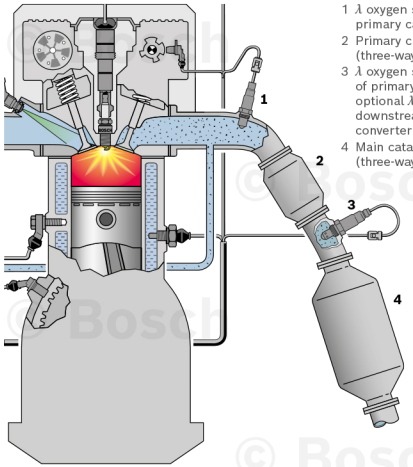
Bosch Classic

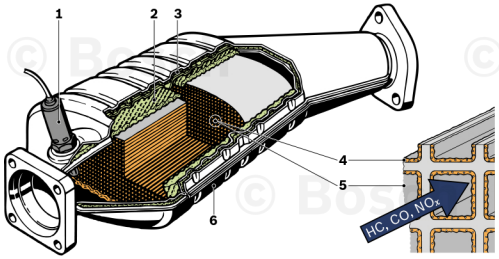
Catalytic Exhaust-Gas Treatment on Gasoline Engines

Exhaust-gas system of a gasoline engine



1 λ oxygen sensor upstream of primary catalytic converter
2 Primary catalytic converter (three-way catalytic converter)
3 λ oxygen sensor downstream of primary catalytic converter, optional λ oxygen sensor downstream of main catalytic converter
4 Main catalytic converter (three-way catalytic converter)

Three-way catalytic converter



1 λ oxygen sensor
2 Swell matting
3 Thermally insulated double shell
4 Washcoat (Al_2O_3substrate coating) with noble-metal coating
5 Substrate (monolith)
6 Housing

Examples for oxidation reactions:

$2\ CO + O_2 \rightarrow 2\ CO_2$

$2\ C_2H_6 + 7\ O_2 \rightarrow 4\ CO_2 + 6\ H_2O$

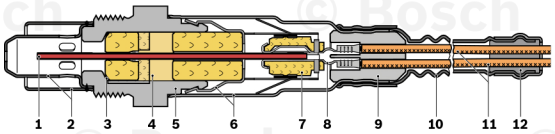
Reduction of nitrous oxides:

$2\ NO + 2\ CO \rightarrow N_2 + 2\ CO_2$

$2\ NO_2 + 2\ CO \rightarrow N_2 + 2\ CO_2 + O_2$

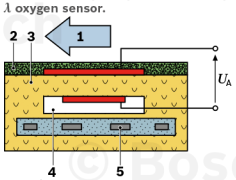
λ oxygen sensor

Sectional view of a λ oxygen sensor (both two-step λ oxygen sensor and broad-band λ oxygen sensor)



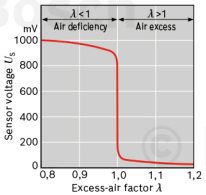
1 Measuring cell (two-step λ oxygen sensor with a planar measuring cell; planar broad-band λ oxygen sensor with a combination of a Nernst concentration cell and an oxygen pump cell)
2 Double protective tube
3 Compensation disk
4 Seal pack
5 Sensor housing
6 Protective sleeve
7 Contact holder
8 Contact clip
9 PTFE grommet
10 PTFE shaped sleeve
11 Connecting leads
12 Seal

Measurement principle of a LSF4.2 planar two-step λ oxygen sensor.

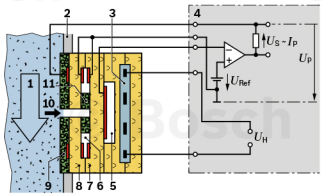


1 Exhaust gas
2 Porous ceramic protective layer
3 Measuring cell with microporous noble-metal coating
4 Reference-air passage
5 Heater
U_A Output voltage

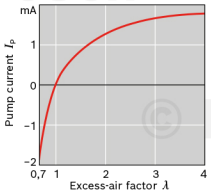
Voltage curve of a two-step λ oxygen sensor



Measurement principle of a LSU planar broad-band λ oxygen sensor



Voltage curve of a broad-band λ oxygen sensor

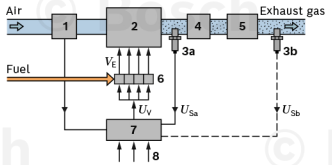


1 Exhaust gas
2 Exhaust pipe
3 Heater
4 Control electronics
5 Reference cell with reference-air passage
6 Diffusion gap
7 Nernst concentration cell with Nernst measuring electrode (on diffusion-gap side) and reference electrode (on reference-cell side)
8 Oxygen pump cell with pump electrode
9 Porous protective layer
10 Gas-access passage
11 Porous diffusion barrier

I_P Pump current
U_P Pump voltage
U_H Heater voltage
U_{Ref} Reference voltage (450 mV corresponds to $\lambda = 1$)
U_S Sensor voltage

λ control loop

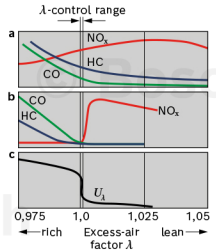
Functional diagram of λ closed-loop control



1 Air-mass sensor
2 Engine
3a λ sensor upstream of primary catalytic converter (two-step λ sensor, or broad-band λ sensor)
3b Two-step λ sensor downstream of main catalytic converter (for two-sensor control)
4 Primary catalytic converter (three-way catalyst)
5 Main catalytic converter (three-way catalyst)
6 Fuel injectors
7 Engine control unit
8 Input signals

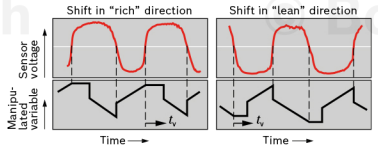
U_S Sensor voltage
U_V Valve control voltage
V_E Injected fuel quantity

Pollutants in the exhaust gas



a) Before catalytic aftertreatment (untreated exhaust gas)
b) After catalytic aftertreatment
c) Voltage curve of two-step λ sensor

Manipulated-variable curve of a two-step control with a λ sensor upstream of primary catalytic converter and controlled λ shift (delay time t_v) due to feedforward control and λ control with the sensor downstream of the main catalytic converter.



www.bosch-classic.com

BOSCH
Invented for life