Lambda sensor LSU 1 Measurement of oxygen content

- It is suitable for industrial applications such as waste gas measurements in gas and oil burners.
- ► Module CJ125: 1267379259 can be used for evaluation.
- The dual-cell wideband sensor is a new type of zirconium dioxide Lambda sensor which can be used for a broad Lambda range from λ > 0.7 to infinity (air).



Application

Combustion processes

- Oil burner
- Gas burner

Design and operation

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.

In an oxygen pump cell, the application of an electrical voltage to a zirconium dioxide ceramic "pumps" oxygen ions from the cathode to the anode. If the continued flow of oxygen molecules out of the exhaust gas to the cathode is prevented by a diffusion barrier, the so-called limit current condition means that a current saturation is reached above a pump voltage threshold. The resulting limit current is proportional to the oxygen concentration in the exhaust gas. In the oxygen sensor, the pump and Nernst cells are arranged in such a way that a diffusion gap of only around $10 - 50 \ \mu m$ exists between them. The gap is connected with the exhaust gas by a gas inlet hole and it acts as a diffusion barrier. This narrow diffusion duct also contains the porous platinum electrodes, one of the pump cells and one of the Nernst cells on the opposite side. The other electrode for the Nernst cell is located in a reference air duct and is exposed to the surrounding atmosphere by an aperture. Under normal conditions, the air here has an oxygen content of 20.9 percent by volume.

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 $U_{\rm N}$ in the concentration cell and supply the pump cell with a variable pump voltage $U_{\rm P}$. If $U_{\rm N}$ 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 concentration 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.

Explanation of characteristic quantities

- λ Air ratio
- $U_{\rm N}$ Nernst voltage
- U_{P} Variable pump voltage

Special accessory

Connectors (mating connectors) are available under order number: 3623 05 K31V167 from

Karl Lumberg GmbH & Co Postfach 13 60 D-58569 Schalksmühle Tel.: 02355/83-01 Fax: 02355/83-263

Installation instructions

We recommend that the sensor element is installed in the flue gas tube suspended, i.e. vertically downward with the connections pointing upwards. A further option is to select an angular installation position of at least 10 from the horizontal (connector outlet upwards). This prevents liquid from accumulating between the sensor housing and the sensor element.

The sensor element should be used in condensation protection mode (standby mode). It is heated to prevent condensation of the moist exhaust gas on the sensor surface. The sensor temperature must be > 75C so that it lies above the dew point temperature.

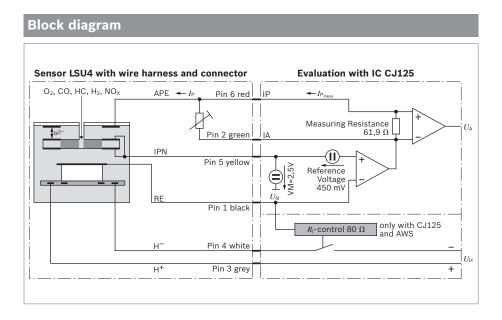
The sensor is resistant to aggressive exhaust gases such as carbon monoxide, carbon dioxide, nitrogen oxide and low tem-

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perature carbonization gas throughout its entire service life. However, if the sensor is exposed to lead, phosphorous, silicon, halogens or very high sulfur concentrations, this can reduce its service life.

Warranty claims

As set out in the general terms of delivery A 17, warranty claims can only be accepted if residue-free gaseous hydrocarbons and light fuel oil in accordance with DIN 51603 are used as permissible fuels.



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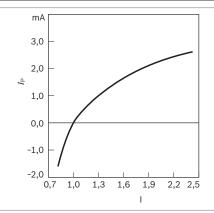
Part number

Technical data	
Measuring range in λ	0,7 ∞
Measuring range for oxygen concentration	0 21 %
Rated heating-voltage value $U_{\rm H}$ (DC or AC voltage)	9,5 V ± 0,5 V
Max. heating power	≤ 15 W
Typical heat output in operation	11 W
Max. switch-on current at -40 °C	≤ 5 A
Heater resistance at room temperature	3 Ω ± 0,5 Ω
Protection of heating circuit with slow-blow fuse	4 A
Sensor storage temperature	- 40 °C + 80 °C
Permissible exhaust-gas temperature at sensor	≤ 250 °C
Permissible ambient temperature	
at sensor housing (connector side)	≤ 80 °C
Temperature of heated sensor element in exhaust-gas area	≤ 800 °C
Reaction time τ with abrupt change of λ by 0.2?	≤ 5 sec.
Permissible vibration capacity during operation	≤ 50 m/s²
Permissible short-term impact capacity	≤ 300 m/s²
Service life in operation	≥ 12.000 hours
Service life in standby mode	≥ 50.000 hours
Output signals with CJ125	
Output voltage at λ = 0.8 1,2	<i>U</i> _A ≈ 0,5 2 V
Output voltage at λ = 1; O ₂ = 0.0 %	<i>U</i> _A = 1.5 V
Output voltage at $\lambda \rightarrow \infty$; O ₂ = 20,9 %	<i>U</i> _A ≈ 4.7 V

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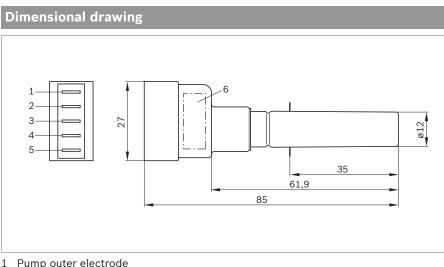


Characteristic curve





 λ = Air ratio



- 1 Pump outer electrode
- Inner Pump-/Nernst electrode 2
- 3 Reference electrode
- 4 Sensor heater +
- 5 Sensor heater -

Notes

Lambda sensor LSU 4.9

Measurement of oxygen content

- The wideband Lambda sensor LSU is a planar ZrO₂ dual-cell limit current sensor with integrated heater.
- It is used for measuring the oxygen content and the λ value of exhaust gases in vehicle engines.
- Thanks to a steady characteristic curve in the range λ = 0.65 to air, it is universally applicable for λ = 1 and for other λ ranges.



Application

Engine management

- Gas engines
- Block-type thermal power stations
- 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 indexIncineration plants
- Wood
- Biomass

Design and operation

The LSU broadband Lambda sensor is a planar ZrO₂ two-cell limit current sensor with integral heater. It is suitable for measuring the oxygen content and the λ value of exhaust gases in vehicle engines (gasoline and diesel). A constant characteristic curve in the range from λ = 0.65 to air makes it suitable for universal use for $\lambda = 1$ and for other $\boldsymbol{\lambda}$ 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 $U_{\rm N}$ in the concentration cell and supply the pump cell with a variable pump voltage $U_{\rm P}$. If $U_{\rm N}$ 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 concentration 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.

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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 ° with respect to the horizontal. This prevents the accumulation of liquid between the sensor housing and sensor element. An angle of 90 ° is desirable, however no greater than 90 ° + 15 ° gas inlet hole with respect to the exhaust gas flow or 90 ° - 30 °. 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

- λ $\,$ Air ratio $\,$
- $U_{\rm N}$ Nernst voltage
- $U_{\rm P}$ Variable pump voltage

Lambda sensor LSU 4.9

Measurement of oxygen content

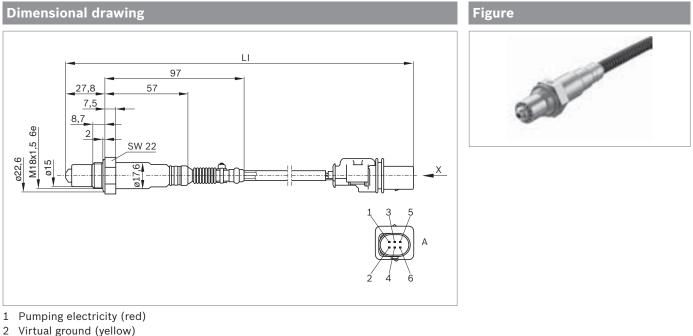
Nominal internal resistance of Nernst cell Continuous AC ?(f = 14 kH2) for R _{in} measurement ≤ 260 μA Max. current load of Nernst cell Continuous AC ?(f = 14 kH2) for R _{in} measurement ≤ 260 μA Recommended reference pump current (usualined) = 20 μA Max. pump current to pump cell for rich-gas signal (λz 0.65) ≥ - 9 mA Max. pump current to pump cell for rich-gas signal (air) ≤ 66 mA Heater suppl Nominal heat output at 7.5 V Heating voltage in steady-state condition with air approx. 7,5 W Nominal heat output at 7.5 V Heating voltage in steady-state condition with air approx. 7,5 W Minimum cold resistance of heater at room temperature, including cable and connector 3.2 Ω Minimum cold resistance of heater at 40C 1.8 Ω When switching on the heater, the heating power is to be limited as follows: Heater voltage in condensate phase U _{inst} ≤ 2 V Maximum permissible effective heater voltage Ugr attainment of operating point briefly ≤ 30 s (200 h cumulated) ≤ 13 V Maximum permissible effective heater voltage Ugr attainment of operating point steady-state ≤ 10,8 V Operating temperatures ≤ 10,8 V Operating temperatures ≤ 10,8 V Operating temperatures ≤ 10,8 V Operatin	Technical data	
Max. current load of Nernst cell Continuous AC ?(f = 14 kHz) for R _{vir} measurement ≤ 250 μA Recommended reference pump current (sustained) = 20 μA Max. pump current to pump cell for ich-gas signal (λ2 0.65) ≤ 9 mA Max. pump current to pump cell for ich-gas signal (λ2 0.65) ≤ 9 mA Meater supply Nominal heat output at 7.5 V Heating voltage in steady-state condition with air approx. 7,5 W Nominal heat output at 7.5 V Heating voltage in steady-state condition with air approx. 7,5 W Winnium cold resistance of heater, the heating power is to be limited as follows: Heater voltage in condensate phase U _{keet} ≤ 2 V Maximum permissible effective heater voltage Ugr attainment of operating point briefly s 30 s (200 h cumulated) ≤ 13 V Maximum permissible vehicle velter voltage Ugr attainment of operating point steady-state ≤ 10.8 V Operating temperatures Kahaust (Gr_tomoga) ≤ 930 °C Cable outtel (PTE Sheath) - sensor side (PTE socket, T _{socnea}) < 250 °C Cable outtel (PTE Sheath) - sensor side (PTE socket, T _{socnea}) < 250 °C Cable outtel (PTE Sheath) - sensor side (PTE socket, T _{socnea}) < 280 °C Cable outtel (PTE sheath) - cable side (upper sleeve, T _{upochone}) < 280 °C <th>Sensor element</th> <th></th>	Sensor element	
Recommended reference pump current (sustained) ≥ 20 µA Max. pump current to pump cell for rich-gas signal (λ≥ 0.65) ≥ 9 mA Max. pump current to pump cell for rich-gas signal (àir) ≤ 6 mA Heater supply Nominal heat output at 7.5 V Heating voltage in steady-state condition with air approx.7,5 W Nominal heat output at 7.5 V Heating voltage in steady-state condition with air approx.7,5 W Whom switching on the heater, the heating power is to be limited as follows: < 2 V	Nominal internal resistance of Nernst cell R _{i,N} As new (operating point, calibration value), (measurement with 14 kHz):	300 Ω
Max. pump current to pump cell for rich-gas signal (λ≥ 0.65) ≥ + 9 mA Max. pump current to pump cell for lean-gas signal (air) < 6 mA	Max. current load of Nernst cell Continuous AC ?(f = 14 kHz) for R _{i,N} measurement	≤ 250 µA
Max. pump current to pump cell for lean-gas signal (air) ≤ 6 mA Heater supply 7,5 V Nominal heat output at 7.5 V Heating voltage in steady-state condition with air approx.7,5 W Typical cold resistance of heater at room temperature, including cable and connector 3,2 Ω Winnimu cold resistance of heater at -40C 1,8 Ω When switching on the heater, the heating power is to be limited as follows: 2 V Maximum permissible effective heater voltage Ugr attainment of operating point briefly ≤ 30 s (200 h cumulated) ≤ 13 V Maximum permissible effective heater voltage Ugr attainment of operating point steady-state < 12 V	Recommended reference pump current (sustained)	= 20 µA
Heater supply 7,5 V Nominal voltage 7,5 V Nominal heat output at 7.5 V Heating voltage in steady-state condition with air approx. 7,5 W Winimum cold resistance of heater at room temperature, including cable and connector 3,2 Ω Winimum cold resistance of heater at room temperature, including cable and connector 1,8 Ω When switching on the heater, the heating power is to be limited as follows: 4 2 V Waximum permissible effective heater voltage Ufor attainment of operating point briefly s 30 s (200 h cumulated) s 13 V Maximum permissible effective heater voltage Ufor attainment of operating point steady-state s 13 V Maximum permissible effective heater voltage Ufor attainment of operating point steady-state s 10,8 V Operating temperatures s 10,8 V Exhaust gas (T _{constance}) < 600 ° C	Max. pump current to pump cell for rich-gas signal (λ > 0.65)	≥ - 9 mA
Nominal voltage 7,5 V Nominal heat output at 7.5 V Heating voltage in steady-state condition with air approx.7,5 W Nominal heat output at 7.5 V Heating voltage in steady-state condition with air approx.7,5 W Winimum cold resistance of heater at 40C 1,8 Ω When switching on the heater, the heating power is to be limited as follows: \$ 2 V Waximum permissible effective heater voltage Ufgr attainment of operating point briefly ≤ 30 s (200 h cumulated) \$ 13 V Maximum permissible effective heater voltage Ufgr attainment of operating point steady-state \$ 10,8 V Operating temperatures \$ 10,8 V Operating temperatures \$ 930 °C Exhaust gas (T_toward) \$ 930 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{toward}) \$ 200 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{toward}) \$ 250 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{toward}) \$ 260 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{toward}) \$ 260 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{toward}) \$ 260 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{toward}) \$ 260 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{toward}) \$ 260 °C	Max. pump current to pump cell for lean-gas signal (air)	≤ 6 mA
Nominal heat output at 7.5 V Heating voltage in steady-state condition with air approx. 7,5 W Typical cold resistance of heater at room temperature, including cable and connector 3,2 Ω Minimum cold resistance of heater at -40C 1,8 Ω When switching on the heater, the heating power is to be limited as follows: Heater voltage in condensate phase U _{itent} ≤ 2 V Maximum permissible effective heater voltage U _i gr attainment of operating point briefly ≤ 30 s (200 h cumulated) ≤ 13 V Maximum permissible effective heater voltage U _i gr attainment of operating point steady-state ≤ 10,8 V Maximum permissible effective heater voltage U _i gr attainment of operating point steady-state ≤ 16,5 V Maximum vehicle electrical system voltage U _{intrine} ≤ 930 °C Cable outel (PTE sheath) - sensor side (PTE socket, T _{cumune}) ≤ 930 °C Cable outel (PTE sheath) - sensor side (PTE socket, T _{cumune}) ≤ 250 °C Cable outel (PTE sheath) - sale side (upper sleeve, T _{ougenos}) ≤ 250 °C Cable outel (PTE sheath) - sale side (upper sleeve, T _{ougenos}) ≤ 100 °C Cable outel (PTE sheath) - sale side (upper sleeve, T _{ougenos}) ≤ 660 °C Cable outel (PTE sheath) - sale side (UPTE socket, T _{cumune}) ≤ 250 °C Cable outel (PTE sheath) - sale side (UPTE socket, T _{cumune}) ≤ 250 °C Cable outel (PTE sheath) - sale side (UPTE socket, T _{cumune}) ≤ 250 °C Cable outel (PTE sheath) - sale side (UPTE socket, T _{cumune}) ≤ 280 °C Cable outel (PTE sheath) - sale side (UPTE socket, T _{cumune}) ≤ 280 °C Cable outel (PTE sheath) - sale side (UPTE socket, T _{cumune}) ≤ 280 °C Cable outel (PTE sheath) - sale side (UPTE socket, T _{cumune}) ≤ 280 °C Cable outel (PTE sheath) - sale side (UPTE socket, T _{cumune}) ≤ 280 °C Cable outel (PTE sheath) - sale side (UPTE socket, T _{cumune}) ≤ 280 °C Cable outel (PTE sheath) - sale side (UPTE socket, T _{cumune}) ≤ 280 °C Cable outel (PTE sheath) - sale side (UPTE socket, T _{cumune}) ≤ 280 °C Cable outel (PTE sheath) - sale side (UPTE socket, T _{cumune}) ≤ 280 °C Cable outel (PTE sheath) - sale side (UPTE socket, T _{cumune}) ≤ 280 °C Cable ou	Heater supply	
Typical cold resistance of heater at room temperature, including cable and connector 3,2 Ω Minimum cold resistance of heater at r40C 1,8 Ω When switching on the heater, the heating power is to be limited as follows: Heater voltage in condensate phase U _{kat} < 2 V	Nominal voltage	7,5 V
Minimum cold resistance of heater at -40C 1,8 Ω When switching on the heater, the heating power is to be limited as follows: \$2 V Heater voltage in condensate phase U _{log} \$2 V Maximum permissible effective heater voltage U _{for} attainment of operating point briefly s 30 s (200 h cumulated) \$13 V Maximum permissible vehicle electrical system voltage U _{for} attainment of operating point steady-state \$16,5 V Maximum permissible vehicle electrical system voltage U _{lot name} \$10,8 V Operating temperatures \$930 °C Exhaust gas (T _{konsegen}) \$600 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{consege}) \$250 °C Colle outlet (PTFE sheath) - cable side (upper sleeve, T _{uupertose}) \$250 °C Connector \$120 °C Maximum temperatures (max. 250 h cumulative over service life) \$280 °C Exhaust gas (T _{ruusupe}) \$600 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{conseg}) \$280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{conseg}) \$280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{conseg}) \$280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{conseg}) \$280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{conse}	Nominal heat output at 7.5 V Heating voltage in steady-state condition with air	approx. 7,5 W
When switching on the heater, the heating power is to be limited as follows: Heater voltage in condensate phase U_{tot} 2 V Maximum permissible effective heater voltage U _d attainment of operating point briefly s 30 s (200 h cumulated) s 12 V Maximum permissible effective heater voltage U_d attainment of operating point steady-state s 12 V Maximum permissible vehicle electrical system voltage U_{dat nax} s 10,8 V Operating temperatures Exhaust gas (T_{exturnat}) s 930 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T_{ournmet}) s 200 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T_{togenese}) c 200 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T_{togenese}) c 200 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T_{togenese}) c 200 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T_{ournmet}) s 1030 °C Hexagon at sensor housing (T_{surage}) s 200 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T_{ournmet}) s 200 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T_{ournmet}) s 200 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T_{ournmet}) s 200 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T_{ournmet}) s 200 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T_{ournmet}) s 200 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T_{ournmet})	Typical cold resistance of heater at room temperature, including cable and connector	3,2 Ω
Heater voltage in condensate phase U _{ivent} \$ 2 V Maximum permissible effective heater voltage Ufgr attainment of operating point briefly \$ 30 s (200 h cumulated) \$ 13 V Maximum permissible effective heater voltage Ufgr attainment of operating point steady-state \$ 12 V Maximum permissible effective heater voltage Ufgr attainment of operating point steady-state \$ 12 V Maximum permissible vehicle electrical system voltage \$ 10,8 V Operating temperatures \$ 930 °C Exhaust gas (T _{busnete}) \$ 930 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{otennete}) \$ 250 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{busnete}) \$ 200 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{busnetee}) \$ 200 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{otennete}) \$ 200 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{otennete}) \$ 280 °C Maximum temperatures (max. 260 h cumulative over service life) \$ 1030 °C Khaust gas (T _{busnete}) \$ 280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{otennete}) \$ 280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{otennete}) \$ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{treennete}) \$ 28	Minimum cold resistance of heater at -40C	1,8 Ω
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Maximum permissible effective heater voltage Uger attainment of operating point steady-state ≤ 12 V Maximum permissible vehicle electrical system voltage U _{pattmax} ≤ 16,5 V Winimum vehicle electrical system voltage ≥ 10,8 V Operating temperatures ≤ 930 °C Exhaust gas (T _{biblandgen}) ≤ 930 °C Cable outlet (PTE sheath) - sensor side (PTE socket, T _{outennet}) ≤ 250 °C Cable outlet (PTE sheath) - cable side (upper sleeve, T _{upperhose}) ≤ 200 °C Cable and protective sheathing ≤ 250 °C Connector ≤ 1030 °C Hexagon at sensor housing (T _{intengen}) ≤ 1030 °C Cable and protective sheathing ≤ 280 °C Maximum temperatures (max. 250 h cumulative over service life) Exhaust gas (T _{bibandgen}) ≤ 1030 °C Hexagon at sensor housing (T _{intengen}) ≤ 280 °C Cable outlet (PTE sheath) - sensor side (PTE socket, T _{cinomen}) ≤ 280 °C Cable outlet (PTE sheath) - sable side (upper sleeve, T _{upperhose}) ≤ 280 °C Cable outlet (PTE sheath) - sensor side (PTE socket, T _{cinomen}) ≤ 280 °C Cable outlet (PTE sheath) - sensor side (PTE socket, T _{cinomen}) ≤ 280 °C Cable outlet (PTE sheath) - sensor side (PTE socket, T _{cinomen}) ≤ 280 °	Heater voltage in condensate phase U _{H.eff}	≤ 2 V
Maximum permissible vehicle electrical system voltage U _{Batronax} ≤ 16,5 V Minimum vehicle electrical system voltage ≥ 10,8 V Operating temperatures ≤ 930 °C Exhaust gas (T _{Exhaugen}) ≤ 600 °C Cable outlet (PTE sheath) - sensor side (PTFE socket, T _{Grammet}) ≤ 250 °C Cable outlet (PTFE sheath) - sensor side (upper sleeve, T _{Upperhote}) ≤ 200 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhote}) ≤ 250 °C Connector ≤ 10,30 °C Hexagon at sensor housing (T _{Intengen}) ≤ 200 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhote}) ≤ 200 °C Cable and protective sheathing ≤ 1030 °C Hexagon at sensor housing (T _{Intengen}) ≤ 1030 °C Maximum temperatures (max. 450 h cumulative over service life in intervals of max. 10 min) Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grammet}) Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grammet}) ≤ 280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grammet}) ≤ 280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grammet}) ≤ 280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grammet}) ≤ 280 °C Cable outlet (PTFE sheath) - cable side upper sleeve, T	Maximum permissible effective heater voltage U_{for} attainment of operating point briefly \leq 30 s (200 h cumulated)	≤ 13 V
Minimum vehicle electrical system voltage ≥ 10,8 V Operating temperatures Exhaust gas (T _{Echanatgan}) ≤ 930 °C Hexagon at sensor housing (T _{Insugan}) ≤ 600 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Greannet}) ≤ 250 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhose}) ≤ 200 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhose}) ≤ 250 °C Connector ≤ 120 °C Maximum temperatures (max. 250 h cumulative over service life) Exhaust gas (T _{Enhandgan}) ≤ 1030 °C Hexagon at sensor housing (T _{Insugan}) ≤ 680 °C Maximum temperatures (max. 40 h cumulative over service life in intervals of max. 10 min) Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Greannet}) ≤ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhoten}) ≤ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhoten}) ≤ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhoten}) ≤ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhoten}) ≤ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhoten}) ≤ 280 °C Cable ou	Maximum permissible effective heater voltage Ufor attainment of operating point steady-state	≤ 12 V
Minimum vehicle electrical system voltage ≥ 10,8 V Operating temperatures Exhaust gas (T _{Echanatgan}) ≤ 930 °C Hexagon at sensor housing (T _{Insugan}) ≤ 600 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Greannet}) ≤ 250 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhose}) ≤ 200 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhose}) ≤ 250 °C Connector ≤ 120 °C Maximum temperatures (max. 250 h cumulative over service life) Exhaust gas (T _{Enhandgan}) ≤ 1030 °C Hexagon at sensor housing (T _{Insugan}) ≤ 680 °C Maximum temperatures (max. 40 h cumulative over service life in intervals of max. 10 min) Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Greannet}) ≤ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhoten}) ≤ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhoten}) ≤ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhoten}) ≤ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhoten}) ≤ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhoten}) ≤ 280 °C Cable ou	Maximum permissible vehicle electrical system voltage U _{Batt.max}	≤ 16,5 V
Exhaust gas (T _{Exhautget}) \$ 930 °C Hexagon at sensor housing (T _{Hexagon}) \$ 600 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Gremmet}) \$ 250 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhoue}) \$ 200 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhoue}) \$ 250 °C Cable and protective sheathing \$ 250 °C Connector \$ 120 °C Maximum temperatures (max. 250 h cumulative over service life) \$ Exhaust gas (T _{Exhautget}) \$ 1030 °C Hexagon at sensor housing (T _{Hexagon}) \$ 680 °C Maximum temperatures (max. 40 h cumulative over service life in intervals of max. 10 min) \$ 280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Gremmet}) \$ 280 °C Cable outlet (PTFE sheath) - sensor side (upper sleeve, T _{Upperhose}) \$ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhose}) \$ 280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Gremmet}) \$ 280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Gremmet}) \$ 280 °C Cable outlet (PTFE sheath) - sensor side (ver service life \$ 230 °C Cable outlet (PTFE sheath) - sensor side secket sensor \$ 280 °C	Minimum vehicle electrical system voltage	≥ 10,8 V
Exhaust gas (T _{Exhautget}) \$ 930 °C Hexagon at sensor housing (T _{Hexagon}) \$ 600 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Gremmet}) \$ 250 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhoue}) \$ 200 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhoue}) \$ 250 °C Cable and protective sheathing \$ 250 °C Connector \$ 120 °C Maximum temperatures (max. 250 h cumulative over service life) \$ Exhaust gas (T _{Exhautget}) \$ 1030 °C Hexagon at sensor housing (T _{Hexagon}) \$ 680 °C Maximum temperatures (max. 40 h cumulative over service life in intervals of max. 10 min) \$ 280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Gremmet}) \$ 280 °C Cable outlet (PTFE sheath) - sensor side (upper sleeve, T _{Upperhose}) \$ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhose}) \$ 280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Gremmet}) \$ 280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Gremmet}) \$ 280 °C Cable outlet (PTFE sheath) - sensor side (ver service life \$ 230 °C Cable outlet (PTFE sheath) - sensor side secket sensor \$ 280 °C	Operating temperatures	
Hexagon at sensor housing (T _{Hexagon}) ≤ 600 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grommet}) ≤ 250 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperhose}) ≤ 200 °C Cable and protective sheathing ≤ 250 °C Connector ≤ 1020 °C Maximum temperatures (max. 250 h cumulative over service life) Exhaust gas (T _{Exhaustgas}) ≤ 1030 °C Hexagon at sensor housing (T _{Hexagon}) ≤ 680 °C Maximum temperatures (max. 40 h cumulative over service life in intervals of max. 10 min) Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grommet}) ≤ 280 °C Maximum temperatures (max. 40 h cumulative over service life in intervals of max. 10 min) Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grommet}) ≤ 280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grommet}) ≤ 280 °C Cable outlet (PTFE sheath) - sensor side (vaper sleeve, T _{Upperhose}) ≤ 280 °C Cable outlet (PTFE sheath) - sensor side (vaper sleeve, T _{Upperhose}) ≤ 280 °C Cable outlet (PTFE sheath) - sensor side (vaper sleeve, T _{Upperhose}) ≤ 280 °C Cable outlet (PTFE sheath) - sensor side (vaper sleeve, T _{Upperhose}) ≤ 280 °C Cable outlet (PTFE sheath) - sensor side (va		≤ 930 °C
Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Greennet}) ≤ 250 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{Upperfore}) ≤ 200 °C Cable and protective sheathing ≤ 250 °C Connector ≤ 120 °C Maximum temperatures (max. 250 h cumulative over service life) Exhaust gas (T _{Exhaustgan}) ≤ 1030 °C Hexagon at sensor housing (T _{Mexagon}) ≤ 680 °C Maximum temperatures (max. 40 h cumulative over service life in intervals of max. 10 min) Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Greennet}) ≤ 280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Greennet}) ≤ 280 °C Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Greennet}) ≤ 280 °C Cable outlet (PTFE sheath) - sensor side (upper sleeve, T _{Upperhose}) ≤ 280 °C Cable and protective sheathing ≤ 280 °C Cable and protective sheathing ≤ 280 °C Cable and protective sheathing ≤ 250 °C Cable and protective sheathing ≤ 280 °C Cable and protective sheathing ≤ 280 °C Cable and protective sheathing ≤ 280 °C Cable and protective sheathing ≤ 250 °C Exhaust gas back pressure <t< td=""><td></td><td>≤ 600 °C</td></t<>		≤ 600 °C
Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{upperhose}) < 200 °C		≤ 250 °C
Cable and protective sheathing ≤ 250 °C Connector ≤ 120 °C Maximum temperatures (max. 250 h cumulative over service life) Exhaust gas (T _{Exhautigas}) ≤ 1030 °C Hexagon at sensor housing (T _{Hexagon}) ≤ 680 °C Maximum temperatures (max. 40 h cumulative over service life in intervals of max. 10 min) Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grommet}) ≤ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{upperhose}) ≤ 280 °C Cable and protective sheathing ≤ 280 °C Exhaust gas back pressure Continuous operation ≤ 2,5 bar Brief maximum pressure, max. 250 h accumulated over service life < 4 bar		≤ 200 °C
Maximum temperatures (max. 250 h cumulative over service life) Exhaust gas (T _{Exhaustgas}) < 1030 °C	Cable and protective sheathing	≤ 250 °C
Exhaust gas (T _{Exhaustgas}) ≤ 1030 °C Hexagon at sensor housing (T _{Hexagon}) ≤ 680 °C Maximum temperatures (max. 40 h cumulative over service life in intervals of max. 10 min) Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grommet}) Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{upperhose}) ≤ 280 °C Cable and protective sheathing ≤ 280 °C Exhaust gas back pressure Continuous operation ≤ 2,5 bar Brief maximum pressure, max. 250 h accumulated over service life ≤ 4 bar Note: If the operating temperatures or the permissible exhaust gas back pressure for continuous operation are exceeded, the sensor accuracy is impaired. Permissible oscillating load ≤ 1000 m/s ² Sinusoidal oscillations ≤ 300 m/s ² Readiness for operation ≤ 300 m/s ²	Connector	≤ 120 °C
Exhaust gas (T _{Exhaustgas}) ≤ 1030 °C Hexagon at sensor housing (T _{Hexagon}) ≤ 680 °C Maximum temperatures (max. 40 h cumulative over service life in intervals of max. 10 min) Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grommet}) Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{upperhose}) ≤ 280 °C Cable and protective sheathing ≤ 280 °C Exhaust gas back pressure Continuous operation ≤ 2,5 bar Brief maximum pressure, max. 250 h accumulated over service life ≤ 4 bar Note: If the operating temperatures or the permissible exhaust gas back pressure for continuous operation are exceeded, the sensor accuracy is impaired. Permissible oscillating load ≤ 1000 m/s ² Sinusoidal oscillations ≤ 300 m/s ² Readiness for operation ≤ 300 m/s ²	Maximum temperatures (max. 250 h cumulative over service life)	
Hexagon at sensor housing (T _{Hexagon}) ≤ 680 °C Maximum temperatures (max. 40 h cumulative over service life in intervals of max. 10 min) Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grommet}) ≤ 280 °C Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{upperhose}) ≤ 230 °C Cable and protective sheathing ≤ 280 °C Exhaust gas back pressure Continuous operation ≤ 2,5 bar Brief maximum pressure, max. 250 h accumulated over service life ≤ 4 bar Note: If the operating temperatures or the permissible exhaust gas back pressure for continuous operation are exceeded, the sensor accuracy is impaired. Permissible oscillating load ≤ 1000 m/s ² Stochastic oscillations (peak value) ≤ 1000 m/s ² Sinusoidal oscillations ≤ 300 m/s ²		≤ 1030 °C
Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grommet}) < 280 °C	Hexagon at sensor housing (T _{Hexagon})	≤ 680 °C
Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grommet}) < 280 °C	Maximum temperatures (max. 40 h cumulative over service life in intervals of max. 10 min)	
Cable and protective sheathing ≤ 280 °C Exhaust gas back pressure Continuous operation ≤ 2,5 bar Brief maximum pressure, max. 250 h accumulated over service life ≤ 4 bar Note: If the operating temperatures or the permissible exhaust gas back pressure for continuous operation are exceeded, the sensor accuracy is impaired. Permissible oscillating load Stochastic oscillations (peak value) ≤ 1000 m/s² Sinusoidal oscillations ≤ 300 m/s²	Cable outlet (PTFE sheath) - sensor side (PTFE socket, T _{Grommet})	≤ 280 °C
Cable and protective sheathing ≤ 280 °C Exhaust gas back pressure Continuous operation ≤ 2,5 bar Brief maximum pressure, max. 250 h accumulated over service life ≤ 4 bar Note: If the operating temperatures or the permissible exhaust gas back pressure for continuous operation are exceeded, the sensor accuracy is impaired. Permissible oscillating load Stochastic oscillations (peak value) ≤ 1000 m/s² Sinusoidal oscillations ≤ 300 m/s²	Cable outlet (PTFE sheath) - cable side (upper sleeve, T _{upperhose})	≤ 230 °C
Continuous operation ≤ 2,5 bar Brief maximum pressure, max. 250 h accumulated over service life ≤ 4 bar Note: If the operating temperatures or the permissible exhaust gas back pressure for continuous operation are exceeded, the sensor accuracy is impaired. Permissible oscillating load Stochastic oscillations (peak value) ≤ 1000 m/s ² Sinusoidal oscillations ≤ 300 m/s ²	Cable and protective sheathing	≤ 280 °C
Brief maximum pressure, max. 250 h accumulated over service life ≤ 4 bar Note: If the operating temperatures or the permissible exhaust gas back pressure for continuous operation are exceeded, the sensor accuracy is impaired. Permissible oscillating load Stochastic oscillations (peak value) ≤ 1000 m/s ² Sinusoidal oscillations ≤ 300 m/s ²	Exhaust gas back pressure	
Note: If the operating temperatures or the permissible exhaust gas back pressure for continuous operation are exceeded, the sensor accuracy is impaired. Permissible oscillating load Stochastic oscillations (peak value) ≤ 1000 m/s² Sinusoidal oscillations ≤ 300 m/s² Readiness for operation ≤ 1000 m/s²	Continuous operation	≤ 2,5 bar
for continuous operation are exceeded, the sensor accuracy is impaired. Permissible oscillating load Stochastic oscillations (peak value) ≤ 1000 m/s² Sinusoidal oscillations ≤ 300 m/s² Readiness for operation ≤ 1000 m/s²	Brief maximum pressure, max. 250 h accumulated over service life	≤ 4 bar
Permissible oscillating load Stochastic oscillations (peak value) ≤ 1000 m/s² Sinusoidal oscillations Readiness for operation	Note: If the operating temperatures or the permissible exhaust gas back pressure	
Stochastic oscillations (peak value) ≤ 1000 m/s² Sinusoidal oscillations ≤ 300 m/s² Readiness for operation	for continuous operation are exceeded, the sensor accuracy is impaired.	
Sinusoidal oscillations ≤ 300 m/s ² Readiness for operation	Permissible oscillating load	
Sinusoidal oscillations ≤ 300 m/s ² Readiness for operation	Stochastic oscillations (peak value)	≤ 1000 m/s²
	Sinusoidal oscillations	
	Readiness for operation	
	Approximate value for sensor ON time ("Light-off")	≤ 10 s

Lambda sensor LSU 4.9

Measurement of oxygen content

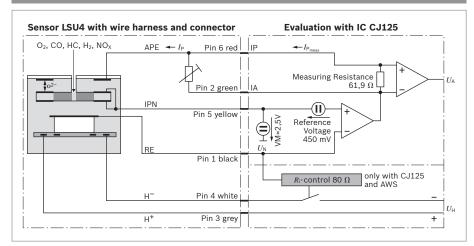
Part number

0 258 017 025

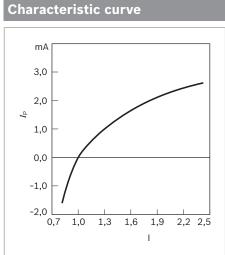


- 3 Heater clock (white)
- 4 Heater clock + U Batt (grey)
- 5 Trimming potentiometers (green)
- 6 Nernst voltage (black)





The evaluation module CJ 125 is required for operation of the LSU 4.9. Further details on request.



 $I_{\rm P}$ = Pump current

 λ = Air ratio

Accessories

Mating connector parts set

Order number 1 986 280 016

List of part numbers

Part number	Page	Part number	Page	Part number	Page
0 232 103 097	19	0 265 005 642	16	0 281 002 593	51
0 232 103 099	20	0 265 005 764	17	0 281 002 616	52
0 258 004 010	114	0 265 007 527	28	0 281 002 667	24
0 258 017 025	119	0 265 007 544	29	0 281 002 668	61
0 261 210 303	21	0 272 230 424	37	0 281 002 671	70
0.001.010.010		0.000.005.000		0.001.000.000	
0 261 210 318	22	0 280 005 620	85	0 281 002 693	53
0 261 210 329	23	0 280 122 024	13	0 281 002 704	94
0 261 230 083	46	0 280 130 026	95	0 281 002 755	76
0 261 230 093	40	0 280 130 039	89	0 281 002 764	107
0 261 230 105	47	0 280 218 087	99	0 281 002 767	71
0 261 230 109	56	0 280 218 089	100	0 281 002 772	41
0 261 230 110	57	0 280 218 113	101	0 281 002 787	77
0 261 230 112	58	0 280 218 119	102	0 281 002 802	108
0 261 230 121	43	0 280 218 176	106	0 281 002 841	72
0 261 230 145	80	0 281 002 209	92	0 281 002 842	73
0 261 230 249	81	0 281 002 238	67	0 281 002 930	74
0 261 230 255	82	0 281 002 244	59	0 281 002 937	75
0 261 230 274	83	0 281 002 316	60	0 281 006 054	111
0 261 230 275	84	0 281 002 398	69	0 281 006 101	25
0 261 231 173	32	0 281 002 412	93	0 281 006 243	86
0 261 231 176	33	0 281 002 421	98	0 281 006 282	62
0 261 231 196	34	0 281 002 487	48		
0 261 545 053	65	0 281 002 522	68		
0 265 005 303	66	0 281 002 566	49		
0 265 005 411	10	0 281 002 573	50		

Notes
