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Workshop Manual

Audi A8 2003 ➢

Motronic injection and ignition system (8-cyl.)									
Engine ID	BFL	BFM	BGK						

Edition 05.2005

List of Workshop Manual Repair GroupsList of Workshop Manual Repair GroupsList of Workshop Manual Repair Groups

Repair Group

24 - Mixture preparation - injection

28 - Ignition system

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Technical information should always be available to the foremen and mechanics, because their careful and constant adherence to the instructions is essential to ensure vehicle road-worthiness and safety. In addition, the normal basic safety precautions for working on motor vehicles must, as a matter of course, be observed.

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Contents

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24 – Mixture preparation - injection

1 Servicing Motronic injection system

1.1 Safety precautions

Note the following if testers and measuring instruments have to be used during a road test:

> **WARNING**
>
> - *Test equipment must always be secured on the rear seat and operated from that position by a second person.*
> - *If test and measuring instruments are operated from front passenger's seat and the vehicle is involved in an accident, the person sitting in this seat could be seriously injured when the airbag is triggered.*

To avoid any risk of injuries to persons and/or damage to the fuel injection and ignition system, always observe the following safety precautions.

- Always switch off the ignition before connecting or disconnecting injection or ignition system wiring or tester cables.
- To operate the engine at starting speed without actually starting it (for example, in order to test compression), unplug the connectors from the output stages for the ignition coils and also the connectors on the injectors.
- Certain tests may lead to a fault being detected by the control unit and stored. The fault memory should therefore be interrogated and (if necessary) erased after completing the tests and any repair work that may be required.
- Always switch off the ignition before cleaning the engine.
- Always switch off the ignition before connecting or disconnecting the battery, otherwise the engine control unit may be damaged.

> **WARNING**
>
> *The fuel system is pressurised. Before loosening hose connections or opening the test connection (to measure fuel pressure), place a cloth around the connection. Then release pressure by carefully unscrewing the connection.*

1.2 Rules for cleanliness

When working on the fuel supply/injection system, pay careful attention to the following "6 rules":

- Thoroughly clean all unions and surrounding areas before disconnecting.
- Place parts that have been removed on a clean surface and cover them over. Use only lint-free cloths.
- Carefully cover or seal open components if repairs cannot be carried out immediately.

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- Only install clean components; replacement parts should only be unpacked immediately prior to installation. Do not use parts that have been stored loose (e.g. in tool boxes etc.).
- When the system is open: Do not work with compressed air if this can be avoided. Do not move vehicle unless absolutely necessary.
- Unplugged electrical connectors; keep them clean and dry. Make sure connections are dry when attaching.

1.3 Technical data

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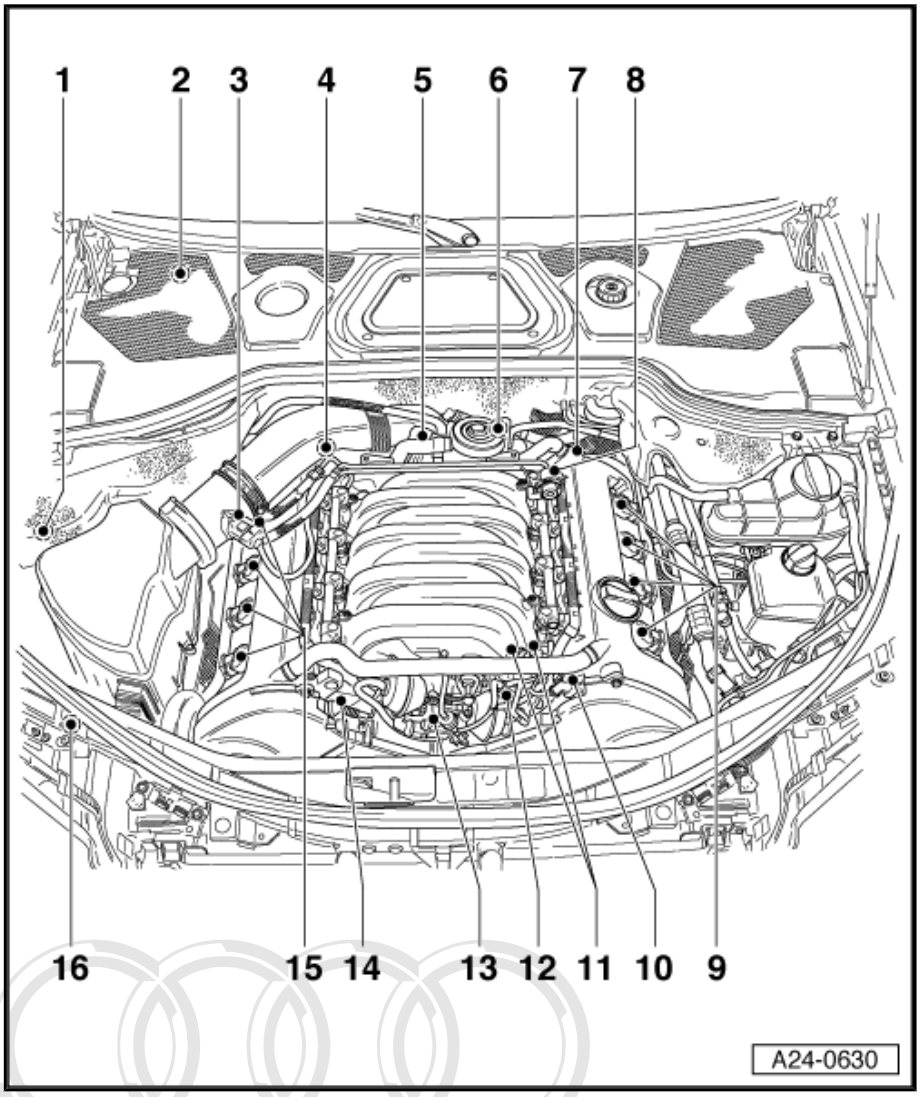
Engine code letters		BFL 3.7 ltr. 206 kW (280 bhp) BFM 4.2 ltr. 246 kW (335 bhp) BGK 4.2 ltr. 246 kW (335 bhp)
Idling speed is not adjustable; controlled by the idling speed stabilisation		640 ... 720 rpm
Speed governing by closing throttle valve		6600 rpm
Fuel pressure at idling speed	Vacuum hose connected (only applies to BFL, BFM)	approx. 2.5 bar
	Vacuum hose disconnected (only applies to BFL, BFM)	approx. 4.0 bar
Residual pressure after 10 minutes		at least 2.5 bar
Injectors	Spray pattern	Multi-hole nozzle (same on all injectors)
	Injection quantity (30 sec.)	BFL: 95...115 ml BFM, BGK: 105...125 ml
	Resistance (room temperature around 20 °C)	13 ... 16 Ω (Ohm)

1.4 Overview of fitting locations

Components A to N are not shown in the exploded view.



1 - Activated charcoal filter solenoid valve 1 -N80-

- ❑ ⇒ page 6

2 - Engine control unit -J623-

- ❑ ⇒ page 7
- ❑ Removing and installing ⇒ page 27

3 - Air mass meter -G70- with intake air temperature sender -G42-

4 - Inlet camshaft control valve 1 -N205-

- ❑ Removing and installing ⇒ Rep. Gr. 15

5 - Throttle valve module -J338-

- ❑ Including throttle valve drive (electric throttle operation) -G186- , angle sender 1 for throttle valve drive (electric throttle operation) -G187- and angle sender 2 for throttle valve drive (electric throttle operation) -G188-

6 - Secondary air inlet valve -N112-

- ❑ ⇒ page 8
- ❑ Checking ⇒ Rep. Gr. 26

7 - Hall sender 2 -G163-

- ❑ Cylinder bank 2

8 - Fuel pressure regulator

- ❑ Not fitted on engines with code letters BGK

9 - Ignition coils with output stages

- ❑ Cylinder bank 2
- ❑ Removing and installing ⇒ page 38

10 - Inlet camshaft control valve 2 -N208-

- ❑ Removing and installing ⇒ Rep. Gr. 15

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11 - 3-pin connector

- ❑ For knock sensor 1 -G61-
- ❑ For knock sensor 2 -G66-
- ❑ ⇒ page 7

12 - Intake manifold change-over valve -N156-

- ❑ Engine code letters BFL 3.7 ltr., ⇒ page 7
- ❑ Engine code letters BFM and BGK 4.2 ltr., ⇒ page 8

13 - Variable intake manifold change-over valve -N261-

- ❑ Engine code letters BFL 3.7 ltr., ⇒ page 7
- ❑ Engine code letters BFM and BGK 4.2 ltr., variable intake manifold change-over valve -N335- , ⇒ page 8

14 - Hall sender -G40-

- ❑ Cylinder bank 1

15 - Ignition coils with output stages

- ❑ Cylinder bank 1
- ❑ Removing and installing ⇒ page 38

16 - Secondary air pump motor -V101-

- ❑ Beneath right-side longitudinal member
- ❑ ⇒ page 8
- ❑ Checking ⇒ Rep. Gr. 26

A - "MIL" exhaust emissions warning lamp

- ❑ In dash panel insert (Notes on warning lamp ⇒ page 6)

B - "EPC" warning lamp

- ❑ In dash panel insert (Notes on warning lamp ⇒ page 6)

C - Accelerator pedal position sender -G79- and accelerator pedal position sender 2 -G185-

- ❑ In footwell on accelerator pedal (both senders are accommodated in one housing)

D - Fuel pump relay -J17-

- ❑ 5-position relay carrier in passenger's footwell, relay position 4
- ❑ ⇒ page 5

E - Electric fuel pump 2 relay -J49-

- ❑ Relay and fuse holder in luggage compartment (right-side), relay position 3
- ❑ ⇒ page 5

F - Secondary air pump relay -J299-

- ❑ 3-position relay carrier in electronics box in plenum chamber, relay position 3
- ❑ ⇒ page 5

G - Motronic current supply relay -J271-

- ❑ 4-position relay carrier in electronics box (plenum chamber)
- ❑ ⇒ page 5

H - Starter motor relay -J53-

- ❑ ⇒ page 5

I - Starter motor relay 2 -J695-

- ❑ ⇒ page 5

J - 3-pin electrical connector for engine speed sender -G28-

- ❑ ⇒ page 7

K - 4-pin electrical connector for Lambda probe -G39- and Lambda probe heater -Z19- before catalytic converter

- ❑ Bank 1
- ❑ Connector ⇒ page 6
- ❑ Removing and installing Lambda probe -G39- ⇒ page 30

L - 4-pin electrical connector for Lambda probe 2 -G108- and Lambda probe heater 2 -Z28- before catalytic converter

- ❑ Bank 2
- ❑ Connector ⇒ page 6
- ❑ Removing and installing Lambda probe 2 -G108- ⇒ page 30

M - 4-pin electrical connector for Lambda probe after catalytic converter -G130- and Lambda probe 1 heater, after catalytic converter -Z29-

- ❑ Bank 1
- ❑ Connector ⇒ page 7
- ❑ Removing and installing Lambda probe after catalytic converter -G130- ⇒ page 34

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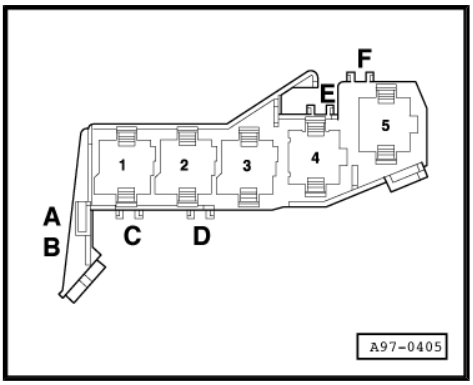
N - 4-pin electrical connector for Lambda probe 2, after catalytic converter -G131- and Lambda probe 2 heater, after catalytic converter -Z30-

- Bank 2
- ⇒ page 7
- Removing and installing Lambda probe 2 after catalytic converter -G131- ⇒ page 35

5-position relay carrier in passenger's footwell



2 - Starter motor relay -J53-

3 - Starter motor relay 2 -J695-

4 - Fuel pump relay -J17-

Refer to ⇒ Current flow diagrams, Electrical fault finding and Fitting locations

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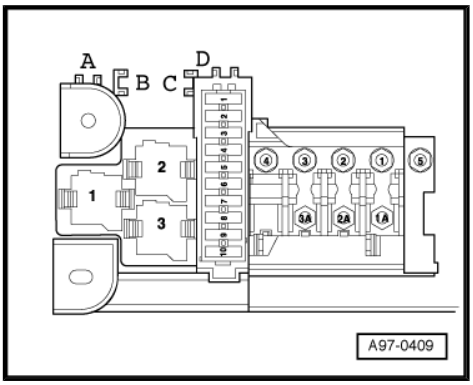
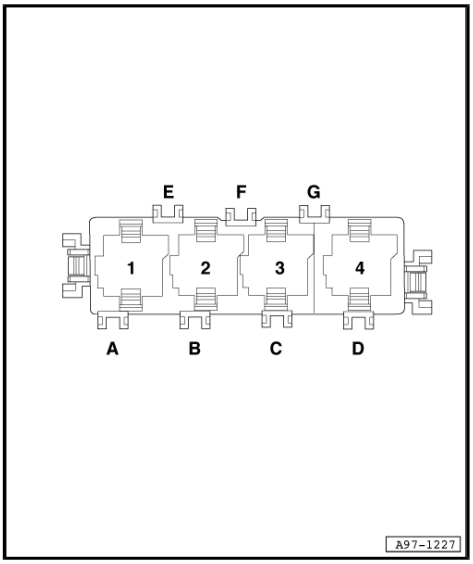
Relay and fuse holder in luggage compartment (right-side)



3 - Electric fuel pump 2 relay -J49-

Refer to ⇒ Current flow diagrams, Electrical fault finding and Fitting locations

4-position relay carrier in electronics box in plenum chamber



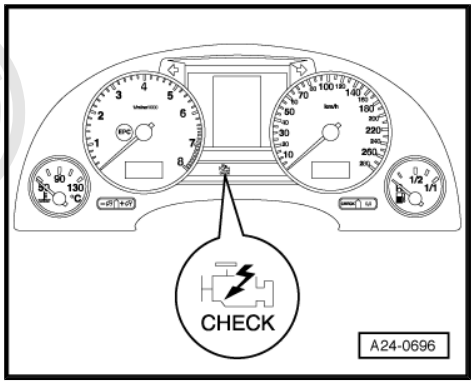
1 - Relay for secondary air pump -J299- , relay position 1

2 - From model year 2004 onwards: Motronic current supply relay -J271-

3 - Model year 2003: Motronic current supply relay -J271-

Refer to ⇒ Current flow diagrams, Electrical fault finding and Fitting locations

MIL exhaust emissions warning lamp



Note

The exhaust emissions warning lamp will either flash or light up constantly. Fault memory has to be interrogated in any case.

Emissions warning lamp is flashing:

- A fault has occurred which, under the current driving conditions, will cause damage to the catalytic converter. In this case the vehicle may only be driven with reduced power (until MIL goes out or lights up constantly). The fault must be rectified as soon as possible.

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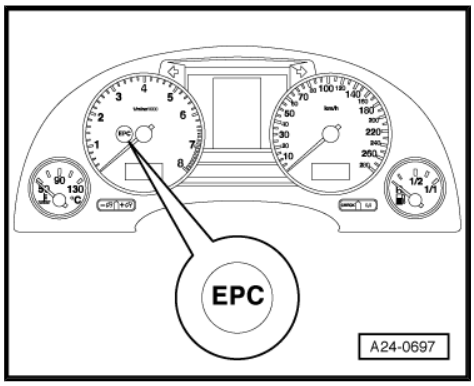
Emissions warning lamp lights up constantly:

- A fault detrimental to emissions has occurred. Interrogate fault memory for engine control unit / automatic gearbox.
- Fault memory must be interrogated and emissions warning lamp must be checked in the event of engine running problems or a customer complaint, even if exhaust emissions warning lamp does not light up. There could be faults stored in the memory which do not activate the emissions warning lamp immediately.

EPC warning lamp



"EPC" stands for Electronic Power Control and refers to the electronic throttle control system.

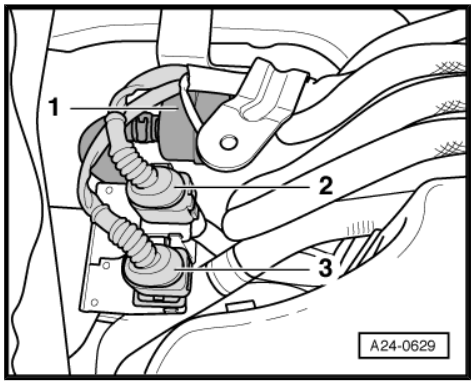
The engine control unit switches the EPC warning lamp on when the ignition is switched on.

After the engine has been started, the engine control unit checks all components for faults relevant to the electronic throttle control system.

During the test sequence the EPC warning lamp lights up for about 3 seconds. If a fault is detected during this check the warning lamp will remain lit.

If a fault is detected in the electronic power control system while the engine is running, the engine control unit switches on the EPC lamp. At the same time an entry is stored in the fault memory of the engine control unit.

Connector assignment



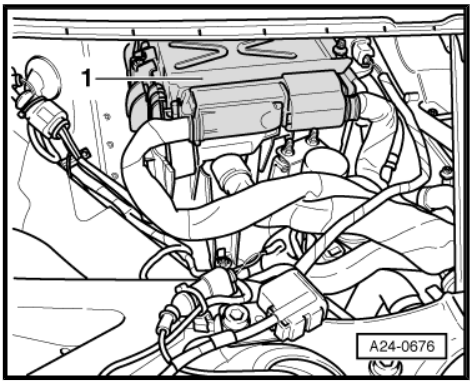
1 - Activated charcoal filter solenoid valve 1 -N80-

2 - 4-pin electrical connector for Lambda probe 2 -G108- and Lambda probe heater 2 -Z28- before catalytic converter (bank 2)

3 - 4-pin electrical connector for Lambda probe -G39- and Lambda probe heater -Z19- before catalytic converter (bank 1)

Electronics box in plenum chamber

1 - Engine control unit -J623-

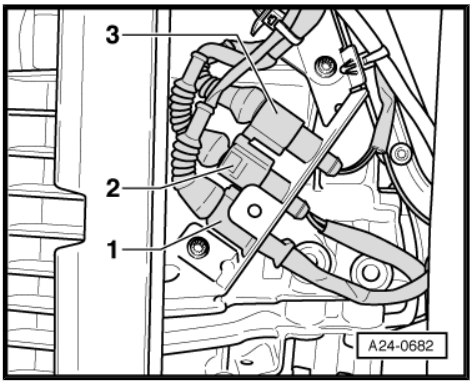


Connector console (secured to underside of gearbox)

1 - 3-position electrical connector for engine speed sender -G28-

2 - 4-pin electrical connector for Lambda probe after catalytic converter -G130- and Lambda probe 1 heater after catalytic converter -Z29- (after catalytic converter, bank 1)

3 - 4-pin electrical connector for Lambda probe 2 after catalytic converter -G131- and Lambda probe 2 heater after catalytic converter -Z30- (after catalytic converter, bank 2)



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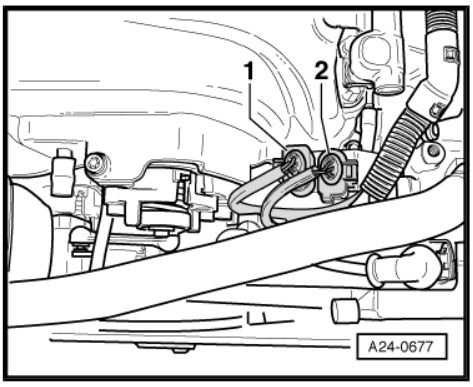
Connectors for knock sensors

1 - 3-pin connector for knock sensor 1 -G61- , cylinder bank 1

2 - 3-pin connector for knock sensor 2 -G66- , cylinder bank 2

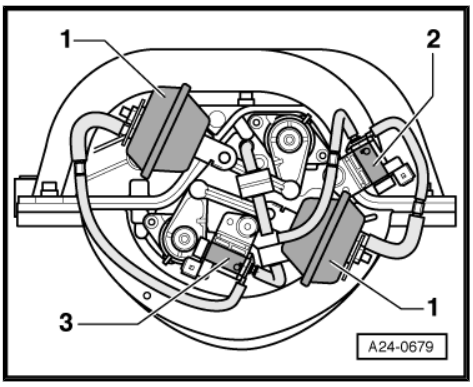


View from front (engine code letters BFL 3.7 ltr.)

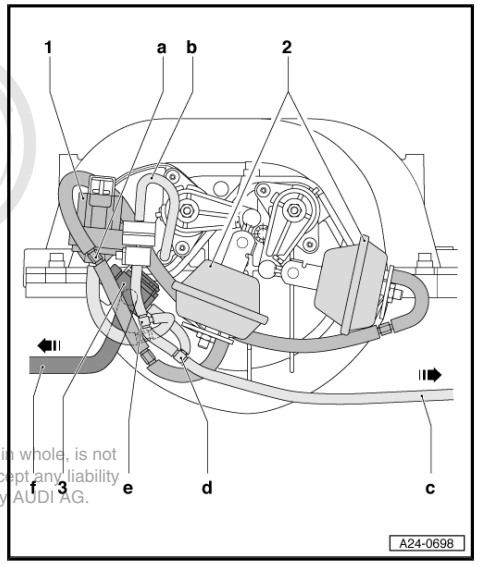
1 - Vacuum units for intake manifold change-over

2 - Intake manifold change-over valve -N156-

3 - Intake manifold change-over valve 2 -N261-



View from front (engine code letters BFM and BGK 4.2 ltr.)



1 - Intake manifold change-over valve -N156-

Actuation for both vacuum units

2 - Vacuum units for intake manifold change-over

3 - Variable intake manifold change-over valve -N335-

Actuation for flap in air cleaner

a - T-connection for vacuum supply from intake manifold change-over valve -N156-

b - Vacuum supply from intake manifold

c - Vacuum line to vacuum reservoir

d - T-connection for vacuum supply from variable intake manifold change-over valve -N335- and the vacuum reservoir

e - T-connection for vacuum supply from intake manifold change-over valve -N156-

f - Vacuum line to flap in air cleaner

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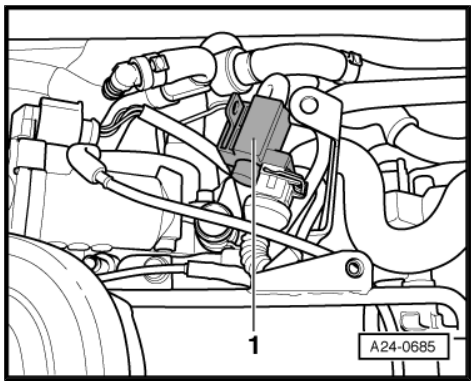
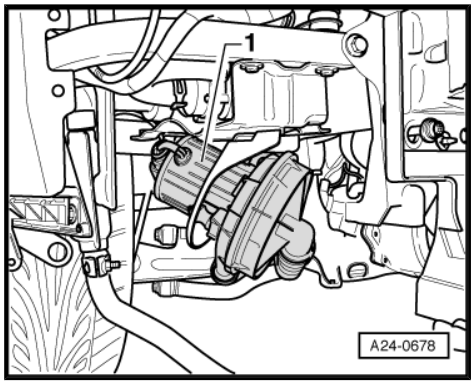
Secondary air inlet valve -N112-



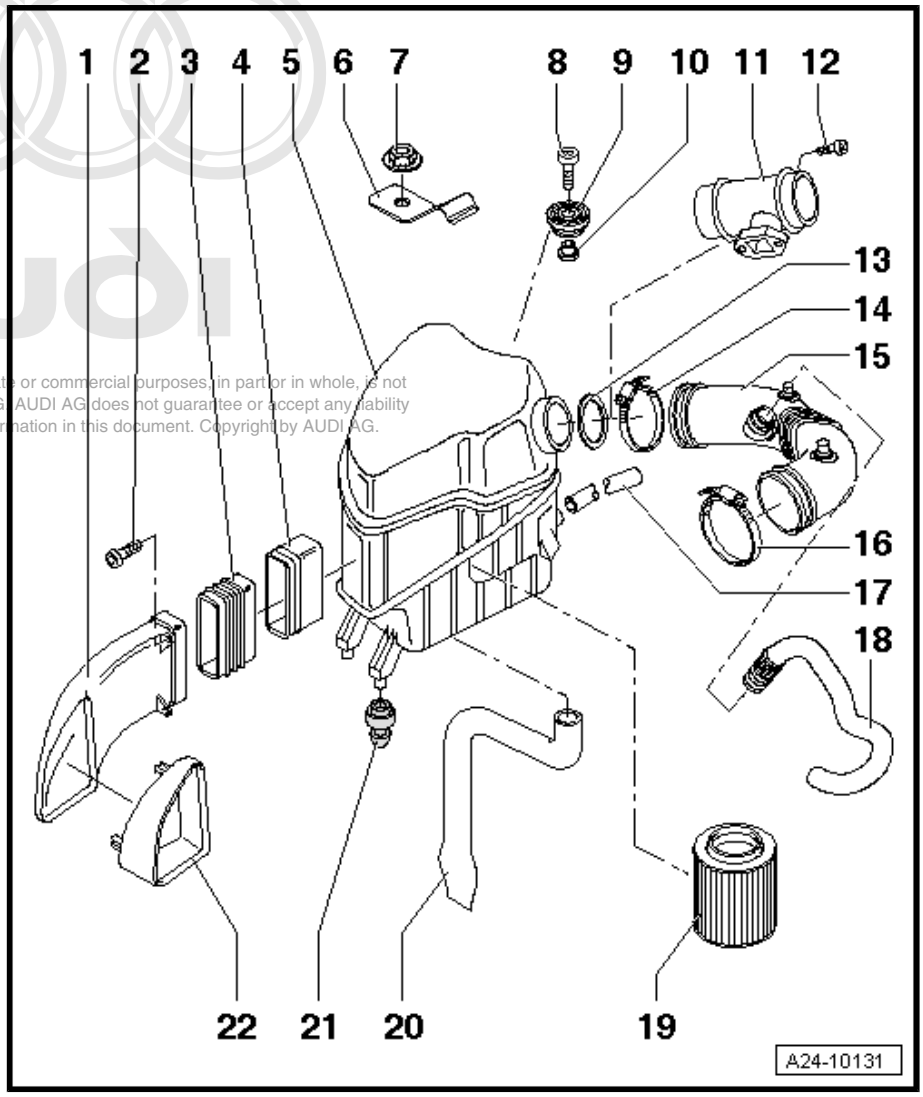
1 - Secondary air inlet valve -N112-

Secondary air pump (beneath right-side longitudinal member)



1 - Secondary air pump motor -V101-

1.5 Air cleaner - exploded view of components



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1 - Air duct

- ❑ Clean dirt and leaves out of air duct

2 - 1.5 Nm

3 - Connecting piece for air duct

- ❑ Clean dirt and leaves out of air duct

4 - Air duct

5 - Air cleaner housing

- ❑ Clean any salt residue, leaves and dirt out of air cleaner housing

6 - Retaining clip

7 - Hexagon flange nut

8 - Bolt

9 - Grommet

10 - Bush

11 - Air mass meter -G70-

- ❑ Removing and installing ⇒ page 12

12 - Bolt

13 - O-ring

- ❑ Renew if damaged

14 - Hose clip

15 - Air intake hose leading to throttle valve module -J338-

- ❑ Clean dirt and leaves out of air duct

16 - Hose clip

17 - Vacuum hose

18 - Vacuum hose

19 - Air filter element

- ❑ Always use genuine part for air filter element
- ❑ Removing and installing ⇒ page 10
- ❑ Observe service intervals ⇒ Maintenance ; Booklet 404
- ❑ Also clean snow screen (if fitted)

20 - Water drain hose

- ❑ Clean any leaves and dirt out of water drain hose
- ❑ Water drain must function properly

21 - Grommet

22 - Air duct

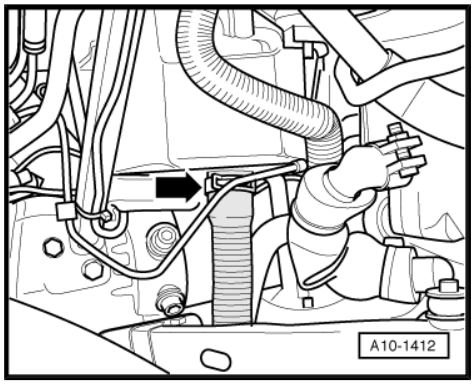
- ❑ To lock carrier
- ❑ Clean dirt and leaves out of air duct

1.6 Removing and installing air filter element

Removing

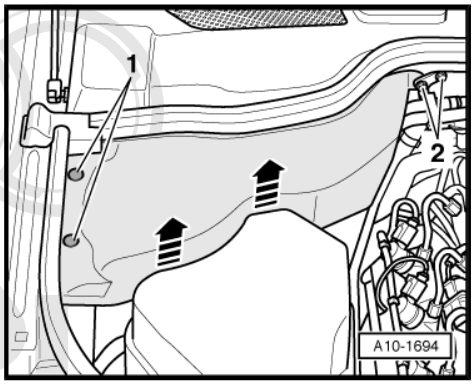
– Detach hose -arrow- to secondary air pump at bottom of air cleaner housing.

– Remove cover for suspension turret (right-side); to do so, detach spreader clips -1- and unscrew nut -2-.

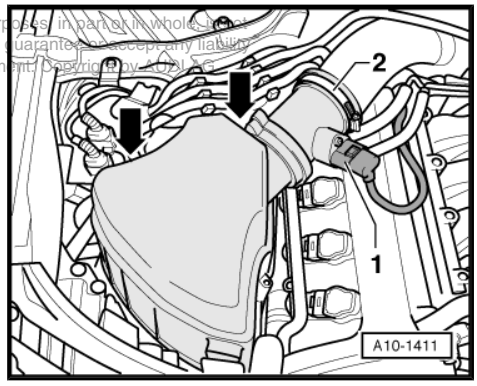


– Pull cover out of retainers -arrows-.

– Detach air intake hose -2- at air cleaner housing.

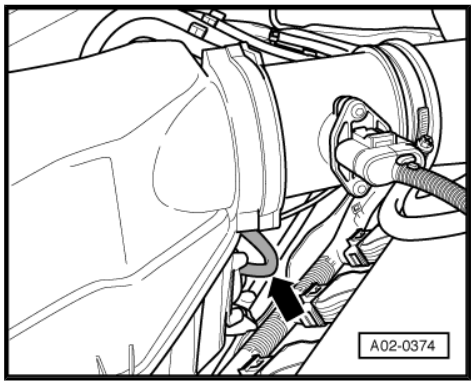


– Unplug electrical connector -1- at air mass meter -G70-.



Note

On vehicles with 4.2 ltr. engine, the vacuum hose for power flap -arrow- must be disconnected.



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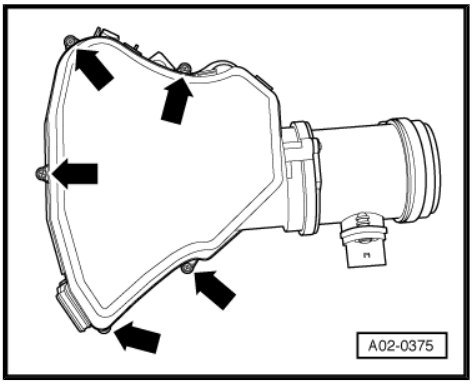
– Unscrew bolts -arrows- from air cleaner housing and detach top section of air cleaner housing.
– Pull out air filter element.
– Cover the open air cleaner housing with a clean cloth.



Note

Make sure no dirt gets into the air cleaner housing.

Installing

To ensure the proper function of the air mass meter -G70- it is important to observe the following notes and instructions.

Note

- *If the air cleaner element is very dirty or wet, dirt or water could reach the air mass meter -G70- and affect the air mass value. This would lead to loss of power, since a smaller injection quantity is calculated.*
- *Always use genuine part for air filter element.*
- *Use a silicone-free lubricant when installing the intake hose.*
- *Secure all hose connections with the correct type of hose clips (same as original equipment): ⇒ Parts catalogue*

– It is essential to clean any dirt and leaves out of water drain hose in air cleaner (bottom section).
– Clean salt residue, dirt and leaves out of air cleaner housing (top and bottom sections); vacuum out if necessary.
– Check for salt residue, dirt and leaves in air mass meter and air intake hose (engine intake side).
– Check for dirt in air duct leading to air filter element.
– When installing the air filter element, check that it is properly centred in the retainer in the air cleaner (bottom section).
– Fit the top section of the air cleaner carefully on the bottom section, without using force. Make sure the top section of the air cleaner is fitted straight on the air filter element. Note position of sealing lip on air filter element (to prevent air leaks).
– Then screw top section of air cleaner back onto bottom section.
– Ensure secure fit of intake hose at air mass meter -G70- .
– The remaining installation steps are carried out in the reverse sequence.

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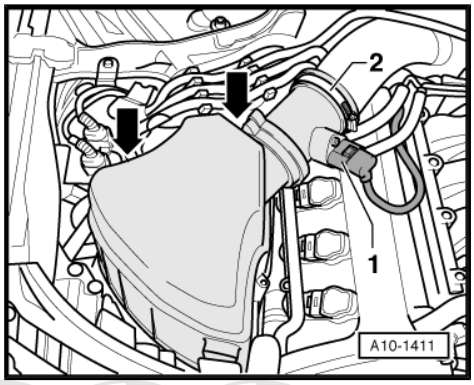
1.7 Removing and installing air mass meter -G70-

Removing



– Unplug electrical connector at air mass meter -G70- -1-.
– Unscrew both bolts from air mass meter -G70- .
– Open hose clip and carefully pull air mass meter -G70- out of guide on air cleaner housing.

Installing

To ensure the proper function of the air mass meter -G70- it is important to observe the following notes and instructions.

Note

- *If the air cleaner element is very dirty or wet, dirt or water could reach the air mass meter -G70- and affect the air mass value. This would lead to loss of power, since a smaller injection quantity is calculated.*
- *Always use genuine part for air filter element.*
- *Use a silicone-free lubricant when installing the intake hose.*
- *Secure all hose connections with the correct type of hose clips (same as original equipment): ⇒ Parts catalogue*

– Check for salt residue, dirt and leaves in air mass meter and air intake hose (engine intake side).
– Check for dirt in air duct leading to air filter element. If necessary, clean salt residue, dirt and leaves out of air cleaner housing (top and bottom sections); wash out or use a vacuum cleaner as required. Removing and installing air cleaner ⇒ page 10
– If air filter element has been removed, clean water drain hose in air cleaner housing (bottom section).
– Align seal in slot on air cleaner housing and carefully push air mass meter -G70- into air cleaner housing.

The remaining installation steps are carried out in the reverse sequence.

1.8 Checking fuel pressure regulator and residual pressure (engine code letters BFM, BFL)

Special tools and workshop equipment required

- K-Jetronic pressure tester -V.A.G 1318-

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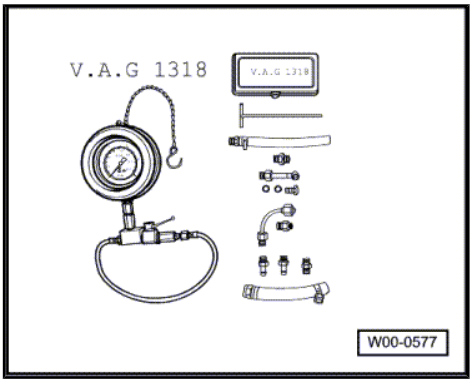
♦ Adapter set -V.A.G 1318/6+7- and -V.A.G 1318/7-



Test conditions

- Fuel pump relay OK
- Fuel pump OK
- Fuel filter OK
- Battery voltage at least 11 V
- Parking brake actuated.
- Vehicles with automatic gearbox: selector lever in position P or N
- Electrical equipment switched off (radiator fan must not run during the test).
- Air conditioner switched off.
- Ignition off.

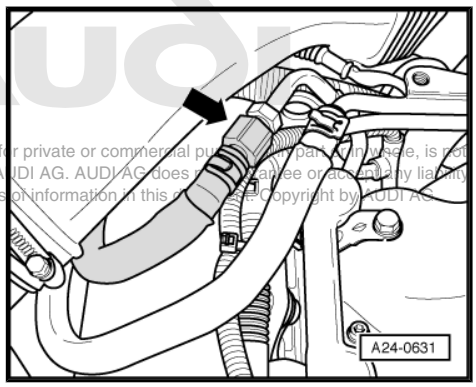
Note

Fuel pressure is controlled by the fuel pressure regulator according to the intake manifold pressure.

WARNING

The fuel system is pressurised. Before loosening hose connections or opening the test connection (to measure fuel pressure), place a cloth around the connection. Then release pressure by carefully unscrewing the connection.

– Briefly open the fuel tank filler cap (to release pressure).
– Cover pressurised union with a cloth.
– Open union on fuel supply line -arrow- and catch escaping fuel with a cloth.



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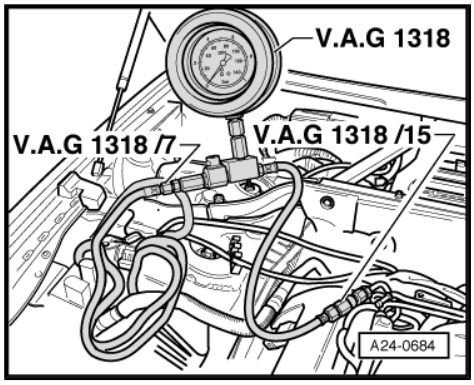
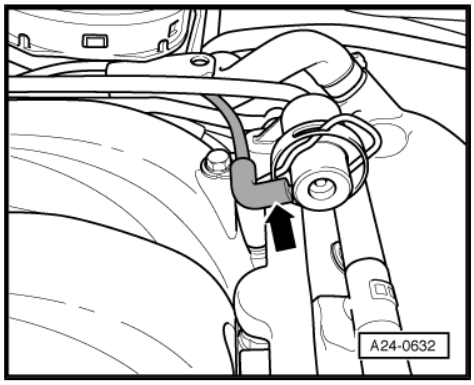
– Connect K-Jetronic tester -V.A.G 1318- with adapters -V.A.G 1318/15- and -V.A.G 1318/7- between supply pipe and fuel rail.
– Open cut-off valve on pressure gauge. Lever must point in direction of flow.
– Start the engine and run at idling speed.
– Measure the fuel pressure.

Specification: approx. 3.5 bar



– Pull vacuum hose -arrow- off fuel pressure regulator.



Note

If fuel flows out at the vacuum connection on the fuel pressure regulator during the following pressure test, fit a new fuel pressure regulator.

Fuel pressure must increase to approx. 4.0 bar.

If the specification is not attained:

– Fit a new pressure regulator as a trial measure and repeat the pressure test.
– If fuel pressure still does not match specification, check fuel pump and supply pipe for damage (e.g. pinching) and renew if necessary.

If the specification is obtained:

– Reconnect vacuum hose.
– Switch off ignition.
– Observe pressure drop on pressure gauge to check leakage and residual pressure.

After 10 minutes pressure should still be at least 2.5 bar.

If the residual pressure drops below 2.5 bar:

– Start engine and let it idle for 4 minutes.

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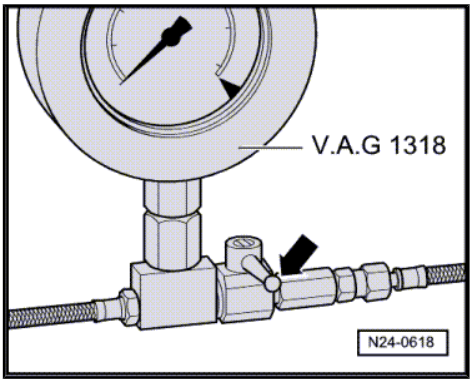
– Allow pressure to build up, then switch off ignition. Simultaneously close the cut-off valve of the K-Jetronic pressure tester -V.A.G 1318- (lever perpendicular to direction of flow).

– Observe pressure drop on pressure gauge.



If the pressure drops again, this may be due to the following:

- Unions on pressure gauge downstream of cut-off valve are leaking
- Fuel pressure regulator defective
- Injectors leaking

If the pressure does not drop, this may be due to the following:

- Union between pressure gauge and fuel supply pipe leaking
- Leak in supply pipe at fuel tank

– Non-return valve in fuel pump leaking. Check fuel pump ⇒ Fuel supply system, petrol engines; Repair group 20 .

– Check for leaks after completing work on fuel system ⇒ page 18 .

1.9 Checking fuel pressure regulator and residual pressure (engine code letters BGK)

A fuel system without fuel return line is installed in USA vehicles (engine code letters BGK).

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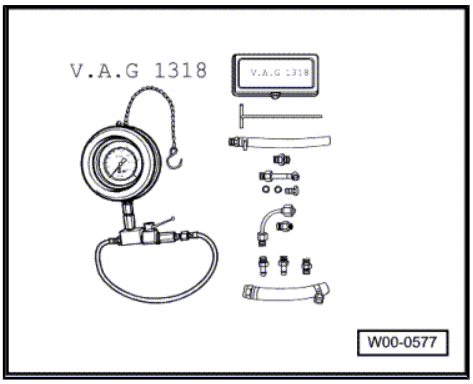
Special tools and workshop equipment required

- Hose clamps for hoses up to 25 mm Ø -3094-
- K-Jetronic pressure tester -V.A.G 1318-
- Adapter -V.A.G 1318/26-



Test conditions

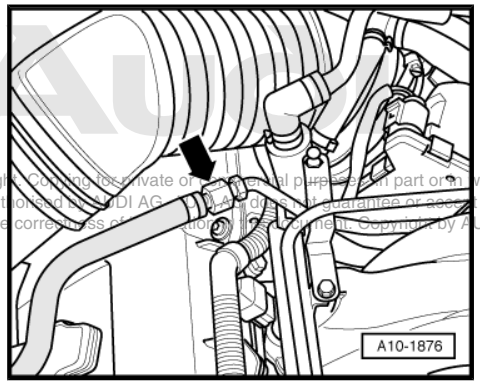
- Fuel pump relay OK
- Fuel pump OK
- Fuel filter OK
- Battery voltage at least 11 V
- Parking brake actuated.
- Vehicles with automatic gearbox: selector lever in position “P” or “N”
- Electrical equipment switched off (radiator fan must not run during the test).
- Air conditioner switched off.

- Ignition off.

WARNING

The fuel system is pressurised. Before loosening hose connections or opening the test connection (to measure fuel pressure), place a cloth around the connection. Then release pressure by carefully unscrewing the connection.

– Briefly open the fuel tank filler cap (to release pressure).
– Remove engine cover.
– Cover pressurised union (fuel supply) with a cloth.
– Open union -arrow- on fuel supply line and catch escaping fuel with a cloth.
– Connect K-Jetronic pressure tester -V.A.G 1318- with suitable adapters between fuel supply line and fuel rail.



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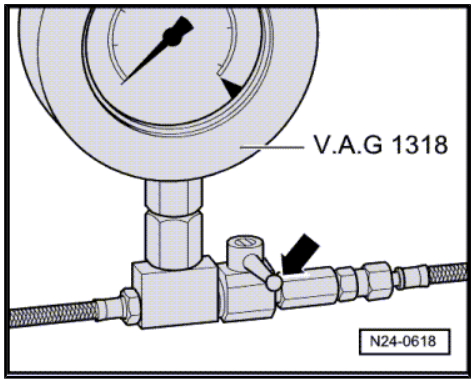
Note

Cut-off valve on K-Jetronic pressure tester -V.A.G 1318- must be installed on the side leading to fuel rail.

– Open cut-off valve on pressure gauge. Lever must point in direction of flow.
– Start the engine and run at idling speed.
– Measure the fuel pressure.
♦ Specification: approx. 4.0 bar
– Switch off ignition.
– Check leak-tightness and residual pressure by watching the drop in pressure on the pressure gauge.
♦ After 10 minutes there should still be a pressure of at least 2.5 bar.

If the residual pressure drops below 2.5 bar:

– Start the engine and run at idling speed.
– Allow pressure to build up, then switch off ignition. At the same time, close cut-off valve of K-Jetronic pressure tester -V.A.G 1318- (so that lever is perpendicular to direction of flow -arrow-).
– Observe pressure drop on pressure gauge.



If the pressure does not drop, this may be due to the following:

♦ Check pressure gauge for leaks.
♦ Check pipe connections and injectors for leaks.

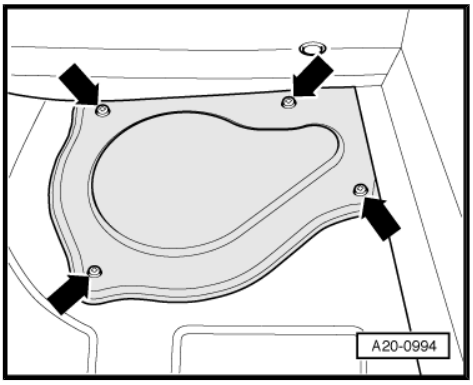
If pressure drops again, this may be due to the following:

♦ Check fuel pressure regulator ⇒ page 16

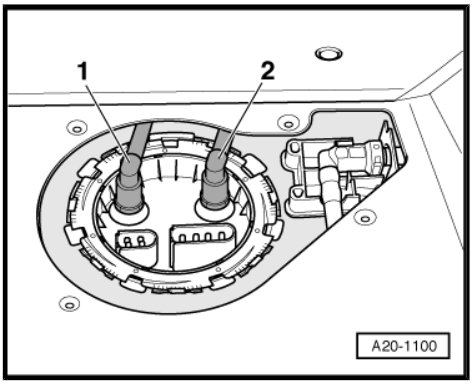
1.9.1 Checking fuel pressure regulator on fuel system without fuel return line

– Detach trim in luggage compartment.

– Unscrew cover for flange -arrows-.



– Disconnect fuel return pipe -1- (press release tab).



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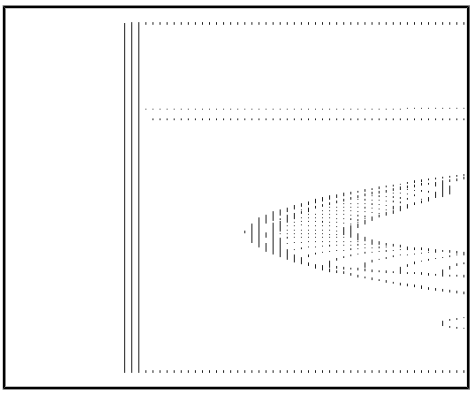
– Connect adapter -V.A.G 1318/26- -2- to fuel return pipe -1-.
– Clamp off adapter -V.A.G 1318/26- using hose clamp up to Ø 25 mm -3094- .



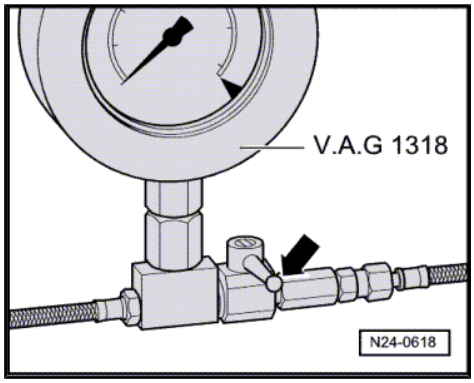
Note

Do not attach hose clamp up to Ø 25 mm -3094- directly to fuel line - Danger of damage.

– Start the engine and run at idling speed.

– Allow pressure to build up, then switch off ignition. At the same time, close cut-off valve of K-Jetronic pressure tester -V.A.G 1318- (so that lever is perpendicular to direction of flow -arrow-). If not yet connected, connect K-Jetronic pressure tester -V.A.G 1318- first ⇒ page 15 .

– Observe pressure drop on pressure gauge.



If pressure drops again, this may be due to the following:

♦ Non-return valve in fuel pump is leaking, renew fuel pump.

If pressure does not drop, this may be due to the following:

– Renew fuel filter with integrated fuel pressure regulator ⇒ Fuel supply system, petrol engines; Repair group 20 .

Assembly is carried out in the reverse order; note the following:

– Before removing pressure gauge, release fuel pressure by opening cut-off valve. Hold a container under the connection.

Note

When the engine is first started it can take up to 15 seconds before it fires.

– Check fuel system for leaks ⇒ page 18 .

1.9.2 Checking fuel system for leaks

– Start engine and let engine run at moderate speed for a few minutes.

Note

To begin with, the engine may not run smoothly due to air in fuel system.

– Stop engine and check fuel system for leaks.

– Interrogate fault memory and erase, if necessary.

– Then carry out a test drive with at least one full-power acceleration.

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Caution

Observe the safety precautions applicable when carrying out a test drive ⇒ page 1

– Once again check fuel system for leaks subsequent to test drive.

– Then again interrogate fault memory and erase, if necessary.

1.10 Checking injection quantity and spray pattern of injectors; checking for leaks

Test condition

• Fuel pressure OK

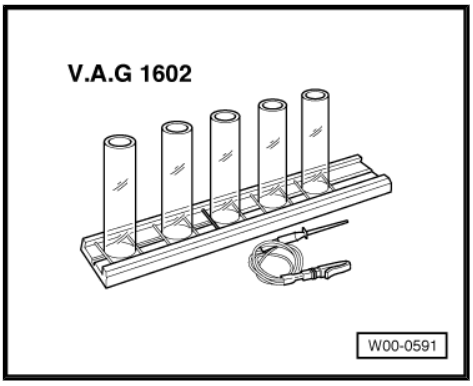
Removing fuel rail

– Remove engine compartment cover.

– Detach vacuum hose from fuel pressure regulator (does not apply to engine code letters BGK).
– Detach connectors from injectors and remove cable ties where necessary.
– Unscrew fuel rail from intake manifold and pull fuel rail upwards off manifold together with injectors.

Checking injectors for leaks

– Place the injector which is to be tested into measuring glass of injection quantity tester -V.A.G 1602- .
– Connect test box with adapter cable (121-pin) -V.A.G 1598/31- to wiring harness for engine control unit. Do not connect engine control unit ⇒ page 24 .
– Bridge contacts 1 and 65 on the test box using test leads from adapter set -V.A.G 1594C- . (This creates an earth connection to one side of the fuel pump relay coil.)
– Switch on ignition.



Note

Once the ignition has been switched on the fuel pump runs continuously, even if the engine is not running. This is because the fuel pump relay receives a positive voltage supply via the central electrics when the ignition is switched on. The earth connection for the fuel pump relay is set up via the test lead bridge connection in the test box.

– Check injectors for leaks (visual check). When the fuel pump is running, no more than 1 to 2 drops a minute should escape from any one of the injectors.
– If the fuel loss is greater, switch off the fuel pump (turn off ignition) and renew the faulty injector.

Checking injection quantity

Test condition

• Adapter cable, 121-pin -V.A.G 1598/31- connected to wiring harness for engine control unit.
– Place the injector which is to be tested into measuring glass of injection quantity tester -V.A.G 1602- .

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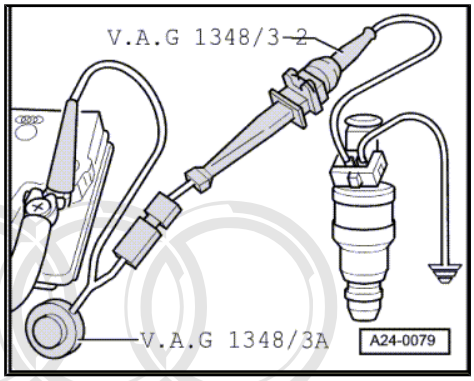
– Connect one of the injector contacts to engine earth using test lead and crocodile clamp from adapter set -V.A.G 1594C- .
– Connect second injector contact to positive using remote control -V.A.G 1348/3A- , adapter lead -V.A.G 1348/3-2- and auxiliary lead.
– Use leads from adapter set -V.A.G 1594C- to bridge contacts 1 and 65 at test box.
– Switch on ignition.
♦ The fuel pump should run.
– Operate remote control -V.A.G 1348/3A- for 30 seconds.
– Perform measurements on all injectors.



Note

When checking the injection quantity, also check the spray pattern. The spray pattern should be the same for all injectors.

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– Once all four injectors (bank 1 or bank 2) have been actuated, place measuring glasses on a level surface.

Specification for each injector:

BFL: 3.7 ltr.	BFM, BGK: 4.2 ltr.
95 ... 115 ml	105 ... 125 ml

If none of the injectors delivers the specified quantity:

– Check fuel pressure (engine code letters BFL and BFM) ⇒ page 12 .
– Check fuel pressure (engine code letters BGK) ⇒ page 15 .

If only one injector fails to deliver the specified quantity:

– Renew the defective injector.

Installation of the fuel rail together with injectors is performed in the reverse sequence. The following points should be noted when installing:

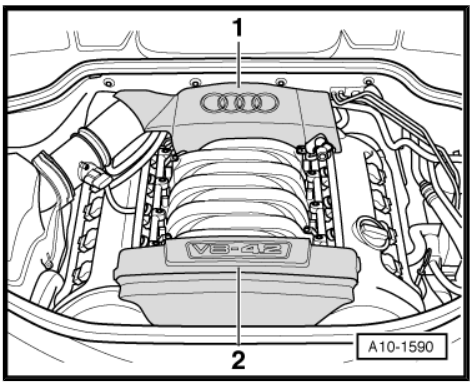
- Renew the O-rings at all opened connections. (When renewing the front O-ring, ensure that the plastic cap is never removed from the injector head. The O-ring must be pulled off over the plastic cap).
- Lubricate the O-rings with clean engine oil.
- Make sure retaining clips are properly connected.
- Bolt fuel rail to intake manifold (tightening torque: 10 Nm).

– Check fuel system for leaks ⇒ page 18 .

1.11 Removing and installing intake manifold

Removing

– Remove engine cover.



– Remove intake hose between air cleaner and throttle valve module.

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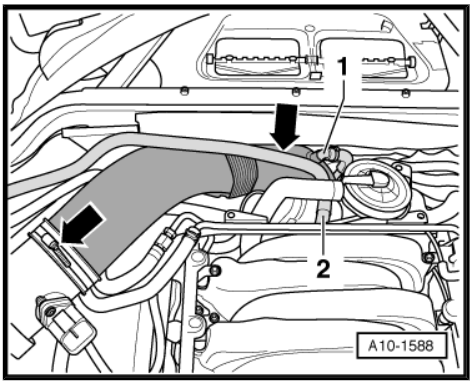
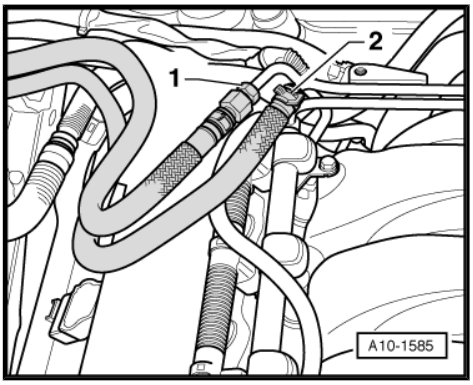


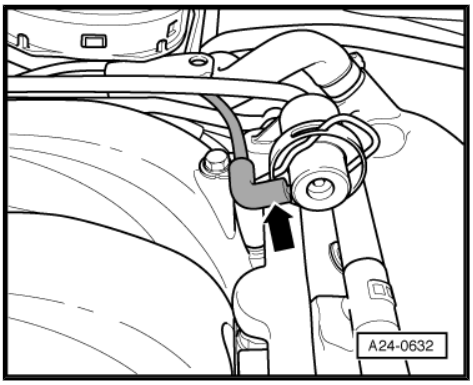
– Open the fuel supply pipe and fuel return pipe -1 and 2-.

Note

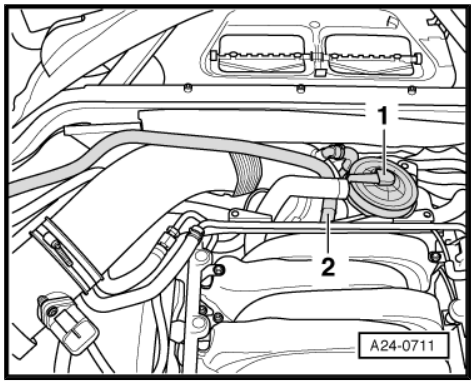
Engines with code letters BGK have no fuel return pipe.



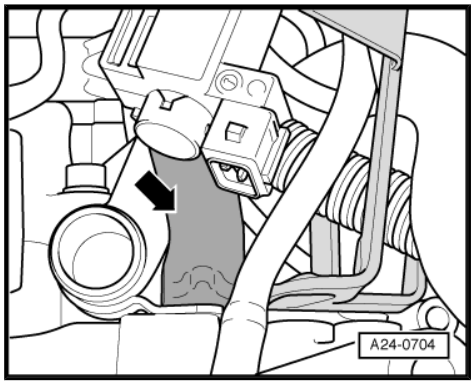
– Pull vacuum hose -arrow- off fuel pressure regulator (does not apply to engine code letters BGK).



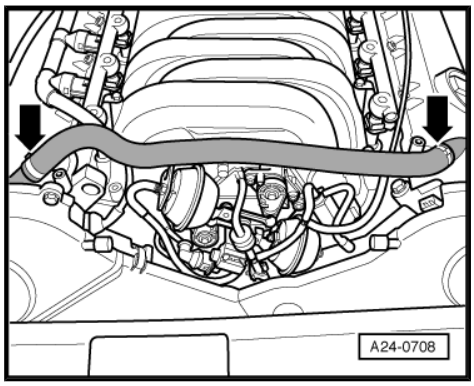
– Detach reservoir -1- and hose -2- from throttle valve module.
– Detach electrical connector from secondary air inlet valve -N112- and from throttle valve module.



– Unscrew bracket from secondary air inlet valve -N112- .



– Remove connecting hose for crankcase breather.
– Disconnect vacuum hose -1- for intake manifold change-over at intake manifold.



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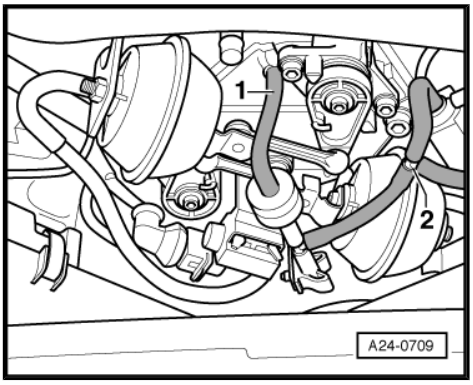
– Disconnect vacuum hose at T-connection -2-.



Note

The illustration is only an example (shows 3.7 ltr. BFL engine).

– Pull off connectors from intake-manifold changeover valves.
– Unplug connectors from Hall sender (bank 1) and from solenoid valve for variable valve timing (bank 2).
– Unplug all 8 electrical connectors from injectors.
– Move both connector rails to side.
– Unscrew all hexagon socket bolts from intake manifold.
– Carefully remove intake manifold upwards. The water connection on the throttle valve module remains connected.
– Place the intake manifold aside (take care with water connection).

Note

Seal intake ports on cylinder heads with clean cloths.

Installing

Installation of intake manifold is carried out in the reverse order; note the following:

Note

- *Renew all seals and gaskets.*
- *Use a silicone-free lubricant when installing the intake hose.*
- *All cable ties which are released or cut open when removing must be fitted in the same position when installing.*
- *Re-secure all hose connections using genuine hose clips (same as original equipment). ⇒ Parts catalogue*

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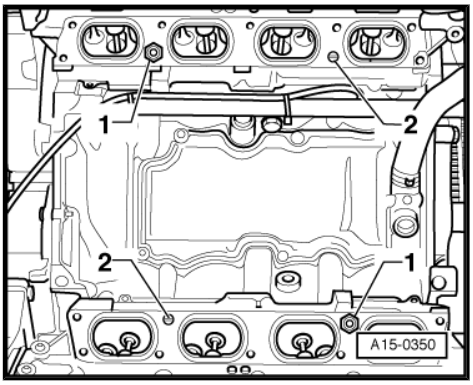
– Remove securing bolts -1- to renew gaskets for intake manifold.

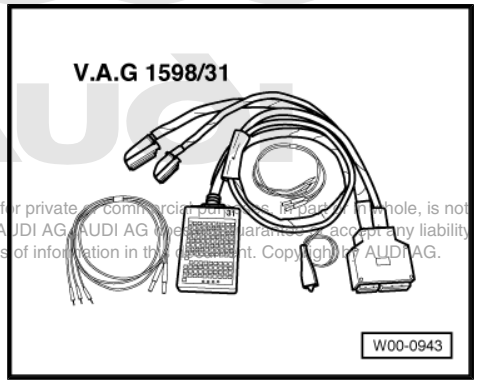


– Observe locating pin when fitting intake manifold.
– Tighten bolts on intake manifold in stages and in diagonal sequence.
– Check fuel system for leaks ⇒ page 18 .

Tightening torque

Component	Nm
Intake manifold	10

1.12 Wiring and component check with adapter cable, 121-pin -V.A.G 1598/31- (test box)



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Note

- *The adapter cable, 121-pin -V.A.G 1598/31- is designed so it can be connected both to the wiring harness for the engine control unit and to the engine control unit itself at the same time.*
- *The advantage of this is that the electronic engine control system remains fully functional when the test box is connected (for example, for measuring signals when the engine is running).*
- *The relevant test procedure will state whether it is necessary to also connect the engine control unit to the test box.*
- *Use the hand multimeter -V.A.G 1526C- and the voltage tester -V.A.G 1527B- for the checks.*
- *To connect the testers to test box -V.A.G 1598/31- , always use the adapter leads from adapter set -V.A.G 1594C- .*

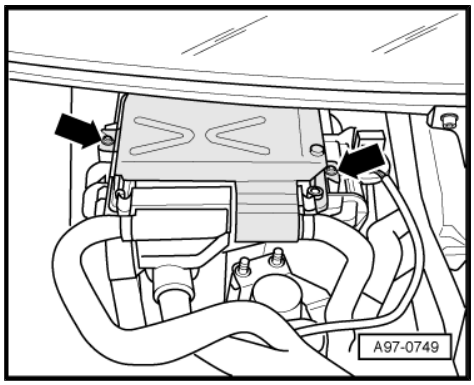
WARNING

To prevent damage to the electronic components, select appropriate measuring range before connecting the measuring cables and observe the test requirements.

– Switch off ignition.

– Remove cover from plenum chamber (right-side).

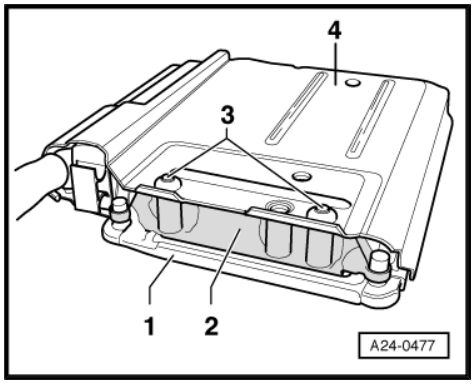
– Unscrew both bolts -arrows- and remove the engine control unit towards front.



To help prevent unauthorised access to the connectors on the engine control units, the engine control unit -1- is bolted to a protective casing -4- by means of shear bolts -3- and a locking plate -2-.

To make it more difficult to unscrew the shear bolts, their threads have been coated with locking fluid.

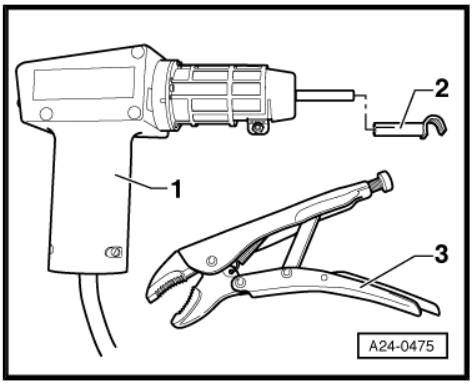
Engine control unit must be separated from protective housing before connectors can be unplugged from engine control unit (e.g. when connecting test box or replacing engine control unit). This procedure is described in the following.



Procedure:

Special tools and workshop equipment required

- Hot air blower -1- from the wiring harness repair set -VAS 1978-



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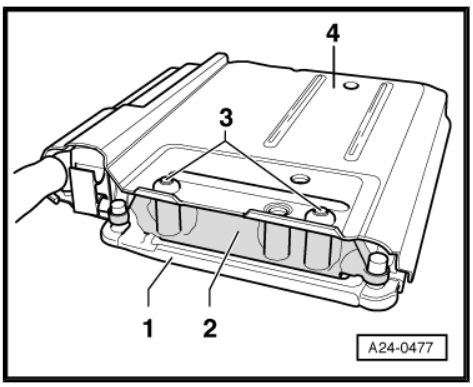
- Nozzle attachment -2- from the wiring harness repair set -VAS 1978-
- Commercially available vice-grip pliers

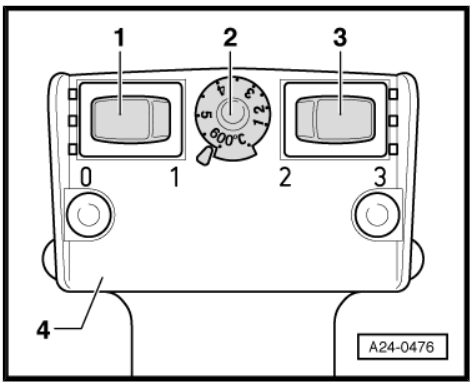
WARNING

The following procedure must be followed exactly to prevent any damage (burning) to wiring, connectors, insulation and control units. Observe operating instructions for hot air blower.

– Tilt engine control unit with protective housing towards engine compartment so that locking plate (item -2- in Fig.) becomes visible; place a clean cloth beneath engine control unit with protective housing.



– Select settings on hot air blower as shown in illustration, i.e. set temperature potentiometer -2- to maximum heat output and two-stage air flow switch -3- to position 3.



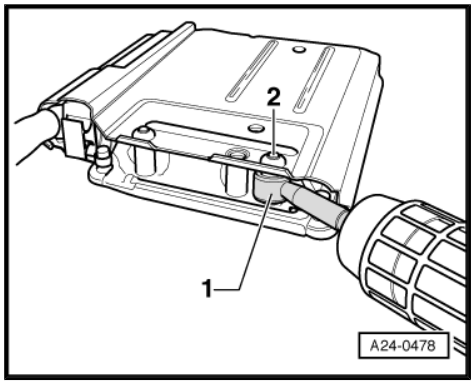
Note

Then use hot-air blower to heat thread of locking plate, into which shear bolts are screwed. This step reduces inhibiting action of locking fluid on shear bolt threads and makes it easier to unscrew these bolts.

WARNING

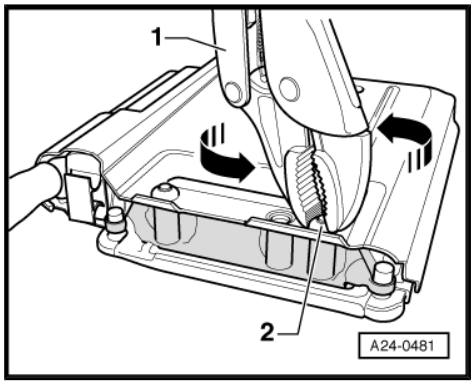
The shear bolts and protective housing also become very hot when heating the threads of the locking mechanism. Take care to avoid burns. It is also important to ensure that only the thread is heated and none of the surrounding components if at all possible. These should be covered if necessary.

– Direct nozzle -1- of hot air blower towards thread of locking plate to enable nozzle to “surround” thread. Allow nozzle to rest on upper end of protective housing.
– Switch on hot air blower and heat thread for about 20 to 25 seconds.

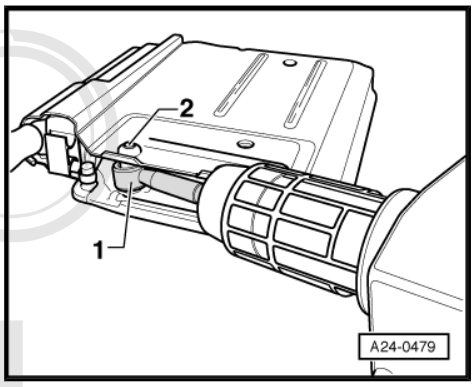


– Then grasp head of bolt -2- with vice-grip pliers -1- and unscrew shear bolt in direction of arrow.

The procedure for the second shear bolt is exactly the same. Take particular care here to avoid the control unit connectors in the immediate vicinity.



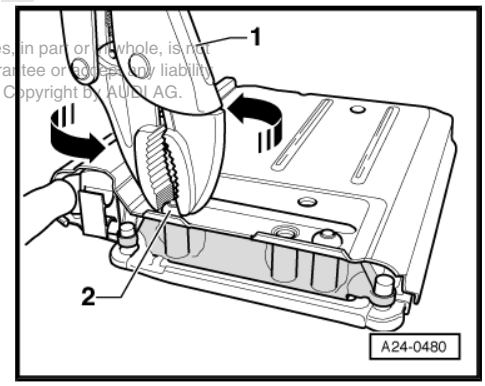
– Direct nozzle -1- of hot air blower towards thread of locking plate again so that the nozzle “surrounds” the thread. Allow nozzle to rest on upper end of protective housing.
– Switch on hot air blower and heat thread for about 20 to 25 seconds.



– Then grasp head of bolt -2- with vice-grip pliers -1- and unscrew shear bolt in direction of arrow.

Engine control unit can now be separated from protective housing.

– Release connectors on engine control unit and unplug connectors.



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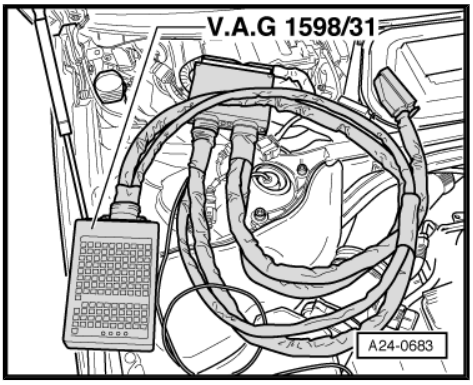
– Connect adapter cable, 121-pin -V.A.G 1598/31- to wiring harness connector. Earth clip must be connected to earth. The instructions for performing the individual tests indicate whether or not the engine control unit itself also needs to be connected to the test box.

– Carry out test as described in appropriate repair procedures.



Installing engine control unit

Installation is performed accordingly in the reverse sequence.

– Make sure you fit protective housing back on engine control unit -J623- .

– Always use new shear bolts.

1.13 Renewing engine control unit -J623-

Note

When the engine control unit is disconnected, the learnt values are erased but the contents of the fault memory remain intact.

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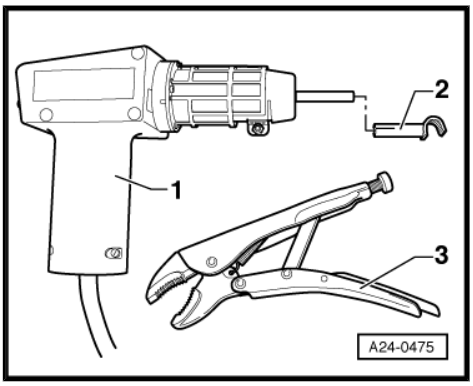
Removing

Special tools and workshop equipment required

♦ Hot air blower -1- from the wiring harness repair set -VAS 1978-



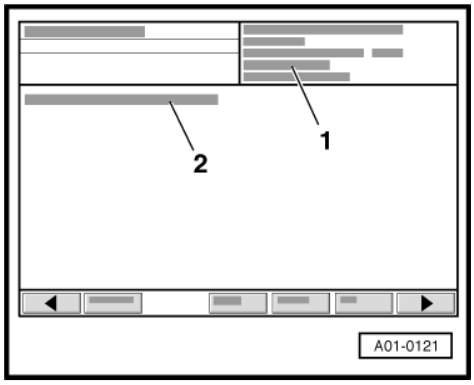
♦ Nozzle attachment -2- from the wiring harness repair set -VAS 1978-

♦ Commercially available vice-grip pliers

♦ Vehicle diagnostic, testing and information system -VAS 5051B-

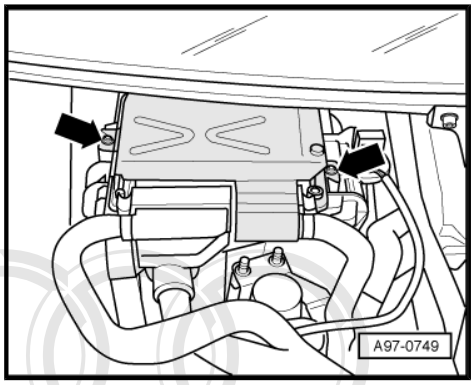
– Connect vehicle diagnostic, testing and information system -VAS 5051B- and select vehicle system “01 - Engine electronics” from list. When doing this, the ignition must be switched on.

The display on vehicle diagnostic, testing and information system -VAS 5051B- will show the control unit identification and the coding -2-.



- Always start by displaying the control unit identification and printing it out.
- Switch off ignition.
- Remove cover from plenum chamber (right-side).

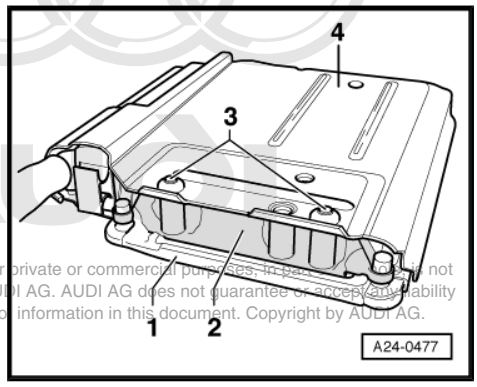
- Unscrew both bolts -arrows- and remove the engine control unit towards front.



To help prevent unauthorised access to the connectors on the engine control units, the engine control unit -1- is bolted to a protective casing -4- by means of shear bolts -3- and a locking plate -2-.

To make it more difficult to unscrew the shear bolts, their threads have been coated with locking fluid.

Engine control unit must be separated from protective housing before connectors can be unplugged from engine control unit (e.g. when connecting test box or replacing engine control unit). This procedure is described in the following.



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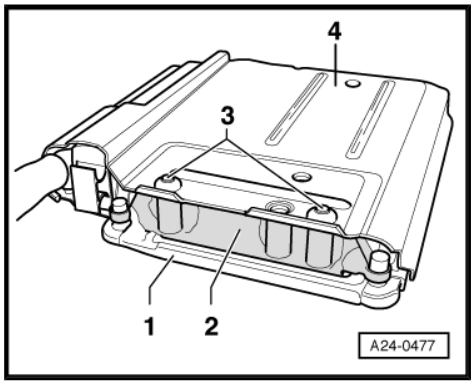
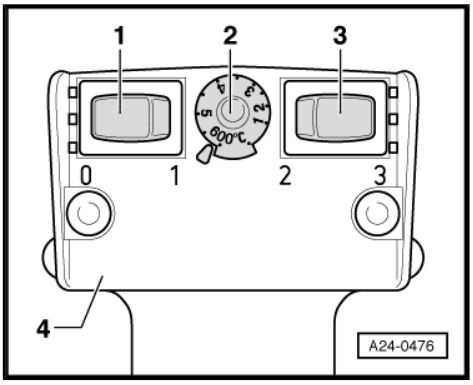
Procedure:

> **WARNING**
>
> ***The following procedure must be followed exactly to prevent any damage (burning) to wiring, connectors, insulation and control units. Observe operating instructions for hot air blower.***

- Tilt engine control unit with protective housing towards engine compartment so that locking plate (item -2- in Fig.) becomes visible; place a clean cloth beneath engine control unit with protective housing.



– Select settings on hot air blower as shown in illustration, i.e. set temperature potentiometer -2- to maximum heat output and two-stage air flow switch -3- to position 3.



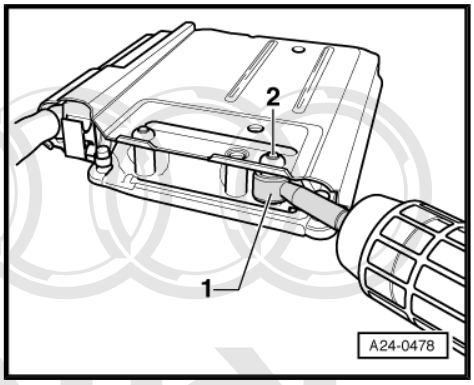
Note

Then use hot-air blower to heat thread of locking plate, into which shear bolts are screwed. This step reduces inhibiting action of locking fluid on shear bolt threads and makes it easier to unscrew these bolts.

WARNING

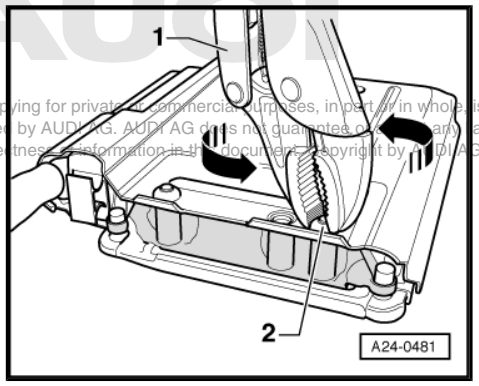
The shear bolts and protective housing also become very hot when heating the threads of the locking mechanism. Take care to avoid burns. It is also important to ensure that only the thread is heated and none of the surrounding components if at all possible. These should be covered if necessary.

– Direct nozzle -1- of hot air blower towards thread of locking plate to enable nozzle to “surround” thread. Allow nozzle to rest on upper end of protective housing.
– Switch on hot air blower and heat thread for about 20 to 25 seconds.



– Then grasp head of bolt -2- with vice-grip pliers -1- and unscrew shear bolt in direction of arrow.

The procedure for the second shear bolt is exactly the same. Take particular care here to avoid the control unit connectors in the immediate vicinity.



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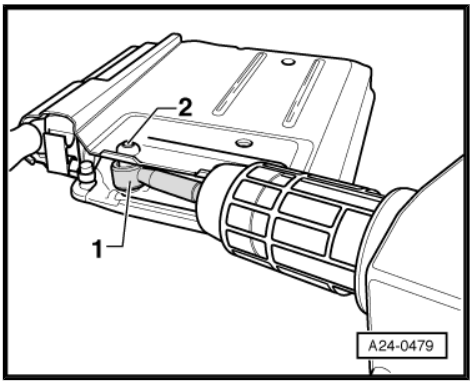
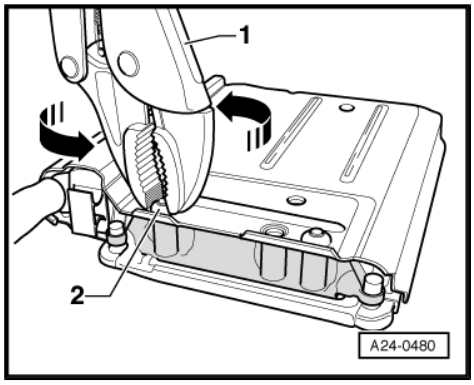
– Direct nozzle -1- of hot air blower towards thread of locking plate again so that the nozzle “surrounds” the thread. Allow nozzle to rest on upper end of protective housing.
– Switch on hot air blower and heat thread for about 20 to 25 seconds.



– Then grasp head of bolt -2- with vice-grip pliers -1- and unscrew shear bolt in direction of arrow.



Engine control unit can now be separated from protective housing.

– Release connectors on engine control unit and unplug connectors.

– Take out old engine control unit and insert new one.

Installing

Installation is performed accordingly in the reverse sequence.

– Make sure you fit protective housing back on engine control unit -J623- .

– Always use new shear bolts.

The following steps must be performed after installing new engine control unit:

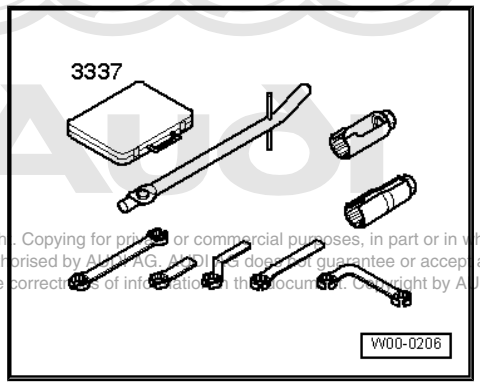
– If engine control unit -J623- is being renewed, select function “J623 replace, further steps” in “Guided Fault Finding”.

1.14 Removing and installing Lambda probes (before catalytic converter)

Removing and installing Lambda probe -G39- bank 1 and Lambda probe 2 -G108- bank 2

Special tools and workshop equipment required

♦ Lambda probe open ring spanner set -3337-



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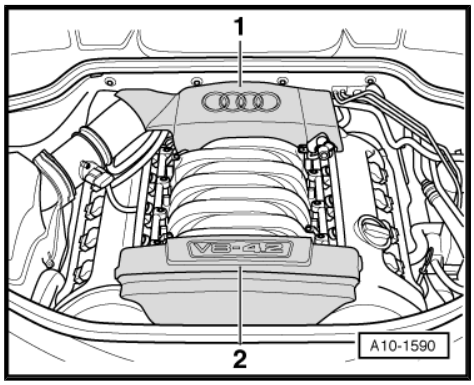
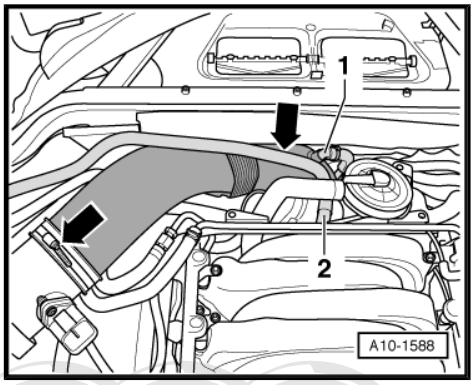
– Remove engine cover.



Note

The intake manifold must first be removed before the Lambda probes before catalytic converter can be removed.

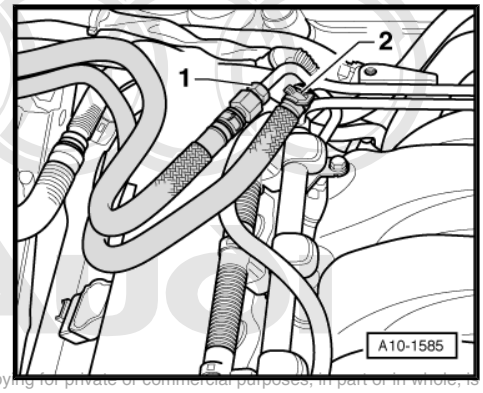
– Remove intake hose between air cleaner and throttle valve module.



– Open the fuel supply pipe and fuel return pipe -1 and 2-.

Note

Engines with code letters BGK have no fuel return pipe.



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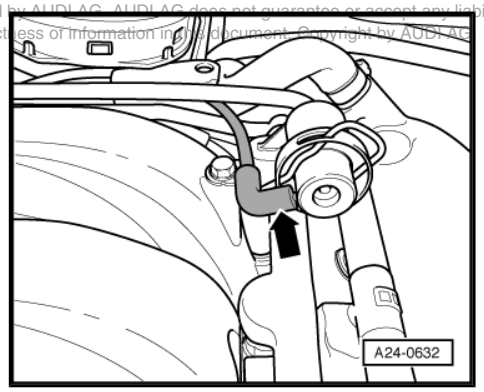
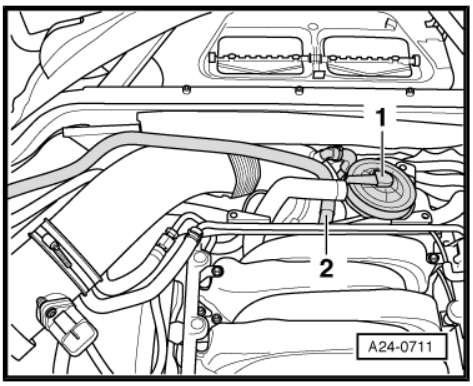
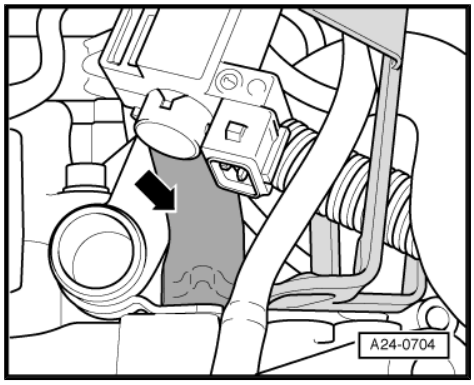
– Pull vacuum hose -arrow- off fuel pressure regulator (does not apply to engine code letters BGK).



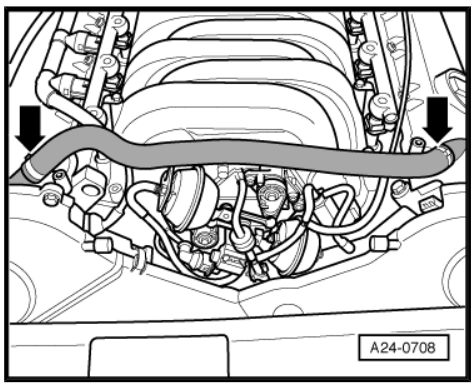
– Detach reservoir -1- and hose -2- from throttle valve module.
– Detach electrical connector from secondary air inlet valve and from throttle valve module.



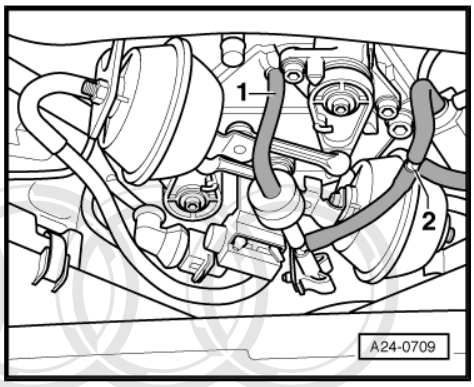
– Unscrew bracket from secondary air inlet valve.



– Remove connecting hose for crankcase breather.
– Disconnect vacuum hose -1- for intake manifold change-over at intake manifold.



– Disconnect vacuum hose at T-connection -2-.



Note

The illustration is only an example (shows 3.7 ltr. BFL engine).

– Pull off connectors from intake-manifold changeover valves.
– Unplug connectors from Hall sender (bank 1) and from solenoid valve for variable valve timing (bank 2).
– Unplug all 8 electrical connectors from injectors.
– Move both connector rails to side.
– Unscrew all hexagon socket bolts from intake manifold.
– Carefully remove intake manifold upwards. The water connection on the throttle valve module remains connected.
– Place the intake manifold aside (take care with water connection).

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Note

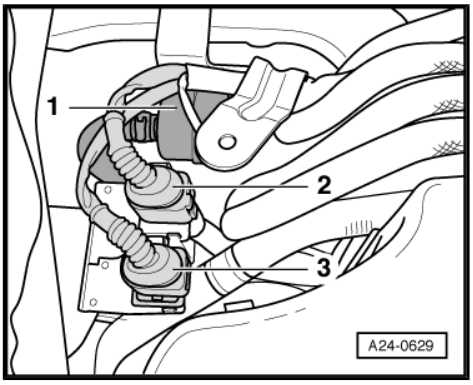
Seal intake ports on cylinder heads with clean cloths.

– Unplug the corresponding Lambda probe connector.

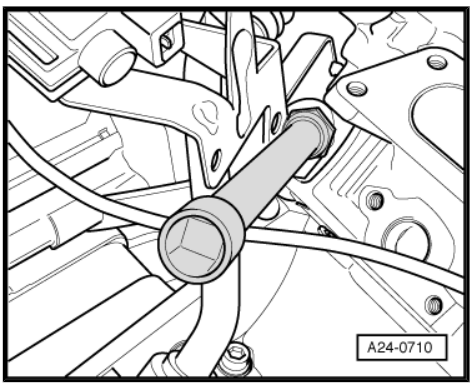
2 - 4-pin electrical connector for Lambda probe 2 -G108- and Lambda probe heater 2 -Z28- before catalytic converter (bank 2)

3 - 4-pin electrical connector for Lambda probe -G39- and Lambda probe heater -Z19- before catalytic converter (bank 1)

– Release all cable ties to move electrical wiring clear.



– Unscrew the corresponding Lambda probe using tool from Lambda probe open ring spanner set -3337- (illustration shows Lambda probe 2 -G108- on bank 2).



Installing

Note

- *Threads of new Lambda probes are already coated with assembly paste; the paste must not get into the slots on the probe body.*
- *In the case of a used Lambda probe grease only the thread with high-temperature paste. The paste must not get into the slots on the probe body. High-temperature paste ⇒ Parts catalogue*
- *Use a silicone-free lubricant when installing the intake hose.*
- *When installing, the Lambda probe wire must always be reattached at the same locations to prevent it from coming into contact with the exhaust pipe.*

Tightening torque

Component	Nm
Lambda probe	55

Installation of intake manifold is carried out in the reverse order; note the following:

Note

- *Renew seals and gaskets.*
- *All cable ties which are released or cut open when removing must be fitted in the same position when installing.*
- *Re-secure all hose connections using genuine hose clips (same as original equipment). ⇒ Parts catalogue*

– Remove securing bolts -1- to renew gaskets for intake manifold.

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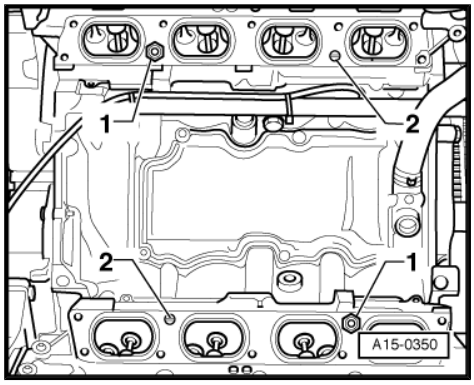
– Observe locating pin -2- when fitting intake manifold.
– Tighten bolts on intake manifold in stages and in diagonal sequence.
– Check fuel system for leaks ⇒ page 18 .



Tightening torque

Component	Nm
Intake manifold	10

1.15 Removing and installing Lambda probe after catalytic converter -G130- - bank 1

Removing

– Unplug electrical connector -2- for Lambda probe after catalytic converter -G130- - bank 1.

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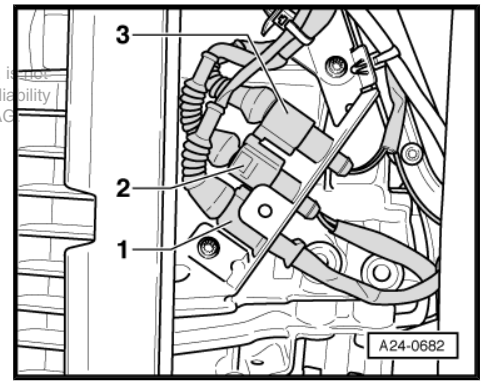


2 - 4-pin electrical connector for Lambda probe after catalytic converter -G130- and Lambda probe 1 heater after catalytic converter -Z29- (bank 1)

3 - 4-pin electrical connector for Lambda probe 2 after catalytic converter -G131- and Lambda probe 2 heater after catalytic converter -Z30- (bank 2)

To remove Lambda probe after catalytic converter -G130- (bank 1), the rear of the gearbox must be lowered to open the cable retainer for the Lambda probe.

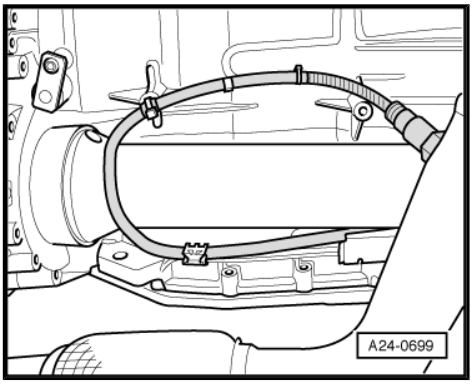
Procedures for lowering the automatic gearbox can be found in the section:

♦ Removing and installing the gearbox support and gearbox mounting ⇒ Rep. Gr. 37

Remove Lambda probe after lowering the gearbox.

– Release all cable ties on gearbox for electrical wiring of Lambda probe after catalytic converter -G130- (bank 1).

– Unscrew Lambda probe using tool from Lambda probe open ring spanner set -3337- .



Installing

Installation of the Lambda probe is carried out in the reverse order; note the following:

Note

- *When installing, the Lambda probe wire must always be reattached at the same locations to prevent it from coming into contact with the exhaust pipe.*
- *Threads of new Lambda probes are already coated with assembly paste; the paste must not get into the slots on the probe body.*
- *In the case of a used Lambda probe grease only the thread with high-temperature paste. The paste must not get into the slots on the probe body. High-temperature paste ⇒ Parts catalogue*
- *For tightening torques when installing the automatic gearbox, refer to Automatic gearbox ⇒ Rep. Gr. 37*

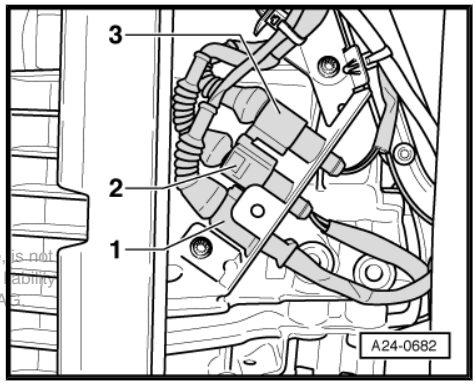
Tightening torque

Component	Nm
Lambda probe	55

1.16 Removing and installing Lambda probe 2 after catalytic converter -G131- - bank 2

Removing

– Unplug electrical connector -3- for Lambda probe 2 after catalytic converter -G131- - bank 2.



2 - 4-pin electrical connector for Lambda probe after catalytic converter -G130- and Lambda probe 1 heater after catalytic converter -Z29- (bank 1)

3 - 4-pin electrical connector for Lambda probe 2 after catalytic converter -G131- and Lambda probe 2 heater after catalytic converter -Z30- (bank 2)

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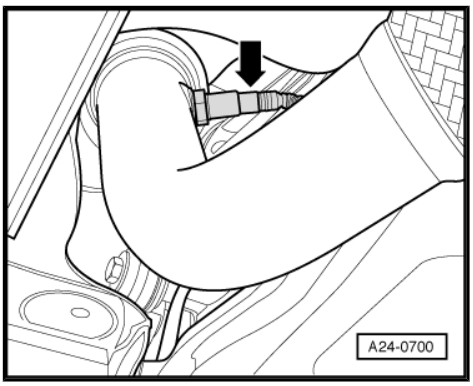
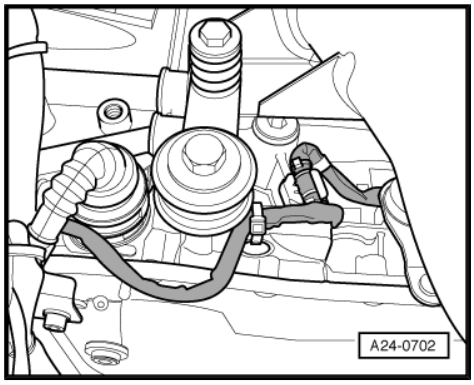
– Release all cable ties on gearbox for Lambda probe 2 after catalytic converter -G131- wiring (bank 2).

– Unscrew Lambda probe -arrow- using tool from Lambda probe open ring spanner set -3337- .



Installing

Installation of the Lambda probe is carried out in the reverse order; note the following:



Note

- *When installing, the Lambda probe wire must always be reattached at the same locations to prevent it from coming into contact with the exhaust pipe.*
- *Threads of new Lambda probes are already coated with assembly paste; the paste must not get into the slots on the probe body.*
- *In the case of a used Lambda probe grease only the thread with high-temperature paste. The paste must not get into the slots on the probe body. High-temperature paste ⇒ Parts catalogue*

Tightening torque

Component	Nm
Lambda probe	55

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28 – Ignition system

1 Checking ignition system

1.1 General notes on ignition system

- The engine control unit has a self-diagnosis capability.
- A voltage of at least 11.5 V is required for proper operation of the electrical components.
- Certain tests may lead to a fault being detected by the control unit and stored. The fault memory should therefore be interrogated and (if necessary) erased after completing the tests and any repair work that may be required.
- If the engine starts, runs for a short period and then cuts out after completing fault finding, repairs or component tests, this may be due to the immobiliser disabling the engine control unit. The fault memory must then be interrogated and, if necessary, the control unit must be adapted.

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1.2 Safety precautions

To avoid any risk of injuries to persons and/or damage to the fuel injection and ignition system, always observe the following safety precautions.

- Do not touch or disconnect ignition wiring when the engine is running or being turned at starter speed.
- Always switch off the ignition before connecting or disconnecting the battery, otherwise the engine control unit may be damaged.
- The ignition must be switched off before connecting or disconnecting injection or ignition system wiring or tester cables.
- To operate the engine at starting speed without actually starting it (for example, in order to test compression), unplug the connectors from the output stages for the ignition coils and also the connectors on the injectors. After completing the work, interrogate and erase the fault memory.
- Always switch off the ignition before cleaning the engine.

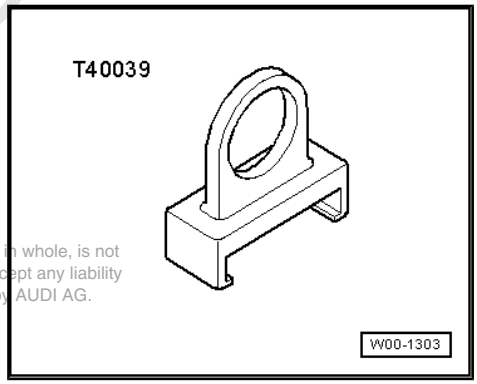
1.3 Technical data

Engine data	3.7 ltr. 206 kW / 4.2 ltr. 246 kW
Idling speed Not adjustable (determined by control unit)	650 ... 750 rpm
Ignition timing Not adjustable (determined by control unit)	
Ignition system	Multi-coil system with 8 ignition coils (output stages integrated) connected directly to spark plugs via spark plug connectors
Removing and installing spark plugs ⇒ Maintenance ; Booklet 404	Tightening torque 30 Nm
Firing order	1-5-4-8-6-3-7-2

2 Removing and installing ignition coils

Special tools and workshop equipment required

- Puller -T40039-



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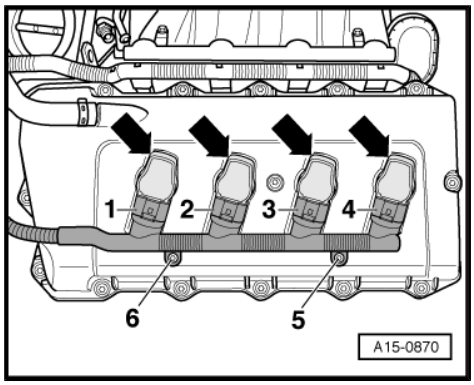
Removing (cylinders 1, 2 and 3):

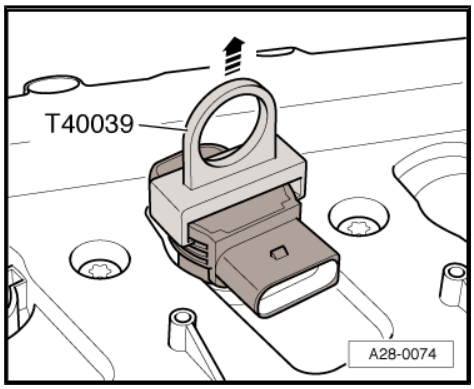
– Unscrew bolts -5 and 6- and unplug electrical connectors at ignition coils.



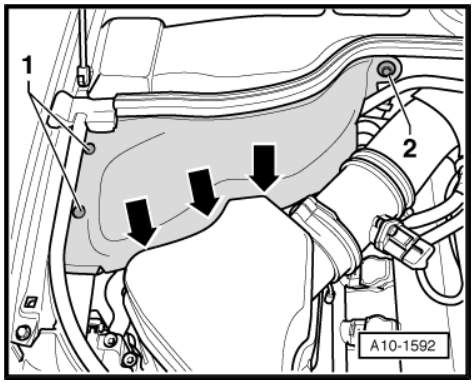
– Pull ignition coil (cylinder 1) out with puller -T40039- .

Removing (cylinder 4):

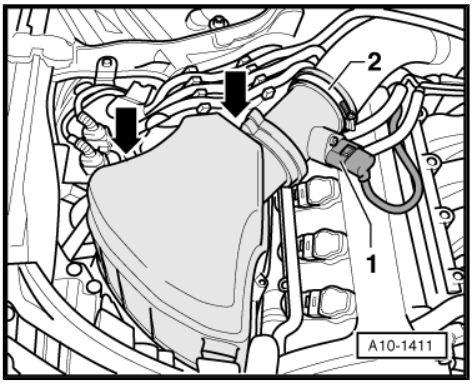
– Pull out clips -1-.



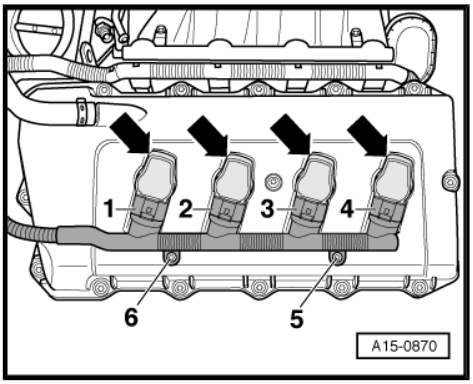
– Unscrew bolt -2- and remove cover.
– Unplug electrical connector -1- at air mass meter -G70- .
– Unfasten hose clip -2-.



– Remove air cleaner housing -arrows-.

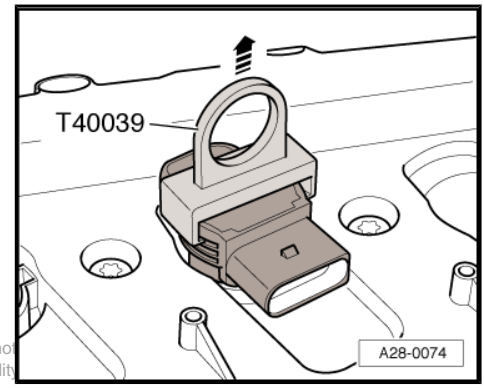


– Unscrew bolts -5 and 6- and unplug electrical connectors at ignition coils.



– Pull ignition coil (cylinder 4) out with puller -T40039- .

Removing (cylinders 5 and 6):



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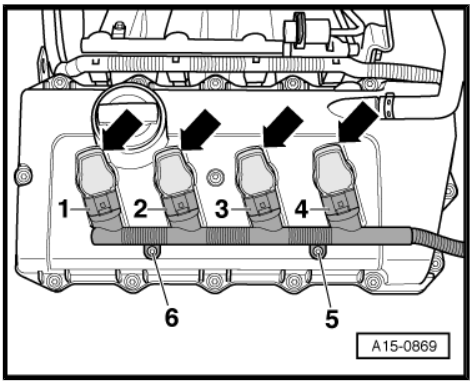
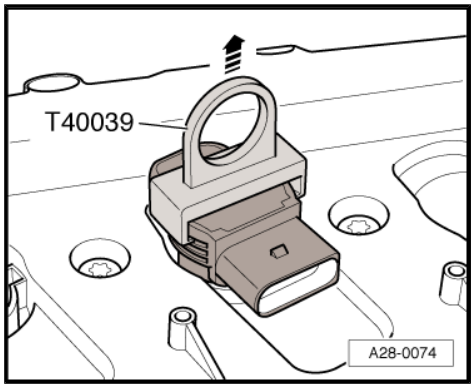
– Unscrew bolts -5 and 6- and unplug electrical connectors at ignition coils.

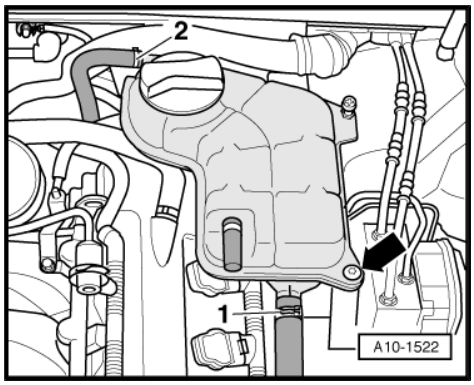


– Pull ignition coils (cylinders 5 and 6) out with puller -T40039- .

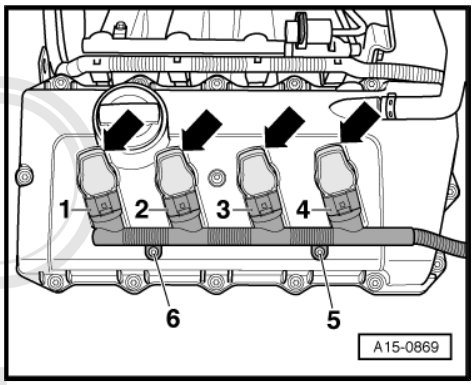


Removing (cylinders 7 and 8):

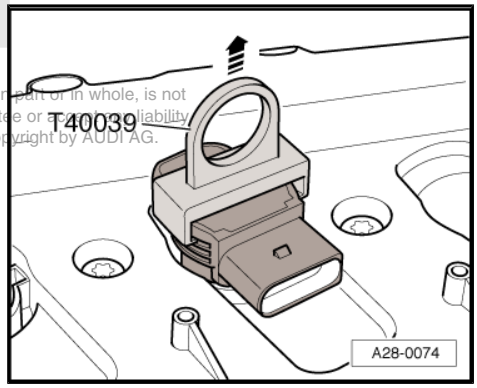
– Unbolt coolant expansion tank -arrow- and lay it aside with coolant hoses -1- and -2- connected.



– Unscrew bolts -5 and 6- and unplug electrical connectors at ignition coils.



– Pull ignition coils (cylinders 7 and 8) out with puller -T40039- .



Installing ignition coils

Install in reverse order.

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