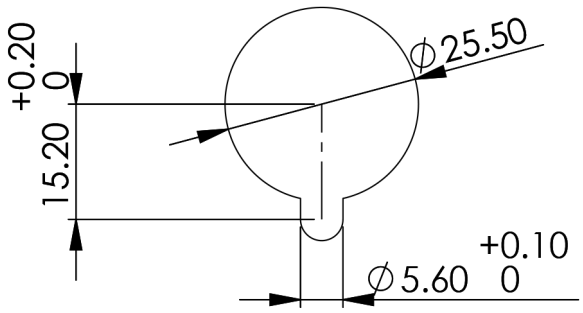
3 Sensor Description

3.1 Mechanical Drawings and Dimensions

Sensor Overview:



Panel Cut Out:



3.2 Construction

The CO_2 sensor consists of a sensor head installed inside the incubator chamber and a sensor electronics housing, a metal cylinder mounted outside the rear wall of the chamber. The sensor head is inserted through a circular opening with a downward-oriented notch that engages a dedicated orientation screw on the back of the head, ensuring defined positioning and correct alignment of the measuring system (see section 5.2 Positioning and Mounting).

The head is secured by three screws (including the orientation screw) and a hexagonal nut on the outside of the chamber wall. The minimum permissible thickness of the chamber back wall at the mounting position is 1.0 mm. The sensor determines the CO_2 concentration using infrared absorption in the ambient gas. No additional flow cell or pump is required.

Electrical connection to the user's equipment is provided via a M9 5-pin Binder connector, supplying power, RS232 communication, and a 4-20 mA current output. The insulation and jacket materials of the sensor cable in the final device must be selected so that they are suitable for the intended environmental conditions and comply with all applicable safety standards.

3.3 Measurement Principle

This sensor measures CO_2 using the non-dispersive infrared (NDIR) absorption principle. CO_2 molecules absorb infrared radiation at a characteristic wavelength near 4.26 µm. An infrared source emits radiation through the gas sample, and the detector - equipped with a CO_2-specific optical filter - measures the remaining light intensity. The signal reduction corresponds directly to the CO_2 concentration.

A reference channel compensates for inevitable small physical changes to the emitter over time. The dual-beam design of the MicroSENS 180-HS 0-20% CO_2 gas sensor enables simultaneous measurement of active and reference signals, ensuring long-term stability and precise CO_2 readings across the entire measurement range.

This gas sensor performs an automatic zero-point correction if drift over time causes it to detect slightly negative CO_2 readings. This happens because negative CO_2 values are physically impossible and such readings therefore indicate a zero-point deviation and are automatically corrected. The sensor will trigger this correction only when all of the following conditions are met:

- The measured CO_2 value is between −0.05 and 0 Vol.-%.
- The sensor head temperature is 40 °C or lower.
- The CO_2 value stays between −0.05 and 0 Vol.-% for at least 30 minutes.
- During those 30 minutes, the maximum temperature gradient does not exceed 1 °C/min.

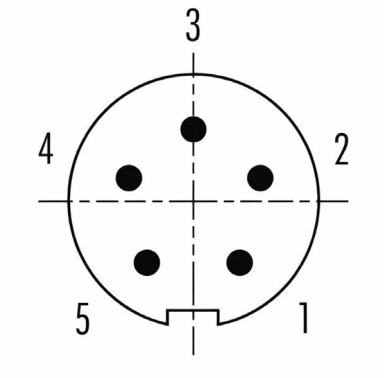
When these criteria are fulfilled, the sensor automatically adjusts the reading to 0.06 Vol.-% CO_2. This 0.06 Vol.-% point is fixed and cannot be changed.

Pressure and temperature are compensated automatically by the sensor. This function cannot be deactivated. Humidity compensation can be enabled by entering a code, as described in the appendix of this manual.

3.4 Accessories

It is possible to additionally purchase a connector cable, and/or communication adapter for the purpose of connecting the sensor to a PC.

3.5 Connector and Pinout Details



Type: Binder M9 Female Connector Series 712

Pin plug	Electrical function
1	24V
2	RS232 Rx
3	RS232 Tx
4	Common GND
5	Current output

The RS232 interface uses the standard default settings: **9600 baud, 8 data bits, no parity, 1 stop bit (8N1), and no flow control**. After power-on or reset, the unit is typically communication-ready within 3 seconds.

The first valid measurement is available in less than 15 seconds, and measurement values are updated every 1 second. The sensor has no external LED status indicators. All operational and diagnostic information is provided digitally. For example, an error code (e.g., -1000) is used to signal a sensor fault condition.

The system integrator must continuously monitor either the RS232 output or the 4-20 mA analog current output, and ensure the overall system responds correctly to all operating states. This includes initialization/warm-up, fault reporting, and intervals where no valid measurement is available (e.g., during self-cleaning or scheduled shutdown). System-level safety and compliance remain the responsibility of the installer or system integrator.

4 Technical Specifications

4.1 Technical Data

Parameter	Value	Unit
Measuring gas	CO_2	
Measuring range	0 ... 20	Vol.-%
Start-up time	< 15	s
Warm-up time	< 5	min
IP protection class	IP20	
Repeatability	< 0.06	% FS
Accuracy	+/- (2 % of reading + 0.2 Vol.-%)	
Response time t90 with filter	< 35	s
Digital resolution	0.001	Vol.-%
Temperature influence	0.125	% FS / 10 K
Pressure influence	0.004	% FS / 10 hPa
Long-term stability	≤ +/- 0.2 Vol.-% at 5 Vol.-% / year	
Operating temperature	0 ... 60	°C
Storage temperature	-20 ... 85	°C
Max sterilization temperature[1]	190	°C
Humidity	0 ... 95 % relative humidity (non-condensing)	
Air pressure	600 ... 1200	hPa

[1] Sensor head only

4.2 Electrical Specifications

Parameter	Specification	Unit
Operating voltage analog connection	15 ... 24	V DC
Operating voltage digital connection	12 ... 24	
Power consumption	< 2	W
Digital output	RS232 ASCII (9600 8-N-1)	
Analog output	4 ... 20	mA

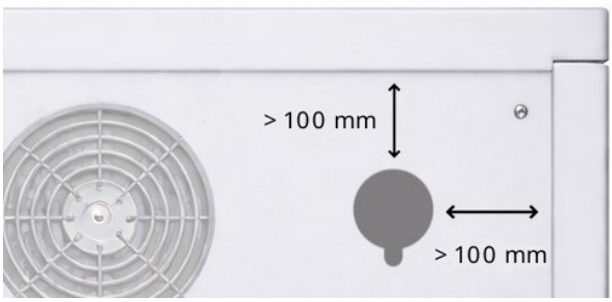
5 Installation

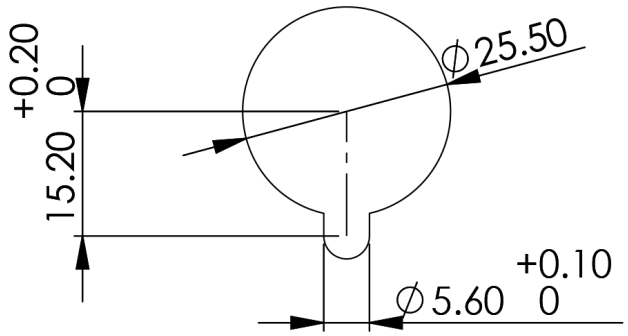
5.1 Pre-Installation Inspection

Symbol	Name	Description
	**Electrical Hazard**	Verify sensor integrity and filter cleanliness before installation. System integrators are responsible for ensuring compliance of the complete device with applicable safety and EMC requirements. Verify physical integrity and cleanliness of the PTFE filter, check cables and connectors for damage, and confirm correct supply voltage before connection. Protective earthing must be implemented via the incubator's main power supply and controller in accordance with national installation standards. The sensor must only be operated in systems with a correctly installed protective grounding. The overall safety of the complete incubator or system is the responsibility of the system integrator or installer. This includes implementation of disconnecting devices, over-voltage protection, and compliance with applicable EMC and safety standards.

5.2 Positioning and Mounting

Here is an overview of all the parts we will be working with in the positioning and mounting process, followed by instructions on the placement of the mounting hole.

Step	Illustration	Description
01		**Part 1:** Sensor head **Part 2:** High-temperature cable **Part 3:** Sensor electronics housing **Part 4:** Connection cable **Part 5:** Hexagonal nut
02		If you plan to drill a new hole in the back of your incubator wall, we recommend positioning the hole on the rear or side wall of the incubator chamber. Avoid having the hole too close to a corner, in order to allow gas to circulate freely around the sensor. A distance of at least 100 mm from the edges of the hole to the inside wall of the incubator should be maintained. This supports reliable sampling and a fast response time.

03		The mounting hole should match the dimensions and shape shown in the figure here. The notch in the circular hole must face downward. Please ensure that the thickness of the wall is at least 1 mm.

To install the sensor in the mounting hole, take the following steps:

Step	Illustration	Description
01		Completely remove the hexagonal nut from the sensor head (if it is attached) and put it aside for the moment.
02		In this photo, the left side of the metal wall represents the inside of the incubator, and the right side represents the outside. Insert the electronics housing through the mounting hole, starting inside the incubator. Ensure the sensor electronics housing extends entirely outside the incubator chamber.
03		There are three screws on the back of the sensor head. One of them protrudes slightly, indicated here by the arrow. This is called the orientation screw. The sensor head must be installed with this orientation screw at the bottom, resting in the notch at the bottom of the mounting hole.

04

Here is a view from outside the incubator. The orientation screw is resting properly in the notch at the bottom. If this orientation screw is positioned incorrectly, it can result in an uneven sensor position, which may affect measurement accuracy.

05

Here is another view from outside the incubator. Slip the nut over the end of the sensor electronics housing, past the high-temperature cable, and secure the nut to the base of the sensor head. Do not apply more than a maximum of 100 Nm torque to the nut.

06

Finally, attach the sensor electronics housing to the outside of the incubator. Position the housing so that the cable outlet at its bottom is at least 10 mm higher than the cable outlet on the rear of the sensor head. This creates a drip path and prevents moisture on the cable from collecting on the electronics housing. The sensor may be installed vertically, horizontally, or diagonally, provided this 10 mm height difference is maintained.

Caution

Before initial power-up, verify that the device has been mounted correctly, all electrical connections are properly made, and that the supply voltage is within the specified range. Ensure that the installation environment complies with the permitted ambient conditions stated in this manual.

Before commissioning, the system integrator must confirm that suitable external protective measures are provided in the final equipment, including a disconnecting means and appropriate overcurrent and overvoltage protection where required by the end application.

Do not energize the device if visible damage, contamination, moisture ingress, or incorrect wiring is suspected.

After power-on or reset, allow the sensor to complete its initialization phase before relying on measurement values or communication responses.

The device is intended for integration into a larger system or final piece of equipment. The final system must provide the protective measures required for safe operation, including a suitable external disconnecting means, appropriate branch-circuit protection, and protection against transient overvoltage, where required by the installation and applicable standards.

6 Calibration and Maintenance

6.1 Calibration Principles

Every MicroSENS 180-HS CO_2 sensor that leaves Micro-Hybrid is factory-calibrated with a 15-point calibration matrix: five gas concentrations tested at three different temperatures each. Each calibration uses DAkkS-traceable reference gas to guarantee accuracy and repeatability. This multi-point approach delivers exceptional linearity across the full 0 - 20% measurement range, far exceeding the precision of many sensors that undergo a less rigorous calibration.

This sensor, like all NDIR sensors, occasionally requires the use of various calibration methods to ensure ongoing precise CO_2 measurement. We will discuss these methods further in this section – but first, here are a few general guidelines. For customers installing this sensor into an incubator, we recommend that you conduct a zero-point calibration or a clean air calibration upon initial installation of the sensor. This can be followed by a span gas calibration and, if necessary, re-verification after sterilization.

For end customers using this sensor, we recommend a clean air or reference gas calibration after every 12 sterilization cycles. One of the key advantages of this sensor is its high resistance to drift, even after numerous sterilization cycles. Nevertheless, it is recommended that the end user calibrate after every 12 cycles to maintain optimal performance. Calibration should also be carried out (regardless of how many sterilization cycles have occurred) if it becomes apparent that the sensor is experiencing a loss of accuracy due to drift. We do not recommend calibrating this sensor by using a third-party sensor as a reference: many competing sensors, unlike Micro-Hybrid sensors, do not compensate for atmospheric pressure automatically and thus we recommend they be considered not accurate enough to be used as a trusted baseline.

Three types of calibration are possible for this sensor.

Type	Name	Description
01	**Zero-point calibration**	Zero-point calibration establishes the sensor baseline using a reference gas with 0 Vol.-% CO_2 (e.g., Nitrogen). This ensures that the sensor correctly interprets the absence of CO_2 and compensates for any internal signal offset.
02	**Clean air calibration**	Clean air calibration establishes the sensor's baseline by exposing it to clean ambient air (approximately 0.06 Vol.-% CO_2). This step compensates for internal signal offsets and defines the reference for "zero" CO_2 concentration under ambient conditions.
03	**Span calibration**	Span calibration defines the upper reference point by exposing the sensor to a certified calibration gas with a known CO_2 concentration, typically close to the operating range (e.g., 5 Vol.-%). This ensures that the sensor output corresponds linearly to the measured gas concentration. Before a span point calibration is carried out, we recommend you first carry out either a zero-point or clean air calibration. By combining two different calibration points, the sensor achieves accurate linear interpolation across the full range. This delivers excellent long-term measurement stability and repeatable performance even under varying environmental conditions.

6.2 Zero-Point Calibration Requirements and Procedure

Before performing a **zero-point calibration**, verify that all of the following conditions are met:

Check	Condition	Description
01	**Stable environment**	Perform the calibration in a well-ventilated area with clean, uncontaminated air. Avoid locations near CO_2 sources such as people, open incubators, exhaust outlets, or gas lines.
02	**Reference concentration**	The reference gas for zero-point calibration must be at least grade 4.0 nitrogen (99.99% purity).
03	**Temperature equilibrium**	The gas temperature should be approximately equal to the sensor head temperature to prevent drift caused by temperature gradients. We recommend letting the reference gas container sit in the same room as the gas sensor for at least one hour before use so that both are at room temperature.
04	**Gas flow**	If using a gas supply, the flow rate must not exceed 1 L/min.
05	**Atmospheric stability**	Perform calibration under stable pressure conditions. Avoid drafts or rapid environmental changes.

Next, to perform a **zero-point calibration,** follow this procedure:

Step	Procedure
01	Power on the sensor and allow it to stabilize for at least 15 minutes.
02	Verify that the CO_2 reading is stable.
03	Use a calibration cap to cover the sensor head as you supply the gas through the tube - or, if calibration is being carried out in the incubator, flush the gas to the incubator. (A calibration cap is available for purchase from Micro-Hybrid.)
04	Do this until the CO_2 levels are stable. When a cap is used, this will take approximately one minute. When the gas is flushed to the incubator, it will take approximately 15 minutes.
05	Send the zero-point calibration command STX 12030 ETX via the digital interface.
06	Wait for the sensor to return a confirmation message STX 0 ETX indicating successful calibration.
07	If calibration fails and therefore returns a result of STX 1 ETX, repeat the procedure after confirming gas purity, temperature stability, and flow conditions.
08	Once calibration is successful, record the calibration date, reference gas, and ambient conditions for quality and traceability.

6.3 Clean Air Calibration Requirements and Procedure

Before performing a **clean air calibration**, verify that all of the following conditions are met:

Check	Condition	Description
01	**Stable environment**	Perform the calibration in a well-ventilated area with clean, uncontaminated air. Avoid locations near CO_2 sources such as people, open incubators, exhaust outlets, or gas lines.
02	**Atmospheric stability**	Perform calibration under stable pressure conditions. Avoid drafts or rapid environmental changes.

Next, to perform a **clean air calibration,** follow this procedure:

Step	Procedure
01	Power on the sensor and allow it to stabilize for at least 15 minutes.
02	Verify that the CO_2 reading is stable.
03	In order to perform a clean air calibration, send the zero-point calibration command STX 120360 ETX which sets the reference value to 0.06 Vol.-% CO_2 (600 ppm). (The 0.06 Vol.-% mentioned here is a general recommended figure. In real-world conditions, different rooms will typically have a CO_2 measurement of between 0.04 and 0.08 Vol.-%. The operator of this sensor is free to adjust this figure as best suits their particular use case.)
04	Verify the response STX 0 ETX indicating successful calibration.
05	Record the calibration result, environmental conditions, and date for documentation.

6.4 Span Calibration Requirements and Procedure

Before performing a **span gas calibration**, verify that all of the following conditions are met:

Check	Condition	Description
01	**Test gas**	Use test gas with a dry and clean CO_2 concentration between 0.500 and 20 Vol.-%.
02	**Thermal stability**	Ensure that the sensor has reached thermal stability before starting the span calibration.
03	**Temperature equilibrium**	The gas temperature should be approximately equal to the sensor head temperature to prevent drift caused by temperature gradients. We recommend you let the reference gas container sit in the same room as the gas sensor for at least an hour before the gas is used, and that they be at room temperature.
04	**Gas flow**	If using a gas supply, the flow rate must not exceed 1 L/min.
05	**Atmospheric stability**	Perform calibration under stable pressure conditions. Avoid drafts or rapid environmental changes.

Next, to perform a **span gas calibration,** follow this procedure:

Step	Procedure
01	Power on the sensor and allow it to stabilize for at least 15 minutes.
02	Verify that the CO_2 reading is stable.
03	Introduce the span gas and allow the reading to stabilize.
04	The command you send to initiate a span calibration will include the Vol.-% of the span gas you are using. For example, send Command STX 14055000 ETX if you are using a span gas of 5.0 Vol.-%. For a span gas with a 20 Vol.-% concentration, enter the command STX 140520000 ETX.
05	Wait for the confirmation message STX 0 ETX indicating successful calibration.
06	If calibration fails - producing a reading of STX 1 ETX - repeat the procedure after confirming gas purity, temperature stability, and flow conditions.
07	Calibration parameters are stored permanently in the sensor's internal memory, unless a factory reset is performed.

6.5 Routine Maintenance and Cleaning

Symbol	Name	Description
	**Hot Surface**	Always handle the sensor by its main housing. Only the sensor head is designed to withstand temperatures up to 190 °C. All electronic components must remain outside any heated chamber.

To ensure long-term stability and accurate measurement results, the sensor should be visually inspected and maintained at regular intervals.

Keep the filter clean and dry. Periodically check the PTFE filter or other protective membrane for dust or biological residue. If contamination is observed, carefully wipe the surface with a slightly damp, lint-free cloth. Alternatively, replacement filters are available for purchase from Micro-Hybrid upon request.

Depending on the application, especially after long periods of continuous operation or following 12 high-temperature sterilization cycles, we recommend the user perform signal verification, and if drift is noticed, perform zero-point calibration or clean air calibration. Check the plausibility of the readings to ensure they are within the expected range.

6.6 General Handling Guidelines, Troubleshooting, and Integration into End System

General Handling Guidelines:

- Change the filter in a dust-free environment and ensure no dust enters the apparatus.
- Avoid stress on the connecting cables: never handle the apparatus by the cable or excessively twist/turn it.
- When the filter is attached to the housing, avoid touching it.
- Prevent mechanical stress, vibration, or bending forces on the connector and mounting threads
- Avoid exposing the sensor to aggressive, corrosive, or solvent vapors, and never clean it with agents containing acetone, toluene, or ammonia.

When storing the sensor, ensure it is kept in a dry, dust-free environment with temperatures ranging from −20 °C to +85 °C and relative humidity below 95% (non-condensing), as specified in the datasheet. Avoid long-term exposure to high humidity, corrosive atmospheres, or direct sunlight. During transport, the sensor should be properly protected in the original packaging in order to prevent mechanical shock or vibration damage.

Troubleshooting

When troubleshooting this sensor, it is possible to receive three distinct codes from it:

Code	Description
Status code -3000	Status code -3000 means the sensor is in standby mode because it is over 85 °C. Solution: wait for the sensor to cool down.
Status code -2000	Status code -2000 means the sensor is not yet ready to measure gas because it has not completed its warm-up phase. Solution: wait more than 15 seconds.
Error code -1000	Error code -1000 is somewhat more complicated. This error code means that the sensor is currently unable to measure CO_2. This can happen for various reasons, clarified in the section below. More than one -1000 error may be seen if the temperature and/or air pressure values detected fall outside of expected measurement ranges. To explain, let's look at a command string and sensor response string in which **no error** occurs, and then discuss what additional error codes in different sensor string positions mean.
Command string	STX 1100 ETX
Example of sensor response string with no errors	STX 7 12345 1200 376 980 ETX 7 = Sensor ID 12345 / 2 = Timestamp (6172.5 s ≈ 1.7 h) 1200 = 1.2 Vol.-% CO_2 concentration 376 = Sensor temperature 37.6 °C 980 = Air pressure 980 hPa

If you see a response string containing a -1000 error in the **third sensor string position**, this corresponds to **CO_2 measurement:**

STX 7 12345 **-1000** 376 980 ETX

This -1000 error could have been reported for a number of reasons. A command could have been entered incorrectly, causing the sensor to misinterpret a request. Another possible cause is that a zero-point calibration took place with far too much CO_2 in the area. (In either case, perform a factory reset and then run a zero-point calibration. If the issue persists after these steps, the sensor requires professional service.)

It is also possible to receive additional -1000 errors in the same sensor response string.

For example, here is an example with a second -1000 error in the string. It is in the **fourth sensor string position**, which corresponds to **temperature measurement:**

STX 7 12345 **-1000 -1000** 980 ETX

This means both the CO_2 and temperature value reported were outside the valid expected range.

Here is another example where the temperature measurement position is valid, but an additional -1000 error in the **fifth sensor string position**, which corresponds to **air pressure measurement.** This sensor string is reporting that the CO_2 and air pressure measurements are both outside of the valid expected range:

STX 7 12345 **-1000** 376 **-1000** ETX

Finally, one last example, indicating two additional -1000 errors in the **fourth and fifth sensor string positions**, meaning that in total **CO_2 measurement, temperature measurement** and **air pressure measurement** have reported values outside of expected ranges.

STX 7 12345 **-1000 -1000 -1000** ETX

Here is what ranges of values are expected:

Code	Range accepted
Error Code -1000 (CO_2 concentration position)	The accepted returned numerical range for CO_2 concentration is -500 to 25000 (corresponding to -0.5 to 25 Vol.-%)
Error Code -1000 (temperature measurement position)	The accepted returned numerical range for CO_2 concentration is -200 to 2500 (corresponding to -20 to 250 °C)
Error Code -1000 (air pressure measurement position)	The accepted range for air pressure is 500 to 1200 (corresponding to 500 to 1200 hPa)

It is unlikely that your environmental conditions will legitimately fall outside those limits, but not impossible. If you receive a -1000 error, please verify that the environment is within these valid ranges. If abnormal drift or persistent -1000 errors continue despite a factory reset and zero-point calibration, the sensor requires professional service.

Integration into End System

This device is intended to be installed as part of a larger electrical or laboratory system. Compliance of the complete installation depends not only on the device itself, but also on the design, wiring, protective measures, enclosure, software behavior, and operating concept of the final equipment.

The manufacturer of the final system, or the system integrator, is responsible for verifying that the complete system complies with all applicable safety, EMC, and performance requirements for the intended application.

This includes, but is not limited to, assessment of:

- correct power supply design
- electrical protection measures
- safe behavior in case of sensor fault, warm-up, missing communication, or invalid measurement values
- environmental protection against moisture, condensation, and contamination
- suitability for the intended installation environment

Caution

The device shall only be operated within the electrical, mechanical, and environmental limits specified in this manual.

The device must not be operated:

- outside the specified supply voltage range;
- outside the permitted ambient temperature, humidity, pressure, or altitude limits;
- in a condition where condensation, dripping liquid, or moisture ingress can affect the electronics;
- with damaged housing parts, damaged cables, or missing protective components;
- with accessories, replacement parts, or connection components not approved or specified by the manufacturer;
- in any application for which the device is not intended.

If safe operation is no longer possible, the device must be taken out of service and secured against unintended use.

Except for the procedures explicitly described in this manual, the device contains no user-serviceable parts. No parts other than the specified replaceable filter, if applicable, are intended for replacement by the operator.

Repairs, internal servicing, and replacement of components not explicitly identified for user replacement may only be carried out by the manufacturer or by personnel authorized by the manufacturer.
Only manufacturer-approved spare parts and accessories shall be used.

Before cleaning, disconnect the device from the supply via the surrounding system and ensure that the device cannot be energized unintentionally. Only cleaning methods and agents that do not attack the housing, seals, cable materials, filter materials, or markings shall be used. Do not allow liquids to enter the device.

If the device has been exposed to hazardous substances, biologically active media, or other contamination during use, the operator must ensure appropriate decontamination before handling, return, or service.

7 Support, Regulatory, and Warranty Information

7.1 Support

We're here to support your NDIR journey. We want you to enjoy working with your NDIR sensor and to be successful in your measurements. This manual is designed to answer the most common questions along the way, but if anything remains unclear, please don't hesitate to contact us. Our team is always happy to help.

Contact	Detail
Address	Micro-Hybrid Electronic GmbH Heinrich-Hertz-Str. 8 07629 Hermsdorf, Germany
Telephone	+49 36601 592-0
Contact email	contact@microhybrid.com
Further Information	www.microhybrid.com

7.2 Warranty

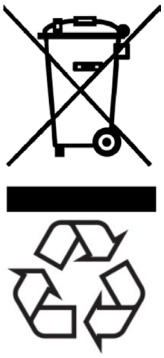
All rights reserved. All information in this document is based on the latest knowledge, results of practical experience, and tests carried out. Earlier specifications are hereby invalid. All specifications - technical included - are subject to change without notice. It is the customer's responsibility to ensure that the performance of the product is suitable for customer's specific application. No liability is accepted for indirect damage, in particular for the use or inability to use the product. Any liability we may have is limited to the value of the product itself.

Opening the sensor as well as tampering with or damaging the device will void the warranty.

The warranty will also be voided if aggressive chemicals are used, contamination or liquids enter the device, or the instructions in this communication description are not observed.

Micro-Hybrid Electronic GmbH accepts no liability for consequential damage or damage to property or personal injury caused by failure to observe the module and communication description.

7.3 Safety and Compliance

Symbol	Name	Description
	**WEEE Compliance**	Do not dispose of this device as household waste. Dispose of it in accordance with local Waste Electrical and Electronic Equipment (WEEE) regulations.

7.4 End-of-Life and Disposal

At the end of its service life, the sensor must be disposed of in accordance with applicable local, national, and international regulations for electronic components and materials.

Step	Procedure
01	Do not dispose of the sensor as household waste. It contains electronic components and materials that require proper recycling.
02	Dispose of the device through an authorized electronic waste collection point.
03	If applicable, remove cables, connectors, and mounting components before disposal.
04	Ensure that all contaminated parts (e.g., components exposed to gases or incubator media) are cleaned or treated in accordance with laboratory safety standards before disposal.

For service and returns:
Micro-Hybrid Electronic GmbH, Hermsdorf, Germany
Email: contact@microhybrid.com
Website: www.microhybrid.com

8 Appendix: Protocol description for CO_2 Gas Sensor Software

8.1 Error and Status Codes

UART Values	Current Values	Description
-1000	1 mA	Sensor defective
-2000	2 mA	Initialization phase
-3000	3 mA	No measurement currently possible
(-500) ... 0 ... 20000 ... (100000)	4 – 20 mA	Sensor OK. CO_2 concentration (-0.5) 0 ... 20 (100) Vol.-%

Standard Port Settings:

Baud rate	9600
Data bits	8
Parity	none
Stop bit	1
Flow control	none

Timing:

Ready for communication after reset / power on	3 s
First measurement value after reset / power on	< 15 s
Measurement data update rate	1 s

8.2 Interface Protocol

Communication is realized with the help of ASCII characters. Transmitting and reading can be handled with terminal software like Windows HyperTerminal.

A standard command string is shown below:

Start	Command (4 characters)	Parameter 1	SP	Parameter 2	Stop
STX (Hex 0x02)	“1100”	“0”	0x20	“0”	ETX (Hex 0x03)

The sensor response uses the same frame structure. The different values are separated by the ‘space’ character: (SP - 0x20). All values are formatted as integers.

Example: Get Measurement Data

ASCII-String	STX	“1”	“1”	“0”	“0”	ETX
Hex	0x02	0x31	0x31	0x30	0x30	0x03

8.3 Commands Overview

Get Measurement Data (1100)
The “Get Measurement Data” command provides the sensor serial number, the timestamp followed by the actual measured value for CO_2 concentration, sensor temperature and air pressure. The temperature and pressure values are used for internal compensation algorithms. The update rate for the measurement value is 1 second. At temperatures above 85 °C, the sensor will automatically switch off the emitter. During this time, no measurement is possible and the CO_2 concentration value is fixed at -3000. When the temperature drops below 85 °C, the sensor automatically restarts the measurement process.

Command string:	“1100”
Parameter:	none
Sensor response:	STX Serial ID Sensor SP Timestamp [s * 2] SP CO_2 concentration [Vol.-% * 1000] SP Sensor temperature [°C *10] SP Air pressure [hPa] ETX

Example:

Command string:	STX 1100 ETX	
Sensor response:	STX 7 12345 1200 376 980 ETX	
Decoded string:	SensorID	= 7
	Timestamp	= 12345 / 2 = 6172.5 s = 1.7 h
	CO_2 concentration	= 1.2 Vol.-%
	Sensor temperature	= 37.6 °C
	Air pressure	= 980 hPa

Parameter	Min Value	Max Value	Error Value
SensorID	0	4294967295	-
Timestamp	0	4294967295	-
CO_2 concentration	-500	100000	-1000 / -2000 /-3000
Sensor Temperature	-200	2500	-1000
Air pressure	600	1200	-1000

Zero Point Adjustment Command (1203)
The "Zero Point Adjustment" command performs a recalculation of the calibration parameter to align the present CO_2 measurement concentration to the set concentration. The alignment is possible for a concentration range up to 0.5 Vol.-%. After a successful adjustment, the new calibration parameters are saved permanently in the sensor.

Command string:	"1203"
Parameter:	set concentration [Vol.-% * 1000] Possible Range (0 ... 0.5 Vol.-%)
Sensor response:	STX 0 adjustment successful or 1 adjustment failed ETX

Example:

Command string:	STX 120340 ETX (zero point adjustment to 0.04 Vol.-%)
Sensor response:	STX 0 ETX (adjustment successful)

The procedure for adjusting the calibration is as follows:

- The sensor should be powered on for a minimum of 15 minutes in a thermally constant atmosphere and fixed in the final installation position.
- If using zero gas, the nominal gas flow should not exceed 1 L /min and the gas temperature should be equal to sensor temperature.
- Wait until the concentration has stabilized.
- Send command "zero point adjustment" with the zero point concentration as parameter.

Change Baud Rate Command (1302)
The "Change Baud Rate" command allows adapting the sensor baud rate to the baud rate of the customer host systems. The new baud rate setting will be permanently saved in the sensor and activated at the next sensor restart.

Command string:	"1302"
Parameter:	0 115200 Baud 1 57600 Baud 2 38400 Baud 3 19200 Baud 4 9600 Baud 5 4800 Baud 6 2400 Baud
Sensor response:	STX 0 adjustment successful or 1 adjustment failed ETX

Span Point Adjustment Command (1405)
The "Span Point Adjustment" command performs a recalculation of the calibration parameter to align the present CO_2 measurement concentration to the set concentration. The alignment is possible for a concentration range from 0.5 Vol.-% up to 20 Vol.-%. After a successful adjustment, the new calibration parameters are saved permanently in the sensor.

Command string:	"1405"	
Parameter:	set concentration [Vol.-% * 1000] Possible Range (0.5 ... 20 Vol.-%)	
Sensor response:	STX 0 or 1 ETX	 adjustment successful adjustment failed

Example:

Command string:	STX 14055000 ETX	(span point adjustment to 5.0 Vol.-%)
Sensor response:	STX 0 ETX	(adjustment successful)

The procedure for adjusting the calibration is as follows:

- The sensor should be powered on for a minimum of 15 minutes in a thermally constant atmosphere.
- Fixed in the final installation position.
- If necessary, perform a zero-point adjustment first (Command 2: Zero Point Adjustment).
- The nominal gas flow should not exceed 1 L/min and the gas temperature should be equal to sensor temperature.
- Wait until the concentration has stabilized.
- Send command "span point adjustment" with the reference concentration as parameter.

Humidity Compensation H_2O Partial Pressure Command (1706)
The "Humidity Compensation H_2O Partial Pressure" command performs an internal compensation algorithm to reduce the humidity influence of the CO_2 measurement. The humidity parameter is stored temporarily in the sensor and all following CO_2 measured values are compensated with the last setting. After power-on or sensor reset, the humidity value is automatically set to 0 hPa (compensation off). If the humidity parameter is out of possible input range, the last valid value will be transmitted as sensor response.

Command string:	"1706"	
Parameter:	Humidity [hPa * 10]	Possible Range (0 ... 200 hPa)
Sensor response:	STX Humidity [hPa * 10] ETX	 received parameter

Example:

Command string:	STX 1706590 ETX	(set current humidity to 59.0 hPa)
Sensor response:	STX 590 ETX	(confirm received value)

Humidity Compensation H_2O and Temperature Command (1809)
The “Humidity Compensation H_2O and Temperature” command performs an internal compensation algorithm to reduce the humidity influence of the CO_2 measurement. This command performs the same humidity compensation as Command 5, “Humidity Compensation H_2O Partial Pressure”, but additionally converts temperature and relative humidity to absolute humidity. The humidity parameter is stored temporarily in the sensor and all following CO_2 measured values are compensated with the last setting. After power-on or sensor reset, the humidity value is automatically set to 0 hPa (compensation off).

Command string:	“1809”	
Parameter 1:	relative humidity [%rH]	Possible Range (0 ... 100 %rH)
Parameter 2:	temperature [°C * 10]	Possible Range (0 ... 600)
Sensor response:	STX 0 adjustment successful or 1 adjustment failed ETX	

Example:

Command string:	STX 180990 370 ETX	(set current humidity to 90 %rH at 37 °C)
Sensor response:	STX 0 ETX	(confirm received value)

Sensor Reset Command (1908)
The “Sensor Reset” command performs a software reset and a reinitialization of all sensor parameters. All user-defined settings are kept.

Command string:	“1908”
Parameter:	none
Sensor response:	none

Set Factory Default Command (5005)
The command “Set Factory Default” sets all sensor parameters and calibration parameters to factory default values. All user-defined settings are deleted.

Command string:	“5005”	
Parameter:	none	
Sensor response:	STX 0 adjustment successful or 1 adjustment failed ETX	

Firmware Version Command (5104)
The command “Firmware Version” provides a string with the current firmware version.

Command string:	“5104”
Parameter:	none
Sensor response:	STX Software version number ETX

Example:

Command string:	STX 5104 ETX
Sensor response:	STX V3.41 ETX