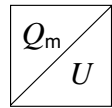


# Hot-film air-mass meter, type HFM 2

Measurement of air-mass throughflow up to 1080 kg/h



- Measurement of air mass (gas mass) throughflow per unit of time, independent of density and temperature.
- Extensive measuring range.
- Highly sensitive, particularly for small changes in flow rate.
- Wear-free since there are no moving parts.
- Insensitive to dirt and contamination.



## Application

Measurement of air-mass flow rate to provide data needed for clean combustion. Air-mass meters are suitable for use with other gaseous mediums.

## Design and function

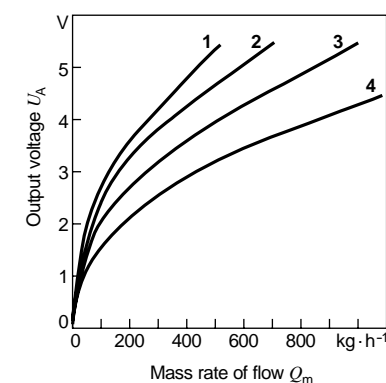
The sensor element comprises a ceramic substrate containing the following thick-film resistors which have been applied using silk-screen printing techniques: Air-temperature-sensor resistor  $R_\theta$ , heater resistor  $R_H$ , sensor resistor  $R_S$ , and trimmer resistor  $R_1$ .

The heater resistor  $R_H$  maintains the platinum metallic-film resistor  $R_S$  at a constant temperature above that of the incoming air. The two resistors are in close thermal contact.

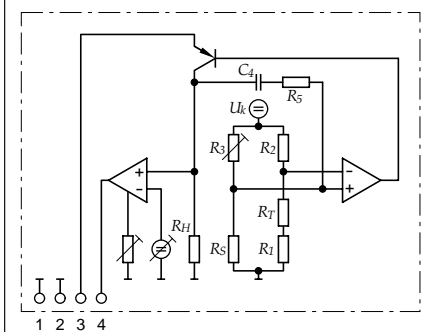
The temperature of the incoming air influences the resistor  $R_\theta$  with which the trimmer resistor  $R_1$  is connected in series. Throughout the complete operating-temperature range it compensates for the bridge circuit's temperature sensitivity. Together with  $R_2$  and  $R_\theta$ ,  $R_1$  forms one arm of the bridge circuit, while the auxiliary resistor  $R_3$  and sensor resistor  $R_S$  form the other arm. The difference in voltage between the two arms is tapped off at the bridge diagonal and used as the measurement signal. The evaluation circuit is contained on a second thick-film substrate. Both hybrids are integrated in the plastic housing of the plug-in sensor.

The hot-film air-mass meter is a thermal flowmeter. The film resistors on the ceramic substrate are exposed to the air mass under measurement. For reasons associated with flow, this sensor is far less sensitive to contamination than, for example, a hot-wire air-mass meter, and there is no need for the ECU to incorporate a self-cleaning burn-off function.

Characteristic curves.



Operating principle.



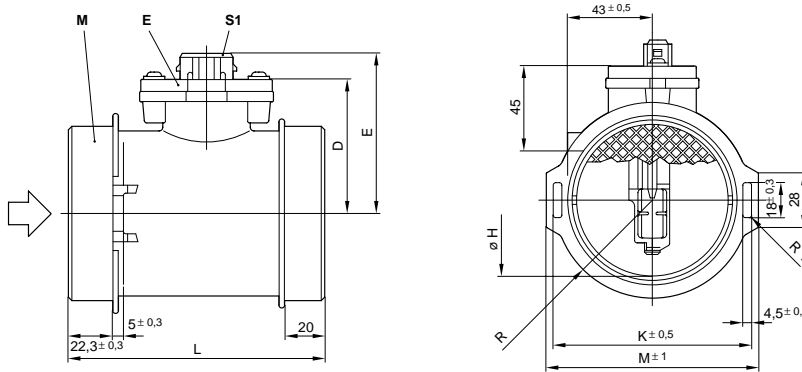
## Technical data / Range

Part number	0 280 217 102	0 280 217 120	0 280 217 519	0 280 217 801
Characteristic curve	1	2	3	4
Installation length L	mm	130	130	130
		96		
Air-flow measuring range	kg · h <sup>-1</sup>	10...350	10...480	12...640
				20...1080
Accuracy referred to measured value	%	±4	±4	±4
Supply voltage	V	14	14	14
Input current				
at 0 kg · h <sup>-1</sup>	A	≤ 0,25	≤ 0,25	≤ 0,25
at Q <sub>m nom.</sub>	A	≤ 0,8	≤ 0,8	≤ 0,8
Time constant <sup>1)</sup>	ms	≤20	≤20	≤20
Temperature range				
Sustained	°C	-30...+110	-30...+110	-30...+110
Short-term	°C	-40...+125	-40...+125	-40...+125
Pressure drop				
at nominal air mass	hPa			
	mbar	<15	<15	<15
Vibration acceleration				
max.	m · s <sup>-2</sup>	150	150	150

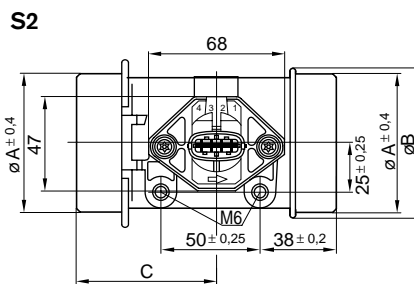
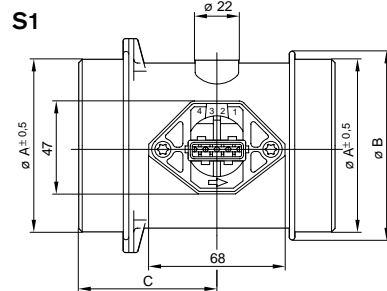
<sup>1)</sup> In case of sudden increase of the air-mass flow from 10 kg · h<sup>-1</sup> auf 0.7 Q<sub>m nominal</sub>, time required to reach 63% of the final value of the air-mass signal.

**Dimension drawings.**

E Plug-in sensor, M Measurement venturi, S1/S2 Plug connection

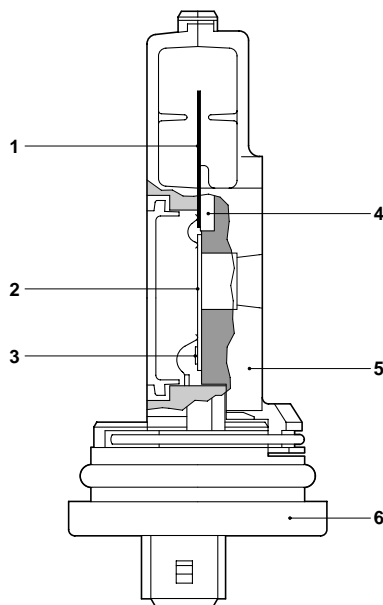


Ø A	Ø B	C	D	E	H	K	L	M	R	Measure- ment venturi	Plug-in connection	Part number
66	70	73	86	33	75	130	82	37	KS	S1	<b>0 280 217 102</b>	
70	76	50	69	82	34.8	–	96	–	42	KS	S1	<b>0 280 217 107</b>
70	76	70	69	82	33.5	85	130	92	42	KS	S2	<b>0 280 217 120</b>
80	86	70	73	86	39	–	130	–	–	KS	S2	<b>0 280 217 519</b>
95.6	102	70	76.2	91.2	45	110	130	117	54	Alu	S1	<b>0 280 217 801</b>



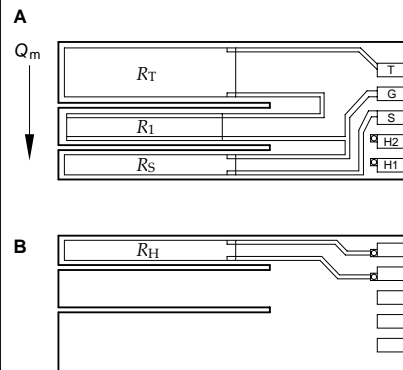
**Plug-in sensor.**

1 Sensor, 2 Hybrid, 3 Power module,  
4 Mounting plate, 5 Heat sink, 6 Plug housing



**Sensor element with thick-film resistors.**

$Q_M$  Mass rate of flow,  $R_1$  Trimmer resistor,  
 $R_H$  Heater resistor,  $R_S$  Sensor resistor,  
 $R_T$  Air-temperature measuring resistor,  
A Front, B Rear



**Installation instructions**

Water and other liquids must not collect in the measurement venturi. The measurement venturi must therefore be inclined by at least 5° relative to the horizontal. Since care must be taken that the intake air is free of dust, it is imperative that an air filter is fitted.

**Explanation of symbols:**

- $R_1$  Trimmer resistor
- $R_2, R_3$  Auxiliary resistors
- $R_5, C_4$  RC element
- $R_H$  Heater resistor
- $R_S$  Platinum metal-film resistor
- $R_T$  Resistance of the air-temperature-sensor resistor
- $U_K$  Bridge supply voltage
- $U_A$  Output voltage
- $U_V$  Supply voltage

**Connector-pin assignment**

- Pin 1 Ground
- Pin 2  $U_A(-)$
- Pin 3  $U_V$
- Pin 4  $U_A(+)$

**Accessories**

**For 0 280 217 102, .. 107, .. 801**

Plug housing	<b>1 284 485 118</b>
Receptacle	<b>1 284 477 121 1)</b>
Protective cap	<b>1 280 703 023 1)</b>

Each 4-pole plug requires 1 plug housing, 4 receptacles, and 1 protective cap.

1) Quantity 5 per package

**For 0 280 217 120, .. 519**

Designation	For conductor cross-section	Part number
-------------	-----------------------------	-------------

Plug housing	–	<b>1 928 403 112</b>
Contact pin	0.5...1.0 mm <sup>2</sup>	<b>1 987 280 103</b>
Individual gasket	1.5...2.5 mm <sup>2</sup>	<b>1 987 280 105</b>
Individual gasket	0.5...1.0 mm <sup>2</sup>	<b>1 987 280 106</b>
Individual gasket	1.5...2.5 mm <sup>2</sup>	<b>1 987 280 107</b>

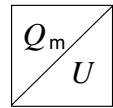
Each 4-pole plug requires 1 plug housing, 4 contact pins, and 4 individual gaskets.

**Note**

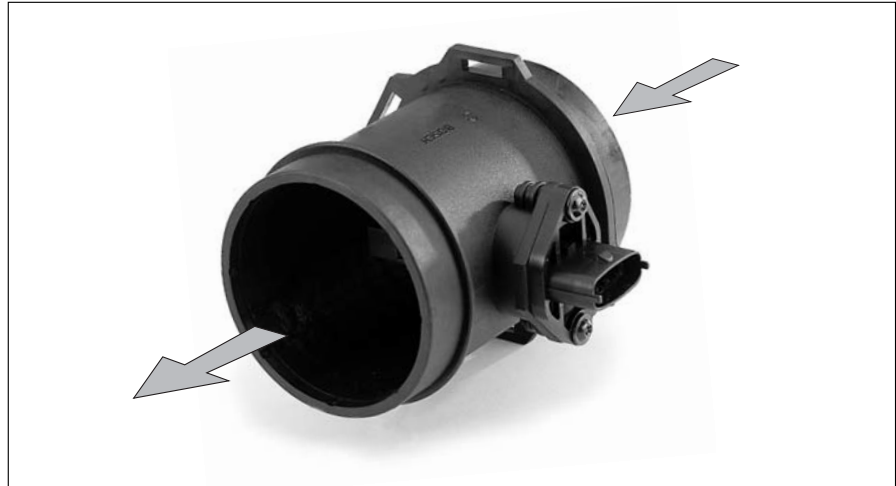
For automotive applications, original AMP crimping tools must be used.

# Hot-film air-mass meter, Type HFM 5

Measurement of air-mass throughflow up to 1000 kg/h



- Compact design.
- Low weight.
- Rapid response.
- Low power input.
- Return-flow detection.



## Application

In order to comply with the vehicle emission limits demanded by law, it is necessary to maintain a given air/fuel ratio exactly.

This requires sensors which precisely register the actual air-mass flow and output a corresponding electrical signal to the open and closed-loop control electronics.

## Design

The micromechanical sensor element is located in the plug-in sensor's flow passage. This plug-in sensor is suitable for incorporating in the air filter or, using a measurement venturi, in the air-intake passages. There are different sizes of measurement venturi available depending upon the air throughflow. The micromechanical measuring system uses a hybrid circuit, and by evaluating the measuring data is able to detect when return flow takes place during air-flow pulsation.

## Operating principle

The heated sensor element in the air-mass meter dissipates heat to the incoming air. The higher the air flow, the more heat is dissipated. The resulting temperature differential is a measure for the air mass flowing past the sensor.

An electronic hybrid circuit evaluates this measuring data so that the air-flow quantity can be measured precisely, and its direction of flow.

Only part of the air-mass flow is registered by the sensor element. The total air mass flowing through the measuring tube is determined by means of calibration, known as the characteristic-curve definition.

## Technical data / range

Nominal supply voltage $U_N$	14 V
Supply-voltage range $U_V$	8...17 V
Output voltage $U_A$	0...5 V
Input current $I_V$	< 0.1 A
Permissible vibration acceleration	≤ 150 ms <sup>-2</sup>
Time constant $\tau_{63}^{1)}$	≤ 15 ms
Time constant $\tau_{\Delta}^{2)}$	≤ 30 ms
Temperature range	-40...+120 °C <sup>3)</sup>

Part number	0 280 217 123	0 280 218 019	0 280 217 531	0 280 218 008	0 281 002 421
Measuring range $Q_m$	8...370 kg/h	10...480 kg/h	12...640 kg/h	12...850 kg/h	15...1000 kg/h
Accuracy <sup>4)</sup>	≤ 3%	≤ 3%	≤ 3%	≤ 3%	≤ 3%
Fitting length $L_E$	22 mm	22 mm	22 mm	16 mm	22 mm
Fitting length $L_A$	20 mm	20 mm	20 mm	16 mm	20 mm
Installation length $L$	96 mm	96 mm	130 mm	100 mm	130 mm
Connection diam. D	60 mm	70 mm	80 mm	86/84 mm <sup>6)</sup>	92 mm
Venturi ID	50 mm	62 mm	71 mm	78 mm	82 mm
Pressure drop at nominal air mass <sup>5)</sup>	< 20 hPa	< 15 hPa	< 15 hPa	< 15 hPa	< 15 hPa
Temperature sensor	Yes	Yes	Yes	No	Yes
Version	1	2	3	4	5

<sup>1)</sup> In case of sudden increase of the air-mass flow from 10 kg · h<sup>-1</sup> auf 0,7  $Q_{m,nominal}$ , time required to reach 63% of the final value of the air-mass signal.

<sup>2)</sup> Period of time in case of a throughflow jump of the air mass  $|\Delta m/m| \leq 5\%$ .

<sup>3)</sup> For a short period up to +130 °C.

<sup>4)</sup>  $|\Delta Q_m/Q_m|$ : The measurement deviation  $\Delta Q_m$  from the exact value, referred to the measured value  $Q_m$ .

<sup>5)</sup> Measured between input and output

<sup>6)</sup> Inflow/outflow end

## Accessories for connector

Plug housing	Contact pins	Individual gaskets	For conductor cross-section
<b>1 928 403 836</b>	<b>1 987 280 103</b>	<b>1 987 280 106</b>	0.5...1 mm <sup>2</sup>
	<b>1 987 280 105</b>	<b>1 987 280 107</b>	1.5...2.5 mm <sup>2</sup>

Note: Each 5-pole plug requires 1 plug housing, 5 contact pins, and 5 individual gaskets.  
For automotive applications, original AMP crimping tools must be used.

## Application

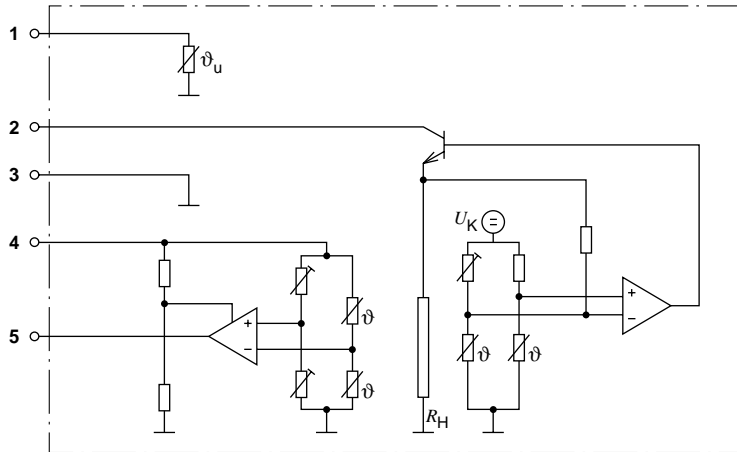
In internal-combustion engines, this sensor is used for measuring the air-mass flow so that the injected fuel quantity can be adapted to the presently required power, to the air pressure, and to the air temperature.

## Explanation of symbols

$Q_m$	Air-mass flow rate
$\Delta Q_m$	Absolute accuracy
$\Delta Q_m/Q_m$	Relative accuracy
$\tau_{\Delta}$	Time until measuring error is ≤ 5%
$\tau_{63}$	Time until measured-value change 63%

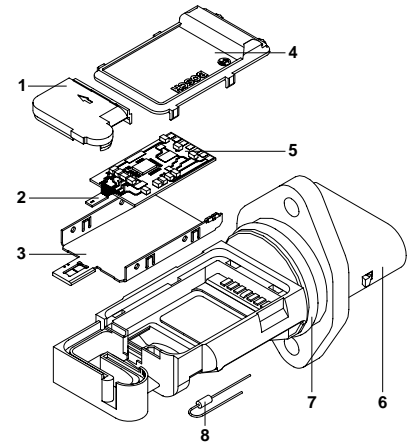
**Function diagram with connector-pin assignment.**

1 Additional temperature sensor  $\vartheta_u$  (not on version 4, Part number 0 280 218 008),  
 2 Supply voltage  $U_V$ , 3 Signal ground, 4 Reference voltage 5 V, 5 Measurement signal  $U_A$ .  
 $\vartheta$  Temperature-dependence of the resistor,  $R_H$  Heater resistor,  $U_K$  Constant voltage



**HFM 5 plug-in sensor design.**

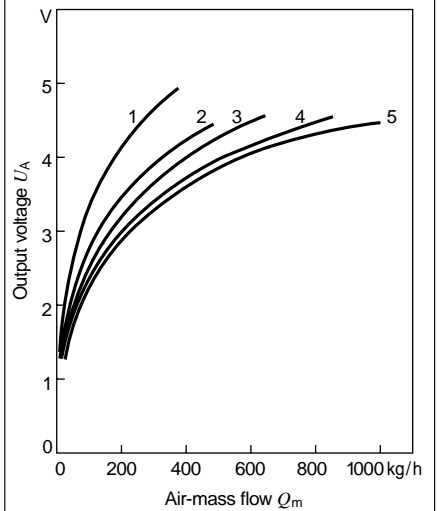
1 Measuring-passage cover, 2 Sensor, 3 Mounting plate, 4 Hybrid-circuit cover,  
 5 Hybrid, 6 Plug-in sensor, 7 O-ring, 8 Auxiliary temperature sensor.



**Output voltage  $U_A = f(Q_m)$  of the air-mass meter**

Part number	0 280 217 123	0 280 218 019	0 280 217 531	0 280 218 008	0 280 002 421
Characteristic curve	1	2	3	4	5
$Q_m$ /kg/h	$U_A$ /V	$U_A$ /V	$U_A$ /V	$U_A$ /V	$U_A$ /V
8	1.4837	1.2390	-	-	-
10	1.5819	1.3644	1.2695	-	-
15	1.7898	1.5241	1.4060	1.3395	1.2315
30	2.2739	1.8748	1.7100	1.6251	1.4758
60	2.8868	2.3710	2.1563	2.0109	1.8310
120	3.6255	2.9998	2.7522	2.5564	2.3074
250	4.4727	3.7494	3.5070	3.2655	2.9212
370	4.9406	4.1695	3.9393	3.6717	3.2874
480	-	4.4578	4.2349	3.9490	3.5461
640	-	-	4.5669	4.2600	3.8432
850	-	-	-	4.5727	4.1499
1000	-	-	-	-	4.3312

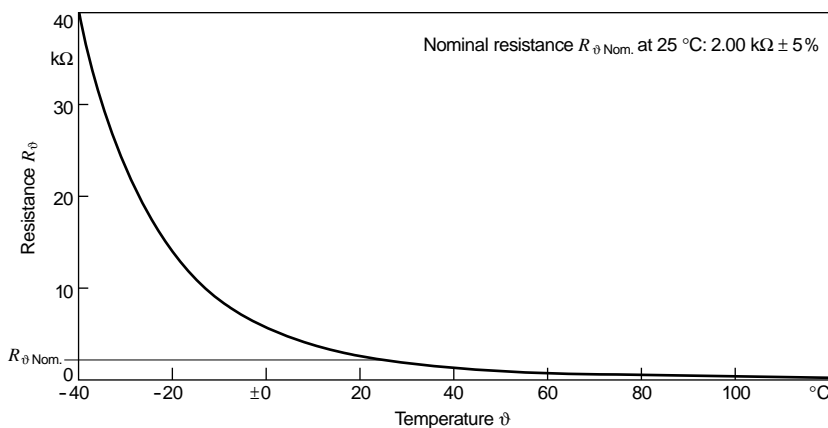
**Air-mass meter output voltage.**



**Temperature-dependence  $R_\vartheta = f(\vartheta)$  of the temperature sensor**

Temperature $\vartheta$ °C	-40	-30	-20	-10	$\pm 0$	10	20	30	40
Resistance $R_\vartheta$ k $\Omega$	39.26	22.96	13.85	8.609	5.499	3.604	2.420	1.662	1.166
Temperature $\vartheta$ °C	50	60	70	80	90	100	110	120	130
Resistance $R_\vartheta$ $\Omega$	835	609	452	340	261	202	159	127	102

**Temperature-resistance diagram of the temperature sensor.**



**Dimensions overview of the HFM 5.**

1 Plug-in sensor, 2 Throughflow direction, 3 Measurement venturi.

