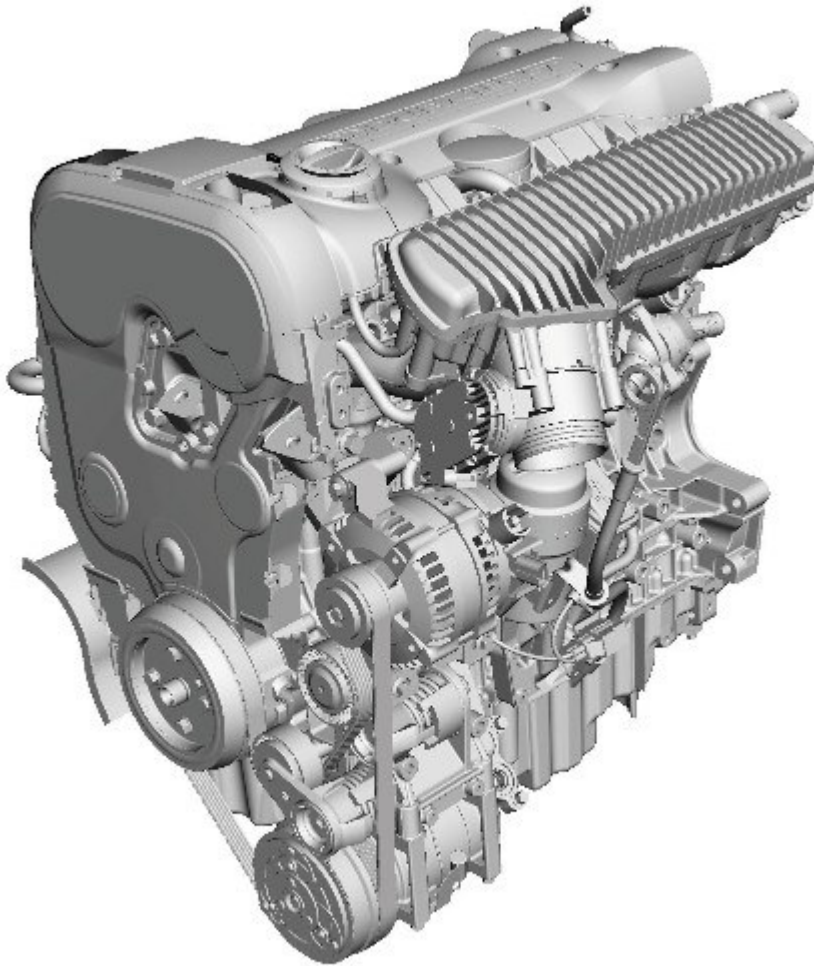


Description and Operation

2.5L Duratec-ST (VI5) engine



E62439

General

The 2.5L Duratec-ST (VI5) engine is a transversely mounted 5-cylinder, 20-valve, 2522 cm³, turbo engine.

The cylinder bore is 83 mm.

The stroke is 93.2 mm.

It has a compression ratio of 9:1.

The valve train is driven by a timing belt.

The valve timing of the intake and exhaust camshafts is adjusted by variable camshaft timing (VCT) control units.

The accessories are driven by two elastic multigroove belts.

The tension of the two multigroove belts is maintained automatically by two separate mechanical belt tensioners.

Engine management

- Bosch ME 9.0 engine management system
- Knock control with two knock sensors
- Electronic throttle plate
- Electronic accelerator pedal
- Variable camshaft timing for intake and exhaust camshafts
- Fuel rail with combined fuel pressure and temperature sensor
- Sequential multi-port fuel injection
- Camshaft position (CMP) sensors for intake and exhaust camshafts.
- Crankshaft position (CKP) sensor

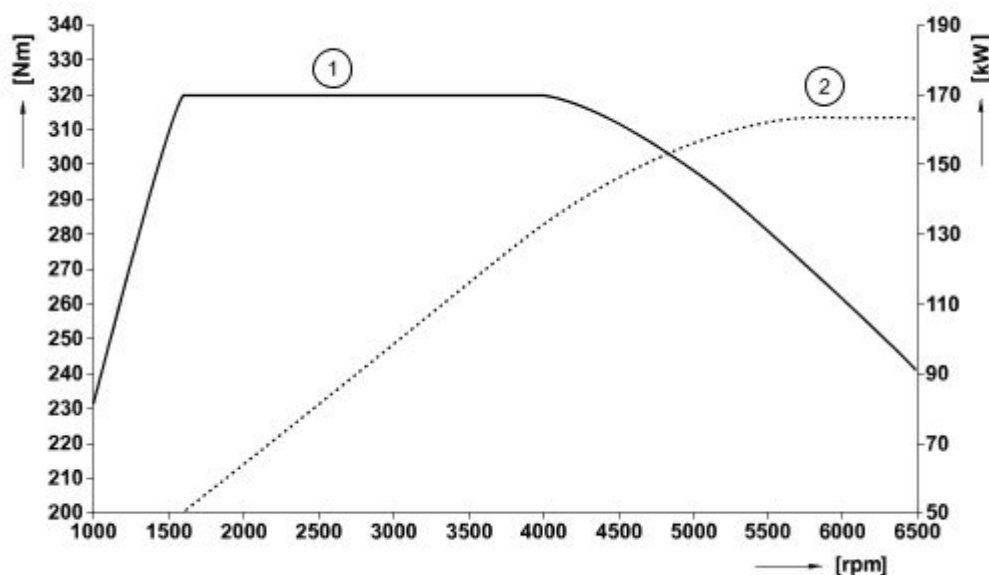
Engine emission control

- Complies with European emissions standard IV
- EOBD (European On-board Diagnostic) for the monitoring of emissions-related components.
- HO2S (Heated Oxygen Sensor), pre- and post-catalytic converter

Diagnosis

Diagnosis is performed using WDS (Worldwide Diagnostic System) via the DLC (Data Link Connector).

Engine power output and torque



E62614

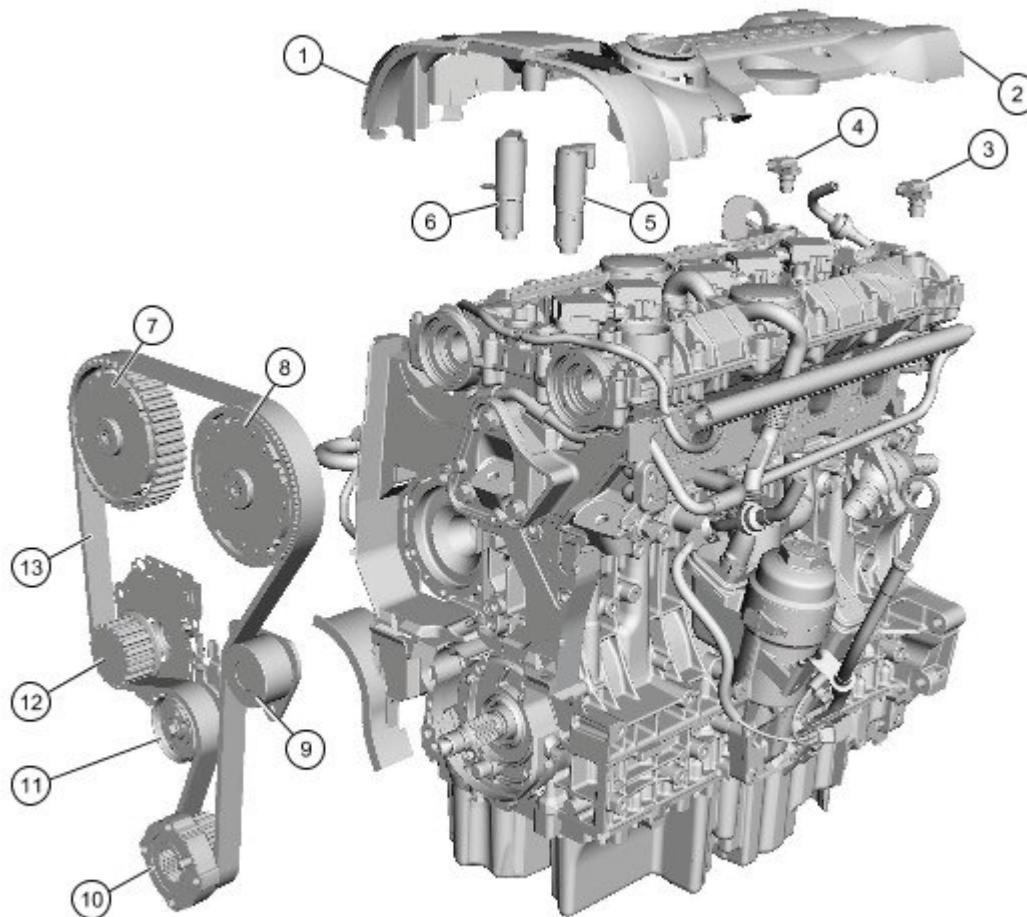
Item	Part Number	Description
1	-	Torque curve
2	-	Power output curve

By the use of VCT for the intake and exhaust camshafts it is possible to attain maximum torque across a wide engine speed range.

The maximum torque of 320 Nm is available between 1600 and 4000 rpm.

Maximum power output of the engine is 166 kW (225 PS) at 6000 rpm.

2.5L Duratec-ST (VI5) engine



E62441

Item	Part Number	Description
1	-	Engine front cover
2	-	Engine rear cover
3	-	CMP sensor, intake camshaft
4	-	CMP sensor, exhaust camshaft
5	-	VCT oil control solenoid, intake camshaft
6	-	VCT oil control solenoid, exhaust camshaft
7	-	Exhaust VCT control unit
8	-	Intake VCT control unit
9	-	Timing belt idler pulley
10	-	Crankshaft timing belt pulley
11	-	Timing belt tensioner
12	-	Coolant pump pulley
13	-	Timing belt

Design

The 2.5L Duratec-ST (VI5) engine is a turbo charged engine with 5 cylinders and 20 valves with electronically-controlled dual VCT.

The entire engine is made of aluminum.

The cylinder head consists of two parts.

The cylinder block consists of three parts.

A conventional cylinder head gasket is installed between the cylinder head and the cylinder block.

The gaskets between the other mating faces are fluid gaskets.

The two camshafts are supported by six bearing caps in the two halves of the cylinder head. The top half of the cylinder head consists of a valve cover with integral camshaft bearing caps.

Maintenance-free mechanical valve tappets are installed in the cylinder head.

The spark plug wells are additionally sealed by O-rings.

A cover has been fitted over the spark plug recesses as a protection against dirt and water.

The valve train is controlled via a timing belt which drives the intake VCT control unit and the exhaust VCT control unit. These control units then drive the respective camshafts.

The timing belt is tensioned via a mechanical timing belt tensioner.

The coolant pump is also driven via the timing belt.

The compact pent-roof combustion chamber design, the V-shaped arrangement of the valves and the centrally-positioned spark plugs ensure optimum combustion, low knock-susceptibility and low exhaust emissions.

The crankshaft has six bearings.

The shims are located at the 5th crankshaft main bearing.

The pistons are made of a homogeneous aluminum alloy with a graphite coating on the sides. This coating serves to reduce friction and dampen noise. The pistons are cooled from below via oil-spray nozzles screwed into the cylinder block.

Design of the variable camshaft timing system

This system is an electronically-controlled, dual, independent VCT control system that allows for independent, variable valve timing for the intake and exhaust camshafts.

A reference mark for the CMP sensor is machined into each camshaft.

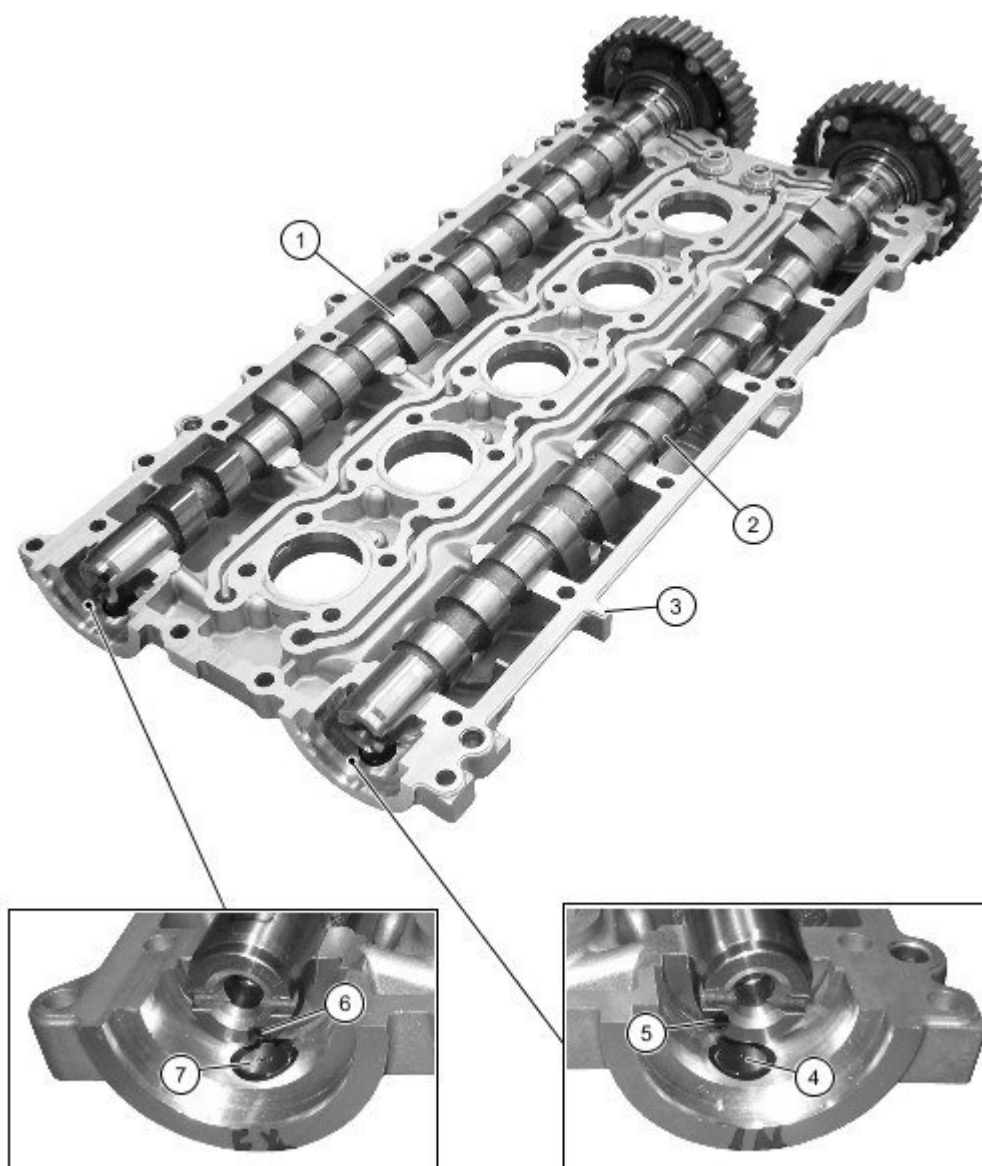
The CMP sensors are located in the valve cover.

Function

The variable camshaft timing system is driven hydro-mechanically by means of the engine oil circuit.

Provided for this purpose on the drive side of each of the camshafts is a electronically-controlled flow valve with an integral spring mechanism (VCT oil control solenoid), which is supplied with the current engine-speed and load values by the powertrain control module (PCM). Based on these input signals, a larger or smaller camshaft rotation angle is achieved relative to the crankshaft. The CMP sensors register the position of the camshafts and transmit this information to the PCM.

Camshafts



E62570

Item	Part Number	Description
1	-	Exhaust camshaft
2	-	Intake camshaft
3	-	Valve cover / upper camshaft bearings
4	-	CMP sensor for intake camshaft
5	-	Intake camshaft reference mark
6	-	Exhaust camshaft reference mark
7	-	CMP sensor for exhaust camshaft

Recesses are provided on the ends of the camshafts; these are for attaching the new special tool (Locking Tool, Camshaft 303-1183) for locking the camshafts.

Threads have been cut into the camshafts for attaching the special tool (303-1178).

NOTE: The new special tool (303-1178) can only be attached when the camshafts are precisely set to the timing marks.

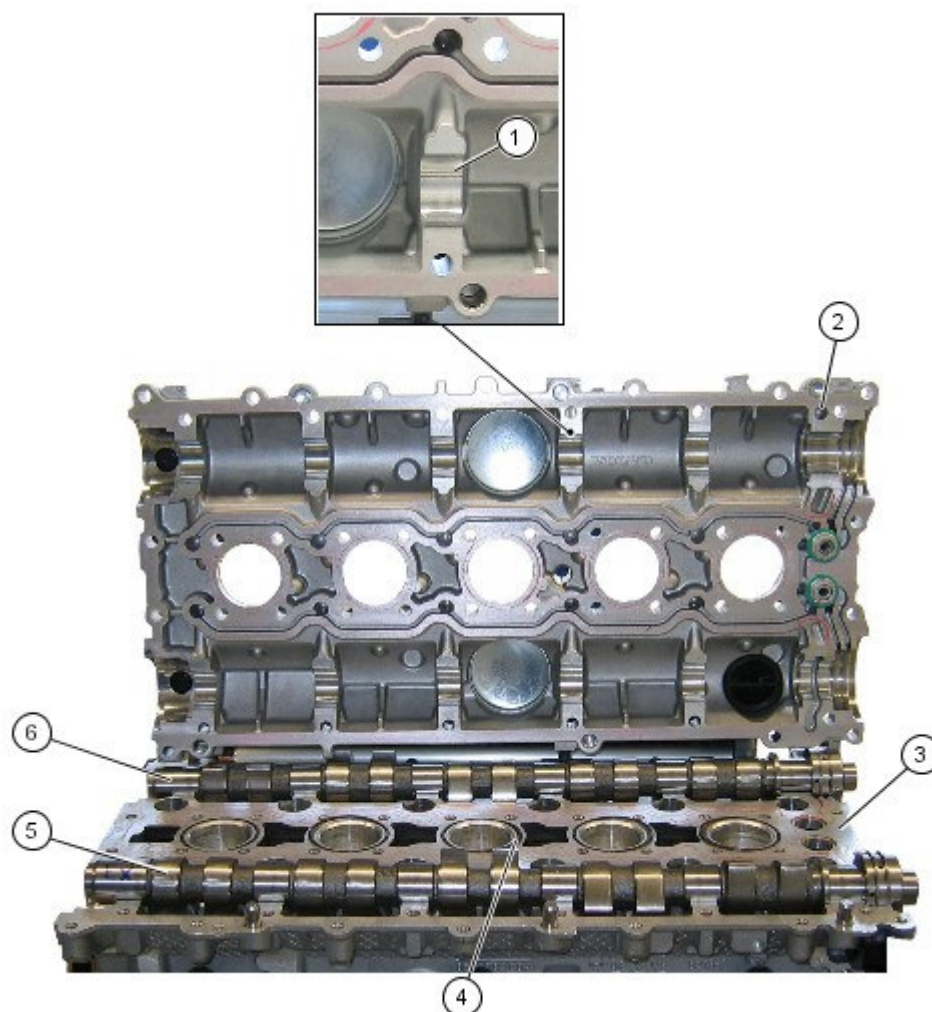
Refer to the workshop literature for the exact procedure for attaching and using the new special tool (303-1178).

For detection of the CMP sensor signals, reference marks in the form of grooves have been machined into the ends of the camshafts. When the camshafts are set precisely to the timing marks, the machined mark on the exhaust camshaft is located roughly at the 5 o'clock position and the machined mark on the intake camshaft is located at 8 o'clock.

No marks have been provided on the camshafts in production; we therefore recommend marking the camshafts before removing them.

Camshaft bearings

Valve cover and cylinder head



E62857

Item	Part Number	Description
1	-	Camshaft bearings
2	-	Valve cover
3	-	Cylinder head
4	-	Spark plug well sealing ring
5	-	Exhaust camshaft
6	-	Intake camshaft

The camshafts are supported in the cylinder head (lower camshaft bearings) and in the valve cover (upper camshaft bearings) by six bearings.

VCT (Variable Camshaft Timing)

VCT control units

The engine oil is pumped from the oil pan via the VCT oil control solenoids to the control units of the intake and exhaust camshaft as needed. Here, the camshaft timing is advanced or retarded, based on the input signals from the PCM.

The VCT control units for the intake and exhaust camshafts are moved into the locked base position when the engine is stopped through the engagement of a spring-loaded locking pin.

The movement to the locked base position is assisted by the tensile force of the timing belt for the intake VCT control unit.

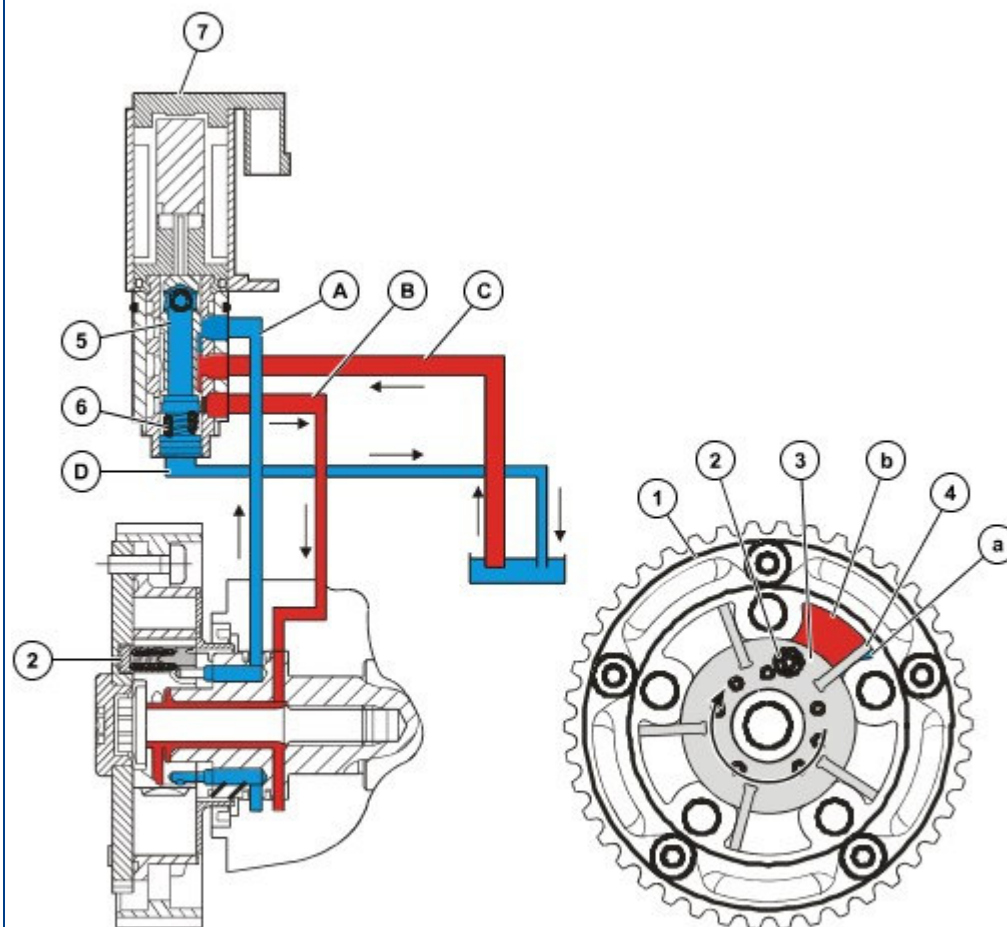
With the exhaust VCT control unit, a spring inside the control unit additionally assists in reaching the locked base position.

The intake VCT control unit is in the "retarded timing" position and the exhaust VCT control unit is in the "advanced timing" position when in the locked base position. When the engine is started, the lock is hydraulically released when a certain EOP (Engine Oil Pressure) is reached.

The procedures must therefore be strictly adhered to when performing adjustment work.

The intake and exhaust VCT control units can only be replaced as complete units during servicing.

Timing retard

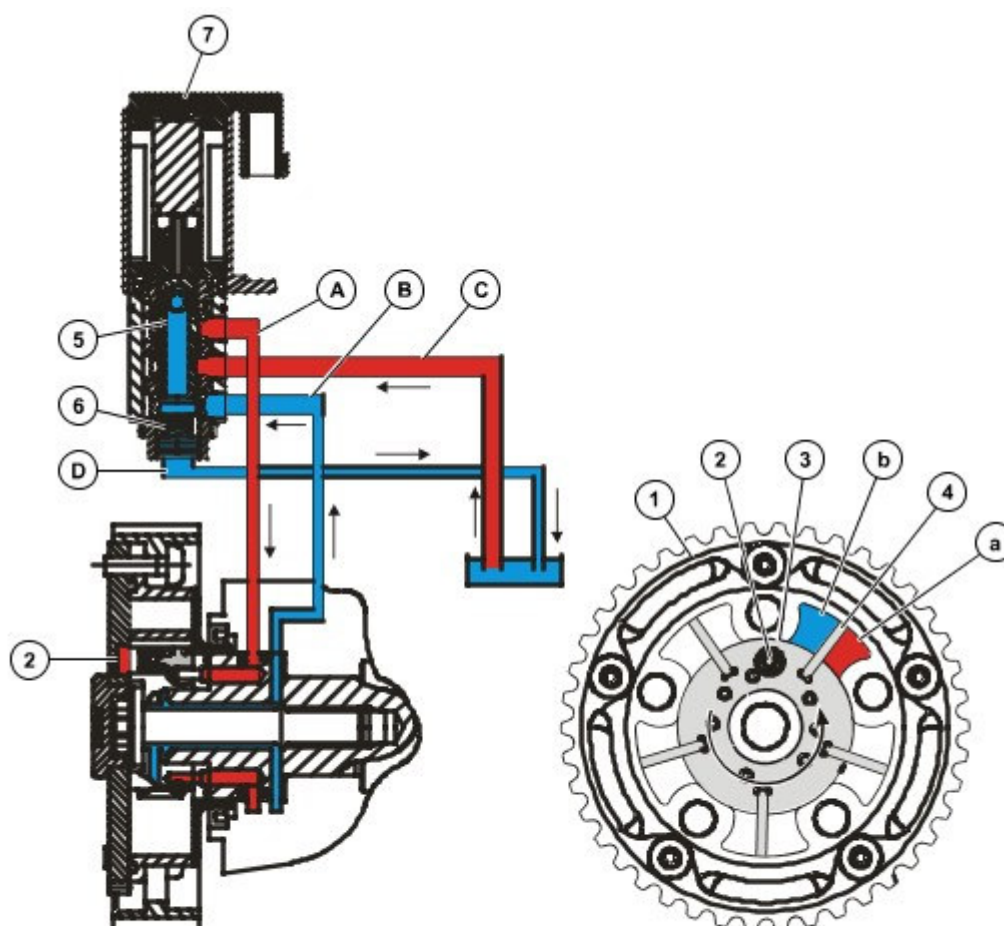


E62711

Item	Part Number	Description
1	-	Camshaft pulley
2	-	Spring-loaded locking pin
3	-	Rotor
4	-	Rotor vane
5	-	Plunger
6	-	Return spring
7	-	VCT oil control solenoid
A	-	Duct connected to chamber (a)
B	-	Duct connected to chamber (b)
C	-	Oil feed duct
D	-	Oil return duct

The engine oil is drawn from the oil pan and routed to the camshaft oil ducts via the engine oil circuit before being routed from there to the VCT oil control solenoid (7) and to the locking pin (2). This releases the locking pin (2) and separates the positive engagement between the camshaft pulley (1) and the rotor (3). When the control unit is being retarded, the chamber (b) fills with engine oil. The rotor (3) starts to turn clockwise as a result of the EOP prevailing in the chamber (b). The engine oil returning from the chamber (a) flows via the oil return duct (D) to the VCT oil control solenoid and from there back into the oil pan.

Timing advance

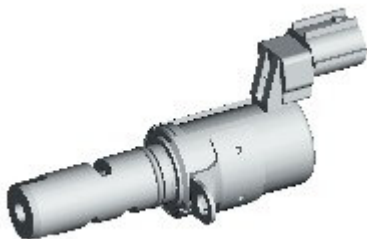


E62710

Item	Part Number	Description
1	-	Camshaft pulley
2	-	Spring-loaded locking pin
3	-	Rotor
4	-	Rotor vane
5	-	Plunger
6	-	Return spring
7	-	VCT oil control solenoid
A	-	Duct connected to chamber (a)
B	-	Duct connected to chamber (b)
C	-	Oil feed duct
D	-	Oil return duct

When the VCT control unit is being advanced, the chamber (a) fills with engine oil. The rotor (3) starts to turn counter-clockwise as a result of the EOP prevailing in the chamber (a). This completes the advance adjustment. The engine oil returning from the chamber (b) flows via the oil return duct (D) to the VCT oil control solenoid and from there back into the oil pan.

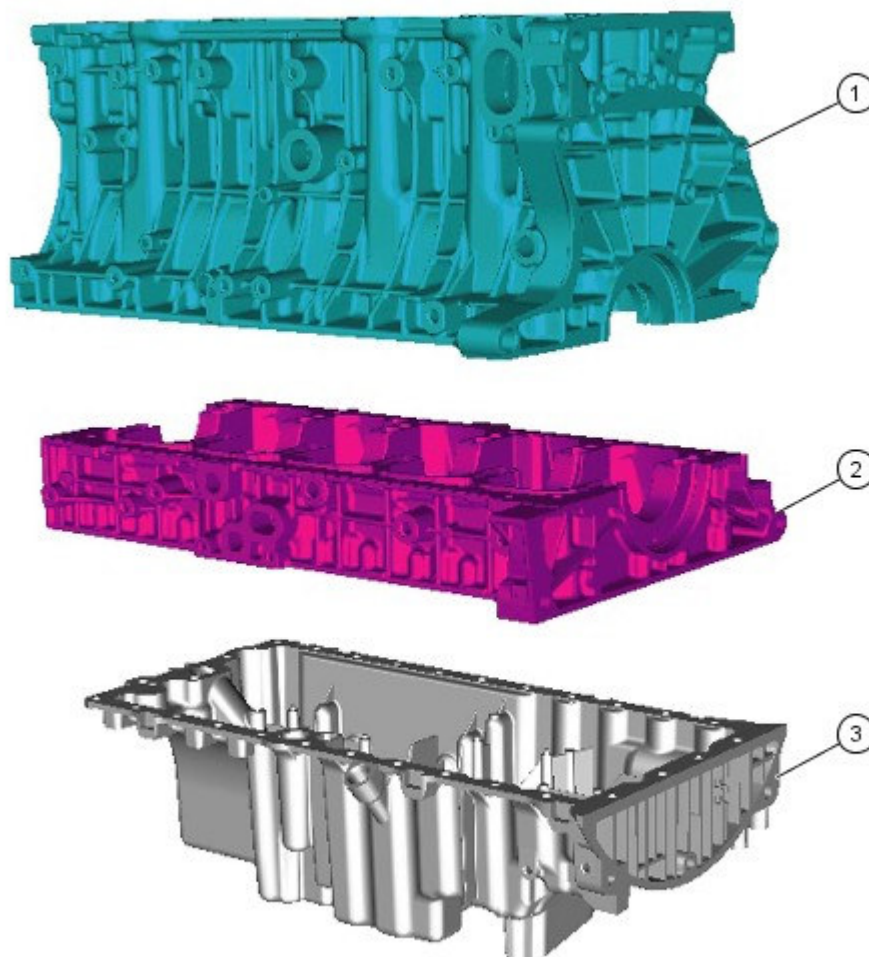
VCT oil control solenoid



E53049

The VCT oil control solenoids are located in the front area in the centre on the valve cover. The purpose of the VCT oil control solenoids is to supply engine oil to the VCT control units in accordance with the actuation by the PCM. This causes the camshaft/valve timing to be either advanced or retarded.

Cylinder block



E64016

Item	Part Number	Description
1	-	Cylinder block
2	-	Ladder frame
3	-	Oil pan

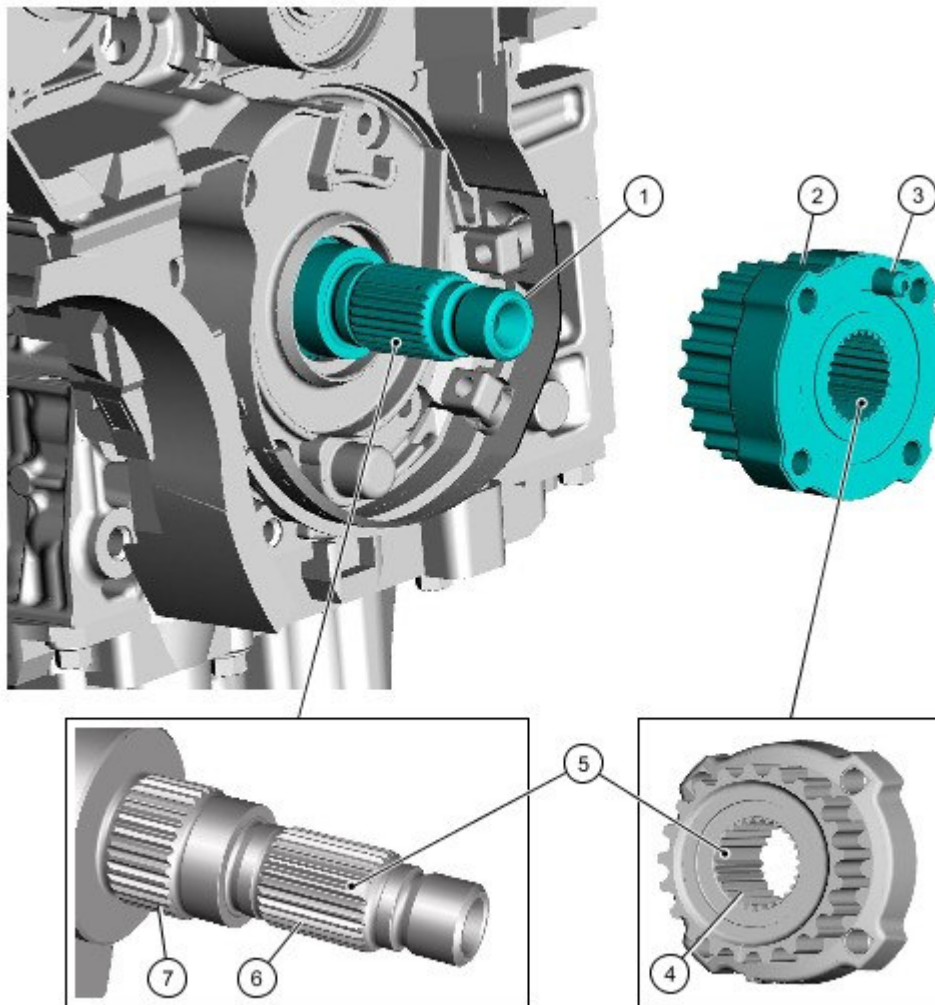
The cylinder block consists of three parts. These are the cylinder block, ladder frame and oil pan.

The cylinder block has five cylinder liners made of cast iron, which cannot be replaced.

The ladder frame serves as a reinforcement and also forms the lower crankshaft bearings.

The oil pan supports the sturdy construction and serves as an additional reinforcement.

Crankshaft



E62853

Item	Part Number	Description
1	-	Crankshaft
2	-	Timing belt pulley
3	-	Cylindrical pin
4	-	Timing belt pulley splines
5	-	Wide spline
6	-	Crankshaft outer splines
7	-	Crankshaft inner splines

The forged crankshaft in the 2.5L Duratec-ST (VI5) engine is supported in the cylinder block (upper crankshaft bearings) and in the ladder frame (lower crankshaft bearings) by six bearings.

The shims are located at the 5th crankshaft main bearing.

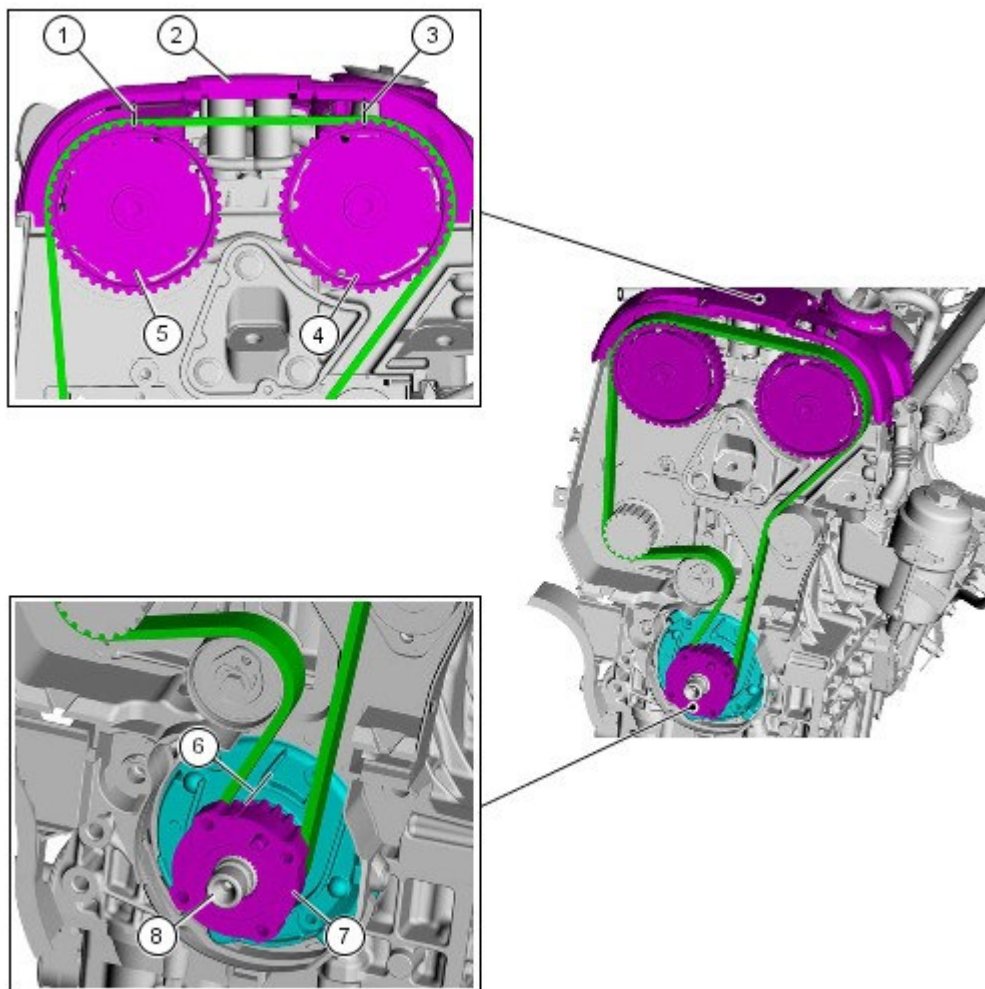
Located on the drive side of the crankshaft are two sets of splines. The inner splines drive the oil pump. The outer splines engage in the timing belt pulley.

The timing belt pulley can only be pushed onto the outer shaft splines in one specific position. For this purpose, one spline on the timing belt pulley and one on the crankshaft have been made wider.

The cylindrical pin secures the mass damper.

Valve timing

Timing marks



E62440

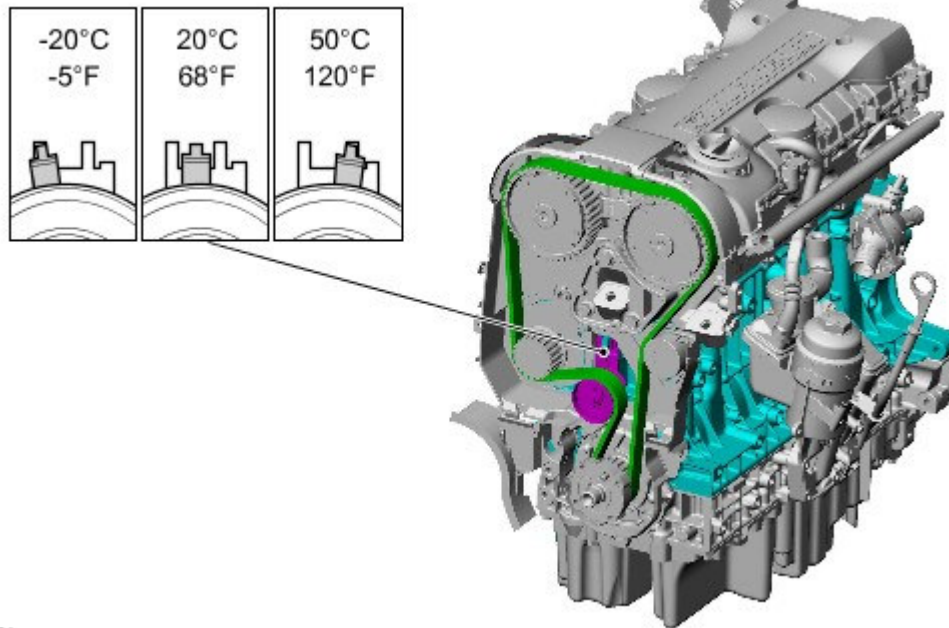
Item	Part Number	Description
1	-	Exhaust camshaft pulley timing mark
2	-	Engine front cover with timing marks
3	-	Intake camshaft pulley timing mark
4	-	Intake camshaft pulley
5	-	Exhaust camshaft pulley
6	-	Crankshaft timing belt pulley timing mark
7	-	Crankshaft timing belt pulley
8	-	Crankshaft

When checking the valve timing, ensure that the timing marks are aligned exactly.

The front engine cover must always be installed when checking and adjusting the valve timing, i.e. timing belt tension, as the timing marks for both camshaft pulleys are provided on its front end.

The mark on the crankshaft timing belt pulley must be in exact alignment with the mark on the oil pump housing.

Timing belt tension



E62854

The interior mechanism of the timing belt tensioner comprises a spring and a friction element. The friction element serves to absorb small vibrations and fluctuations in engine speed. The spring ensures the correct timing belt tension, regardless of wear and temperature.

The tension of the timing belt should be set when the engine is cold.

NOTE: If the engine temperature is higher or lower, remember that a different position is specified for the timing belt tensioner (see illustration).

The timing belt should be fitted starting from the crankshaft over the idler pulley, the intake and exhaust camshaft pulleys, the coolant pump and finally on the timing belt tensioner.

Once the timing belt has been correctly tensioned, the engine must be rotated by hand two turns clockwise at the crankshaft in order to allow a subsequent check of the timing belt tension and adjustment.

No direction of movement is specified when using a new timing belt. If, however, the old timing belt is reused, the direction of movement must be marked prior to removal.