

24 - MULTIPOINT FUEL INJECTION (MFI)

MOTRONIC FUEL INJECTION SYSTEM, SERVICING

Safety precautions

Observe the following if test and measuring instruments are required during a test drive:

CAUTION:

- Test and measuring equipment must always be secured to the rear seat and be operated from there by a second person.
- If test and measuring instruments are operated from the front passengers seat and the vehicle is involved in an accident, there is a possibility that the person sitting in this seat may receive serious injuries when the airbag is triggered.

To reduce risk of personal injury and/or damage to the fuel injection and ignition system, always observe the following:

- Only disconnect and reconnect wires for injection and ignition system, including test leads, when ignition is switched off.
- If engine is to be cranked at starting RPM without starting (e.g. for compression testing), disconnect connectors from power output stage for ignition coils and from fuel injectors.
- It is possible that the control module will recognize a malfunction and store a DTC during some tests. Therefore after completing all checks and repairs the DTC memory must be checked and if necessary erased.
- Cleaning the engine should only be performed with ignition switched off.
- The battery must only be disconnected and connected with the ignition switched off, since the Engine Control Module (ECM) can otherwise be damaged.

CAUTION: Fuel system is under pressure! Before loosening hose connections or opening the test connection (for fuel pressure testing), place rags around the connection area. Then release pressure by carefully loosening the connection.

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

- Thoroughly clean all connections and surrounding area before disconnecting.
- Place parts that have been removed on a clean surface and cover them. Use lint-free cloths.
- Carefully cover over opened components or seal, if repairs are not performed immediately.
- Only install clean components: Only unpack replacement parts immediately prior to installation. Do not use parts that have been stored loose (e.g. in tool boxes etc.).
- When the system is open: Avoid working with compressed air if possible. Do not move vehicle unless

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absolutely necessary.

- Separated electrical connections: Protect from dirt and moisture. Connect only when dry.

Component locations, overview

Components A through H are not depicted in exploded view illustration.

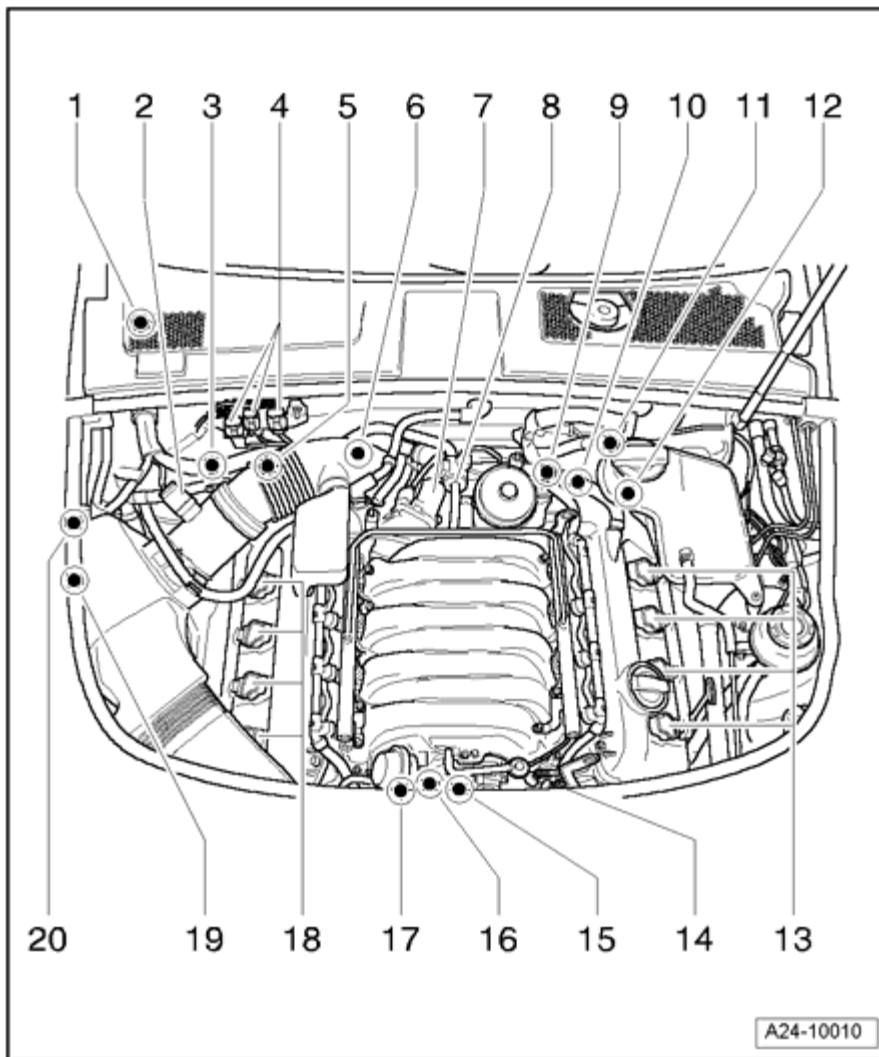


Fig. 506: Motronic Fuel Injection System, Servicing - Component Locations, Overview
Courtesy of VOLKSWAGEN UNITED STATES, INC.

1 - Engine control module J623

- Component location: In E-box in right plenum chamber

2 - Mass air flow (MAF) sensor G70 with intake air temperature (IAT) sensor G42

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- Removing and installing --> **Mass air flow (MAF) sensor, removing and installing**

3 - Camshaft Adjustment Valve 1 N205

- **Engine viewed from rear**

4 - Connector strip

- Connector assignment **Connector strip on right side of bulkhead**

5 - Camshaft Position (CMP) sensor G40

- Cylinder bank 1
- **Engine viewed from rear**

6 - Engine coolant temperature (ECT) sensor G62

7 - Throttle valve control module J338

- With Throttle Drive (for Electronic Power Control (EPC)) G186 , Throttle Drive Angle Sensor 1 (for Electronic Power Control (EPC)) G187 and Throttle Drive Angle Sensor 2 (for Electronic Power Control (EPC)) G188
- **Engine viewed from rear**

8 - Evaporative Emission (EVAP) Canister Purge Solenoid Valve N80

9 - Oil pressure switch F1

- **Engine viewed from rear**

10 - Camshaft position (CMP) sensor 2 G163

- Cylinder bank 2
- **Engine viewed from rear**

11 - Connector strip

- Connector assignment
- **Connector strip beneath coolant reservoir**

12 - Camshaft Adjustment Valve 2 N208

- **Engine viewed from rear**

13 - Ignition coils with power output stages

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- Cylinder bank 2
- To remove, puller for ignition coil T10094 can be used.

14 - 3-pin harness connector

- For Knock Sensor (KS) 3 G198
- For Knock Sensor (KS) 4 G199

15 - Secondary Air Injection (AIR) Solenoid Valve N112

- **Engine viewed from front**

16 - Intake Manifold Change-Over Valve N156

- **Engine viewed from front**

17 - 3-pin harness connector

- For Knock Sensor (KS) 1 G61
- For Knock Sensor (KS) 2 G66
- **Engine viewed from front**

18 - Ignition coils with power output stages

- Cylinder bank 1
- To remove, puller for ignition coil T10094 can be used.

19 - Intake air switch-over valve N335

- For controlling a flap in air filter housing
- The intake air switch-over valve N335 is located behind air filter housing. The air filter housing must be completely removed to test the valve.

20 - Secondary Air Injection (AIR) Pump Motor V101

- Front bottom in driving direction
- Refer to --> **Secondary Air Injection (AIR) Pump Motor V101**

A - Throttle position (TP) sensor G79 and Accelerator Pedal Position Sensor 2 G185

- In footwell on accelerator pedal (both sensors are integrated into one housing)

B - Brake light switch F

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C - Clutch pedal switch F36

- In footwell on pedal mount near clutch pedal

D - Fuel pump (FP) relay J17

- In 3-socket relay carrier in plenum chamber, left side, relay position 2
- **Component located on 3-socket relay carrier in left plenum chamber**

E - Motronic engine control module (ECM) power supply relay J271

- In 3-socket relay carrier in plenum chamber, left side, relay position 3
- **Component located on 3-socket relay carrier in left plenum chamber**

F - Secondary Air Injection (AIR) Pump Relay J299

- In 4-socket relay carrier in E-box, in right side of plenum chamber, relay position 3
- **Component located on 4-socket relay carrier in E-box of right plenum chamber**

G - Data Link connector (DLC)

- Located in knee bolster on drivers side

H - Engine Speed (RPM) Sensor G28

- In transmission housing over ring gear

Emissions Malfunction Indicator Lamp (MIL)

- The Malfunction Indicator Lamp (MIL) lights up when emissions-related malfunctions are recognized by the Engine Control Module (ECM).
- Component location of emissions MIL (CHECK): In instrument cluster

NOTE:

- **The emissions MIL can blink or remain lit continuously. In any case, DTC memory must be checked.**

If malfunction indicator lamp (MIL) is blinking

- A malfunction exists that, under these driving conditions, may damage the catalytic converters. In this case, driving may only be continued at a reduced load (until the MIL goes out or remains constantly lit) and malfunction must be eliminated as quickly as possible!

If malfunction indicator lamp (MIL) is constantly lit

- A malfunction exists that causes increased emissions. Interrogate DTC memory of engine control module

(ECM) or transmission.

- For driveability problems or customer complaints where the emissions MIL is not lit, DTC memory must be checked after a function test of the MIL because malfunctions can be stored without causing the MIL to light up immediately.

EPC warning lamp

- "EPC" is an abbreviation and stands for Electronic Power Control, also known as electronic performance regulation (E-Gas).
- Component location of EPC warning lamp: In instrument cluster

With ignition on, the engine control module (ECM) switches EPC lamp on.

After engine is started, engine control module (ECM) tests all components important to function of EPC system.

While these components are being tested, EPC lamp stays lit for approx. 3 seconds. If a malfunction is detected during these tests, the lamp will remain lit constantly.

If malfunctions are detected in EPC system during engine operation, the ECM switches on the EPC warning lamp. The malfunction is stored in DTC memory of ECM at the same time.

Component located on 3-socket relay carrier in left plenum chamber

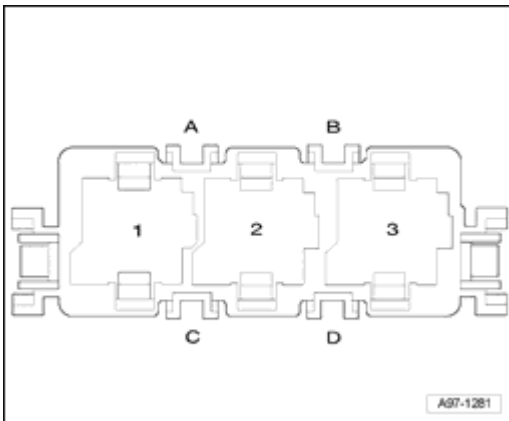


Fig. 507: Component Located On 3-Socket Relay Carrier In Left Plenum Chamber
Courtesy of VOLKSWAGEN UNITED STATES, INC.

2 - Fuel pump (FP) relay J17

3 - Motronic engine control module (ECM) power supply relay J271

Component located on 4-socket relay carrier in E-box of right plenum chamber

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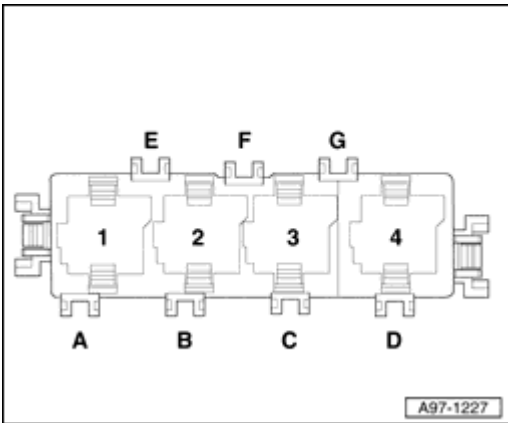


Fig. 508: Component Located On 4-Socket Relay Carrier In E-Box Of Right Plenum Chamber
Courtesy of VOLKSWAGEN UNITED STATES, INC.

3 - Secondary Air Injection (AIR) Pump Relay J299

Connector strip on right side of bulkhead

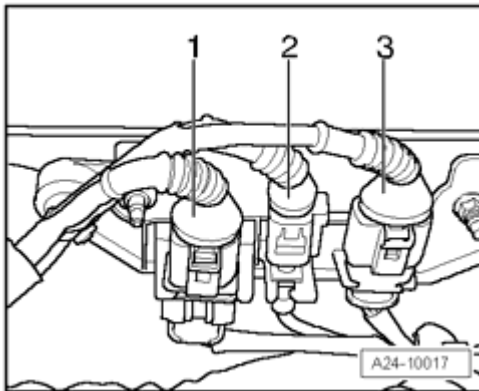


Fig. 509: Connecting Electrical Connector
Courtesy of VOLKSWAGEN UNITED STATES, INC.

1 - 6-pin connection for heated oxygen sensor (HO2S) G39 and oxygen sensor heater Z19 before catalytic converter of bank 1

2 - 2-pin connection for bank 1 Camshaft Adjustment Valve 1 N205

3 - 4-pin connection for oxygen sensor (O2S) behind three way catalytic converter (TWC) G130 and oxygen sensor (O2S) heater 1 (behind three way catalytic converter (TWC)) Z29 of bank 1

Connector strip beneath coolant reservoir

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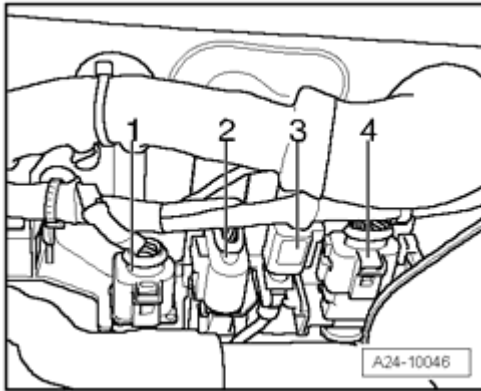


Fig. 510: Identifying Bulkhead Electrical Connector
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- 1 - 6-pin connection for heated oxygen sensor (HO2S) 2 G108 and oxygen sensor (O2S) heater 2 Z28 before catalytic converter of bank 2
- 2 - 3-pin connection (gray) for engine speed (RPM) sensor G28
- 3 - 2-pin connection for bank 2 Camshaft Adjustment Valve 2 N208
- 4 - 4-pin connection for oxygen sensor (O2S) 2 behind three way catalytic converter (TWC) G131 and oxygen sensor (O2S) heater 2 (behind three way catalytic converter (TWC)) Z30 of bank 2

Engine viewed from front

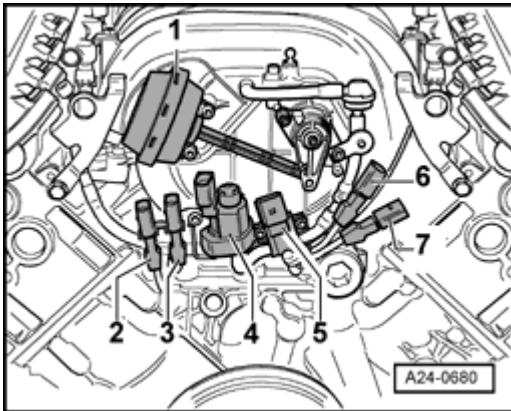


Fig. 511: Engine Viewed From Front
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- 1 - Vacuum diaphragm for intake manifold change-over
- 2 - Knock sensor (KS) 1 G61
- 3 - Knock sensor (KS) 2 G66

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- 4 - Intake Manifold Change-Over Valve N156
- 5 - Secondary Air Injection (AIR) Solenoid Valve N112
- 6 - Knock sensor (KS) 3 G198
- 7 - Knock sensor (KS) 4 G199

Engine viewed from rear

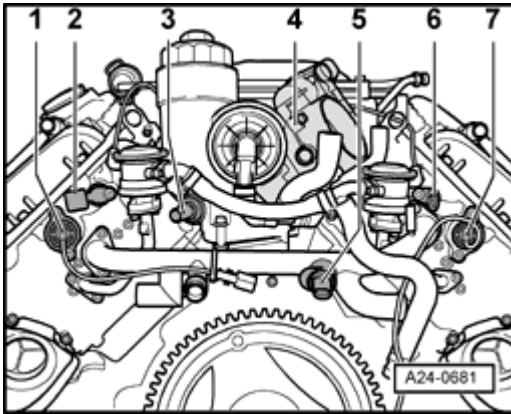


Fig. 512: Engine Viewed From Rear

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- 1 - Camshaft Adjustment Valve 2 N208
- 2 - Camshaft position (CMP) sensor 2 G163 cylinder bank 2
- 3 - Oil pressure switch F1
- 4 - Throttle valve control module J338
- 5 - Engine coolant temperature (ECT) sensor G62
- 6 - Camshaft position (CMP) sensor G40 cylinder bank 1
- 7 - Camshaft Adjustment Valve 1 N205

Secondary Air Injection (AIR) Pump Motor V101

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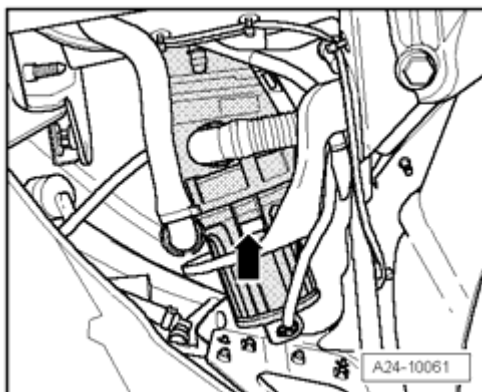


Fig. 513: Secondary Air Injection (AIR) Pump Motor V101
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Lower right, in driving direction

Air filter, overview



Courtesy of VOLKSWAGEN UNITED STATES, INC.

- 1 - Vent hose
- 2 - Intake air switch-over valve N335
- 3 - Lower part of air filter housing
 - Clean air filter housing of salt residue, dirt and leaves
- 4 - Rubber grommet
- 5 - Air duct
 - Check air duct for dirt and leaves

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6 - 1.5 Nm

7 - Air duct

- Check air duct for dirt and leaves

8 - Connection

9 - Air duct hose to Throttle Valve Control Module J338

- With resonator

10 - Wiring router

11 - O-ring

- Replace

12 - 1.5 Nm

- For securing air filter element

13 - Upper part of air filter housing

- Clean air filter housing of salt residue, dirt and leaves

14 - Air duct

- Clipped into upper part of air filter housing

15 - Air filter element

- Always use a genuine air filter element

16 - O-ring

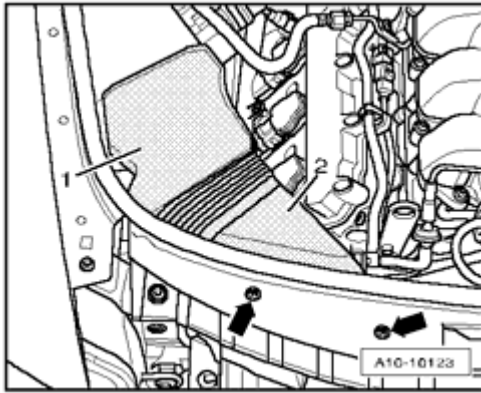
- Replace

17 - Spreader clip

18 - Grommet

Air filter, removing and installing

Removing

**Fig. 515: Removing Bolts & Air Duct**

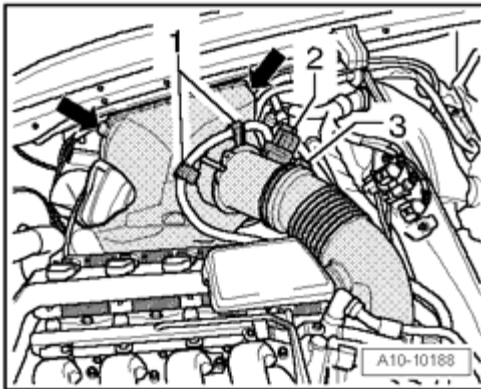
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - **arrow** -.
- Remove air duct - **1** - and - **2** -.
- Unclip fuel hose - **1** -.

NOTE:

- **The fuel hose is routed behind the air duct hose - 3 -.**

- Disconnect electrical connector - **2** - from mass air flow (MAF) sensor G70.
- Disconnect mass air flow (MAF) sensor G70 from air duct hose - **3** -.

**Fig. 516: Disconnecting Mass Air Flow (MAF) Sensor G70 Electrical Harness Connector**

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Open clips - **arrows** - and remove upper part of air filter housing with mass air flow (MAF) sensor G70.

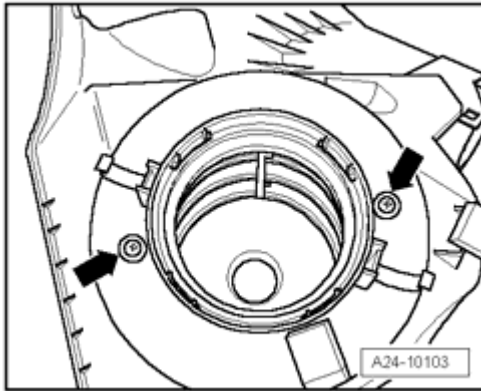


Fig. 517: Identifying Air Filter Insert Securing Screws
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove 2 bolts - **arrows** - from air filter element.

Removing lower part of air filter housing

- Separate hose connections at lower part of air filter housing.

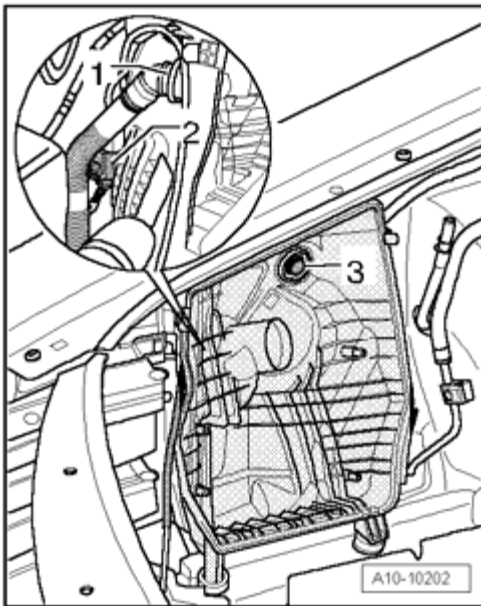


Fig. 518: Identifying Expanding Clip, Hose, And Electrical Harness Connector
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove pin from spreader clip - **3** -.
- Remove lower part of air filter housing and, on backside, disconnect electrical connection - **2** - at intake air switch-over valve N335.

Installing

For problem-free operation of mass air flow (MAF) sensor G70 it is very important to observe the following notes and procedures.

NOTE:

- If the air filter element is very dirty or soaked, dirt particles or moisture may have contaminated the Mass Air Flow (MAF) Sensor G70 and may be causing false mass air flow values. This results in a reduction of power, since a lower injection quantity is calculated.
- Always use an original equipment air filter element.
- Use a lubricant (silicone-free) for installing the intake hose.
- Secure all hose connections using hose clamps appropriate for the model type

- Using compressed air, blow through water drain hose in lower part of air filter housing.
- Clean air filter housing (upper and lower sections) of salt residue, dirt or leaves (use vacuum cleaner if necessary).
- Check MAF sensor and intake hose (intake air side) for salt residue, dirt, and leaves.
- Check intake ducting up to air filter element for dirt.
- Make sure that air filter element is properly centered when placed into mounting of lower part of air filter housing.

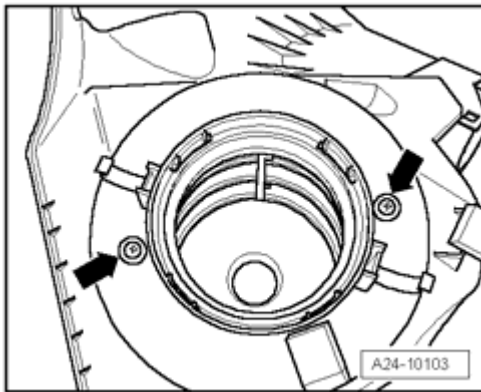


Fig. 519: Identifying Air Filter Insert Securing Screws

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Secure air filter element again with both bolts - **arrows** -
- Set upper part of air filter housing onto lower part of air filter housing, without using much force. When doing this, make sure that the upper part of air filter housing is not placed crooked onto air filter element. Pay attention to sealing lip of air filter element (false air).
- Then, attach upper part of air filter housing to lower part of air filter housing.
- Further installation is performed in reverse order.

Intake manifold, overview

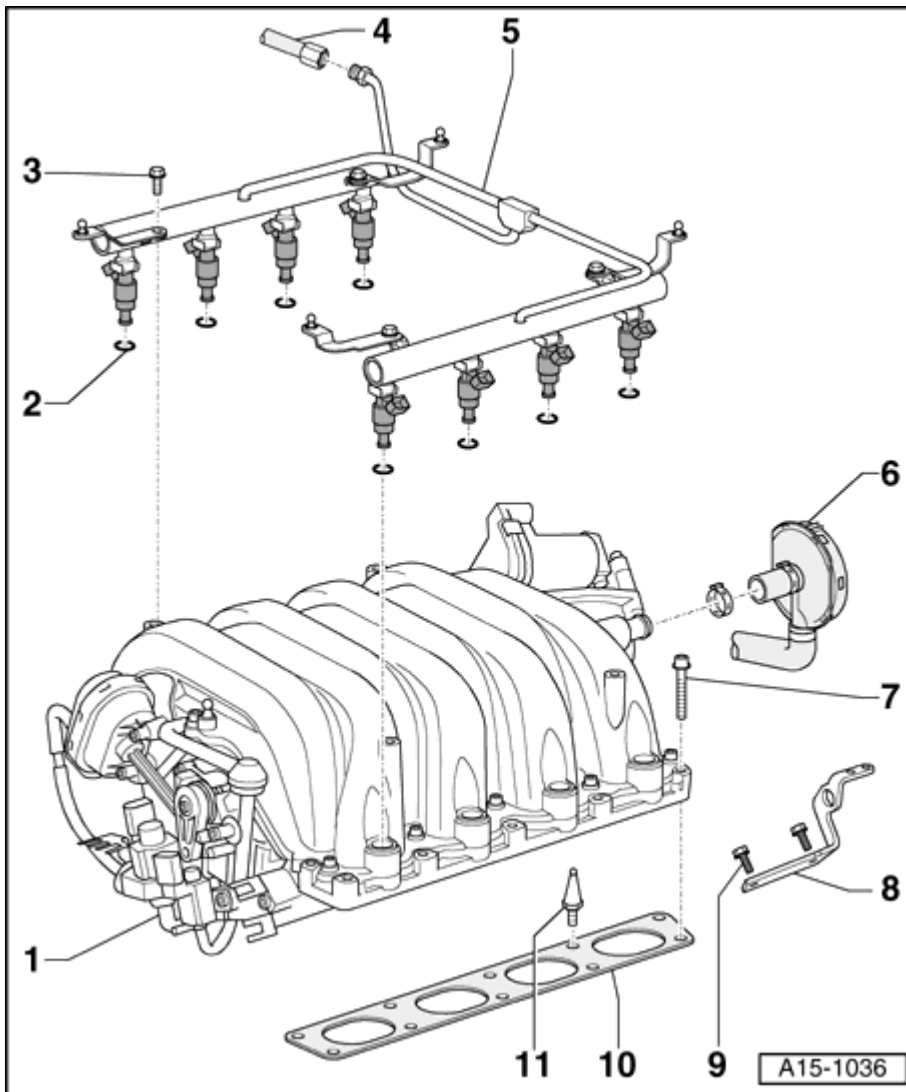


Fig. 520: Intake Manifold, Overview

Courtesy of VOLKSWAGEN UNITED STATES, INC.

1 - Intake manifold

- Removing and installing --> **Intake manifold, removing and installing**

2 - O-rings

- For fuel injectors
- Replace

3 - 10 Nm

4 - Fuel supply line

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- Tighten union nut to 25 Nm

5 - Fuel rail

6 - Pressure regulator valve

- For crankcase ventilation

7 - 10 Nm

- Fasten diagonally in steps

8 - Lifting eye

9 - 23 Nm

10 - Gasket

- For intake manifold
- Replace

11 - Locking pin, 0.6 Nm

Intake manifold, removing and installing

Removing

NOTE:

- All cable ties which are opened or cut open when removing, must be replaced in the same position when installing.
- Remove front and rear engine covers.
 - Disconnect vacuum hose - **3** - to brake booster at bulkhead.

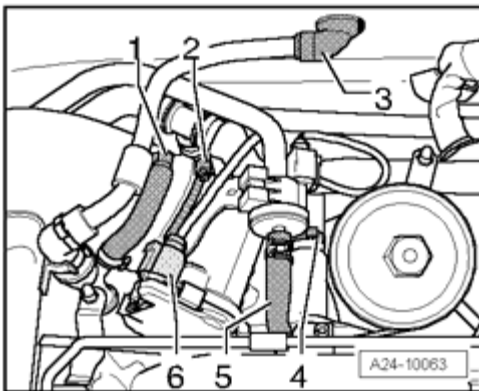


Fig. 521: Disconnecting Throttle Valve Control Module J338 Electrical Harness Connector
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect vacuum hose - 1 -.
- Disconnect electrical connection - 6 - at throttle valve control module J338.

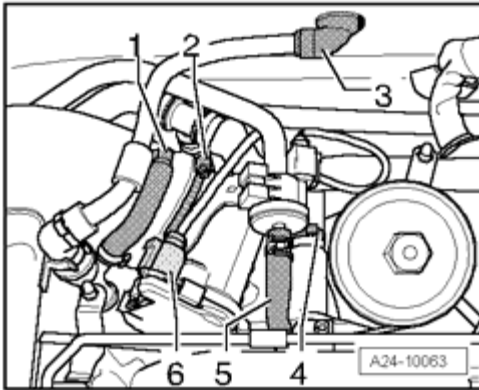


Fig. 522: Disconnecting Throttle Valve Control Module J338 Electrical Harness Connector
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Release hose clamp - 2 - and pull out air duct hose.
- Pull off vacuum hose - 4 - from crankcase breather at intake manifold.

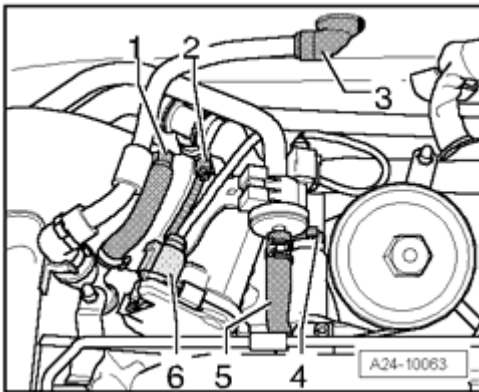


Fig. 523: Disconnecting Throttle Valve Control Module J338 Electrical Harness Connector
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect vacuum hose - 5 - at intake manifold.

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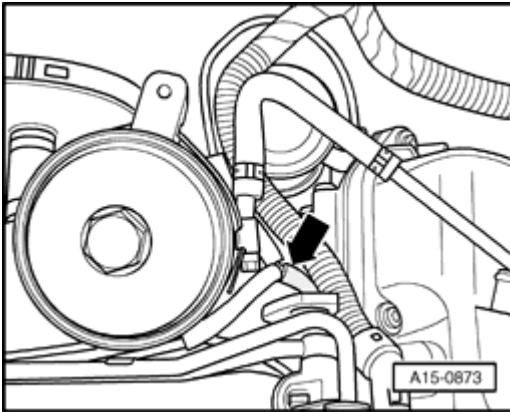


Fig. 524: Disconnecting Vacuum Hose At T-Piece
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect vacuum hose - **arrow** - at T-piece.

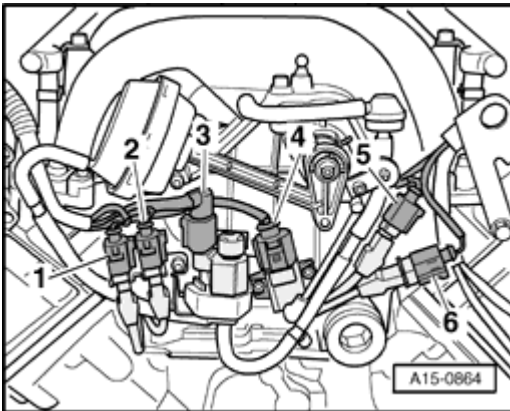


Fig. 525: Remove Electrical Harness Connectors Toward Front From Brackets On Intake Pipe
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove electrical connections 1 through 4 forward from their retainers and off of intake manifold.

NOTE:

- The electrical connections must not be separated.

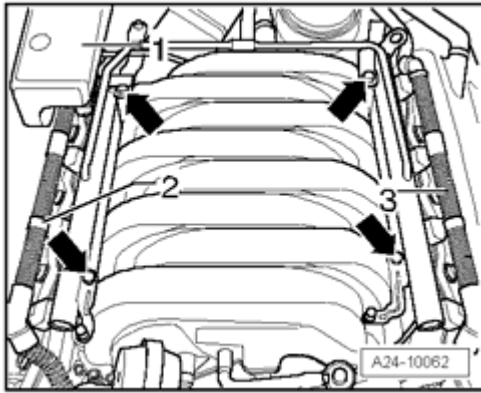


Fig. 526: Pulling Off Connector Strips At Fuel Injectors & Removing Bolts From Fuel Rail
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove connector strips - **2** - and - **3** - at 8 fuel injectors.
- Remove resonance container - **1** -.
- Remove bolts - **arrows** - from fuel rail.
- Pull fuel rail with injectors upward uniformly from intake manifold and set aside in engine compartment on a clean cloth.

NOTE:

- **Carefully protect the removed fuel injectors from contamination.**

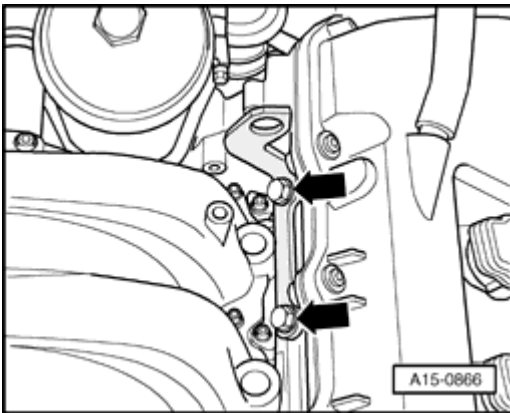


Fig. 527: Removing Left/Rear Engine Lifting Eye
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove left rear engine lifting eye - **arrows** -.

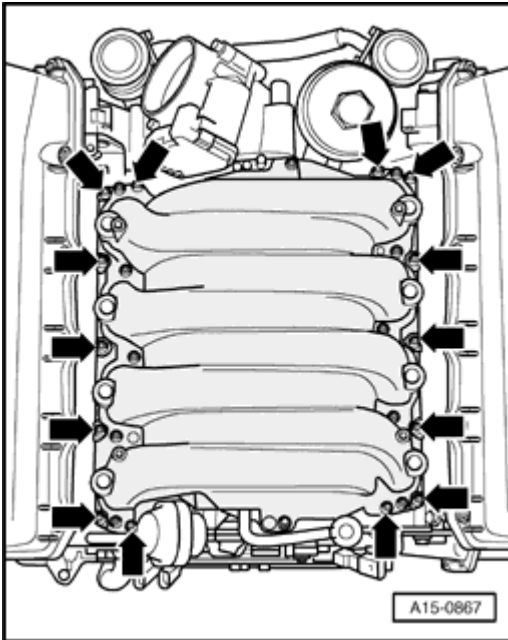


Fig. 528: Removing Intake Manifold Bolts

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove intake manifold bolts - **arrows** - and remove it.

NOTE:

- Plug intake ports of the cylinder head with clean rags.

Installing

Installation is in reverse order of removal, note the following:

NOTE:

- Replace gaskets and O-rings.
- During installation, all cable ties must be re-installed at the same location.
- Secure all hose connections using hose clamps appropriate for the model type

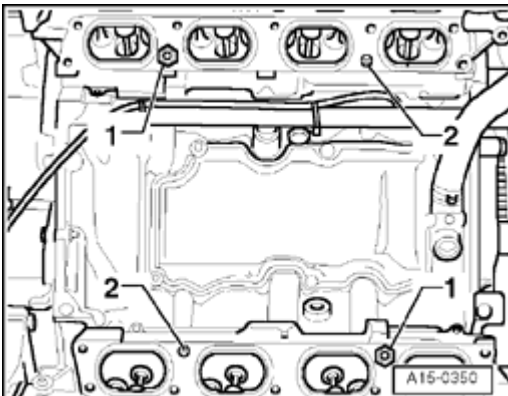


Fig. 529: Replacing Intake Manifold Gaskets, Thereby Removing Locking Bolt
 Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Replace intake manifold gaskets, thereby removing locking bolt - **1** -.
- Be aware of alignment pins - **2** - when setting intake manifold in place.

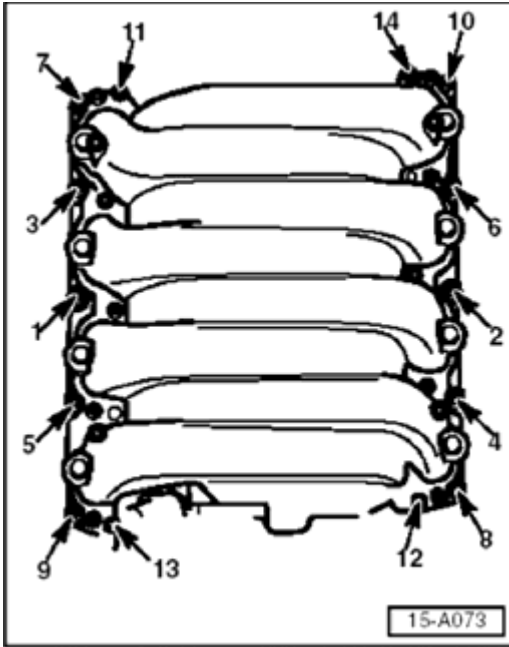


Fig. 530: Tightening Intake Manifold Bolts In Stages And In Sequence
 Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Tighten intake manifold bolts - **arrows** - in stages and in sequence shown.

Intake manifold torque: 11 Nm

- Reconnect all vacuum lines.
- Make sure electrical connections are securely seated.
- Bleed fuel system --> **Fuel system, bleeding**

Torque specifications

Component	Nm
Locking bolt to cylinder head	0.6
Intake manifold to cylinder head	11
Engine lifting eye to cylinder head	22
Fuel rail to intake manifold	10

Fuel system, bleeding

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- Start engine and allow engine to run several minutes at average RPM and then turn off again.

NOTE:

- **At the beginning, engine may run roughly due to air in fuel supply system.**

- Start engine and allow engine to run several minutes at average RPM and then turn off again.
- Check fuel system for leaks.
- Check DTC memory and, if necessary, erase.

CAUTION:

- **Test and measuring equipment must always be secured to the rear seat and be operated from there by a second person.**
- **If test and measuring instruments are operated from the front passengers seat and the vehicle is involved in an accident, there is a possibility that the person sitting in this seat may receive serious injuries when the airbag is triggered.**

- Perform a road test with at least one acceleration at Wide Open Throttle (WOT), and then check fuel system again for leaks.
- After the road test, check DTC memory again.

Fuel pressure regulator and residual pressure, checking

NOTE:

- **The fuel pressure regulator is located in the fuel filter under the fuel tank.**

Special tools, testers and auxiliary items required

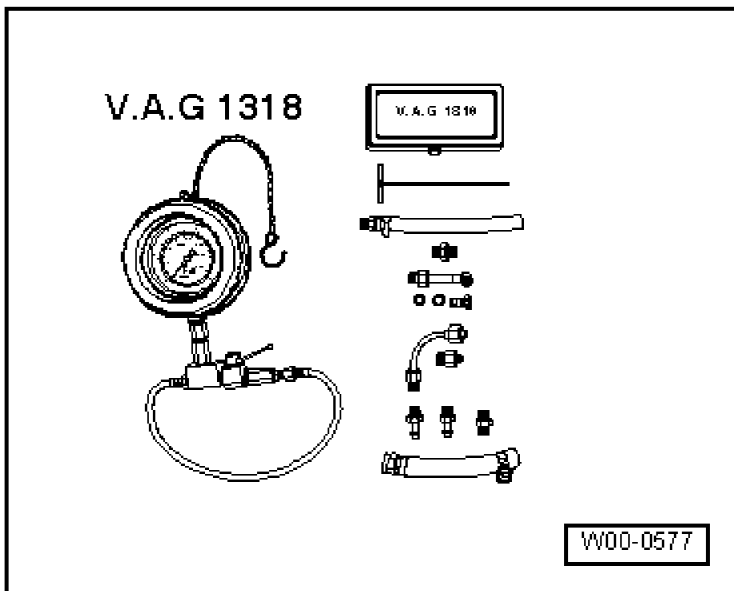


Fig. 531: Identifying Pressure Gauge V.A.G 1318
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Fuel injection pressure gauge V.A.G 1318 with V.A.G 1318/6 and V.A.G 1318/7

Test conditions

- Fuel Pump (FP) Relay OK.
- Fuel Pump (FP) OK.
- Fuel filter OK.
- Battery voltage at least 11 Volts.
- Vehicles with automatic transmission: Selector lever in position P or N
 - Briefly open fuel filler cap (pressure release).
 - Remove engine cover.

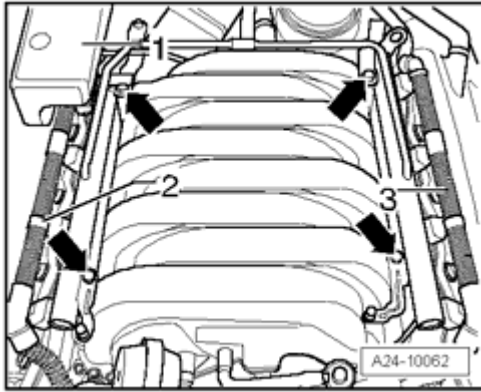


Fig. 532: Pulling Off Connector Strips At Fuel Injectors & Removing Bolts From Fuel Rail
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove resonance container - 1 -.

CAUTION: Fuel system is under pressure! Before loosening hose connections or opening the test connection (for fuel pressure testing), place rags around the connection area. Then release pressure by carefully loosening the connection.

- Cover threaded connections that hold fuel pressure (fuel supply) with a shop rag.

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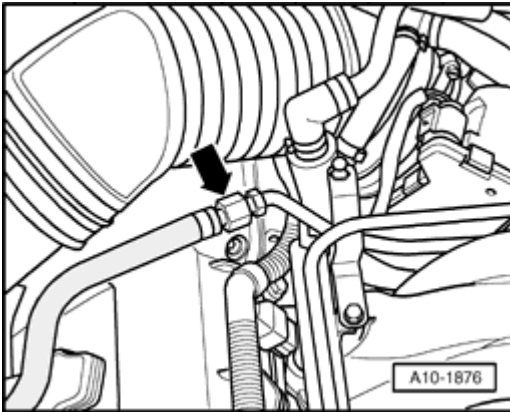


Fig. 533: Identifying Threaded Connection

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Open threaded connection - **arrow** - and catch escaping fuel using a shop rag.

NOTE:

- **The fuel line is routed differently.**

- Install fuel injection pressure gauge V.A.G 1318 with adapters V.A.G 1318/6 and 1318/7 between fuel supply line and fuel rail.

NOTE:

- **The shut-off valve of fuel injection pressure gauge V.A.G 1318 must be installed on the tank-side (fuel supply line)!**

- Open shut-off valve of pressure gauge. The lever points in direction of flow.
- Start engine and run at idle speed.
- Measure fuel pressure.

Specified value: approx. 4 bar positive pressure

- Switch off ignition.
- Check for leaks and for residual pressure by observing pressure loss on pressure gauge.

After 10 minutes there must be a residual pressure of at least 2.5 bar.

The holding pressure drops below 2.5 bar:

- Start engine and run at idle speed.

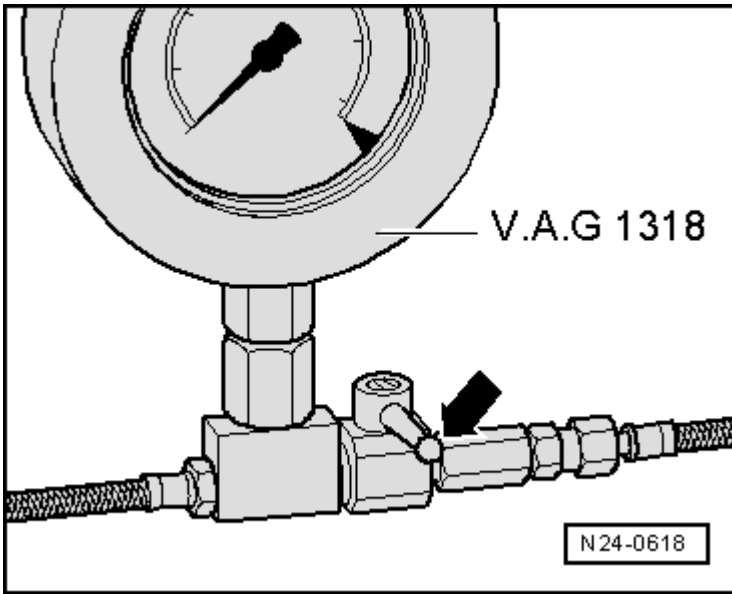


Fig. 534: Locating V.A.G 1318 Shut-Off Tap

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Wait until pressure has built up, then switch off ignition. Simultaneously close shut-off valve of fuel injection pressure gauge V.A.G 1318 (lever perpendicular to direction of flow).
- Watch pressure drop on gauge.

If pressure drops again:

- There is a leak in threaded connection between pressure gauge and fuel supply line.
- Check pressure gauge for leaks.
- Check line connections, O-rings at fuel rail and fuel injectors for leaks.

If the pressure does not drop:

- Replace fuel filter. --> **20 - FUEL SUPPLY**
- Test check-valve of Fuel Pump (FP) --> **20 - FUEL SUPPLY**

Checking for leaks, injection quantity and spray pattern of fuel injectors

Test conditions

- Fuel pressure OK.

Fuel rail, removing and installing

CAUTION: Fuel system is under pressure! Before loosening hose connections or opening the test connection (for fuel pressure testing), place rags around the connection area. Then release pressure by carefully loosening the

connection.

- Remove engine cover.
- Remove connectors from fuel injectors.

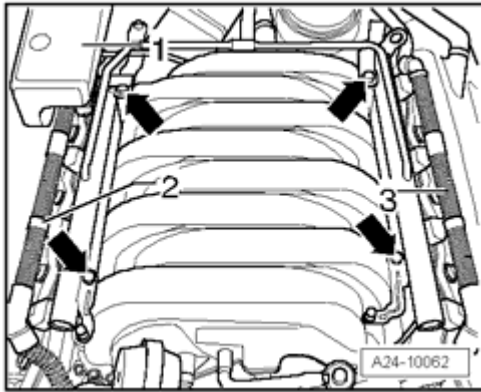


Fig. 535: Pulling Off Connector Strips At Fuel Injectors & Removing Bolts From Fuel Rail
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove resonance container - 1 -.
- Cover threaded connections that hold fuel pressure (fuel supply) with a shop rag.
- Open threaded connection - **arrow** - and catch escaping fuel using a shop rag.

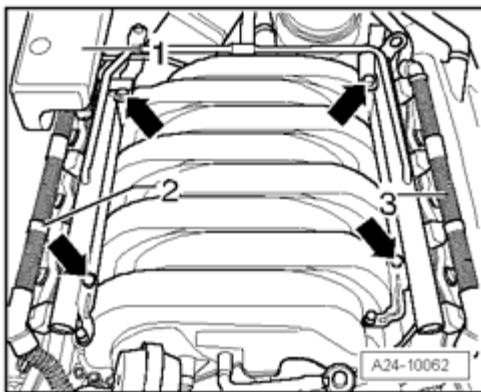


Fig. 536: Pulling Off Connector Strips At Fuel Injectors & Removing Bolts From Fuel Rail
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove fuel rail from intake manifold - **arrows** - and pull it with fuel injectors upward and off from intake manifold.

Installation of fuel rail with fuel injectors is the same in reverse order. Observe the following points when installing:

- Replace O-rings at all opened connection points. (To replace front O-rings, push O-rings over plastic cap

at head of the injector - under no circumstances may plastic cap be removed).

- Lubricate O-rings with clean engine oil.
- Check clips for proper seating.
- Fasten fuel rail to intake manifold with 10 Nm.

Injectors, checking for leaks

- Remove engine cover.
- Disconnect connectors from fuel injectors.

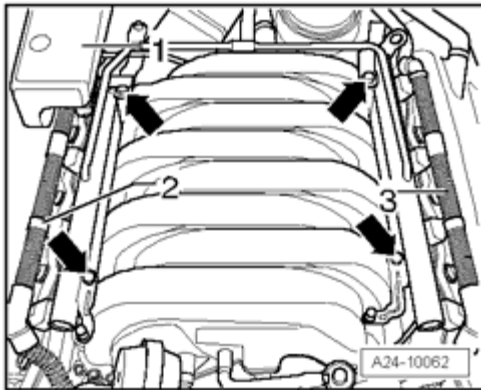


Fig. 537: Pulling Off Connector Strips At Fuel Injectors & Removing Bolts From Fuel Rail
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove resonance container - 1 -.
- Remove fuel rail from intake manifold - **arrows** - and pull it with fuel injectors upward and off from intake manifold.

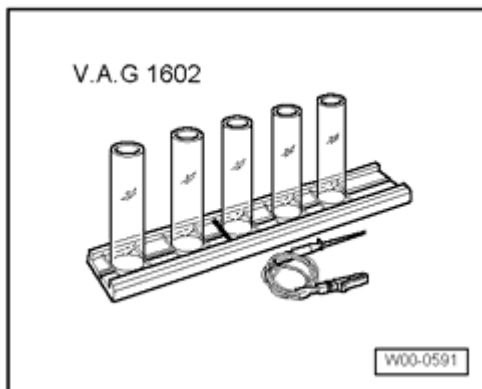


Fig. 538: Identifying Injection Quantity Tester VAG 1602
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Insert fuel injector to be tested into measuring container of fuel injection quantity tester V.A.G 1602.
- Connect test box V A G 1598/31 at wiring harness to engine control module (ECM) do not connect ECM

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--> **Wiring and components, checking with adapter cable (121-pin) V.A.G 1598/31 test box.**

- Bridge terminals 1 and 65 at test box using adapter cables from connector test set V.A.G 1594 C (this step supplies Ground (GND) to one side of relay coil of Fuel Pump -FP- relay).
- Switch ignition on.

NOTE:

- **After switching ignition on, Fuel Pump (FP) will run continuously, even with engine not running for the following reason: after switching ignition on, Fuel Pump (FP) relay supplies continuous B+ via central electronics. Ground is supplied to the FP relay via the bridge in test box.**

- Check fuel injector for leaks (visual check). Only 1 to 2 drops per minute may emit from each valve when fuel pump is running.
- If fuel loss is greater, stop Fuel Pump (FP) from running (switch off ignition) and replace faulty fuel injector.

Injection quantity, checking

- Insert fuel injector to be tested into measuring container of fuel injection quantity tester V.A.G 1602.

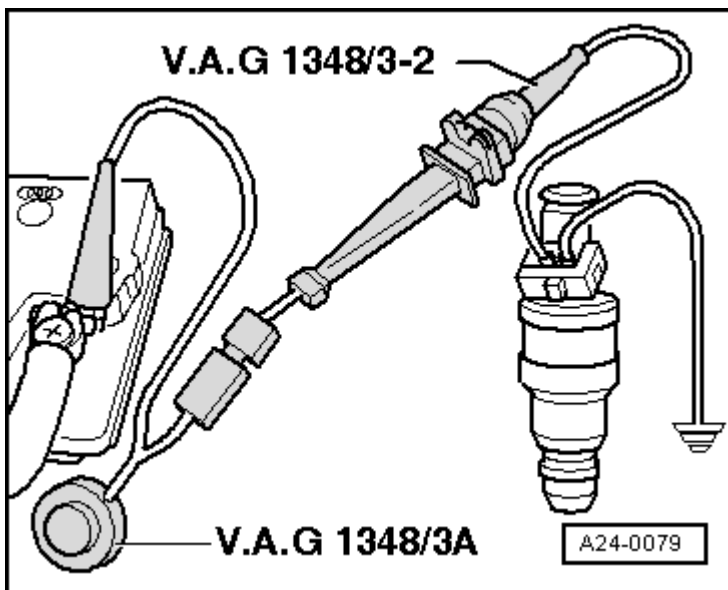


Fig. 539: Connecting Second Injector Contact To Remote Control V.A.G 1348/3 With V.A.G 1348/3-2
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Connect one terminal of fuel injector to engine Ground (GND) using an adapter cable and an alligator clip from connector test set V.A.G 1594 C.
- Connect second contact of fuel injector with remote control for VAG 1348 V.A.G 1348/3 A , adapter cable V.A.G 1348/3 - 2 and assisting cable to Positive (B+).
- Bridge terminals 1 and 65 at test box using wires from connector test set V.A.G 1594 C.
- Switch ignition on.

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- Fuel Pump (FP) must run.
 - Operate remote control for VAG 1348 V.A.G 1348/3 A for 30 seconds.
 - Perform measurement with all fuel injectors.
 - After all 4 fuel injectors have been activated, place measuring containers on a level surface.

Specified value per fuel injector: 105 to 125 ml

If specified value is not obtained for all fuel injectors:

- Check fuel pressure --> **Fuel pressure regulator and residual pressure, checking.**

If specified value is not obtained for only one fuel injector:

- Replace appropriate fuel injector.

NOTE:

- **While checking the injection quantity, the spray pattern should also be checked. Spray pattern must be the same for all injectors.**

Installation of fuel rail with fuel injectors is the same in reverse order. Observe the following points when installing:

- Replace O-rings at all opened connection points. (To replace the front O-rings, push the O-rings over the plastic cap at the head of the injector - under no circumstances may the plastic cap be removed).
- Lubricate O-rings with clean engine oil.
- Check clips for proper seating.
- Fasten fuel rail to intake manifold with 10 Nm.

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



Fig. 540: V.A.G 1598/31 Test Box

Courtesy of VOLKSWAGEN UNITED STATES, INC.

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NOTE:

- The test box adapter cable (121-pin) V.A.G 1598/31 is designed so that it can be connected simultaneously to the engine control module harness and the engine control module itself.
- This is advantageous because electronic engine control remains fully functional (e.g. measurement of signals with engine running) when the test box is attached.
- The procedures will indicate whether the engine control module is to remain connected to the test box or not.
- To connect testing devices to the test box V.A.G 1598/31, always use adapters from connector test set V.A.G 1594 C.

CAUTION: To avoid damaging electronic components, switch to the corresponding measuring range and observe all test conditions before connecting the test leads.

Special tools, testers and auxiliary items required

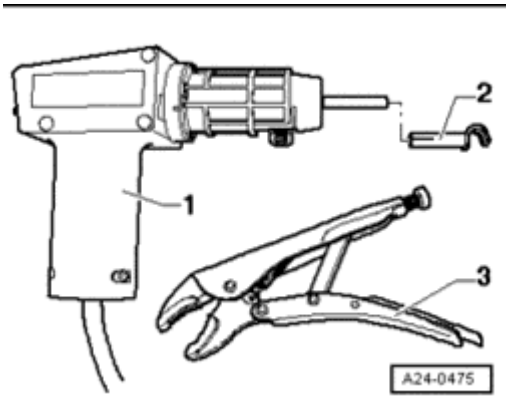


Fig. 541: Heat Gun, Adapter Nozzle And Pliers

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Heat gun - 1 - from wiring harness repair kit VAS 1978
- Nozzle attachment - 2 - also from wiring harness repair kit VAS 1978
- Small, commercially available locking pliers (vise grips)

CAUTION: By heating the threads, the retaining tabs, shear bolts and parts of the metal housing become very hot. Do not burn yourself on this! Make sure that only the threads are heated as much as possible, and not any of the surrounding parts. Possibly cover these parts.

Work steps

- Switch off ignition.

- Remove rubber seal - 1 - for plenum chamber cover.

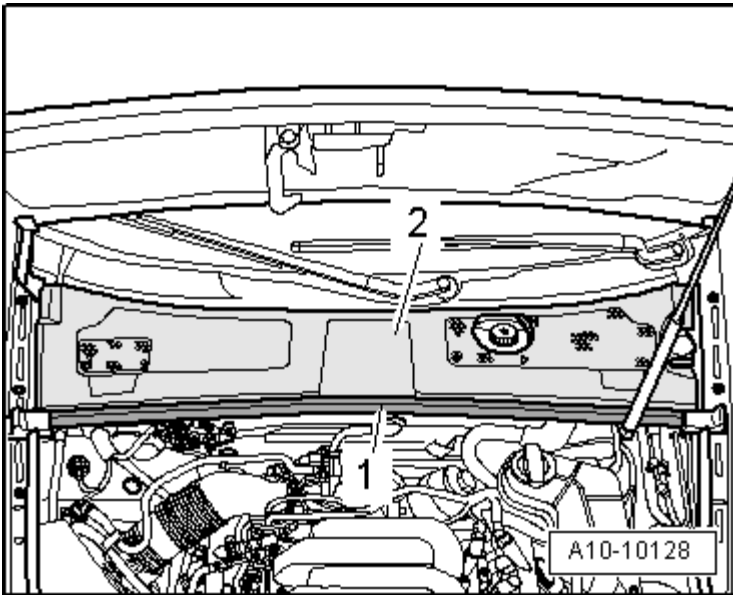


Fig. 542: Removing Rubber Seal For Plenum Chamber Cover & Plenum Chamber Cover
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove plenum chamber cover - 2 -.
- Pry off caps on wiper arms with a screwdriver and remove nuts.
- Pull wiper arms from wiper axles.

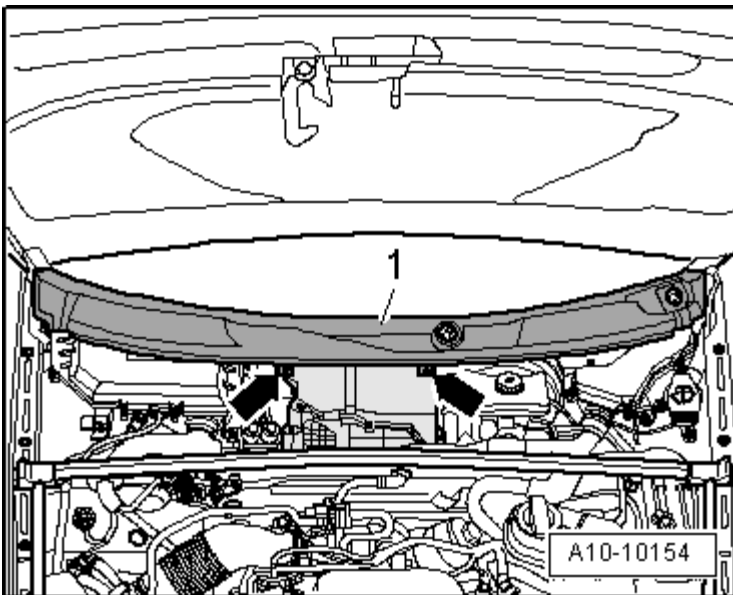


Fig. 543: Removing Bolts For Cowl Grill
Courtesy of VOLKSWAGEN UNITED STATES, INC.

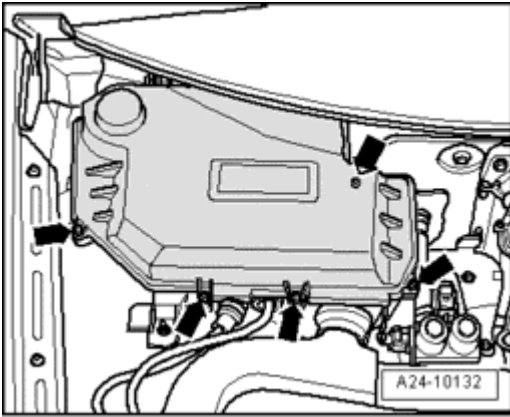


Fig. 544: Removing Bolts And Cover Form E-Box
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - **arrows** - and remove cover form E-box.

CAUTION: The heater pump valve unit (left of E-box) becomes very hot during operation - Risk of burning!

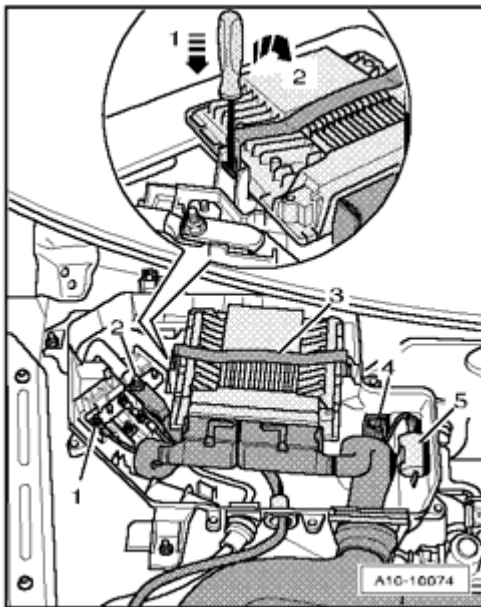


Fig. 545: Prying Off Retaining Clip With Screwdriver And Removing ECM From E-Box
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Carefully pry off retaining clip - **3** - with a screwdriver - **arrows 1 and 2** - and remove ECM from E-box.

To increase difficulty with which ECM connectors can be accessed, the ECM is secured in a metal housing with retaining tabs and shear bolts.

this reason, threads must be heated with heat gun to remove both bolts.

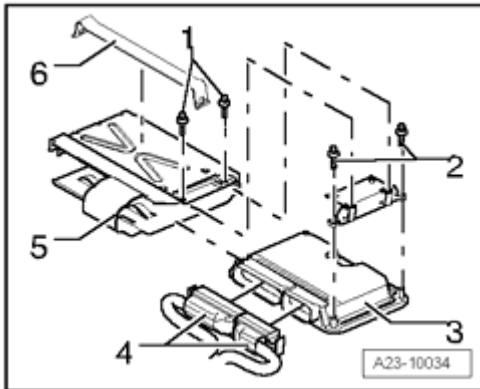


Fig. 546: Identifying ECM Shear Bolts

Courtesy of VOLKSWAGEN UNITED STATES, INC.

The threads of both shear bolts - 2 -, that are installed into the ECM, are not coated with a locking compound. The threads in the ECM housing must not be heated and do not require to be heated (unintentional heating of the ECM).

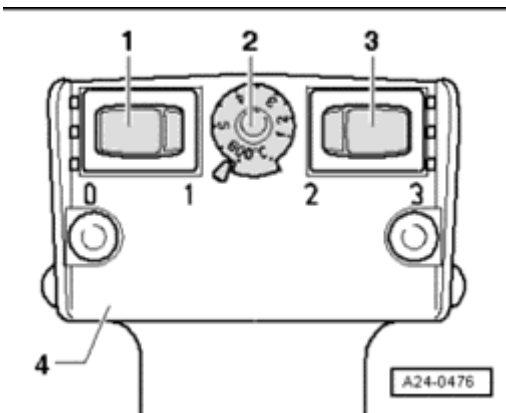


Fig. 547: Performing Adjustments On Hot Air Gun

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Set adjustment on heat gun as shown in the illustration, with temperature potentiometer - 2 - set to maximum heat and two-stage air flow switch - 3 - set to level 3.

CAUTION: By heating the threads, the retaining tabs, shear bolts and parts of the metal housing become very hot. Do not burn yourself on this! Make sure that only the threads are heated as much as possible, and not any of the surrounding parts. Possibly cover these parts.

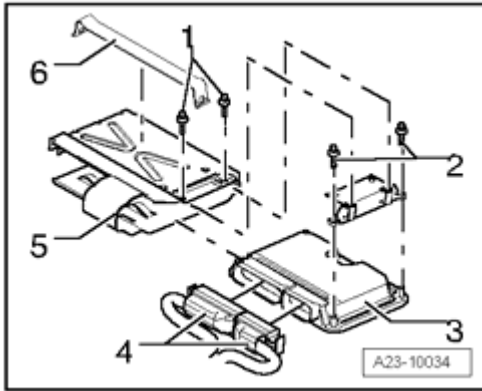


Fig. 548: Identifying ECM Shear Bolts

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Heat threads of both shear bolts - 1 - for approx. 25 to 30 seconds.
- Remove shear bolts with locking pliers.
- Both shear bolts that are installed into the ECM do not require heating to be removed. They can be removed without heat.
- Disconnect metal retainers from ECM connectors.
- Release and pull off connector from engine control module (ECM).
- Connect adapter cable (121-pin) V.A.G 1598/31 to wiring harness connector. Ground (GND) clip at test box must be clipped to battery minus. The procedures will indicate whether engine control module is to be connected to test box.
- Perform test as described in relevant repair sequences.

Installing engine control module (ECM) J623

Installation is in reverse order of removal.

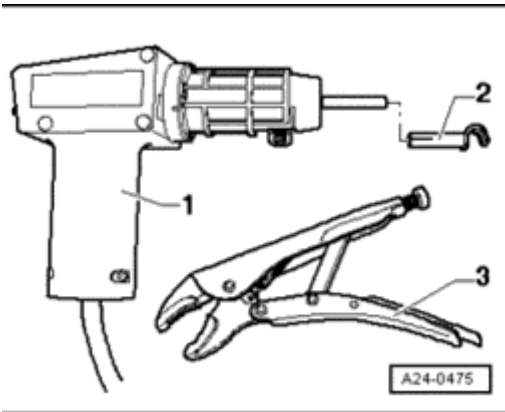
- The ECM must be equipped with metal retainer again.
- New shear bolts must always be used.
- Clean threaded holes of residue and locking compound for new shear bolts. Cleaning can be performed with a thread cutter (tap).
- Check DTC memory and, if necessary, erase. Vehicle diagnostic, testing, and information system VAS 5051

Engine Control Module (ECM) J623 , replacing

NOTE:

- When connector is disconnected from the Engine Control Module (ECM), adaptation values are erased and content of DTC memory remains intact.

Special tools, testers and auxiliary items required

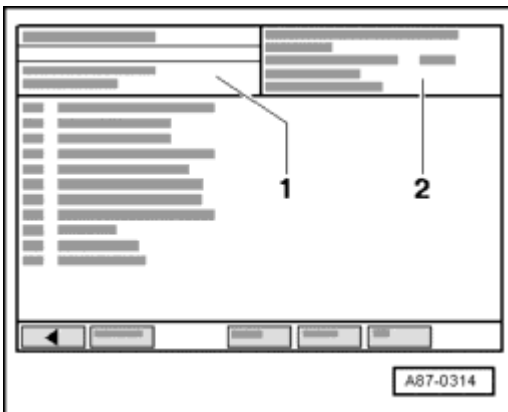
**Fig. 549: Heat Gun, Adapter Nozzle And Pliers**

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Heat gun - 1 - from wiring harness repair kit VAS 1978
- Nozzle attachment - 2 - also from wiring harness repair kit VAS 1978
- Small, commercially available locking pliers (vise grips)

Removing

- Connect vehicle diagnostic, testing, and information system VAS 5051 A and select vehicle system "01 - Engine electronics". Thereby, the ignition must be switched on.

**Fig. 550: Locating Control Module Identification With Code Indicated On Display**

Courtesy of VOLKSWAGEN UNITED STATES, INC.

On the screen of vehicle diagnostic, testing, and information system VAS 5051 A , the control module identification and coding - 2 - are displayed.

- Allow control module identification to be displayed and then print it out.
- Switch off ignition.
- Remove rubber seal - 1 - for plenum chamber cover.

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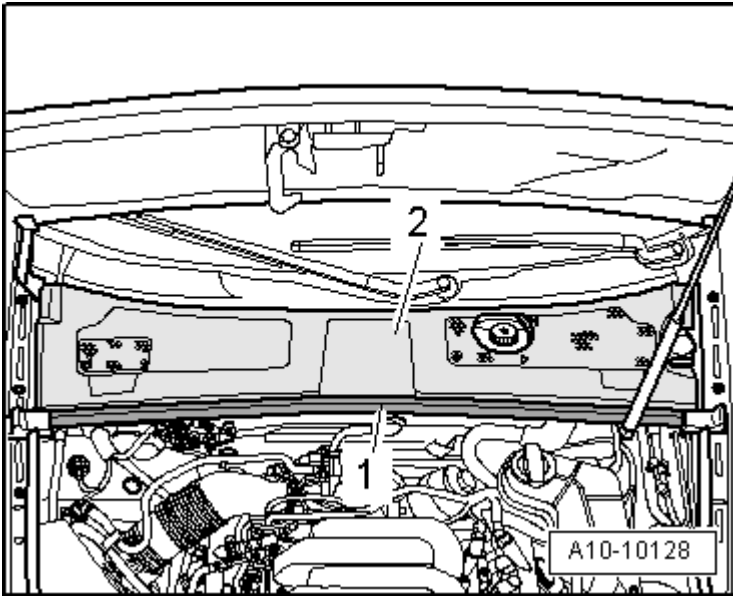


Fig. 551: Removing Rubber Seal For Plenum Chamber Cover & Plenum Chamber Cover
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove plenum chamber cover - 2 -.
- Pry off caps on wiper arms with a screwdriver and remove nuts.
- Pull wiper arms from wiper axles.

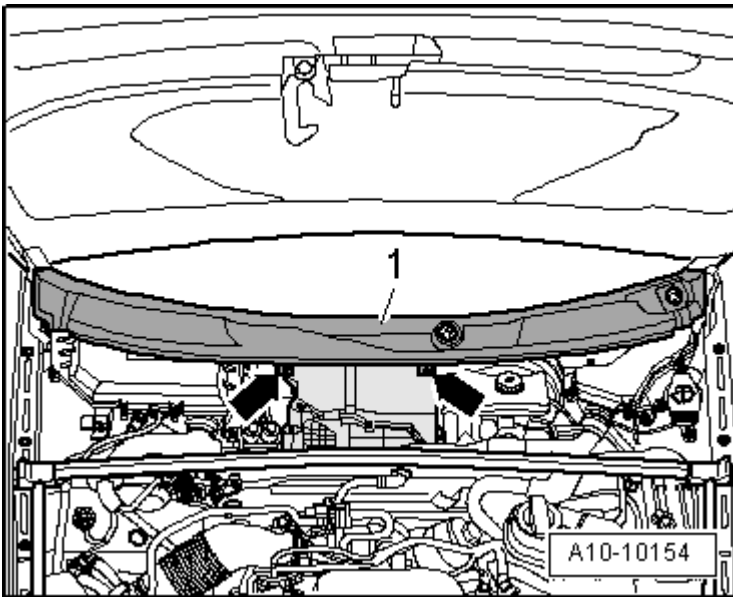


Fig. 552: Removing Bolts For Cowl Grill
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove left and right bolt - **arrows** - from cowl - 1 -.

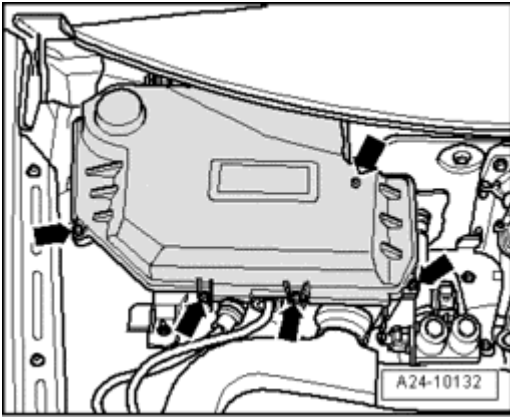


Fig. 553: Removing Bolts And Cover Form E-Box
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove bolts - **arrows** - and remove cover form E-box.

CAUTION: The heater pump valve unit (left of E-box) becomes very hot during operation - Risk of burning!

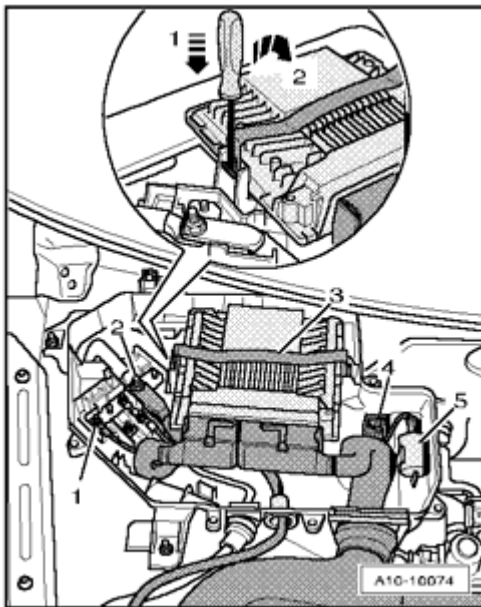


Fig. 554: Prying Off Retaining Clip With Screwdriver And Removing ECM From E-Box
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Carefully pry off retaining clip - **3** - with a screwdriver - **arrows 1 and 2** - and remove ECM from E-box.

To increase difficulty with which the ECM connectors can be accessed, the ECM is secured in a metal housing with retaining tabs and shear bolts.

this reason, the threads must be heated with heat gun to remove both bolts.

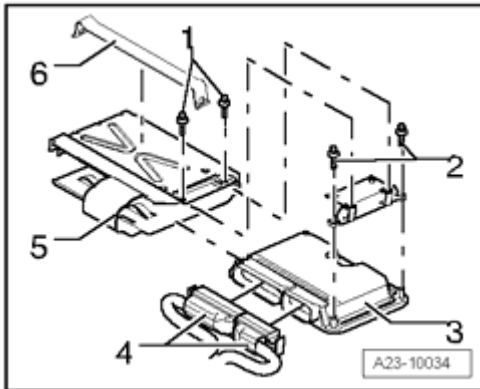


Fig. 555: Identifying ECM Shear Bolts

Courtesy of VOLKSWAGEN UNITED STATES, INC.

The threads of both shear bolts - 2 -, that are installed into the ECM, are not coated with a locking compound. The threads in ECM housing must not be heated and do not require to be heated (unintentional heating of ECM).

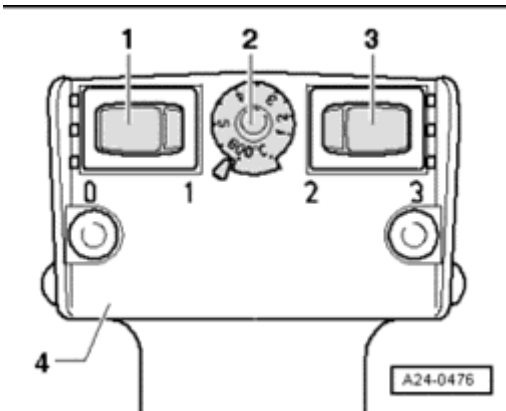
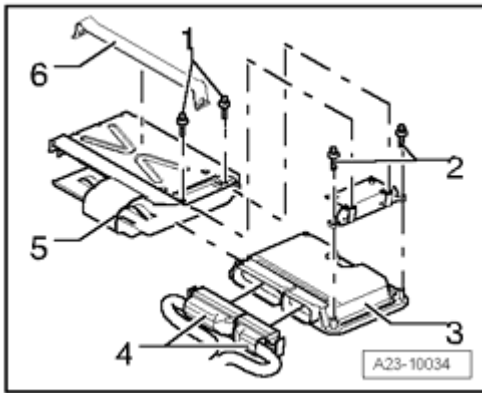


Fig. 556: Performing Adjustments On Hot Air Gun

Courtesy of VOLKSWAGEN UNITED STATES, INC.

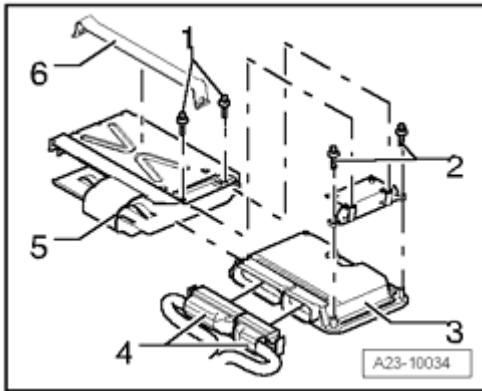
- Set adjustment on heat gun as shown in the illustration, with temperature potentiometer - 2 - set to maximum heat and two-stage air flow switch - 3 - set to level 3.

CAUTION: By heating the threads, the retaining tabs, shear bolts and parts of the metal housing become very hot. Do not burn yourself on this! Make sure that only the threads are heated as much as possible, and not any of the surrounding parts. Possibly cover these parts.

**Fig. 557: Identifying ECM Shear Bolts**

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Heat threads of both shear bolts - **1** - for approx. 25 to 30 seconds.
- Remove shear bolts with locking pliers.
- Both shear bolts that are installed into ECM do not require heating to be removed. They can be removed without heat.
- Disconnect metal retainers from ECM connectors.

**Fig. 558: Identifying ECM Shear Bolts**

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Release connector - **4** - from ECM and disconnect it.
- Remove old engine control module (ECM) J623 and install engine control module (ECM) J623.

Installing

Installation is in reverse order of removal.

- The ECM must be equipped with metal retainer again.
- New shear bolts must always be used.

with a thread cutter (tap).

The procedures to follow after connecting the new ECM are described in Guided Fault Finding and Guided Functions.

- Enter correct vehicle into Guided Fault Finding
- Press "Go to" button
- Select "Function/component selection"
- Select "powertrain"
- Select "engine code"
- "01 - On Board Diagnostic (OBD) capable systems
- "Motronic fuel injection and ignition system"
- Select "Engine Functions"
- Select "Engine Control Module (ECM)"

Mass air flow (MAF) sensor, removing and installing

Removing

- Disconnect connector from mass air flow (MAF) sensor G70 - 2 -.

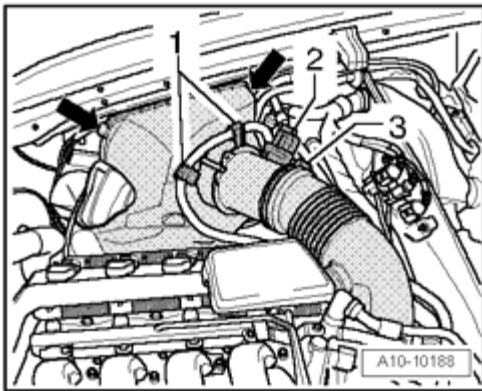


Fig. 559: Disconnecting Mass Air Flow (MAF) Sensor G70 Electrical Harness Connector
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Open hose clamp - 3 - and clips of mass air flow (MAF) sensor G70 and remove mass air flow (MAF) sensor G70.

Installing

For problem-free operation of mass air flow (MAF) sensor G70 it is very important to observe the following notes and procedures.

NOTE:

- If the air filter element is very dirty or soaked, dirt particles or moisture may have contaminated the Mass Air Flow (MAF) Sensor G70 and may be causing false mass air flow values. This results in a reduction of power, since a lower injection quantity is calculated.
 - Always use an original equipment air filter element.
 - Use a lubricant (silicone-free) for installing the intake hose.
 - Secure all hose connections using hose clamps appropriate for the model type
- Check MAF sensor and intake hose (intake air side) for salt residue, dirt, and leaves.
 - Check intake ducting up to air filter element for dirt. If any contaminants are discovered, clean air filter housing (upper and lower parts) of salt residue, dirt and leaves (if necessary, clean by washing or vacuuming). Air filter, removing and installing --> **Air filter, removing and installing**
 - If air filter element was removed, blow out water in lower part of air filter housing with compressed air.

Further installation is in reverse order of removal.

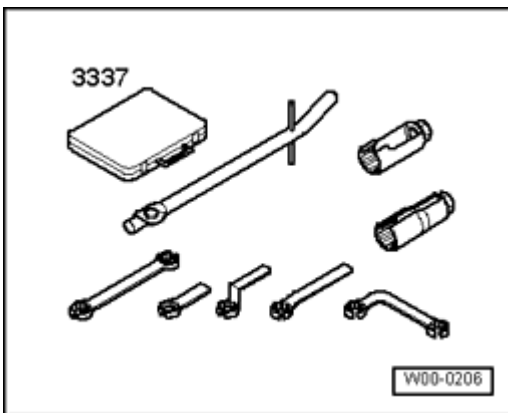
OXYGEN SENSORS, REMOVING AND INSTALLING**Oxygen sensors, removing and installing****Special tools, testers and auxiliary items required**

Fig. 560: Identifying Ring Spanner 7-Piece Set 3337

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Ring spanner 7-piece set 3337 for oxygen sensor

Heated oxygen sensor (HO2S) G39 before catalytic converter, bank 1 (right), removing and installing**NOTE:**

- All cable ties which are opened or cut open when removing, must be replaced in the same position when installing.

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- Remove engine cover.
- Remove MAF sensor with air duct hose between air filter and throttle valve control module J338.

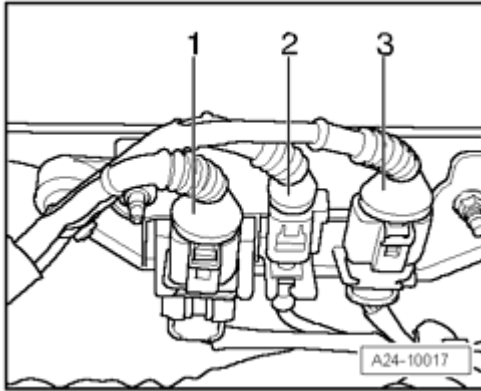


Fig. 561: Connecting Electrical Connector
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Connect electrical connector - 1 -.
- Free up oxygen sensor wire up to oxygen sensor.
- Remove oxygen sensor from between engine and bulkhead, using tool from Ring spanner 7-piece set 3337.

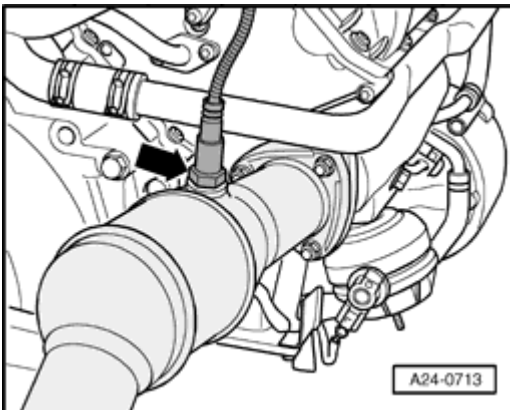


Fig. 562: Removing Heated Oxygen Sensor (HO2S) Using Special Tool 3337
Courtesy of VOLKSWAGEN UNITED STATES, INC.

NOTE: • Shown in illustration with engine removed.

Installing

Installation is in reverse order of removal, note the following:

NOTE: • New oxygen sensor threads are coated with an assembly paste. This paste

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must not contact sensor openings.

- For a used oxygen sensor, only grease threads with hot bolt paste. This paste must not contact sensor openings; Hot bolt paste
- During installation, all cable ties must be re-installed at the same location to prevent the oxygen sensor wiring from contacting the exhaust manifold.

Torque specifications

Component	Nm
Oxygen sensor	55

Heated oxygen sensor (HO2S) 2 G108 before catalytic converter, bank 2 (left), removing and installing

Special tools, testers and auxiliary items required

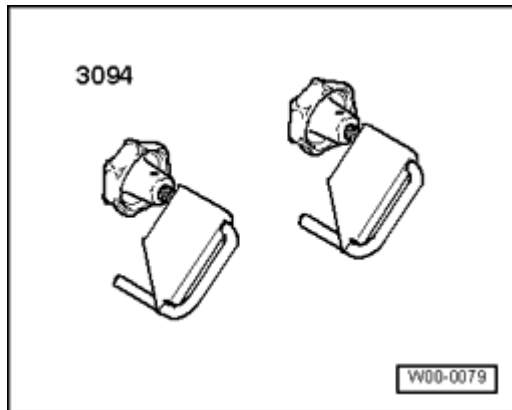


Fig. 563: Identifying Hose Clamps 3094

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Hose Clamps Up to 25 mm dia. 3094

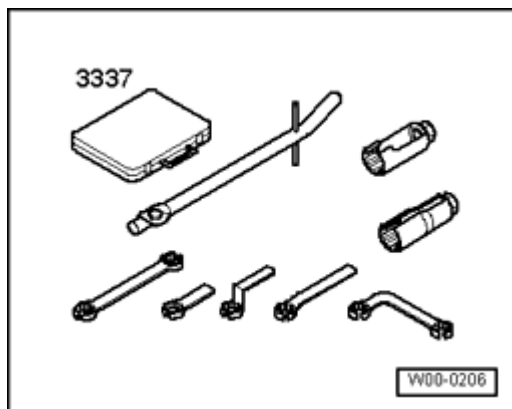


Fig. 564: Identifying Ring Spanner 7-Piece Set 3337

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Ring spanner 7-piece set 3337 for oxygen sensor

Removing

- Remove engine cover.
- Clamp off coolant hose - **2** - using Hose Clamps Up to 25 mm dia. 3094 and pull off coolant hose.
- If necessary, seal connection using an appropriate plug.

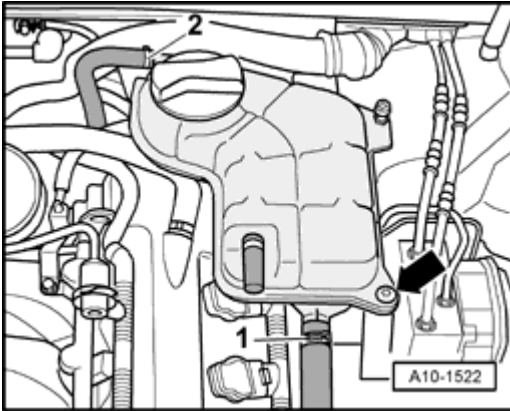


Fig. 565: Removing Coolant Hoses & Coolant Expansion Tank
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove coolant reservoir. - **arrow** -.
- Disconnect electrical wire from engine coolant level (ECL) warning switch F66 at bottom on coolant reservoir and set aside coolant reservoir with coolant hose - **1** - connected.

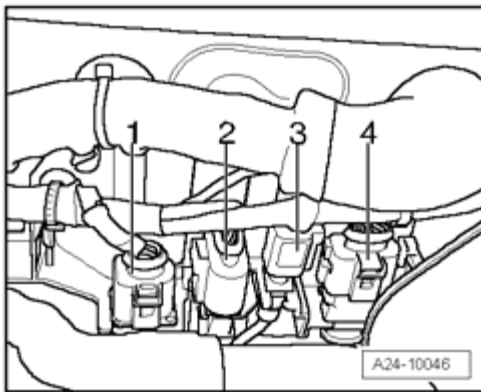


Fig. 566: Identifying Bulkhead Electrical Connector
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect electrical connector - **1** -.
- Remove retainer for 4 electrical connections on bulkhead (to simplify removal and installation of oxygen sensor).
- Free up oxygen sensor wire up to oxygen sensor

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ENGINE 4.2 Liter 8-Cyl. 5V Engine Mechanical Engine Code(s): BAT, BNK

- Remove oxygen sensor from between engine and bulkhead, using tool from Ring spanner 7-piece set 3337.

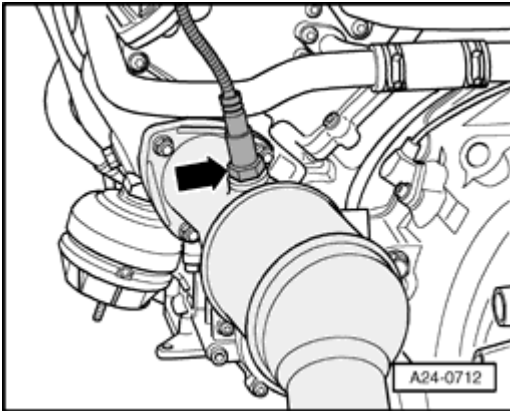


Fig. 567: Removing Heated Oxygen Sensor (HO2S) Using Special Tool 3337
Courtesy of VOLKSWAGEN UNITED STATES, INC.

NOTE: • Shown in illustration with engine removed.

Installing

Installation is in reverse order of removal, note the following:

- NOTE:**
- New oxygen sensor threads are coated with an assembly paste. This paste must not contact sensor openings.
 - For a used oxygen sensor, only grease threads with hot bolt paste. This paste must not contact sensor openings; Hot bolt paste
 - During installation, all cable ties must be re-installed at the same location to prevent the oxygen sensor wiring from contacting the exhaust manifold.
 - Secure all hose connections using hose clamps appropriate for the model type

Torque specifications

Component	Nm
Oxygen sensor	55

Oxygen sensor (O2S) behind three way catalytic converter (TWC) G130 , bank 1 (right), removing and installing

Special tools, testers and auxiliary items required

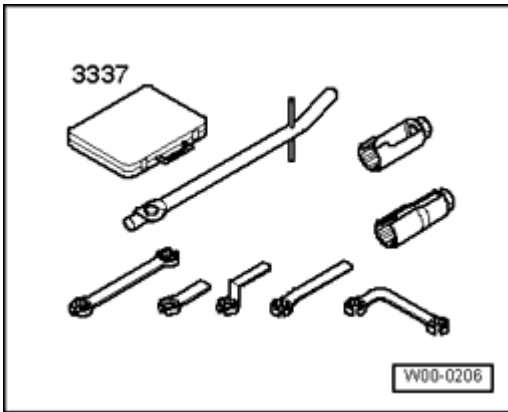


Fig. 568: Identifying Ring Spanner 7-Piece Set 3337
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Ring spanner 7-piece set 3337 for oxygen sensor

Removing

NOTE:

- All cable ties which are opened or cut open when removing, must be replaced in the same position when installing.

- Remove engine cover.
- Remove air duct hose with mass airflow (MAF) sensor and set it aside.

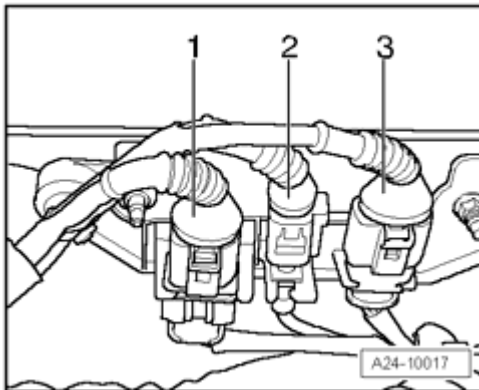


Fig. 569: Connecting Electrical Connector
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect electrical connector - 3 -.
- Free up oxygen sensor wire up to oxygen sensor.
- Remove noise insulation.
- Remove right front exhaust pipe --> **26 - EXHAUST SYSTEM, EMISSION CONTROLS**

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ENGINE 4.2 Liter 8-Cyl. 5V Engine Mechanical Engine Code(s): BAT, BNK

Installing

Installation is in reverse order of removal, note the following:

NOTE:

- New oxygen sensor threads are coated with an assembly paste. This paste must not contact sensor openings.
- For a used oxygen sensor, only grease threads with hot bolt paste. This paste must not contact sensor openings; Hot bolt
- During installation, all cable ties and clips on transmission must be re-installed at the same location to prevent the oxygen sensor wiring from contacting the exhaust manifold.

- Install exhaust system so it is free of tension. --> **26 - EXHAUST SYSTEM, EMISSION CONTROLS**

Torque specifications

Component	Nm
Oxygen sensor at catalytic converter	55

Oxygen Sensor (O2S) 2 Behind Three Way Catalytic Converter (TWC) G131 , bank 2 (left), removing and installing

Special tools, testers and auxiliary items required

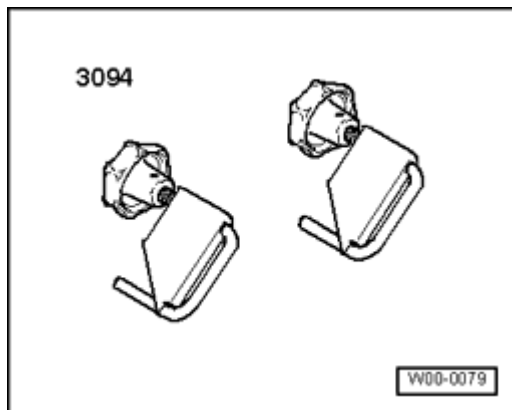


Fig. 570: Identifying Hose Clamps 3094

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Hose Clamps Up to 25 mm dia. 3094

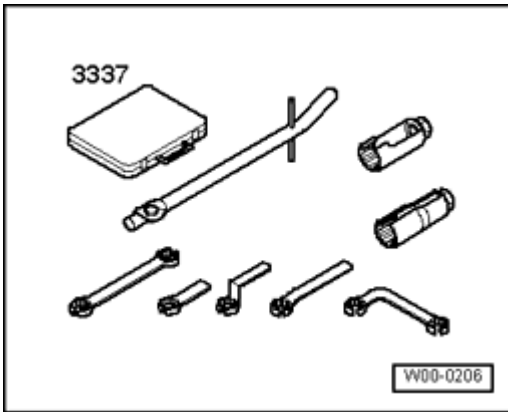


Fig. 571: Identifying Ring Spanner 7-Piece Set 3337
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Ring spanner 7-piece set 3337 for oxygen sensor

Removing

NOTE:

- All cable ties which are opened or cut open when removing, must be replaced in the same position when installing.

- Remove engine cover.
- Clamp off coolant hose - 2 - using Hose Clamps Up to 25 mm dia. 3094 and pull off coolant hose.
- If necessary, seal connection using an appropriate plug.

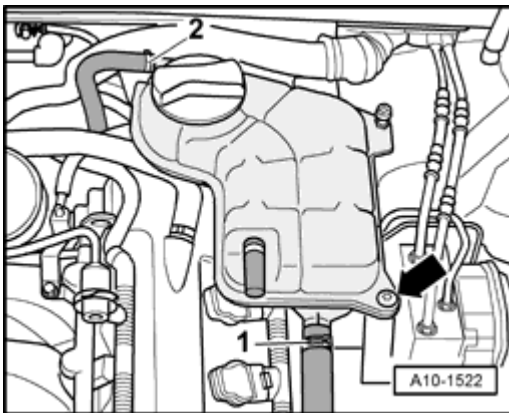


Fig. 572: Removing Coolant Hoses & Coolant Expansion Tank
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove coolant reservoir. - **arrow** -.
- Disconnect electrical wire from engine coolant level (ECL) warning switch F66 at bottom on coolant reservoir and set aside coolant reservoir with coolant hose - 1 - connected.

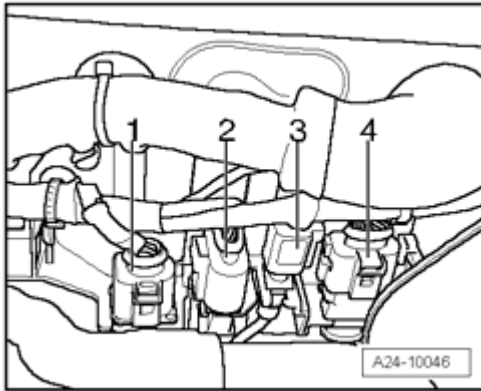


Fig. 573: Identifying Bulkhead Electrical Connector
Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Disconnect electrical connector - 4 -.
- Remove retainer for 4 electrical connections on bulkhead (to simplify removal and installation of oxygen sensor).
- Free up oxygen sensor wire up to oxygen sensor.
- Remove rear noise insulation.

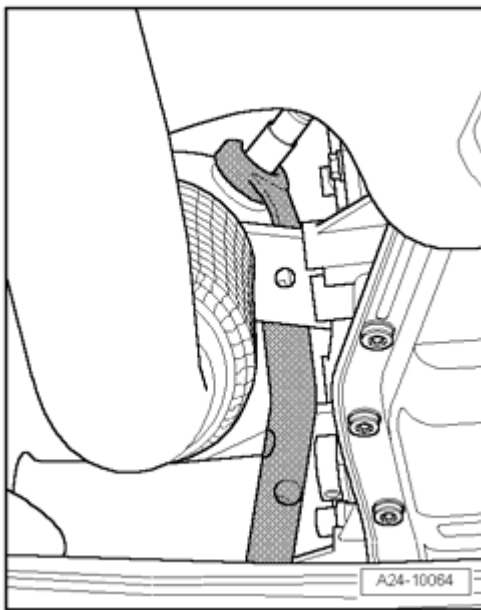


Fig. 574: Removing Oxygen Sensor Using Tool 3337/5 And Extension 3337/6 From Ring Spanner 7-Piece Set 3337

Courtesy of VOLKSWAGEN UNITED STATES, INC.

- Remove oxygen sensor using tool 3337/5 and the extension 3337/6 from Ring spanner 7-piece set 3337.

Installing

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ENGINE 4.2 Liter 8-Cyl. 5V Engine Mechanical Engine Code(s): BAT, BNK

Installation is in reverse order of removal, not the following:

NOTE:

- New oxygen sensor threads are coated with an assembly paste. This paste must not contact sensor openings.
- For a used oxygen sensor, only grease threads with hot bolt paste. This paste must not contact sensor openings; Hot bolt paste
- During installation, all cable ties and clips on transmission must be re-installed at the same location to prevent the oxygen sensor wiring from contacting the exhaust manifold.
- Secure all hose connections using hose clamps appropriate for the model type

Torque specifications

Component	Nm
Oxygen sensor	55