Bosch Powertrain Sensors

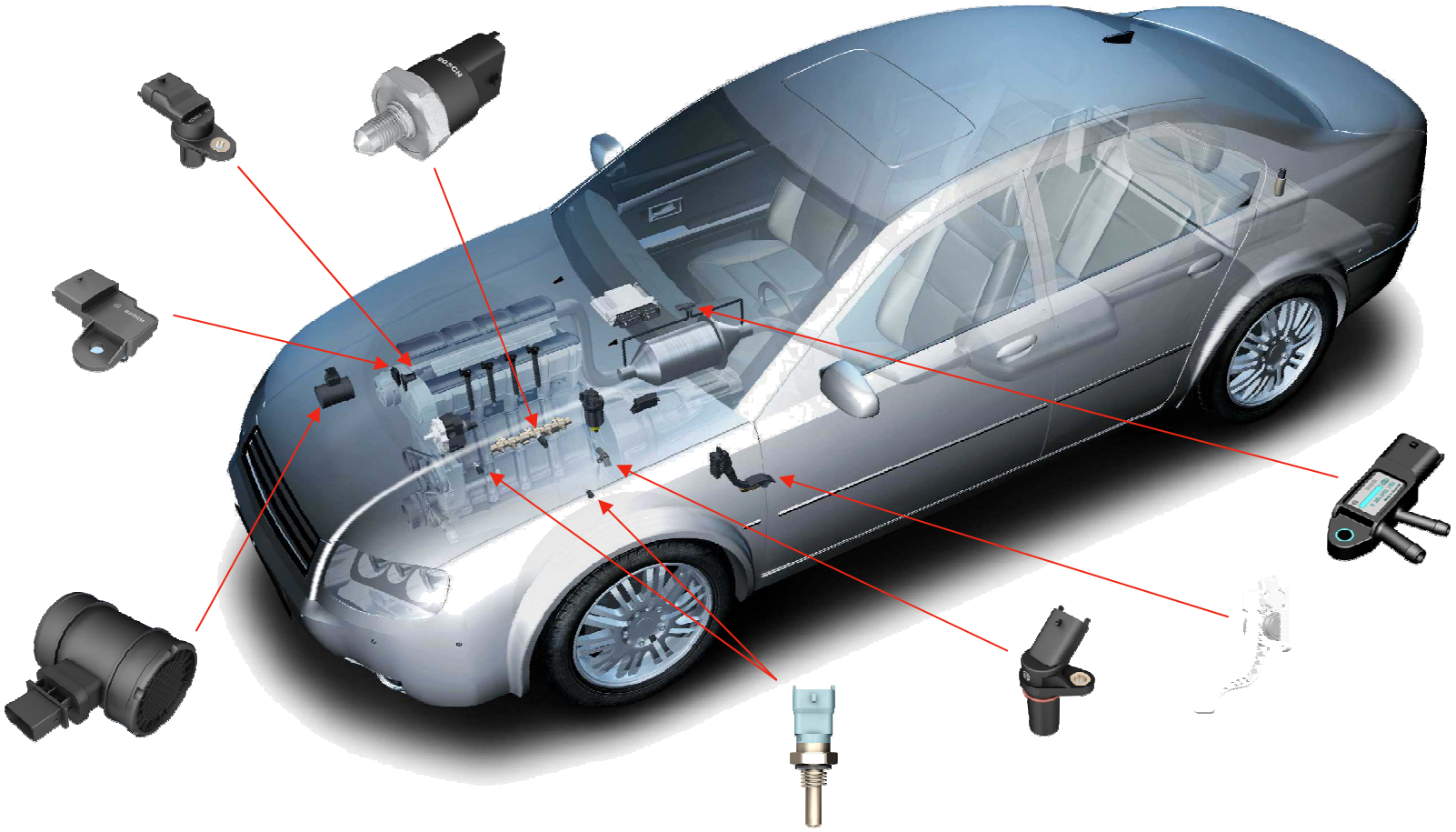
Sensor Training
28.10.07

We Engineer Automotive Sensors

Gasoline Systems

BOSCH

Diesel System



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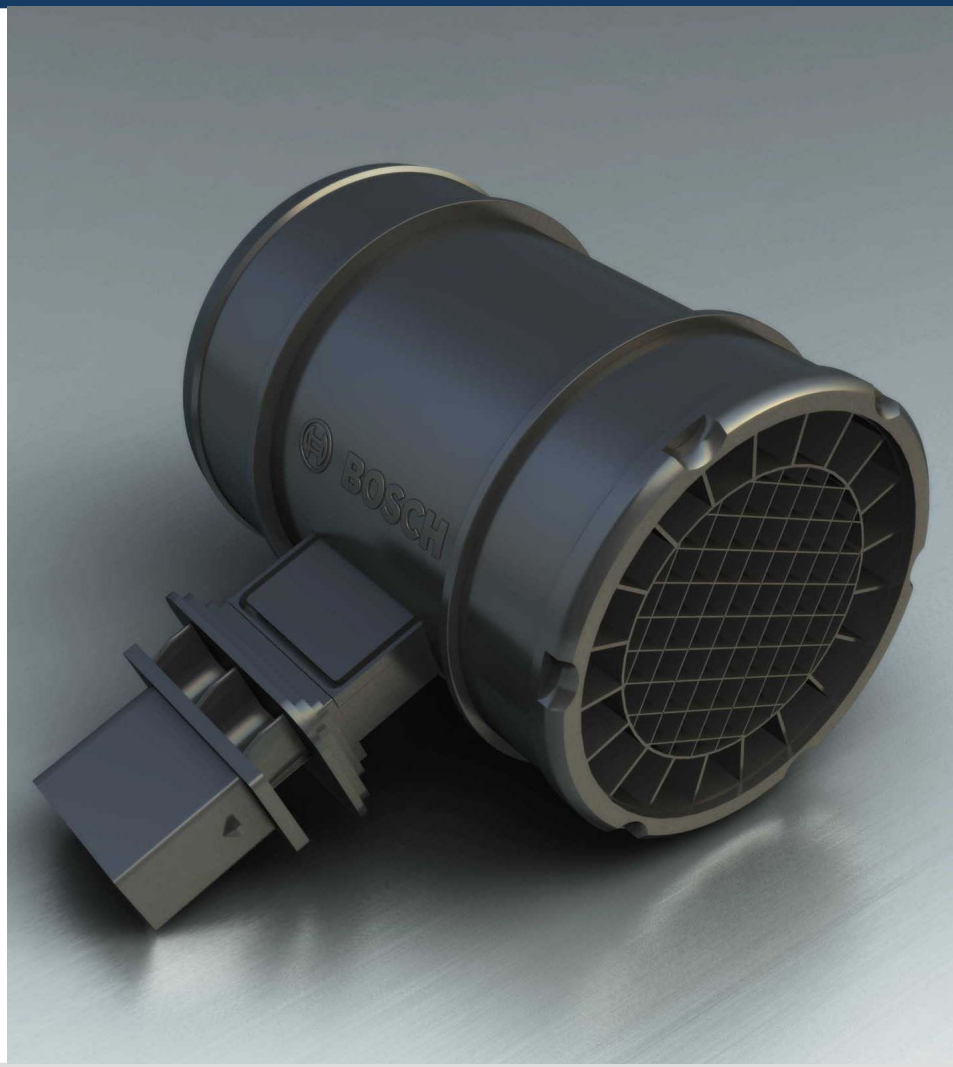
Agenda

- Features & Benefits
- Technical Overview HFM5/6/7



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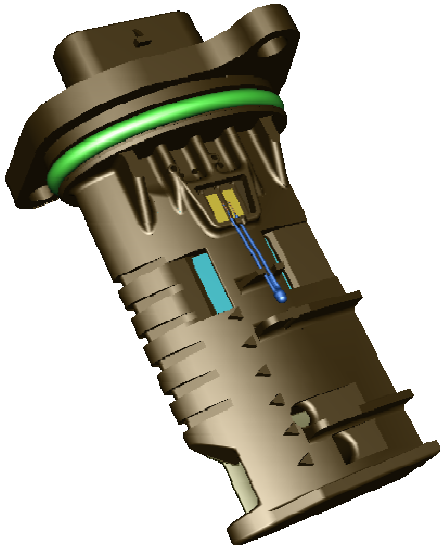
Hot-Film Mass Airflow Sensor



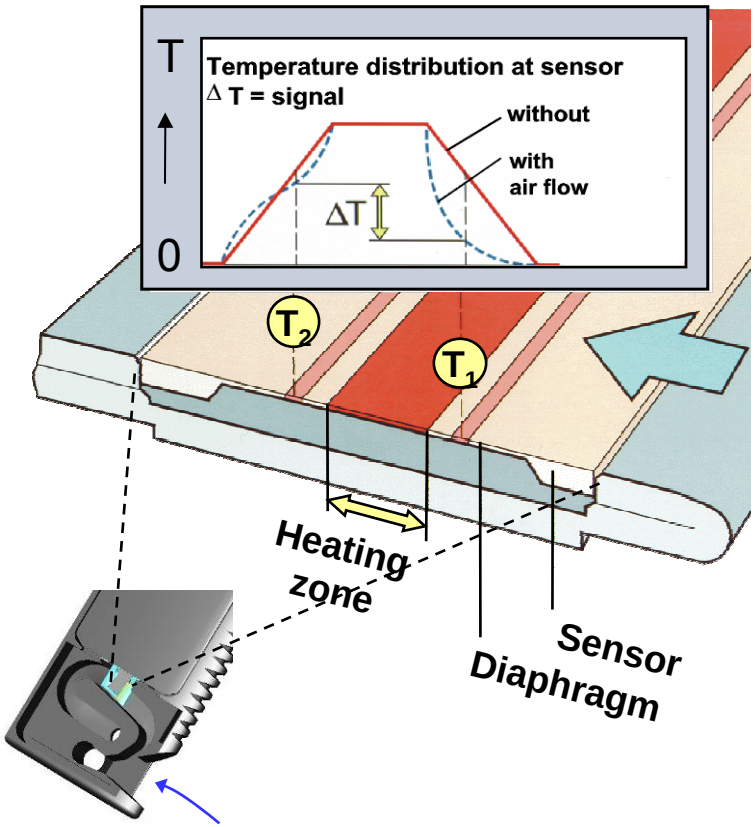
Features

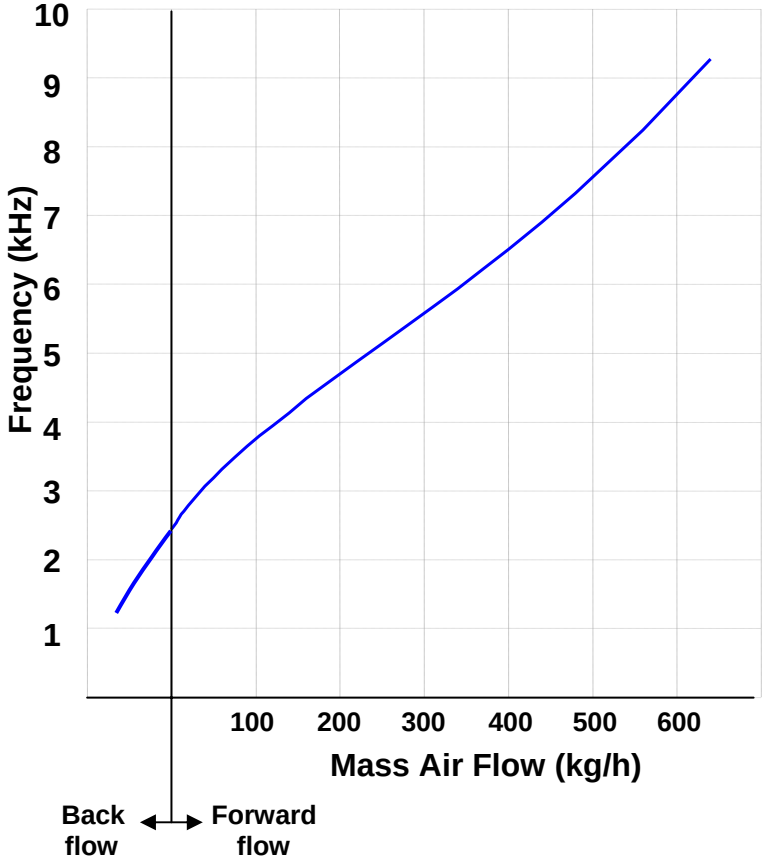
- Digital/analog interface
- High level of tolerance/robustness
- Plug-in application without cylinder-housing possible
- Integrated temperature sensor (optional)

Customer benefits

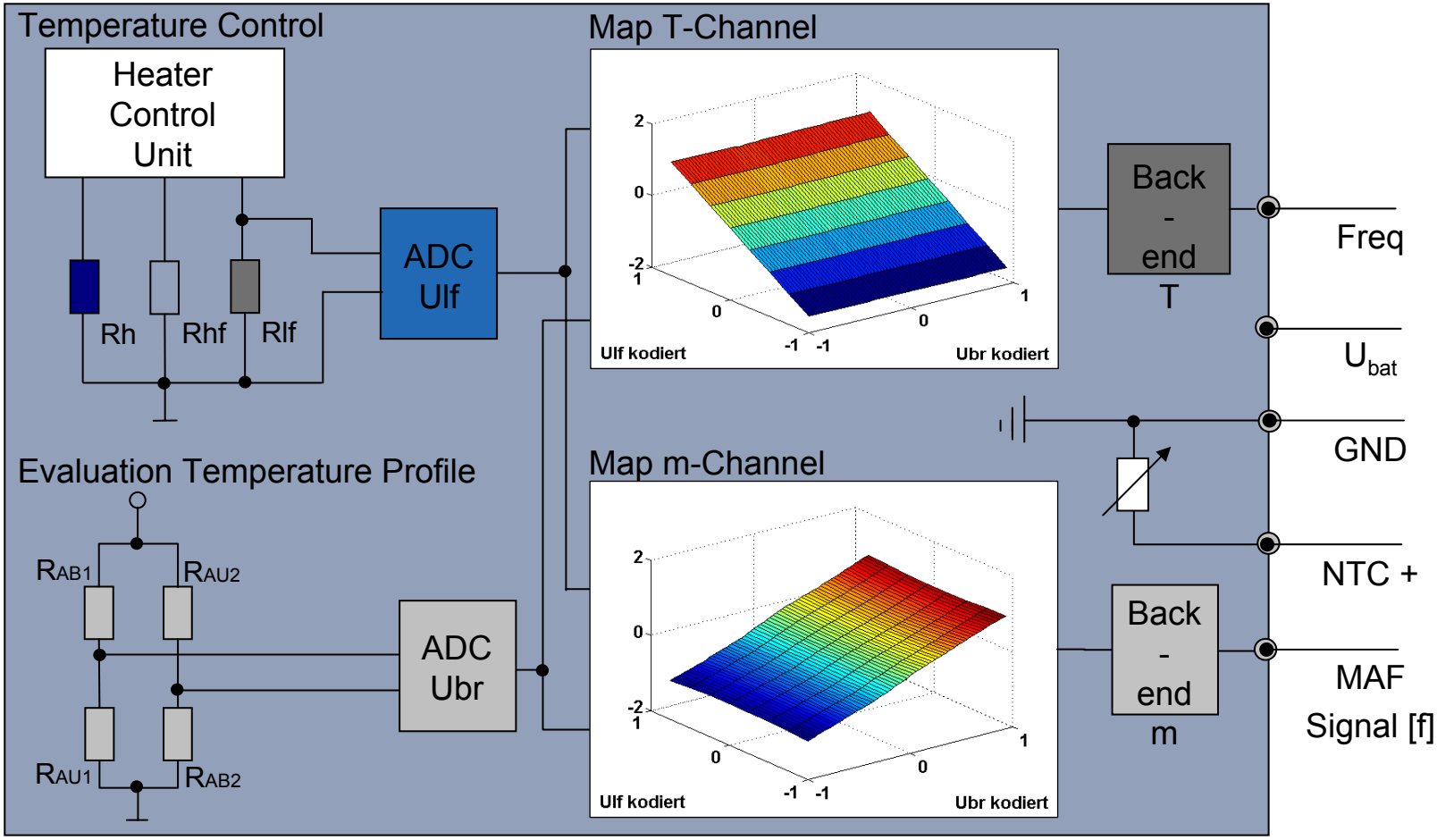
- Simplified application for gasoline and diesel engines by standardized characteristic curve and reduced packaging
- Low-emission engine management and reduced effort with exhaust-gas treatment

HFM Measuring Principle

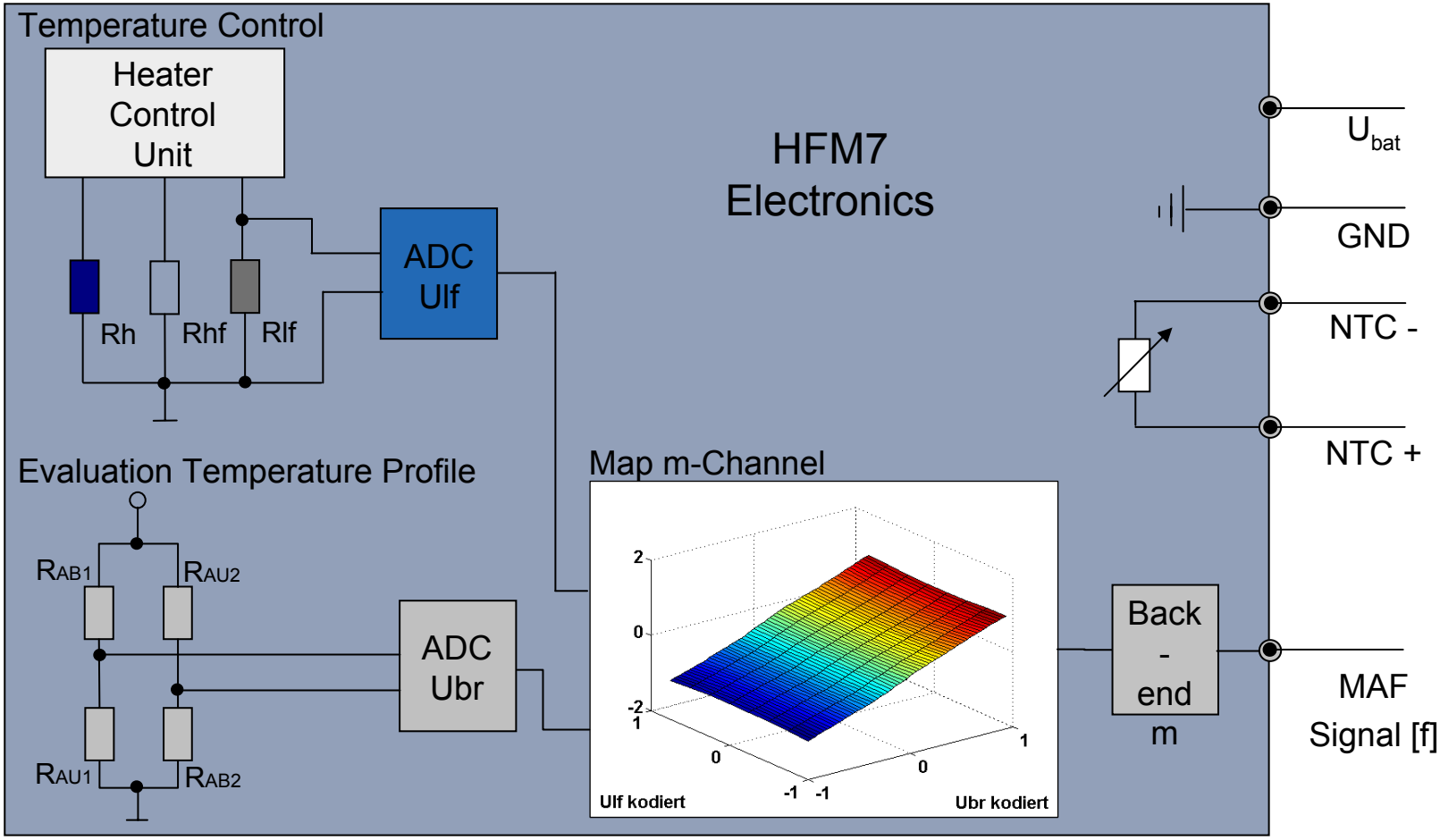




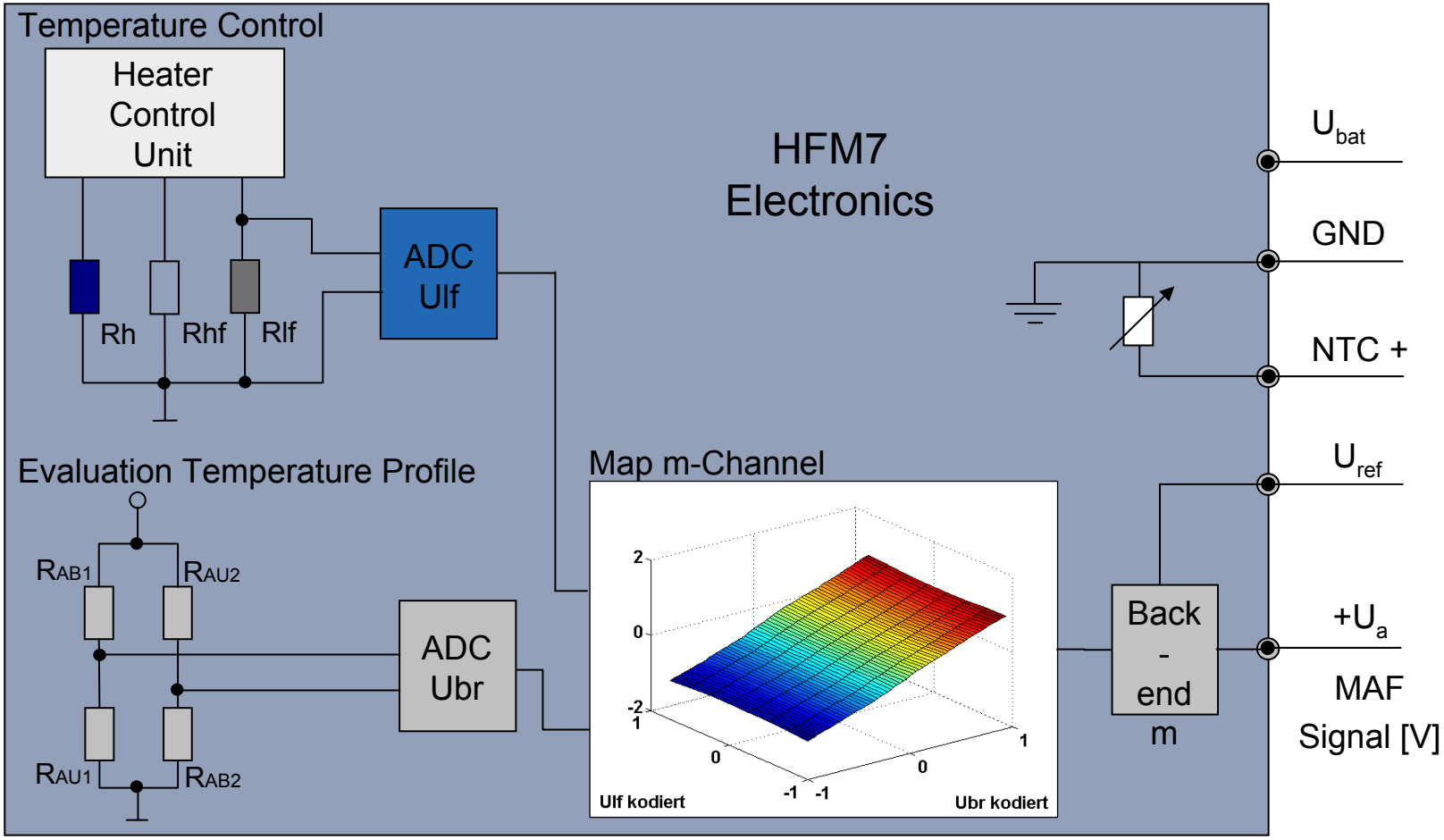
HFM6 Function - Frequency Ratiometric



HFM7 Function - Frequency Absolute



HFM7 Function - Analog

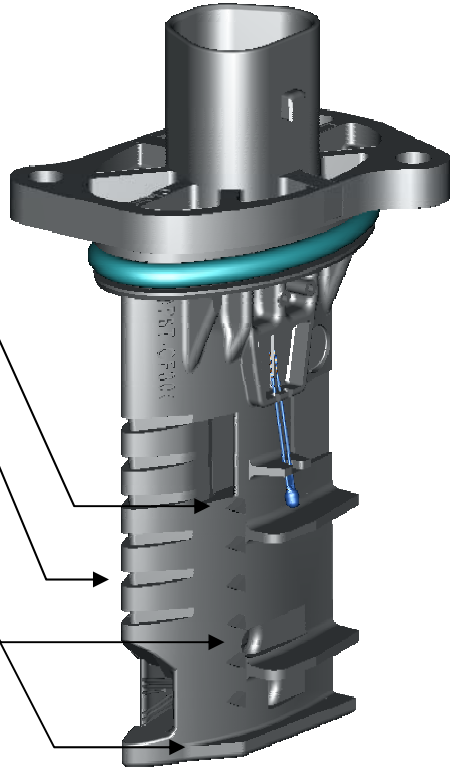


Implementation of improvements: housing → plug-in

Optimization of… / Realization in…	Pulsation performance	Robustness	Pressure drop, inflow sensitivity
cylinder housing	Not applicable	CI	RP
plug-in	e.g. CL	ID	IP

Aerodynamic Design of HFM7 IP*

- Cross-section based on wing geometry
- Turbulators define flow condition
- Vortex generators stabilize airflow
- Bypass outlet sideways and winglet reduce wall influence
- Benefits
  - Lowest pressure drop of the HFM-series
  - Improved signal noise
  - Smaller than ID Plug-in sensor
  - Lower flow disturbance sensitivity
  - Improved pulsation behavior

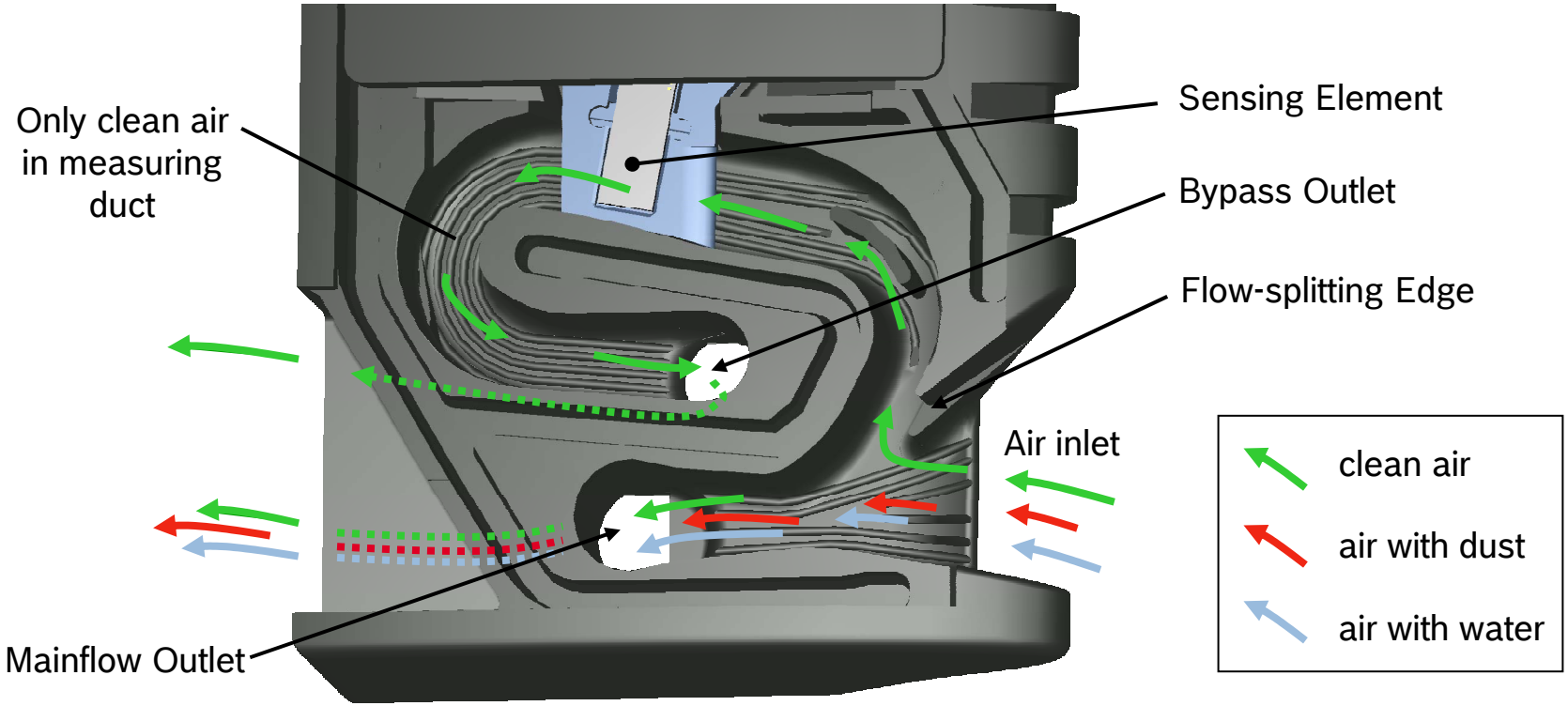


*IP: Integrated deflection and reduced pressure

Integrated Deflection – Working Principle

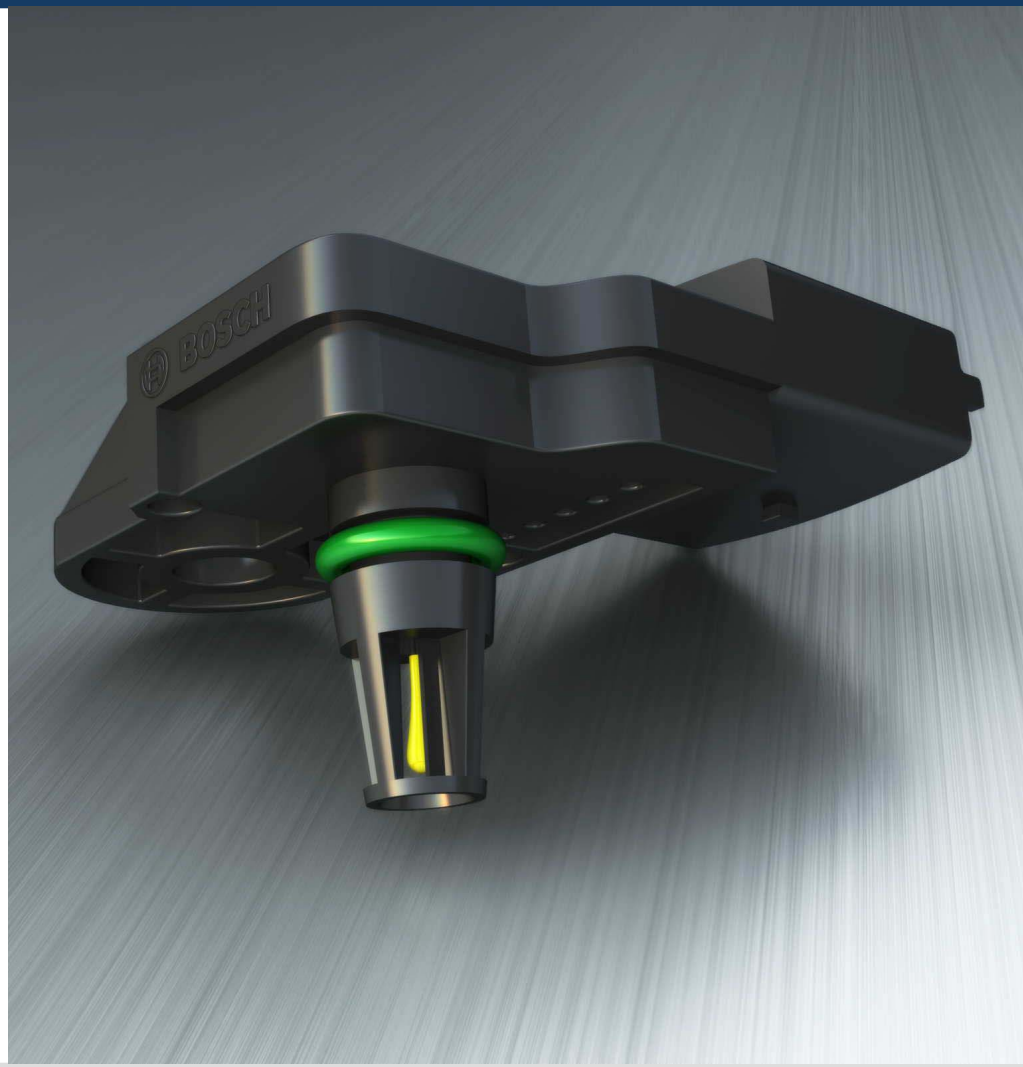
Water and dust are flow through the main outlet due to their inertia

→ Measured airstream is cleaned



Agenda

- Features & Benefits
- Design & Chip Overview



Low-Pressure Sensor

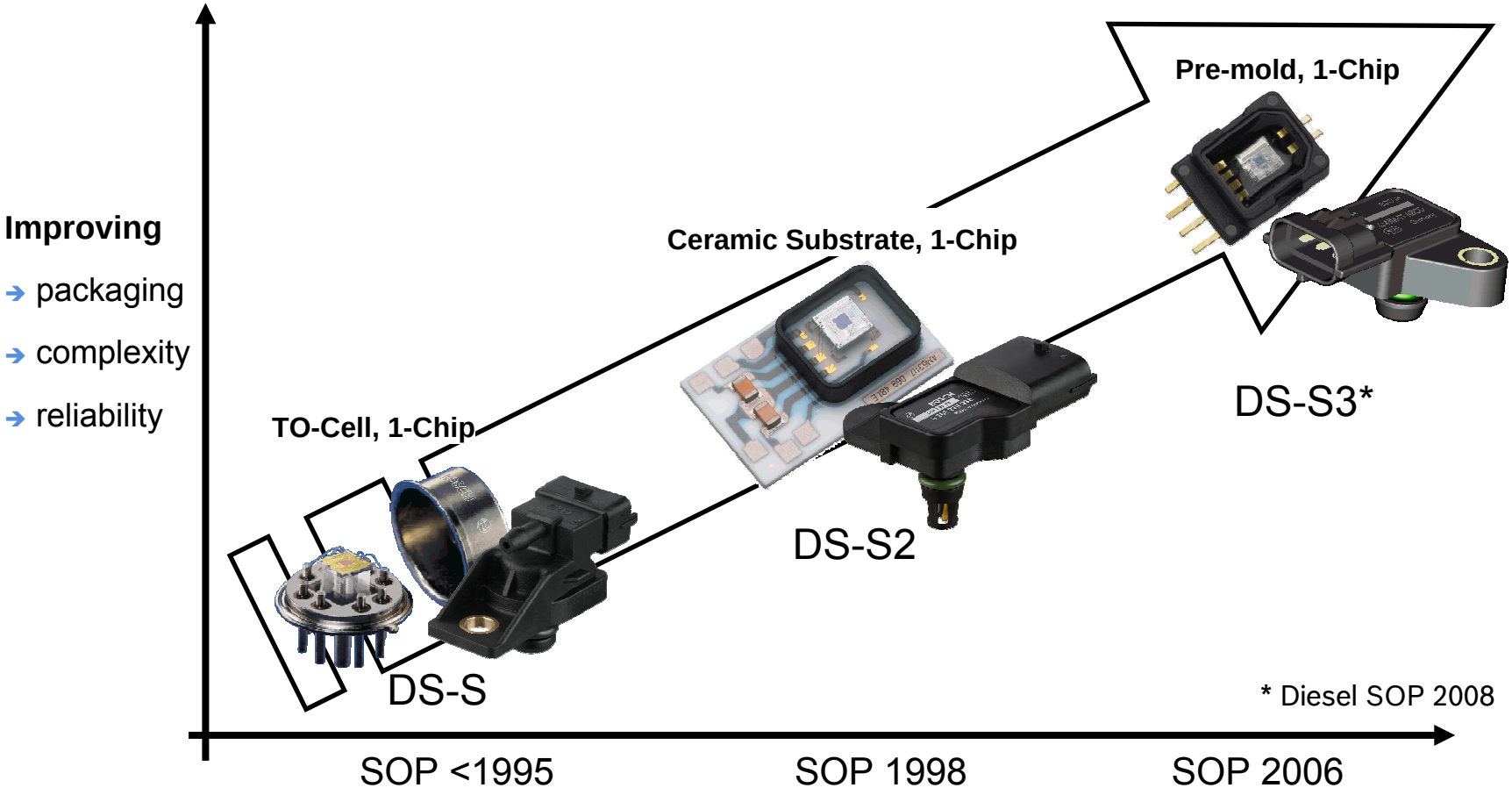
Features

- Silicon micromechanics, 1-chip-concept
- Standardized design for different applications
- Absolute, differential, relative pressure applications

Customer benefits

- High accuracy
- Short response time
- Compact
- Diagnostics for short-circuit and wire breaks
- Customer specific modifications easy to realize
- Optionally integrated temperature sensor reduces wiring

BOSCH Low Pressure Sensor Generations

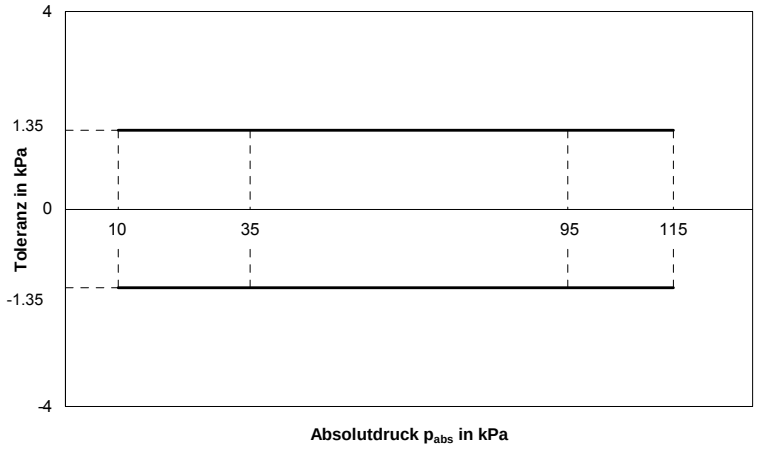


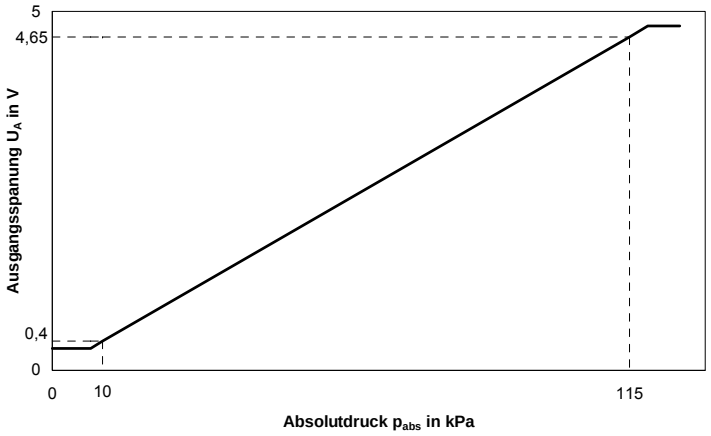
Functional Parameters

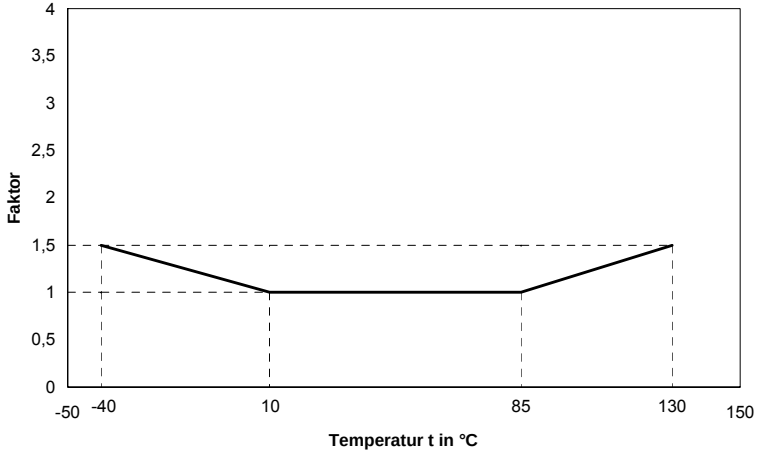
Transfer function and accuracy (e.g. 10 - 115 kPa)

$U_A = (c_1 \cdot p_{abs} + c_0) \cdot U_S$

U_A = output voltage in V
U_S = supply voltage in V
p_{abs} = absolute pressure in kPa
c_0 = -0,1/105
c_1 = 0,85/105 kPa^{-1}







Agenda

- Features & Benefits
- Design & Function

High-Pressure Sensor for CRS Application

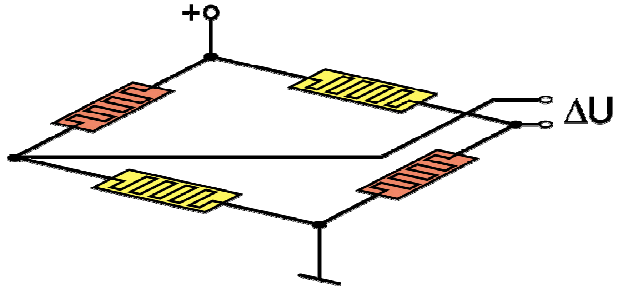
Features

- Stainless steel sensing element with metal thin film strain gages
- Digital circuit concept with analogue output signal
- Modular, compact design, small overall height
- Pressure ranges: 150, 180, 200, 220 MPa

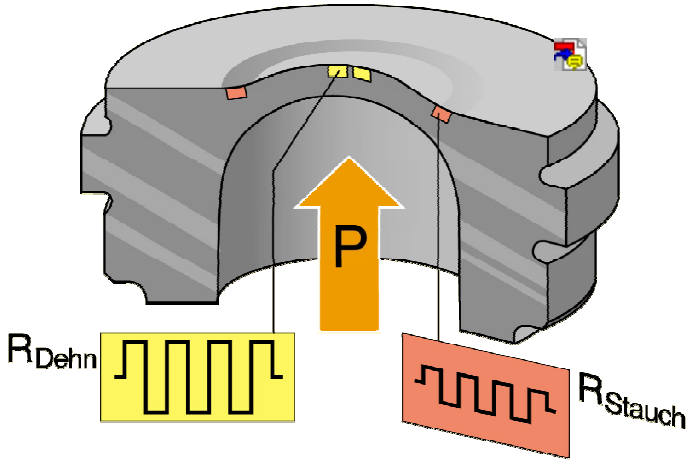
Customer benefits

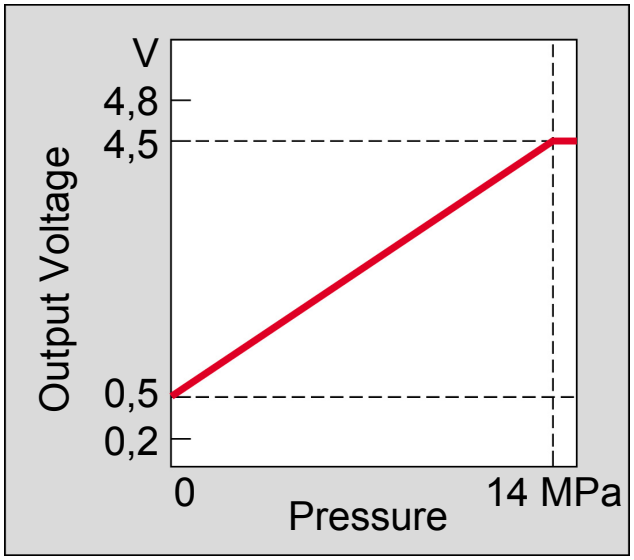
- Very high sensor accuracy: higher metering accuracy
- Resistant to media, hermetic sealing of measured media
- Variation of plug connection and hydraulic connection possible
- 5V or 3.3V characteristic curve (optional)
- Easy assembly, vibration-resistant, high thermal stability
- Fault diagnostics using signal-range check

Measuring Principle



Sensorelement





Agenda

- Features & Benefits
- Functional principle

Crankshaft Sensor DG-6P

Features

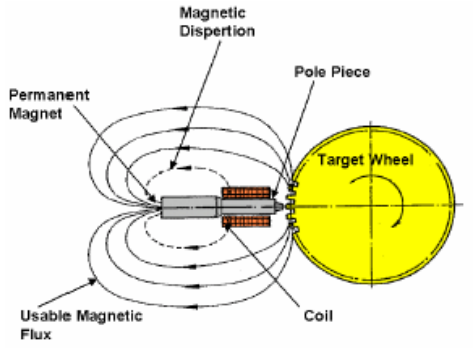
- 2-wire Variable Reluctance principle
- 100% compatible to predecessor DG6
- Output Voltage > 1650 mV (@ 416 RPM)
- Wide temperature range

Customer benefits

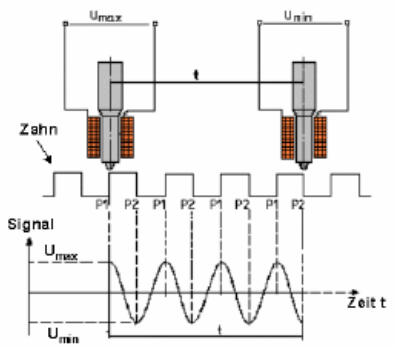
- Increased robustness (improved Thermal Shock resistance)
- Reduced drift over lifetime
- Well-proven design and manufacturing concepts

DG-6P Functional Principle

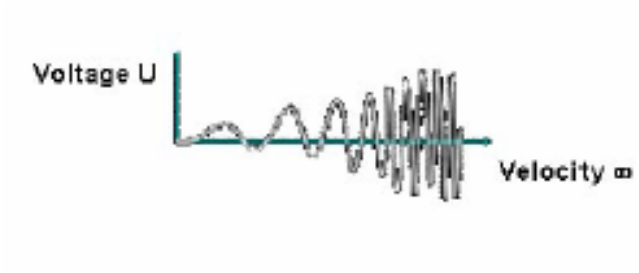
- Function principle



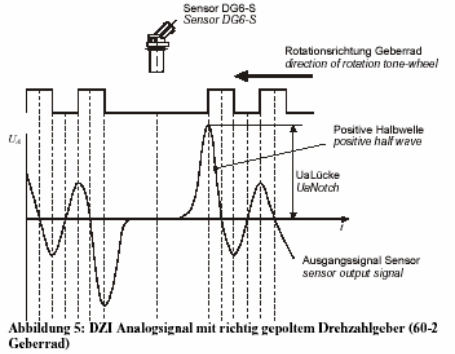
- Signal generation



- Output versus speed



- Signal with a 60-2 target



Comparison DG-6 versus DG-6P

	DG-6	DG-6P
tightness; water resistance	IPX4K	**IPX6K / IPX9K**
mounting tolerance	air gap 0,3 – 1,8 mm	air gap 0,3 – 1,8 mm
resistance against external fields	H= 500 kA/m	**H= 2000 kA/m**
thermal shock	300 cycles - 40 / +130°C	**600 cycles - 40 / +150°C** respectively **1800 cycles -30 / +120 °C**
life time	> 160 Tkm	**Passenger car: 300,000 km** **Commercial vehicle: 1,000,000 km**

Agenda

- Features & Benefits
- Design & Function

Camshaft Sensor PG-3.9

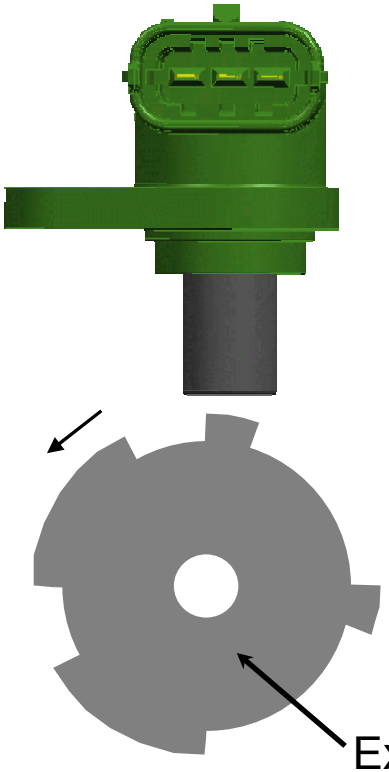
Features

- Single Hall principle / single-track target wheel
- True-Power-On
- Twist insensitive mounting
- Wide temperature range

Customer benefits

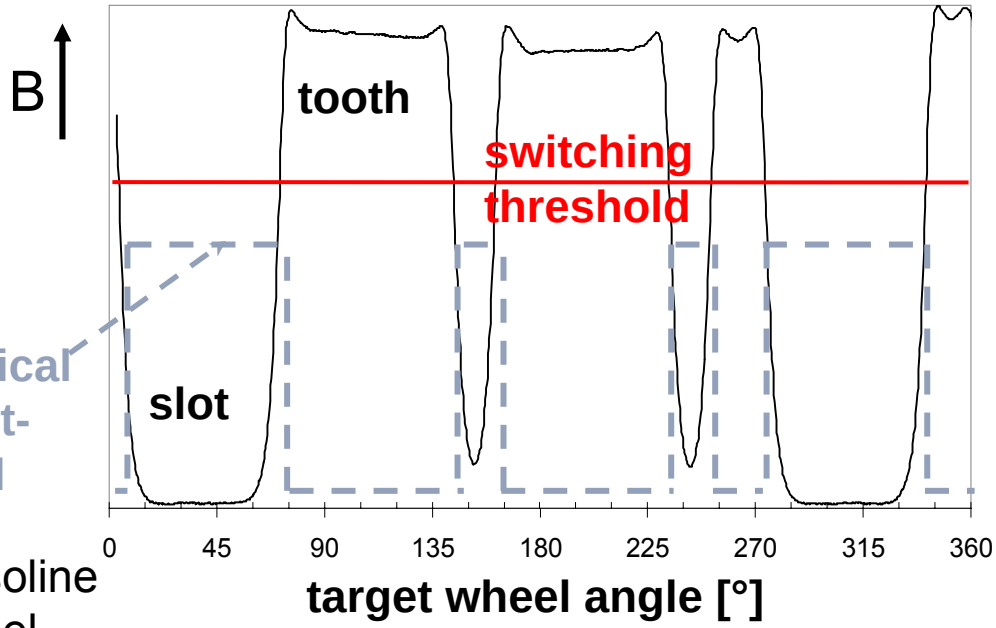
- Robust
- High accuracy
- Low mass
- Small packaging size and functional diameter (11 mm)
- Digital output logic reversible
- Low consumption current
- High EMC/ESD Robustness

Functional Principle



Example Gasoline target wheel (20°/70° quick-start)

Variation of magnetic field (B) during one target wheel rotation

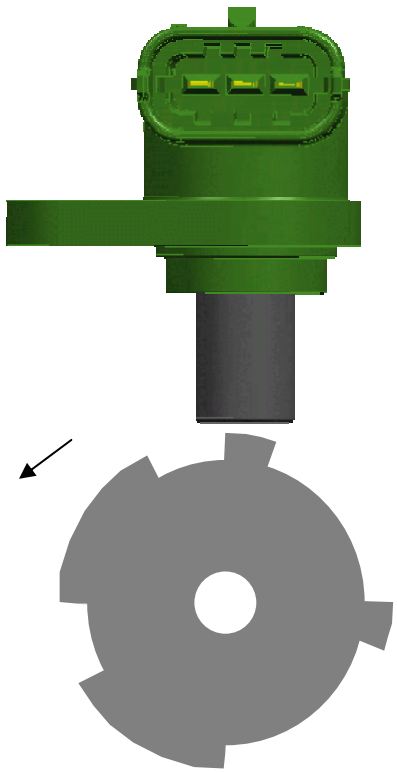


PG-3.9 Specification (with 20°/70° target wheel)

Speed (Cam)	0 ... 4500 rpm
Airgap	0.1 ... 1.8 mm [1] (2,0 mm [1, 2])
Temperature range	-40°C ... +150°C (100h@160 °C)
Supply voltage	4.5 V ... 16 V
Supply current	≤ 10 mA
Output current	≤ 20 mA
Leakage current	≤ 10 µA
Falltime (high ⇒ low)	≤ 1 µs
Risetime (low ⇒ high)	~ 20 µs (with R_{load} = 3.3 kΩ)
Accuracy (full operate range)	≤ ± 1 °CAM [1, 3]
Repeatability (3s)	≤ ± 0.26 °CAM [1]

[1] depends on target wheel
[2] with reduced accuracy but True-Power-On-functionality
[3] with compensation of systematic errors

Optimum Design PG-3.9 Target Wheel



Optimum design of the target wheel
(bottom read, radial sensing)

- single track
- diameter ≥ 54 mm
- tooth height ≥ 5 mm
  (difference between B_{max} and B_{min} ⇧)
- slot width ≥ 10 mm
  (back-bias-field reaches B_{min})
  (“side-looking” of sensor ⇩)
- thickness ≥ 8 mm
  (lateral displacement of sensor ⇧)

Agenda

- Features & Benefits
- Function

Water/Oil Temperature Sensor

Features

- temperature range: -40°C ↔ +130°C (+150°C)
- supply voltage: 5V (only with series resistance)
- response time (τ(63): 20 …80°C): 10 …15 sec
- vibration proof: max. a(sin) = 300 m/s²
- isolation: 500V for 1…3 sec.
- durable against operating materials (fuel, oil, battery acid, ...)
- durable against water according DIN 40 050, IPX4K 9K

Customer benefits

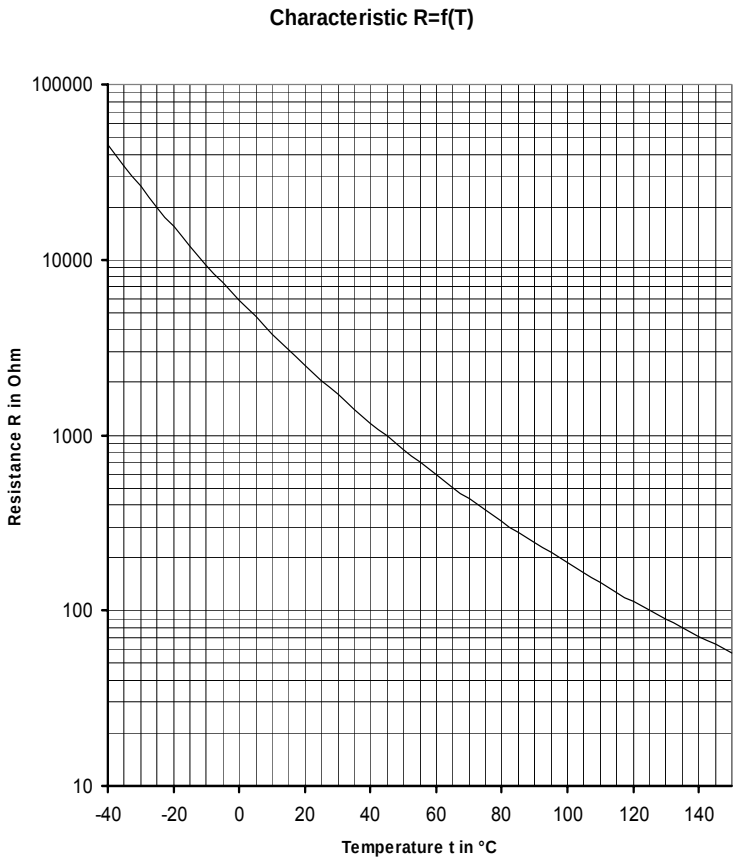
- engine coolant water / oil temperature
- can be mounted on engine block for air cooled engines
- modifications with small complexity: NTC (accuracy), screw thread (M12x1,5 or M14x1,5), length of shaft, connector (compact or Jetronic), flat connector (tin or gold), captive sealing-ring cooper or aluminum)

Function

Nominal resistance
20°C 2.5 kΩ ± 6%
100°C 0.186 kΩ ± 2%

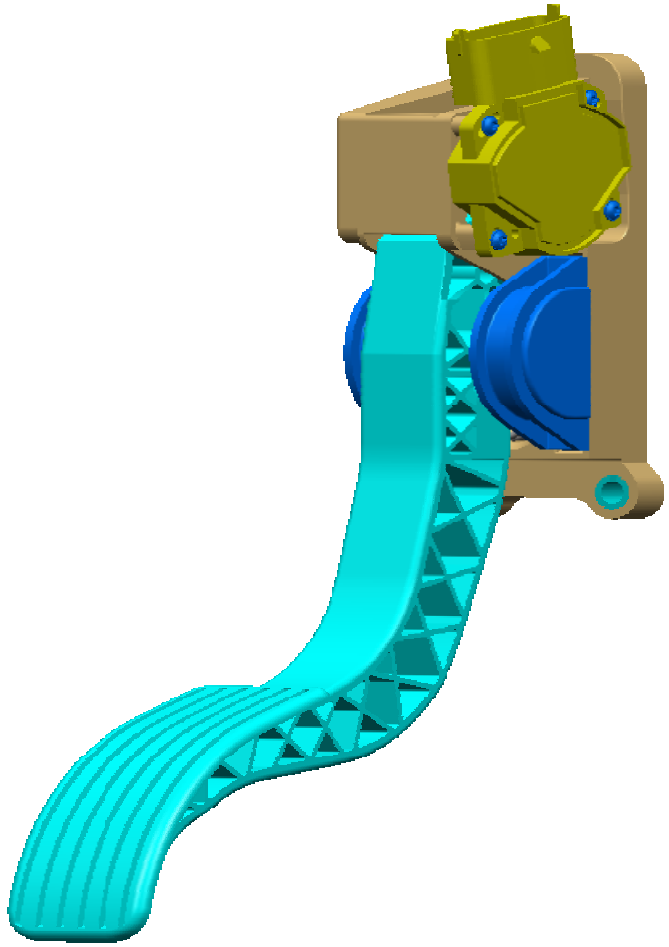
Nominal voltage 5 ± 0.15 V
Operation only permitted with Electronic Control Unit (ECU)

Temperature time constant
checked in water/oil
τ63 ≈ 15s

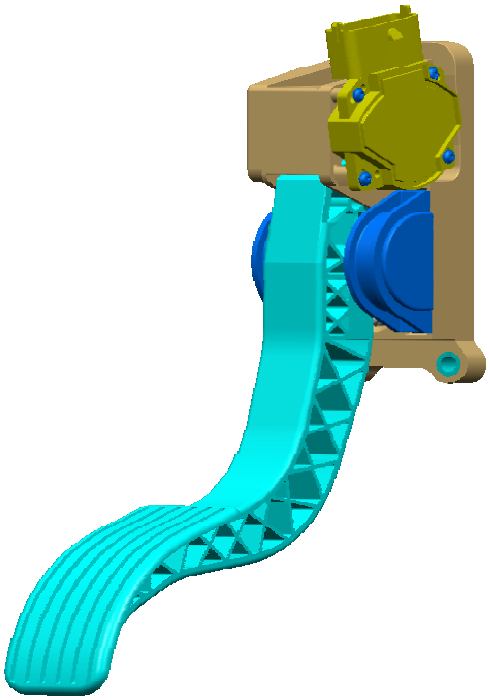


Agenda

- Features & Benefits
- APM output data
- Electrical characteristics



Accelerator Pedal Module



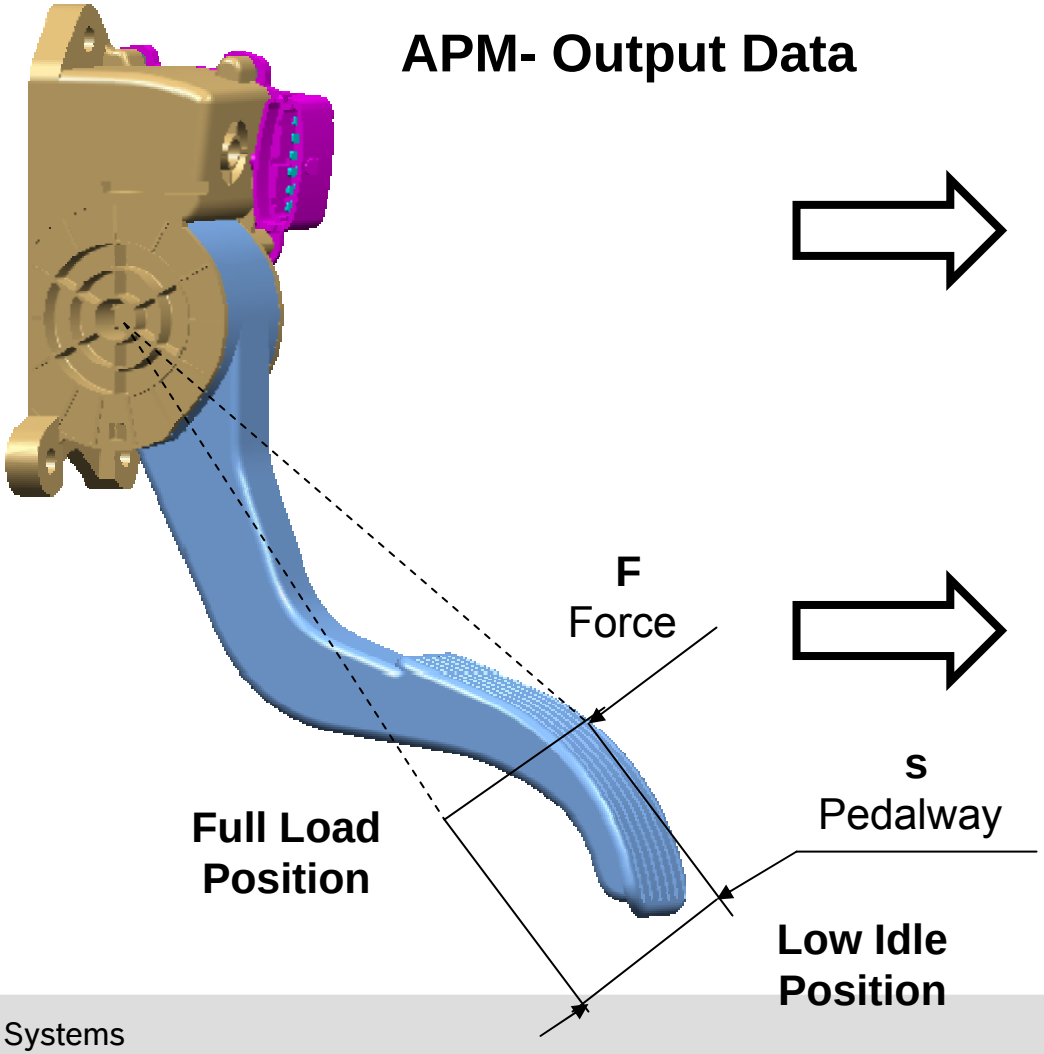
Features

- Separate (FPM1) or integrated potentiometers (FPM1.2) with two potentiometers for redundancy
- Integrated hall sensor with 2 output signals (FPM 2.2)
- Integrated hall sensor with digital output (FPM2.3)

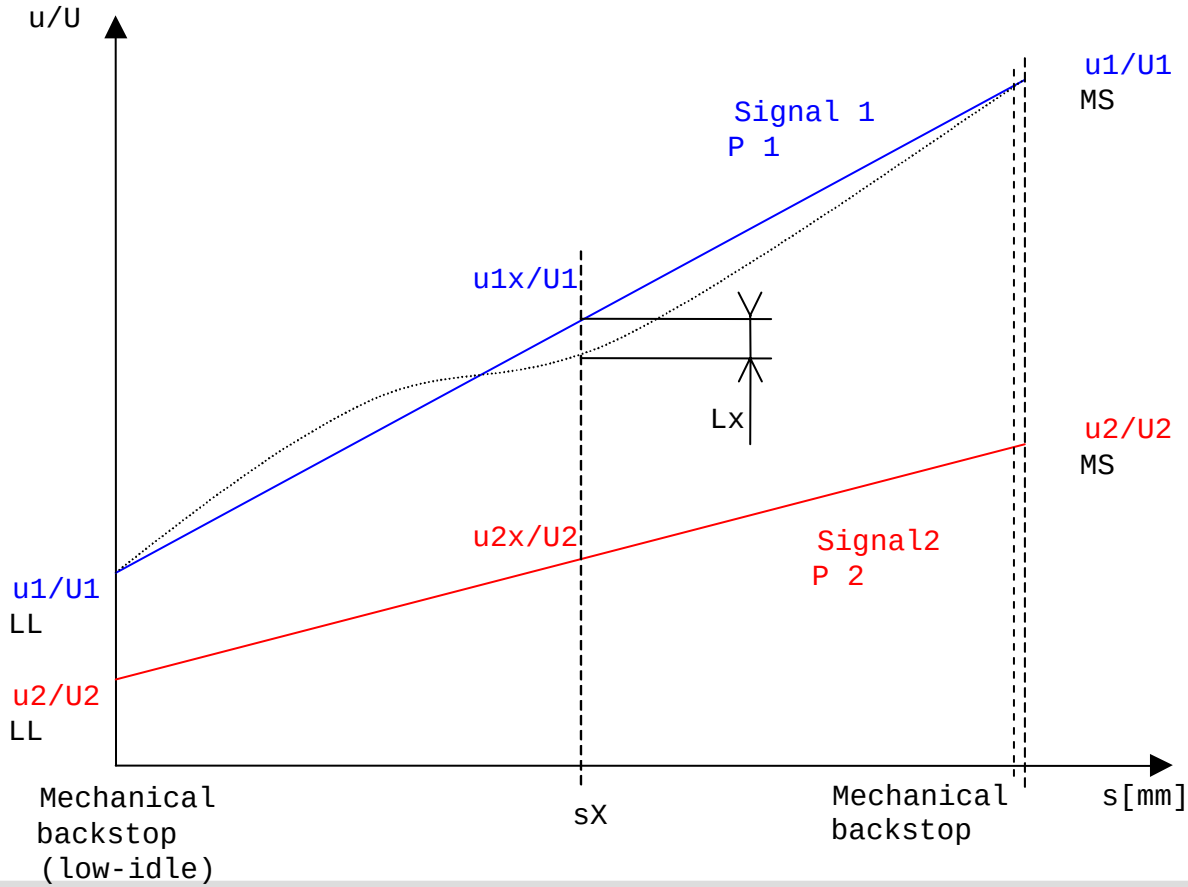
Customer benefits

- Innovative and robust engineering technology
- Vehicle specific application
- Proven design with twin-potentiometer for diesel applications
- Used in passenger and light duty applications

Bosch Accelerator Pedal Module



Electrical Characteristics - Function Voltage/Pedalway



Legend :

U : Voltage ref.
U = 5 ± 0,3 V

P1:
Low Idle :
0,15±0,02 u/U (over lifetime)
Mechanical backstop :
0,82±0,04 u/U (over lifetime).

P2:
P2 = P1/2 ± 0.014 (u/U)

Linearity P1
Lx = ± 0,02 (u/U)

Synchronity

P1 = 2*P2

THANK YOU

In case of questions you can contact by e-mail:
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