



DIESEL ENGINE

ADCR

SERVICE MANUAL

A/ADCR/S/a

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Contents

1	Precautions during operation and servicing.....	3
2	General engine view.....	5
3	Engine identification.....	5
4	Technical data.....	6
5	Engine structure - description of major elements.....	7
6	Operating materials.....	8
6.1	Diesel oil (fuel).....	8
6.2	Engine oil (lubricating oil).....	8
7	ECU wiring diagram.....	9
8	EGR System control diagram.....	11
9	Clearance table.....	12
10	Tightening torque of main screw connections.....	13
11	Operating the engine.....	14
11.1	Preparation for first start-up.....	14
11.2	Engine start-up.....	14
11.3	Engine run-in.....	15
11.4	Engine shut-down.....	15
12	Routine servicing operations.....	15
12.1	Table of the routine servicing operations:.....	15
12.2	Check, fill-up and change engine oil.....	16
12.3	Engine oil and oil filter change.....	16
12.4	Replace and tension drive belts.....	17
12.5	Fuel filter service.....	18
12.6	Adjust valve clearance.....	18
	Replace timing belt and set up timing.....	19
13	Some repair operations.....	21
13.1	Replace oil pan seals.....	21
13.2	Replace pistons.....	22
13.3	Replace camshaft housing gasket.....	23
13.4	Replace cylinder head gasket.....	24
13.5	Replace injectors.....	25
14	List of special tools.....	26
15	Fault code list.....	27

List of figures

Fig. 1.	ADCR diesel engine.....	5
Fig. 2.	Engine identification.....	5
Fig. 3.	Diagram of engine oil selection to ambient temperature.....	8
Fig. 4.	ECU wiring diagram.....	9
Fig. 5.	EGR System control diagram.....	11
Fig. 6.	Checking oil level.....	16
Fig. 7.	Adding oil.....	16
Fig. 8.	Draining engine oil.....	16
Fig. 9.	Oil filter change.....	16
Fig. 10.	Alternator and water pump drive	17
Fig. 11.	Power assisted steering pump drive.....	17
Fig. 12.	Fuel filter.....	18
Fig. 13.	Replace timing belt and set up timing.....	19
Fig. 14.	Automatic timing belt tensioner.....	20
Fig. 15.	Oil pan seals.....	21
Fig. 16.	Connecting rod with assembly marking.....	22
Fig. 17.	Camshaft locating bearing cap and vacuum pump cap.....	23
Fig. 18.	Order to tighten cylinder head bolts.....	24
Fig. 19.	Markings on injector.....	25

Andoria-Mot reserves the right to introduce modifications to this manual any time without previous notification.

1 Precautions during operation and servicing



Daily checks

Let the daily checking of engine and engine compartment before operation (**start up**) and after operation (**stopping**) become your habit. It will help you to detect fuel, coolant and oil leaks quickly and to locate any abnormal things, which just happened or are going to happen.



Refueling

There is a danger of fire or explosion during refueling. Smoking is prohibited, and engine must be shut down.

Never overfill the fuel tank. Retighten fuel tank filler tank well. Use only fuels recommended in this manual. Improper fuel grade may cause operation problems or cause engine stopping. On diesel

engines, poor fuel quality may cause injection pump control rod sizing and engine overrunning, what in turn may cause engine damage and personal injury.



Carbon monoxide poisoning

Run the engine only in well ventilated areas. When the engine works in closed space, make sure there is sufficient ventilation to remove exhaust gases and crankcase vapors out of the work area.



Operation

The engine cannot operate in areas where explosive materials or gases are present. Not all the electrical and mechanical engine components are non-sparking.

Approaching the running engine is dangerous. Loose clothing, hair, fingers or dropped tools may catch rotating engine components and cause serious personal injury.

After installing the engine, all rotating and hot engine components must be protected.



Servicing and operation

Stop the engine

Before opening or removing engine covers, stop the engine. If otherwise not specified, all operation and servicing operations must be performed with engine immobilized.

To avoid accidental engine start up, before beginning any works on engine remove ignition key. At the engine control location, place warning sign that works are performed on the engine.

Approaching or performing works on running engine is dangerous. Loose clothing, hair, fingers or dropped tools may catch rotating engine components and cause serious personal injury.

Lifting the engine

When lifting the engine use lifting eyes fitted on it. Always make sure that lifting equipment is in good condition and of sufficient lifting capacity (engine weight plus all accessories). Never perform any works on engine hanging on lift.

Before starting the engine

Before starting the engine refit all the covers removed during servicing operations. Check if no tools or other objects are left on the engine.

Never start up turbocharged engine without air filter installed. Rotating compressor in turbocharger may cause serious personal injuries. Also foreign objects may be sucked in and cause mechanical engine damage.



Fire and explosion

Fuels and lubrication oils

All the fuels, most of lubrication oils and many chemicals are flammable. Read instructions on packaging and follow them.

When working on fuel system, make sure the engine is cold. Fuel spilled on hot surface or electrical components may cause fire.

Do not smoke during refueling or adding oil, near fuel station or engine house.

Batteries

Batteries contain and educe hydroxide gas, especially during charging. This gas is inflammable and very flammable. Do not smoke, do not use open flame and do not allow any sparking near the batteries or in battery compartment, under no circumstances.

Incorrect cable connection to battery clamps or jumper cables to external batteries may cause sparking, what in turn may cause explosion.



Hot surfaces and fluids

There is always a threat of burning when working on hot engine. Be careful with hot surfaces, e.g. exhaust pipes, turbocharger, oil pan, charge air pipes, hot coolant and hot oil in oil pipes and hoses.



Chemicals

Most of chemicals, as antifreeze, anticorrosion agents, preservation oil, degreasing agents, etc. are hazardous for health. Read recommendations on packaging and follow them.

Fuels, oils, greases, are flammable and dangerous when inhaled. Ensure good ventilation and use protective masks when applying by spraying. Read instructions on packaging and follow them.



Lubrication system

Hot oil may cause burning. Avoid skin contact with hot oils. Before commencing work on lubrication system, make sure it is not under pressure. Never start up or run the engine with oil filler cap open because oil may be spread out.



Cooling system

Avoid opening radiator cap when engine is hot. Steam or hot coolant may be spread out causing burning.

If the works must be performed on engine at operating temperature and with radiator cap open, or hose disconnected, then unscrew radiator cap carefully and slowly to release the pressure before removing the cap. Note that still coolant may be hot and cause burning.



Fuel injection system

Always wear protective gloves when seeking leaks. Fluids ejected under pressure may puncture body tissues and cause serious personal injuries. There is a threat of blood poisoning.



Electrical system

Power supply breaking

Always before commencing works on electrical system, stop the engine and cut off power supply.

Batteries

Batteries contain extremely corrosive electrolyte. Protect skin and clothing when charging or servicing batteries. Always wear protective goggles and gloves.

In case of contact of uncover skin with electrolyte immediately wash the skin with plenty of water with soap. If electrolyte comes into eyes, immediately wash eyes with plenty of water and right away get medical aid.

2 General engine view

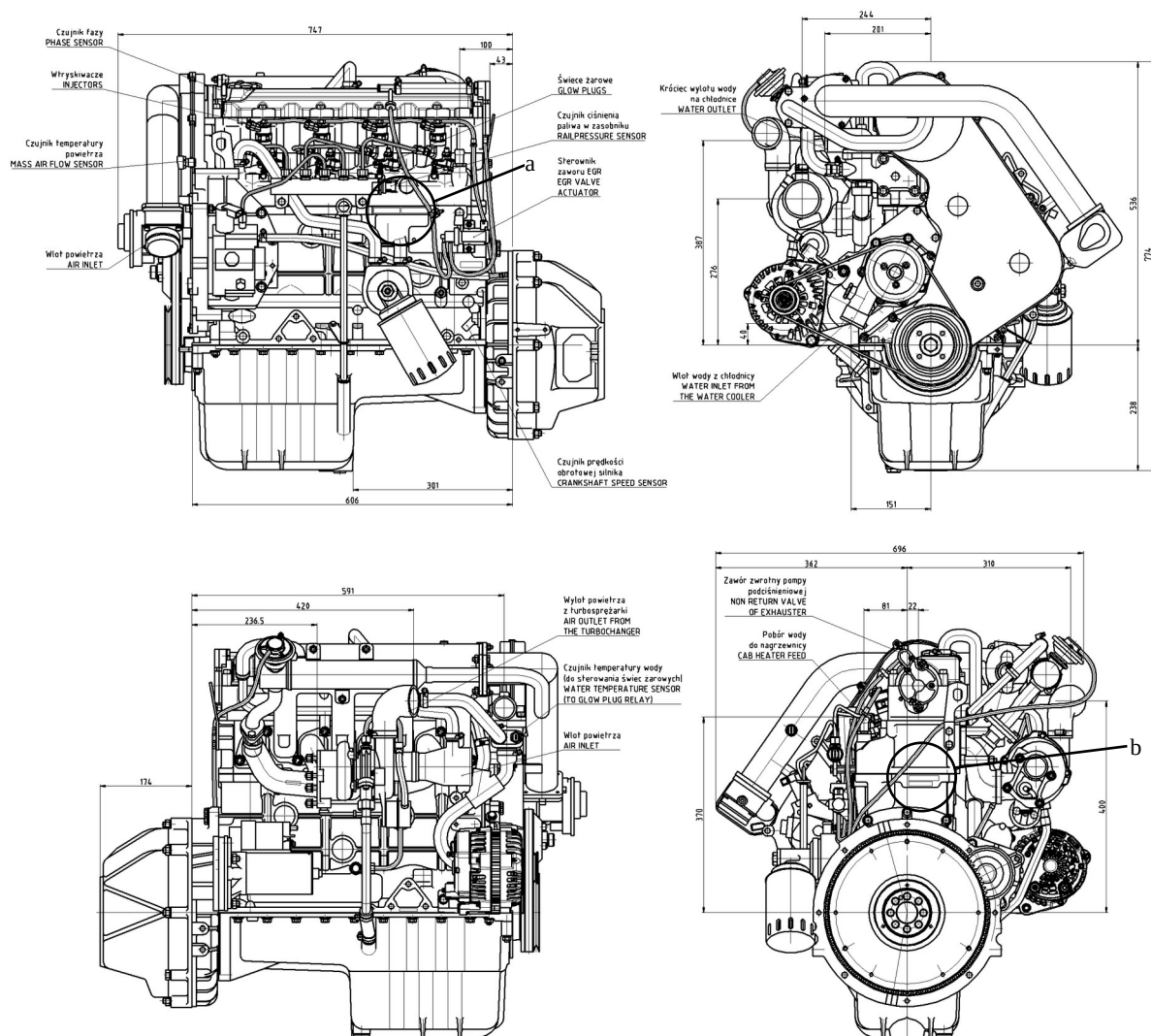
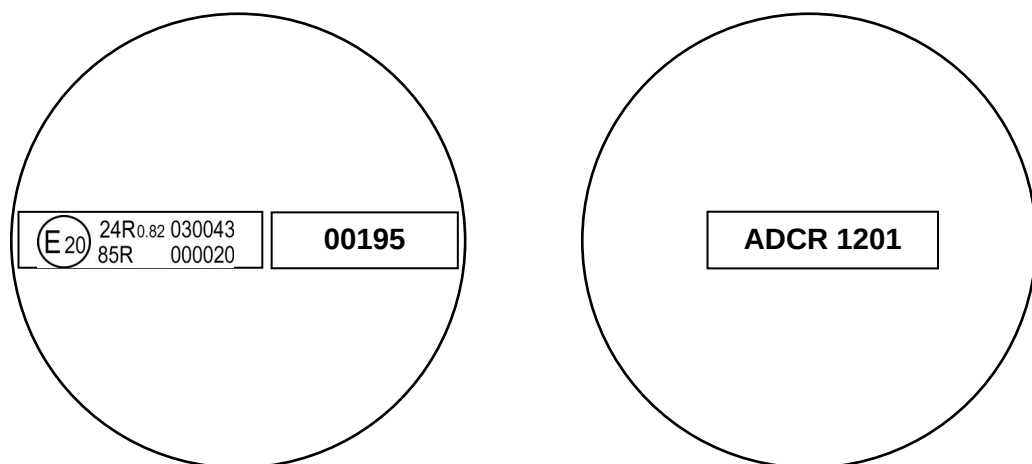


Fig. 1. ADCR diesel engine

3 Engine identification



a) Homologation marking and engine number
(See Fig.1, left upper view, detail 'a')

b) Engine type (ADCR) and version (e.g. 1201)
(See Fig.1, right bottom view, detail 'b')

Fig. 2. Engine identification

4 Technical data

Engine	ADCR
Engine type	Diesel, 4-cycle, turbocharged with charge air cooler
Fuel injection	Common Rail
Number and arrangement of cylinders	4 cylinders in-line, vertical
Bore diameter / piston stroke	94 / 95 mm
Swept volume	2636 cm ³
Compression ratio	17,5 : 1
Rated power*/speed	85 kW / 3700 rpm
Peak torque*/speed	250 Nm / 1800-2200 rpm
Minimum idle speed	750 rpm
Specific fuel consumption at peak torque*	210 g/kWh
Direction of crankshaft rotation	clockwise (seen from timing drive side)
Valve train	overhead camshaft driven with toothed belt
Engine starting-up	electric starter motor with aid of glow plugs
Oil pressure with warm engine (within 1500 - 3700 rpm)	0,25 – 0,50 MPa
Oil pressure with warm engine at minimum idle speed	min. 0,1 MPa
Maximum permissible oil temperature at the main gallery	continuous 130°C (momentarily 140°C)
Oil capacity for oil change ("max" level)	about 7 dm ³
Engine cooling system capacity (without radiator)	6,8 dm ³
Maximum permissible coolant temperature in pressurized circuit (0,12 MPa)	105°C
Recommended optimum coolant temperature	80 – 90°C
Intake and exhaust valve clearance	0,2 mm (with cold engine)
Firing order	1-3-4-2
Dry engine weight	about 230 kg
Permissible engine inclination - longitudinal - transverse	30° 20°

* in accordance with ISO 1585

5 Engine structure - description of major elements

Cylinder block	linerless, cast iron with five main bearings, of which the fifth one (the one closest to the flywheel) is a thrust bearing; the crankcase is closed from the bottom with an aluminum oil pan.
Main and connecting rod bearing shells	thin-wall, three-layer, replaceable
Cylinder head	cast iron, inlet and exhaust ports at one side, valve seats and guides are replaceable
Piston	of controlled thermal expansion made of aluminum alloy die-casting with a cast iron insert near the upper compression ring
Crankshaft	forged of alloy steel, toughened and nitrided
Camshaft	cast iron, working faces of the cams chilled in casting process, driven by crankshaft via timing belt
Valves	driven by the camshaft cams via second-order rocker arms made of cast iron
Connecting rod	forged of alloy steel, toughened
Injection equipment (Bosch)	Common Rail CR2.0
Glow plug	bar-type, two heating coils
Alternator	driven by the crankshaft via Poly-V-belt; 12V, 100A
Starter motor (Bosch or Remy)	electrical, 12V; 2 kW
Turbocharger	radial with wastegate
Vacuum pump	for brake boost; sliding-vane pump driven by camshaft
Oil pump	internal gear pump, (gerotor); located on the crankshaft front end
Oil filter	full-flow cartridge
Oil cooler	in-series, located under the oil filter
Fuel filter (Bosch)	full flow cartridge
Fan	with liquid coupling fixed to water pump hub
Power assisted steering pump (option)	for steering system assistance, driven by crankshaft via V-belt
EGR system	vacuum-operated EGR valve with EGR cooler
Electric system	12V, "minus to ground"

6 Operating materials

6.1 Diesel oil (fuel)

Use **only diesel fuels consistent with EN 590**.

EN 590 Standard specifies for temperate climate **three periods** (summer, transition and winter) and **three diesel fuel grades** for these periods:

„B”: for use in summer (May 1 to Sept. 15) – with cold filter clogging point: 0°C

„D”: for use in transition period (Mar.16 to Apr. 30 and Sept. 16 to Nov. 15) - with cold filter clogging point: -10°C

„F”: for use in winter (Nov. 16 to Mar. 15) - with cold filter clogging point: -20°C

6.2 Engine oil (lubricating oil)

Use engine oil:

- 1) of quality grade according to: at least CF
- 2) of viscosity grade according to SAE, proper to ambient operation conditions, but at least:
 - a) for temperate climate: 10W/40
 - b) for tropical climate: 20W/50

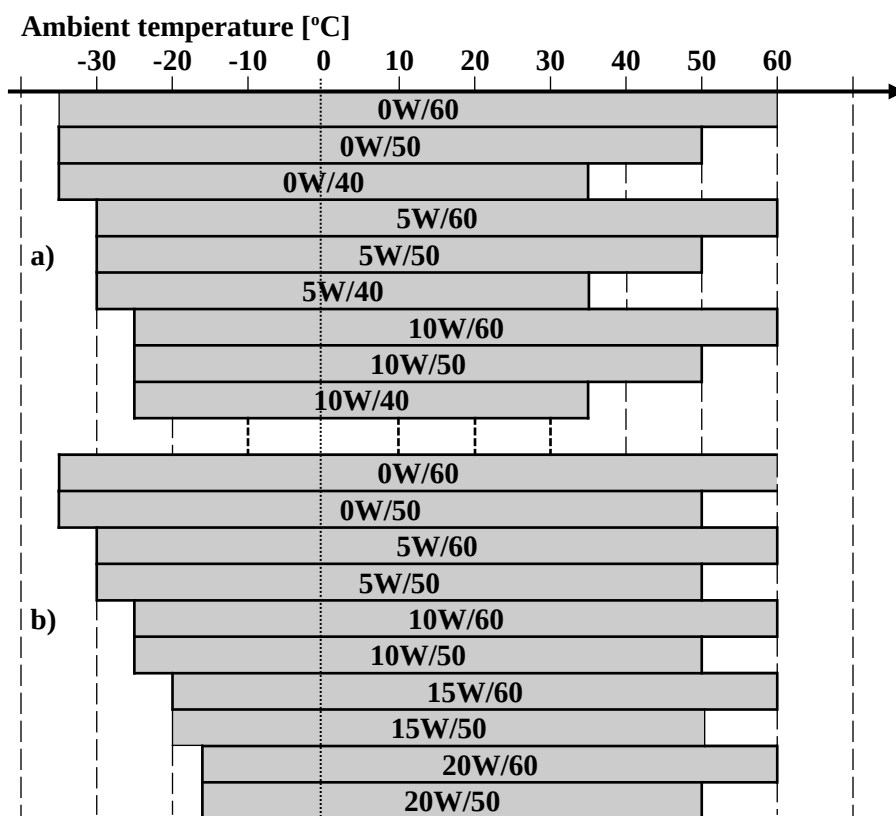


Fig. 3. Diagram of engine oil selection to ambient temperature

7 ECU wiring diagram

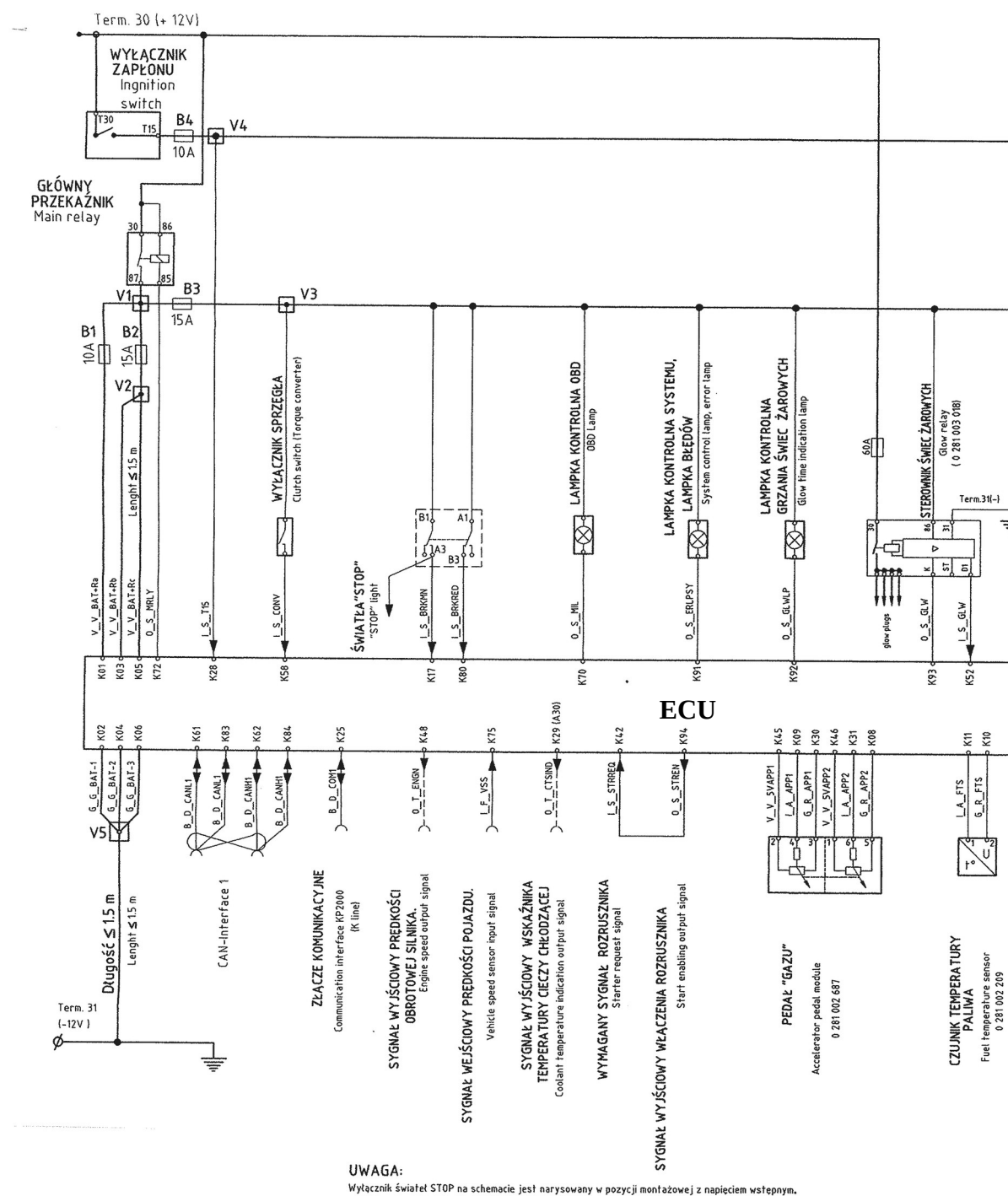
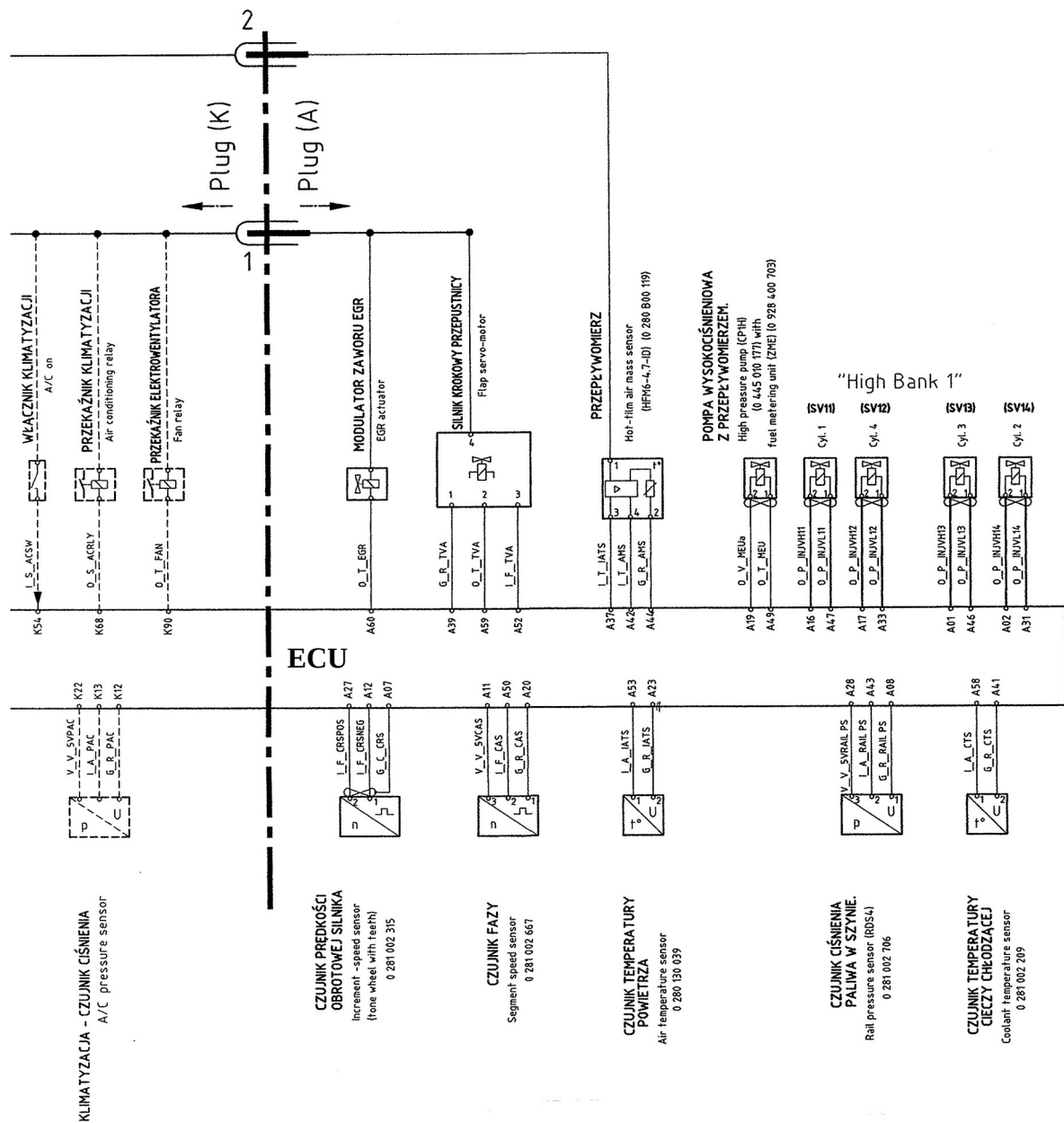
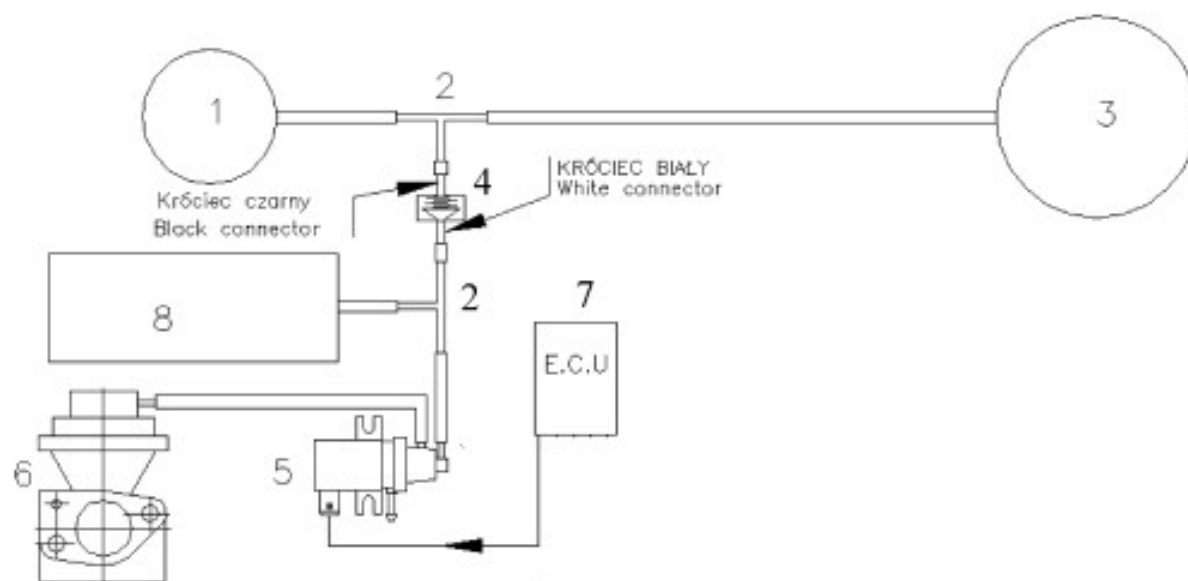


Fig. 4. ECU wiring diagram



8 EGR System control diagram



1. Vacuum pump
2. T-connector
3. Brake booster
4. Check valve
5. EGR modulator
6. EGR valve
7. ECU
8. Vacuum tank

Fig. 5. EGR System control diagram

Note: The above diagram shows only one signal from ECU (7) to EGR modulator (5). All the other signals, see Fig 4. ECU wiring diagram.

9 Clearance table

No.	Clearance description	Clearance (mm)	
		Nominal	Permissible
1.	Main bearing radial clearance	0.040 - 0.096	0.15
2.	Crankshaft end play	0.080 - 0.300	0.35
3.	Big end bearing radial clearance	0.040 - 0.092	0.15
4.	Connecting rod axial play on crankshaft	0.180 - 0.350	0.40
5.	Radial clearance: piston pin to small end bush	0.030 - 0.042	0.10
6.	Radial clearance: piston pin to piston (cold)	0.003 - 0.013	0.07
7.	Piston protrusion over engine block surface	0.500 - 0.600	
8.	Piston ring clearance in piston groove: - 1st compression ring - 2nd scraper ring - 3rd oil control ring	0.050 - 0.090 0.030 - 0.062 0.040 - 0.075	0.25 0.25 0.25
9.	Piston ring gap: - 1st compression ring - 2nd scraper ring - 3rd oil control ring	0.300 - 0.450 0.250 - 0.450 0.250 - 0.450	1.50 1.50 1.50
10.	Camshaft bearing radial clearance	0.050 - 0.100	0.20
11.	Camshaft end play	0.070 - 0.180	0.20
12.	Valve clearance measured between cam and rocker arm with cold engine, for intake and exhaust valves	0.200	0.20
13.	Clearance: intake valve stem to valve guide exhaust valve stem to valve guide	0.020 - 0.049 0.030 - 0.059	0.15 0.15
14.	Vacuum pump rotor end play	0.100 - 0.220	0.25
15.	Vacuum pump rotor journal radial clearance	0.032 - 0.077	0.12
16.	Oil pump rotor gear backlash	0.030 - 0.150	0.20
17.	Turbocharger rotor clearance: - radial - axial	0.0560 - 0.127 0.0254 - 0.084	- -
18.	Axial flywheel run-out	0.150	-
19.	Pulley groove run-out	0.300	-
20.	Phase sensor gap to camshaft gear hub tooth	0.20 – 1.80	-
	Distance from phase sensor abutting surface to camshaft gear hub tooth	24.7 – 25.5	-
21.	Speed sensor gap to flywheel teeth	0.50 – 1.50	-
	Distance from speed sensor abutting surface to flywheel teeth	35.1 – 35.8	-

10 Tightening torque of main screw connections

	Torque
Main bearing cap (2 x M14)	147 – 157 Nm
Connecting rod cap (2 x M11X1)	see 13.2
Cylinder head (18 x M12x1.25)	see 13.4
Flywheel housing (3 x M8)	24.5 – 26.5 Nm
Flywheel housing (8 x M10)	46 – 51 Nm
Flywheel (8 x M12x1)	127,5 – 136 Nm
Crankshaft pulley with vibration damper (M16)	186 – 196 Nm
Glow plug (M10x1)	12 - 18 Nm
Camshaft gear hub	186 – 196 Nm
Camshaft gear rim to camshaft gear hub (3 x M8)	20 – 24 Nm
High pressure pipe to injector (M12x1,5)	25 – 29 Nm
High pressure pipe to high pressure pump (M12x1,5)	18 – 22 Nm
High pressure pipe to rail (M14x1)	18 – 22 Nm
Injector fixing nut (M8x1,25)	21.5 – 26.5 Nm
Timing belt tensioner (M8)	20 – 24 Nm
Camshaft housing (13 x M8x1,25)	17 – 19 Nm
Camshaft bearing cap (2 x M8 x 1,25)	17 – 19 Nm
Camshaft locating bearing cap (2 x M8 x 1,25)	17 – 19 Nm
Vacuum pump cap (2 x M8 x 1,25)	17 – 19 Nm
High pressure pump gear (M14x1,5)	65 – 75 Nm
Oil jet nozzle valve (M11x1)	17 – 19 Nm
Phase sensor (M6)	7,5 – 8,5 Nm
Engine speed sensor (M6)	7,5 – 8,5 Nm
Intake air temperature sensor (M12x1,5)	13 – 15 Nm
Fuel / coolant temperature sensor (2 sensors M12x1,5)	21 – 25 Nm
Glow plug controller (M6)	4 – 6 Nm
Thermal switch in fuel filter	30 – 35 Nm
Water sensor in fuel filter	1 – 1.6 Nm
Air drain screw in fuel filter	7 – 9 Nm
Fitting in fuel filter (M14x1,5)	30 – 35 Nm

Other standard screw connections:

Bolts and nuts	Torque
M6	8 – 9 Nm
M8	20 – 24 Nm
M10	41 – 49 Nm

11 Operating the engine

11.1 Preparation for first start-up

- a) Charge the battery
- b) Fill up the fuel tank with proper diesel fuel (see 6.1).
- c) Fill up the engine with proper engine oil (see 6.2). The oil level should reach the upper mark on oil dipstick (see Fig. 6).
- d) Fill up cooling system with coolant to the level above the “min” mark on compensation tank installed in the vehicle. Irrespective of ambient conditions, do not use water but antifreeze liquid, what is necessary to protect cooling system against furring up, and because of higher boiling temperature of the antifreeze liquid (see 4).
- e) Check intake system for any leaks. Leaks of this system enable contamination getting into the engine what leads to accelerated wearing out of pistons, piston rings and cylinder bores and to power reduction and excessive smoke emission. Leaks may also cause turbocharger damage.

11.2 Engine start-up

- a) Before first start-up, or after complete fuel exhausting and refilling, operate the manual fuel feed pump on fuel filter (see Fig. 12) until filling up fuel system and generating some pressure (noticeable resistance when pressing the manual fuel feed pump head), there is no need to release the air drain screw. If the engine does not start after a few attempts, or stalls after starting up, operate again the manual fuel feed pump pressing couple times its head.

WARNING: Avoid complete fuel exhausting as it may cause damage of high pressure pump.

- b) Turn the ignition key to position I. The following indicator lamps go ON: glow plug, battery charging, oil pressure, OBD fault and system fault (Check Engine).
- c) Put the gear change lever in neutral position and press down clutch pedal (to reduce resistance to motion, especially important in winter).
- d) After glow plug indicator lamp goes OFF, turn the ignition key to position II and immediately after engine start release the key, which automatically returns to position I. Do not hold the key in starter motor ON position for longer than 10 seconds. If within this time engine does not start, repeat start-up procedure after an interval of at least 15 seconds. If after a few consecutive attempts the engine still does not start, turn OFF the ignition and seek for the cause.
- e) After successful engine start all the indicator lamps should go OFF.

WARNING: After engine start, leave it at idle for at least 10 seconds to allow engine oil to reach turbocharger bearings. It is especially important in winter, or when engine was not operated for longer time. Increasing engine speed immediately after its starting may lead to reducing turbocharger life or even to sizing turbocharger bearings.

WARNING: Because valve train is driven via toothed belt it is forbidden to start up the engine by towing or pushing the vehicle, as due to high inertia of the engine movable elements it may cause jump over of the belt teeth and serious engine damage (interference of valves and pistons).

11.3 Engine run-in

Note: Within driving the first 1000 km it is recommended to not exceed 3/4 of the nominal engine load.
Obeying this recommendation extends engine life to first overhaul. The above recommendation applies also to engine after repairs with dismantling pistons and piston rings or crankshaft.

11.4 Engine shut-down

In order to stop the engine, stop the vehicle, put the gear change lever to neutral position, and turn the ignition key to “STOP” or “OFF” position. Remove key from the ignition switch.

WARNING: After long and severe driving, when coolant temperature indicator is closed to red zone, before stopping the engine leave it at idle for at least 30 seconds in order to cool it down. Immediate engine shut-down causes stop of coolant circulation and increase of its temperature, what may lead to its boiling and discharge through expansion tank cap. It also may cause turbocharger bearings damage.

WARNING: Stop the engine immediately in case of any abnormal noise indicating a failure.

12 Routine servicing operations

12.1 Table of the routine servicing operations:

S = Check (adjust, clean, fill-up, repair or replace if necessary)

W = Replace

No.	Operation	Mileage in kilometers x 1000 (with tolerance ± 500 km)						
		1,5	15	30	45	60	75	90
1.	Engine oil	W	W	W	W	W	W	W
2.	Oil filter	W	W	W	W	W	W	W
3.	Lubrication system; condition of sealing, leaktightness of joints	S	S	S	S	S	S	S
4.	Poly-V-belt; water pump and alternator drive	S	S	S	S	S	S	S
5.	V-belt; power assisted steering pump drive	S	S	S	S	S	S	S
6.	Cooling system; coolant level and quality, leaktightness of joints	S	S	S	S	S	S	S
7.	Air intake system; leaktightness of joints	S	S	S	S	S	S	S
8.	Air filter element*		W	W	W	W	W	W
9.	Fuel system; leaktightness of joints	S	S	S	S	S	S	S
10.	Fuel filter cartridge *			W		W		W
11.	Exhaust system; condition of catalysts, leaktightness of joints	S	S	S	S	S	S	S
12.	Valve clearance	S		S		S		S
13.	Condition of electrical connections (alternator, starter motor, wires)	S	S	S	S	S	S	S
14.	Timing belt				S			W

* frequency of replacement depends on operation conditions – in case of increased dustiness, contamination, etc., may require more often replacement

12.2 Check, fill-up and change engine oil

Check engine oil level when the vehicle is parked on horizontal surface and the engine is cold. When checking after engine shut-down, wait for about 10 minutes to let the oil dripping down to oil pan. Remove and wipe clean the oil dipstick, insert it back home and remove again to check oil level that should be within the rod flattening with diamond knurling. If necessary remove oil filler cap in valve cover, add fresh, recommended engine oil (see 6.2), and check the level again.

Note:

1. Never add too much oil to not exceed the maximum level, as it may cause damage of sealing and oil leak, excessive oil consumption, as well as excessive smoke emission, contamination of injectors and in extreme cases damage of catalyst and engine.
2. Remember to insert back the oil dipstick, tight up the oil filler cap and check for leaktightness.

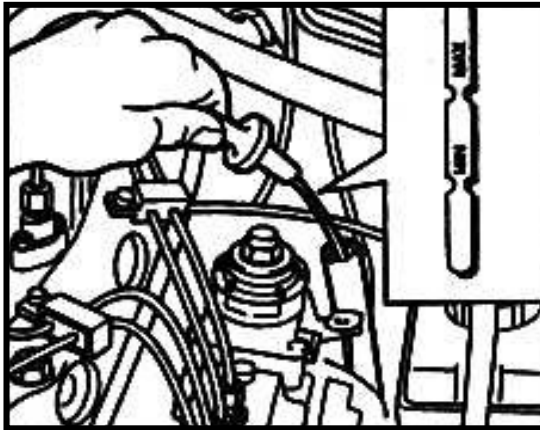


Fig. 6. Checking oil level

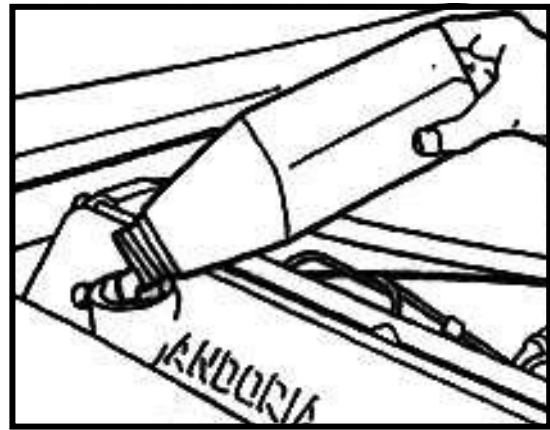


Fig. 7. Adding oil

12.3 Engine oil and oil filter change

Drain oil from warm engine. Prepare a container of proper volume (over 7 dm³). Unscrew oil drain plug in oil pan and drain oil to the container.

CAUTION: Be careful as the oil may be hot!

Note:

1. To facilitate oil draining, remove oil dipstick or remove the oil filler cap in valve cover.
2. Dispose the used oil in accordance with regulations.

Wash the drain plug and replace its packing washer with new one. After complete draining of the used oil, refit the drain plug screwing it in with fingers to at least 3/4 of its thread length (to avoid thread damage and oil leak). Then tighten up the drain plug with a wrench.

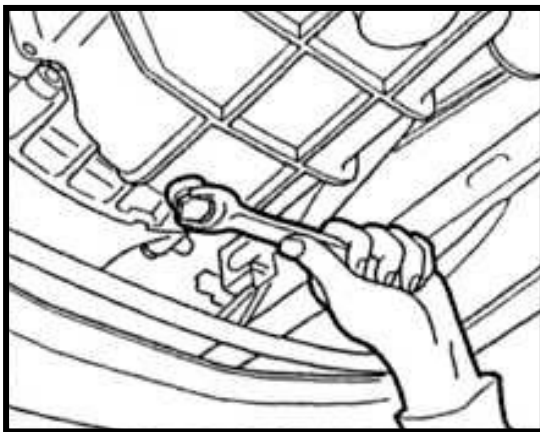


Fig. 8. Draining engine oil

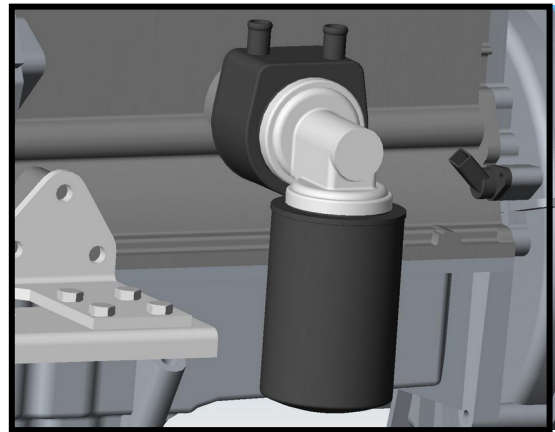


Fig. 9. Oil filter change

Wipe clean the oil filter cartridge and head. Unscrew the oil filter cartridge with filter wrench.

Note:

1. Always when changing engine oil, change oil filter.
2. Dispose the used oil filter in accordance with regulations.

Apply thin film of engine oil to rubber seal of the new oil filter cartridge and tighten up the cartridge firmly by hands without using the wrench.

Unscrew the oil filler cap (see previous point) and fill the engine with about 6.5 dm³ of fresh, recommended engine oil (see 6.2). Refit the oil filler cap. Start up the engine and let it idle until the oil pressure indicator lamp goes OFF. Shut down the engine and wait about 10 minutes to let the oil dripping down to oil pan. Check and fill-up the oil level (see previous point).

Check leaktightness of all the joints.

12.4 Replace and tension drive belts

a) Replace and tension alternator and water pump drive belt (see Fig. 10)

Alternator and water pump are driven via poly-V-belt. The poly-V-belt is tensioned correctly if under pressure of force $P = 60\text{ N}$, **it deflects about 7 mm**.

In a case of damage or excessive stretching of the belt (further tensioning impossible), replace the belt with new one.

In order to replace the belt, loosen bolt (1) fixing bottom alternator lug to bracket and bolt (2) fixing upper alternator lug to tensioner (4). Unscrewing the belt tension adjustment bolt (3), loosen and remove the belt. Install new belt and screwing in the adjustment bolt (3) properly tension the belt. Then tighten up the previously loosened bolts.

b) Replace and tension power assisted steering pump belt (see Fig. 11)

The power assisted steering pump V-belt driving is tensioned correctly if under pressure of force $P = 100\text{ N}$, applied in the middle between pulley, **it deflects about 10 mm**. In a case of damage or excessive stretching of the belt (further tensioning impossible), replace the belt with new one.

In order to replace the V-belt, loosen bolt and nut fixing the pump with front and rear hangers to bracket and bolt and nut fixing front hanger to bracket. Rotating the front hanger with pump down towards the engine, loosen and remove old belt. Install new belt and removing the pump away from engine properly tension the belt. Then tighten up the previously loosened bolts and nuts.

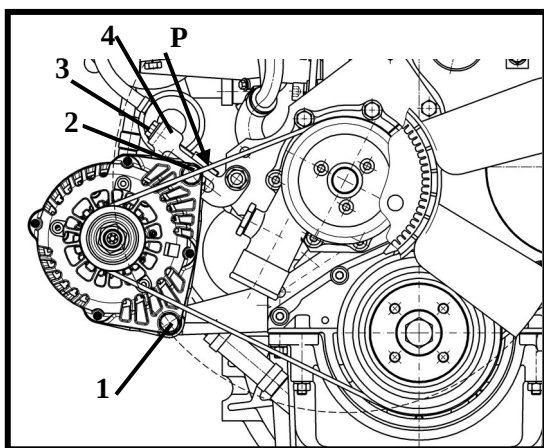


Fig. 10. Alternator and water pump drive

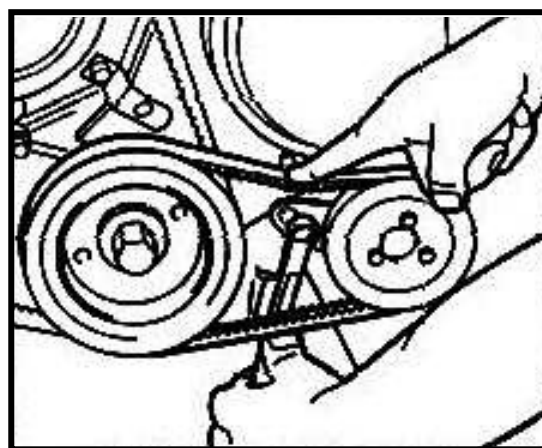
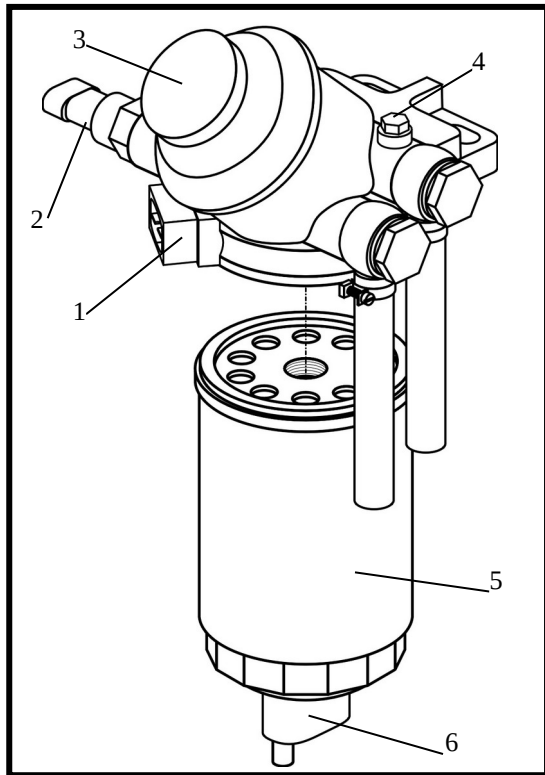


Fig. 11. Power assisted steering pump drive

12.5 Fuel filter service



1. Fuel heater connector
2. Thermal switch (for heater)
3. Manual fuel feed pump head
4. Air drain screw
5. Fuel filter cartridge
6. Water sensor

Fig. 12. Fuel filter

a) Replace fuel filter cartridge

Remove harness plug from water sensor in fuel filter. Unscrew fuel filter cartridge by means of filter wrench. Apply thin film of engine oil to rubber seal of the new fuel filter cartridge and tighten up the cartridge firmly by hands without using the wrench. Unscrew water sensor from the old cartridge and screw it by fingers in the new cartridge. Insert harness plug to water sensor. Operate the manual fuel feed pump on fuel filter (3) until filling up fuel system and generating some pressure (noticeable resistance when pressing the manual fuel feed pump head), there is no need to

release the air drain screw. If the engine does not start after a few attempts, or stalls after starting up, operate again the manual fuel feed pump pressing couple times its head. After starting the engine, check leaktightness of the joints.

b) Clean water separator

In a case when the water sensor indicator lamp goes ON, remove harness plug from water sensor in fuel filter. Loosen air drain screw (4) on fuel filter. Unscrew water sensor (6) and drain water from fuel filter to previously prepared container. Refit water sensor with fingers. Tighten up air drain screw. Operate the manual fuel feed pump on fuel filter (3) until filling up fuel system and generating some pressure. After starting the engine, check leaktightness of the joints.

12.6 Adjust valve clearance

Check and adjust valve clearance on cold engine by means of feeler gauge of 0.2 mm thickness, both for intake and exhaust valves. Loosen hose clamps and remove ventilation hose from valve cover. Remove phase sensor. Unscrew valve cover bolts and remove it, first lifting its front side to pass by the vacuum pump fitting. Rotating crankshaft bring first cylinder piston to TDC position (see Fig. 13). Check valve clearance inserting feeler gauge between rocker arm and camshaft cam. The clearance is correct if feeler gauge moves with small resistance. If the clearance is incorrect, loosen lock-nut on adjustment bolt and adjust clearance rotating adjustment bolt by means of screwdriver. Holding adjustment bolt by means of screw driver, tighten up the lock-nut, and recheck valve clearance. If incorrect – repeat adjustment procedure. Repeat the same procedure for the second valve of first cylinder. In the same manner, adjust valve clearance of the remaining cylinders according to firing order (1-3-4-2), each time rotating crankshaft by half-turn. Tighten up the lock-nut, and recheck valve clearance. If incorrect – repeat adjustment procedure.

Insert valve cover seal (it is recommended to replace the seal with new one each time the valve cover is removed). Before installing valve cover, apply silicone in corners between locating bearing cap and camshaft housing, and vacuum pump cap and camshaft housing (see Fig. 17). Install ventilation hose.

12.7 Replace timing belt and set up timing

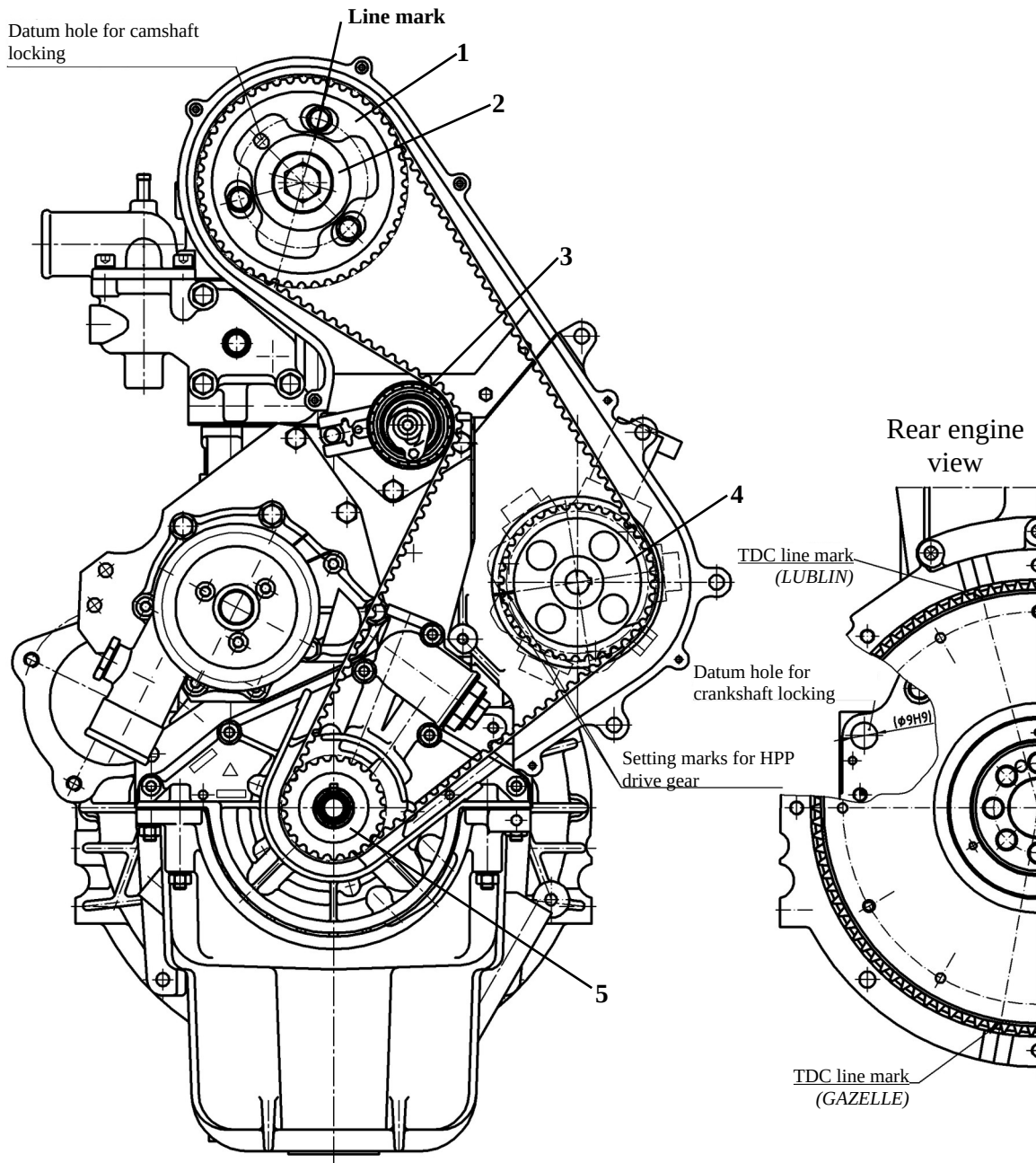


Fig. 13. Replace timing belt and set up timing

Remove air intake pipe. Remove alternator drive belt. Remove timing belt cover. Lock up the flywheel and unscrew the bolt fixing belt pulley with vibration damper to crankshaft. By means of extraction tool 031902, extract belt pulley with vibration damper from crankshaft. Unlock flywheel.

Procedure to replace timing belt and set up timing (see Fig. 13 and 14):

- 1) Rotating crankshaft in normal engine operation direction (clockwise, seen from the camshaft drive side), bring first cylinder piston to TDC – align the line mark with GMP inscription on flywheel (LUBLIN at the top, GAZELLE at the bottom) with the line mark on flywheel housing.
- 2) Insert the setting tool (1.3.0742) into the datum hole in cylinder block (after removing the engine speed sensor) and turn its arm to the extreme bottom position to lock the crankshaft in TDC.
- 3) Loosen the bolts fixing camshaft gear rim (1) to gear hub (2).

Note: Camshaft gear rim and its hub make an assembly balanced together. In case of complete detaching of the gear rim and hub, put them back together in position where the line mark on gear rim is to the right of the datum hole in the hub.

- 4) Insert the setting tool (2.03.066) into datum hole in camshaft gear hub (2) and the camshaft locating bearing cap, then turn it clockwise or anticlockwise to lock camshaft in TDC.
- 5) Loosen the bolt fixing automatic belt tensioner (3), what will cause loosening of the belt tension, then remove the belt. Unscrew completely the fixing bolt and remove the automatic belt tensioner.

Note: Always when replacing timing belt, replace the automatic belt tensioner with new one.

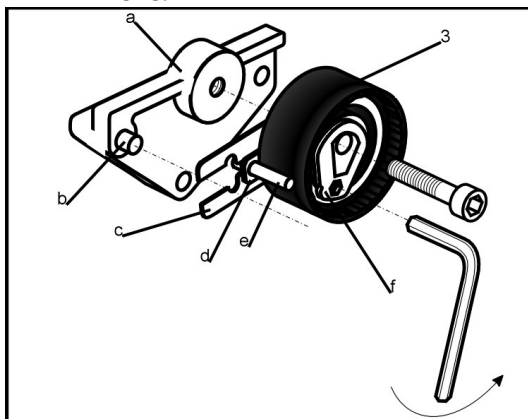


Fig. 14. Automatic timing belt tensioner

- 6) Install new belt tensioner (3) on its bracket (a), so as the opening in its rear plate (c) gets on the bracket dowel pin (b), do not tighten completely the fixing bolt. New tensioner is delivered as locked with pin (e).
- 7) Set up high pressure pump gear (4) on its marks (it is necessary due to high pressure pump bearing load).

Note: If it is necessary to remove high pressure pump gear (4), use locking tool AD-057 to lock the gear in order to unscrew the fixing bolt.

- 8) Put new timing belt on crankshaft gear (5), then pulling it slightly insert its teeth in tooth spaces of high pressure pump gear (4) and then onto camshaft gear (1), then put it on the roller of automatic belt tensioner (3).
- 9) Remove pin (e), tensioner spring will rotate the eccentric and move pointer (d). By means of 'Allen' key inserted into front plate seat (f) rotate the eccentric in accordance with the arrow on the front plate until pointer (d) comes back to its original position (holes in pointer (d) and rear plate (c) aligned). Then holding the eccentric in this position, tighten up the fixing bolt with torque 20 – 24 Nm.
- 10) Tighten up the bolt fixing camshaft gear rim (1) to its hub (2) with torque 20 – 24 Nm, remove setting tools from camshaft and crankshaft.
- 11) Make two full crankshaft turns in direction of normal engine operation and recheck timing belt tensioning, i.e. whether the holes in pointer (d) and rear plate (c) are aligned. Check alignment of flywheel TDC (GMP) marks and camshaft datum holes. Setting marks on high pressure pump gear are not aligned after two crankshaft turns (they will align after six crankshaft turns). If necessary, loosen the bolt fixing belt tensioner and repeat timing belt tensioning procedure.

By means of mandrel 031969 drive the belt pulley with vibration damper on crankshaft. Lock up flywheel, screw in the bolt with washer fixing belt pulley with vibration damper and tighten it up with torque 186 – 196 Nm. Unlock flywheel. Install timing belt cover. Install air intake pipe. Install alternator drive belt (see 12.4).

13 Some repair operations

13.1 Replace oil pan seals

Prepare a container of proper volume (over 7 dm³). Unscrew oil drain plug (1) in oil pan and drain oil to the container.

CAUTION: Be careful as the oil may be hot!

Note: To facilitate oil draining, remove oil dipstick or remove the oil filler cap in valve cover.

Wash the drain plug and replace its packing washer (2) with new one. After complete draining of the used oil, refit the drain plug screwing it in with fingers to at least 3/4 of its thread length (to avoid thread damage and oil leak). Then tighten up the drain plug with a wrench.

Unscrew dipstick guide fixing bolt and remove the guide.

Loosen hose clamps on oil return hose from turbocharger.

Unscrew 8 M8 nuts (3), 14 M8x22 bolts (4) and 2 M8x105 bolts (5) fixing oil pan (6). Remove oil pan. Remove 2 semicircular rubber seals (7) and 2 flat gaskets (8) of the oil pan. Thoroughly clean sealing surfaces between oil pan and cylinder block, oil pump and locating bearing cap.

Install 2 new flat gaskets (8) on cylinder block and apply small quantity of silicone in corners between cylinder block and oil pump and locating bearing cap (A). Install 2 new semicircular rubber seals (7) in grooves of oil pump and locating bearing cap. Apply small quantity of silicone on joints between flat gaskets and rubber seals (A). Install oil pan (6), inserting oil pan fitting (9) into oil return hose from turbocharger. If necessary to remove fitting (9), before its refitting apply STAG sealant on it. Screw 8 M8 nuts (3) with spring washers (10) on studs (11) and screw in 14 M8x22 bolts (4) and 2 M8x105 bolts (5) with spring washers (10). Apply STAG sealant on the bolts. Tighten up all the M8 bolts and nuts uniformly, starting from the middle of the oil pan. Tighten up the clamps on the oil return hose from turbocharger. Put new O-ring on dipstick guide and install the guide, then tighten up the guide fixing bolt with flat and spring washer.

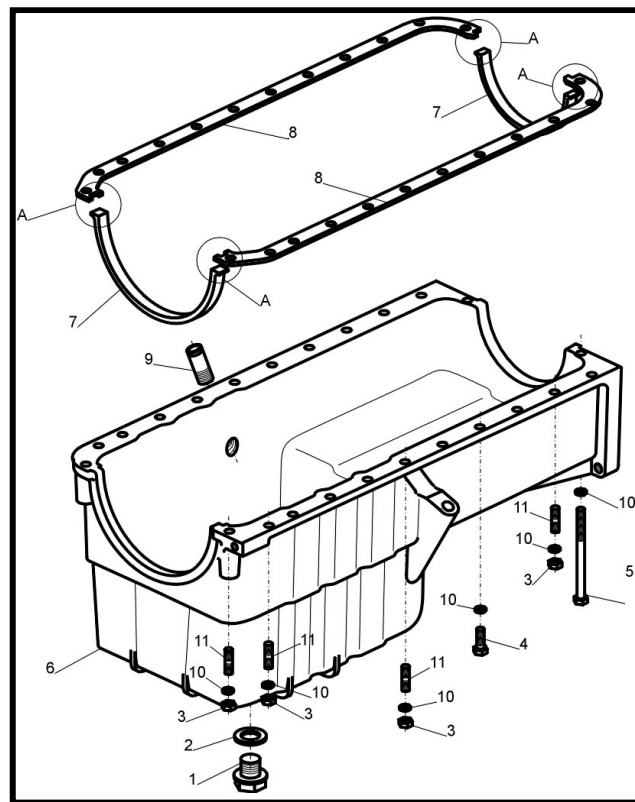


Fig. 15. Oil pan seals

13.2 Replace pistons

Remove oil pan (see 13.1). Remove cylinder head (see 13.4). Unscrew connecting rod cap nuts and remove connecting rod cap with bearing shell. Push piston and connecting rod up and take it out from cylinder bore. Attach back connecting rod cap to connecting rod, maintaining previous position of connecting rod cap, bolts and nuts (see Fig. 16). In the same manner, remove the other pistons and connecting rods and put them aside in order of cylinders.

Note: When reassembling, bolts and nuts must always be installed in their original positions (the same con-rod and the same hole).

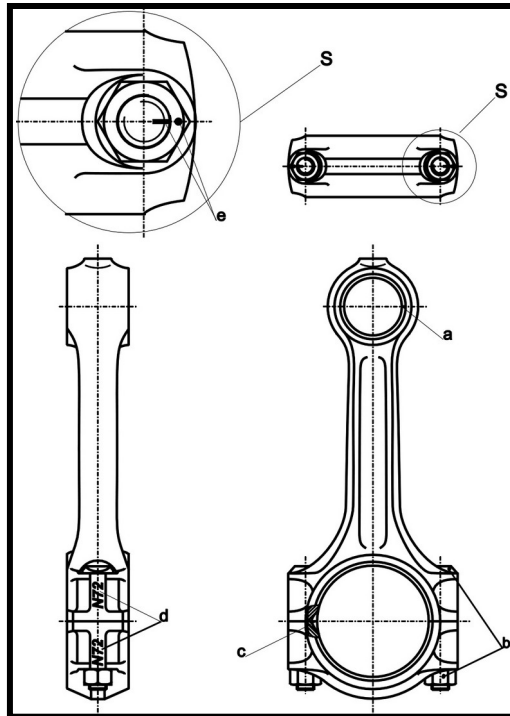


Fig. 16. Connecting rod with assembly marking

- a – position of small end bush parting
- b – dot marks on external bolt and nut surfaces at connecting rod alphanumeric marking side
- c – big end bearing shell locking lugs
- d – alphanumeric identification marking on connecting rod and cap (e.g. N72)
- e – marks on bolts and nuts made after proper nut tightening, i.e. bolt elongation by 0.14 – 0.17 mm (what corresponds to torque of about 70 – 75 Nm)

By means of pliers remove piston pin retaining rings and press out piston pin. Remove piston from connecting rod.

When reassembling, install one piston pin retaining ring. To facilitate assembly heat up the piston to around 70°C, apply thin film of engine oil to small end bush, insert connecting rod to piston so as the arrow on piston points to engine front when connecting rod identification marking faces high pressure pump, then slide piston pin in piston hole and small end bush. Install the other piston pin retaining ring.

Before installing pistons with connecting rods into cylinder block, clean up and lubricate cylinder bores with engine oil. Remove connecting rod cap. Apply engine oil to piston and big end bearing shells. Using universal assembly tool insert piston with connecting rod into cylinder block (arrow on piston crown points engine front, and connecting rod identification marking faces high pressure pump). Install connecting rod cap and nuts in their previous positions so as the nut and bolt with dot marking on side surface are at the side of connecting rod identification marking (see Fig. 16 – e). In the same manner install the other pistons with connecting rods. Install oil pan (see 13.1). Install cylinder head (see 13.4)

13.3 Replace camshaft housing gasket

Remove air intake pipe. Remove timing belt cover. Bring first cylinder piston to TDC (GMP). (see 12.7). If it is not necessary to replace timing belt, take off timing belt only from camshaft gear (see 12.7, Fig. 13, do not remove belt pulley from crankshaft). Lock up camshaft by means of locking tool (AD-056) and unscrew the bolt fixing camshaft gear hub to camshaft. Remove camshaft gear rim (1) with hub (2) from camshaft. Unscrew rear timing belt cover bolts and remove the cover. Loosen hose clamps and remove ventilation hose from valve cover. Remove phase sensor. Loosen hose clamps and remove vacuum pump hose. Unscrew valve cover bolts and remove the cover, first lifting its front side to pass by the vacuum pump fitting. Unscrew 13 M8x1.25 bolts fixing camshaft housing and remove complete camshaft housing with camshaft. Remove camshaft housing gasket. Clean up sealing surfaces between camshaft housing and cylinder head. Install new camshaft housing gasket on locating bushes. Install camshaft housing in reverse order to dismantling.

Tighten up all the camshaft housing fixing bolts uniformly, starting from the middle of the camshaft housing. Finally, tighten up the bolts in the same manner with torque of 17 – 19 Nm.

If necessary to replace camshaft sealing ring, before installing rear timing belt cover, unscrew 2 M8x1.25 bolts fixing camshaft locating bearing cap and remove the cap. Remove sealing ring. Clean up sealing surfaces between camshaft housing and camshaft locating bearing cap. Apply thin film of silicone on sealing surface of camshaft locating bearing cap, only from the grooves outside (see Fig. 17), and install the cap tightening uniformly both bolts and finally with torque of 17 – 19 Nm.

WARNING: If silicone gets into camshaft bearing surfaces it may cause camshaft seizure.

Drive in new sealing ring by means of mandrel AD-059, previously applying thin film of engine oil to sealing lip.

If necessary to remove vacuum pump cover, unscrew 2 M8x1.25 bolts and remove the cap. Clean up sealing surfaces between camshaft housing and vacuum pump cap. Apply thin film of silicone on the entire sealing surface of vacuum pump cap (see Fig. 17), and install the cap tightening uniformly both bolts and finally with torque of 17 – 19 Nm.

Before installing valve cover, apply silicone in corners between camshaft locating bearing cap and camshaft housing, and vacuum pump cap and camshaft housing.

Complete assembling in reverse order to dismantling.

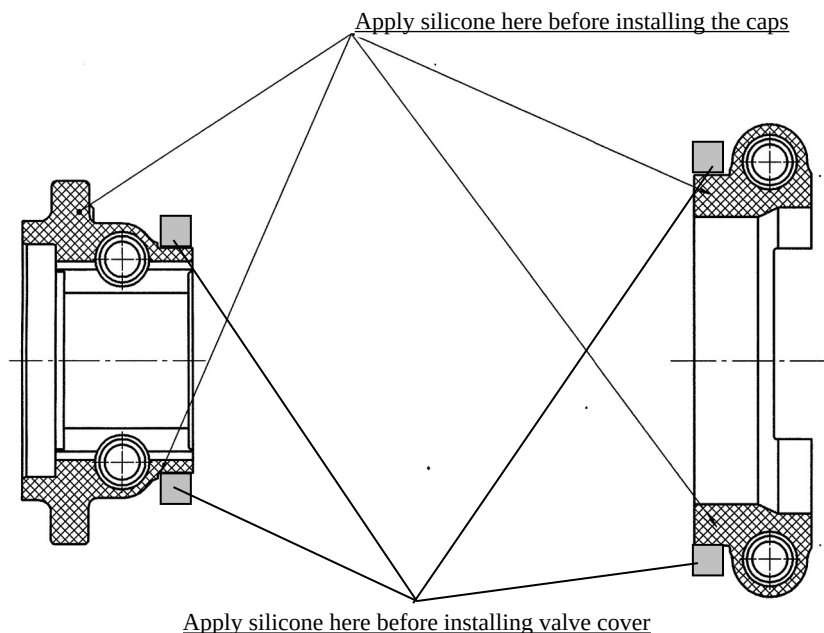


Fig. 17. Camshaft locating bearing cap and vacuum pump cap

13.4 Replace cylinder head gasket

Prepare proper container for coolant. After cooling down the engine, carefully unscrew compensation tank cap to release pressure, and then drain cooling system. If it is not necessary to replace timing belt, take off timing belt only from camshaft gear (see 12.7, Fig. 13, do not remove belt pulley from crankshaft). Remove camshaft housing (see 13.3). Detach oil tubes from turbocharger. Detach exhaust pipe from turbocharger. Detach air tubes from turbocharger and intake manifold. Remove EGR system. Remove intake and exhaust manifold. Exhaust manifold remove together with turbocharger. Loosen hose clamps and remove water hose: thermostat housing – radiator. Loosen hose clamps of water hose: thermostat housing – water pump. Detach fuel pipe: high pressure pump – rail, the openings protect with caps.

Unscrew cylinder head bolts in reverse order to tightening (see Fig. 18). Using engine lifting eyes and sling, remove cylinder head by means of lifting equipment. Remove cylinder head gasket. Clean up sealing surfaces of cylinder block and head.

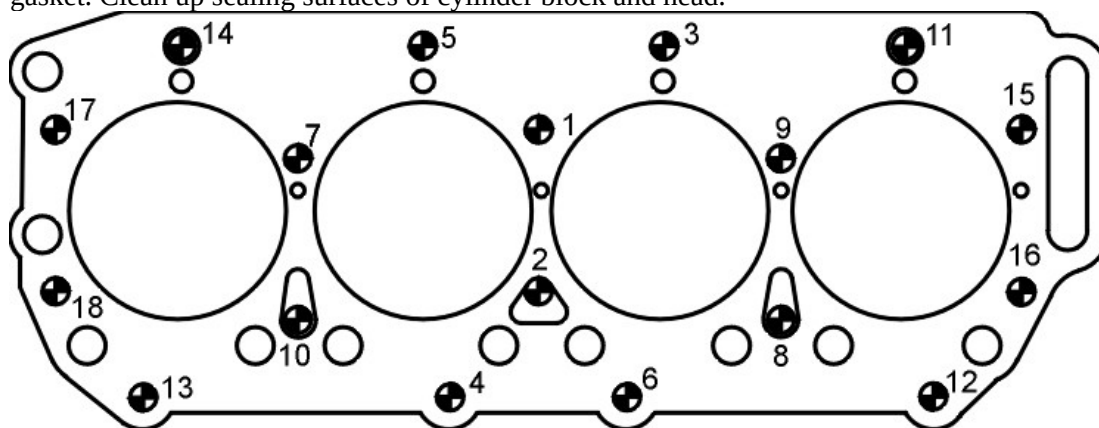


Fig. 18. Order to tighten cylinder head bolts

Before installing cylinder head, thoroughly blow out with compressed air any contamination from cylinder bores and threaded holes (wear safety goggles), and then using clean fabric wipe out sealing surfaces of cylinder block and head, as well as cylinder bores. Install new cylinder head gasket on locating bushes. Using engine lifting eyes and sling, carefully put cylinder head by means of lifting equipment on locating bushes.

Before screwing in cylinder head bolts, apply small amount of grease with additive of molybdenum disulfide (MoS_2) or graphite on bolt thread and head abutting surface. Tighten the bolts in stages, obeying in each stage the tightening order shown in Fig. 19.

Procedure to tighten up cylinder head bolts

a) During engine assembly

- Stage I: 40 Nm (± 10 Nm)
- Stage II: 85 Nm (± 5 Nm)
- Stage III: 125 Nm (± 5 Nm)
(after completing this stage, recheck tightening of all the bolts with the same torque)

After completing stage III of tightening cylinder head bolts, install all the previously dismantled elements in reverse order to dismantling. Remove air draining hose from upper thermostat housing and slowly pour coolant in cooling system allowing its deaeration. Then attach air draining hose and close compensation tank cap.

- b) Start up the engine. After reaching coolant temperature of 80°C let the engine idle for 15 minutes.
- c) Shut down the engine. After cooling down the coolant to temperature of about 60°C, remove valve cover (see 12.6) and tighten up cylinder head bolts with the following torque, without their loosening

- Stage IV 125 Nm (± 5 Nm)
(after completing this stage, recheck tightening of all the bolts with the same torque)

13.5 Replace injectors

Unscrew nuts fixing high pressure pipe to injector and rail and remove high pressure pipe, the openings protect with caps. Unscrew injector yoke nut, remove the yoke and remove the injector with washer.

Notes:

1. Each time when reinstalling injector, install new injector washer.
2. Always replace complete injector assembly.
It is impossible to replace just the nozzle.

Install new injector with new injector washer, install injector yoke and tighten up the nut with torque of 21,5 – 26,5 Nm. Install high pressure pipe and tighten up the nuts to injector with torque 25 – 29 Nm and to rail with torque 18 -22 Nm.

Note: After replacing injector with new one, it is necessary to change injector IMA code (containing hydraulic characteristics of the injector) in ECU by means of tester. Recommended KTS510F tester of BOSCH.

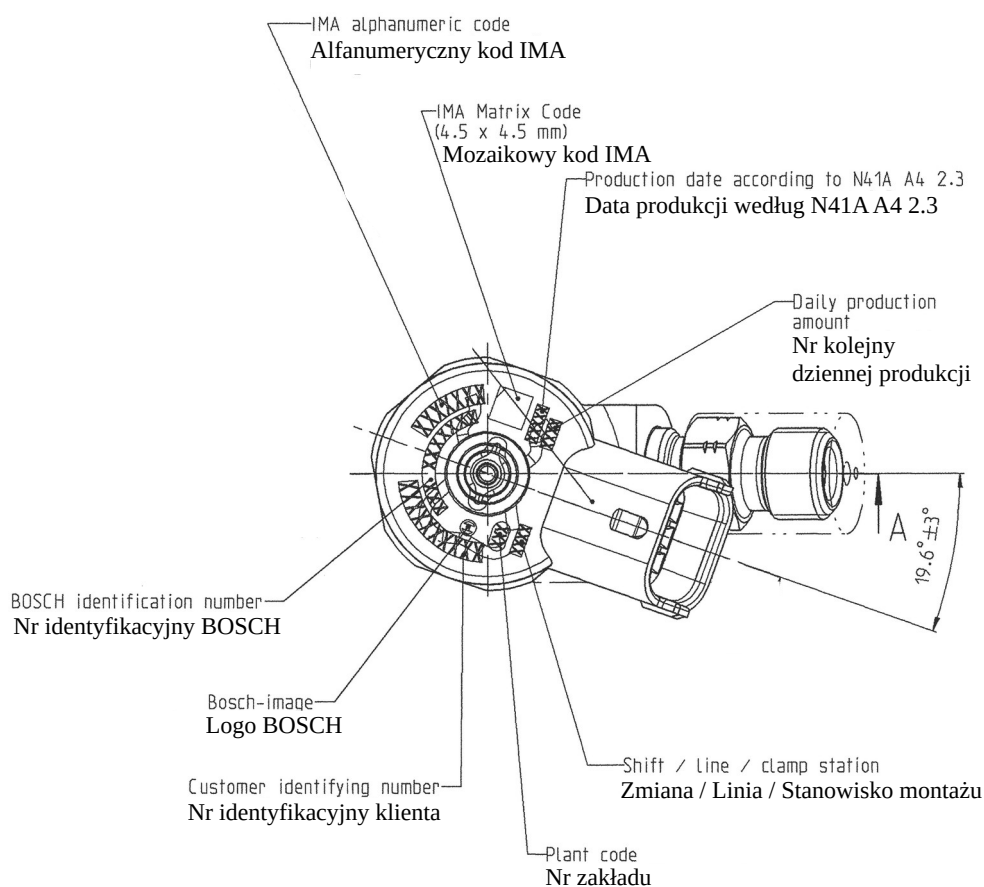


Fig. 19. Markings on injector

14 List of special tools

No.	Tool marking	Tool name / use
1.	1.3.0742	Setting tool to set up crankshaft at TDC
2.	2.03.066	Setting tool to set up camshaft at TDC
3.	AD-056	Locking tool to lock up camshaft drive gear
4.	AD-057	Locking tool to lock up high pressure pump drive gear
5.	AD-059	Mandrel to drive in camshaft sealing ring
6.	031902	Extraction tool to extract belt pulley with vibration damper from crankshaft
7.	031903	Extraction tool to extract gear from crankshaft
8.	031969	Mandrel to drive gear on crankshaft
9.	034341	Mandrel to drive in oil pump sealing ring
10.	036080	Insertion tool to press in rear crankshaft sealing ring

15 Fault code list

As defined by the regulations on measures to be taken against air pollution by emissions from motor vehicles, 'OBD' an on-board diagnostic system for emission control which has the capability of identifying the likely area of malfunction by means of fault codes stored in computer memory.

ADCR engine diagnostics system besides the law-required diagnostics of emission relevant elements, faulty operation of which would cause exceeding of the imposed emission limits (hereafter called „OBD fault”), diagnosis also other faulty operations („System fault”), see the following fault code list.

Reading OBD faults by means of any standard OBD tester that handles data transmission protocol ISO 14230.

Reading system faults by means of BOSCH testers with diagnostics software developed especially for ADCR engine. Recommended KTS510F tester. The diagnostics software especially developed for ADCR engine except reading fault codes enables also reading set and actual values of many parameters, performing actuator tests, performing functional tests and entering into ECU injector IMA codes (containing injector hydraulic characteristics). The tester handles 23 languages (including English).

Last two columns of the following lists show when the indicator lamps for OBD faults and System faults (Check Engine) go ON. ON3 means the lamp goes ON in third driving cycle with existing malfunction. 'A driving cycle' consists of engine start-up, driving mode where a malfunction would be detected if present, and engine shut-off.

Indicator lamp is de-activated after three subsequent sequential driving cycles during which the monitoring system responsible for activating the indicator lamp ceases to detect the malfunction and if no other malfunction has been identified that would independently activate the indicator lamp.

The OBD system erases a fault code and the distance traveled and freeze-frame information if the same fault is not re-registered in at least 40 engine warm-up cycles. 'A warm-up cycle' means sufficient vehicle operation such that the coolant temperature has risen by a least 22 °K from engine starting and reaches a minimum temperature of 343 °K (70 °C).

Fault code		Description in KTS	Fault description	Lamp	
KTS	OBD			Check Engine	OBD
14	P0118	Coolant temperature sensor	voltage too high	OFF	ON3
15	P0117	Coolant temperature sensor	voltage too low	OFF	ON3
16		Internal refr. voltage, ctrl. unit	voltage too high	ON3	OFF
17		Internal refr. voltage, ctrl. unit	voltage too low	ON3	OFF
20		Internal refr. voltage, ctrl. unit	faulty	ON3	OFF
22	P0116	Coolant temperature sensor	not in range	OFF	ON3
24		Internal refr. voltage, ctrl. unit	faulty	ON3	OFF
38		Clutch switch	signal improbable	OFF	OFF
69	P0101	Air- mass sensor	maximum exceeded	OFF	ON3
72		Accelerator pedal position sensor 2	sensor 1/2 signal compare improbable	ON3	OFF
73	P0101	Air- mass sensor	less than minimum	OFF	ON3
99	P0340	Camshaft position sensor	no signal	OFF	ON3
100	P0340	Camshaft position sensor	incorrect signal	OFF	ON3
103	P0335	Crankshaft position sensor	open circuit/no signal	OFF	ON3
104	P0335	Crankshaft position sensor	incorrect signal	OFF	ON3
105	P0016	Camshaft sensor / crankshaft sensor	deviation excessive	OFF	ON3
109		Torque monitoring / Requested torque	signal improbable	ON3	OFF
112	P0183	Fuel temperature sensor	voltage too high	OFF	ON3
113	P0182	Fuel temperature sensor	voltage too low	OFF	ON3
235	P0123	Accelerator pedal position sensor 1	voltage too high	ON3	OFF
246		Glow duration control	short circuit	ON3	OFF
247		Glow duration control	malfunction	ON3	OFF
248		Glow duration control	communication faulty	ON3	OFF
249		Glow duration control	communication faulty	ON3	OFF
250		Accelerator pedal position sensor 2	voltage too high	ON3	OFF
261		Glow indicator lamp	short to b+	OFF	OFF
262		Glow indicator lamp	short to earth	OFF	OFF
264		Glow indicator lamp	open circuit	OFF	OFF
265		Glow indicator lamp	temperature too high	OFF	OFF
279		Engine control unit	faulty	ON3	OFF
280		Engine control unit	internal fault	ON3	OFF
281		Engine control unit	internal fault	ON3	OFF
282		Engine control unit	internal fault	ON3	OFF
286		Internal refr. voltage, ctrl. unit	voltage too high	ON3	OFF

Fault code		Description in KTS	Fault description	Lamp	
KTS	OBD			Check Engine	OBD
287		Internal refr. voltage, ctrl. unit	voltage too low	ON3	OFF
288	P0098	IAT sensor	voltage too high	OFF	ON3
289	P0097	IAT sensor	voltage too low	OFF	ON3
298	P2148	Capacitor voltage, bank 1	open circuit/positive short	OFF	ON3
319	P0108	Atmospheric pressure sensor	voltage too high	OFF	ON3
322	P0107	Atmospheric pressure sensor	voltage too low	OFF	ON3
351	P0650	Emission warning lamp (MIL)	short to b+	OFF	ON3
352	P0650	Emission warning lamp (MIL)	short to earth	OFF	ON3
353	P0650	Emission warning lamp (MIL)	no signal	OFF	ON3
354	P0650	Emission warning lamp (MIL)	temperature too high	OFF	ON3
355		Plausibility, brake/accel. pedals	signal improbable	ON3	OFF
356		Main relay	faulty	OFF	OFF
357		Main relay	faulty	OFF	OFF
358		Engine control unit	faulty	ON3	OFF
366		Thrust monitoring	faulty or time exceeded	OFF	OFF
370		Thrust monitoring	not plausible	OFF	OFF
425		Engine control unit	internal fault	ON3	OFF
426		Engine control unit	internal fault	ON3	OFF
427		Engine control unit	internal fault	ON3	OFF
428		Sensor voltage supply 1	voltage too high	ON3	OFF
429		Sensor voltage supply 1	voltage too low	ON3	OFF
430		Sensor voltage supply 2	voltage too high	ON3	OFF
431		Sensor voltage supply 2	voltage too low	ON3	OFF
446		Error lamp	short to b+	ON3	OFF
447		Error lamp	short to earth	ON3	OFF
448		Error lamp	signal error	ON3	OFF
449		Error lamp	temperature too high	ON3	OFF
452		Output, terminal 15	faulty	OFF	OFF
454		Engine control unit	internal fault	ON3	OFF
471	P0500	Driving speed sensor	driving speed too fast	OFF	ON3
473	P0500	Driving speed sensor	signal faulty or wrong signal	OFF	ON3
480		Injection pumps - control unit	unknown error type	ON3	OFF
542		Battery voltage	voltage too high	OFF	OFF
543		Battery voltage	voltage too low	OFF	OFF
568		Glow control	short to b+	ON3	OFF

Fault code		Description in KTS	Fault description	Lamp	
KTS	OBD			Check Engine	OBD
569		Glow control	short to earth	ON3	OFF
580	P2148	Capacitor voltage, bank 1	malfunction	OFF	ON3
591	P0216	Injector output stage	faulty	OFF	ON3
592	P0216	Injector output stage	faulty	OFF	ON3
593	P0216	Injector output stage	faulty	OFF	ON3
594	P0216	Injector output stage	faulty	OFF	ON3
595	P0216	Injector output stage	faulty	OFF	ON3
596	P0216	Injector output stage	faulty	OFF	ON3
597	P0216	Injector output stage	faulty	OFF	ON3
598	P0216	Injector output stage	faulty	OFF	ON3
601	P0261	Injector cylinder 1	not plausible	OFF	ON3
604	P0201	Injector cylinder 1	signal faulty or wrong signal	OFF	ON3
610	P0266	Injector cylinder 2	not plausible	OFF	ON3
613	P0202	Injector cylinder 2	signal faulty or wrong signal	OFF	ON3
617	P0267	Injector cylinder 3	not plausible	OFF	ON3
620	P0203	Injector cylinder 3	signal faulty or wrong signal	OFF	ON3
624	P0270	Injector cylinder 4	not plausible	OFF	ON3
627	P0204	Injector cylinder 4	signal faulty or wrong signal	OFF	ON3
668		Accelerator pedal position sensor 1	sensor 1/2 signal compare improbable	ON3	OFF
671	P0193	Rail pressure sensor	voltage too high	OFF	ON3
672	P0192	Rail pressure sensor	voltage too low	OFF	ON3
688	P0500	Driving speed sensor	signal improbable	OFF	ON3
691	P0402	Exhaust-gas recirculation system	control deviation positive	OFF	ON3
692	P0401	Exhaust-gas recirculation system	control deviation negative	OFF	ON3
699		Brake light switch (BLS)	not plausible	OFF	OFF
1017	P0001	Fuel trim unit/ Metering unit	not plausible	OFF	ON3
1020	P0002	Fuel trim unit/ Metering unit	temperature too high	OFF	ON3
1021	P0004	Fuel trim unit/ Metering unit	short to b+	OFF	ON3
1022	P0003	Fuel trim unit/ Metering unit	short to earth	OFF	ON3
1025	P0103	Air- mass sensor	maximum exceeded	OFF	ON3
1026	P0102	Air- mass sensor	less than minimum	OFF	ON3
1061	P0080	Exhaust-gas re-circulation	short to b+	OFF	ON3
1062	P0079	Exhaust-gas re-circulation	short to earth	OFF	ON3
1063	P0027	Exhaust-gas re-circulation	temperature too high	OFF	ON3
1064	P0078	Exhaust-gas re-circulation	open circuit	OFF	ON3

Fault code		Description in KTS	Fault description	Lamp	
KTS	OBD			Check Engine	OBD
1119	P0191	Rail pressure sensor	maximum exceeded	OFF	ON3
1120	P0191	Rail pressure sensor	less than minimum	OFF	ON3
1121	P0093	Fuel delivery control	malfunction	OFF	ON3
1122	P0093	Fuel delivery control	maximum exceeded	OFF	ON3
1123	P0088	Fuel delivery control	control deviation negative	OFF	ON3
1124	P0087	Fuel delivery control	less than minimum	OFF	ON3
1125	P0088	Fuel delivery control	maximum exceeded	OFF	ON3
1151	P0113	Intake air temperature sensor 1 (in hot-film air-mass sensor 1)	voltage too high	OFF	ON3
1152	P0112	Intake air temperature sensor 1 (in hot-film air-mass sensor 1)	voltage too low	OFF	ON3
1157	P0101	Air- mass sensor	malfunction	OFF	ON3
1158	P0101	Air- mass sensor	reference voltage too high	OFF	ON3
1159	P0101	Air- mass sensor	reference voltage too low	OFF	ON3
1160	P0101	Air- mass sensor	signal improbable	OFF	ON3
1286	P2142	Throttle valve	short to b+	OFF	ON3
1287	P2141	Throttle valve	short to earth	OFF	ON3
1288	P0488	Throttle valve	not plausible	OFF	ON3
1289	P0487	Throttle valve	signal error	OFF	ON3
2949	P0488	Throttle valve control	deviation	OFF	ON3
2950	P0487	Throttle valve control	above upper limit	OFF	ON3