

## Installation and User Instructions for the MF020 Series High Temperature Oxygen Sensors

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### WARNING

#### PERSONAL INJURY

DO NOT USE these products as safety or emergency stop devices or in any other application where failure of the product could result in personal injury.

**Failure to comply with these instructions could result in death or serious injury.**

### 1.0 GENERAL INFORMATION

### WARNING

#### IMPROPER INSTALLATION, OPERATION AND MAINTENANCE

- Strictly adhere to all installation instructions.
- Consult with US and/or European agencies, as well as local regulations, and their requirements when designing sensor control and interface elements.
- Ensure all sensor installation, operation and maintenance is carried out by properly qualified personnel.
- Ensure damaged sensors are repaired by the manufacturer only.

**Failure to comply with these instructions could result in death or serious injury.**

### 1.1 Product use

### WARNING

#### IMPROPER USE

- Do not use the sensor where combustible or explosive gas mixtures are likely to occur.
- Do not use the sensor to determine the oxygen concentration in a hydrogen atmosphere.
- Ensure the sensor's output signals are read and processed by a user-specified external monitoring device.

**Failure to comply with these instructions could result in death or serious injury.**

The MF020 Series High Temperature Oxygen Sensor is designed to determine the oxygen concentration in air or inert gas mixtures with temperatures from -100 °C to 400 °C [-148 °F to 752 °F] max.

Standard measuring ranges are:

- 0.1 vol%O<sub>2</sub> to 25 vol%O<sub>2</sub>
- 0.1 vol%O<sub>2</sub> to 100 vol%O<sub>2</sub>

The entire measurement range is linear.

### 1.2 Product description

The actual oxygen sensor is mounted in the tip of the bar probe and is protected by a stainless-steel sintered disk which serves as a flame back-flash stop. The water-proof plastic housing accommodates the electronics and is mechanically connected to the sensor bar probe.

Sensor electronics include:

1. Signal amplifier
2. Control for the ionic pump with an analog component
3. Test component
4. Internal monitoring logic component
5. Power supply for the sensor heating element as well as for the analog and digital component
6. Reset
7. Voltage monitor
8. Analog output
9. Bi-directional digital output
10. Internal potentiometer

### 1.3 Operation overview

Measurement is based on a dynamic process that occurs on two zirconium dioxide discs which form a hermetically sealed chamber.

The sensor outputs measured values via an analog channel (4 mA to 20 mA or 0 V to 10 V) and a digital channel (also provides any error signals) which are evaluated and further processed in a user-specified external mounting device such as a fuel controller, display, measuring instrument, programmable logic controller or a ventilation system.

The MF020 Series may be calibrated manually or self-calibrated using atmospheric air instead of a reference gas. The sensor can also conduct external operational self-tests.

The MF020 Series can also operate in a fault-proof mode. The sensor self-monitors during operation and provides error signal output. A second oxygen sensor is not necessary.

1.4 Pollutants

**CAUTION**

**PRODUCT DAMAGE**

- Ensure the gas mixture to be measured contains none of the following substances:
  - Heavy metals
  - Sulphuric compounds
  - Silicone vapors
  - Fluorine
  - NH<sub>3</sub> (as of 1000 ppm)
  - Halogenated hydrocarbons (as of 100 ppm)
  - Phosphate ester
  - Chlorine
  - SF<sub>6</sub>
  - Carbons
  - Salts
- Do not store materials containing silicone, heavy metals and/or saline in the same room as the sensor.
- Do not subject sensor to dust, vibrations, dirt, humidity, oils, greases, furnace cleaning agents, heavy gas oil, pyrolysis gases and silicon oxide (generated when silicones burn in a furnace), or long periods in a reduction atmosphere.

**Failure to comply with these instructions may result in product damage.**

1.5 Other required equipment (see Figure 1.)

**1.5.1 User-specified external monitoring device**

A user-specified external monitoring device is needed to evaluate the measured signals as well as to manage and monitor the periodic self-tests. This device also manages error signal response.

Ensure the user-specified external monitoring device meets the following requirements:

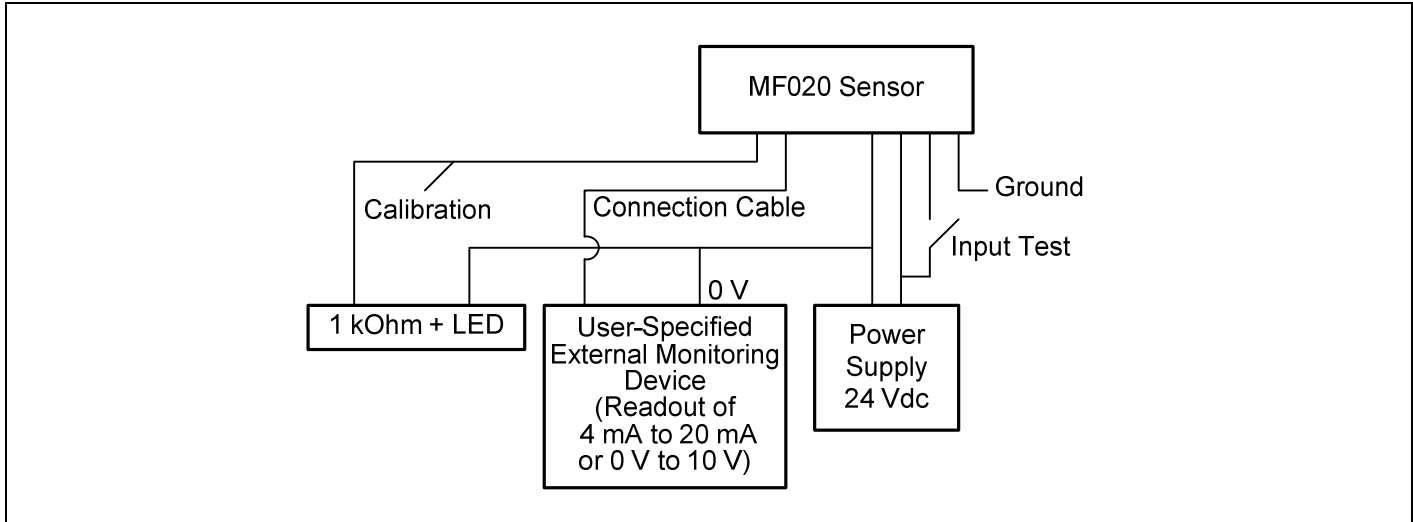
- The device must be fault-proof, i.e. the processes described below must be carried out without any errors, the input signals must be read-in without errors and the output signals must output without errors.
- Channel 1 and Channel 2 measured values must be compared permanently within the fault tolerance time permissible for the application.
- Channel 2 output signal timing must be checked constantly. In this respect, static signals are to be considered internal errors.
- A self-test must be initiated periodically and its effects on the measured signal must be determined and evaluated. The time interval between two test cycles must not exceed a certain value.

**1.5.2 Connection cable (connects sensor to user-specified external monitoring device)**

Ensure the connection cable meets the following requirements:

- Permanent, six-core and shielded, with a diameter of 9 mm to 11 mm. [0.35 in to 0.43 in].
- Capable of withstanding expected mechanical, chemical and thermal conditions.

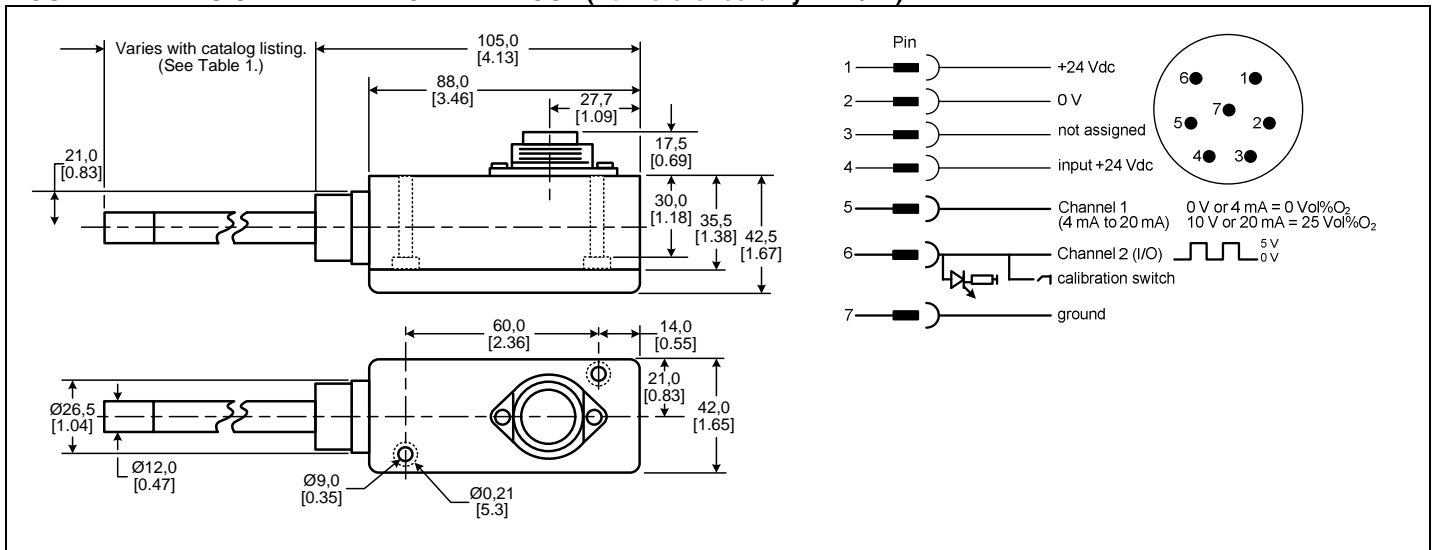
**FIGURE 1. SYSTEM BLOCK DIAGRAM**



**TABLE 1. SPECIFICATIONS**

Characteristic	Catalog Listing			
	MF020-0-LC1 MF020-1-LC1 MF020-2-LC1	MF020-0-LC2 MF020-1-LC2 MF020-2-LC2	MF020-0-LC3 MF020-1-LC3 MF020-2-LC3	MF020-0-LC4 MF020-1-LC4 MF020-2-LC4
Temperature range at probe tip	-100 °C to 400 °C [-148 °F to 752 °F]			
Output	0 Vdc to 10 Vdc		4 mA to 20 mA	
O <sub>2</sub> range (O <sub>2</sub> partial pressure) with equivalent O <sub>2</sub> output	1 mbar to 250 mbar 0.1 vol%O <sub>2</sub> to 25 vol%O <sub>2</sub>	1 mbar to 1000 mbar 0.1 vol%O <sub>2</sub> to 100 %volO <sub>2</sub>	1 mbar to 250 mbar 0.1 vol%O <sub>2</sub> to 25 vol%O <sub>2</sub>	1 mbar to 1000 mbar 0.1 vol%O <sub>2</sub> to 100 vol%O <sub>2</sub>
Probe length:				
-0-LXX	220 mm [8.7 in]			
-1-LXX	400 mm [15.7 in]			
-2-LXX	600 mm [23.6 in]			
Characteristic	Parameter			
Supply voltage	24 Vdc ±5%			
Supply current	500 mA			
Ambient temperature (includes solar radiation)	-10° C to 50° C [14 °F to 122 °F]			
Resolution	12 bit			
Heat-up time	approx. 10 min			
Accuracy	±2% FS (Full Scale)			
Reproducibility	±1% FS (Full Scale)			
Gas flow rate	0 m/s to 10 m/s			
Exhaust gas speed	5 m/s max.			
Reaction time	approx. 3 s			
Repetitive permissible acceleration	5 g			
Incidental permissible acceleration	30 g			
Bar probe material	stainless steel 1.4301			
Housing material	Makrolon 8030 (30% GV), UL94 V-1			
Housing sealing	IP65			
Connector sealing	IP67			
Weight (without bar probe)	150 g [5.3 oz]			
Termination (female connector)	99-4226-14-07 (Binder 693 series)			
Certification	complies with EMC directives EN 50082-2 and EN 50081-1 and directives 89/336/EWG and 92/31/EWG			

**FIGURE 2: DIMENSIONAL DRAWING AND PINOUT (For reference only: mm/in.)**



## 2.0 INSTALLATION

### CAUTION

#### IMPROPER INSTALLATION

Ensure the following installation conditions are met:

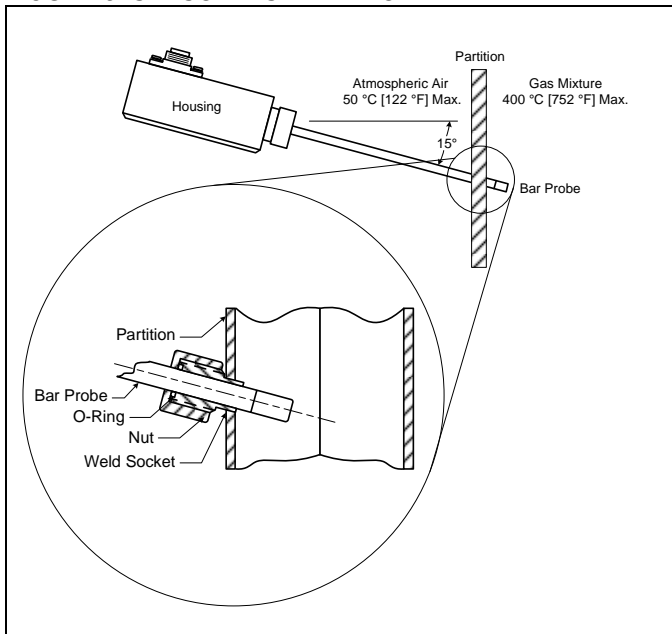
- Housing ambient temperature is -10° C to 50° C [-14 °F to 122° F]. (Includes solar radiation.)
- Bar probe ambient temperature is -100 °C to 400 °C [-148 °F to 752 °F].
- Sensor housing is visible and accessible at all times.
- Sensor is protected from the weather if mounted outdoors.
- Sensor does not come into contact with water, including condensate.
- Sensor does not come into contact with dust (may block the filter at the bar probe).
- None of the pollutants listed in Section 1.4 are present in the gas mixture to be measured.
- Bar probe is not mounted in humid or hazardous areas where combustible or explosive gas mixtures are likely to occur.
- There is no ground leakage current.

**Failure to comply with these instructions may result in product damage.**

### 2.1 Mount sensor

Mount the sensor using standard available 12 mm [0.47 in] pipe fittings so that the bar probe projects through the partition directly into the gas mixture to be measured (e.g. gas pipe, chimney, container). Ensure the housing remains on the same side of the partition as the atmospheric air (see Figures 2 and 3.)

**FIGURE 3: SENSOR INSTALLATION**



### 2.2 Mount/install user-specified external monitoring device

## 3.0 ELECTRICAL CONNECTION

### ⚠ DANGER

#### ELECTROCUTION

- Do not allow contact with water.
- Disconnect the mains voltage prior to installation.
- Disconnect power supply before performing repairs or opening product housing.

**Failure to comply with these instructions will result in death or serious injury.**

### ⚠ WARNING

#### IMPROPER ELECTRICAL CONNECTION

- Ensure sensor is connected to suitable power supply.
- Ensure suitable fuse protection suitable for the power supply is provided.
- Ensure power is always supplied to the sensor to avoid the formation of condensate.
- Do not locate power and connection cables next to each other.

**Failure to comply with these instructions could result in death or serious injury.**

### 3.1 Connect sensor and user-specified external monitoring device

Use connector cable described in Section 1.5.2.

#### 3.1.1 Connection for basic operation

- Connect sensor to the electric circuit via Pin 1, Pin 2 and Pin 7 (see Fig. 2).
- Read off the measured data via Pin 5 (4 mA to 20 mA or 0 V to 10 V) from the user-specified external monitoring device.

#### 3.1.2 Connection for fault-proof operation

- Connect sensor to the electric circuit via Pin 1, Pin 2 and Pin 7 (see Fig. 2).
- Read off the measured data via Pin 5 (4 mA to 20 mA or 0 V to 10 V) from the user-specified external monitoring device.
- Connect Pin 4 (test channel) and Pin 6 (digital output).
- The user-specified external monitoring device evaluates and processes the measured signals. Sensor output signal is 4 mA to 20 mA or 0 V to 10 V.

## 4.0 OPERATION

### WARNING

#### PERSONAL INJURY AND/OR FIRE HAZARD

- Wear protective gloves when working around hot bar probe.
- Protect hot bar probe with a touch guard (e.g. perforated plate, not provided).
- Ensure a safety distance between the bar probe and inflammable materials.

**Failure to comply with these instructions could result in death or serious injury.**

### 4.1 Start-up

#### 4.1.1 Ensure the following tasks are complete:

- Sensor is installed and connected.
- Sensor housing is accessible and visible.
- Ambient conditions have been taken into account.
- Power supply is on.

#### 4.1.2 Conduct measured values test as follows:

- Thoroughly ventilate the bar probe surroundings (e.g. chimney, container) until fresh atmospheric air is present.
- Check the measured value on the user-specified external monitoring device. A value of  $20.7 \text{ vol\%O}_2 \pm 1\% \text{O}_2$  of FS (0.25%) indicates the sensor is ready for operation.

### 4.2 Output and error signals (see Fig. 4 and Table 2)

The sensor outputs two measuring signals via two different channels. These signals must be read and processed by the user-specified external monitoring device.

#### 4.2.1 Output

- Channel 1 linear analog signal is 4 mA to 20 mA or 0 V to 10 V:
  - 17.25 mA (8.28 V) corresponds to  $20.7 \text{ vol\%O}_2$
  - 20 mA (10 V) corresponds to  $25 \text{ vol\%O}_2$
- Channel 2 digital signal is a pulse-width modulated alternating signal (high phase 5 V, low phase 0 V). The low phase duration is the oxygen measurement concentration and is indicated by the user-specified external monitoring device:
  - 0.09 s corresponds to  $0.1 \text{ vol\%O}_2$
  - 0.71 s corresponds to  $25 \text{ vol\%O}_2$

#### 4.2.1 Error signals

- Digital signal (low + high) does not equal 0.2 s to 4 s (10% error tolerance), or is constant at 5 V indicates the measured value is outside the measuring range.
- Digital signal is constant at 0 V indicates the hardware is defective. Please notify the manufacturer and replace the device.

FIGURE 4: CHANNEL 2 OUTPUT SIGNALS

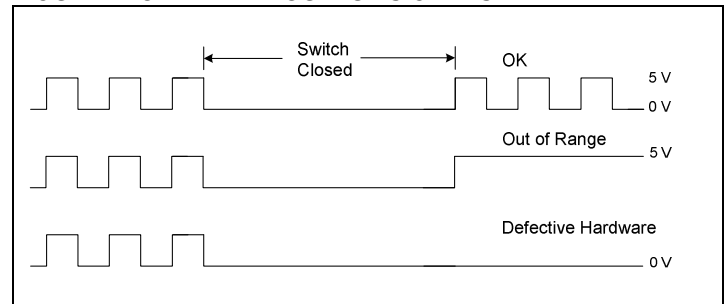


TABLE 2: SENSOR ERROR SIGNALS (0.1 vol%O<sub>2</sub> to 100 vol%O<sub>2</sub>)

Sensor Ready for Operation			
State	Channel 1 Measured Signal (Analog)	Channel 2 Measured Signal (Digital)	Channels 1-2 Measured Signal Difference
Normal Operation (test switch open)	4 mA to 20 mA or 0 V to 10 V	low phase + high phase = 0.2 s to 4 s	4% max.
External Operational Test (switch closed, +24 V)	>20% decrease	>20% decrease	4% max.
Sensor Out of Order			
State	Channel 1 Measured Signal	Channel 2 Measured Signal	Channels 1-2 Measured Signal Difference
Normal Operation (test switch open)	—	<ul style="list-style-type: none"> <li>• no signal</li> <li>• low phase + high phase &lt;0.2 s or &gt;4 s</li> </ul>	>4%
External Operational Test (switch closed, +24 V)	<20% decrease	<20% decrease	>4%

## 5.0 CALIBRATION

### NOTICE

The sensor measures the oxygen partial pressure. According to Dalton's Law, the oxygen partial pressure depends on the air pressure and relative humidity. Strong fluctuations of these parameters will affect calibration.

The sensor is designed so that no additional calibration is needed, even during long periods of operation. However, if necessary, a manual or a self calibration may be conducted.

### 5.1 Manual calibration

Manual calibration is conducted using an internal potentiometer (See Figure 5) located inside the sensor housing:

1. Thoroughly ventilate the bar probe surroundings (e.g. chimney, container) until fresh atmospheric air is present (20.7 vol%O<sub>2</sub> ±10%). The atmospheric air serves as reference gas.
2. Ensure the voltage supply is lower than 28 V.
3. Remove the sensor housing.
4. Using a slot screwdriver, turn the potentiometer screw (See Figure 5) until Channel 1 emits a current signal of 17.25 mA or a voltage signal of 8.28 V.
5. Replace the sensor housing.

FIGURE 5: INTERNAL POTENTIOMETER



### 5.2 Self-calibration (only possible in the 0.1 vol%O<sub>2</sub> to 25 vol%O<sub>2</sub> measuring range)

The sensor self calibrates in atmospheric air (20.7 vol%O<sub>2</sub> ±10%). In the event of a voltage cutoff, the newly-calibrated value will be saved.

1. Ensure Pin 6 is connected.
2. Thoroughly ventilate the bar probe surroundings (e.g. chimney, container) until fresh atmospheric air is present (20.7 vol%O<sub>2</sub> ±10%). The atmospheric air serves as reference gas.
3. Use the user-specified external monitoring device to close switch S (Pin 6 or Channel 2) for at least 10 s. The sensor will now self-calibrate:
  - Alternating Channel 2 output signal indicates measured oxygen concentration is within 10% error tolerance.
  - Constant 5 V Channel 2 output signal indicates measured oxygen concentration is outside 10% error tolerance. Ensure sensor is exposed to enough atmospheric air and repeat calibration procedure. If constant 5 V continues, notify the manufacturer and replace the sensor.
4. After successful calibration, the sensor corrects Channel 1 to:
  - 17.25 mA = 20.7 vol%O<sub>2</sub>
  - 20 mA = 25 vol%O<sub>2</sub>

### 5.3 External operational self-test requirements

1. Ensure Pin 4 and Pin 6 are connected.
2. Apply +24 V to Pin 4 to simulate a lower oxygen concentration than actually exists at the bar probe. The measured signals at the digital and analog outputs must drop equally by at least 20%. If this does not occur, then the bar probe is defective and must be replaced.
3. Disconnect the +24 V after the test is complete.
4. Conduct this test periodically.

### 5.3 Fault-proof operation

#### 5.3.1 Requirements

- Channel 1 analog signal corresponds to Channel 2 digital signal (4% max. difference).
- Channel 2 signal low phase is 0.09 s to 0.71 s, which corresponds to an oxygen concentration of 0.1 vol%O<sub>2</sub> or 25 vol%O<sub>2</sub>. (At a different measuring range the values change accordingly.)

#### 5.3.2 Error signals

- Digital signal (low + high) does not equal 0.2 s to 4 s (10% error tolerance), or is constant at 5 V, means the measured value is outside the measuring range.
- Digital signal is constant at 0 V means the hardware is defective. Please notify the manufacturer and replace the device.

## 6.0 MAINTENANCE AND SERVICE

**⚠ DANGER**  
**ELECTROCUTION**

- Do not allow contact with water.
- Disconnect the mains voltage prior to installation.
- Disconnect power supply before performing repairs or opening product housing.

**Failure to comply with these instructions will result in death or serious injury.**

**⚠ WARNING**  
**IMPROPER MAINTENANCE**

Ensure maintenance is carried out by qualified personnel.

**Failure to comply with these instructions could result in death or serious injury.**

### 6.1 Maintenance checklist

Ensure the following:

- The sensor and connecting cable are checked by qualified personnel at least every six months and a servicing report is prepared.
- Periodic maintenance intervals are adapted to local safety requirements.
- Check the measured value after each operation interruption. If the measured value is 20.7 vol%  $\pm 1\%$  of FS (0.25%), the device is ready for operation. If the measured value is outside this range, calibrate the sensor and conduct an external functional test. Inform the manufacturer or dealer or, if possible.
- Ensure the measured value is checked, the sensor calibrated and an external functional test is performed after every fault message.
- Ensure the sensor and its surroundings are always clean, accessible and visible.

### 6.2 Shutdown

Switch off the mains voltage. Refer to Section 6.4 for storage conditions.

### 6.3 Packaging and transport

The sensor contains sensitive electronic components. When returning the sensor, use appropriate packaging according to applicable regulations.

### 6.4 Storage

The sensor may be stored in a packed state in a dry environment between 10 °C and 50 °C [50 °F to 122 °F]. Protect the sensor against moisture, humidity, dust and dirt.

### 6.5 Disposal

Ensure inoperable sensors are rendered unusable immediately. Dispose of according to regulations.

## WARRANTY/REMEDY

Honeywell warrants goods of its manufacture as being free of defective materials and faulty workmanship. Honeywell's standard product warranty applies unless agreed to otherwise by Honeywell in writing; please refer to your order acknowledgement or consult your local sales office for specific warranty details. If warranted goods are returned to Honeywell during the period of coverage, Honeywell will repair or replace, at its option, without charge those items it finds defective. **The foregoing is buyer's sole remedy and is in lieu of all other warranties, expressed or implied, including those of merchantability and fitness for a particular purpose. In no event shall Honeywell be liable for consequential, special, or indirect damages.**

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