

- **TURBOCHARGERS**
- **UNIT INJECTORS**
- **COMMON RAIL INJECTORS**
- **COMMON RAIL PUMPS**





is a company that specialises in professional renovation of turbochargers and injection systems. By having the state-of-the-art equipment resources and highly qualified personnel as well as thanks to restrictive procedures and repair techniques, we offer products that meet the highest quality and technical standards. Our experience, passion and commitment allowed us to develop our operations to European markets. The entire renovation process takes place on the spot in a newly erected production building with the floor area of 1,600m². Thanks to our warehouses, we can offer selling a ready product on the spot.

Our offer includes:

Renovation and/or the purchase of renovated turbochargers for:

- Cars
- Delivery trucks
- Motor trucks
- Construction equipment and machines
- Agricultural equipment and machines

Renovation and/or the purchase of renovated injectors

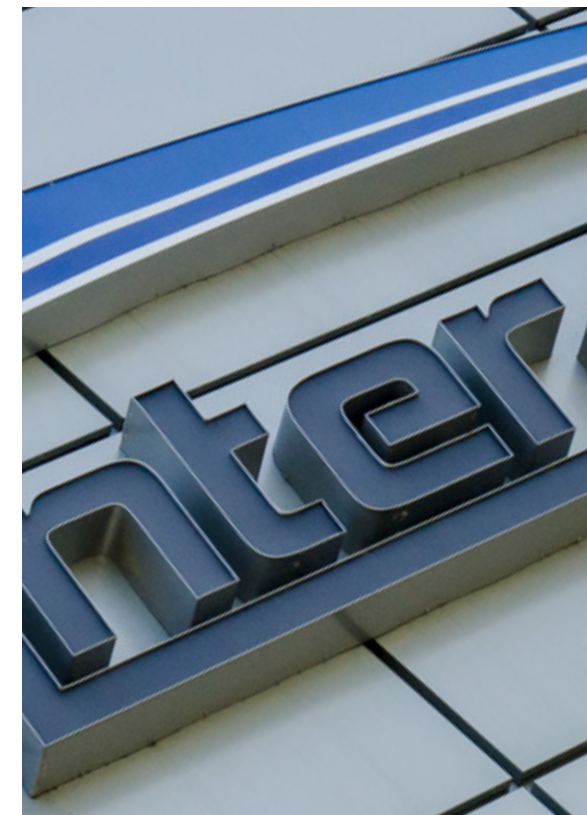
- Common Rail Bosch (Electromagnetic and Piezoelectric)
- Common Rail Delphi
- Common Rail Denso (Electromagnetic and Piezoelectric)
- Common Rail Siemens VDO (Continental)
- Mechanical injectors (spring-loaded, two-spring-loaded)
- GDI, FSI, TSi Fuel Injectors with direct fuel injection

Renovation and/or the purchase of renovated unit injectors

- Bosch
- Delphi
- Siemens VDO (Continental)

Renovation and/or the purchase of renovated injection pumps- Bosch Zexel, VP29, VP30, VP44

- Bosch Common Rail CP1, CP2, CP3, CP4
- Delphi Common Rail DFP1, DFP3, DFP6
- Denso Common Rail HP2, HP3, HP4
- Siemens VDO (Continental) PCR, K9K, Lion, PV 6C,



INTER-TURBO book describes the full scope of operations carried out by us in the case of renovation of subassemblies as well as includes information about assembly and diagnostics of our products.



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01

TURBOCHARGERS

1. General Information

We offer renovation of all sorts of turbochargers, and also sale of an already renovated product.

- ▶ We make current stocks available to everybody in the on-line form
- ▶ More than 1,500 turbochargers for cars and delivery trucks available on the spot
- ▶ selection of turbochargers and gaskets to a vehicle model www.sklep.inter-turbo.pl
- ▶ search engine of availability of turbochargers by the manufacturer's numbers www.inter-turbo.pl/turbo
- ▶ 400 models of assembly kits for turbochargers available in our stock
- ▶ we carry out renovation of turbochargers for motor trucks, agricultural, building machines, and also industrial engines within three (3) working days.

2. We offer three (3) options of sale of turbochargers:

1 Basic Kit



2 Set with Gaskets



3 Full Assembly Kit



Full renovation process - Step by step



1

Disassembling determining the cause of damage



2

Cleaning all elements in high pressure washers



3

Removing impurities, rust and oil sinters by sandblasting and grit blasting of the turbine elements



4

Dimensioning and defining the scope of repair



5

Replacing damaged subassemblies



6

Balancing the turbocharger body



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7

Putting the turbocharger together



8

Calibrating the turbocharger according to the manufacturer's standards



9

Repairing the electric actuator



10

Programming the new scope of operation



11

Final inspection.



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2. Causes of Damage

It is of utmost importance for the entire concept of our selling to determine the cause of damage to a subassembly. Elimination of the cause will ensure smooth operation of a product renovated by us. Below, the most common causes of damage to turbochargers are shown that could make it considerably easier to find the cause of a failure.

OIL CONTAMINATION

Where do the impurities come from?

1. A contaminated oil filter, an oil filter of low quality, the damaged by-pass valve in an oil filter
2. Too low oil level, use of an improper sort of oil to the engine
3. Oil mixed with fuel as a result of often burning off the diesel particulate filter or misoperation of
4. Wear and tear of the engine internal pieces
5. Considerable amount of carbon deposit in the engine
6. Negligence in carrying out periodical services
7. Too long periods without servicing

How to prevent breakdowns?

1. Using only quality, and particularly recommended by the manufacturer oil filters
2. Used oil has to be of adequate grade in accordance with the manufacturer's recommendations
3. Adequate venting of the lubrication system during the replacement of the turbocharger
4. Checking flow capacity of the system for supplying and channelling oil from the turbocharger
5. Measurement of oil pressure and output of the lubrication system (oil flow measurement)

Indications of oil contamination:

1. The smell of fuel in oil
2. Scratched surfaces on bearing rings
3. scratches on retaining parts
4. scratches on the shaft journal bearings



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NO LUBRICATION / TOO LOW OIL FLOW

What are the causes of no lubrication?

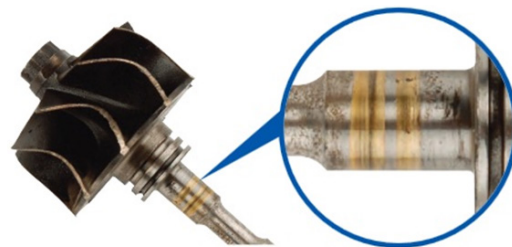
1. A too low oil level in the sump
2. An improper gasket on the feed of the turbocharger with oil
3. A damaged or mismatched oil filter
4. Carbon deposit, carbon accumulated on the power lead (carbonization)
5. Blockages caused by using silicone during the installation of the turbocharger oil pipes
6. Coked oil in the turbocharger housing created as a result of switching off the hot engine too fast.
7. Bends or twists of oil feed pipes
8. Faulty lubrication system
9. Low output of the oil pump

How to prevent breakdowns?

1. Prior to mounting a new turbocharger, be sure to check the oil pressure and the oil pump output
2. When mounting the turbocharger, always use new oil and a filter indicated by the manufacturer.
3. When mounting the turbocharger, do not use silicone because it may come off easily and jam the ducts
4. Oil pipes need to be cleaned or replaced with new ones to remove carbon deposits and/or sludge which could restrict oil flow to the bearing systems

Indications of no lubrication, of too low oil flow

1. Material accumulated on the retaining parts and the shaft journal bearings - caused by high temperatures as a result of lack of formation of an appropriate oil film
2. Colour change of the retaining parts, the shaft journal bearings
3. Excessive wear and tear of the thrust bearing thrust washers
4. Excessive wear and tear of slide bearings



DAMAGE BY FOREIGN MATTER

What is the cause of damage by foreign matter?

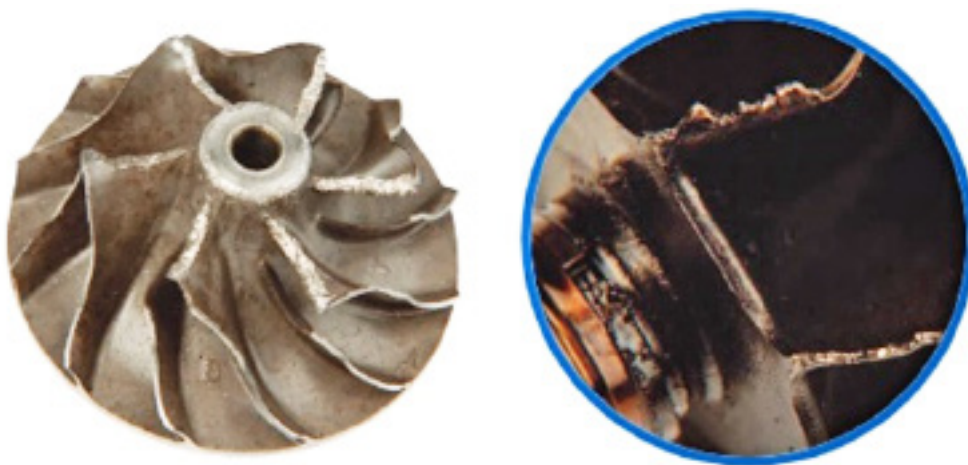
1. Remains after the previous turbocharger breakdown
2. Particles getting into through damaged ducts
3. A damaged air filter, an air filter of low quality,
4. Cracked elements of the engine, e.g. valves and/or fragments of a damaged piston, nozzles of the injector, valve,
5. Screws nuts, washers, pieces of materials and/or other objects left in the pipe during servicing
6. Choked exhaust system causing often burning off of the diesel particulate filter

How to prevent breakdowns?

1. Check cleanness and tightness of the ducts before mounting a turbocharger
2. Replace gaskets with new ones, which will prevent fragmentation and ensure best possible sealing
3. Make sure that there are no elements left that come from the previous breakdown
4. 4- Check flow capacity of the exhaust system

Indications of damage by foreign matter:

1. Power drop
2. Noise coming from the turbocharger during operation
3. Damage to the compressor wheel and/or shaft
4. Pits round the air intake
5. Pits on the compressor wheel blades





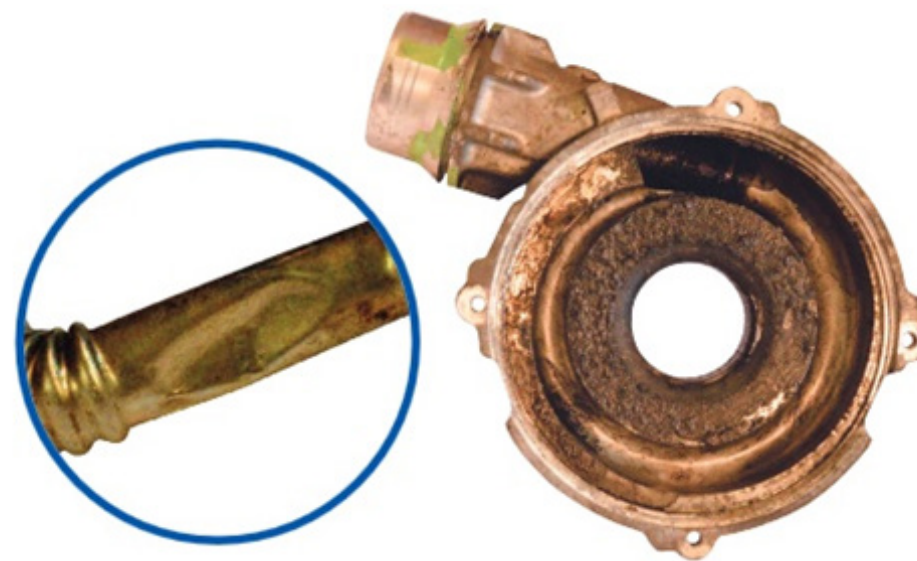
OIL LEAKAGES

What is the cause of oil leakages from the turbocharger?

1. Leaky intake system
2. Removed catalyst and/or diesel particulate filter
3. Too high pressure in the crankcase
4. Choked outflow duct of the turbocharger
5. Contaminated and/or low-quality air filter
6. Coked oil passages in the turbocharger
7. Physical damage to the turbocharger pieces and excessive bearing slackness
8. Limited and/or blocked venting system of the crankcase
9. Mismatched set of assembly gaskets

How to prevent?

1. Use only original and recommended by the manufacturer air filters and outlet of the crankcase breather vent
2. Check the system venting the crankcase whether not too high pressure is produced.
3. Make sure that the diesel particulate filter and the catalyst are unobstructed



OVERSPEEDING / FATIGUE

What is the cause of overspeeding?

1. modifications to the engine, including "Chiptuning", over-fuelling
2. Work at considerable heights above sea level
3. Variable air access to the turbocharger (a cracked pressure conduit, a low-quality air filter)
4. Incorrect position of the exhaust gas throttling valve and/or variable-geometry mechanism
5. Used injectors
6. Mounting an unsuitable turbocharger
7. Wrong information between sensors and executive elements

How to prevent

1. Do not carry out any modifications not in accordance with the manufacturer's instructions
2. Use original air filters
3. Ensure tightness of the intake and exhaust systems

Indications of overspeeding:

1. Orange peel effect: on the back surface of the compressor wheel is caused by expanding and shrinking material
2. Damage to the compressor wheel blades as a result of rubbing against the turbocharger housing
3. Colour change because of material oxidation
4. Wheel fracture
5. Material losses on the compressor wheel



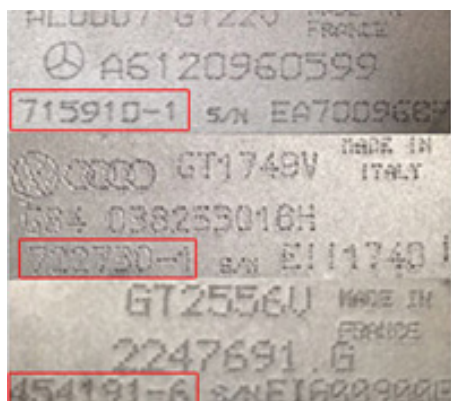
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3.Turbocharger Diagnostics



4. Selection of a Turbocharger - how to look for?

In the case of cars and delivery trucks, there are four fundamental turbocharger manufacturers. Below, a pattern for the location of the manufacturers' numbers by which a turbocharger can be selected in our catalogue is shown.



Garrett®
by Honeywell

On the left, the rating plates from three different models of cars. The number to select a turbocharger is the TURBOCHARGER NUMBER marked above in red which in the case of GARRETT is always characterised by six (6) digits, then there is a hyphen and one or four digit(s). If there is only one digit after the hyphen it is in this case, this means that the turbocharger was manufactured directly to be installed in a car. In the case the number was the following **715910-5006S**, this means that the turbocharger was manufactured for the secondary market. In most cases to select a turbocharger, it is enough to provide us with six (6) digits from the bottom left corner of the rating plate

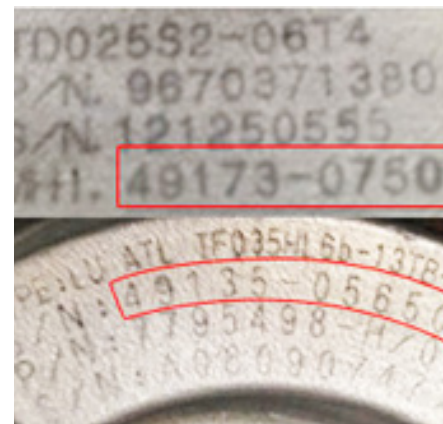


In the KKK turbochargers, turbocharger numbers also are located in the bottom left corner of the rating plate but they have different symbols. In cars the following models can be found: KP, BV, K03, K04, K14, K16, and the following symbols may be used them:

- KP**35-0019** = 54**35**97000**19**
- BV**39B-0050** = 54**39**97000**50**
- K**03/029** = 53**03**9700**29**
- K**04-54** = 53**04**97000**54**
- K**14-7018** = 53**14**970**7018**

Above, some dependences can be seen. The middle of the number 970 means that the turbocharger was manufactured directly for production in the case there is number 988 in the middle segment, this indicates a part manufactured for the secondary market for most catalogues the turbocharger full number i.e. XXXX-970-XXXX is required.

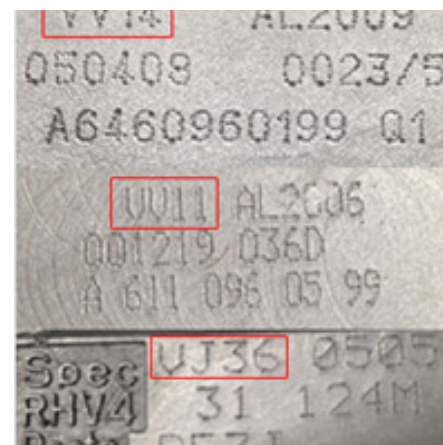




MITSUBISHI®

MHI (Mitsubishi) turbochargers have permanent designation **XXXXXX-XXXXXX** and are placed on the plates in different places. Below, two turbochargers as an example:

49173-07508
49135-05650



IHI

In the case of IHI turbochargers, designations by which the turbocharger can be selected are located on the left upper part of the rating plate. For example the plates on the left.

VV14
VV11
VJ36

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TURBOCHARGER ASSEMBLY MANUAL

The presented procedure is only a supplement to the manual anticipated by the vehicle manufacturer.

All procedures concerning the disassembly, damage verification and reassembly of the turbocharger back into the vehicle should be carried out by personnel in possession of relevant technical knowledge and specialist equipment. One should strictly follow the manufacturer's manual, use the tools recommended by the manufacturer and follow safety rules. Before the assembly of the turbocharger, one should verify and remove the malfunction which had direct influence on their being damaged previously. During the performance of the works related to the replacement of the turbocharger one should use only the replacement parts recommended by the manufacturer. Due to the precision of the workmanship, it is forbidden to make any modifications to the pressure value through regulations on the turbocharger itself, or to interfere with the engine software (chip tuning). The basis for malfunction-free work of the turbocharger is the regular conduction of the oil services, using only original service parts recommended by and anticipated by the manufacturer, as well as proper exploitation of the turbocharger.

The stages of the turbocharger assembly:

1. Check if the entire inlet system is clean, when the turbocharger is damaged, its heated elements often hit the inlet cables and, only after some time, they are torn away, again damaging the turbocharger.
2. Replace the air filter with an original one or a replacement anticipated by the vehicle manufacturer.
3. Check if the exhaust system is clean, in case the catalyst or diesel particulate filter are blocked, the turbocharger will not reach its efficiency and this will, in addition, lead to the damaging of the thrust block inside the turbocharger body. If need be, replace the catalyst or the diesel particulate filter. **WARNING!** One cannot remove the catalyst or the diesel particulate filters. After removing or drilling these elements, the turbocharger will lose its air tightness and oil will start leaking from it.
4. Check if the pneumatic/hypotension units are properly connected and air tight.
5. Replace the oil in the engine and the oil filter. Use only the oils from the norm anticipated by the manufacturer. The viscosity and density of the oil is the key condition for maintaining the oil coating, which, in turn, influences the malfunction-free operation of the turbocharger.
6. During the assembly of the turbocharger, always use new sets of gaskets (copper nuts and bolts with appropriate hardness), check the bolt fastening in the block (outstretched threads) all leakages on the side of the hot turbocharger can be distinguished with a metallic shriek, and, on the inlet side, with the whistling of the air.
7. Delicately screw the oil supply cable, the oil drain line should remain not screwed.
8. Turn the starter motor without turning on the engine in order to fill the unit with oil until the appearance of leaking oil on the connection between the power cable and the turbocharger.
9. Screw the power cable with the torque anticipated by the manufacturer.
10. Turn the starter motor without turning on the engine until the appearance of oil steadily flowing out of the turbocharger.
11. Turn the drain cable with appropriate torque and then turn on the engine for approximately 1 min.
12. Check the air tightness of all connections.
13. Perform a test drive.





Questions?

Address them to the competent person



Technical Information:

turbo@inter-turbo.pl
tel: 515 510 600



Service Office:

biuro@inter-turbo.pl
tel: 602 510 015



Orders:

sales@inter-turbo.pl
tel: +48 32 454 76 65
tel: +48 494 76 65

Turbochargers fitted out with release valves are put in relation to the manufacturers' operation sheets, whereas turbochargers with the variable-geometry mechanism of a turbocharger blades, the so-called VNT, are checked and calibrated on a flow device, the so-called Flow Bench. We are one of a few companies in Poland that has two independent Flow Bench devices by G3Concept and Turbotecnics, which ensures us 100% of certainty of setting this the most important parameter of a turbocharger. In the case of turbochargers with the variable-geometry mechanism electronic controllers, then except for a chance to check all sorts of currently used controllers, we also repair Hella and VDO controllers. After repairing electronic controllers, we use G3 Rea Master and APD-1 programmers to programme correct scope of operation of the controllers after replacing a controller power transmission system. A parameter confirming the quality of execution of the turbocharger body renovation is its balance level. In operation sheets, the manufacturers determine the maximum unbalance in accordance with ISO 1940-1 standard at a level of 0,6G to approx. 90,000 revolutions, and then 1,5 to 180,000. Since the beginning when high-speed balancers have been released on the market, unbalance of turbochargers renovated by us does not exceed 0.35G in the entire scope of revolutions, which results in no later problems connected with loud operation of the turbochargers. After selling any of the products from our offer, we offer technical assistance on the basis of many years of experience in this specialisation. Once a turbocharger is taken to pieces, we can determine the cause of damage and steer the person assembling our product onto a solution to the cause of damage, which results in minimising possible complaint about our product.





02

COMMON RAIL INJECTORS

We offer testing and complex repair of injectors working in the Common Rail systems by Bosch, Delphi, Denso, Siemens VDO. We have extensive equipment resources allowing us to carry out a repair in accordance with the manufacturers' severe requirements. The quality of a repair is confirmed by generating the corrective code to an injector being repaired irrespective of the manufacturer. Still following new technologies, we bought innovative equipment enabling renovations of a stack occurring in all sorts of piezoelectric injections combined with many years of experience of repair of this sort of injectors, today we can boldly say that we are a company that on a large scale renovates all sorts of piezoelectric injectors giving a full guarantee and setting at the same time new IMA codes confirming correct operation of these precise injectors. Like turbochargers, for the most popular cars and delivery trucks, we have already earlier renovated electromagnetic and piezoelectric injectors available on the spot.

TEST TABLES ON WHICH WE TEST COMMON RAIL INJECTORS:

- Bosch EPS 205
- Bosch EPS 708
- Bosch EPS 815
- Carbon Zapp CRU2i
- Carbon Zapp CRU2r
- Carbon Zapp DS2i

ELECTROMAGNETIC AND PIEZOELECTRIC BOSCH COMMON RAIL INJECTORS

- a chance to do an injector test before repair to determine the degree of wear and tear
- assembly of the injector pieces according to Bosch technology
- setting dimensions set with the use of 3 phase by Bosch
- high pressure internal cleaning with the use of a chemical detergent with the injector set-point enabling to remove residues inside the injector.
- electronic tests (resistance, inductance, capacity) with printing set and real values on devices by Carbon Zapp CRU2i or CRU2R as a complement to the report on EPS205, 708, 815 test tables.
- a spray test in special chambers enabling to assess the quality of a stream
- a tightness test
- an injector opening pressure test when supplying a setting signal- a test of reaction time of injectors to its set-point
- a-few-point test of injection doses and overflows in the full scope of loads
- measurement of an injector dosage with a set-point of many doses at the same time, e.g. two pilot doses, the main dose, two additional injections

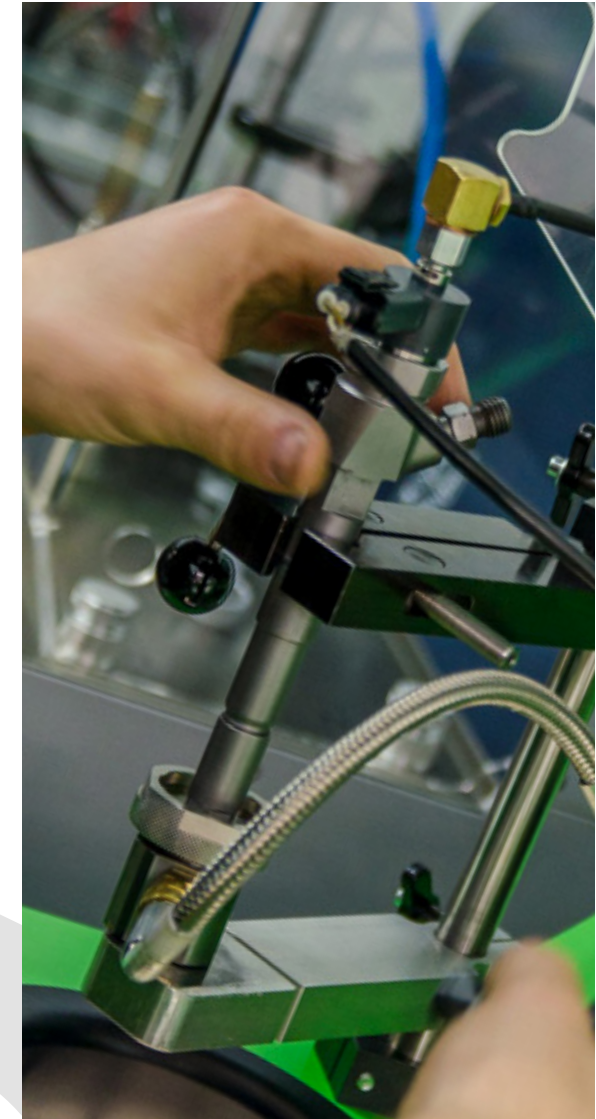
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- a high pressure tightness test with measurement of an overflow without an injector set-point
- measurement of a dose with full load
- measurement of a dose with partial load
- measurement of a dose on neutral
- measurement of a pilot dose or a few pilot doses
- **coding injectors and giving new IMA code**
- **restoration of a stack in piezoelectric injectors**
- **coding piezoelectric injectors after carried out repair: IMA code, ISA code**

DELPHI Common Rail Injectors

- high pressure internal cleaning with the use of a chemical detergent with the injector set-point enabling to remove residues inside the injector.
- a chance to do an injector test before repair to determine the degree of wear and tear
- assembly of the injector pieces according to Delphi technology
- electronic tests (resistance, inductance, capacity) with printing set and real values on devices by Carbon Zapp CRU2i or CRU2R
- a spray test in special chambers enabling to assess the quality of a stream
- a tightness test
- an injector opening pressure test when supplying a setting signal
- a test of reaction time of injectors to its set-point
- an injector reaction test - testing a delay from supplying a current signal to the actual opening of the injection nozzle
- a-few-point test of injection doses and overflows in the full scope of loads
- measurement of an injector dosage with a set-point of many doses at the same time, e.g. two pilot doses, the main dose, two additional injections
- a high pressure tightness test with measurement of an overflow without an injector set-point
- measurement of a dose with full load
- measurement of a dose with partial load
- measurement of a dose on neutral
- measurement of a pilot dose or a few pilot doses
- **setting new C2I (16-character) or C3I (20-character) code**





DENSO Common Rail Injectors

- ↻ high pressure internal cleaning with the use of a chemical detergent with the injector set-point enabling to remove residues inside the injector.
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- ↻ measurement of a dose with full load
- ↻ measurement of a dose with partial load
- ↻ measurement of a dose on neutral
- ↻ measurement of a pilot dose or a few pilot doses
- ↻ **giving new 16QR or 30QR code to Denso injectors, concerns electromagnetic and piezoelectric injections**
- ↻ **renovation of a stack through restoration in Denso piezoelectric injectors**

Siemens / VDO / Continental Injectors

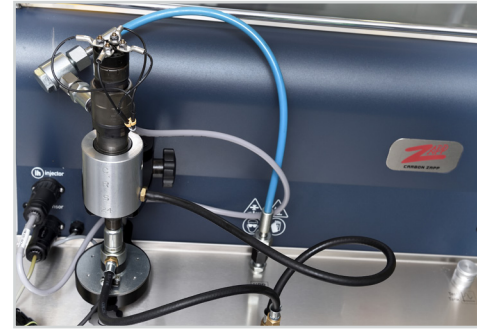
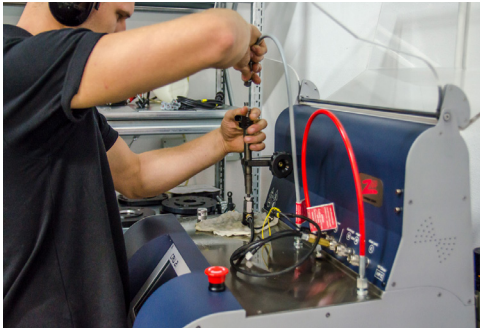
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- ↻ measurement of a dose with partial load
- ↻ measurement of a dose on neutral
- ↻ measurement of a pilot dose or a few pilot doses
- ↻ **restoration of a stack in piezoelectric injectors**

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Our offer includes also

Cleaning and testing 4 Common Rail Bosch CRIN 4.2 vertical injectors from Mercedes Actros

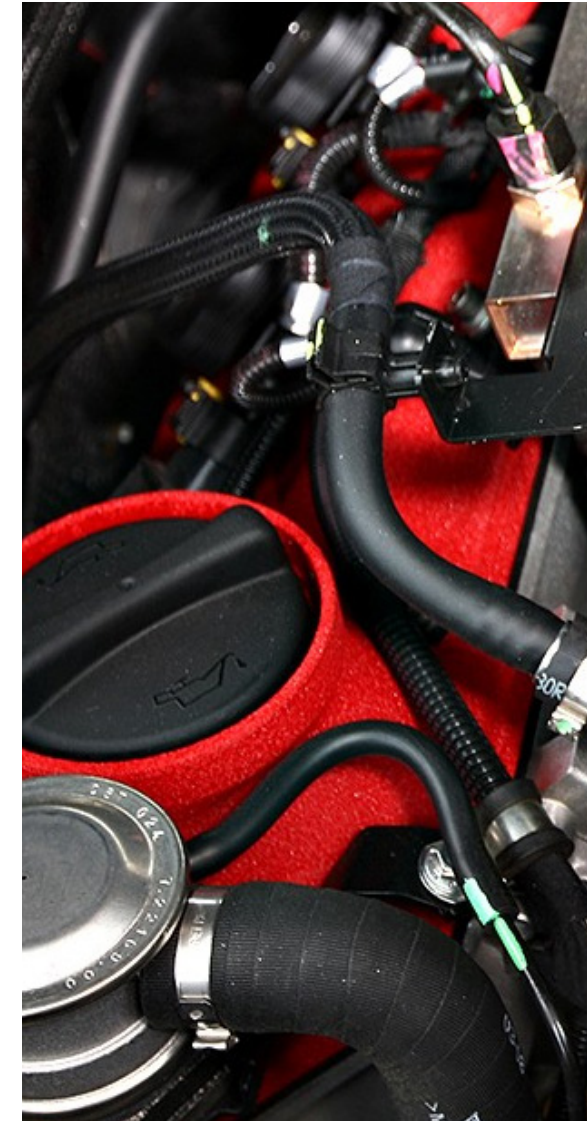
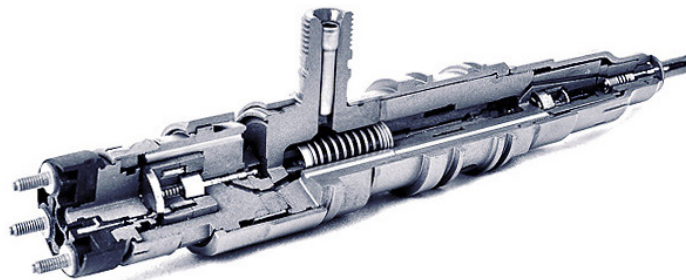


Four (4) vertical injectors with a hydraulic amplifier, the so-called HADI, are used in this system. CPN5 high pressure pump generates maximum pressure only up to 900 or 1,200 bars depending on the structure. With low loads, only one coil is set and the injector operates on a similar principle as Common Rail traditional injector. Where higher injection pressure is required under load, also the second coil is set and the pressure is increased in the injector itself with the use of a hydraulic amplifier up to the pressure of even 2,700 bars.

This system finds application in such models as, e.g. Actros, Antos, Arocs and has been installed on a considerable scale since 2013, and single models two years earlier.

In the case of these injectors, we use Carbon Zapp CRU2r test table with suitable instrumentation on which we successfully carry out the process of cleaning and testing CRIN4.2 injectors.

The test includes assessment of electrical parameters of both coils, a test of injection doses with different loads, including generating high pressure by the injector itself, and also opening pressure as well as delay in injection in relation to the set-point. Also, as part of the service, we clean the injector with a chemical detergent under high pressure. We deliver a detailed report on each test.





COMMON RAIL INJECTOR ASSEMBLY PROCEDURE

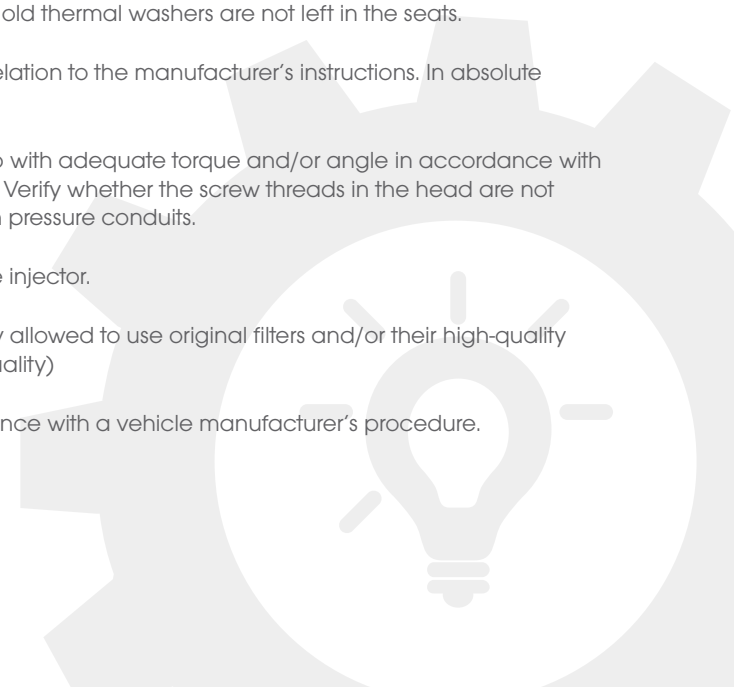
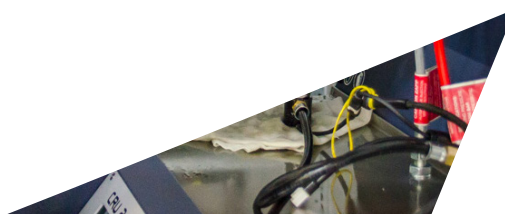
This procedure is only a complement to the manual provided by a vehicle manufacturer.

Any activity including disassembly, damage verification and re-assembly of the Common Rail system injectors in a vehicle has to be done by the personnel having adequate technical knowledge and specialist equipment. In absolute terms, the manufacturer's manual should be followed, tools recommended by them used and the safety rules kept to. Prior to mounting Common Rail injectors, the failure that had a direct influence on an injector damage has to be verified and removed. When performing work with the injection system, it is necessary to strictly keep to a vehicle manufacturer's standards and service documentation. The Common Rail system requires to meet special cleanness standards during servicing.

An injector assembly stages:

1. At each stage of work connected with the Common Rail system an adequate level of cleanness should be kept. In the case of impurities in the area of repair, it is necessary to immediately remove them by suction. Do not use compressed air to clean the area of repair - an impurity may get unnoticeably into the combustion chamber, and then bring about a breakdown of this system.
2. Cleanness and the quality of fuel have to be checked. In the case there are impurities in fuel, it is necessary to clean the fuel tank, change the fuel filter and rinse the entire fuel system. In this case, a high pressure pump has to be additionally delivered to check whether or not it is the cause of these impurities (an often cause of contaminated fuel is a peeling high pressure pump).
2. All connection elements should be cleaned in an ultrasonic washer or replaced with new ones. It is also recommended to wash the entire rail in an ultrasonic tank.
3. Carefully clean the injector seat in the head off carbon deposit, oil and other impurities with the use of a suction device, which will ensure tightness between the thermal gasket and the combustion chamber. Make sure that old thermal washers are not left in the seats.
4. Check correctness of the selected dimensions of thermal and sealing washers in relation to the manufacturer's instructions. In absolute terms, use only new washers.
5. Mount injectors in the head seats. Clamping screws/yokes have to be tightened up with adequate torque and/or angle in accordance with the manufacturer's recommendations. If required, replace the screws with new ones. Verify whether the screw threads in the head are not tightened. Unscrew red plugs on high pressure terminals directly before installing high pressure conduits.
6. It is recommended to install new high pressure conduits coupling a bunker with the injector.
7. Before starting the engine, the fuel filter replacement is absolutely required. It is only allowed to use original filters and/or their high-quality substitutes (for Delphi systems, fuel filters by this manufacturer or a piece with OEM quality)
8. Fill a new fuel filter with clean diesel oil. Fill the injection system with fuel in accordance with a vehicle manufacturer's procedure.

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9. Fill the injection system with fuel in accordance with the procedure provided by the manufacturer. Where it is possible to vent the system through the function of a diagnostic test apparatus, proceed as instructed. Otherwise, the system needs to be vented manually.

10A. Manual Venting of the Common Rail System in Electromagnetic Injectors

- ▶ Carefully turn down high pressure conduits so that it is possible for air to escape from the conduits
- ▶ Do not connect service line or overflow line
- ▶ turn the starter at time intervals until there is fuel on high pressure nozzles, then tighten up the high pressure terminal with adequate torque.
- ▶ turn the starter at time intervals until there is fuel on an overflow line, then assemble the overflow system and connect the injector conductors.

10B Manual Venting of the Common Rail System in Piezoelectric Injectors:

- ▶ Carefully turn down high pressure conduits so that it is possible for air to escape from the conduits
- ▶ Assemble the overflow system of injectors, make sure that O-rings on overflow nozzles are not damaged.
- ▶ Do not connect service line
- ▶ turn the starter at time intervals until there is fuel on high pressure nozzles, then tighten up the high pressure terminal with adequate torque and connect conductors.

11. Before starting the engine, errors have to be deleted from the controller's memory and "IMA CODES" individual corrective codes of performance characteristic of each of the injectors introduced. An IMA individual code can be found in the measurement report attached to an injector. Each report is assigned to a given injector by numbering the injections.

12. In the case of DENSO injectors, CALIBRATION OF REFERENCE DOSES OF INJECTORS needs to be done through diagnosis after entering 16QR or 30GR IMA code. It is a step necessary to adjust correct operation of the engine on neutral.



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IMA CODES - important information.

It is of utmost importance to enter IMA codes to the controller. Correctness of IMA code is protected with a checksum. The controller will not accept a code with confused characters.

IMA (injector adjustment values) influence the engine operation in terms of ecology, fuel consumption, performance and operation culture. Not all injectors require coding.

The location of original correction codes of an injector.

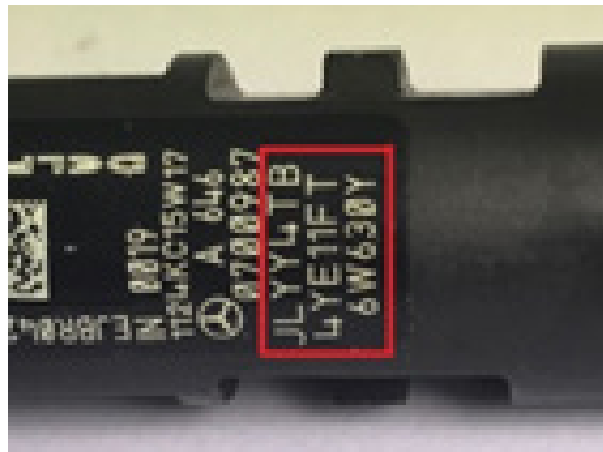
BOSCH: 6-, 7-, 8- or 9-character. The position of a code as well as the number of characters (figures and letters) depends on a vehicle make a type of injector as well as EDC system generation. They are always located on a coil.



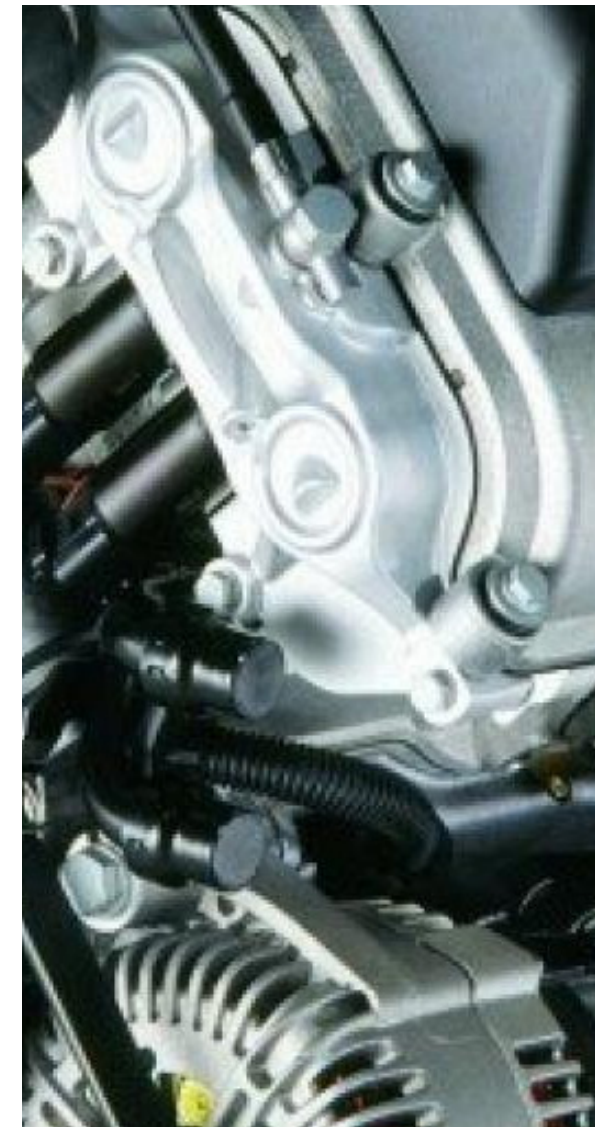
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DELPHI: There are two sorts of codes: C2i - 16-character, C3i - 20-character. Located on the label with the serial number as well as the injector model.



DENSO: A 16- or 30-character code located on the injector coil. After entering through the diagnostic test apparatus, calibration of the injector reference doses has to be additionally carried out.



Should you have any questions, do not hesitate to ask for technical support:
Customer Service Office: email: biuro@inter-turbo.pl, tel: **+48 720 056 056**



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03

COMMON RAIL PUMPS

Common Rail BOSCH Pumps CP1 / CP1H / CP3 / CP4

We service all Common Rail high pressure pumps by Bosch used on the market. Each pump delivered to be checked (Cat. No. 0445 010 XXX, 0445 020 XXX) is taken to pieces and subassemblies to do an optical assessment of wear and tear of the pieces. After replacing the damaged pieces, the pump is put together and the second stage of repair is carried out on a test table.

We do the following in the course of renovation of Bosch pumps:

- ▶ cleaning all elements of the pump with the ultrasonic method
- ▶ replacing internal seals with new ones, Bosch original parts
- ▶ assembling the pump pieces and subassemblies with the use of Bosch specialist tools and technology
- ▶ if need be replacing other used pieces of the pump
- ▶ a computer test after repair with printing set and real values on BOSCH EPS-815 or EPS-708 test table:
- ▶ measurement of the parameters determining the pump efficiency
- ▶ measurement of a dose after switching off one section (if applicable)
- ▶ measurement of the roughing pump internal pressure (if applicable)
- ▶ measurement of a share of the pump section as well as correctness of operation of suction and high pressure valves
- ▶ measurement of the nominal pressure for full load
- ▶ two-point measurement of the reference dose
- ▶ measurement of the start-up efficiency
- ▶ measurement of the efficiency of a dosing valve and/or a high pressure controlling valve
- ▶ examination of dosage performance in a few points for different set-points
- ▶ a-dozen-or-so-point measurement of a delay in the pump response to its set-point by the test table
- ▶ other advanced tests with the use of Bosch EPS 815 or EPS 708 test table as well as Bosch database

COMMON RAIL DELPHI PUMPS DFP1 / DFP3 / DFP6

Common Rail Delphi pumps (with the beginning of cat. No. 9042... 9044... 9421... 9422... 9424... 282... 283...) delivered to be checked are taken to pieces and subassemblies to do an initial optical assessment of wear and tear of the pieces with the use of a microscope. It enables more accurate verification of the pump. The optical assessment of wear and tear of the pieces and a computer test ensure correct verification. The second stage of the pump check consists in cleaning it, replacing seals and testing on a test table.

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We do the following in the course of renovation of Delphi pumps:

- ↻ cleaning all elements of the pump with the ultrasonic method
- ↻ replacing internal seals with new ones, Delphi original parts
- ↻ assembling the pump pieces and subassemblies with the use of specialist tools and technology
- ↻ if need be replacing other used pieces of the pump
- ↻ a computer test after repair with printing set and real values on BOSCH EPS-815 or EPS-708 test table:
- ↻ measurement of the parameters determining the pump efficiency
- ↻ measurement of the roughing pump internal pressure
- ↻ measurement of a share of the pump section as well as correctness of operation of suction and high pressure valves
- ↻ measurement of the nominal pressure for full load
- ↻ two-point measurement of the reference dose
- ↻ measurement of the start-up efficiency
- ↻ measurement of the efficiency of IMV dosing valve
- ↻ examination of dosage performance in a few points for different set-points
- ↻ other advanced tests with the use of Bosch EPS 815 or EPS 708 test table as well as Delphi database

COMMON RAIL DENSO PUMPS HP2 / HP3 / HP4

Common Rail Denso pumps (with the beginning of cat. No. 097300-... 294000-... 294050-... HU294000-... SM294000-...) delivered to be checked are taken to pieces and subassemblies to do an initial optical assessment of wear and tear with the use of a microscope. It enables more accurate verification of the pump. The optical assessment of wear and tear of the pieces and a computer test ensure correct verification. The second stage of the pump check consists in cleaning it, replacing seals and testing on a test table. pomiar ciśnienia wewnętrznego pompy wstępnej



NOTE!

After replacing Denso pump, SCV valve calibration has to be done through diagnosis it is a process necessary for correct operation of the engine.



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We do the following in the course of renovation of Denso pumps:

- ▶ cleaning all elements of the pump with the ultrasonic method
- ▶ replacing internal seals with new ones, Denso original parts
- ▶ assembling the pump pieces and subassemblies with the use of specialist tools and technology
- ▶ if need be replacing other used pieces of the pump
- ▶ a computer test after repair with printing set and real values on BOSCH EPS-815 or EPS-708 test table:
- ▶ measurement of the parameters determining the pump efficiency
- ▶ measurement of the roughing pump internal pressure
- ▶ measurement of a share of the pump section as well as correctness of operation of suction and high pressure valves
- ▶ measurement of the nominal pressure for full load
- ▶ two-point measurement of the reference dose
- ▶ measurement of the start-up efficiency
- ▶ measurement of efficiency of both SVC dosing valves (for HP2) and SCV dosing valve (for HP3 and HP4)
- ▶ examination of dosage performance in a few points for different set-points
- ▶ other advanced tests with the use of Bosch EPS 815 or EPS 708 test table as well as Denso database

Common Rail Siemens VDO / Continental Pumps PCR / K9K / LION / DV 6C/

Common Rail Siemens VDO / Continental pumps (with the beginning of cat. No. 5WS4... or A2C5...) delivered to be checked are taken to pieces and subassemblies to do an initial optical assessment of wear and tear with the use of a microscope. It enables more accurate verification of the pump. The optical assessment of wear and tear of the pieces and a computer test ensure correct verification. The second stage of the pump check consists in cleaning it, replacing seals and testing on a test table.

We do the following in the course of renovation of pumps:

- ▶ cleaning all elements of the pump with the ultrasonic method
- ▶ replacing internal seals with new ones, Siemens VDO original parts
- ▶ assembling the pump pieces and subassemblies with the use of specialist tools and technology
- ▶ if need be replacing other used pieces of the pump
- ▶ a computer test after repair with printing set and real values on BOSCH EPS-815 or EPS-708 test table:
- ▶ measurement of the parameters determining the pump efficiency
- ▶ measurement of the roughing pump internal pressure
- ▶ measurement of a share of the pump section as well as correctness of operation of suction and high pressure valves
- ▶ measurement of the nominal pressure for full load
- ▶ two-point measurement of the reference dose
- ▶ measurement of the start-up efficiency
- ▶ measurement of the efficiency of VCV dosing valve and PCV high pressure valve
- ▶ examination of dosage performance in a few points for different set-points
- ▶ other advanced tests with the use of Bosch EPS 815 or EPS 708 test table as well as Siemens VDO database

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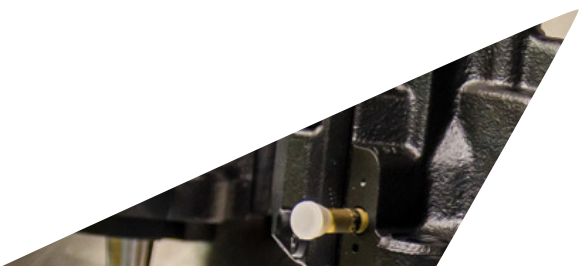
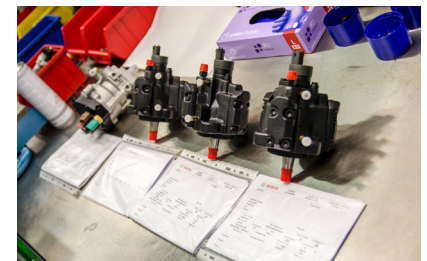
COMMON RAIL HIGH PRESSURE PUMP ASSEMBLY MANUAL

The presented procedure is only a supplement to the manual anticipated by the vehicle manufacturer.

All procedures concerning the disassembly, damage verification and reassembly of the Common Rail pump back into the vehicle should be carried out by personnel in possession of relevant technical knowledge and specialist equipment. One should strictly follow the manufacturer's manual, use the tools recommended by the manufacturer and follow safety rules. Before the assembly of the Common Rail pump, one should verify and remove the malfunction which had direct influence on their being damaged. During the performance of the works related to the replacement of the high pressure pump one should use only the replacement parts recommended by the manufacturer. The basis for malfunction-free work of the high pressure pump is the regular conduction of the oil services, using only original service parts recommended by and anticipated by the manufacturer. The disassembly process, especially in the case of the installing of the Common Rail high pressure pump, requires extra care for keeping the cleanness of connection places, that is why one should not use detergents containing fibers and leaving them on the cleaned surface, and one should also not blow these connections.

Please find below the **STAGES** of the Common Rail pump assembly:

1. Before proceeding with the assembly of the pump, one should verify the pureness and quality of the fuel. If the presence of pollution in the fuel is confirmed, it is necessary to clean the fuel tank, power cables, crossover fuel lines, and replace the fuel filter with an original one anticipated by the manufacturer.
2. If anticipated by the manufacturer, block the camshaft.
3. In case of a big amount of pollution, replace the fuel line with new ones.
4. Replace the high pressure Line connecting the pump with the Common Rail rail
5. Fill the filter/filters unit with diesel fuel
6. Fill the injection system with fuel in compliance with the manufacturer's procedure (in the chapter Common Rail Injectors description of deaeration of the unit)
7. After the deaeration, turn on the engine for 30 sec.
8. Check the unit air tightness.
9. **WARNING!** In the case of the DENSO HP2/ HP3/ HP4 pump replacement, after the assembly, perform the pump SCV valve calibration through a diagnostic device. This operation is necessary in order to obtain a mild operation of the engine.





04

UNIT INJECTOR

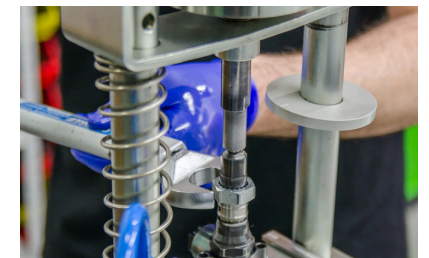
Complex Repair of Unit Injectors for Cars, Delivery and Motor Trucks.

In 2016 we introduced full renovation technology for TDI unit injectors into our diesel component regeneration workshop, including a tool set by BOSCH for repairing the upper part of unit injectors, the so-called 3-level of repair. Thanks to the full technology, we can control injection doses, and also BIP signal which, in turn, extends the life of unit injectors, and also causes lower fuel consumption combined with smooth operation of the engine. Along with Bosch EPS 815-CAM-BOX test table, the purchased technology enable us to:

- control a unit injector opening pressure
- do a computer test with printing set and real values on Bosch EPS205 and Bosch EPS100 devices
- measure the opening pressure
- do a crackling test
- test tightness of the complete injection piece of a unit injector
- test tightness of an injector nozzle
- examine the shape of a spray stream

With the use of Bosch EPS815 device with Bosch CAMBOX attachment, we do a full load test of a unit injector which includes the following measurements:

- measurement of a unit injector electric circuit
- measurement of an injection dose and overflow with full load
- measurement of a dose and overflow with partial load
- measurement of a dose and overflow on neutral
- measurement of a dose and overflow under the engine start-up conditions
- measurement of BIP injection start signal with different loads and examination of the history of its changes during operation



We also have Carbon Zapp UA2 device that we use to do:

- a comparative test of injection doses for individual unit injectors
- a spray test
- internal cleaning with the use of a chemical detergent with the electric and mechanical set-point of a unit injector which enables to remove residues that reside inside the unit injector.



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UNIT INJECTOR ASSEMBLY MANUAL

The presented procedure is only a supplement to the manual anticipated by the vehicle manufacturer.

All procedures concerning the disassembly, damage verification and reassembly of the unit injectors back into the vehicle should be carried out by personnel in possession of relevant technical knowledge and specialist equipment. One should strictly follow the manufacturer's manual, use the tools recommended by the manufacturer and follow safety rules. Before the assembly of the unit injectors, one should verify and remove the malfunction which had direct influence on their being damaged. During the performance of the works related to the replacement of the unit injectors, one should use only the replacement parts recommended by the manufacturer. The basis for malfunction-free work of the unit injectors is the regular conduction of the oil services, using only original service parts recommended by and anticipated by the manufacturer. The disassembly process, especially in the case of the installing of unit injectors, requires extra care for keeping the cleanness of connection places, that is why one should not use detergents containing fibers and leaving them on the cleaned surface, and one should also not blow these connections.

Please find below the STAGES of the unit injector assembly:

1. Cleaning the unit injector assembly area and the socket within the head – removing varnish residues, oil and other pollution (being careful so as the residues do not get inside the cylinder, it is recommended to suck off all residues in the area of the combustion chamber).
2. During the assembly of the new unit injectors, one should use only net thermal pads, but also new sealing rings.
3. Lightly moisten the o-ring type gaskets and mount the unit injector within the head.
4. If the unit injector is mounted to the head by one bolt, measure the distance between the head edge and the round surface of the electromagnetic valve with a caliper. The dimensions and the tightening torque values are given in the vehicle manufacturer's service documentation.
5. Before tightening the assembly bolts, each unit injector should be strongly fastened to the socket.
6. Check the condition of the regulating bolts in the drive levers. If the surface cooperating with the unit injector pusher is worn out – replace the regulation bolt.
7. If there is replacement of the unit injector pusher from the "pivot" (long) type into the new "socket" type (short), one should absolutely use the regulation bolts of the new type.
8. Set appropriate lash in the driver unit of each of the unit injectors individually: Turning the engine crankshaft, lead to a situation when the drive lever is situated in such a way that the unit injector spring is maximally tightened (the other end of the drive lever is, on the other hand, in the highest possible position). Use the comparator gauge to determine the location. Screw in the regulation bolt all the way. Then, unscrew the jacking bolt to the angle required by the vehicle manufacturer and secure with a lock nut.
9. Tighten all screw connection with a torque value as per the service documentation of the given vehicle.
10. It is advised to check the pressure under which the unit injector is supplied with fuel.



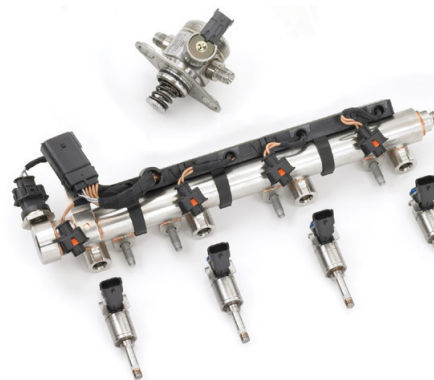
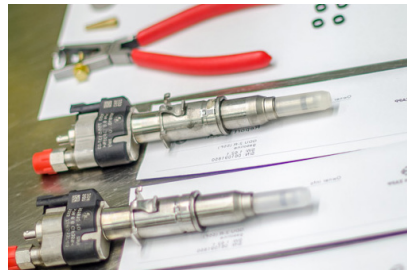
PETROL INJECTORS

WITH DIRECT FUEL INJECTION OF ALL MANUFACTURERS.

05

We introduced the service of cleaning and testing injectors with direct fuel injection from engines with the following designations: TSI, TFSI, FSI, GDI, etc. For this purpose, we use Carbon Zapp GDU2R test table. This device does such test as:

- a spray test with the injector operating pressure
- electronic tests with accurate weighing measurement of injection doses with full scope of operating pressure and opening time
- RSP test - a reaction test of an injector from the moment of set-point to the moment of actual fuel injection
- restoration of a stack in piezoelectric injectors used, for example, by BMW Siemens VDO
- we test injectors with direct fuel injection of such manufacturers as:
- BOSCH, Siemens VDO, Continental, Denso, Hitachi – HTC, Delphi, Magneti Marelli, FoMoCo tip.
- the designations of engines with direct injection:
- FSI, TSI, TFSI, JTS, HPI, HPDI, Ecotec, Ecoboost, CGI, DISI, GDI, SCi, IDE, SIDI, etc.



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06

WTRYSKIWACZE MECHANICZNE

Renovation of One-Spring-Loaded and/or Stage Injectors from the PLD System

Our company offers also repair of earlier-generation injectors such as one-spring-loaded ones of each manufacturer from cars as well as stage injectors from the PLD system of motor trucks. In this sort of injectors, we:

- adjust an injector opening pressure
- assemble in accordance with the manufacturer's technology
- multiple-hole injectors are tested on Bosch Eps 205 table and ended with printing set and real values
- measure the opening pressure
- do a computer crackling test
- do tightness test of a complete injector
- test tightness of an injector nozzle
- examine the shape of a spray stream



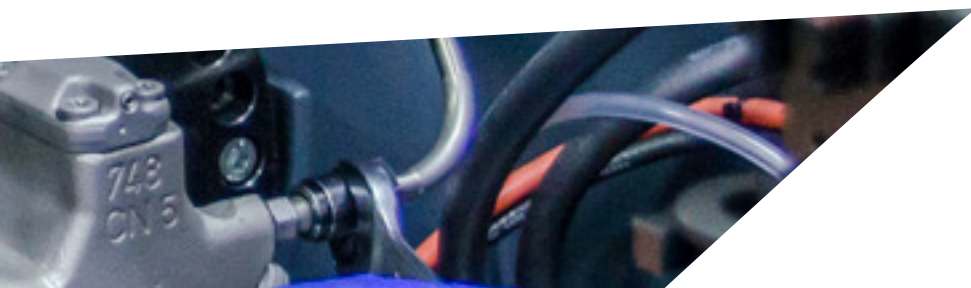
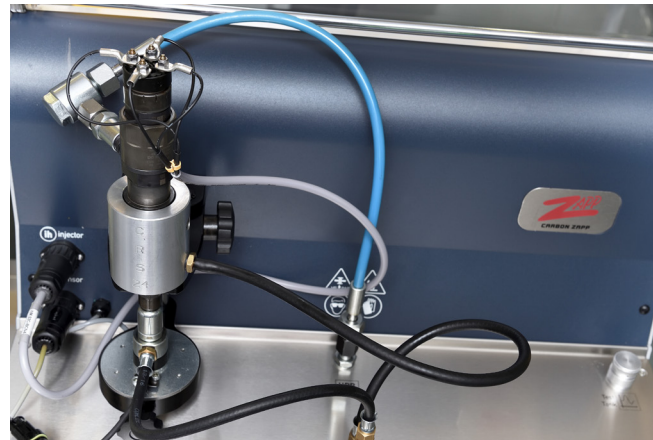
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Examination and Repair of Two-Spring-Loaded Injectors

We carry out a complex process of repair of two-spring-loaded injectors of all manufacturers. We have Bosch EPS 100 and Bosch EPS 205 test table enabling to carry out repairs of this sort of injectors in accordance with the manufacturers' technological instructions. We do a number of tests and adjustments enabling to restore the default parameters to repaired injectors, we listed more important stages below:

- adjustment of both opening pressure of the injector (the first and second degree of opening)
- assembly of the injector subassemblies with the use of Bosch specialist tools and technology
- a computer test after repair with printing set and real values on BOSCH EPS-205 device:
 - measurement of the first degree opening pressure
 - measurement of the second degree opening pressure
 - a computer crackling testing
 - computer tightness testing of a complete injector



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07

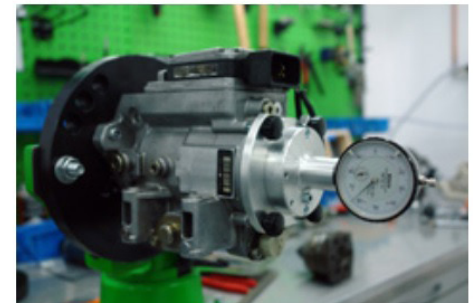
VP PUMP

VP29, VP30, VP44 and Zexel 44 Bosch Injection Pumps

VP44 (with the beginning of cat. No. 0 470 50...) as well as VP30 and VP29 (with the beginning of cat. No. 0 470 00 ...) pumps delivered to be checked are taken to pieces and subassemblies to do an initial optical assessment of wear and tear of the pieces with the use of a microscope. It enables more accurate verification of the pump. The optical assessment of wear and tear of the pieces and a computer test ensure correct verification. The second stage of the pump check consists in cleaning it, replacing seals and testing on a test table

We do the following in the course of VP pump renovation process:

- ▶ cleaning all elements of the pump with the ultrasonic method
- ▶ replacing internal seals with new ones, Bosch original parts
- ▶ assembling the pump pieces and subassemblies with the use of Bosch specialist tools and technology
- ▶ if need be replacing other used pieces of the pump
- ▶ a computer test and calibration after repair with printing set and real values on BOSCH EPS-815 test table:
- ▶ measuring and programming the lift points of a cam
- ▶ measuring, regulating and programming the internal feed pump pressure
- ▶ measurement of a correct adjustment of the angle of injection
- ▶ measurement of a delay in reaction of the dosing valve to its set-point
- ▶ measurement of dosage performance of each of the channels in all load points
- ▶ a-dozen-or-so-point, many-hour calibration of the pump, a perfect reproduction of the parameters of its operation in the pump controller map occurs
- ▶ measuring and programming the beginning of pumping based on an electronic measurement
- ▶ - preparation of the pump to be mounted in a vehicle



UNIT PUMPS

08

PLD unit pumps

Unit pumps from the PLD system (with the beginning of cat. No. 0 414 755... or 0 414 799...) delivered to be checked are taken to pieces and subassemblies to do an initial optical assessment of wear and tear of the pieces with the use of a microscope. It enables more accurate verification of pumps. The optical assessment of wear and tear of the pieces and a computer test ensure correct verification. The second stage of the check of the pumps consists in cleaning them, replacing seals and testing on a test table

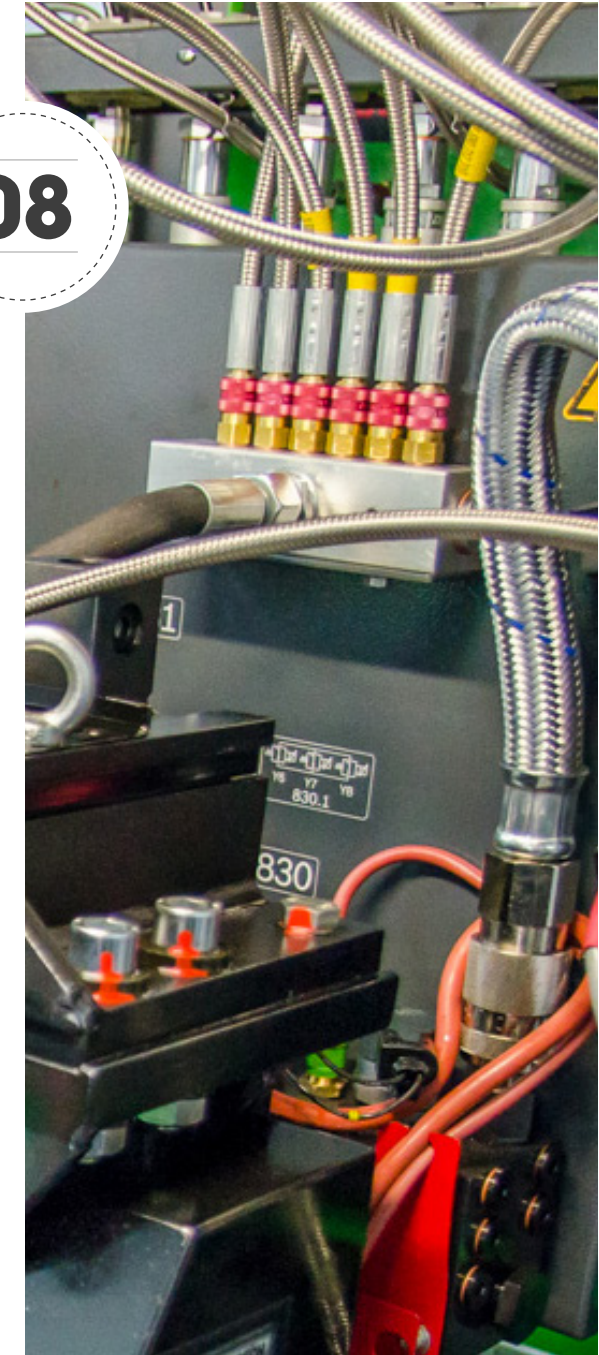
Repair and renovation

- ▶ - cleaning all elements of the pump with the ultrasonic method
- ▶ - replacing internal seals with new ones, Bosch original parts (the cost of parts is additionally paid)
- ▶ - assembling the pump pieces and subassemblies with the use of Bosch specialist tools and technology
- ▶ - if need be replacing other used pieces of the pump (the cost of parts additionally paid)
- ▶ - a computer test after repair with printing set and real values on BOSCH EPS-815 test table:
- ▶ - measurement of the pump electric circuit
- ▶ - measurement of the pump tightness
- ▶ - measurement of delivery of the pump under load
- ▶ - measurement of an overflow from the pump
- ▶ - measurement of BIP injection start signal with different loads

PF unit pumps

Repair and renovation

- ▶ - cleaning all elements of the pump with the ultrasonic method
- ▶ - replacing internal seals with new ones, Bosch original parts (the cost of parts is additionally paid)
- ▶ - assembling the pump pieces and subassemblies with the use of specialist tools and technology
- ▶ - if need be replacing other used pieces of the pump (the cost of parts additionally paid)



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