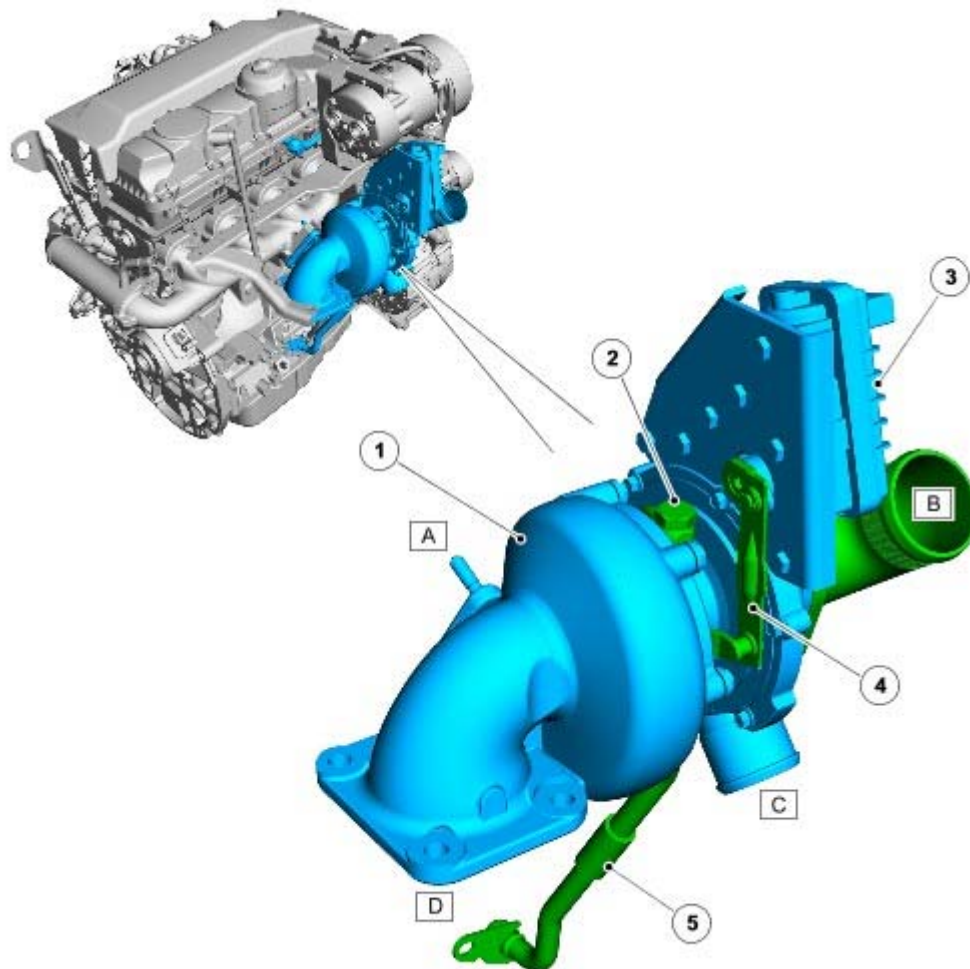


Specifications

Description	Nm	lb-ft
Turbocharger inlet duct bolts	23	17
Turbocharger nuts	23	17
Turbocharger oil return tube	10	7
Turbocharger oil supply pipe	35	26
Catalytic converter nuts	45	33
Catalytic converter lower mounting bracket bolts	30	22
Front muffler to catalytic converter nuts	30	22
Turbocharger mounting bracket	20	15
Turbocharger heat shield	10	7
Turbocharger to charge air cooler clip	3	2

Turbocharger

COMPONENT LOCATION



E86485

Item	Part Number	Description
A		Exhaust manifold connection
B		Intake air connection
C		Charge air cooler connection
D		Exhaust pipe connection
1		Turbine housing
2		Oil feed
3		Actuator motor
4		Actuator lever
5		Oil return

OVERVIEW

The variable vane turbocharger, fitted to the exhaust manifold, makes it possible to vary the exhaust gas flow of the turbine, dependent on engine operation. This improves the power transfer to the turbine wheel and compressor, particularly at low engine speeds, thus increasing the boost pressure. The guide vanes are opened progressively as the engine speed increases so that the power transfer always remains in balance with the required charger speed and the required boost pressure level. Variable vanes facilitate better use of the exhaust gas energy so as to further

improve the efficiency of the turbocharger and thus of the engine, compared to the more conventional 'wastegate control'.

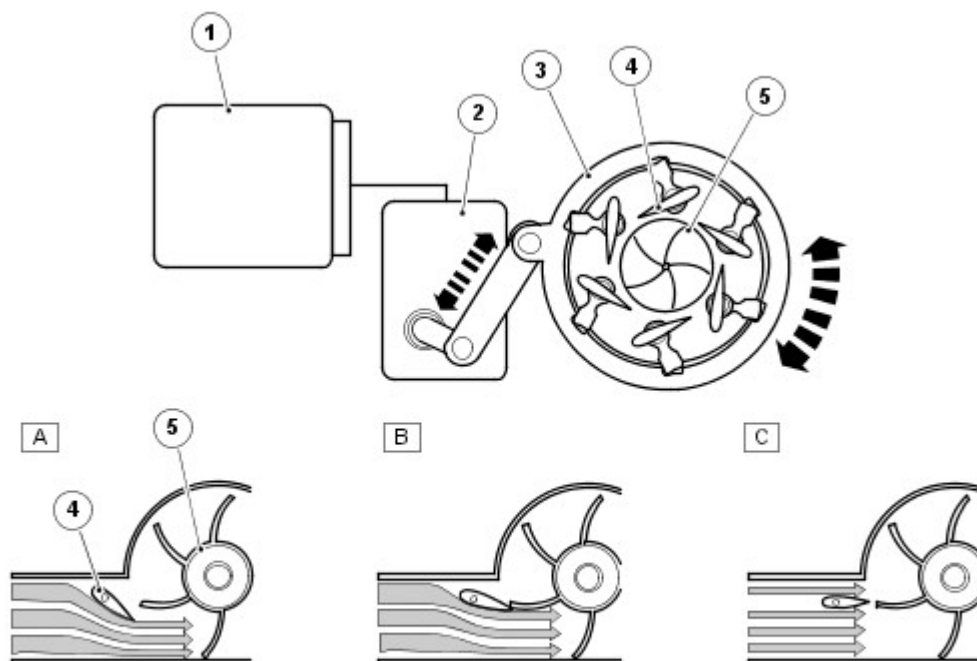
Advantages:

- High torque at both high and low engine speeds
- Continuous and optimum adjustment for all engine speeds
- No wastegate valve required, exhaust energy is better utilised, less back-pressure in conjunction with same compressor work
- Low thermal and mechanical load improves engine power output
- Lower emissions
- Optimised fuel consumption over the entire engine speed range

A Direct Current (DC) rotary actuator motor operates a drive shaft. The drive shaft is connected to the vanes by an actuating lever. Adjustment of the vanes is achieved by moving the actuating lever. When the drive shaft is turned, a signal is created at the end of the drive shaft; this feedback signal is used to determine the angular position of the vanes. This information is transmitted to the Engine Control Module (ECM).

The turbocharger is designed for fail safe operation. If a fault occurs regarding the control of the unit, the vanes default to the fully open position so as to produce minimum boost. The ECM detects any malfunctions in the stepper motor and generates Diagnostic Trouble Codes (DTC).

PRINCIPLES OF OPERATION



E80503

Item	Part Number	Description
A		Low engine speed
B		Moderate engine speed
C		Maximum engine speed
1		ECM
2		Actuator motor
3		Adjusting ring
4		Vanes
5		Turbine

A - Low Engine Speed

At low engine speeds the volume of exhaust gas is low so the vanes are moved towards the closed position to reduce the turbine inlet area. This reduction causes an increase in the gas velocity into the turbine wheel thereby increasing wheel speed and boost.

B - Moderate Engine Speed

As the engine speed increases and the volume of exhaust gas increases the vanes are moved towards the open position to increase the turbine inlet area and maintain the gas velocity.

C - Maximum Engine Speed

At maximum engine speed the vanes are almost fully open maintaining the gas velocity into the turbine wheel.

Barometric Pressure Sensor

When the vehicle is driven at high altitudes the ambient pressure reduces causing the compressor wheel to do less work for the same boost pressure. To prevent the turbine wheel from over-speeding under these conditions a barometric pressure sensor, located in the ECM, protects the turbocharger by opening the vanes further to reduce the turbine wheel speed. This is known as the altitude margin of the turbocharger.

Turbocharger Lubrication

The rapid acceleration and deceleration response demands of the turbocharger rely greatly on a steady flow of clean oil. The oil supplied from the engine's lubrication system provides lubrication to the turbocharger's spindle and bearings, while also acting as a coolant for the turbocharger centre housing.

To maintain the life expectancy of the turbocharger, it is essential that the oil has a free-flow through the turbocharger and unrestricted return to the engines sump. It is therefore imperative that the engine oil is replenished at regular service intervals with the recommended quality and quantity of oil.

Charge Air Cooler

The charge air cooler is used to increase the density of air as it flows from the turbocharger compressor to the intake manifold.

Compression of the charge air by the turbocharger raises the temperature of the air. This generation of heat expands the air density and consequently less oxygen is able to enter the cylinders, reducing the engines power. To overcome this, the air is routed through the charge air cooler before it enters the engine; the temperature is reduced by transferring the heat to atmosphere.

Cooling of the intake air also helps to reduce engine emissions by limiting nitrogen oxides (NOx) production.

Turbocharger

Overview

For information on description and operation:

[Turbocharger](#)

Inspection and Verification

1 .



WARNING: The following tests may involve working in close proximity to hot components. Make sure adequate protection is used. Failure to follow this instruction may result in personal injury.



WARNING: The turbocharger can continue to rotate after the engine has stopped. Do not attempt to check the turbocharger until one minute has elapsed since the engine was switched off. Failure to follow this instruction may result in personal injury.

Verify the customer concern.

2 . Visually inspect for obvious mechanical or electrical faults.

Mechanical	Electrical
<ul style="list-style-type: none"> Intake air system Hose(s)/hose connections Turbocharger General engine condition. 	<ul style="list-style-type: none"> Circuit(s) Electrical connections and harnesses Turbocharger actuator Engine control module (ECM)

3 . If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.

4 . Use the approved diagnostic system or a scan tool to retrieve any diagnostic trouble codes (DTCs) before moving onto the symptom chart or DTC index.



Make sure that all DTCs are cleared following rectification.

Make sure that all DTCs are cleared following rectification.

Symptom Chart

Symptom	Possible source	Action
Poor performance (off-boost)	<ul style="list-style-type: none"> Low/contaminated fuel Restricted intake air system General engine condition Engine control module (ECM) failure 	Check the fuel level and condition. Draw off approximately 1 ltr (2.11 pints) of fuel and allow to stand for 1 minute. Check to make sure there is no separation of the fuel indicating water or other liquid in the fuel. Check the intake air system for restriction. Check the engine condition, compressions, etc. if there are indications of a mechanical fault. Check for DTCs indicating a module fault. Refer to the warranty policy and procedures manual if an ECM is suspect.
No boost	<ul style="list-style-type: none"> Electrical connections and harnesses Restricted intake air system Charge air cooler restricted/leaking Turbocharger actuator failure Turbocharger failure 	Check the electrical connections and harnesses. Check the intake air system for restriction/leakage. Check the turbocharger actuator and circuits. Refer to the electrical guides. Check the turbocharger for wear. Disconnect the turbocharger intake and outlet pipework and turn the turbocharger by hand. Any roughness indicates a fault. Check any up and down movement in the turbocharger shaft. Excessive movement indicates a fault. If in doubt, compare the suspect unit with a new turbocharger. Check for DTCs indicating an actuator or module fault. Refer to the warranty policy and

	<ul style="list-style-type: none"> Engine control module (ECM) failure 	procedures manual if an ECM is suspect.
No boost/excessive noise	<ul style="list-style-type: none"> Turbocharger failure 	Disconnect the turbocharger intake and outlet pipework and turn the turbocharger by hand. Any roughness indicates a fault. Check any up and down movement in the turbocharger shaft. Excessive movement indicates a fault. If in doubt, compare the suspect unit with a new turbocharger.

DTC Index

NOTE:

If a control module or component is suspect and the vehicle remains under manufacturer warranty, refer to the Warranty Policy and Procedures manual (section B1.2), or determine if any prior approval program is in operation, before the replacement of a component.

NOTE:

Generic scan tools may not read the codes listed, or may read only 5-digit codes. Match the 5 digits from the scan tool to the first 5 digits of the 7-digit code listed to identify the fault (the last 2 digits give extra information read by the manufacturer-approved diagnostic system).

NOTE:

When performing voltage or resistance tests, always use a digital multimeter (DMM) accurate to three decimal places, and with an up-to-date calibration certificate. When testing resistance always take the resistance of the DMM leads into account.

NOTE:

Check and rectify basic faults before beginning diagnostic routines involving pinpoint tests.

NOTE:

Inspect connectors for signs of water ingress, and pins for damage and/or corrosion.

NOTE:

If DTCs are recorded and, after performing the pinpoint tests, a fault is not present, an intermittent concern may be the cause. Always check for loose connections and corroded terminals.

NOTE:

For a full list of engine control module (ECM) DTCs:

[Electronic Engine Controls](#)

DTC	Description	Possible causes	Actions
P004611	Turbocharger boost control A circuit range/performance - circuit short to ground	<ul style="list-style-type: none"> Turbocharger control solenoid circuit: short circuit to ground Turbocharger fault 	Check the turbocharger control solenoid and circuits. Refer to the electrical guides. Install a new turbocharger if necessary. Turbocharger (19.42.01) Clear the DTCs and test for normal operation.
P004612	Turbocharger boost control A circuit range/performance - circuit short to battery	<ul style="list-style-type: none"> Turbocharger control solenoid circuit: short circuit to power Turbocharger fault 	
P00461A	Turbocharger boost control A circuit range/performance - circuit resistance below threshold	<ul style="list-style-type: none"> Turbocharger control solenoid circuit: short circuit to ground Turbocharger control solenoid circuit: short circuit to power Turbocharger control solenoid circuit: open circuit Turbocharger fault 	Check the turbocharger control solenoid and circuits. Refer to the electrical guides. Install a new turbocharger if necessary.
		<ul style="list-style-type: none"> Turbocharger 	

P00461B	Turbocharger boost control A circuit range/performance - circuit resistance above threshold	<p>control solenoid circuit: short circuit to ground</p> <ul style="list-style-type: none"> • Turbocharger control solenoid circuit: short circuit to power • Turbocharger control solenoid circuit: open circuit • Turbocharger fault 	Turbocharger (19.42.01) Clear the DTCs and test for normal operation.
P006900	Manifold absolute pressure (MAP) sensor - barometric pressure correlation	<p>NOTE:</p> <p>The MAP sensor is part of the manifold absolute pressure temperature (MAPT) sensor</p> <p>NOTE:</p> <p>Barometric pressure sensor is part of the engine control module (ECM)</p> <ul style="list-style-type: none"> • MAP sensor circuit: short circuit to other pins • MAP sensor circuit: open circuit • MAP sensor fault • Barometric pressure sensor fault 	<p>Check for related DTCs. Rectify as necessary. Using a data logger function check the barometric and manifold absolute pressure readings, both sensors should read approximately atmospheric pressure (ignition on, engine NOT running). A reading significantly higher or lower on one sensor would indicate a sensor fault. Install a new MAPT sensor if necessary.</p> <p>Manifold Absolute Pressure and Temperature (MAPT) Sensor Clear the DTCs and check for normal operation. Refer to the warranty policy and procedures manual, if a module is suspect.</p>
P006A00	Manifold absolute pressure (MAP) sensor - mass or volume air flow correlation	<p>NOTE:</p> <p>The MAP sensor is part of the manifold absolute pressure temperature (MAPT) sensor</p> <ul style="list-style-type: none"> • Restricted air intake path • Exhaust gas recirculation (EGR) valve stuck open • Turbocharger fault • MAP sensor fault • Mass air flow (MAF) sensor fault 	Check the intake air path for restrictions. Rectify as necessary. Check for DTCs indicating an EGR, turbocharger, MAPT or MAF sensor fault. Rectify as necessary. Clear the DTCs and check for normal operation.
P00952F	Intake air temperature (IAT) sensor 2 circuit - signal erratic	<p>NOTE:</p> <p>The IAT sensor 2 is part of the manifold absolute pressure temperature (MAPT) sensor</p> <ul style="list-style-type: none"> • IAT sensor 2 circuit: open circuit • IAT sensor 2: short circuit to power • IAT sensor 2: short circuit to ground • IAT sensor 2 fault 	<p>Check the IAT sensor 2 and circuits. Refer to the electrical guides. Install a new MAPT sensor if necessary.</p> <p>Manifold Absolute Pressure and Temperature (MAPT) Sensor Clear the DTCs and test for normal operation.</p>
	Intake air temperature	<p>NOTE:</p> <p>The IAT sensor 2 is part of the manifold absolute pressure temperature (MAPT) sensor</p>	Check the IAT sensor 2 and circuits. Refer to the electrical guides. Install a new MAPT sensor if necessary.


P009511	(IAT) sensor 2 circuit - circuit short to ground	<p>sensor</p> <ul style="list-style-type: none"> • IAT sensor 2: short circuit to ground • IAT sensor 2 fault 	Manifold Absolute Pressure and Temperature (MAPT) Sensor Clear the DTCs and test for normal operation.
P009515	Intake air temperature (IAT) sensor 2 circuit - circuit short to battery or open	<p>NOTE:</p> <p>The IAT sensor 2 is part of the manifold absolute pressure temperature (MAPT) sensor</p> <ul style="list-style-type: none"> • IAT sensor 2: open circuit • IAT sensor 2: short circuit to power • IAT sensor 2 fault 	<p>Check the IAT sensor 2 and circuits. Refer to the electrical guides. Install a new MAPT sensor if necessary.</p> <p>Manifold Absolute Pressure and Temperature (MAPT) Sensor Clear the DTCs and test for normal operation.</p>
P010029	Mass or volume air flow A circuit - signal invalid	<ul style="list-style-type: none"> • Restricted air intake path • Check for leak between mass air flow (MAF) sensor and turbocharger • MAF sensor fault • Turbocharger fault • Exhaust gas recirculation (EGR) valve fault 	<p>Check the intake air system for leaks, restrictions, etc.. Check for related DTCs. Rectify as necessary. Clear the DTCs and test for normal operation.</p>
P023400	Turbocharger A over boost condition	<ul style="list-style-type: none"> • Turbocharger circuit fault • Turbocharger fault • Engine control module (ECM) fault 	<p>Check the turbocharger and circuits. Refer to the electrical guides. Rectify as necessary. Check turbocharger operation, check for sticking turbocharger vanes etc.. Install a new turbocharger if necessary.</p> <p>Turbocharger (19.42.01) Clear the DTCs and test for normal operation. Refer to the warranty policy and procedures manual if a module is suspect.</p>
P023521	Turbocharger boost sensor A circuit - signal amplitude less than minimum	<p>NOTE:</p> <p>The MAP sensor is part of the manifold absolute pressure temperature (MAPT) sensor</p> <ul style="list-style-type: none"> • MAP sensor circuit: short circuit to other pins • MAP sensor circuit: open circuit • MAP sensor fault 	<p>Check the MAPT sensor and circuit. Refer to the electrical guides. Install a new MAPT sensor if necessary.</p> <p>Manifold Absolute Pressure and Temperature (MAPT) Sensor Clear the DTCs and test for normal operation.</p>
P023522	Turbocharger boost sensor A circuit - signal amplitude greater than maximum	<p>NOTE:</p> <p>The MAP sensor is part of the manifold absolute pressure temperature (MAPT) sensor</p> <ul style="list-style-type: none"> • MAP sensor circuit: short circuit to other pins • MAP sensor circuit: open circuit • MAP sensor fault 	
		<p>NOTE:</p> <p>The MAP sensor is</p>	

P02352F	Turbocharger boost sensor A circuit - signal erratic	part of the manifold absolute pressure temperature (MAPT) sensor <ul style="list-style-type: none"> • MAP sensor circuit: short circuit to other pins • MAP sensor circuit: open circuit • MAP sensor fault 	
P029900	Turbocharger A under boost condition	<ul style="list-style-type: none"> • Turbocharger circuit fault • Turbocharger fault • Engine control module (ECM) fault 	Check the turbocharger and circuits. Refer to the electrical guides. Rectify as necessary. Check turbocharger operation, check for sticking turbocharger vanes etc. Install a new turbocharger if necessary. Turbocharger (19.42.01) Clear the DTCs and test for normal operation. Refer to the warranty policy and procedures manual if a module is suspect.
P256234	Turbocharger boost control position sensor A circuit - signal high time less than minimum	<ul style="list-style-type: none"> • Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault 	Check turbocharger sensor and circuit. Refer to the electrical guides. Install a new turbocharger if necessary. Turbocharger (19.42.01) Clear the DTCs and test for normal operation.
P256235	Turbocharger boost control position sensor A circuit - signal high time greater than maximum	<ul style="list-style-type: none"> • Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault 	
P256236	Turbocharger boost control position sensor A circuit - signal frequency too low	<ul style="list-style-type: none"> • Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault 	
P256237	Turbocharger boost control position sensor A circuit - signal frequency too high	<ul style="list-style-type: none"> • Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit 	

		<ul style="list-style-type: none"> • Turbocharger fault 	
P25632F	Turbocharger boost control position sensor A circuit range/performance - signal erratic	<ul style="list-style-type: none"> • Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault 	<p>Check turbocharger sensor and circuit. Refer to the electrical guides. Install a new turbocharger if necessary. Turbocharger (19.42.01) Clear the DTCs and test for normal operation.</p>
P256372	Turbocharger boost control position sensor A circuit range/performance - actuator stuck open	<ul style="list-style-type: none"> • Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault 	
P256373	Turbocharger boost control position sensor A circuit range/performance - actuator stuck closed	<ul style="list-style-type: none"> • Turbocharger boost control position sensor A circuit: short circuit to power • Turbocharger boost control position sensor A circuit: short circuit to ground • Turbocharger boost control position sensor A circuit: open circuit • Turbocharger fault 	


Turbocharger (19.42.01)

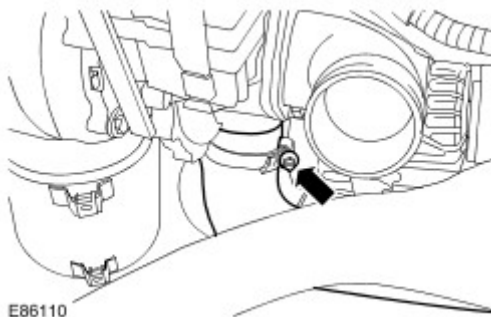
Removal

1.  **WARNING:** Do not work on or under a vehicle supported only by a jack. Always support the vehicle on safety stands.

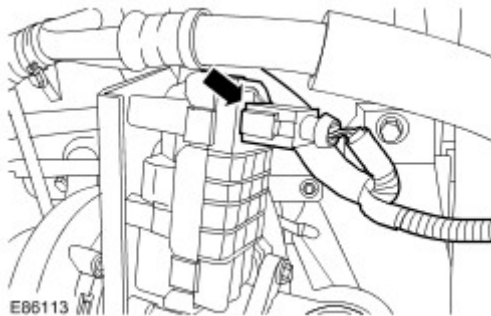
Raise and support the vehicle.


For additional information, refer to [Lifting](#).

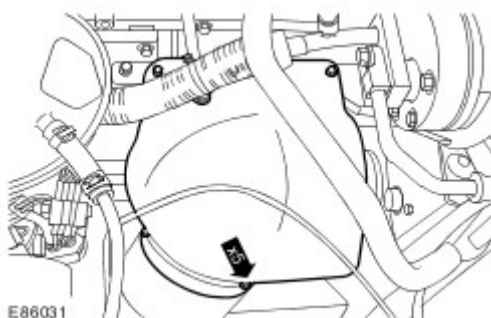
2. Remove the air cleaner outlet pipe.
For additional information, refer to [Air Cleaner Outlet Pipe](#).
3. Disconnect the charge air cooler inlet hose.
 Release the clip.



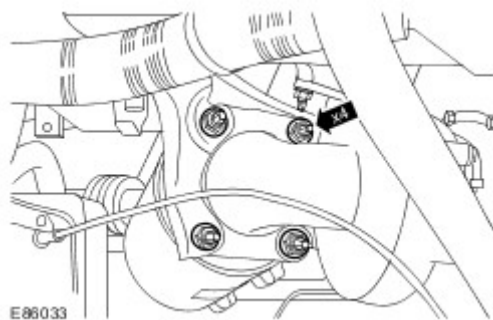
4. Disconnect the turbocharger electrical connector.



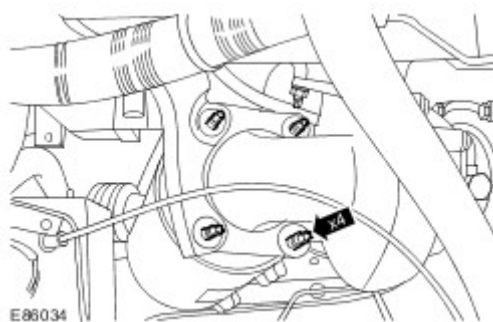
5. Remove the turbocharger heat shield.
 Remove the 5 bolts.



6 . Remove and discard the 4 nuts from the catalytic converter.

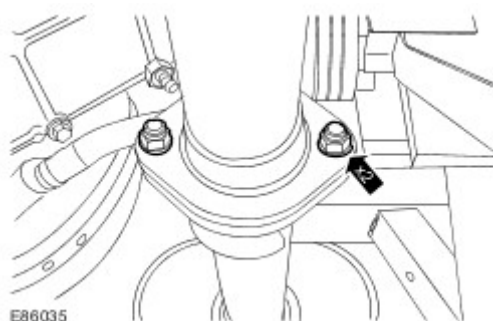


7 . Remove and discard the 4 studs from the catalytic converter.



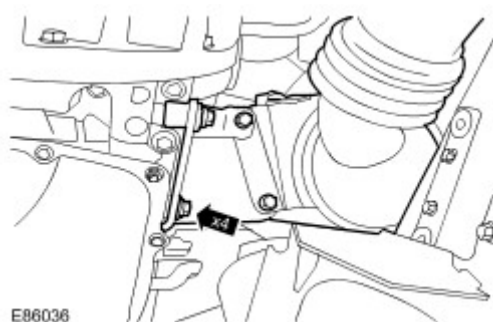
8 . Release the catalytic converter.

➤ Remove and discard the 2 nuts.



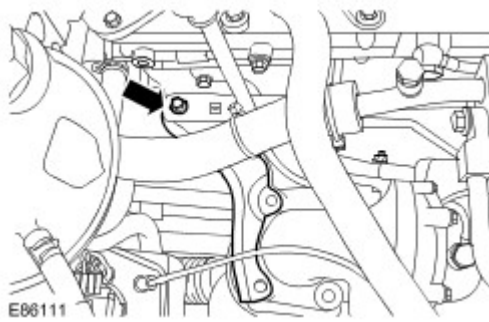
9 . Release the catalytic converter.

➤ Loosen the 4 bolts.



10 . Remove the catalytic converter bracket.

➤ Remove the bolt.



11 .

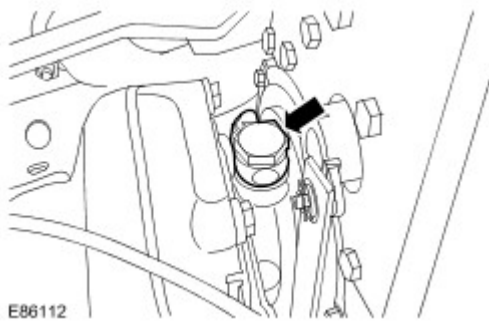


CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Disconnect the turbocharger oil supply pipe.

➤ Remove the banjo bolt.

➤ Remove and discard the sealing washers.



12 .

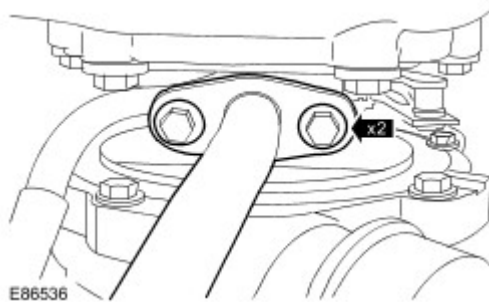


CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Release the turbocharger oil return tube.

➤ Remove the 2 bolts.

➤ Remove and discard the gasket.



13 . Remove and discard the 3 turbocharger nuts.



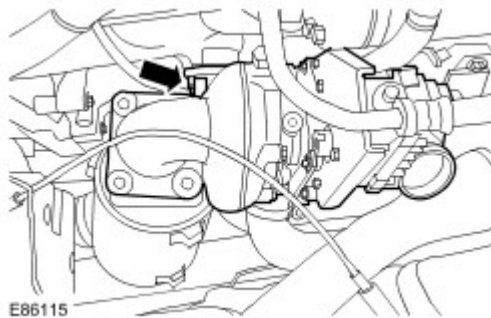
14 .



CAUTION: Make sure that all openings are sealed. Use new blanking caps.

Remove the turbocharger.

- ▶ Remove and discard stud.
- ▶ Remove and discard the gasket.

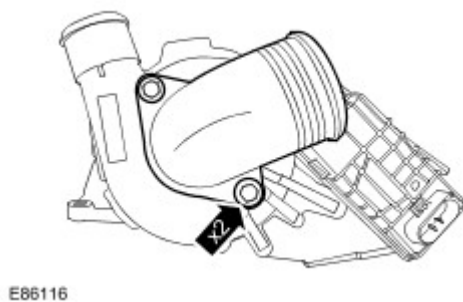


15 . **NOTE:**

Do not disassemble further if the component is removed for access only.

Remove the turbocharger inlet duct.

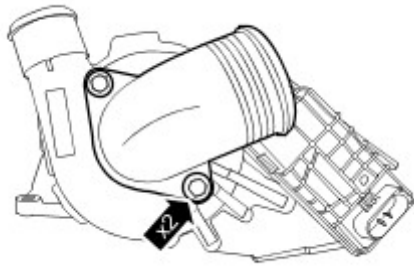
- ▶ Remove the 2 bolts.



Installation

1 . Install the turbocharger inlet duct.

- ▶ Tighten to 23 Nm (17 lb.ft).



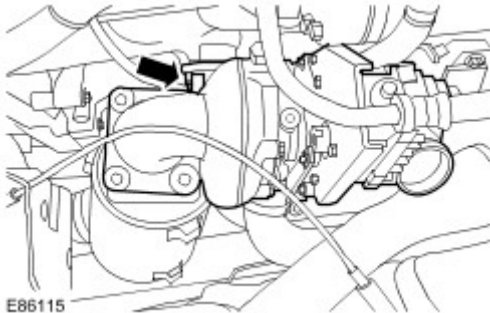
E86116

2 . NOTE:

Remove and discard the blanking caps.

Install the turbocharger.

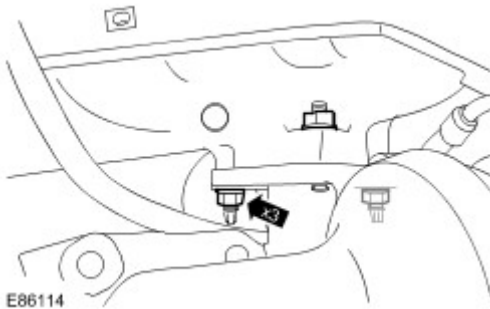
- Install a new gasket.
- Install new studs.



E86115

3 . Install new turbocharger nuts.

- Tighten the nut to 23 Nm (17 lb.ft).



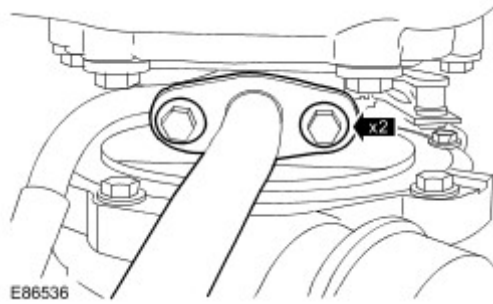
E86114

4 . NOTE:

Remove and discard the blanking caps.

Secure the turbocharger oil return tube.

- Install a new gasket.
- Tighten the bolts to 10 Nm (7 lb.ft).

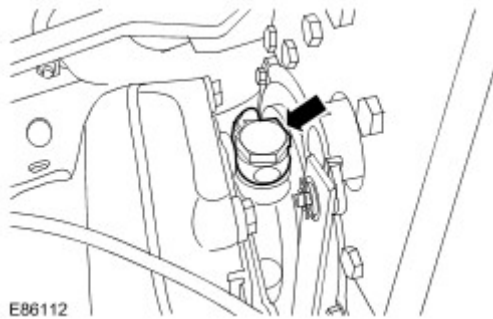


5 . **NOTE:**

Remove and discard the blanking caps.

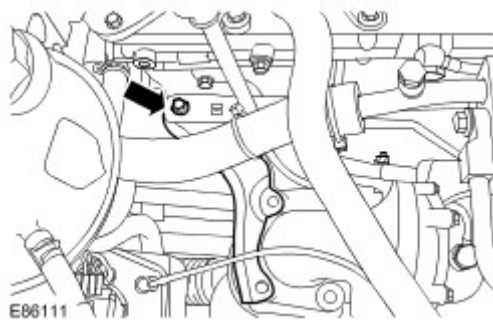
Connect the turbocharger oil supply pipe.

- Install new sealing washers.
- Tighten the banjo bolt to 35 Nm (26 lb.ft).

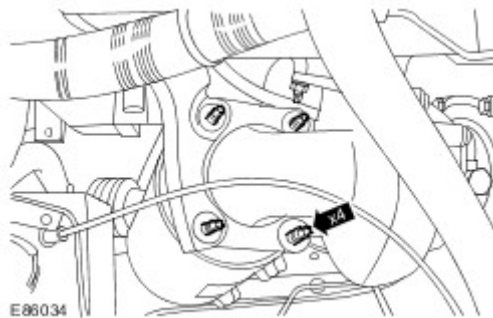


6 . Install the catalytic converter bracket.

- Loosely install the bolt.

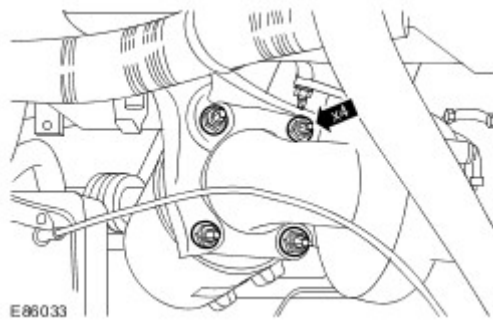


7 . Install 4 new studs to the catalytic converter.

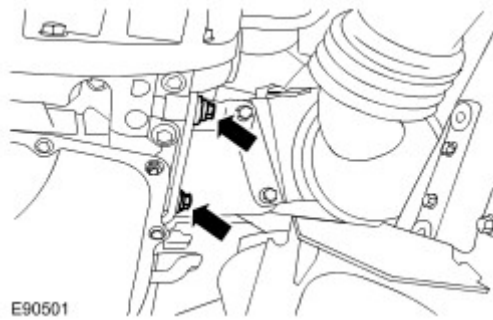


8 . Install 4 new nuts to the catalytic converter.

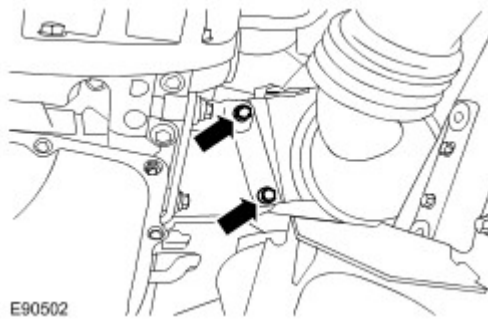
▶ Tighten to 45 Nm (33 lb.ft).



9 . Tighten to 30 Nm (22 lb.ft).

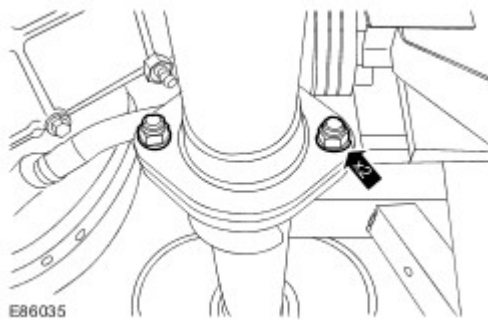


10 . Tighten to 30 Nm (22 lb.ft).

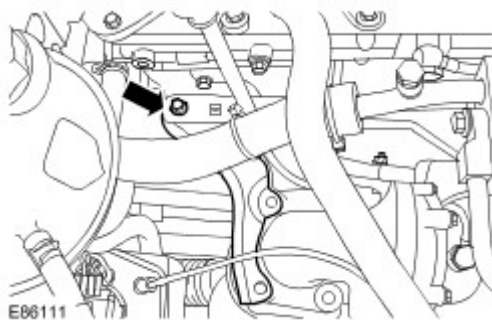


11 . Install new nuts.


▶ Tighten to 30 Nm (22 lb.ft).

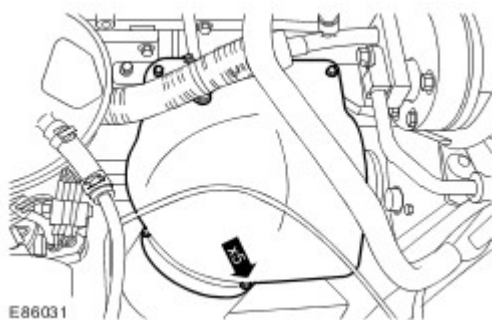


12 . Tighten to 20 Nm (15 lb.ft).

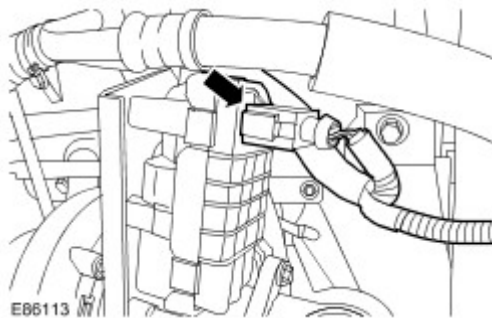


13 . Install the turbocharger heat shield.

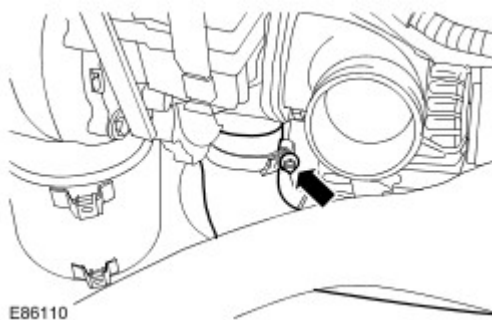
 Tighten to 10 Nm (7 lb.ft).



14 . Connect the turbocharger electrical connector.



15 . Tighten to 3 Nm (2 lb.ft).



16 . Install the air cleaner outlet pipe.

For additional information, refer to [Air Cleaner Outlet Pipe](#).