



PolyGard® 2 / µGard® 2 Infrared Carbon Dioxide Sensors for Dispensing and Refrigeration Systems

Sensor Cartridge for CO₂
Series: SC2 and MC2 Series

User Manual

November, 2019

Up-to-date data sheets and user manuals can be found in the download area of www.msr-24.com.



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Intended Use

The PolyGard®2 sensors (SC2) are designed for the measurement of CO₂ gases mainly in dispensing and refrigeration systems and only in connection with the basic units SB2, MSC2, MSB2 and WSB2 of the PolyGard®2 series.

The MC2 sensor (µGard®2) is operated with 24 V DC and outputs an analog 4-20 mA standard signal.

The PolyGard®2 / µGard®2 sensors must not be used in potentially explosive atmospheres. The sensor must only be employed in areas within the environmental conditions specified in the Technical Data.

1 Functional Description

1.1 General

The Sensor Cartridge includes a µController for measurement value processing in addition to the CO₂ gas sensor element and the measuring amplifier. All data and measured values of the sensor element are stored in a fail-safe way in the µController and are digitally transferred via the local bus to the Basic Sensor Board. The calibration management is also integrated in the µController of the Sensor Cartridge.

The Sensor Cartridge SC2 is connected to the SB2 / MSB2 / MSC2 / WSB2.

The µCartridge MC2 works according to the same principle as the SC2 series with the exception that the MC2 outputs an analog signal of 4-20 mA (2-10 V as an option).

1.2 Measuring Mode

See description of the SB2, MSC2, MSB2 und WSB2 devices.

1.3 Special Mode

See description of the SB2, MSC2, MSB2 und WSB2 devices.

1.4 Infrared Sensor Element for CO₂

The integrated sensor is based on the principle of the infrared absorption of gases and accomplishes highest requirements concerning accuracy, reliability and economy. The sensor technology uses the individual absorption spectrum of the carbon dioxide gas and determines its exact concentration through its accurate, quantitative analysis. The infrared principle nearly eliminates the cross-sensitivity to other gases.

An integrated evaluation electronic system reliably compensates all drift and temperature influences and therefore a genuine measurement result is guaranteed.



Certain substances and gases in the monitored ambient can affect the sensitivity of the sensor element or destroy the sensor completely. This is called poisoning.

The following are currently known:

- Polymerising substances, such as ethylene oxide, acrylonitrile, butadiene, styrene, silicone.
- Corrosive substances, such as halogenated hydrocarbons.
- Catalytic poisons, such as sulphur and phosphor compounds, silicon compounds, metal vapours.

2 Installation



Electronics can be destroyed by electrostatic discharge (ESD). Therefore, the installation work should be done only by persons connected to ground, e. g. by standing on a conductive floor or by taking appropriate grounding measures (acc. to DIN EN 100015).

2.1 Mounting Instructions

See description of the SB2, MSC2, MSB2 und WSB2 devices.

When choosing the mounting site please pay attention to the following:

- **The specific weight of carbon dioxide CO₂ is higher than that of air (factor 1,529). Recommended mounting height for leak detection is 0.6 m to 0.8 m (2 to 5 feet) above floor.**
- Choose mounting location of the sensor according to the local regulations.
- Consider ventilation conditions! Do not mount the sensor near the airflow (air passages, suction holes etc.).
- Mount the sensor at a location with minimum vibration and minimum variation in temperature (avoid direct sunlight).
- Avoid locations where water, oil etc. may influence proper operation and where mechanical damage might be possible.
- Provide adequate space around the sensor for maintenance and calibration work.

3 Electrical Connection

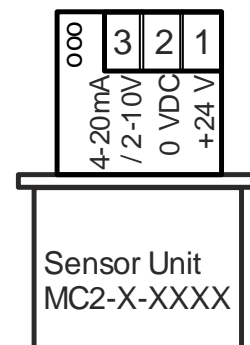
3.1 Plug Connection (SC2) in SB2, MSB2, MSC2, WSB2

SC2 sensors are equipped with a reverse polarity protected connector (3-pin). It mustn't be plugged in the wrong position by force (already clamped at the factory).

All black plugs are connected in parallel, so it is irrelevant which plug to use.

3.2 Terminal Connection (MC2)

- Open cover.
- Insert field bus cable from above, cut and strip it.
- Connect it to the terminal (only 3-wire connection possible).
- For the 4 to 20 mA operating mode, please remove the built-in 500-ohm resistor between terminals 2 and 3.



4 Commissioning

Only trained technicians should perform the following when commissioning:

- Check for correct mounting location.
- Check if connection is correct.
- Check power voltage (for MC2).
- Install the Sensor Cartridge(s) if not already installed ex works.
- Check Sensor Cartridge connector for correct engagement.
- Calibrate (if not already factory-calibrated).

Within the first weeks after commissioning, there may be a deviation in the sensor behaviour.

Required instruments for commissioning (calibration):

- Service Tool STL06 or
- PCE06 Software incl. USB/RS-485 communication set:
- Calibration
 - Test gas bottle with pure nitrogen 5.0 for zero-point calibration
 - Test gas bottle with CO₂ in the range of 30–90 % of the measuring range. Rest is synthetic air.
 - Extraction set consisting of gas pressure regulator and flow meter.
 - Calibration adapter with tube, type C2Z4.

4.1 Installation of Sensor Cartridge

The Sensor Cartridge is supplied in a separate package and should be installed on the housing only during commissioning to protect it against dirt and damage.

- Check gas type, range and calibration date of Sensor Cartridge.
- Define installation place on the housing of the basic or remote sensor and break out knockouts.
- Tighten the Sensor Cartridge with M32 hexagon lock nut.
- Plug in the Sensor Cartridge at X2 or X3 of the sensor board. Observe plug polarity, the plug must engage.

4.2 Registration of the Sensor Cartridge

Registration and addressing of the field bus address can be read in the User Manual for Boards GA_Boards.

5 Calibration

The service tool STL06 or PCE06 Software are available for convenient on-site calibration. See description of Service Tool STL06 or PCE06 Software.

There is also the possibility to exchange the SC against a calibrated SC on site. The used SC can then be calibrated directly in the office or at the MSR_E Calibration Service and then reused.



Prior to calibration the Sensor Cartridge must be supplied with power voltage without interruption for warm-up and stabilisation. The warm-up time depends on the sensor element and is shown in the following table:

Sensor Cartridge	Warm-up calibration (h)	Stabilization time to spec (min)	Flow rate (ml/min)
CO ₂	24 fresh air	10	1500

Table Calibration



Please observe proper handling procedures for compressed gas and test gas bottles (regulations TRGS 220)!



Test gas can be toxic, so never inhale it!
Symptoms: Dizziness, headache and nausea.
Procedure if exposed: Remove victim to fresh air, seek medical attention.

5.1 Calibration Work

Prior to calibration you have to activate the mode "Special Mode" at the basic device, only then the calibration menu is enabled. During the special mode the basic device doesn't issue alerts.

- Connect calibration adapter carefully to the sensor cartridge.
- Connect calibration tool you want to use to the Basic Sensor Board.
- Select the Sensor Cartridge to be calibrated by selecting the gas type.

Zero calibration

- Apply pure nitrogen 5.0 (flow rate according to the table "Calibration", 1 bar ± 10%) to the Sensor Cartridge.
- The current zero offset and the offset value of the first calibration is read with "Read".
- When the value is stable, the new zero offset factor is calculated with "Calibration".

The new offset factor is checked for plausibility and stored in the buffer memory. The current measured value is output with the new offset factor and the offset display is updated.

- With "Save" the new offset factor is written in the SC memory, only then the Zero calibration has been successfully completed. If you exit the menu without pressing "Save", the original offset data for the measured value calculation will continue to be used.

With a zero reading > 10% of measuring range during the zero calibration, zero calibration is not possible.

Gain calibration

- Enter test gas concentration (value between 30 and 90 % of the measuring range)
- The current sensor element sensitivity is read with "Read".
- Apply CO₂ test gas (flow rate according to the table "calibration", 1 bar ± 10%) to the Sensor Cartridge.
- When the value is stable, the new gain factor is calculated with "Calibration".

The new gain factor is checked for plausibility and stored in the buffer memory. The current measured value is output with the new gain factor and the sensor element sensibility is updated.

- With "Save" the new gain factor is written in the SC memory, only then the gain calibration has been successfully completed. If you exit the menu without pressing "Save", the original gain data for the measured value calculation will continue to be used.

By limiting the gain factor, calibration will not be possible anymore when the sensitivity of the sensor reaches a residual sensitivity of 40 %. Then the Sensor Cartridge has to be replaced

For more information, see the user manual of the corresponding tool.

5.2 Exchange of Sensor Cartridge

Instead of the on-site calibration, the used SC can be replaced simply and conveniently by a calibrated one.



The communication of the local bus (Sensor Cartridge <> BSB) is continuously monitored during operation and results in an immediate error message on the gas controller in case of fault or interruption. When replacing the sensor unit, the communication of the local bus is interrupted when unplugging the SC connector which leads to an immediate triggering of the error message.

- Disconnect the SC connector from the BSB or the RSB (error message will be activated).
- Loosen the locknut.
- Remove used SC.
- Take calibrated SC out of the original packaging, check for gas type, measuring range and valid calibration date.
- Insert the SC and retighten with lock nut.
- Insert the SC plug into the socket at the BSB or RSB. Check plug for proper engagement.

The local bus communication is automatically established and tested. At the same time the gas type and the measuring range of the "new" SC are compared with the data stored in the BSB. If they match and the communication is correct, the error message will be automatically acknowledged in the Gas Controller.

The yellow LED of the BSB flashes with a pulse of 1 sec. as long as the SC connector is disconnected (communication error). After the local bus communication has been re-established and the conformity test has been successful, the LED goes into flashing mode with 3 sec. pulse duration until the sensor's warm-up time is over.

Apply a defined gas concentration on sensor element with the help of the gas generator and check the measurement signal at the analog output or at the relay outputs.

With this test, the complete function chain "Sensor Element > Sensor Cartridge> Local Bus> BSB> Field Bus> GC Controller" is tested.



6 Inspection and Service

Inspection, service and calibration of the sensor should be done by trained technicians at regular intervals. We therefore recommend concluding a service contract with MSR or one of their authorized partners.

According to EN 45544-4, inspection and service have to be executed at regular intervals. The maximum intervals have to be determined and respected by the person responsible for the gas warning system according to the legal requirements. MSR-E recommends employing the common inspection and service intervals as specified in the general regulations of the gas measuring technique. The inspection interval normally is 12 months.

Inspections and services must be documented. The date for the next maintenance has to be affixed to the sensor.

6.1 Inspection

Gas sensors should be controlled regularly by a competent person according to EN 45544-4. The following has to be checked in particular:

- Maintenance/ calibration interval not exceeded.
- Visual inspection of the sensor including cable for damage etc.
- Remove dust deposits, especially at the gas inlet.
- The filter at the gas inlet has to be replaced if extremely dirty.

6.2 Service and Calibration

When performing the maintenance, you have to do the calibration and the functional test, see chapter 5, in addition to the inspection.

A fixed calibration interval is stored for each sensor type.

SC2 Sensor heads:

If this interval is exceeded, a digital maintenance message is generated and forwarded.

Performing the calibration automatically deletes this message.

MC2 Sensor heads:

If this interval is exceeded, the current output of the MC2 goes to a fixed 19 mA signal. For new devices (factory calibration), the interval may be exceeded by a factor of 1.5.

After voltage recovery, there is a defined interruption of this message. This can be of use in order to employ the device without the maintenance message for a few days (adjustable in system parameters -> error time, value range > 1) until the calibration is repeated.

Performing the calibration automatically deletes this message.



7 Troubleshooting

7.1 Indications at the SC2

The SC2 has got no diagnostic indications; they are only available on the basic sensor boards of SB2, MSC2, MSB2 or WSB2.

7.2 Indications at the MC2

The 4-20 mA output of the MC2 can be used as diagnostic indicators.

	Output current
Restart:	1 mA
Device error:	2 mA
Tolerable negative sensor drift:	3-4 mA
Normal measurement mode:	4-20 mA
Tolerable overrange:	20-21 mA
Overrange error:	> 21 mA
Maintenance message:	19 mA

7.3 Basic Sensor Board

Trouble	Cause	Solution
Green LED isn't on.	Power voltage not applied.	Measure tension at X4: (16-28 V DC) Pin 1 (+) and 2 (-)
	Polarity not correct at X4.	Connect correctly.
	Connector X4 not plugged in.	Check the plug.
	Wire breakage	Check the wiring.
Green LED doesn't flash.	BSB: no address	Check BSB address, address correctly.
	BSB: no field bus communication	Check field bus wiring, topology and termination.
No measured value at the Tool or Controller	SC not or wrongly plugged in.	Check SC plug.
	SC not registered.	Register SC.
	SC gas type/measuring range doesn't match with registered ones.	Check SC data<> registration data for conformity.
Message at the Tool / Controller: - 24 V DC voltage <range> - 5 V DC voltage <range> - Temp. <range> - WatchDog triggered	Internal error	Replace BSB.

7.4 Sensor Cartridge (Messages at the Tool / Controller)

Measuring signal <range>	Internal error	Replace SC.
5 V DC voltage < range >		
Temp. < range >		
WatchDog triggered		
SC Input 1 ≠ stored type	Wrong SC type at input 1	Check SC at input 1, replace it.
SC Input 2 ≠ stored type	Wrong SC type at input 2	Check SC at input 2, replace it.
SC Input 3 ≠ stored type	Wrong SC type at input 3	Check SC at input 3, replace it.



8 Technical Data

8.1 MC2

Electrical	
Power supply	16-29 V DC, reverse-polarity protected 18-27 V AC (only for output signal 2-10 V)
Power consumption	40 mA, max. (1,0 VA for 24 V)
Sensor element	
Gas type	Carbon dioxide CO ₂
Sensor element	Infrared (NDIR)
Measuring range	0-2 Vol. %, 0-5 Vol. % , 0-2000 ppm
Accuracy	< 10 % of reading
Response time	t ₉₀ < 100 s
Sensor lifetime	15 years for normal ambient conditions
Calibration interval (recommendation)	5 years
Temperature range	-35 °C to +50 °C (-31 °F to 122 °F)
Humidity range	0-95 % RH non- condensing
Pressure range	Atmosphere ± 30 % (influence + 1.6 % on measured value per kPa)
Storage temperature range	5 °C to 30 °C (41 °F to 86 °F)
Storage time	6 months
Physical	
Housing type P	Polycarbonate
Combustion	UL 94 V2
Enclosure colour	RAL 7032 (light grey)
Dimensions: Housing type P	(D x H) 24 x 22 mm (0.94 x 0.87 in.)
Weight	ca. 25 g (0.055 lb.)
Protection class	IP 65
Mounting	Screw mounting
Connection	Plug connection 3-pin
Guidelines	EMC Directives 2014/30/EU CE Conformity to: EN 378-1; EN 45544 EN 61010-1:2010 ANSI/UL 61010-1 CAN/CSA-C22.2 No. 61010-1
Approvals Housing type A	UL 508A
Warranty	1 year on sensor (not if poisoned or overloaded), 2 years on device

All specifications were collected under optimal test conditions.

We confirm compliance with the minimum requirements of the applicable standard.

8.2 Sensor Cartridge (SC2)

Electrical	
Power supply	5 V DC from SB, reverse polarity protected
Power consumption	50 mA, max. (0.25 VA)
Serial interface local bus	1-wire / 19200 Baud
Sensor element	
Gas type	Carbon dioxide CO ₂
Sensor element	Infrared (NDIR)
Measuring range	0–2 Vol. %, 0-5 Vol. % , 0–2000 ppm
Accuracy	< 10 % of reading
Response time	t ₉₀ < 100 s
Sensor lifetime	15 years for normal ambient conditions
Calibration interval (recommendation)	5 years
Temperature range	-35 °C to +50 °C (-31 °F to +122 °F)
Humidity	0–90 % RH non-condensing
Pressure range	Atmosphere ± 30 % (influence + 1.6 % on measured value per kPa)
Storage temperature range	5 °C to 30 °C (41 °F to 86 °F)
Storage time	6 months
Physical	
Housing type P	Polycarbonate
Flammability	UL 94 V2
Enclosure colour	RAL 7032 (light grey)
Dimensions: Housing type P	(d x H) 24 x 22 mm (0.94 x 0.87 in.)
Weight	ca. 30 g (0.066 lb.)
Protection class	IP 65
Mounting	Screw type mounting
Wire connection	Plug connection 3-pin
Cable length standard	110 mm (4.33 in.)
Directives	EMC Directives 2014/30/EU CE Conformity to: EN 378-1; EN 45544 EN 61010-1:2010 ANSI/UL 61010-1 CAN/CSA-C22.2 No. 61010-1
Warranty	1 year on sensor (not if poisoned or overloaded), 2 years on device

All specifications were collected under optimal test conditions.

We confirm compliance with the minimum requirements of the applicable standard.

9 Figures

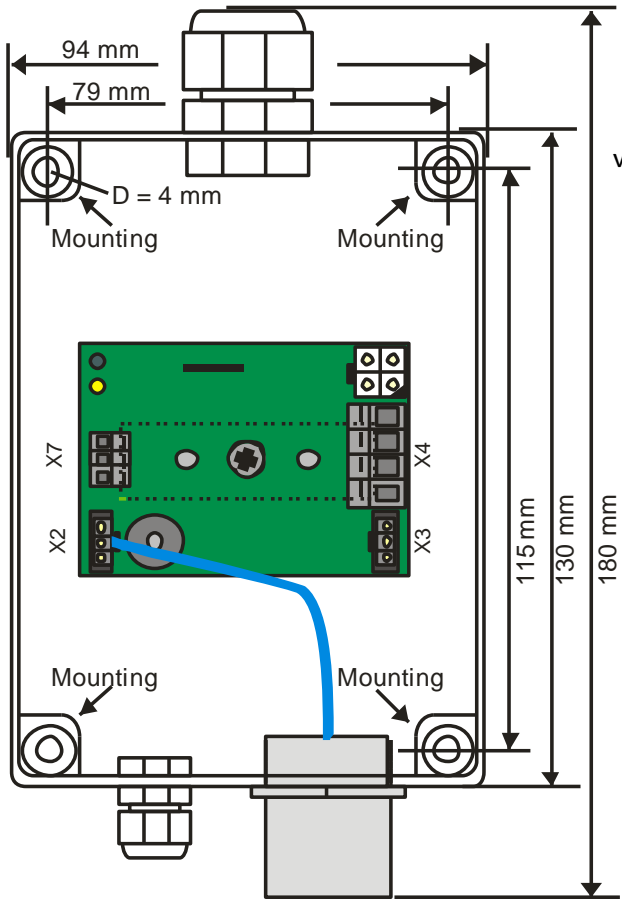


Fig. 1
Basis Sensor Board with Sensor Cartridge



Fig. 3
SC2 connection to Basic Sensor Board



Fig. 2
Calibration adapter C2Z4



10 Part Disposal

Since August 2005 there are EC-wide directives defined in the EC Directive 2002/96/EC and in national codes concerning the waste electrical and electronic equipment and also regarding this device.

For private households there are special collecting and recycling possibilities. For this device isn't registered for the use in private households, it mustn't be disposed this way. You can send it back to your national sales organisation for disposal. If there are any questions concerning disposal, please contact your national sales organisation.

Outside the EC, you have to consider the corresponding directives.

11 Notes and General Information

It is important to read this user manual thoroughly and clearly in order to understand the information and instructions. The PolyGard®2 / µGard®2 devices must be used within product specification capabilities. The appropriate operating and maintenance instructions and recommendations must be followed.

Due to on-going product development, MSR-Electronic GmbH reserves the right to change specifications without notice. The information contained herein is based upon data considered to be accurate. However, no guarantee is expressed or implied regarding the accuracy of these data.

11.1 Intended Product Application

The PolyGard®2 / µGard®2 devices are designed and manufactured for control applications and air quality compliance in commercial buildings and manufacturing plants.

11.2 Installers' Responsibilities

It is the installer's responsibility to ensure that all PolyGard®2 / µGard®2 devices are installed in compliance with all national and local codes and OSHA requirements. Installation should be implemented only by technicians familiar with proper installation techniques and with codes, standards and proper safety procedures for control installations and the latest edition of the National Electrical Code (ANSI/NFPA70).

The equipotential bonding required (also e.g. secondary potential to earth) or grounding measures must be carried out in accordance with the respective project requirements. It is important to ensure that no ground loops are formed to avoid unwanted interference in the electronic measuring equipment.

It is also essential to follow strictly all instructions as provided in the user manual.

11.3 Maintenance

It is recommended to check the PolyGard®2 / µGard®2 devices regularly. Due to regular maintenance any performance deviations may easily be corrected. Re-calibration and part replacement in the field may be implemented by a qualified technician and with the appropriate tools. Alternatively, the easily removable plug-in sensor cartridge with the sensor element may be returned for service to MSR-Electronic GmbH.

11.4 Limited Warranty

MSR-Electronic GmbH warrants the PolyGard®2 / µGard®2 devices for a period of one (1) year from the date of shipment against defects in material or workmanship. Should any evidence of defects in material or workmanship occur during the warranty period, MSR-Electronic GmbH will repair or replace the product at their own discretion, without charge.

This warranty does not apply to units that have been altered, had attempted repair, or been subject to abuse, accidental or otherwise. The warranty also does not apply to units in which the sensor element has been overexposed or gas poisoned. The above warranty is in lieu of all other express warranties, obligations or liabilities.

This warranty applies only to the PolyGard®2 / µGard®2 devices. MSR-Electronic GmbH shall not be liable for any incidental or consequential damages arising out of or related to the use of the PolyGard®2 / µGard®2 devices.