

## 8.2 Air-mass sensors HFM with digital interface



### Product type

**HFM-7**

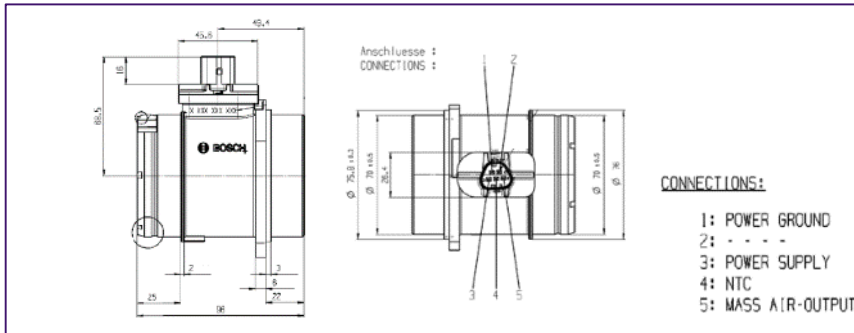
### Part number

**0 280 218 225**

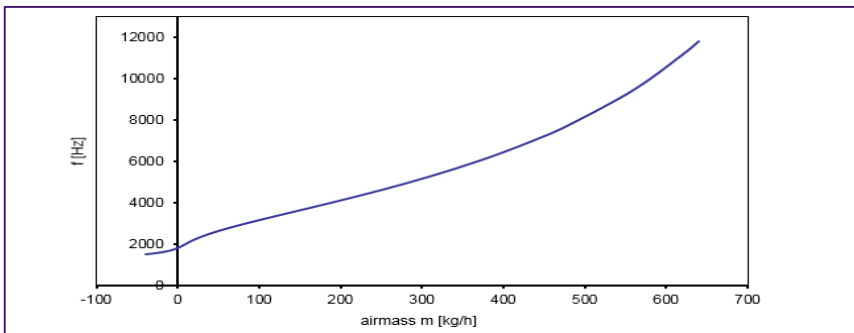
### Picture



### Dimensional drawings



### Air-mass characteristic curve at ambient temperature



### Technical data

Features	With ambient-temperature sensor.	
Nominal airflow	$\dot{m}_N$	480 kg/h
Measuring range	$\dot{m}_N$	-40 ... 620 kg/h
Rated supply voltage	$U_N$	14 V
Supply-voltage range	$U_V$	6 ... 17 V
Relative accuracy <sup>1)</sup>	$\Delta \dot{m} / \dot{m}$	$\pm 5 \%$
Temperature range <sup>2)</sup>	$^{\circ}\text{C}$	-40 ... +120
Pressure drop at $\dot{m}_N$	$\Delta p$	< 12 hPa
Current input	$I_V$	< 0,06 A
Time constant	$\tau_{63}$ <sup>3)</sup>	$\leq 10$ ms
Time constant	$\tau\Delta$ <sup>4)</sup>	$\leq 30$ ms

1) for  $0,04 \leq \Delta \dot{m} / \dot{m}_N \leq 1,3$

2) short-time ( $\leq 3$  min.) to  $130^{\circ}\text{C}$

3) Time required for step response of output voltage to 63 % of final value given an abrupt change in air mass from 10 kg/h to 310 kg/h

4) Delay on switch-on and after any change in flow rate until the output voltage has attained the relative measurement deviation  $|\Delta \dot{m} / \dot{m}| \leq 5 \%$ .



## 8.2 Air-mass sensors HFM with digital interface



### Product type

**HFM-7**

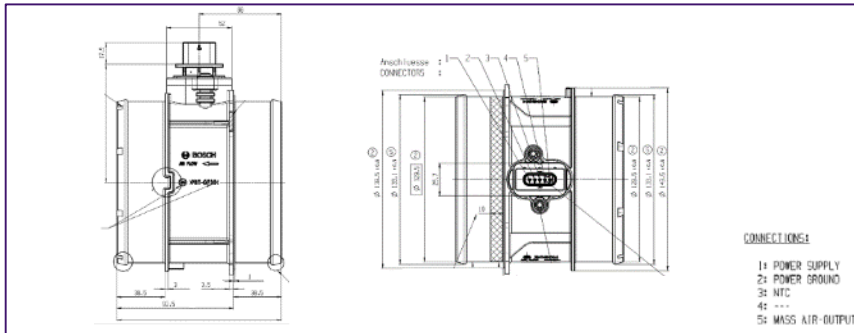
### Part number

**0 281 006 275**

### Picture



### Dimensional drawings



### Air-mass characteristic curve at ambient temperature

Due to the replacement concept of the HFM plug-in, it has to be calibrated individually, w/o cylinder housing. Since these characteristic curves depend on the specific layout of the air intake system, no characteristic curves of the assembly can be given here.

### Technical data

Features	With ambient-temperature sensor.	
Nominal airflow	$\dot{m}_N$	2300 kg/h
Measuring range	$\dot{m}_N$	-140 ... 2900 kg/h
Rated supply voltage	$U_N$	14 V
Supply-voltage range	$U_V$	6 ... 17 V
Relative accuracy <sup>1)</sup>	$\Delta \dot{m} / \dot{m}$	± 5 %
Temperature range <sup>2)</sup>	°C	-40 ... +120
Pressure drop at $\dot{m}_N$	$\Delta p$	< 15 hPa
Current input	$I_V$	< 0,08 A
Time constant	$\tau_{63}$ <sup>3)</sup>	≤ 10 ms
Time constant	$\tau\Delta$ <sup>4)</sup>	≤ 30 ms

1) for  $0,04 \leq \Delta \dot{m} / \dot{m}_N \leq 1,3$

2) short-time (≤ 3 min.) to 130 °C

3) Time required for step response of output voltage to 63 % of final value given an abrupt change in air mass from 10 kg/h to 310 kg/h

4) Delay on switch-on and after any change in flow rate until the output voltage has attained the relative measurement deviation  $|\Delta \dot{m} / \dot{m}| \leq 5 \%$ .

### Accessories

Connector housing	4-pin	1 928 403 736
Contact pins	For Ø 0.5...1.0 mm <sup>2</sup> ; Contents: 100 x	1 928 498 056
Contact pins	For Ø 1.5...2.5 mm <sup>2</sup> ; Contents: 100 x	1 928 498 057
Single-wire seal	For Ø 0.5...1.0 mm <sup>2</sup> ; Contents: 10 x	1 928 300 599
Single-wire seal	For Ø 1.5...2.5 mm <sup>2</sup> ; Contents: 10 x	1 928 300 600
Dummy plug		1 928 300 601

Accessories are not included in the scope of delivery of the sensor and therefore to be ordered separately as required.

## 8.2 Air-mass sensors HFM with digital interface

### Product type

**HFM-7-IPH**

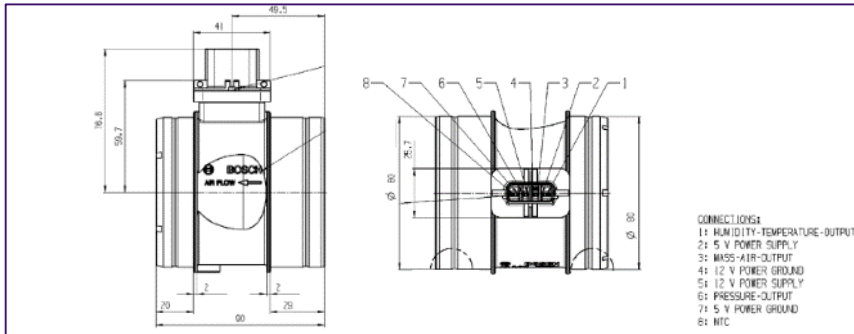
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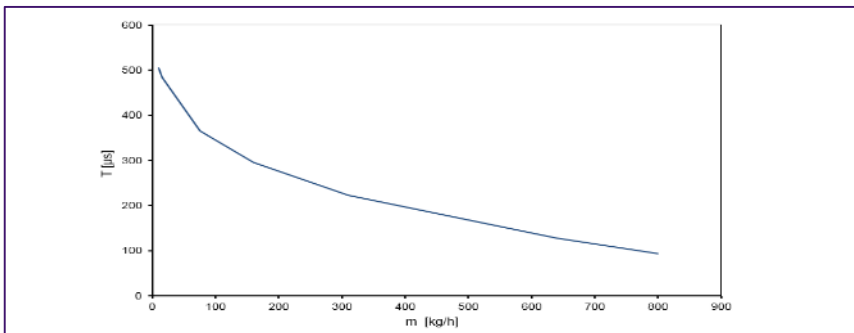
### Picture



### Dimensional drawings



### Air-mass characteristic curve at ambient temperature



### Technical data

Features	With integrated pressure, humidity and ambient-temperature sensor.	
Nominal airflow	$\dot{m}_N$	640 kg/h
Measuring range airflow	$\dot{m}_N$	-40 ... 800 kg/h
Measuring range pressure	kPa	12,5 ... 115
Measuring range humidity	%rH	10 ... 90
Rated supply voltage	$U_N$	14 V
Supply-voltage range	$U_V$	6 ... 17 V
Relative accuracy <sup>1)</sup>	$\Delta \dot{m} / \dot{m}$	± 5 %
Temperature range <sup>2)</sup>	°C	-40 ... +120
Pressure drop at $\dot{m}_N$	$\Delta p$	< 12 hPa
Current input	$I_V$	< 0,06 A
Time constant	$\tau_{63}$ <sup>3)</sup>	≤ 25 ms
Time constant	$\tau\Delta$ <sup>4)</sup>	≤ 30 ms

1) for  $0,04 \leq \Delta \dot{m} / \dot{m} \leq 1,3$

2) short-time (≤ 3 min.) to 130 °C

3) Time required for step response of output voltage to 63 % of final value given an abrupt change in air mass from 10 kg/h to 310 kg/h

4) Delay on switch-on and after any change in flow rate until the output voltage has attained the relative measurement deviation  $|\Delta \dot{m} / \dot{m}| \leq 5 \%$ .

## 8.2 Air-mass sensors

### HFM with digital interface



#### Product type

**HFM-7-SF-IPH**

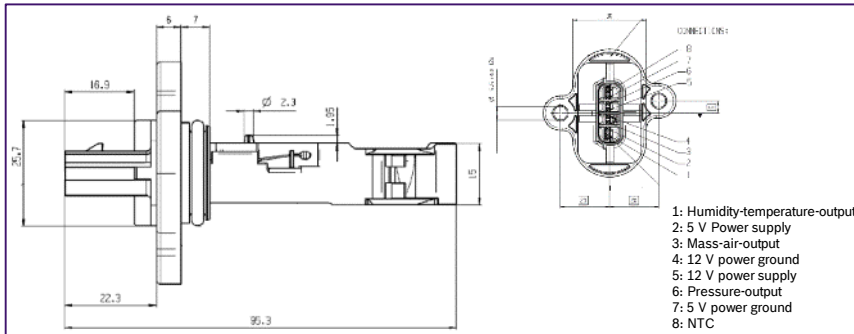
#### Part number

**0 280 218 419**

#### Picture



#### Dimensional drawings

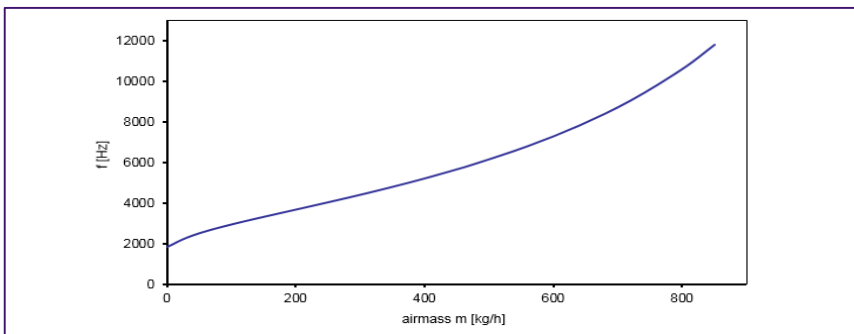


#### Technical data

Features	With integrated pressure, humidity and ambient-temperature sensor.	
Nominal airflow	$\dot{m}_N$	640 kg/h
Measuring range airflow	$\dot{m}_N$	-60 ... 800 kg/h
Measuring range pressure	kPa	12,5 ... 115
Measuring range humidity	%rH	10 ... 90
Rated supply voltage	$U_N$	14 V
Supply-voltage range	$U_V$	6 ... 17 V
Relative accuracy <sup>1)</sup>	$\Delta \dot{m} / \dot{m}$	$\pm 5 \%$
Temperature range <sup>2)</sup>	°C	-40 ... +120
Pressure drop at $\dot{m}_N$	$\Delta p$	depending on size and design of cross section area
Current input	$I_V$	< 0,06 A
Time constant	$\tau_{63}$ <sup>3)</sup>	$\leq 25$ ms
Time constant	$\tau\Delta$ <sup>4)</sup>	$\leq 80$ ms

- 1) for  $0,04 \leq \Delta \dot{m} / \dot{m}_N \leq 1,3$
- 2) short-time ( $\leq 3$  min.) to 130 °C
- 3) Time required for step response of output voltage to 63 % of final value given an abrupt change in air mass from 10 kg/h to 310 kg/h
- 4) Delay on switch-on and after any change in flow rate until the output voltage has attained the relative measurement deviation  $|\Delta \dot{m} / \dot{m}| \leq 5 \%$ .

#### Air-mass characteristic curve at ambient temperature



## 8.2 Air-mass sensors

### HFM with digital interface



#### Product type

**HFM-7-SF**

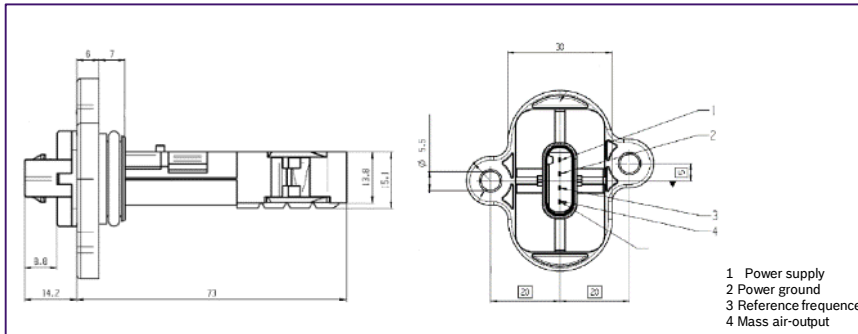
#### Part number

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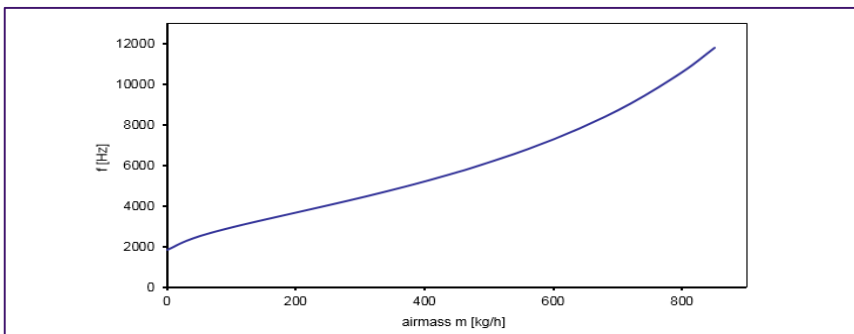
#### Picture



#### Dimensional drawings



#### Air-mass characteristic curve at ambient temperature



#### Technical data

Features	With ambient-temperature sensor.	
Nominal airflow	$\dot{m}_N$	640 kg/h
Measuring range	$\dot{m}_N$	-60 ... 800 kg/h
Rated supply voltage	$U_N$	14 V
Supply-voltage range	$U_V$	6 ... 17 V
Relative accuracy <sup>1)</sup>	$\Delta \dot{m} / \dot{m}$	± 5 %
Temperature range <sup>2)</sup>	°C	-40 ... +120
Pressure drop at $\dot{m}_N$	$\Delta p$	depending on size and design of cross section area
Current input	$I_V$	< 0,06 A
Time constant	$\tau_{63}$ <sup>3)</sup>	≤ 25 ms
Time constant	$\tau\Delta$ <sup>4)</sup>	≤ 80 ms

1) for  $0,04 \leq \Delta \dot{m} / \dot{m} \leq 1,3$

2) short-time (≤ 3 min.) to 130 °C

3) Time required for step response of output voltage to 63 % of final value given an abrupt change in air mass from 10 kg/h to 310 kg/h

4) Delay on switch-on and after any change in flow rate until the output voltage has attained the relative measurement deviation  $|\Delta \dot{m} / \dot{m}| \leq 5 \%$ .

## 8.2 Air-mass sensors HFM with digital interface



### Product type

**HFM-8-SF-PTH**

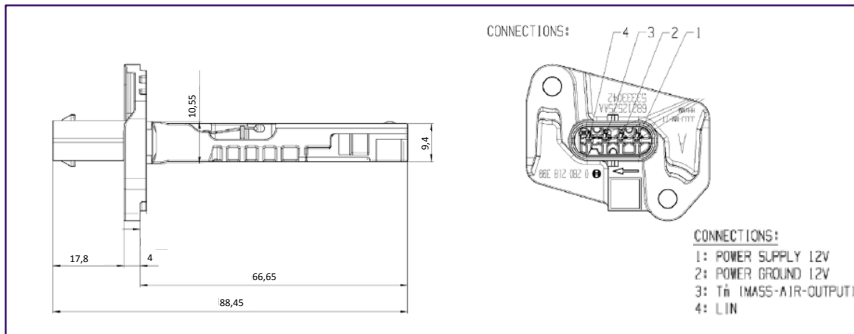
### Part number

**0 280 218 399**

### Picture



### Dimensional drawings



### Technical data

Features	With integrated pressure, humidity and ambient-temperature sensor.	
Nominal airflow	$\dot{m}_N$	640 kg/h
Measuring range airflow	$\dot{m}_N$	-60 ... 1150 kg/h
Measuring range pressure	kPa	10 ... 125
Measuring range humidity	%rH	0 ... 100
Rated supply voltage	$U_N$	5 V
Supply-voltage range	$U_V$	4,85 ... 5,15 V
Relative accuracy <sup>1)</sup>	$\Delta \dot{m} / \dot{m}$	$\pm 5 \%$
Temperature range <sup>2)</sup>	°C	-40 ... +140
Pressure drop at $\dot{m}_N$	$\Delta p$	depending on size and design of cross section area
Current input	$I_V$	< 0,06 A
Time constant	$\tau_{63}$ <sup>3)</sup>	$\leq 10$ ms
Time constant	$\tau\Delta$ <sup>4)</sup>	$\leq 30$ ms

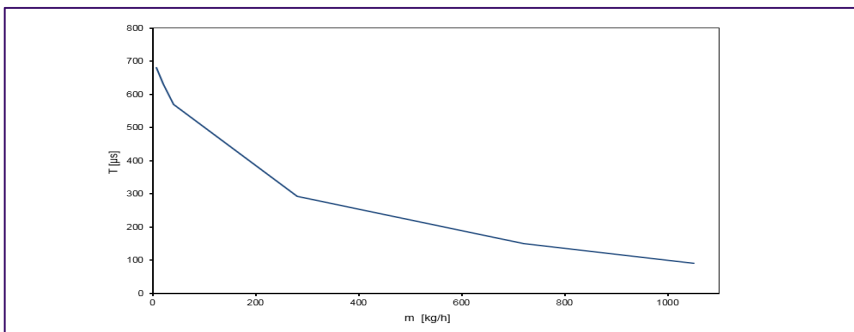
1) for  $0,04 \leq \Delta \dot{m} / \dot{m} \leq 1,3$

2) short-time ( $\leq 3$  min.) to 130 °C

3) Time required for step response of output voltage to 63 % of final value given an abrupt change in air mass from 10 kg/h to 310 kg/h

4) Delay on switch-on and after any change in flow rate until the output voltage has attained the relative measurement deviation  $|\Delta \dot{m} / \dot{m}| \leq 5 \%$ .

### Air-mass characteristic curve at ambient temperature



## 8.2 Air-mass sensors HFM with digital interface

### Product type

**HFM-8-SF-TH**

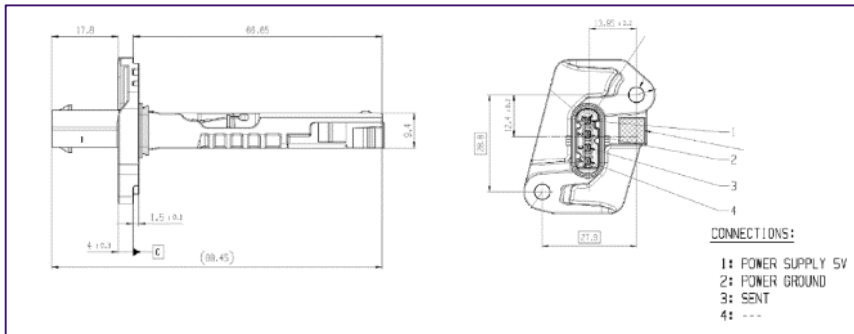
### Part number

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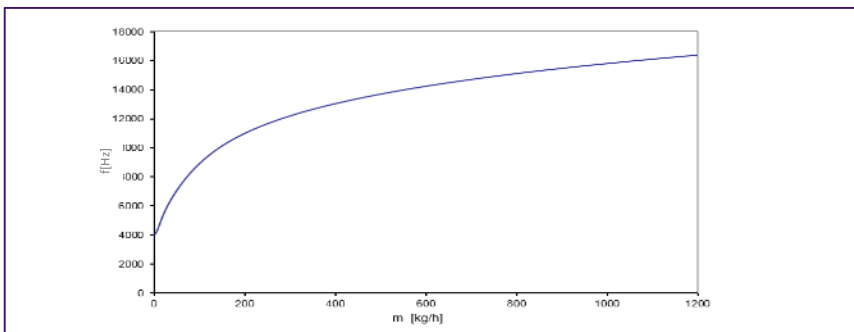
### Picture



### Dimensional drawings



### Air-mass characteristic curve at ambient temperature



### Technical data

Features	With integrated humidity and ambient-temperature sensor.	
Nominal airflow	$\dot{m}_N$	640 kg/h
Measuring range airflow	$\dot{m}_N$	-60 ... 1200 kg/h
Measuring range humidity	%rH	0 ... 100
Rated supply voltage	$U_N$	5 V
Supply-voltage range	$U_V$	4,85 ... 5,15 V
Relative accuracy <sup>1)</sup>	$\Delta \dot{m} / \dot{m}$	± 5 %
Temperature range <sup>2)</sup>	°C	-40 ... +130
Pressure drop at $\dot{m}_N$	$\Delta p$	depending on size and design of cross section area
Current input	$I_V$	< 0,06 A
Time constant	$\tau_{63}$ <sup>3)</sup>	≤ 10 ms
Time constant	$\tau\Delta$ <sup>4)</sup>	≤ 30 ms

1) for  $0,04 \leq \Delta \dot{m} / \dot{m}_N \leq 1,3$

2) short-time (≤ 3 min.) to 130 °C

3) Time required for step response of output voltage to 63 % of final value given an abrupt change in air mass from 10 kg/h to 310 kg/h

4) Delay on switch-on and after any change in flow rate until the output voltage has attained the relative measurement deviation  $|\Delta \dot{m} / \dot{m}| \leq 5 \%$ .

# 9.1 Lambda sensors

## Type LSU 4.9 (wideband)



- ▶ The wideband Lambda sensor LSU is a planar  $ZrO_2$  dual-cell limit current sensor with integrated heater.
- ▶ It is used for measuring the oxygen content and the  $\lambda$  value of exhaust gases in vehicle engines.
- ▶ Thanks to a steady characteristic curve in the range  $\lambda = 0.65$  to air, it is universally applicable for  $\lambda = 1$  and for other  $\lambda$  ranges.



### Application

#### Engine management

- Gas engines
- Combined heat and thermal power units (CHP)
- Diesel engines
- Gasoline engines
- Lean combustion engines

#### Industrial processes

- Tempering furnaces
- Chemical industry
- Packaging equipment
- Process engineering
- Drying plants
- Metallurgy

#### Measurement and analysis processes

- Flue gas measurement
- Gas analysis
- Determination of Wobbe index
- Incineration plants
- Wood
- Biomass

### Design and operation

The LSU broadband Lambda sensor is a planar  $ZrO_2$  dual-cell limit current sensor with integrated heater. It is suitable for measuring the oxygen content and the  $\lambda$  value of exhaust gases in vehicle engines (gasoline and diesel). A constant characteristic curve in the range from  $\lambda = 0.65$  to air makes it suitable for universal use for  $\lambda = 1$  and for other  $\lambda$  ranges. The connector module includes a trimming resistor, which determines the characteristics of the sensor and is necessary for the sensor to function. To function, the LSU requires special operating electronics (e.g. AWS. LA4 or IC CJ125 evaluation circuit) and may only be operated in conjunction with these. The Lambda sensor consists of two cells. It is made up of a Nernst type potentiometric oxygen concentration cell and an amperometric oxygen pump cell. Nernst cells have the property that oxygen ions diffuse through their ceramic

at high temperatures, as soon as there are differences in the partial oxygen pressure at both ends of the ceramic. The transport of ions results in an electrical voltage between them, which is measured using electrodes. The components of the exhaust gas diffuse through the diffusion duct to the electrodes for the pump and Nernst cell, where they are brought to thermodynamic equilibrium. Control electronics record the Nernst voltage  $U_N$  the concentration cell and supply the pump cell with a variable pump voltage  $U_P$ . If  $U_N$  takes on a value of less than 450 mV, the exhaust gas is lean and the pump cell is supplied with a current that causes oxygen to be pumped out of the duct. By contrast, if the exhaust gas is rich,  $U_N > 450$  mV and the flow direction is reversed, causing the cell to pump oxygen into the duct. An integrated module (CJ125) can be used for signal evaluation. As well as the controller for the pump flow and the controller that keeps the Nernst cell at 450 mV, this module includes an amplifier. The sensor element is manufactured using thick-film techniques, which results in production distribution. This means that the characteristic curves for different sensors will vary. At an oxygen concentration of 0%, the output voltage is a uniform 0 V, as when using the evaluation circuit. However, at air the voltage scatters between approx. 6 and 8 V. This means that each sensor has to be individually calibrated so that a clear relationship between the measured oxygen concen-

tration and the output voltage can be created. Calibration can be carried out on air in which the oxygen content is 20.9%. Calibration is recommended at each maintenance.

### Installation instructions

- Installation in exhaust gas pipes at a location exhibiting a representative exhaust gas composition given compliance with the specified temperature limits.
- The ceramic sensor element warms up rapidly after switching on the sensor heating. Once the ceramic element has warmed up, the occurrence of condensate, which could damage the hot ceramic sensor element, must be avoided.
- If possible, the installation position should be vertically upwards, however at least at an angle of  $10^\circ$  with respect to the horizontal. This prevents the accumulation of liquid between the sensor housing and sensor element. An angle of  $90^\circ$  is desirable, however no greater than  $90^\circ + 15^\circ$  gas inlet hole with respect to the exhaust gas flow or  $90^\circ - 30^\circ$ . Other angular positions are to be assessed separately if applicable.
- Tightening torque: 40 - 60 Nm, the material properties and strength of the thread must be designed accordingly.

### Explanation of characteristic quantities

- $\lambda$  Air ratio
- $U_N$  Nernst voltage
- $U_P$  Variable pump voltage

# 9.1 Lambda sensors

## Type LSU 4.9 (wideband)



### Product type

**LSU-4.9**

### Part number

**0 258 017 025**

### Picture

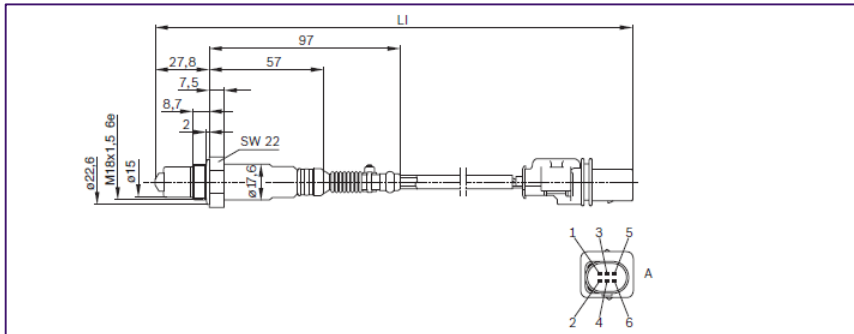


### Technical data

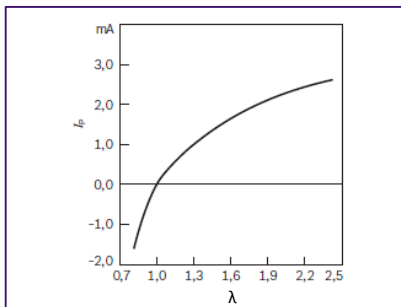
Due to the complexity of this product a detailed technical product Description is available. Please request it at:

[bosch.lambdasonde@de.bosch.com](mailto:bosch.lambdasonde@de.bosch.com)

### Dimensional drawings

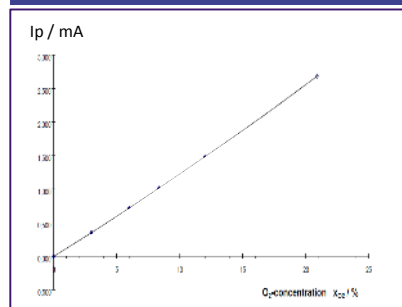


### Characteristic curve



$I_p$  = Pump current  
 $\lambda$  = Air ratio

### Characteristic curve



### Accessories

Mating connector parts set	Connector housing, contacts, grommet	1 986 280 016
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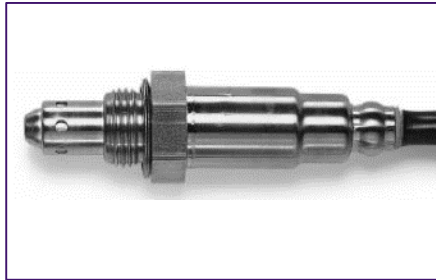
► [Product groups](#)

## 9.2 Lambda sensors

### Type LSF4 (narrow band)



► compared to the wideband lambda sensor LSU4.9 the narrow band LSF4 type is limited to applications in the near operation vicinity of  $\lambda=1$



#### Application

##### Engine management

- Gas engines
- Combined heat and thermal power units (CHP)
- Gasoline engines
- Lean combustion engines

##### Industrial processes

- Tempering furnaces
- Chemical industry
- Packaging equipment
- Process engineering
- Drying plants
- Metallurgy

##### Measurement and analysis processes

- Flue gas measurement
- Gas analysis
- Determination of Wobbe index
- Incineration plants
- Wood
- Biomass

#### Design and Application

The LSF4 lambda sensor operates according to the principle of a galvanic oxygen concentration cell with solid electrolyte. The sensor element is in the form of a long wafer with rectangular cross section. The measuring cell and the heater are integrated in this planar ceramic. The measuring cell's surfaces are coated with microporous layers of noble metal. On the one side, due to their catalytic activity, these layers define the sensor's characteristic curve, while on the other they serve as contact elements. On the surface of the ceramic exposed to the exhaust gas, the noble-metal electrode is protected by a porous ceramic layer which, across the whole operating-temperature range, prevents erosion damage due to the deposits in the exhaust gas. This protective layer is applied using sintering techniques and, due among other things to its perfect adhesion and structure, it guarantees a long service life and compliance with the high functional demands made upon the sensor.

The heater is a wave-shaped element and contains noble metals. It is insulated, and integrated in the ceramic wafer. Even at low heater inputs it ensures that the sensor heats up quickly. The Lambda sensor operates as a reference-gas sensor, and compares the residual oxygen in the exhaust gas with the oxygen in the reference atmosphere (air circulating inside the sensor). In the stoichiometric region of the air/fuel mixture ( $\lambda = 1$ ), there is a sudden jump in the sensor output voltage. The system is closed-loop controlled to  $\lambda = 1$  (two-state controller), and this voltage jump is evaluated in the 450...500 mV area of the system's characteristic curve. The following approximate values apply as guidelines for sensor voltage:

- rich mixture ( $\lambda < 1$ ) 800...1000 mV,
- lean mixture ( $\lambda > 1$ )
- in the area around 100 mV.

A prerequisite for efficient and reliable functioning is that the active sensor ceramic has a temperature of  $\approx 350$  °C. The integrated heater ensures that the sensor functions at exhaust-gas temperatures as low as 150 °C. Since this sensor's ceramic temperature is determined by the electrical heating at low engine loads (i.e. low exhaust-gas temperatures), this means that it can also be installed in the exhaust system at a point remote from the engine.

The electrical sensor heating means that the exhaust-gas temperature's influence on the sensor-ceramic temperature, and therefore upon the temperature-dependent sensor functions, are considerably reduced. In addition, the direct sensor heating ensures that the sensor element heats up so rapidly that lambda closed loop control can come into operation within 10 secs. after engine start. These advantages make an important contribution towards achieving low, stable exhaust-gas emission values.

#### Characteristics

- Field-proven,
- robust and compact,
- reliable,
- high-temperature-resistant up to 1000 °C exhaust-gas temperature
- resistant to stone impact,
- resistant to corrosion,
- isolated ground sensor signal circuit,
- submersible,
- low heater rating,
- resistant to coating and poisoning,
- stable control characteristic,
- short switch-on time.



