Operating Instructions

for

Electronic Mass Flow Meter

Model: MAS

1. Contents

Manufactured and sold by:

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2. Note

Please read these operating instructions before unpacking and putting the unit into operation. Follow the instructions precisely as described herein.
The instruction manuals on our website www.kobold.com are always for currently manufactured version of our products. Due to technical changes, the instruction manuals available online may not always correspond to the product version you have purchased. If you need an instruction manual that corresponds to the purchased product version, you can request it from us free of charge by email (info.de@kobold.com) in PDF format, specifying the relevant invoice number and serial number. If you wish, the operating instructions can also be sent to you by post in paper form against an applicable postage fee.

Operating instructions, data sheet, approvals and further information via the QR code on the device or via www.kobold.com

The devices are only to be used, maintained and serviced by persons familiar with these operating instructions and in accordance with local regulations applying to Health & Safety and prevention of accidents.

When used in machines, the measuring unit should be used only when the machines fulfil the EC-machine guidelines.

as per PED 2014/68/EU
In acc. with Article 4 Paragraph (3), "Sound Engineering Practice", of the PED 2014/68/EU no CE mark.

3. Instrument Inspection

Instruments are inspected before shipping and sent out in perfect condition.
Should damage to a device be visible, we recommend a thorough inspection of the delivery packaging. In case of damage, please inform your parcel service / forwarding agent immediately, since they are responsible for damages during transit.

Scope of delivery:
The standard delivery includes:
- Electronic Mass Flow Meter model: MAS
- Connector

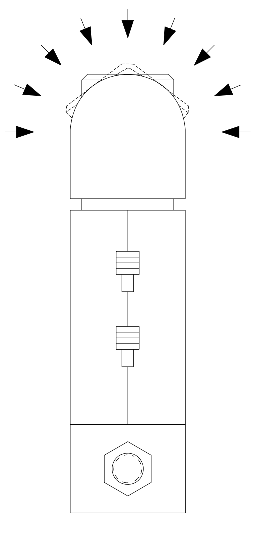
4. Regulation Use

Any use of the Electronic Mass Flow Meter, model: MAS, which exceeds the manufacturer's specifications, may invalidate its warranty. Therefore, any resulting damage is not the responsibility of the manufacturer. The user assumes all risk for such usage.

5. Application

The KOBOLD Electronic Mass Flow Meter, model: MAS, makes very precise measurements of the Mass Flow Rate of gases in different measuring ranges from 0 - 10 Ncm³/min up to 0 - 500 Nl/min nitrogen. The operation of the meter is based on the calorimetric principle.
The measuring accuracy is ±1,5% of full scale including linearity over 15 to 25 °C and 0.3 to 4 bar absolute. Its response time is 800 ms. The typical response time is 6 seconds to display 98% of the full scale value. This can be realised in between 25 to 100% of the full scale value.
Compared to most of the volume flow meters there is no temperature- or pressure-correction necessary. This means that the MAS is ideally suited for almost every gas flow application. Typical industrial applications are process control, laboratory measuring tasks, OEM applications, gas indication panels, leakage and filter monitoring.

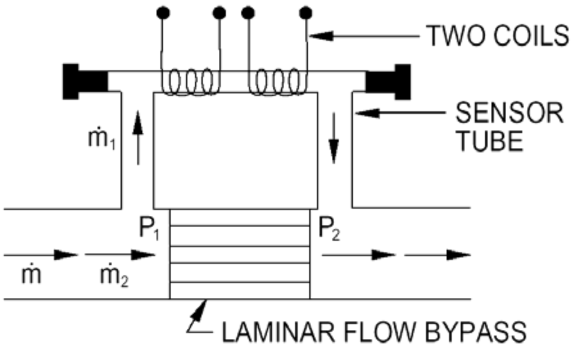
Display rotatable



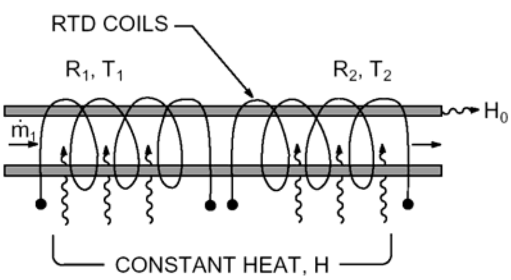
6. Operating Principle

6.1 Measuring principle

The operation of the Mass Flow Meter, model: MAS, is based on the principle of heat transport (first law of thermodynamic).
The medium flows through the bypass measuring system. Gas enters the MAS flow body and divides into two flow paths. Part of the flow goes through the laminar flow bypass the other part flows through the above located measuring pipe.
Due to the differential pressure between P1 and P2 which is generated by the laminar flow bypass element a part flow (m_1) is separated from the main flow (m) and guided through the sensor tube.



Two resistance temperature detectors (RTD elements) transferring a constant amount of heat to the gas stream are mounted on the measuring tube. Under flow conditions, the gas molecules absorb and transport the heat away from one to the other coil. The resulting temperature difference is detected by the RTD-sensors and evaluating by the measuring electronic into an output signal or a display value. Since the heat is transported by gas molecules, the output signal is linear proportional to the gas mass flow.



FIRST LAW OF THERMODYNAMICS
(HEAT IN = HEAT OUT)

$$H = \dot{m}_1 C_p (T_2 - T_1) + H_0$$

$$\boxed{\dot{m} = \frac{H - H_0}{C_p \Delta T}}$$

7. Mechanical Installation

In order to ensure a successful installation, inlet and outlet tubing or piping should be in a clean state prior to plumbing your MAS to the system. MAS is applicable to clean gas only because particles and other foreign matter may pollute the sensor tube and laminar flow element and cause wrong measurement results. In case of doubt, we recommend to use filters.

The following working pressures and/or medium temperatures may not be exceeded:

- 10 bar or 50 °C for devices with nylon casing (MAS-1xxx and MAS-2xxx)
- 35 bar or 50 °C for devices with stainless steel casing (MAS-3xxx and MAS-4xxx)

Be sure that the arrow on the side of the transducer points in the direction of flow. With the nylon casing you must take care not to the turn the thread too far (maximum 1.5 turns).

Attention! Over-tightening will crack the fittings and shift calibration.

The preferred mounting position is horizontal. A vertical installation is possible, but this must be considered during factory-calibration, since one has to count on a zero-point movement depending on the operating pressure.

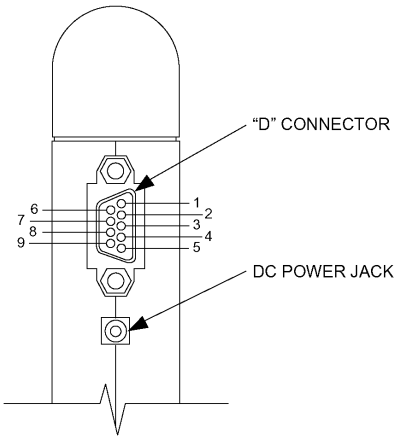
Swagelok and NPT screw connections must not be removed from the casing nor should their position be altered since they form a unit with the laminar element and could alter the calibration.

Swagelock-connections:
For the first installation of compression fittings, simply insert the tubing into the fitting. Make sure that the tubing rests firmly on the shoulder of the fitting and that the nut is hand-tight. Mark the nut at the six o'clock position. While holding the fitting body steady with a back-up wrench, tighten the nut $1\frac{1}{4}$ turns. Watching the mark on the nut, make one complete revolution and continue to the nine o'clock position. After this, the fitting can be reconnected by tightening with a wrench. Do not fail to use a back-up wrench or the inlet fitting may be damaged.

8. Electrical Connection

The standard MAS is provided with a 9-pin “D” sub type connector located on the side of the MAS.

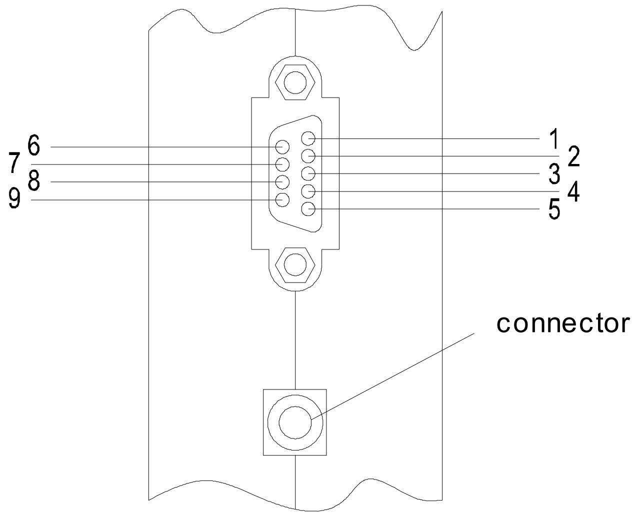
Attention! Ensure that the voltage of your installation corresponds with the voltage of the measuring device.



Attention! A wrong terminal assignment may lead to a damage of the electronic. If a power supply is connected, do not supply with any additional voltage on the 9-pin-Sub-D-connector.

When the MAS is configured for a remote display, the display is supplied via the 9-pin “D” connector.

Attention! Please note that opening the device cancels the guarantee. We therefore recommend that you let such work be done by KOBOLD Messring GmbH.



Pin No.	Function
1	No Connection
2	Flow Signal Ground
3	0 to +5 VDC Flow Signal
4	+ Power Supply (12 VDC) *1, *2
5	Remote Display Flow Signal
6	Remote Display Ground
7	Power Supply Ground
8	Analogue output 4 to 20 mA Ground
9	Analogue output 4 to 20 mA signal

*[1] Power supply voltage must be specified at time of order. Operating a 12 VDC meter at 24 VDC will cause damage. Running a 24 VDC meter at 12 VDC will result in faulty operation.
*[2] Do not supply + DC power at the "D" connector while using a power supply at the DC power jack. Both supplies may be damaged.

8.1 Power supply

If you use a KOBOLD MAS-5000 or MAS-5015 power pack, insert the jack plug in the foreseen socket on the Mass Flow Meter MAS. Then simply connect the power unit to the mains.
If not using a MAS-5000 or MAS-5015 power pack, supply the MAS via the 9-Pin Sub-D-Connector with a voltage of 12-15 VDC. MAS Flow Meters require a single +12 to +15 VDC power supply capable of providing a minimum current of 100 mA. The MAS can also be configured for +24 VDC power at 100 mA.

After the power has been switched on the output signal is initially maximum for a short time (c. 10-20 seconds). It then returns to 0 Volt (or 4 mA, depending on the model provided). Please note that the warming up period for the MAS should be about 15 minutes.
After the warming up phase the MAS indicates the measured flow values on the display.

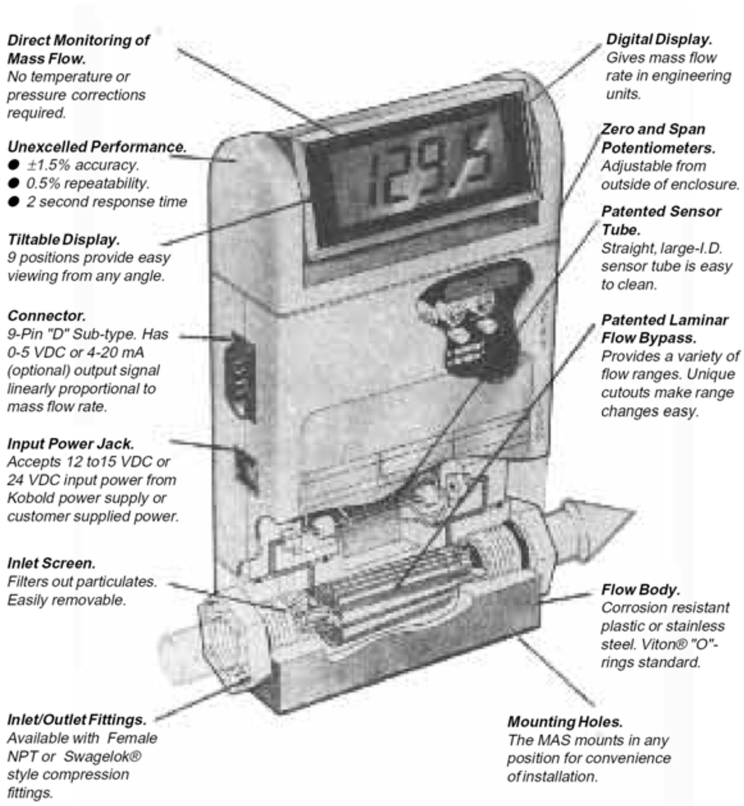
8.2 Output signals

The output signal is obtained from the 9-pin "D" connector. A 0 to 5 VDC output signal linearly proportional to gas mass flow rate is standard. A 4-20 mA current loop signal is optionally available.

8.3 Display

KOBOLD Mass Flow Meters, model MAS, for gases are available with an integrated digital display, a remote digital display and without a digital display. The decimal point on the version with digital display is set at the factory. It is always a 3 ½-digit display.

Attention! KOBOLD Messring accepts no liability for any damage, claims or faults resulting from operation with oxygen. MAS devices can be manufactured oil and grease free if desired.



9. Operation

Pressure- and temperature conditions
The gas flow rate output of your MAS always refers to “standard” conditions of 21 °C (70 °F) and 760 mm of mercury (1 atmosphere), unless you have specified otherwise. Make sure that your MAS is always calibrated on the operating conditions.

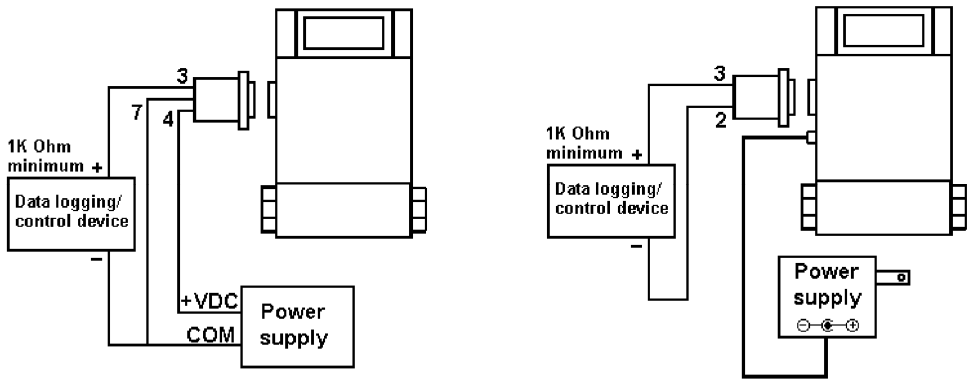
Accuracy
The standard accuracy of the MAS is ±1.5% of full scale.

Overranging
If the flow rate exceeds the full scale range listed on your MAS’s front label, the output signal and digital display (if available) will read a higher value.

Overrange conditions are indicated from the display and/or output by going to a high level, above the full scale range. After the overrange condition has been removed, it may take several seconds for the MAS to recover and resume normal operation. This will not harm the instrument.

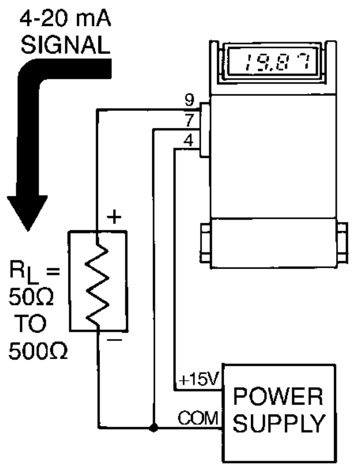
Zero and Span Adjustments
The zero and span potentiometers are accessed through marked ports on the right side of your MAS. The analogue output is factory set and should only be adjusted, when the zero point is drifting away more than 2% of the maximum scale value and when you are absolutely sure that no gas is flowing.

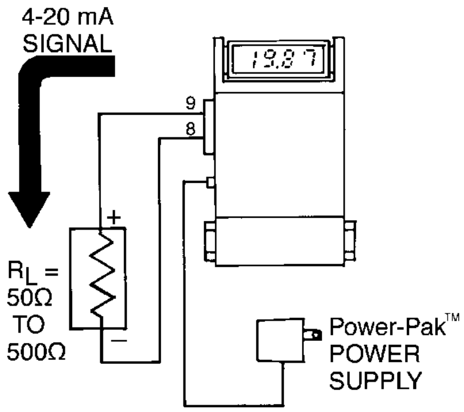
Standard 0-5 V_{DC} Output Signal
The standard 0-5 V_{DC} output signal flows from Pin 3 (0-5 V_{DC} Out) through the load (1 K Ohm minimum) to Pin 7 (Power Common). The figure below is a typical example of input power and output signal connections.



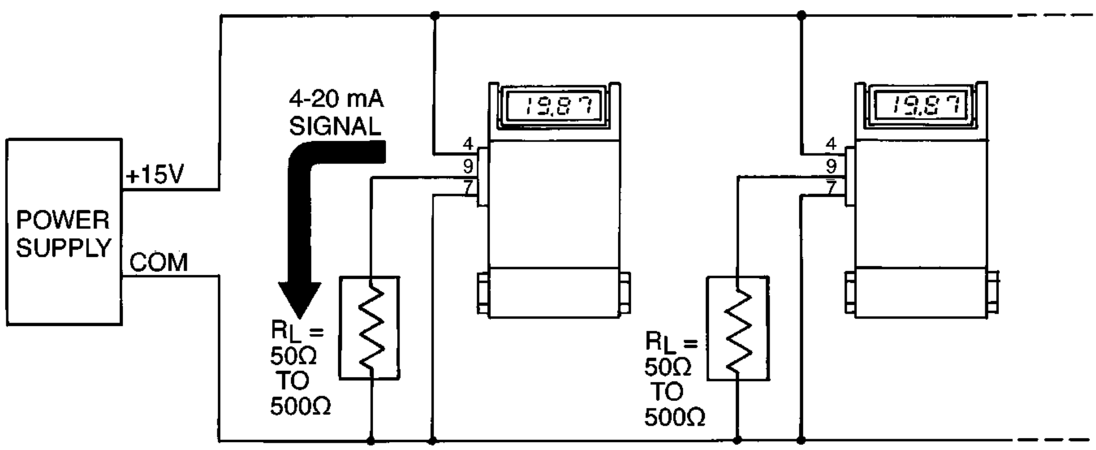
Optional 4-20 mA output signal
As an option for all MAS Mass Flow Meters, a 4-20 mA analogue output is available. The output signal is provided at 9-Pin Sub-D-Connector. (Attention! Maximum load 50 to 500 Ohms)

Single unit





Multiple Installation



10. Totalizer

The totalizer is designed to provide a totalizer function for the MAS-11/MAS-31. It will display the totals as well as the flow.

Display:
The totalizer display has three screens which are accessed by pressing the button as indicated below:

Screen 1 (start-up screen):	Flow units are shown together with the actual flow
Screen 2:	Totalizer
Screen 3:	Actual flow is shown together with the totalizer

Totalizer:
A total of 8 digits can be shown by the totalizer ranging from .0000001 to 99999999. The decimal point will automatically shift position as the total increases. Upon reaching the maximum count (99999999), the totalizer will “roll-over” be cleared and counting starts from zero again.

The totalizer is cleared by going to screen 2 or 3 and then press the button for more then 5 seconds. The clearing of the totalizer can be observed on the screen.

The total count is stored in non-volatile memory every 5 minutes. If the unit is switched off within 5 minutes from power-up then no total will be saved and the previous total will be shown at the next power-up.

Due to the combination of the hardware/LCD it may happen that during power up the screen remains blank. Please turn the unit off and then back on again.

11. Maintenance

Sensor cleaning and Inspection

Your MAS essentially requires no maintenance and has no regular maintenance schedule, other than periodic flow path cleaning if the gas is dirty. Calibrations may be scheduled once or twice yearly, depending on the accuracy to be maintained, or as needed.
It is recommended that your MAS be returned to Kobold Messring if cleaning, repair, or recalibration are necessary. This is usually your most cost-effective and reliable alternative.

Attention! If you wish to clean your MAS purge it with a neutral gas (e.g. nitrogen) thoroughly before disconnection from the gas line when toxic or corrosive gases have been measured. Never return an MAS to KOBOLD Messring or any other repair or calibration facility without fully neutralising any toxic gases trapped inside.

Note: A cleaning, described as follows, is only possible with instruments made out of stainless steel (MAS-3xxx and MAS-4xxx)

Cleaning is accomplished by simply rodding out the sensor with the Sensor Cleaning Stylette, available from Kobold Messring for this purpose. (A 0.020 inch to 0.028 inch diameter piano wire may also be used.) During maintenance and cleaning please observe the following steps:

1. Remove the unit from the system.
2. Remove the two socket head access port plugs with a 6mm (¼ inch) allen wrench.
3. Visually inspect the sensing ports and sensor concerning dirt and corrosion.
4. Use a hemostat or tweezers to push the cleaning wire into the downstream opening of the sensor tube. Do not force the cleaning wire; move it back and forth – **Do not twist or rotate**.
5. Flush the sensor tube with a non-residuous solvent. In cases where solids are deposited on the sensor and can not be removed, units should be returned to factory for complete cleaning and re-calibration.
6. Blow dry all parts with dry nitrogen and re-assemble the unit.
7. When the transducer is re-installed in the system, leak test the connections. Do not use a liquid leak-search medium, instead watch the possible arising pressure loss in your system.
8. Check transducer calibration.

12. Conversion to other Working Conditions

The flow rate of your MAS is referenced to certain “standard” Conditions of temperature and pressure. Unless otherwise specified in your order, these standard conditions are 21 °C (70 °F) and 760 mm of mercury (1 atmosphere). If you wish to convert to other “standard” conditions or to find the “actual” conditions in the pipe where your MAS is installed, use the following relationship:

$$Q_2 = \frac{P_1}{P_2} x \frac{T_2}{T_1} x Q_1$$

( )$_1$= Refers to the standard conditions with which your MAS was calibrated
( )$_2$= Refers to the new standard conditions or to the actual temperature and pressure conditions in the pipe,
Q_1 = The gas mass flow rate referenced to the calibrated standard conditions (SCCM or SLM),
Q_2 = The gas mass flow rate referenced to the new standard or actual conditions (SCCM or SLM–“S” means “standard”; ACCM or ALM–“A” means “actual”),
P = Absolute pressure (kg/cm2 or psia), and
T = Absolute temperature (°K or °R) °K = °C + 273; °R = °F + 460)

Example 1 changing „standard“ conditions
If your MAS has a flow rate reading of 10.00 SLM and was calibrated at standard conditions of 70 °F (21 °C) and 1 atmosphere (14.7 psia), and if you wish to convert this reading to standard conditions of 32 °F (0 °C) and 1 atmosphere, then you would use the equation as follows:

$$Q_2 = \frac{1bar(abs.)}{1bar(abs.)} x \frac{273K}{(273K + 21K)} x Q_1$$

$$Q_2 = 0{,}928 x 10 Nl/\min = 9{,}28 Nl/\min$$

So, you can see that the flow rate referenced to 0 °C will be approximately 7% lower than when referenced to conditions of 21 °C.

Example 2 Finding the “Actual” flow rate
If the flow rate and calibrated standard conditions are as given in Example 1 and you wish to find the actual flow rate at 100 °F and 30 psig, then you would use equation as follows:

$$Q_2 = \frac{14.7}{14.7 + 30} \quad \frac{460 + 100}{460 + 70} \text{ (10.00) = 3.47 slm}$$

K-factors, gas-tables and conversion formulas

In the following formulas and tables K-factors are used for calibrating its flow rate values. This has two advantages:

a) Calibrating an “actual” gas with a reference gas. This is particularly useful if the actual gas is not a common gas or if it is a so-called “nasty” gas (i.e., toxic, flammable, corrosive, etc.).
b) Interpreting the reading of a flow meter or flow controller which has been calibrated with a gas other than the actual gas.

Using these formulas, the following fundamental relationship is used:

$$\frac{Q_1}{Q_2} = \frac{K_1}{K_2} \qquad (1)$$

Where:

Q =	The volumetric flow rate of the gas referenced to standard conditions of 0°C and 760 mm Hg (SCCM or SLM)
K =	The “K” factor defined in equation (6)
$( )_1$ =	Refers to the “actual” gas
$( )_2$ =	Refers to the “reference” gas

The K-factor is derived from the first law of thermodynamics applied to the sensor tube.

$$H = \frac{mCp\Delta T}{N} \qquad (2)$$

where:

H =	The constant amount of heat applied to the sensor tube
m =	The mass flow rate of the gas (gm/min)
C_P =	The specific heat coefficient of the gas (Cal/gm); C_P is given in the gas tables (at 0 °C)
ΔT =	The temperature difference between the upstream and downstream coils
N =	A correction factor for the molecular structure of the gas given by the following table:

Number of Atoms in the Gas Molecule	N
Monatomic	1.040
Diatomic	1.000
Triatomic	0.941
Polyatomic	0.880

The mass flow rate can also be written as:

$$m = \rho Q \tag{3}$$

where:

ρ = The gas mass density at standard conditions (g/l); ρ is given in the tables (at 0 °C, 760 mm Hg).

Furthermore, the temperature difference ΔT is proportional to the output voltage E of the Mass Flow Meter

$$\Delta T = aE \tag{4}$$

where:
a = constant.

If we combine Equations (3) and (4), insert them into Equation (2), and solve for Q, we get:

$$Q = \left(\frac{bN}{\rho Cp}\right) \tag{5}$$

where:

b = H/aE = A constant if the output voltage is constant.

For our purposes, we want the ratio of the flow rate Q_1, for an actual gas to the flow rate of a reference gas Q_2, to produce the same output voltage in a particular Mass Flow Meter or controller.
We get this by combining equations (1) and (5):

$$\frac{Q_1}{Q_2} = \frac{K_1}{K_2} = \frac{\left(\frac{N_1}{\rho_1 x C_{p1}}\right)}{\left(\frac{N_2}{\rho_2 x C_{p2}}\right)} \tag{6}$$

Please note that the constant b cancels out. Equation (6) is the fundamental relationship used in the accompanying tables. For convenience, the tables give “relative” K-factors, which are the ratios K_1/K_2, instead of the K-factors themselves.

In the third column of the tables, the relative K-factor is $K_{actual}/K_{references}$, where the reference gas is a gas molecularly equivalent to the actual gas. In the fourth column, the relative K-factor is K_{actual}/KN_2, where the reference gas is the commonly used gas, nitrogen (N_2). The remaining columns give C_P and r, enabling you to calculate K1/K2 directly using Equation (6). In some instances, K1/K2 from the tables may be different from that which you calculate directly. The value from the tables is preferred because in many cases it was obtained by experiment.

Kobold calibrates every MAS Mass Flow Meter with primary standards using the actual gas or a molecularly equivalent reference gas. The calibration certificate accompanying your MAS will cite the reference gas used. When a reference gas is used, the actual flow rate will be within 2-4% of the calculated flow rate.

Example:
A MAS is calibrated for nitrogen (N2), and the flow rate is 1000 SCCM for a 5 VDC output signal. The flow rate for carbon dioxide at a 5 VDC output is:

$$Q_{(CO2)} / Q_{(N2)} = K_{(CO2)} / K_{(N2)}$$
$$Q_{(co2)} = (0{,}74 / 1{,}000)\ 1000 = 740 Ncm^3 / \min$$

Calculating gas mixtures

Equation (6) is used for gas mixtures, but we must calculate $\frac{N}{\rho.Cp}$ for the mixture.
The equivalent values of r, C_P, and N for a gas mixture are given as follows:
The equivalent gas density is:

$$\rho = (m_1 / m_T)\rho_1 + (m_2 / m_T)\rho_2$$

where:
mT = m1 + m2 = total mass flow rate (gm/min),
$( )_1$= Refers to gas #1, and
$( )_2$= Refers to gas #2.

The equivalent specific heat is:

$$C_p = F_1 C_{p1} + F_2 C_{p2}$$

where:

$$F_1 = (m_1 \rho_T) / (m_T \rho)$$
$$F_2 = (m_2 \rho_2) / (m_T \rho)$$

The equivalent value of N is:

$$N = (m_1 / m_T) N_1 + (m_2 / m_T) N_2$$

The equivalency relationships for r, C_P, and N for mixtures of more than two gases have a form similar to the dual-gas relationship given above.

13. Technical Information

Operating instructions, data sheet, approvals and further information via the QR code on the device or via www.kobold.com

14. Order Codes

Operating instructions, data sheet, approvals and further information via the QR code on the device or via www.kobold.com

15. Dimensions

Operating instructions, data sheet, approvals and further information via the QR code on the device or via www.kobold.com

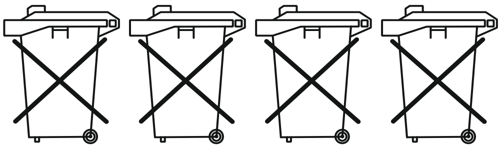
16. Disposal

Note!

- Avoid environmental damage caused by media-contaminated parts
- Dispose of the device and packaging in an environmentally friendly manner
- Comply with applicable national and international disposal regulations and environmental regulations.

Batteries

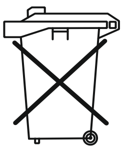
Batteries containing pollutants are marked with a sign consisting of a crossed-out garbage can and the chemical symbol (Cd, Hg, Li or Pb) of the heavy metal that is decisive for the classification as containing pollutants:



Cd[1] Hg[2] Pb[3] Li[4]

1. „Cd" stands for cadmium
2. „Hg" stands for mercury
3. „Pb" stands for lead
4. „Li" stands for lithium

Electrical and electronic equipment



17. EU Declaration of Conformance

We, KOBOLD Messring GmbH, Nordring 22-24, 65719 Hofheim, Germany, declare under our sole responsibility that the product:

Electronic Mass Flow Meter model: MAS

to which this declaration relates is in conformity with the following EU directives stated below:

2014/30/EU **EMC Directive**
2011/65/EU **RoHS** (category 9)

Also, the following standards are fulfilled:

EN 61326-1:2013 Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements

Hofheim, 23 April 2024

H. Volz
General Manager

J. Burke
Compliance Manager

18. Supplement

Gas tables and K-factors (see tables on the following pages)

Actual Gas	Chemical Symbol	Ref. Gas	KFactor Rel. to Ref. Gas	KFactor Relative N2	Cp (Cal/g)	Density (g/ l) @ 0°C	Elastomer O-Ring*	Elastomer Valve Seat
Acetylene	C_2H_2	N_2	.58		.4036	1.162		
Air		N_2	1.00		.240	1.293		
Allene (Propadiene)	C_3H_4	N_2	..43		.352	1.787		KR
Ammonia	NH_3	N_2	.73		.492	.760	NEO	NEO
Argon	Ar	Ar	1.000	1.45	.1244	1.782		
Arsine	AsH_3	N_2	.67		.1167	3.478		KR
Boron Trichloride	BCl_3	N_2	.41		.1279	5.227	KR	KR
Boron Trifluoride	BF_3	N_2	.51		.1778	3.025		KR
Bromine	Br_2	N_2	.81		.0539	7.130		
Boron Tribromide	Br_3	N_2	.38		.0647	11.18		KR
Bromine Pentafluoride	BrF_5	N_2	.26		.1369	7.803		KR
Bromine Trifluoride	BrF_3	N_2	.38		.1161	6.108		KR
Bromotrifloromethane (Freon-13 B1)	$CBrF_3$	N_2	.37		.1113	6.644		
1,3-Butadiene	C_4H_6	N_2	.32		.3514	2.413		
Butane	C_4H_{10}	N_2	.26		.4007	2.593	NEO	KR
1-Butane	C_4H_8	N_2	.30		.3648	.2.503	NEO	KR
2-Butane	C_4H_8 CIS	N_2	.324		.336	2.503	NEO	KR
2-Butane	C_4H_8 TRANS	N_2	.291		.374	2.503		
Carbon Dioxide	CO_2	N_2	.74		.2016	1.964		
Carbon Disulfide	CS_2	N_2	.60		.1428	3.397		
Carbon Monoxide	CO	N_2	1.00		.2488	1.250		
Carbon Tetrachloride	CCl_4	N_2	.31		.1655	6.860		KR
Carbon Tetrafluoride (Freon-14)	CF_4	N_2	.42		.1654	3.926		KR
Carbonyl Fluoride	COF_2	N_2	.54		.1710	2.945		
Carbonyl Sulfide	COS	N_2	.66		.1651	2.680		
Chlorine	CL_2	N_2	.86		.114	3.163		KR
Chlorine Trifluoride	ClF_3	N_2	.40		.1650	4.125		KR
Chlorodifluoromethane (Freon-22)	$CHClF_2$	N_2	.46		.1544	3.858		KR
Chloroform	$CHCl_3$	N_2	.39		.1309	5.326		KR
Chloropentafluoroethane (Freon-115)	C_2ClF_5	N_2	.24		.164	6.892		KR
Chlorotriflurometháne (Freon-13)	$CClF_3$	N_2	.38		.153	4.660		KR
Cyanogen	C_2N_2	N_2	.61		.2613	2.322		
Cyanogen Chloride	ClCN	N_2	.61		.1739	2.742		KR
Cychlopropane	C_3H_5	N_2	.46		.3177	1.877		KR
Deuterium	D_2	N_2	1.00		.1722	1.799		
Diborane	B_2H_6	N_2	.44		.508	1.235		KR
Dibromodifluoromethane	CBr_2F_2	N_2	.19		.15	9.362		KR
Dibromethane		N_2	.47		.075	7.76		KR
Dichlorodifluoromethane (Freon-12)	CCl_2F_2	N_2	.35		.1432	5.395		KR
Dichlorofluoromethane (Freon-21)	$CHCl_2F$	N_2	.42		.140	4.952		KR
Dichloromethylsilane	$(CH3)_2SiCl_2$	N_2	.25		.1882	5.758		KR
Dichlorosilane	SiH_2Cl_2	N_2	.40		.150	4.506		KR
Dichlorotetrafluoroethane (Freon-114)	$C_2Cl_2F_4$	N_2	.22		.1604	7.626		KR
1,1-Difluoroethylene (Freon-1132A)	$C_2H_2F_2$	N_2	.43		.224	2.857		KR
Dimethylamine	$(CH_3)_2NH$	N_2	.37		.366	2.011		KR

Actual Gas	Chemical Symbol	Ref. Gas	KFactor Rel. to Ref. Gas	KFactor Relative N2	Cp (Cal/g)	Density (g/ l) @ 0°C	Elastomer O-Ring*	Elastomer Valve Seat
Dimeyl Ether	$(CH_3)_2O$	N_2	.39		.3414	2.055		KR
2,2-Dimethylpropane	C_3H_{12}	N_2	.22		.3914	3.219		KR
Ethane	C_2H_6	N_2	.50		.4097	1.342		
Ethanol	C_2H_6O	N_2	.39		.3395	2.055		KR
EthylAcetylene	C_4H_6	N_2	.32		.3513	2.413		KR
Ethyl Chloride	C_2H_5Cl	N_2	.39		.244	2.879		KR
Ethylene	C_2H_4	N_2	.60		.1365	1.251		
Ethylene Oxide	$C_2H_4O)$	N_2	.52		.268	1.965		KR
Fluorine	F_2	N_2	.980		.1873	1.695		KR
Fluoroform (Freon-23)	CHF_3	N_2	.50		.176	3.127		KR
Freon-11	CCl_3F	N_2	.33		.1357	6.129		KR
Freon-12	CCl_2F_2	N_2	.35		.1432	5.395		KR
Freon-13	$CClF_3$	N_2	.38		.153	4.660		KR
Freon-13	B1 $CFrF_3$	N_2	.37		.1113	6.644		KR
Freon-14	CF_4	N_2	.42		.1654	3.926		
Freon-21	$CHCl_2F$	N_2	.42		.140	4.952		KR
Freon-22	$CHClF_2$	N_2	.46		.1544	3.858		KR
Freon-113	CCl_2FCClF_2	N_2	.20		.161	8.360		KR
Freon-114	$C_2Cl_2F_4$	N_2	.22		.160	7.626		KR
Freon-115	C_2ClF_5	N_2	.24		.164	6.892		KR
Freon-C318	C_4F_8	N_2	.17		.185	8.397		KR
Germane	GeH_4	N_2	.57		.1404	3.418		
Germanium Tetrachloride	$GeCL_4$	N_2	.27		.1071	9.565		KR
Helium	He	He	1.000	1.454	1.241	.1786		
Hexafluoroethane (Freon-116)	C_2F_6	N_2	.24		.1834	6.157		KR
Hexane	C_6H_{14}	N_2	.18		.3968	3.845		KR
Hydrogen	H_2	H_2	1.000	1.01	3.419	.0899		
Hydrogen Bromide	HBr	N_2	1.000		.0861	3.610		KR
Hydrogen Chloride	HCl	N_2	1.000		.1912	1.627	KR	KR
Hydrogen Cyanide	HCN	N_2	1.070		.3171	1.206		KR
Hydrogen Fluoride	HF	N_2	1.000		.3479	.893	KR	KR
Hydrogen Iodide	HI	N_2	1.000		.0545	5.707		KR
Hydrogen Selenide	H_2Se	N_2	.79		.1025	3.613		KR
Hydrogen Sulfide	H_2S	N_2	.80		.2397	1.520		KR
Iodine Pentafluoride	IF_5	N_2	.25		.1108	9.90		KR
Isobutane	$CH(CH_3)_3$	N_2	.27		.3872	3.593		KR
Isobutylene	C_4H_8	N_2	.29	.	.3701	2.503		KR
Krypton	Kr	Ar	1.002	1.453	.0593	3.739		
Methane	CH_4	N_2	.72		.5328	.715		
Methanol	CH_3OH	N_2	.58		.3274	1.429		
Methyl Acetylene	C_3H_4	N_2	.43		.3547	1.787		KR
Methyl Bromide	CH_2Br	N_2	.58		.1106	4.236		
Methyl Chloride	CH_3Cl	N_2	.63		.1926	2.253		KR
Methyl Fluoride	CH_3F	N_2	.68		.3221	1.518		KR
Methyl Mercaptan	CH_3SH	N_2	.52		.2459	2.146		KR
Methyl Trichlorosilane	$(CH_3)\ SiCl_3$	N_2	.25		.164	6.669		KR
Molybdenum Hexafluoride	MoF_6	N_2	.21		.1373	9.366		KR
Monoethylamine	$C_2H_5NH_2$	N_2	.35		.387	2.011		KR
Monomethylamine	CH_3NH_2	N_2	.51		.4343	1.386		KR
Neon	NE	Ar	1.006	1.46	.245	.900		
Nitric Oxide	NO	N_2	.990		.2328	1.339		
Nitrogen	N_2	N_2	1.000		.2485	1.25		
Nitrogen Dioxide	NO_2	N_2	.74		.1933	2.052		

Actual Gas	Chemical Symbol	Ref. Gas	KFactor Rel. to Ref. Gas	KFactor Relative N2	Cp (Cal/g)	Density (g/ l) @ 0°C	Elastomer O-Ring*	Valve Seat
Nitrogen Trifluoride	NF_3	N_2	.48		.1797	3.168		KR
Nitrosyl Chloride	NOCl	N_2	.61		.1632	2.920		KR
Nitrous Oxide	N_2O	N_2	.71		.2088	1.964		
Octafluorocyclobutane (Freon-C318)	C_4F_6	N_2	.17		.185	8.397		KR
Oxygen Difluoride	OF_2	N_2	.63		.1917	2.406		
Oxygen	O_2	N_2	1.000		.2193	1.427		
Ozone	O_3	N_2	.446		.3	2.144		
Pentaborane	B_5H_9	N_2	.26		.38	2.816		KR
Pentane	C_5HI_2	N_2	.21		.398	3.219		KR
Perchloryl Fluoride	ClO_3F	N_2	.39		.1514	4.571		KR
Perfluoropropane	C_3F_8	N_2	.174		.197	8.388		KR
Phosgene	$COCl_2$	N_2	.44		.1394	4.418		KR
Phosphine	PH_3	N_2	1.070		.2374	1.517		KR
Phosphorous Oxychloride	$POCl_3$	N_2	.36		.1324	6.843		KR
Phosphorous Pentafluoride	PH_5	N_2	.30		.1610	5.620		KR
Phosphorous Trichloride	PCl_5	N_2	.30		.1250	6.127		KR
Propane	C_3H_8	N_2	.36		.3885	1.967		KR
Propylene	C_3H_6	N_2	.41		.3541	1.877		KR
Silane	SiH_4	N_2	.60		.3189	1.433		KR
Silicon Tetrachloride	$SiCl_4$	N_2	.28		.1270	7.580		KR
Silicon Tetrafluoride	SiF_4	N_2	.35		.1691	4.643		KR
Sulfur Dioxide	So_2	N_2	.69		.1488	2.858		KR
Sulfur Hexafluoride	SF_6	N_2	.26		.1592	6.516		KR
Sulfuryl Fluoride	SO_2F_2	N_2	.39		.1543	4.562		KR
Teos		N_2	.090				KR	KR
Tetrafluorahydrazine	N_2F_4	N_2	.32		.182	4.64		KR
Trichlorofluormethane (Freon-11)	CCl_3F	N_2	.33		.1357	6.129		KR
Trichlorisilane	$SiHCl_3$	N_2	.33		.1380	6.043		KR
1,1,2-Trichloro-1,2,2 Trifluorethane (Freon-113)	CCl_2FCClF_2	N_2	.20		.161	8.360		KR
Trisobutyl Aluminum	$(C_4H_9)Al$	N_2	.061		.508	8.848		KR
Titanium Tetrachloride	$TiCl_4$	N_2	.27		.120	8.465		KR
Trichloro Ethylene	C_2HCl_3	N_2	.32		.163	5.95		KR
Trimethylamine	$(CH_3)_3N$	N_2	.28		.3710	2.639		KR
Tungsten Hexasfuoride	WF_6	N_2	.25		.0810	13.28	KR	Teflon
Uranium Hexafluoride	UF_6	N_2	.20		.0888	15.70		KR
Vinyl Bromide	CH_2CHBr	N_2	.46		.1241	4.772		KR
Vinyl Chloride	CH_2CHCl	N_2	.48		.12054	2.788		KR
Xenon	Xe	Ar	.993	1.44	.0378	5.858		