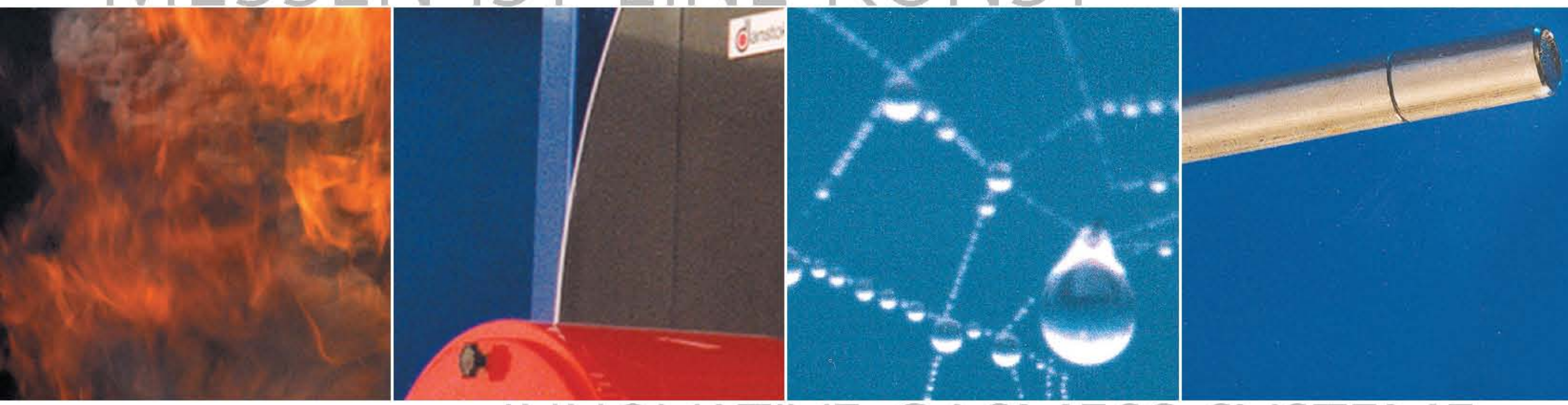
Technical Data Sheet

MF420-O-M

MESSEN IST EINE KUNST



INNOVATIVE GASMESS-SYSTEME

1. Properties

The extremely robust oxygen measuring system MF420-O-M is especially suitable for measuring the oxygen content in compost formation pits or piles up to 100° C. As a means of protection against the aggressive medium, the electronics are accommodated in a water-proof aluminium housing and the bar probe is arranged in a special stainless-steel probe protection tube (insertion probe). A microbe-proof cable is available on request. Power supply occurs via 24 V DC. Standard measuring range is from 0.1 to 25 vol.% oxygen; from 0.1 to 100 vol.% oxygen, upon request.

The central element of the oxygen measuring system is a dynamic oxygen sensor based on zirconium dioxide (ZrO_2). The measuring process is based on dynamic reactions on two zirconium dioxide discs, which form a hermetically sealed chamber. The entire measuring range is linear.

Since no chemical substances are used, dynamic oxygen sensors exhibit a significantly longer service life than electrochemical sensors.

MF420-O-M determines the oxygen partial pressure since it measures the oxygen concentration directly in the gas mixture. Therefore, it detects the absolute oxygen content – contrary to a lambda probe, which measures the relative oxygen content!

Since the measuring system monitors its own function during operation and signals malfunctions in the hardware and sensor, it can be operated fault-proof, if required. A second oxygen sensor is not necessary! Furthermore, it can be calibrated without personnel or reference gas in atmospheric air.

The measured values are output via an analog (4-20 mA) and a digital channel, with the latter also providing any error messages.

The measured values are evaluated and processed further in subsequent devices according to the specifications of the user (for e.g. display, measuring instrument, programmable logic controller, ventilation system).

2. Design of the oxygen measuring system

The oxygen measuring system MF420-O-M (see Fig. 1) was specifically developed for measuring the oxygen content in compost formation pits or piles. The applied materials fulfil the particular requirements of this field: the bar probe, the probe protection tube and the handles on the sides of the housing are made of stainless steel. The water-proof aluminium housing is screwed on the insertion probe and includes the transmitter, a pressure compensating element and a connector plug.

Fig. 1: Oxygen measuring system MF420-O-M.

The sensor electronics include: (1) a signal amplifier, (2) a control for the ionic pump with an analog part, (3) a test part, (4) the internal monitoring logic component, (5) the power supply for the sensor heating element as well as for the analog and digital part, (6) the reset and (7) the voltage monitor as well as (8) a bi-directional digital output (channel K2 or Pin 6) and (9) an analog output with 4-20 mA (channel K1 or Pin 5).

3. Technical Data

Transmitter		
Power supply	7-pole plug-in contact	Amphenol Tuchel circular connector
	Voltage	24 V DC ± 5%
	Electric current	about 500 mA, please observe switch-on current, about 4x nominal current!
Connections	Pin 1	24 V DC ± 5%
	Pin 2	0 V
	Pin 3	not assigned
	Pin 4	Test
	Pin 5 (Analog output; channel K1)	4-20 mA (max. load 550 Ω)
	Pin 6 (Digital output; channel K2)	Impulse and fault, external calibration
	Pin 7	functional ground
Ambient temperature	-10° C to +50° C	Please note solar radiation!
Output	4-20 mA	
Resolution	12 bit	
Housing	Aluminium	blue
Type of protection housing	IP 54	
Total size (with handles)	about L320 x W100 x H80 mm	without handles Ø 100 mm
Probe protection tube		
Length	about 1,150 mm	
Diameter	about 30 mm	
Material	stainless steel 1.4301	
Total weight MF420-O-M	about 3,500 g	Transmitter + insertion probe
Sensor		
Heating-up time	about 10 min	
Measuring range	0.1 - 25 vol.% oxygen (oxygen partial pressure)	or 0.1 - 100 vol.% oxygen
Accuracy	± 2%	FS (full scale)
Reproducibility	± 1%	
Temperature	up to +100° C	
Reaction time	about 3 s	
Length	400 mm	
Diameter	12 mm	
Type of protection sensor	IP 40	

J.DITTRICH ELEKTRONIC GmbH & Co. KG • Bahnhofstraße 67 • D-76532 Baden-Baden
Fon +49/7221/64103 • Fax +49/7221/17103 • www.dittrich-systeme.de • info@dittrich-systeme.de

4. Connection of MF420-O-M

The oxygen measuring system has to be connected to the downstream unit by means of a seven-core shielded cable with maximum 100 Ω cable resistance, including the forward and return lead (see Fig. 2). Power supply has to be designed in a way that provides the maximal switch-on current of 950 mA (cold oxygen measuring system).

For normal operation, the oxygen measuring system is connected to power supply via Pin 1, Pin 2 and Pin 7 (see Fig. 2). The measured values are output via Pin 5 (4-20 mA), for e.g. to a measuring instrument, a display or a programmable logic controller.

For fault-proof operation, Pin 4 (test channel) and Pin 6 (digital output) have to be connected, too. Further processing and evaluation will then take place in downstream devices according to the specifications of the user.

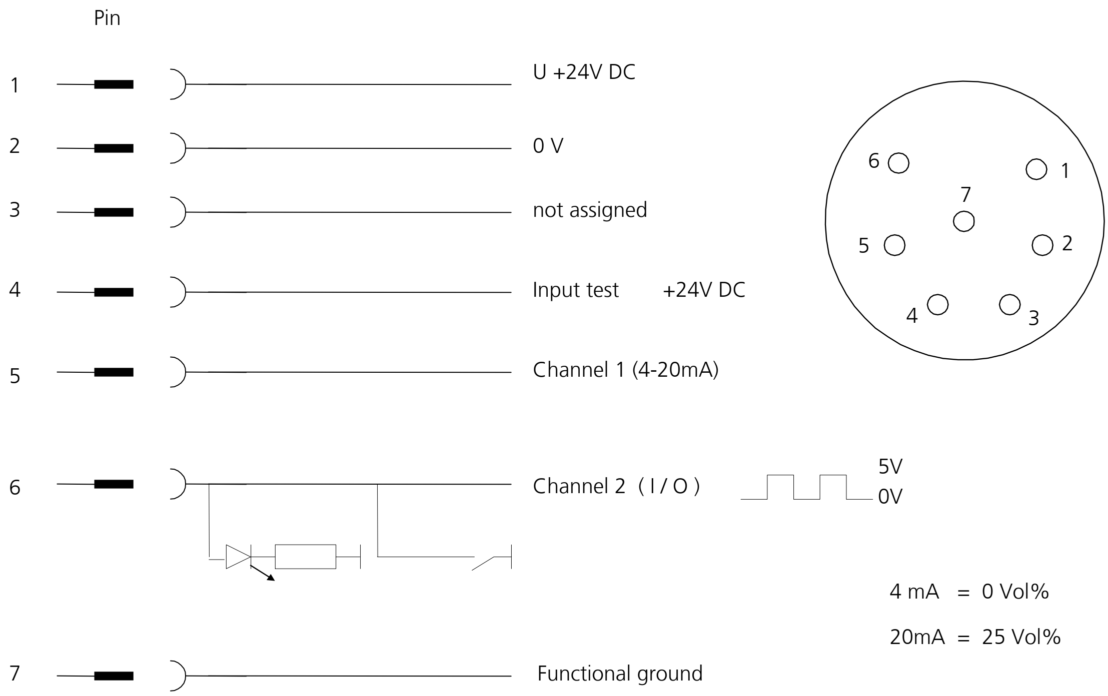


Fig. 2: Connection of MF420-O-M.

5. Fault-proof operation

If required, the oxygen measuring system MF420-O-M can be operated fault-proof.

How does the oxygen measuring system detect faults?

The oxygen measuring system outputs two measuring signals through two different channels:

- on channel K1 the measured value is available as an analog signal (4-20 mA),
- on the bi-directional channel K2 it is available as a digital pulse duration modulated alternate signal (low/high phase: 0/5 V). The length of the low phase is the measure for the oxygen concentration.

The oxygen measuring system is working fault-free when the analog signal from channel K1 corresponds to the signal of digital channel K2 (maximum deviation 4%). In addition, the low phase of channel K2 has to last from 0.09 to 0.71 s, which corresponds to an oxygen concentration of 0.1 or 25 vol.%. (At a differing measuring range the values change accordingly.)

If the alternate signal (low+high) exceeds a time window of 0.2 to 4 s (i.e. 10% fault tolerance) or if it changes into a constant fault signal of 5 V, the measured values lie outside the measuring range. If the hardware is defective, the output signal remains constant at 0 V.

Since the measuring method is dynamic, the proper performance of the oxygen measuring system can be checked any time, also during operation; ideally such check should occur cyclically (see Fig. 3).

For this purpose, 24 V are applied to a separate test channel, causing the sensor current to be reduced 20% from outside. An oxygen concentration lower than the one actually prevailing is simulated in the measuring system. On channel 1 is examined, whether the measuring system correctly calculates the virtual concentration of oxygen.

In this connection, a range of 4% is permissible, i.e. the measured value has to lie between 0.76 and 0.84 times the previous measured value during the self-test.

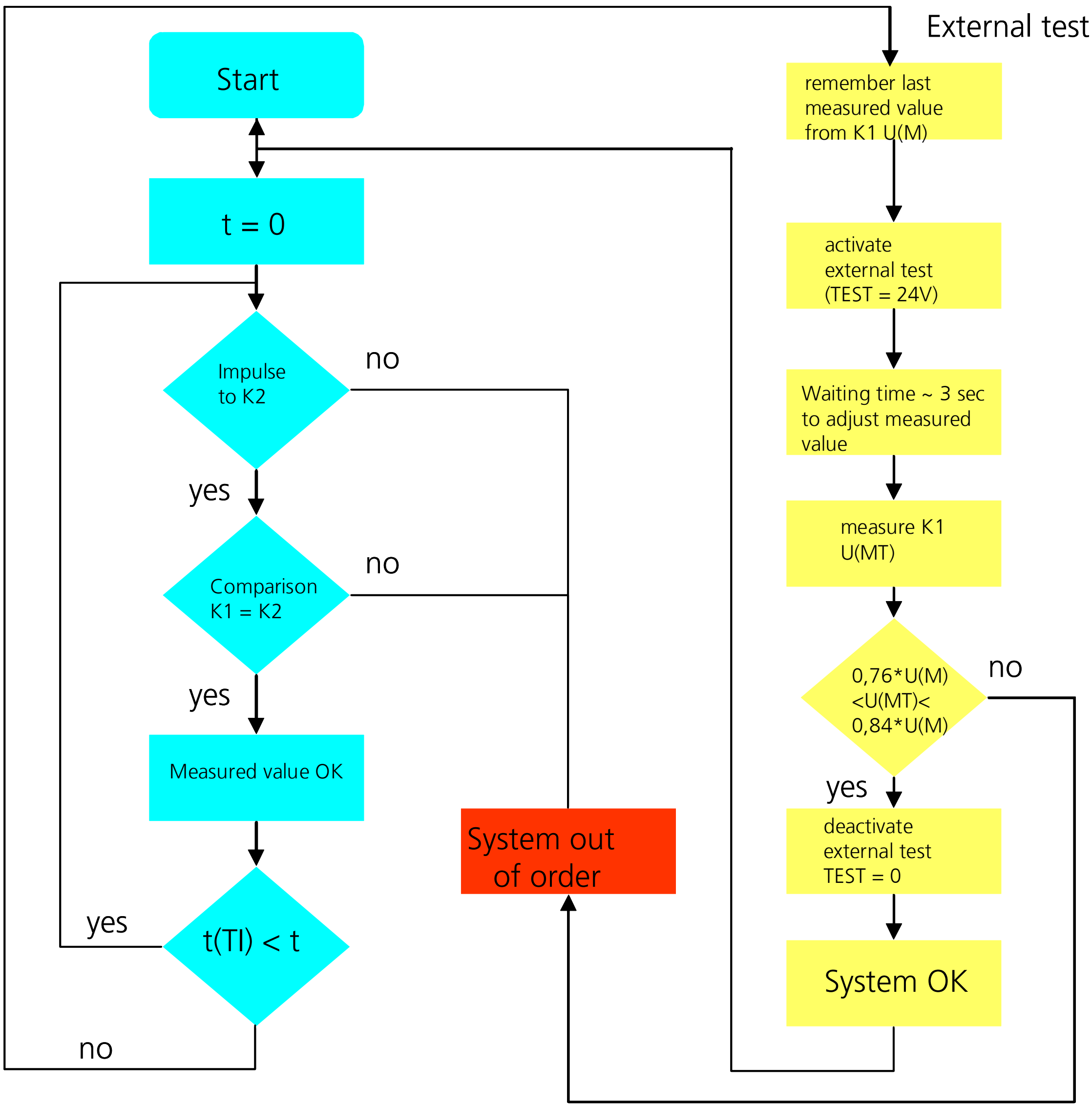


Fig. 3: Flow chart: External test in order to monitor the function of the measuring system during operation. K1 = Channel 1 U(M); K2 = Channel 2 f(M); t(TI) = time interval for the external test. Size of the time interval depends on application; U(MT) = measured signal of K1 during the external test.

With this test layout it is possible for the first time not only to detect faults in the hardware of the measuring system but also on the sensor itself, i.e. on the zirconium dioxide chamber!

External monitoring unit of the user

An external device arranged downstream by the user has to take over the evaluation of the measured signals as well as handle and monitor the cyclical self-tests.

The reaction to a fault message has to be in accordance with the specifications of the user and is managed by his external monitoring unit as well.

For this reason, such device must meet certain requirements:

- The unit must be fault-proof, i.e. the processes described below must be carried out without any errors, the input signals have to be read-in without errors and the output signals have to be output without errors.
- The measured values of channels K1 and K2 must be compared permanently within the fault tolerance time permissible for the application.
- The plausibility of the time of the output signal K2 must be checked constantly. In this respect, static signals are to be considered internal errors.
- A self-test is to be initiated at cyclic intervals and its effects on the measured signal have to be determined and evaluated. The time interval between two test cycles must not exceed a certain value.
- When a fault message is output, the process must be transferred into a safe state.

When is fault-free operation of the oxygen measuring system ensured?

The oxygen measuring system monitors its entire system on its own during operation and, in addition, requires only one oxygen sensor. Fault-free operation is ensured when:

- the analog and digital output signals correspond to one another (see Table 1),

- the measured signal of channel K2 lies within a defined time window and is not static, and
- the self-test is carried out cyclically and correctly.

Oxygen measuring system ready for operation			
	measured signal channel K1	measured signal channel K2	difference measured signals (K1-K2)
normal operation (test switch open)	linear (4-20 mA or 0-10 V)	digital, length low+high phase 0.2-4 s	max. difference 4%
external test (switch closed, +24V)	measured value decreases > 20%	measured value decreases > 20%	max. difference 4%
Oxygen measuring system out of order			
	measured signal channel K1	measured signal channel K2	difference measured signals (K1-K2)
normal operation (test switch open)		no impulse or length low+high phase <0.2 or >4 s.	difference > 4%
external test (switch closed, +24V)	measured value decreases < 20%	measured value decreases < 20%	difference > 4%

Table 1: Error messages of the oxygen measuring system; measuring range 0.1-25 vol.% O_2.

6. Calibration of the measuring system

The measuring system is constructed in a way that an additional calibration is not obligatory, even after a long operation period. However, if required, electric calibration is possible:

The measuring system MF420-O-M calibrates itself in atmospheric air (i.e. 20.7 vol.% oxygen ±10%). For this purpose, atmospheric air has to be applied to the sensor for at least 30 seconds, i.e. the insertion probe has to be pulled out of the compost pile. If switch S (see Fig. 2, pin 6 or channel K2) is closed for 10 seconds either manually or by means of a downstream device (see Fig. 4), the sensor will calibrate itself. If the newly measured oxygen concentration lies within the tolerance range of 10%, channel K2 continues to emit an alternating output signal. (If the measured value lies outside the tolerance range, channel K2 will emit an error signal of 5 V. If a hardware fault occurs, channel K2 emits an error signal of 0 V.) After the calibration has been successfully concluded, the measuring sensor will correct the output signal of channel K1; in this connection 20.7 vol.% oxygen correspond to 8.28 V or about 17.25 mA (25 vol.% oxygen correspond to 10 V or 20 mA). If a voltage interruption occurs to happen, the newly calibrated value will be reset to the value at delivery from the plant.

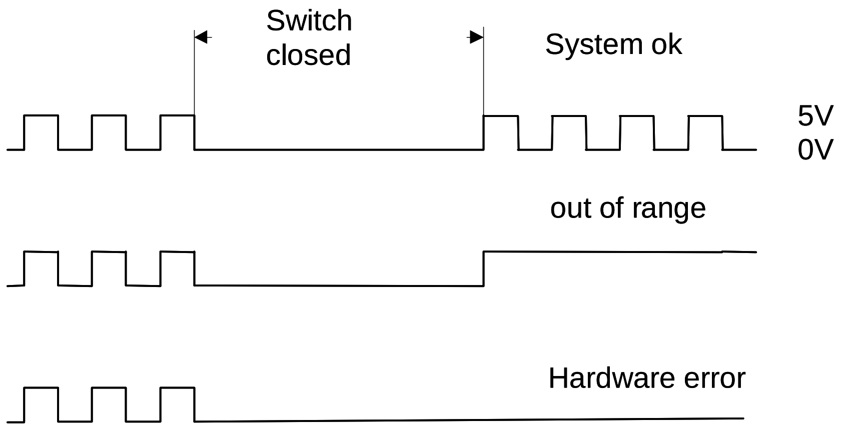


Fig. 4: Output diagram of channel K2.

Please note: MF420-O-M measures the oxygen partial pressure. According to the Dalton's law of partial pressure the oxygen partial pressure changes depending on the atmospheric air pressure and the humidity of the air. Particularly the humidity of the air can increase in the compost pile at high temperatures, consequently the oxygen partial pressure and hence the measured values decrease. This decrease is due to physical reasons and not to a defective oxygen measuring system!

7. Pollutants

Since the oxygen sensor contains zirconium dioxide and platinum, the following substances can destroy it:

- Heavy metals
- Sulphuric compounds
- Silicone vapors
- Fluorine
- NH_3 (as of 1000 ppm)
- Halogenated hydrocarbons (as of 100 ppm)
- Phosphate ester
- Chlorine
- SF_6
- Carbons
- Salts
- Long time in reducing atmosphere

Dust, vibrations, dirt, humidity, oils, greases, furnace cleaning agents, heavy gas oil, pyrolysis gases and silicon oxide decrease the service life of the oxygen sensor.

No responsibility is taken for the completeness of this list.

The user should test whether the oxygen measuring system MF420-O-M is suitable for his application under the given conditions.

Subject to technical modifications without notice. (07/05)

J.DITTRICH ELEKTRONIC GmbH & Co. KG • Bahnhofstraße 67 • D-76532 Baden-Baden
Fon +49/7221/64103 • Fax +49/7221/17103 • www.dittrich-systeme.de • info@dittrich-systeme.de