Bosch Service Training

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Invented for life

מערכות טורבו וניהול ממוחשב

ארז מוספי-מדריך ראשי ומנהל ההדרכה
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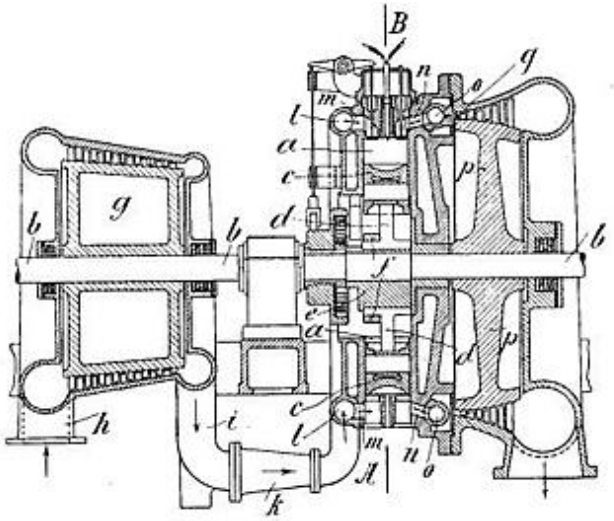
History of exhaust-gas turbocharger

Alfred Büchi
1879-1959



Patent: Turbocharger by Alfred Büchi (1905)

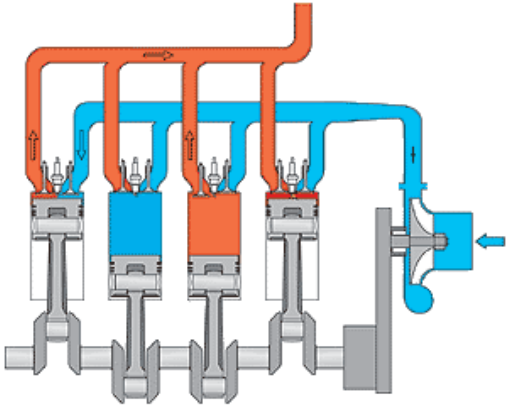
1924 Ship's engine

1938 Commercial vehicle (Saurer)

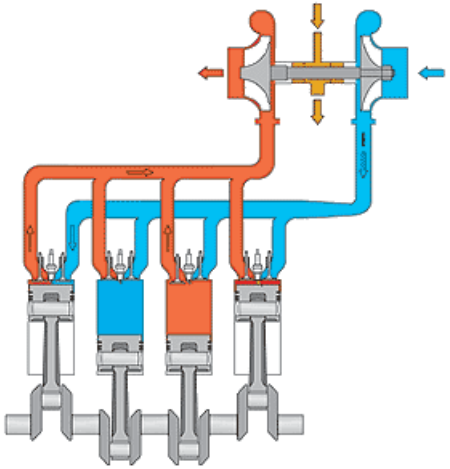
1974 BMW 2002 Turbo

1978 Mercedes Benz 300 SD

Turbocharging concept



Mechanical supercharging



Exhaust-gas turbocharging

In case of mechanical supercharging, a compressor is driven directly by the internal combustion engine. Mechanically driven compressors are available as positive displacement superchargers (compressor) with different designs (e.g. roots charger, sliding-vane supercharger, spiral-type supercharger, exhaust-driven screw-charger) or as the centrifugal turbo-compressor (e.g. radial compressor). The power to drive a mechanical turbocharger is up to 15 % of the engine output. Therefore, fuel consumption is higher when compared with a naturally aspirated engine with the same power output.

The main components of an exhaust-gas turbocharger are - an exhaust-gas turbine and a compressor, whose wheels are arranged on a common shaft. These components are seated in the exhaust-gas system, so that the exhaust-gas can drive the exhaust-gas turbine. The compressor compresses the aspirated air and thus, increases the cylinder charge.

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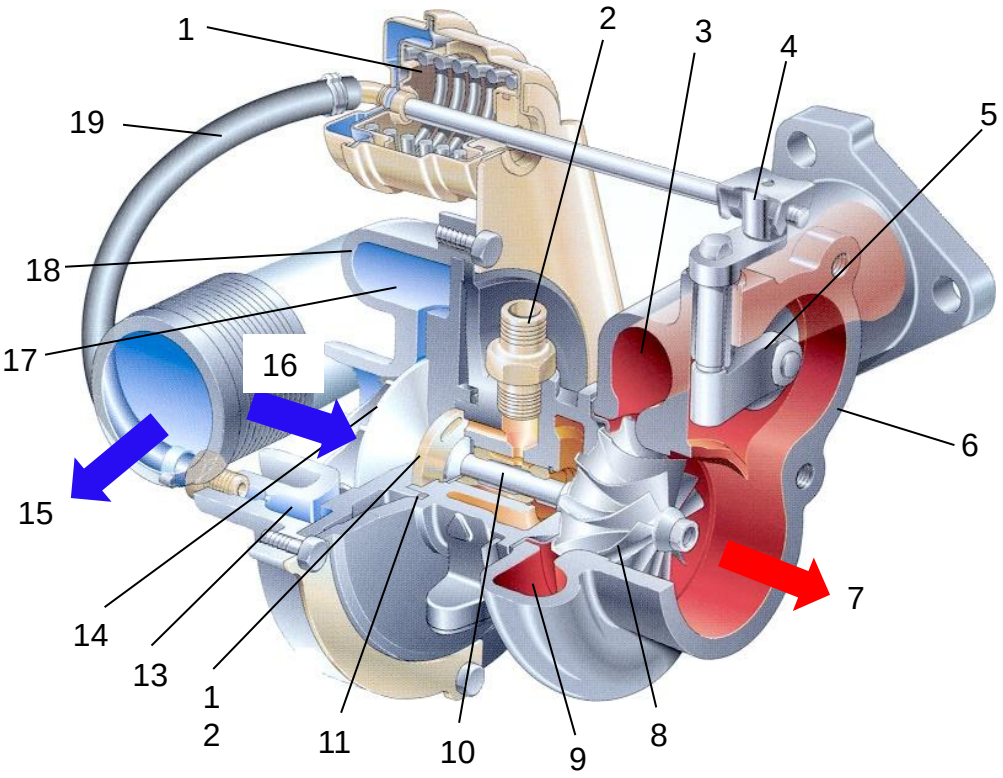
Exhaust-gas turbocharger with charge regulation



1. Aneroid capsule
2. Lubricating oil inlet
3. Swirl duct
4. Aneroid capsule adjustment
5. Control flap
6. Turbine housing
7. Exhaust gas
8. Turbine wheel
9. Swirl duct
10. Shaft
11. Bearing housing
12. Axial bearing
13. Swirl duct
14. Compressor wheel
15. Compressor outlet
16. Intake air
17. Compressed air to the intercooler
18. Compressor housing
19. Control line

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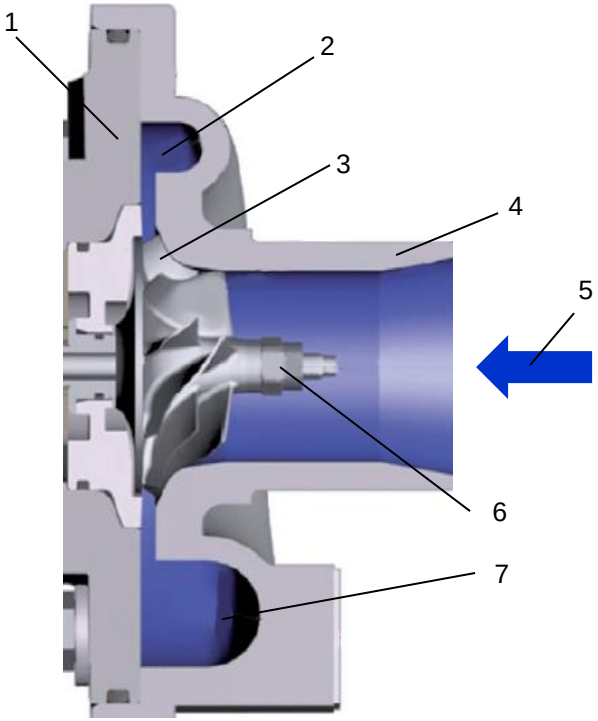
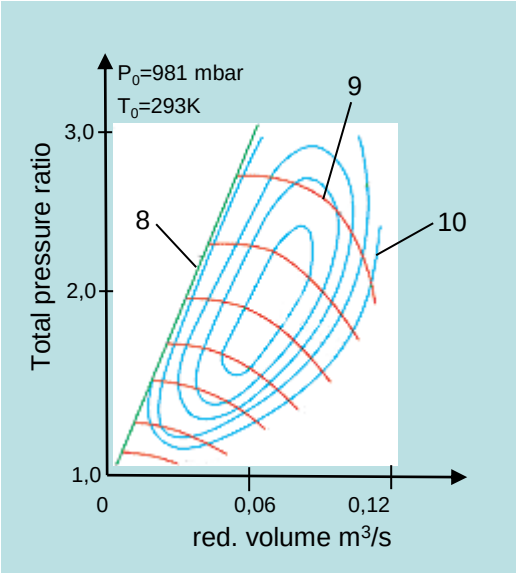
Exhaust-gas Turbocharger - Compressor





Compressor map of a turbo-charger for passenger cars

1. Compressor housing backplate
2. Swirl duct
3. Compressor wheel
4. Compressor housing
5. Fresh air from the engine
6. Lock nut
7. Compressed air to the intercooler
8. Surge limit
9. Maximum permissible ATL-speed
10. Choke line

The compressor consists of the impeller, diffuser, and compressor housing. As with the exhaust gas turbine-, the compressor is tuned optimally to meet the engine specifications.

The radial-flow compressor impeller transfers the majority of the kinetic energy, provided by the turbine, to the air flow. The required pressure increase is then generated in a diffuser in the compressor housing.

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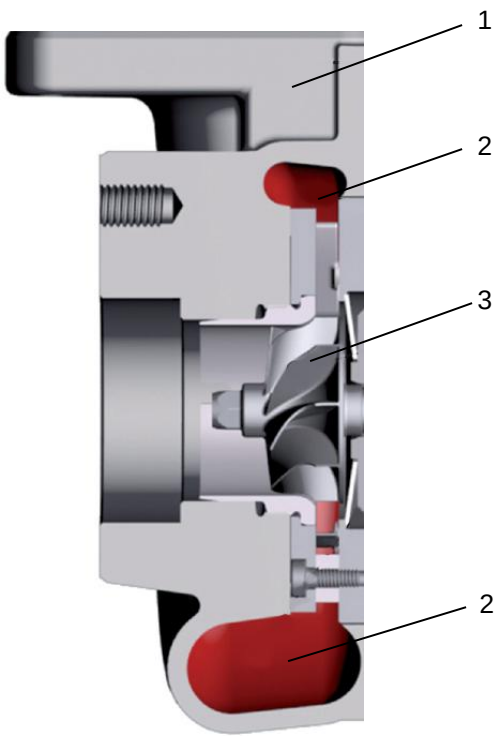
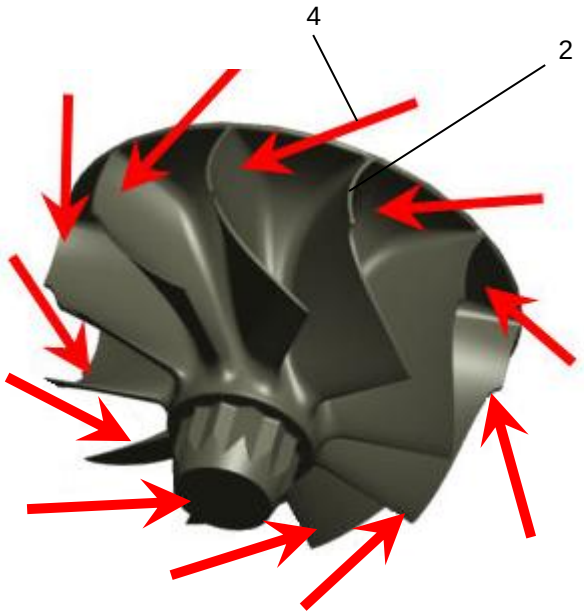
Exhaust-gas turbocharger – Turbine





1. Turbine housing
2. Swirl duct
3. Rotor shaft=Turbine wheel
4. Exhaust gas flow

Generally, the turbine of a turbocharger consists of the turbine wheel and the turbine housing. The turbine converts the engine exhaust gas into mechanical energy to drive the compressor. The gas, which is restricted by the turbine's flow cross-sectional area, results in a pressure and temperature drop between the inlet and outlet. This pressure drop is converted by the turbine into kinetic energy to drive the turbine wheel.

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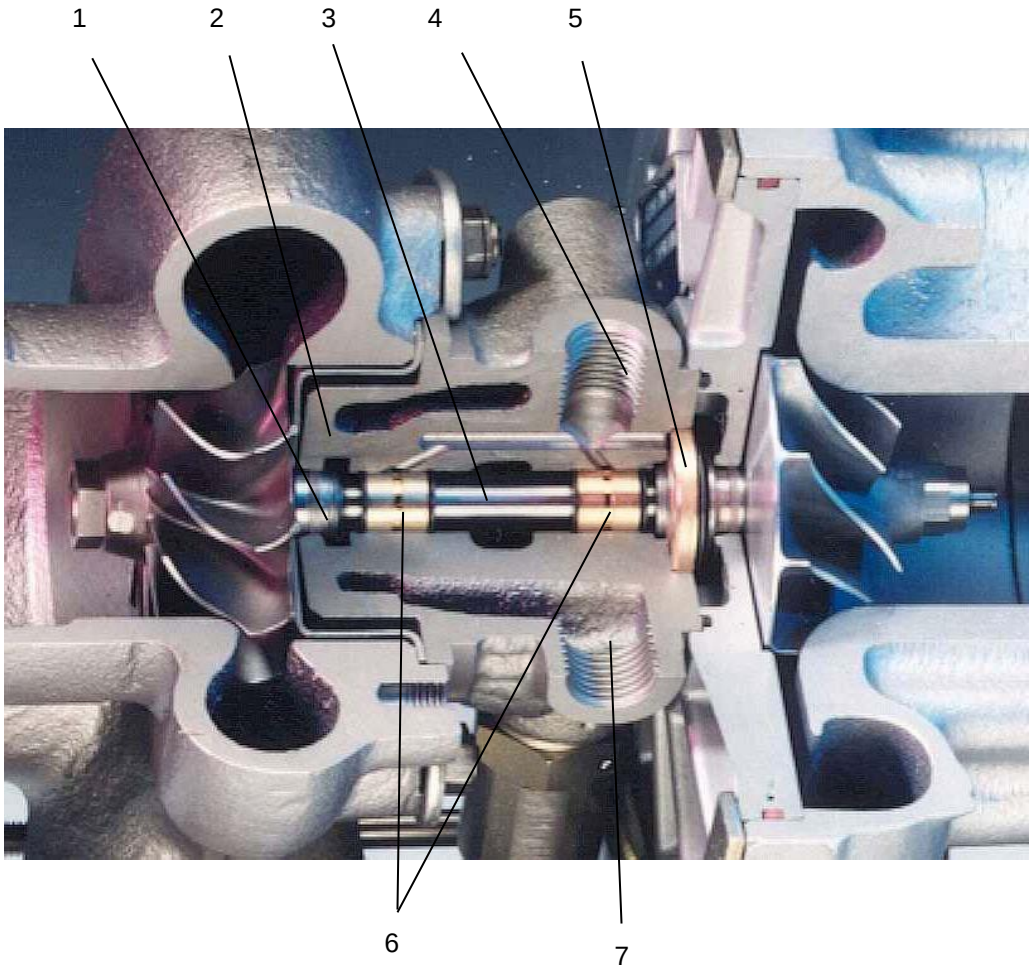
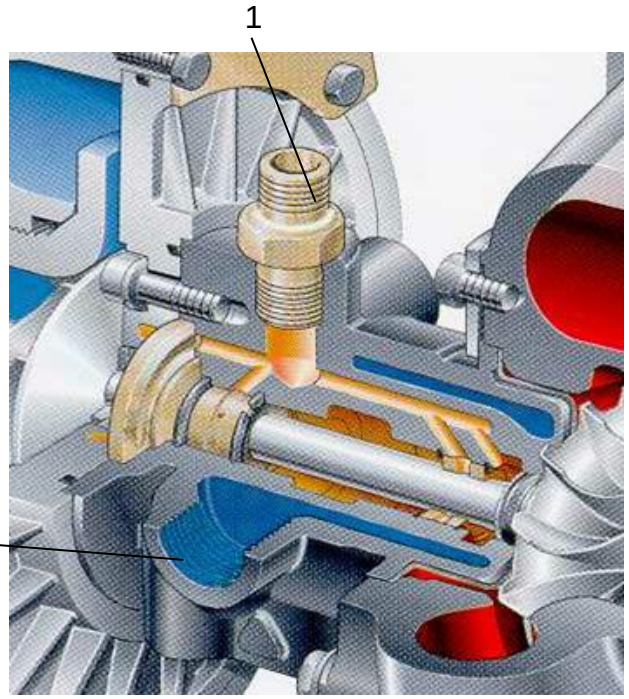
Exhaust-gas turbocharger - Lubrication



1. Piston-ring seal
2. Bearing housing
3. Rotor shaft
4. Oil inlet
5. Axial bearing
6. Radial bearing bushing
7. Water inlet

Exhaust-gas turbocharger - Cooling



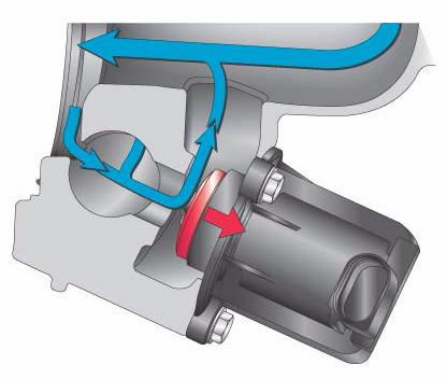
1. Oil inlet connection
2. Water inlet connection

The cooling system of the turbocharger is integrated in the cooling circuit of the engine. After the engine is shut down, it is possible to actuate an electrical water pump that further drives the small engine cooling circuit.

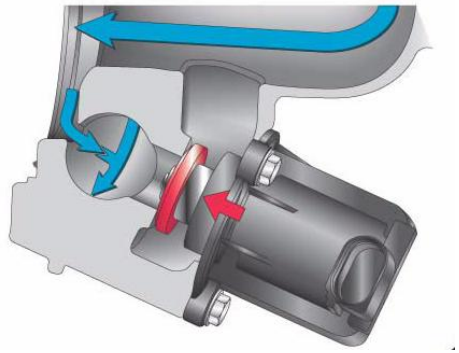
Gasoline engine 900-1050°C

Diesel engine 650-850 °C.

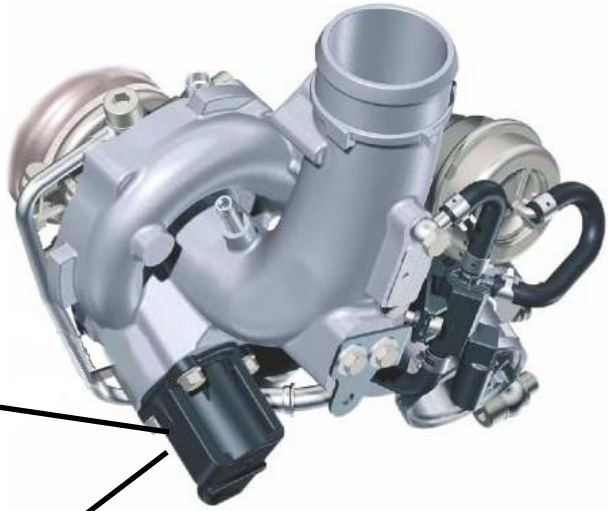
Exhaust-gas turbocharger - Divert-air valve



Divert air valve open
(overrun mode)

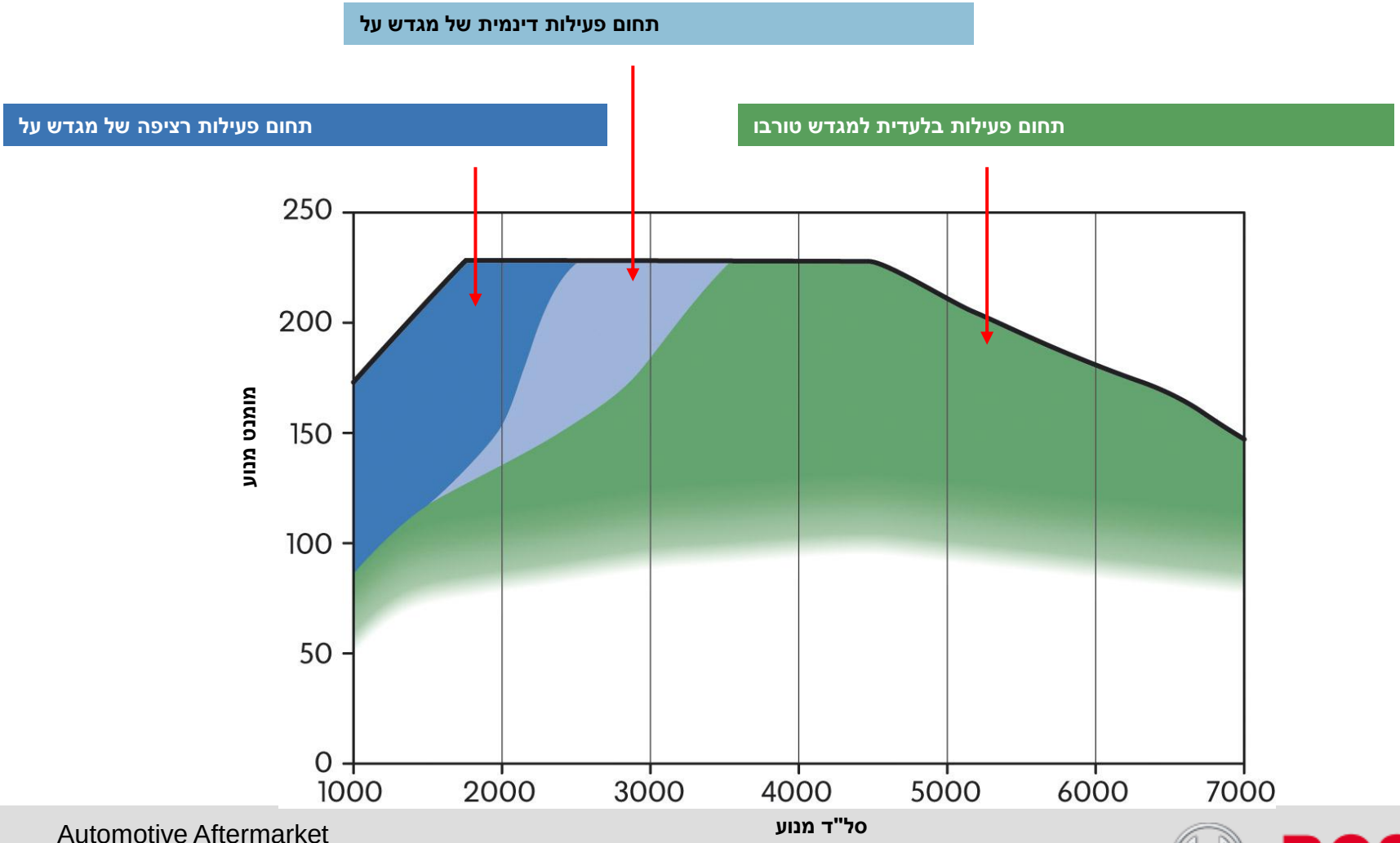


Divert air valve closed
(load mode)



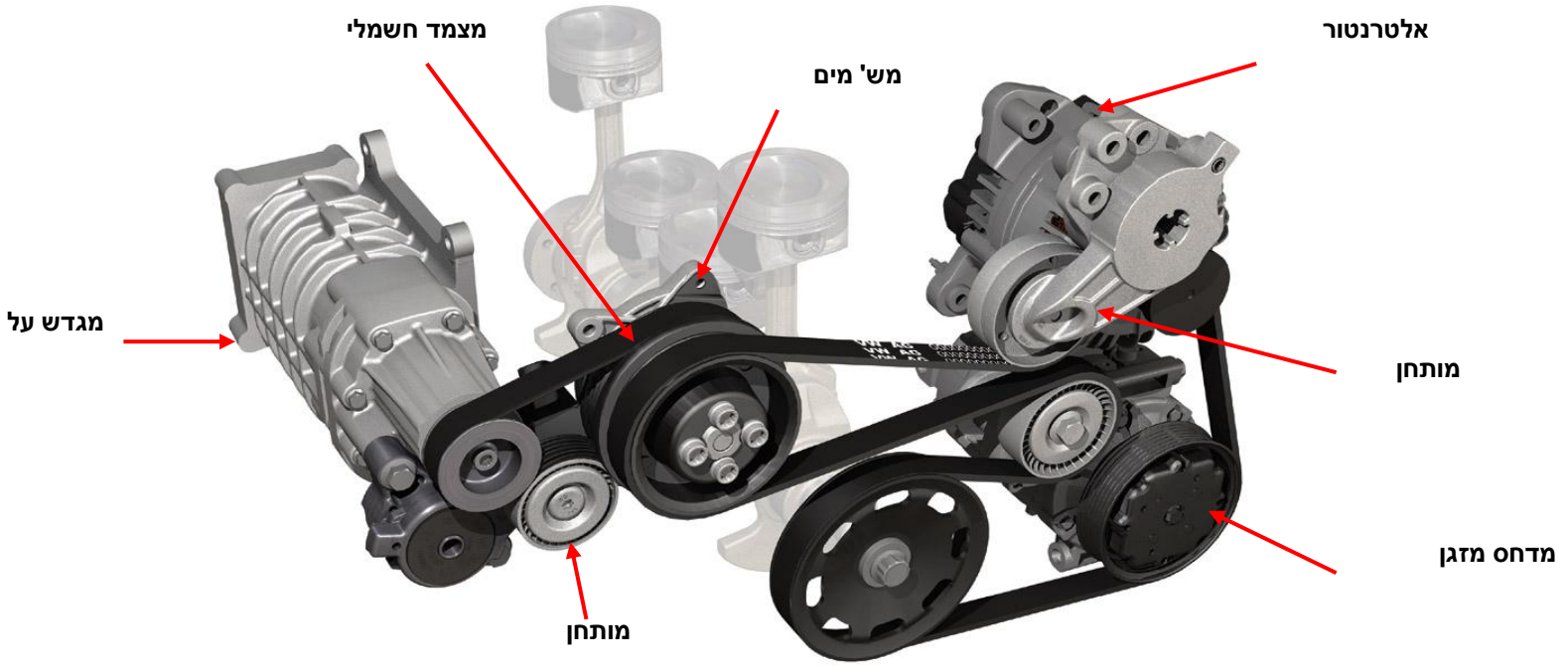
A back pressure acts during the overrun mode and during deceleration; this back pressure slows down the compressor wheel (turbo lag). In order to avoid this, the divert air valve is opened by an electric actuator.

תחומי הפעלת הגידוש



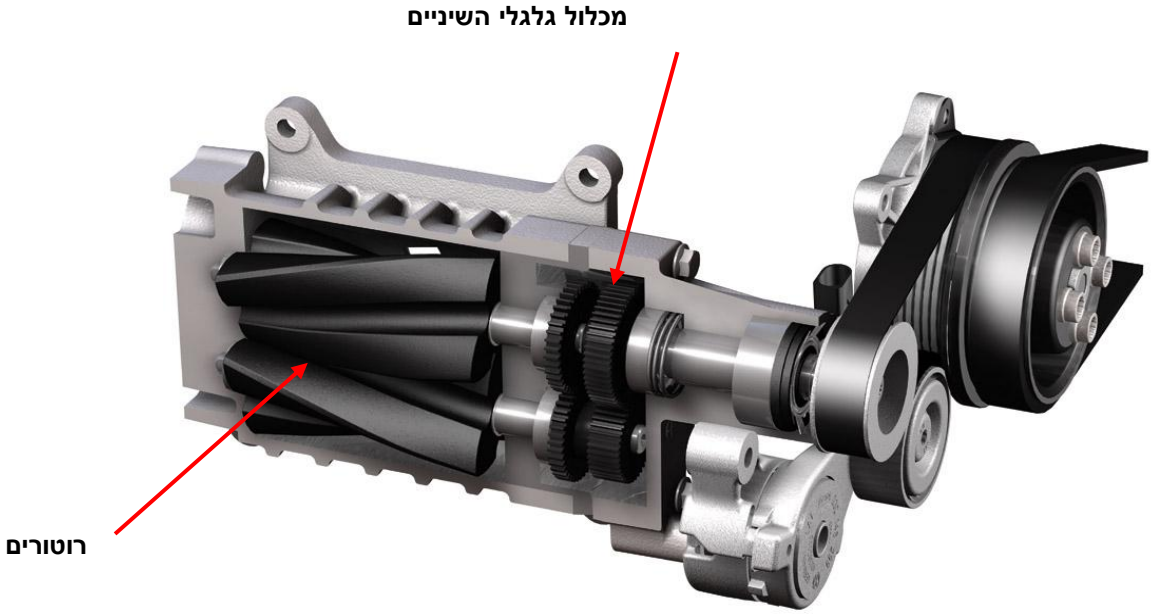
Exhaust-gas turbocharger

- מניעות את מכלולי העזר של המנוע Poly V 2 רצועות מסוג
- רצועה אחת מניעה את מש' המים, מדחס המזגן והאלטרנטור
- רצועה שניה מניעה את מגדש העל דרך מצמד חשמלי המותקן ע"ג מכלול מש' המים

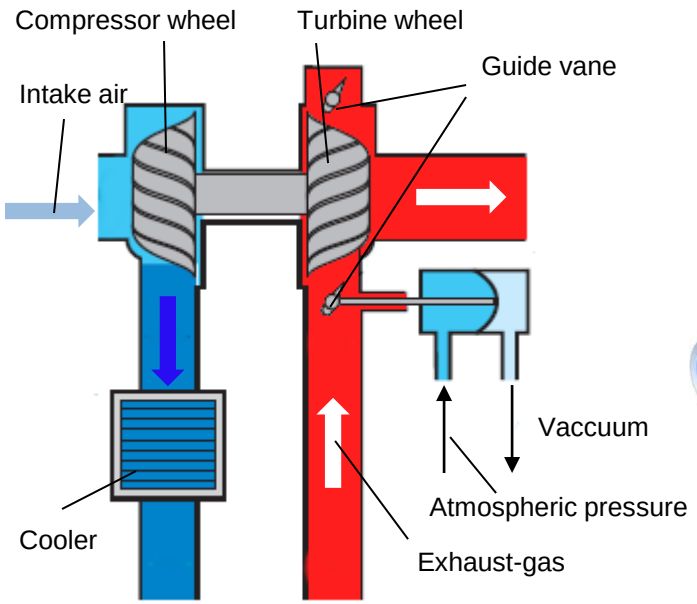


מגדש על

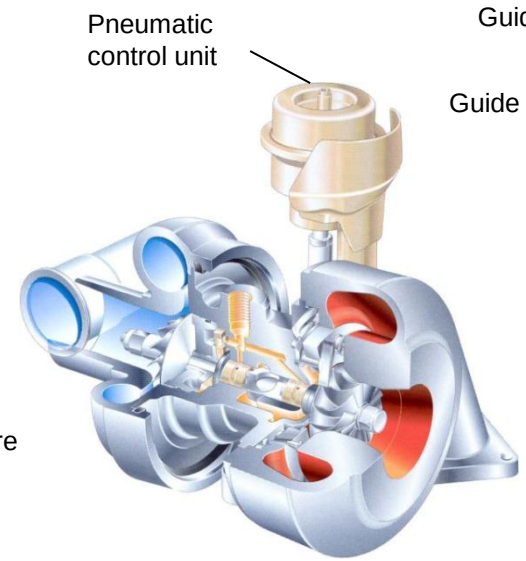
- מגדש העל מגיע כיחידה לא ניתנת לפירוק
- מכלול גלגלי השיניים מלא בשמן מיוחד וללא טיפול
- המגדש מסתובב במהירות של פי 5 מגל הארכובה
- מהירות הסיבוב המקסימלית של המגדש היא 17,500 סל"ד



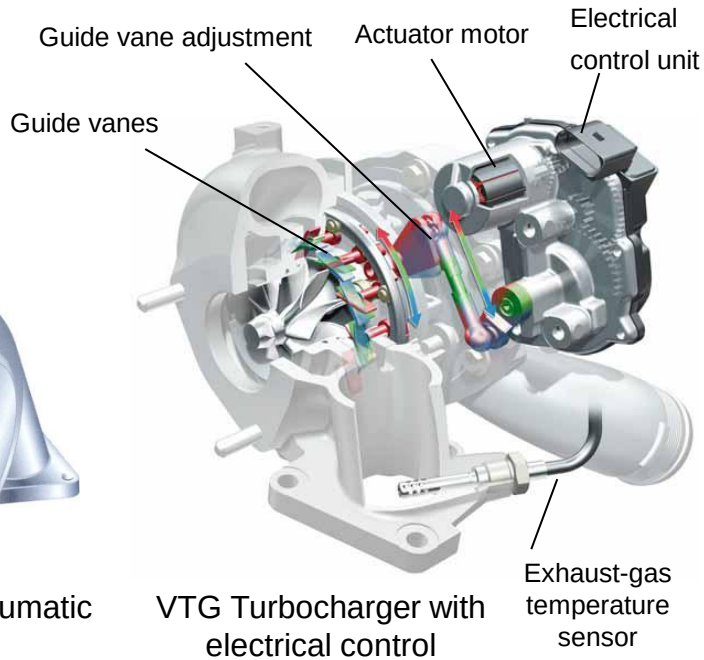
Turbocharger with Variable Turbine Geometry (VTG)



Functional principle



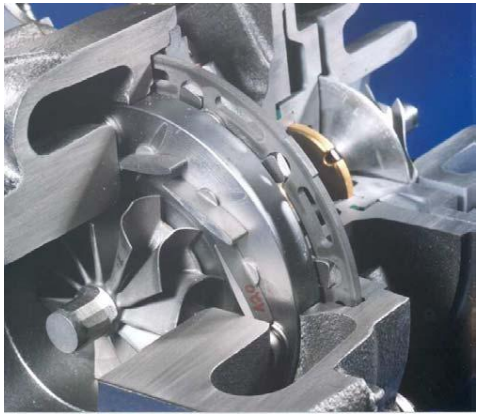
VTG Turbocharger with pneumatic control



VTG Turbocharger with electrical control

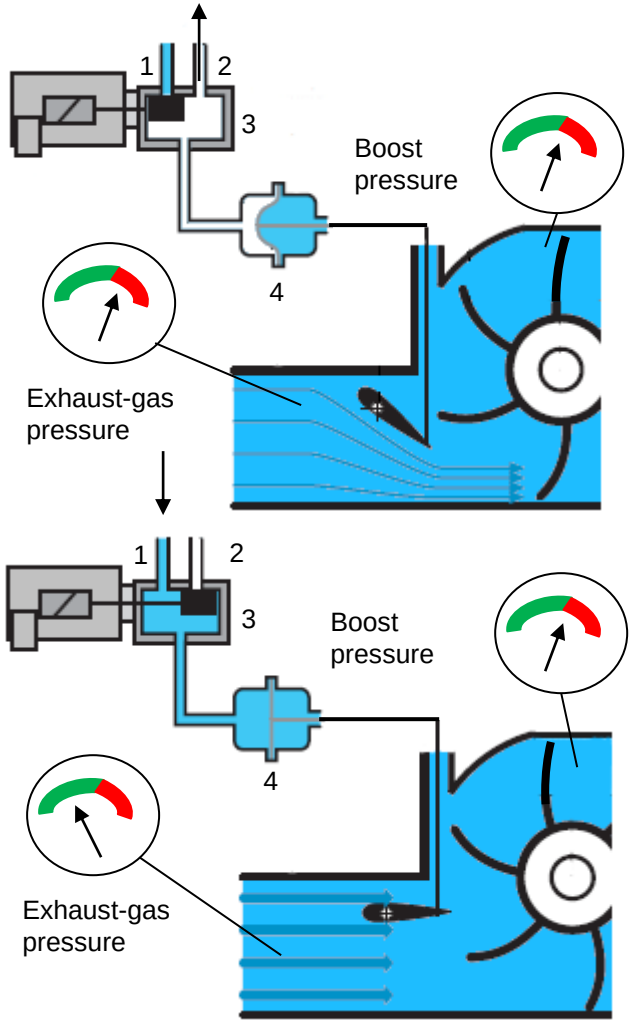
Varying the rate of gas flow through the turbine by means of variable turbine geometry (VTG) is another method by which the exhaust-gas flow rate can be limited at high engine speeds. The adjustable deflector blades (3) alter the size of the gap through which the exhaust gas flows in order to reach the turbine (variation of geometry). By doing so, they adjust the exhaust-gas pressure acting on the turbine in response to the required turbocharger pressure.

Boost pressure control - VTG



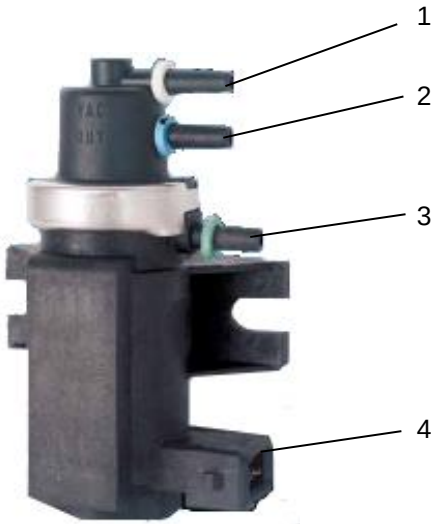
Engine speed low

Engine speed high



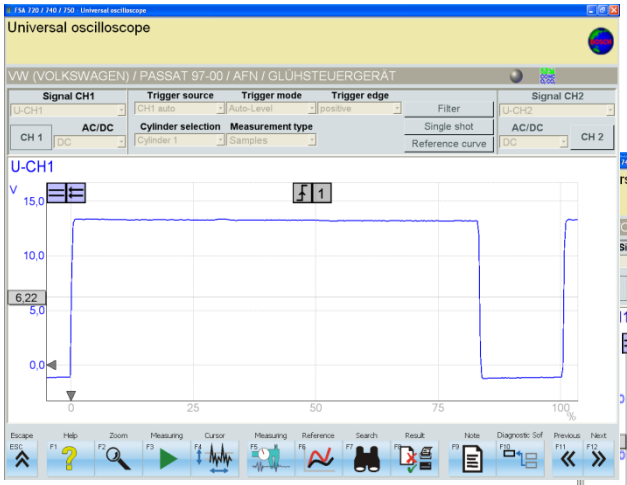
1. Atmospheric pressure
2. Vaccuum
3. Solenoid valve
4. Vaccuum unit

Boost pressure control - Electro-pneumatic pressure transducer

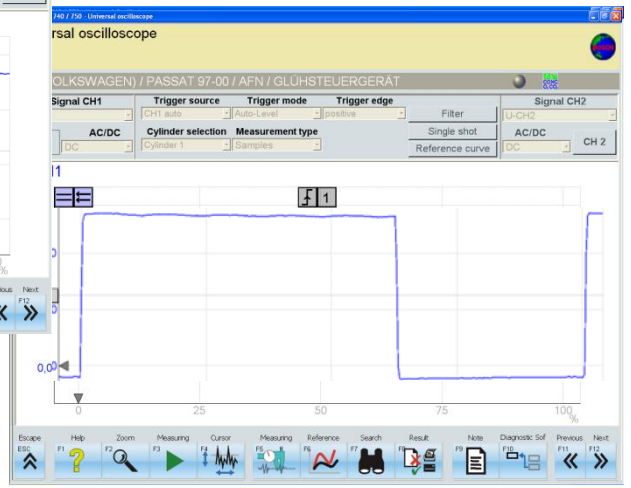


1. Supply - vaccuum (VAC)
2. Variable control pressure (OUT)
3. Ventilation connection (ATM)
4. Electrical connection

Test: Signal recording with FSA



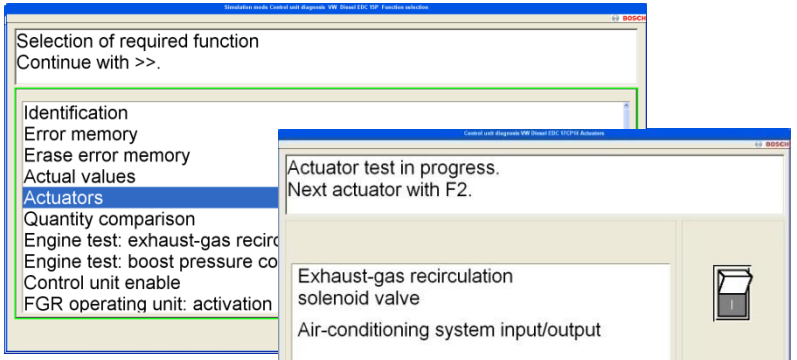
Idling

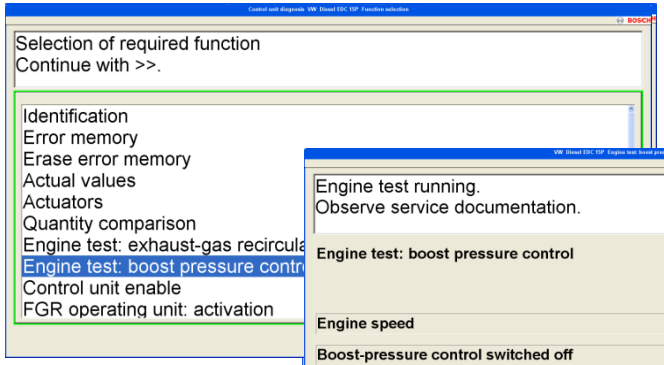


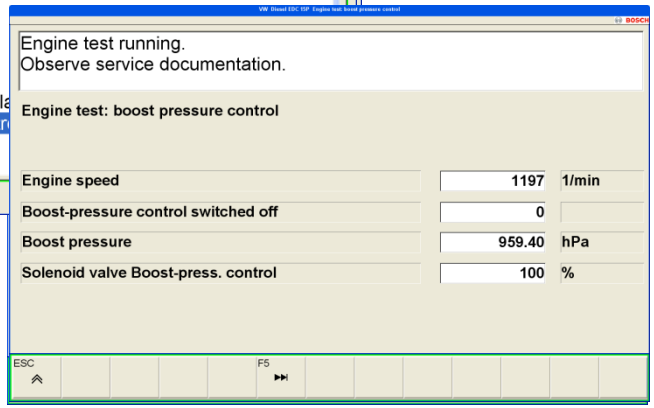
Acceleration

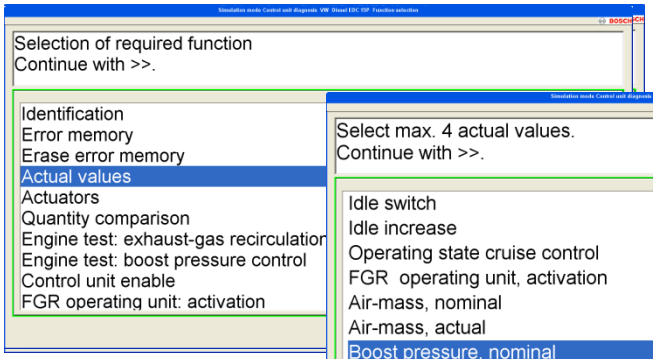
The core piece of the EPW is a double-seated valve. On the one hand, the supply pressure VAC is actuated by a diaphragm; on the other hand, a controlling magnetic force acts upon the double-seated valve via an armature. Hence, the EPW forms a mixed pressure from the vacuum and the ambient pressure (control pressure). The vent connection should be equipped with a filter to protect the EPW from contamination. The control unit provides a PWM-signal, to actuate the EPW.

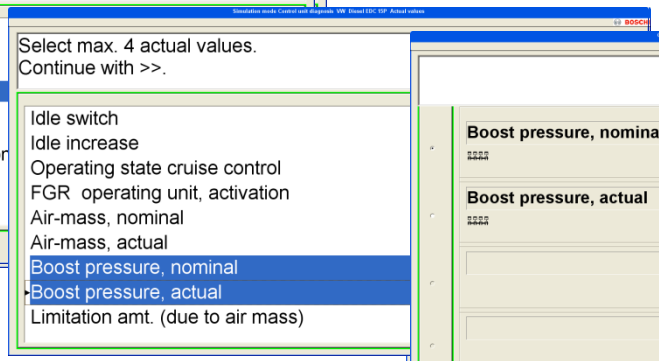
Diagnosis in the vehicle using KTSxxx

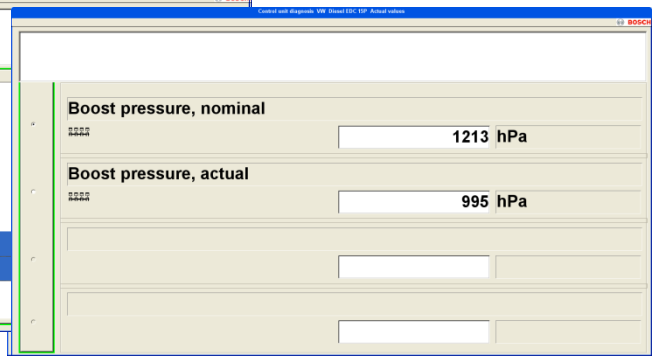




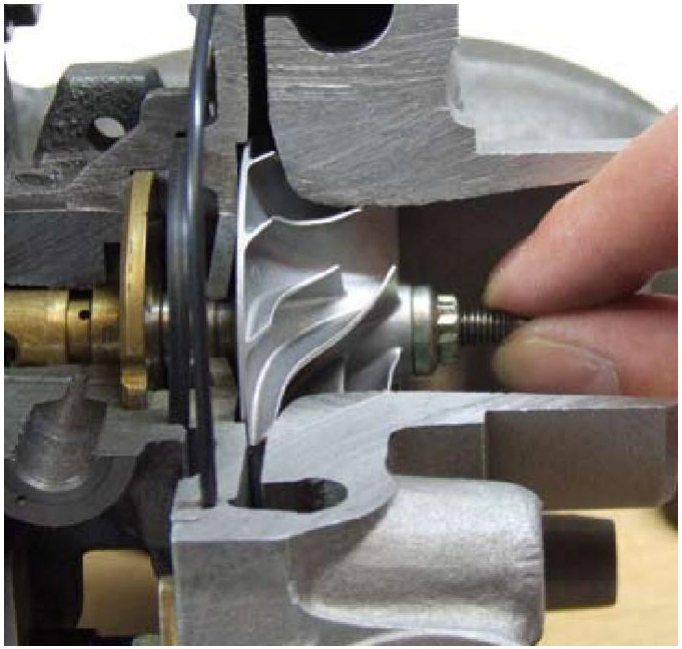


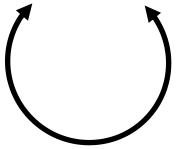




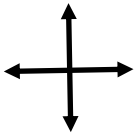


Checking shaft play





Inspection for the ease of movement and for grinding noises

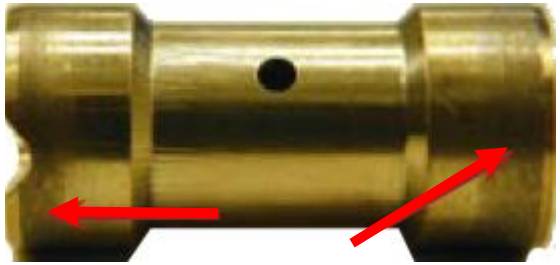


Checking axial and radial play

Testing the shaft play

1. Hold the shaft and move it radial. Thereby, a (required) radial play of 1/10 mm – 6/10 mm is permitted. Depends on the manufacturer
2. Lift the shaft slightly and rotate. In the process, no grinding noises should be noticeable and the turning resistance should not change. Otherwise, bearing damage can be expected.
3. Missing clearance indicates bearing problems, which would arise due to coked oil.
4. An axial clearance (to and fro movement of the shaft) should not be (significantly) perceivable.

Turbocharger damage types 1

Fault: Poor lubrication or oil loss	Foreign objects in the compressor or the turbine.	Poor oil quality
Fault pattern:		
		
Discoloration and bearing metal deposition	Damage caused by foreign bodies	Dirt ridges on the shaft
		
Twisting of the bearing bush due to lack of oil	Compressor wheel damaged by hard foreign bodies	Ridges on the radial bearing bush due to dirt particles

One-stop Solution

Bosch-Diagnostics für die Werkstatt

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