

Component Procedures: Variable Valve Timing

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Component Procedures: Variable Valve Timing

Parts and Labor (itype_189)

Parts

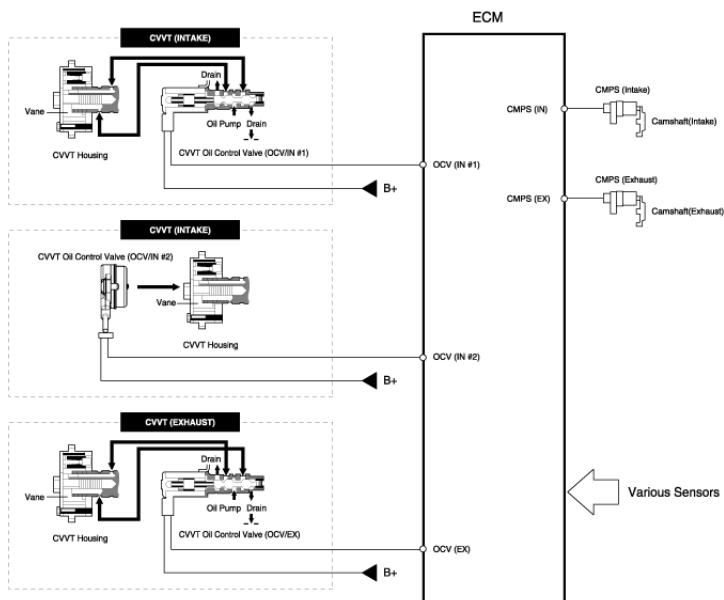
Qualifier	Part #	Name	Price	Note
Variable Valve Timing > Actu?	243702E020	19 - Exhaust	306.10	
Variable Valve Timing > Actu?	243502E700	19 - Intake	382.13	
Variable Valve Timing > Valv?	243752E100	Exhaust	134.15	
Variable Valve Timing > Valv?	243552E100	Intake	168.48	

Labor

Operation	Qualifier Path	Skill	Std Hrs	Wty Hrs
Remove & Replace	Variable Valve Timing > Actuator, R&R > Both	B	4.9	0.0
Remove & Replace	Variable Valve Timing > Solenoid, R&R	B	0.7	0.0

CVVT (Continuously Variable Valve Timing) System - Description and Operation (Article 44109)

- Description



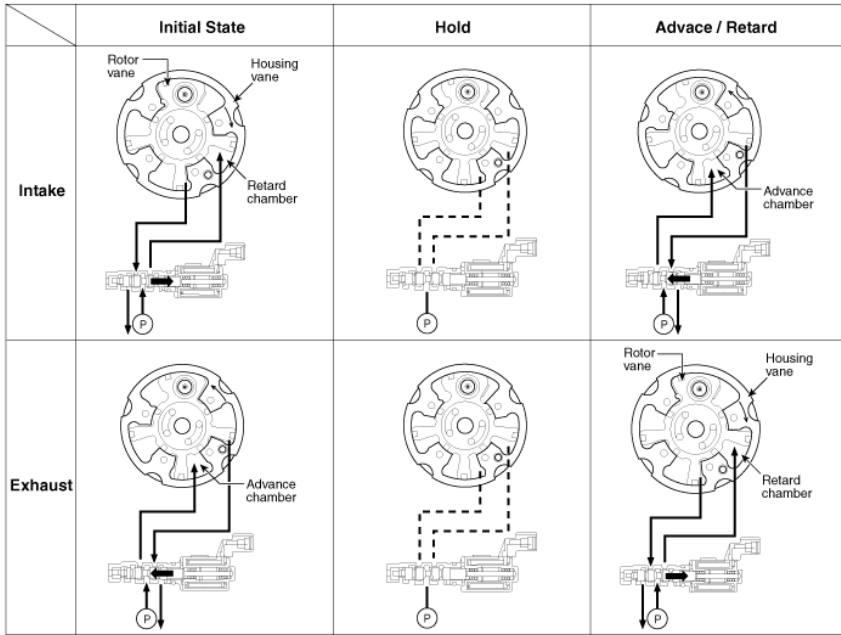
- Operation Principle

A separate solenoid valve is installed on the chain cover in the intake side for closing and releasing a separate lock pin.

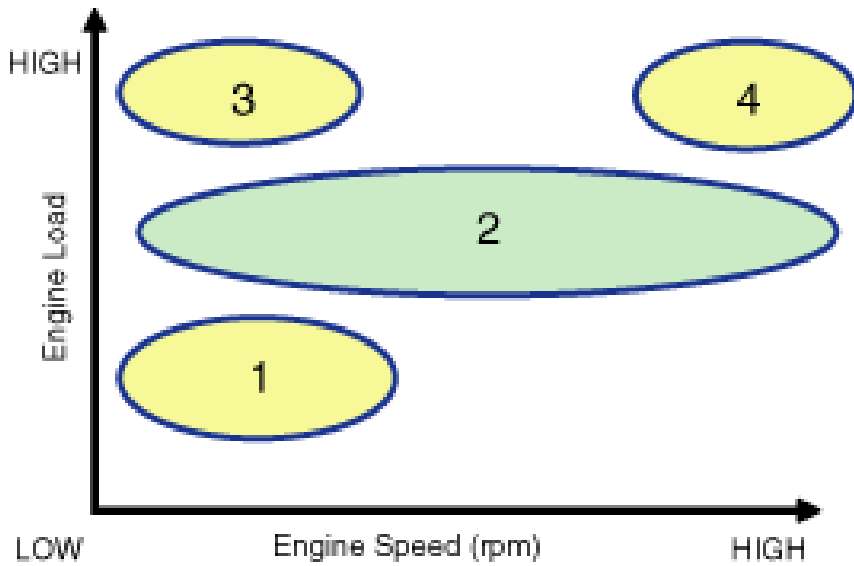


Information

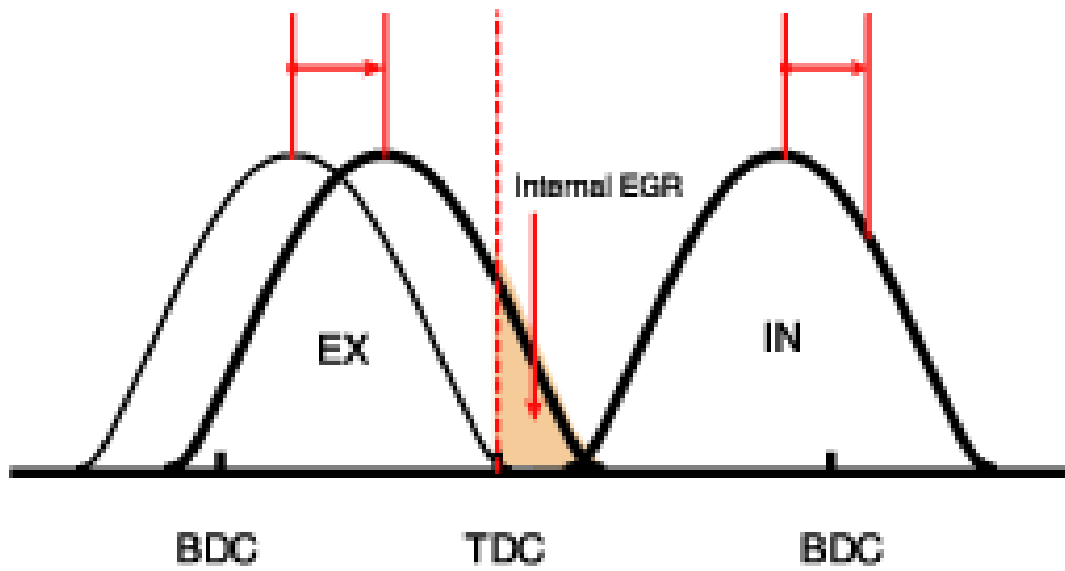
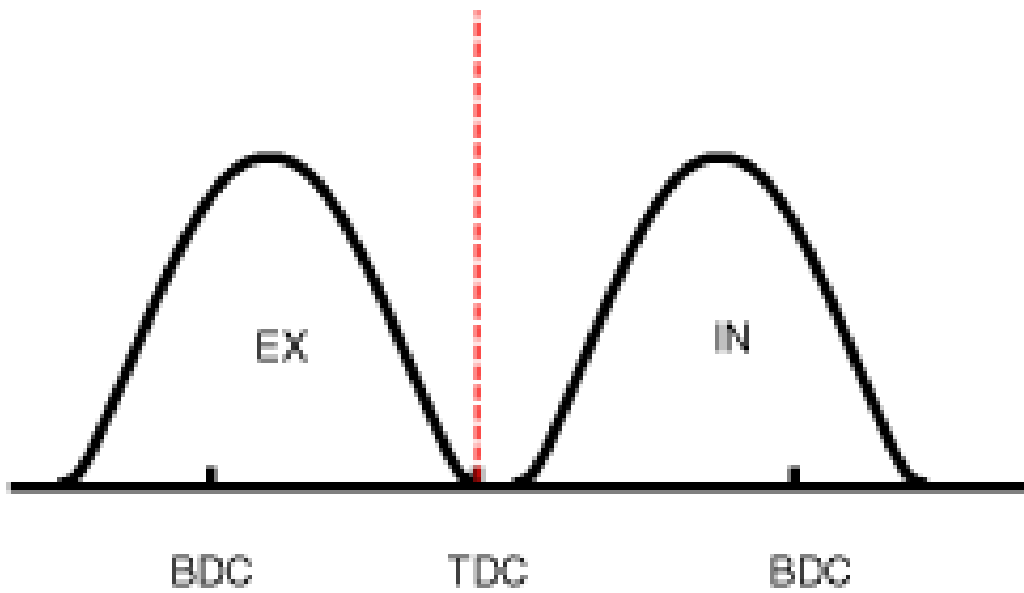
- A separate solenoid valve is installed on the chain cover in the intake side for closing and releasing a separate lock pin.



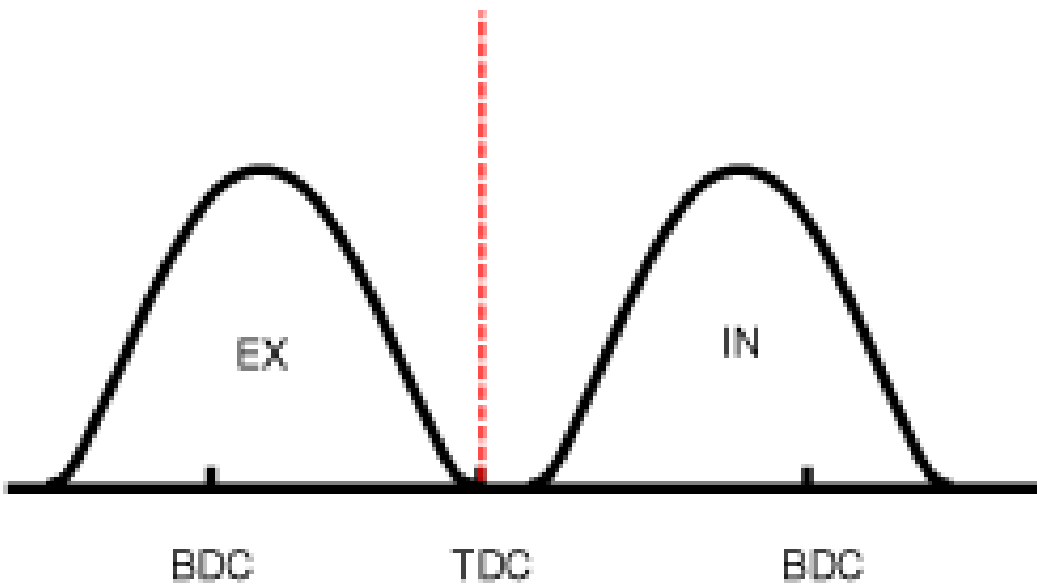
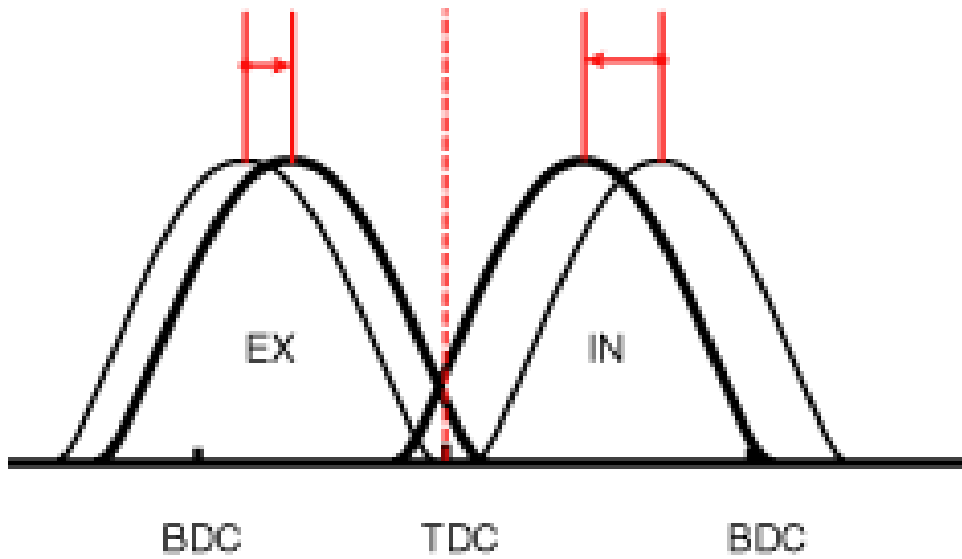
[CVVT System Mode]



(1) Low Speed / Low Load (2) Part Load



(3) Low Speed / High Load (4) High Speed / High Load



Driving Condition Exhaust Valve Intake Valve

Valve Timing Effect Valve Timing Effect

(1) Low Speed /Low Load Completely Advance * Valve Under-lap * Improvement of combustion stability Completely

Retard * Valve Under-lap * Improvement of combustion stability

(2) Part Load Retard * Reduction of HC Retard * Delays the closing time of intake valve to reduce pumping loss

* Increases expansion work

(3) Low Speed /High Load Retard * Increase of expansion work Advance * Prevention of intake back flow

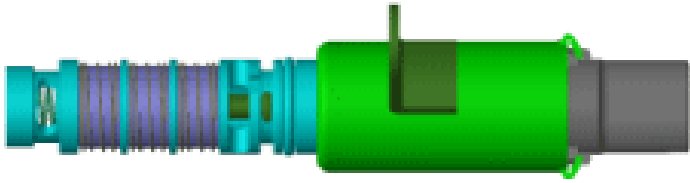
(Improvement of volumetric efficiency)

(4) High Speed /High Load Advance * Reduction of pumping loss Retard * Improvement of volumetric efficiency

CVVT Oil Control Valve (OCV) - Description and Operation (Article 44157)

- Description

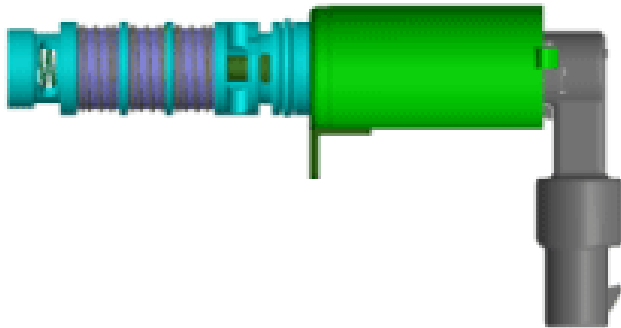
[Bank 1 / Intake] #1



[Bank 1 / Intake] #2

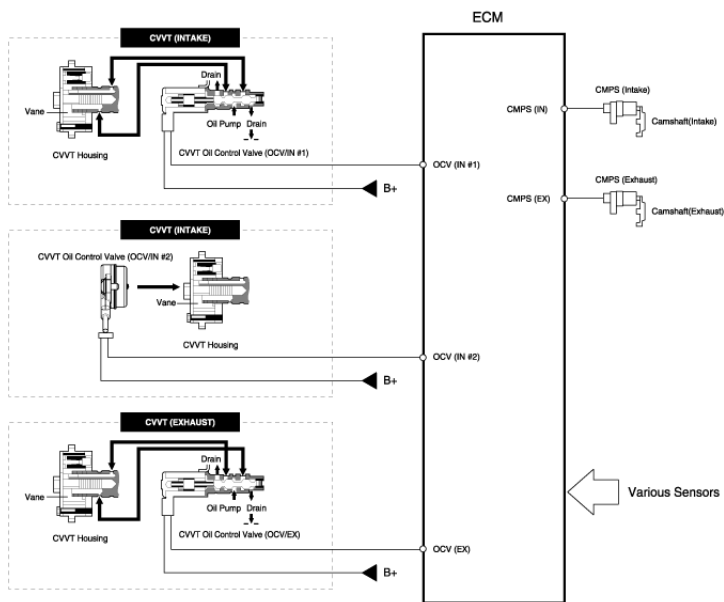


[Bank 1 / Exhaust]



CVVT and Camshaft - Description and Operation (Article 45344)

- Description
- the CVVT Oil Control Valve (OCV) which supplies the engine oil to the cam phaser or runs out the engine oil from the cam phaser in accordance with the ECM PWM (Pulse With Modulation) control signal,
- and the Cam Phaser which varies the cam phase by using the hydraulic force of the engine oil.



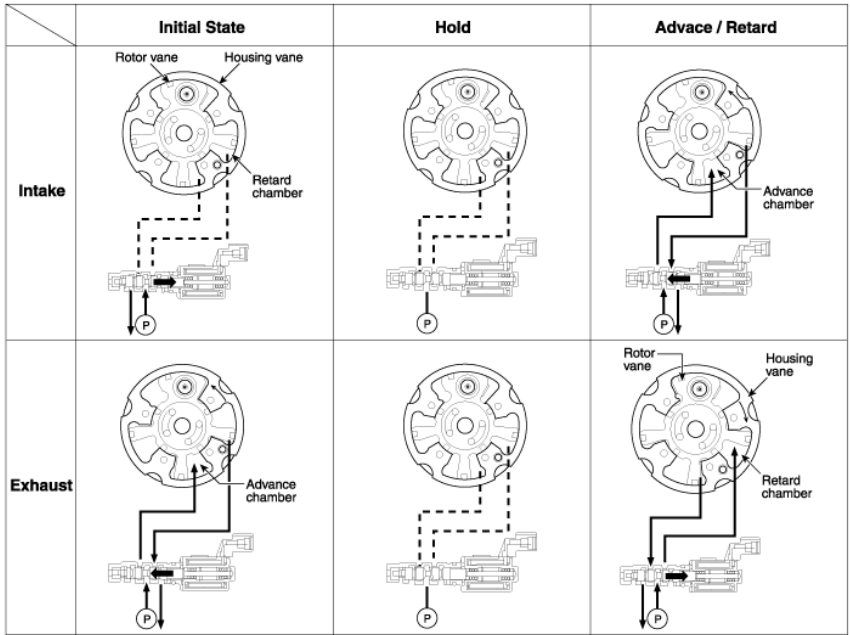
- Operation Principle

A separate solenoid valve is installed on the chain cover in the intake side for closing and releasing a separate lock pin.

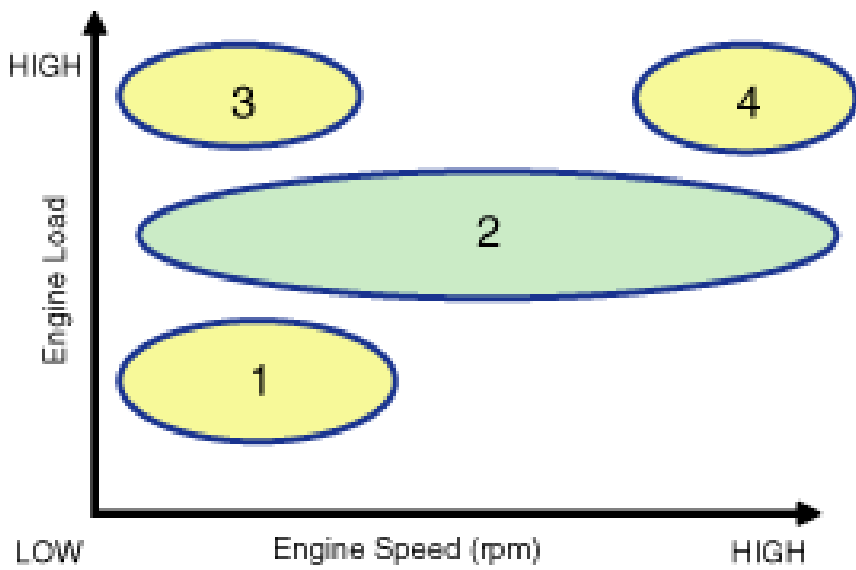


Information

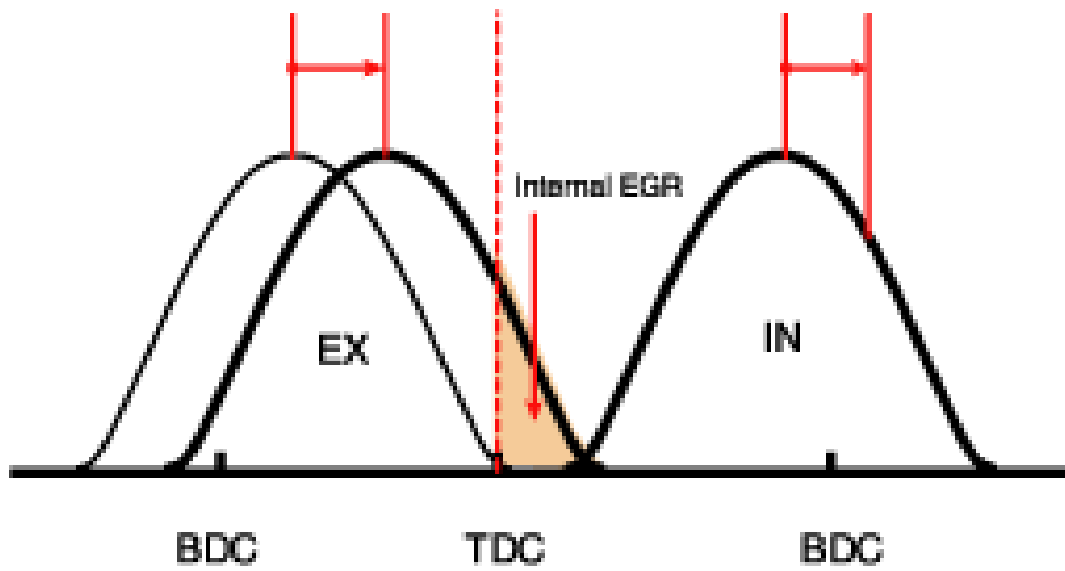
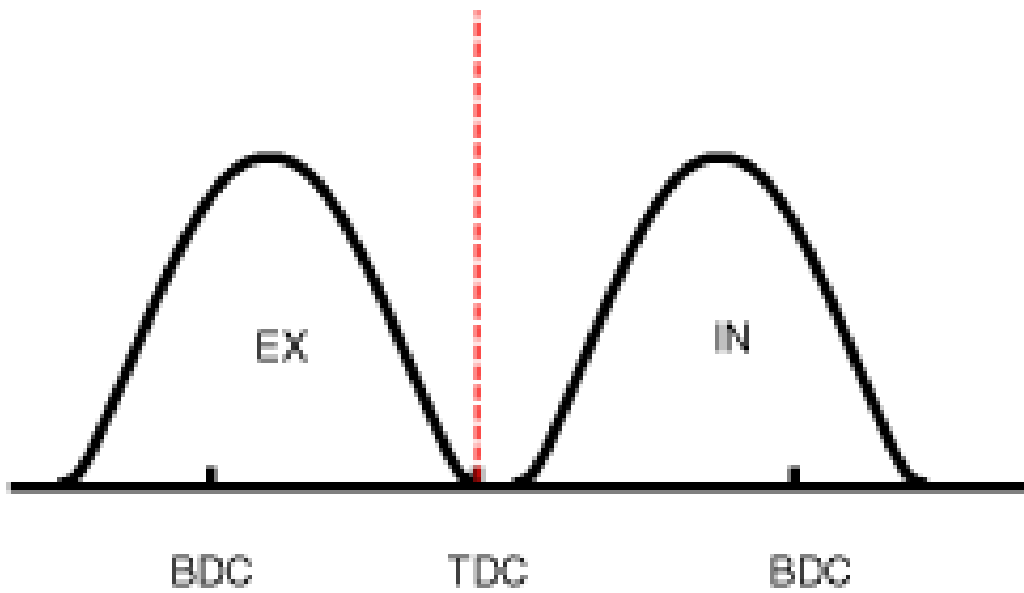
- A separate solenoid valve is installed on the chain cover in the intake side for closing and releasing a separate lock pin.



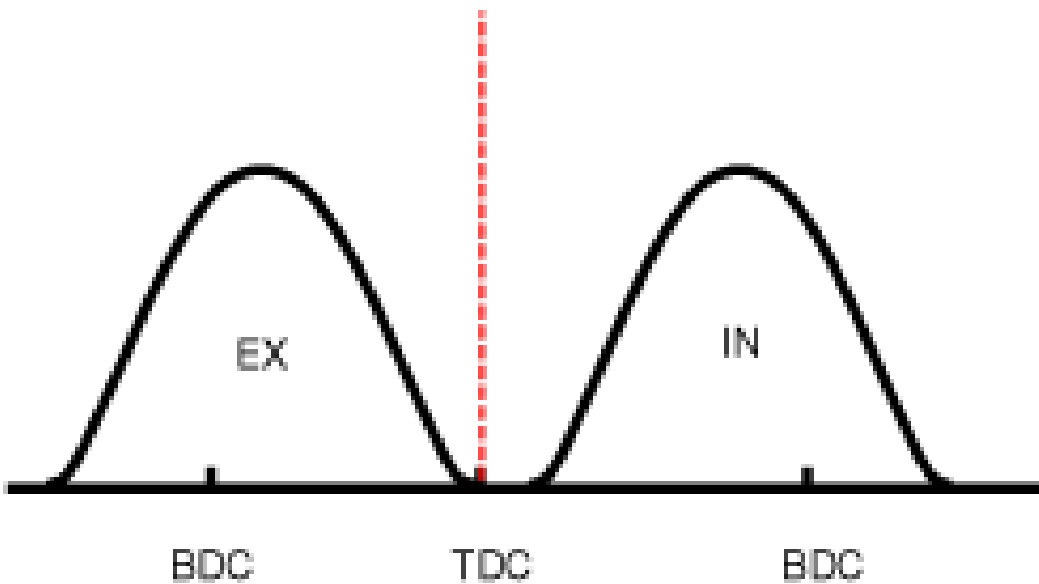
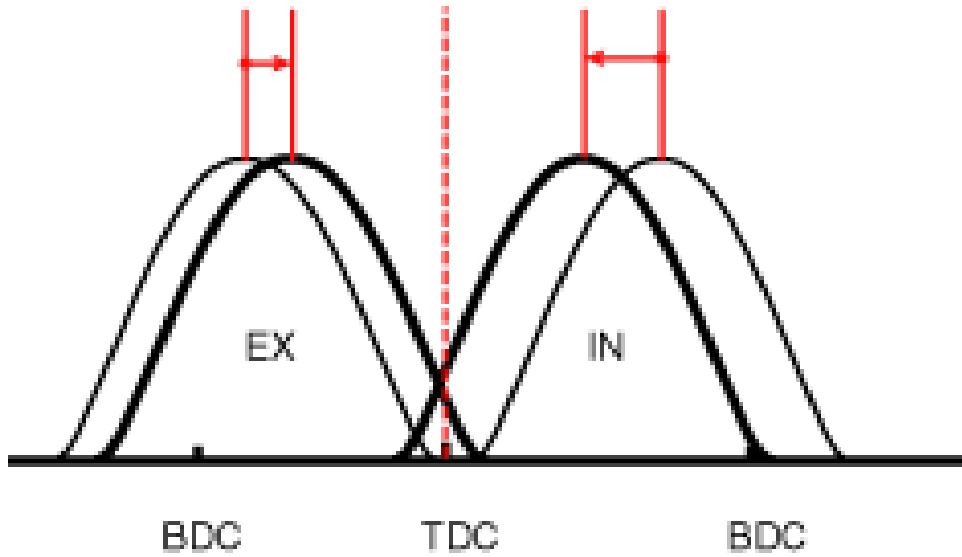
- [CVVT System Mode]



(1) Low Speed / Low Load (2) Part Load



(3) Low Speed / High Load (4) High Speed / High Load



Driving Condition Exhaust Valve Intake Valve

Valve Timing Effect Valve Timing Effect

(1) Low Speed /Low Load Completely Advance * Valve Under-lap * Improvement of combustion stability Completely

Retard * Valve Under-lap * Improvement of combustion stability

(2) Part Load Retard * Reduction of HC Retard * Delays the closing time of intake valve to reduce pumping loss

* Increases expansion work

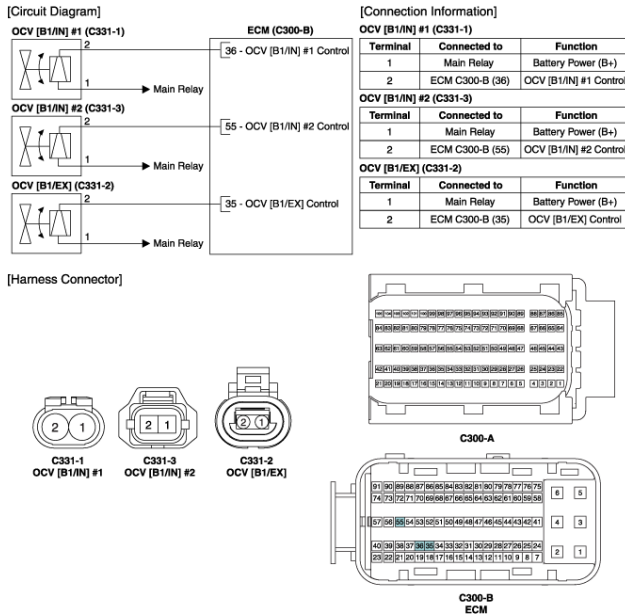
(3) Low Speed /High Load Retard * Increase of expansion work Advance * Prevention of intake back flow

(Improvement of volumetric efficiency)

(4) High Speed /High Load Advance * Reduction of pumping loss Retard * Improvement of volumetric efficiency

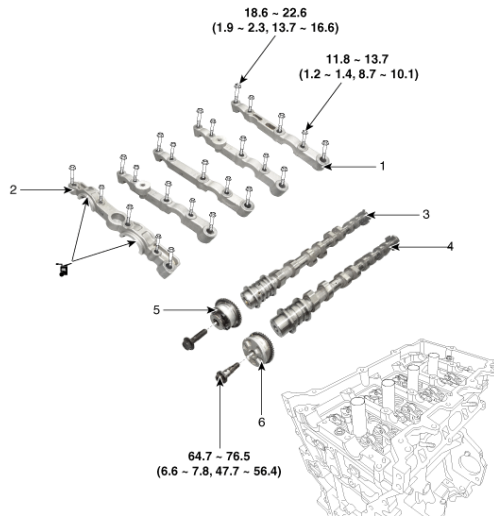
CVVT Oil Control Valve (OCV) - Schematic Diagrams (Article 44165)

- Circuit Diagram



CVVT and Camshaft - Components and Components Location (Article 45342)

- Components



Tightening torque : N.m (kgf.m, lb-ft)

1. Camshaft bearing cap 2. Camshaft front bearing cap 3. Exhaust camshaft 4. Intake camshaft 5. Exhaust CVVT assembly 6. Intake CVVT assembly

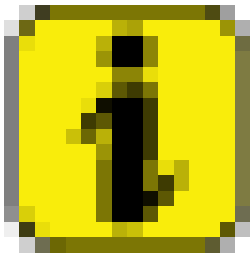
CVVT and Camshaft - Repair Procedures (Article 45346)

- Removal

Use fender covers to avoid damaging painted surfaces. To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

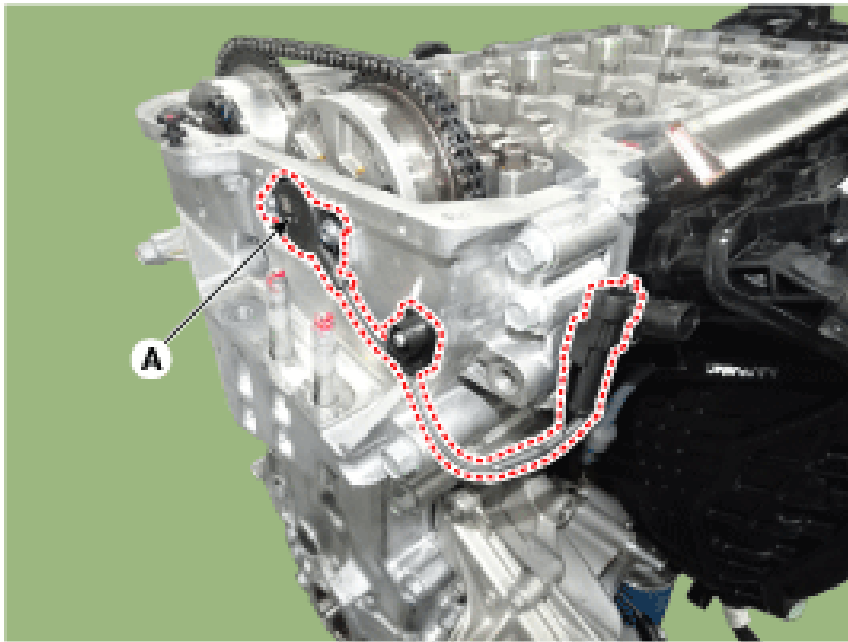
NOTICE

- Use fender covers to avoid damaging painted surfaces.
 - To avoid damage, unplug the wiring connectors carefully while holding the connector portion.
- Mark all wiring and hoses to avoid misconnection. Turn the crankshaft pulley so that the No. 1 piston is at top dead center.

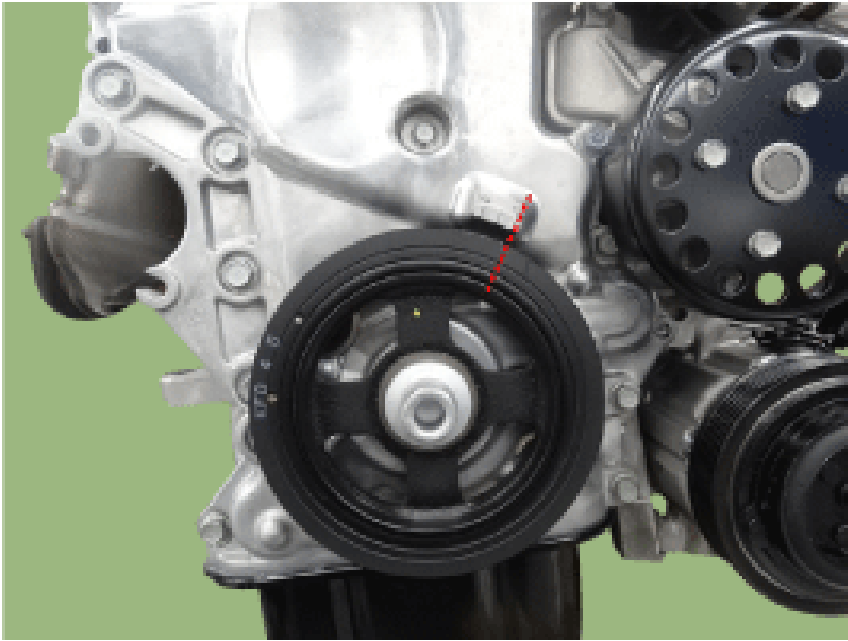


Information

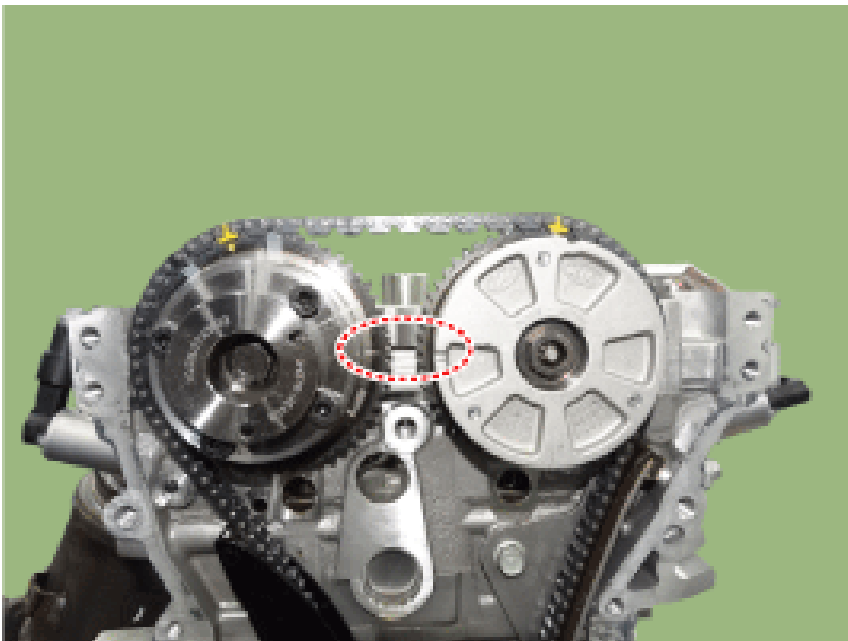
- Mark all wiring and hoses to avoid misconnection.
- Turn the crankshaft pulley so that the No. 1 piston is at top dead center.
- Remove the cylinder head cover . (Refer to Cylinder Head Assembly - "Cylinder Head Cover")
- Remove the intermediate lock CVVT actuator (A).



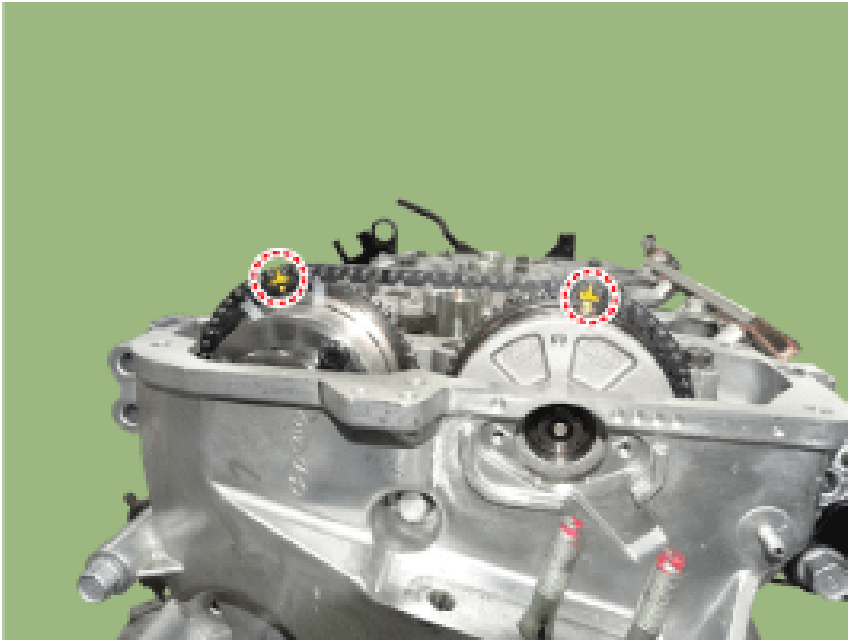
- Set No.1 cylinder to TDC (Top dead center) on compression stroke. Turn the crankshaft pulley and align its groove with the timing mark of the timing chain cover. Check that the TDC marks of the intake and exhaust CVVT sprockets are in straight line on the cylinder head surface as shown in the illustration. If not, turn the crankshaft by one revolution (360°) more. Mark the timing chains corresponding to the timing marks of the CVVT sprockets.
- Turn the crankshaft pulley and align its groove with the timing mark of the timing chain cover.



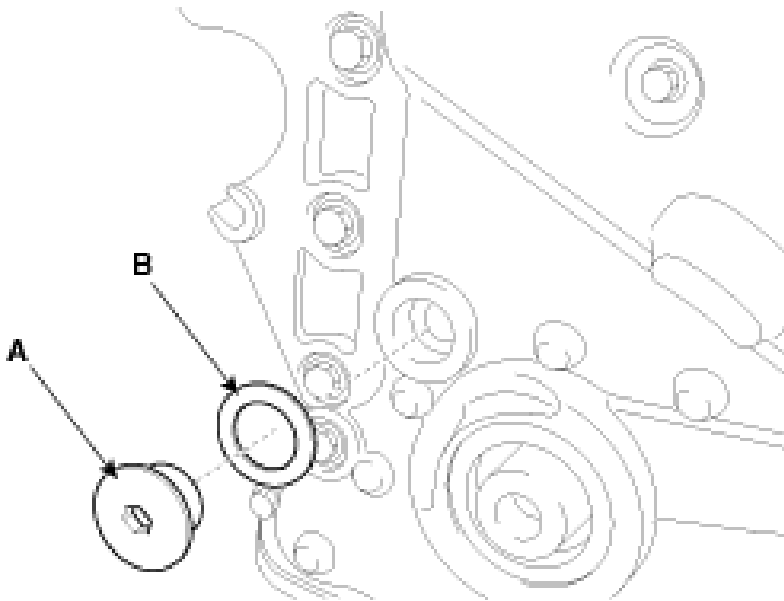
- Check that the TDC marks of the intake and exhaust CVVT sprockets are in straight line on the cylinder head surface as shown in the illustration. If not, turn the crankshaft by one revolution (360°) more.



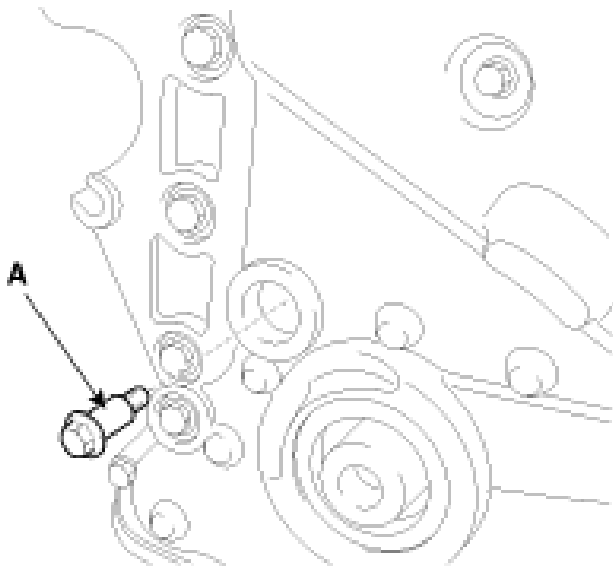
- Mark the timing chains corresponding to the timing marks of the CVVT sprockets.



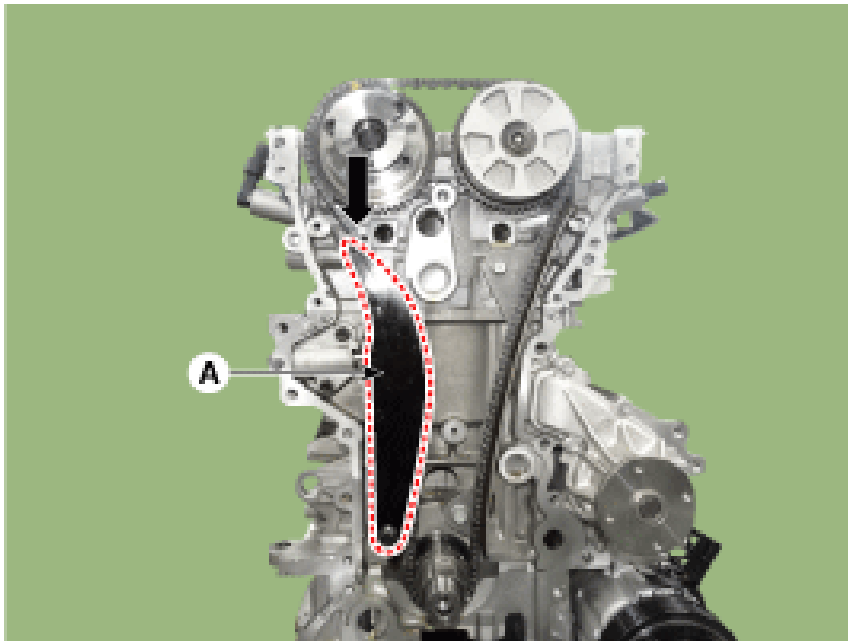
- Remove the crankshaft damper pulley. (Refer to Timing System - "Crankshaft Damper Pulley")
- Remove the service plug bolt (A) with the gasket (B).



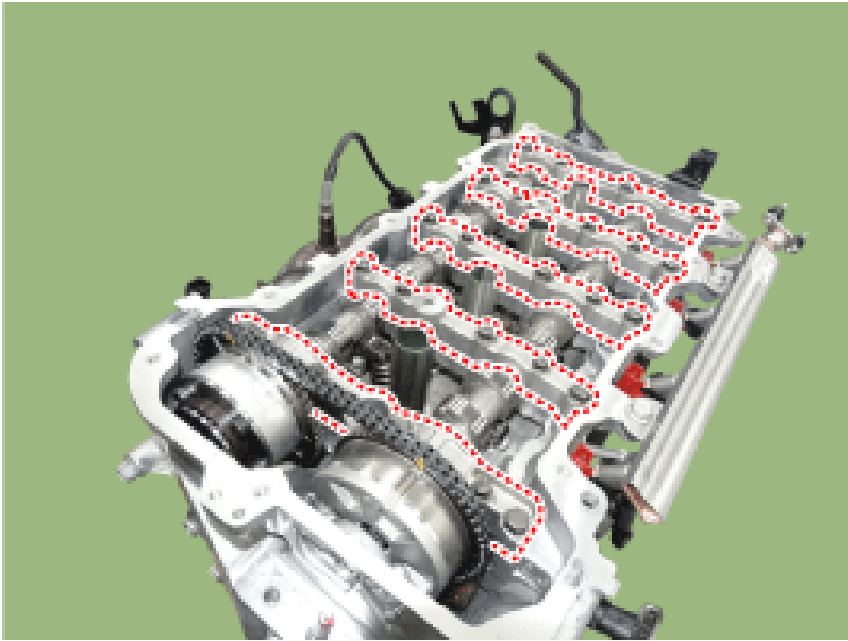
- Remove the tensioner arm bolt (A).



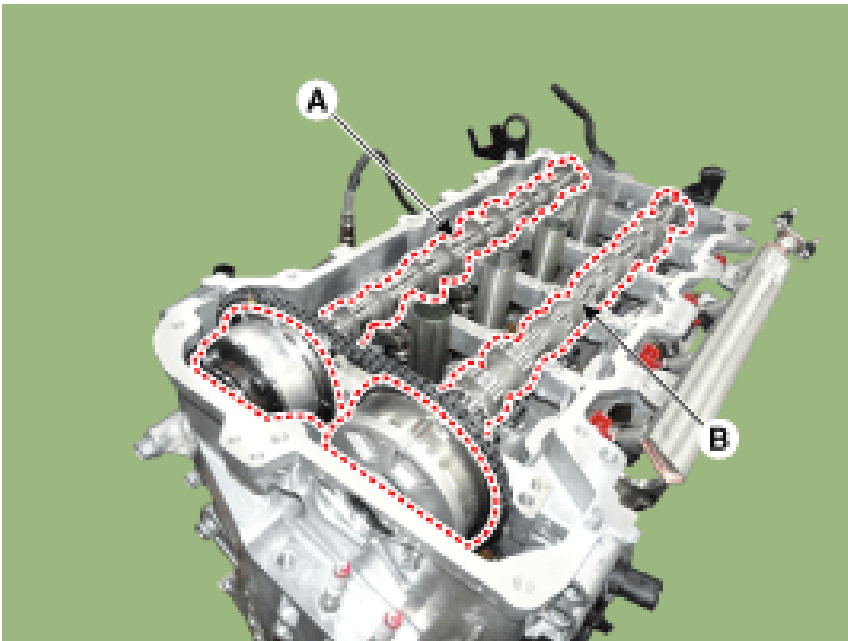
- Push down the tensioner arm (A).



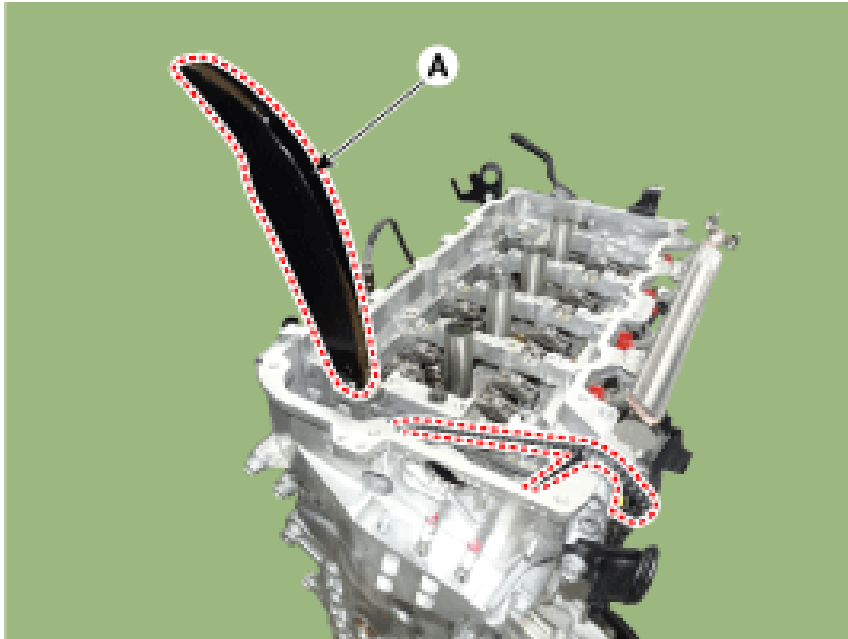
- Remove the camshaft bearing caps.



- Remove the exhaust camshaft (A) first, then intake camshaft (B).



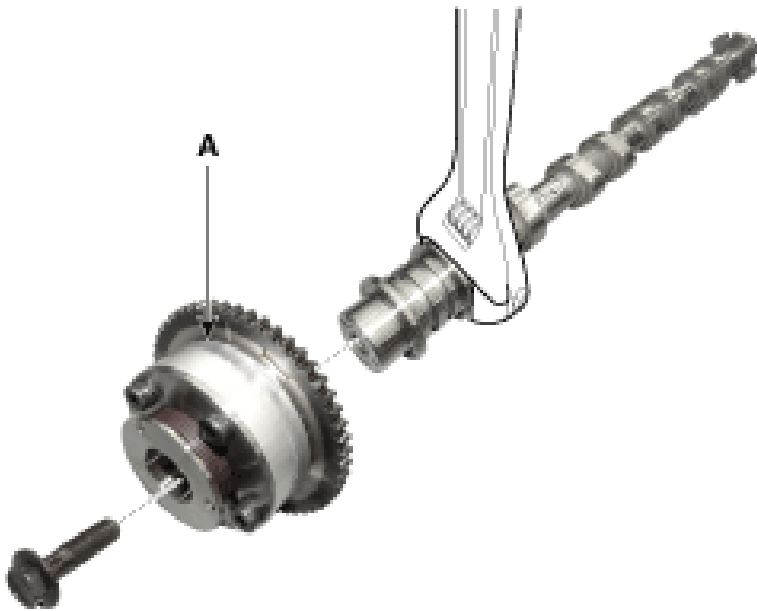
- Remove the tensioner arm (A). To hold the timing chain, tie it with strap.



To hold the timing chain, tie it with strap.

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- Remove the CVVT assembly (A) from the camshaft . When removing the CVVT assembly bolt, hold the camshaft with a wrench to prevent the camshaft from rotating.



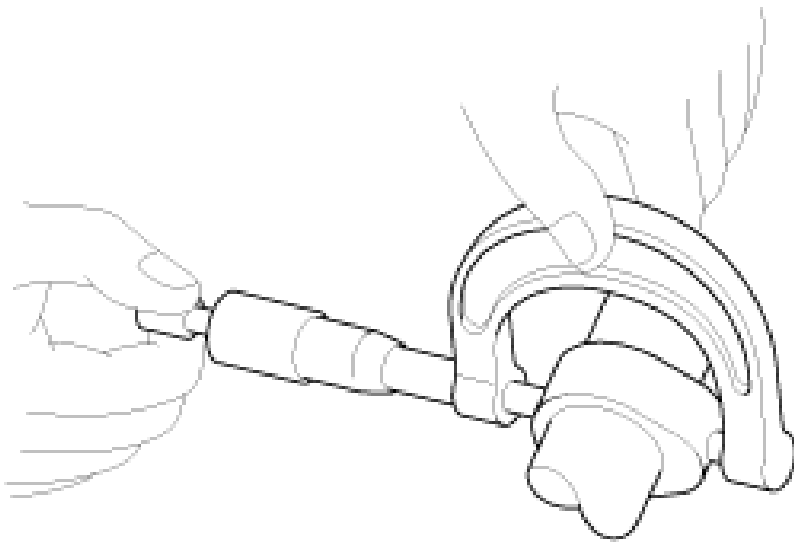
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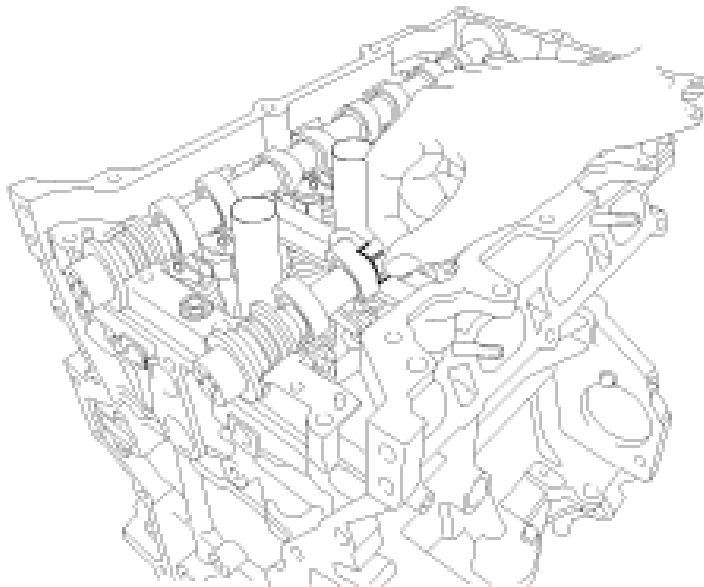
- Inspection

Camshaft

- Inspect the cam lobes. Using a micrometer, measure the cam lobe height. If the cam lobe height is less than specification, replace the camshaft. Cam height Intake : 39.0 mm (1.5354 in.) Exhaust : 39.0 mm (1.5354 in.)

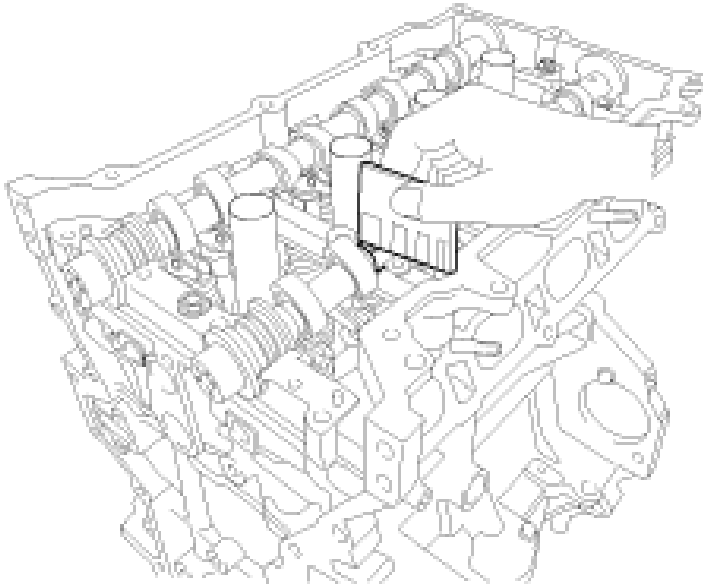


- Check the surface of the camshaft journal for wear. If the journal is worn excessively, replace the camshaft.
- Inspect the camshaft journal clearance. Clean the bearing caps and camshaft journals. Place the camshafts on the cylinder head. Lay a strip of plastigage across each of the camshaft journal. Install the bearing caps and tighten the bolts with specified torque. Tightening torque M6 bolts : 11.8 - 13.7 N.m (1.2 - 1.4 kgf.m, 8.7 - 10.1 lb-ft) M8 bolts : 18.6 - 22.6 N.m (1.9 - 2.3 kgf.m, 13.7 - 16.6 lb-ft) Do not turn the camshaft. Remove the bearing caps. Measure the plastigage at its widest point. If the oil clearance is greater than specification, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set. Bearing oil clearance Standard : 0.032 - 0.062 mm (0.00126 - 0.00244 in.)
- Clean the bearing caps and camshaft journals.
- Place the camshafts on the cylinder head.
- Lay a strip of plastigage across each of the camshaft journal.



- Install the bearing caps and tighten the bolts with specified torque. Tightening torque M6 bolts : 11.8 - 13.7 N.m (1.2 - 1.4 kgf.m, 8.7 - 10.1 lb-ft) M8 bolts : 18.6 - 22.6 N.m (1.9 - 2.3 kgf.m, 13.7 - 16.6 lb-ft) Do not turn the camshaft.
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- Remove the bearing caps.

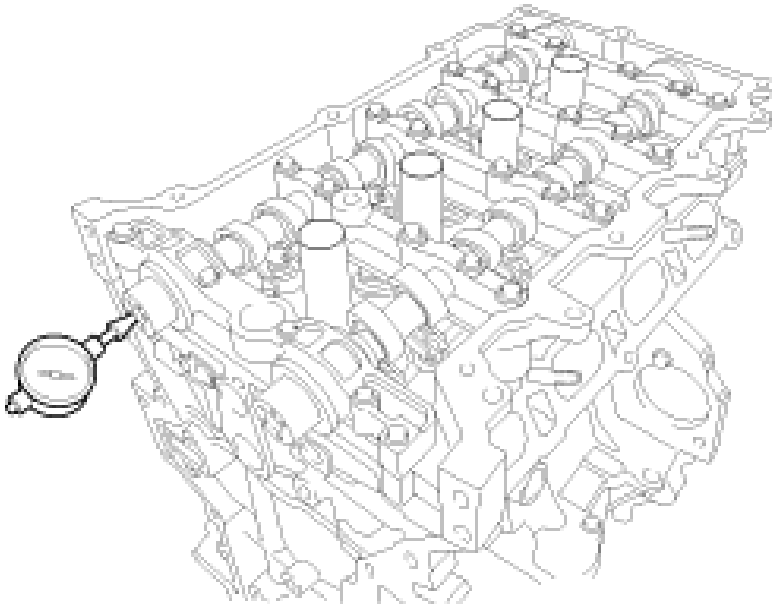
- Measure the plastigage at its widest point. If the oil clearance is greater than specification, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set. Bearing oil clearance Standard : 0.032 - 0.062 mm (0.00126 - 0.00244 in.)



- Inspect the camshaft end play. Install the camshaft bearing caps. Using a dial indicator, measure the end play while moving the camshaft back and forth. If the end play is greater than specification, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set. Camshaft end play Standard : 0.10 - 0.19 mm (0.0039 - 0.0075 in.) Remove the camshafts.

- Install the camshaft bearing caps.

- Using a dial indicator, measure the end play while moving the camshaft back and forth. If the end play is greater than specification, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set. Camshaft end play Standard : 0.10 - 0.19 mm (0.0039 - 0.0075 in.)



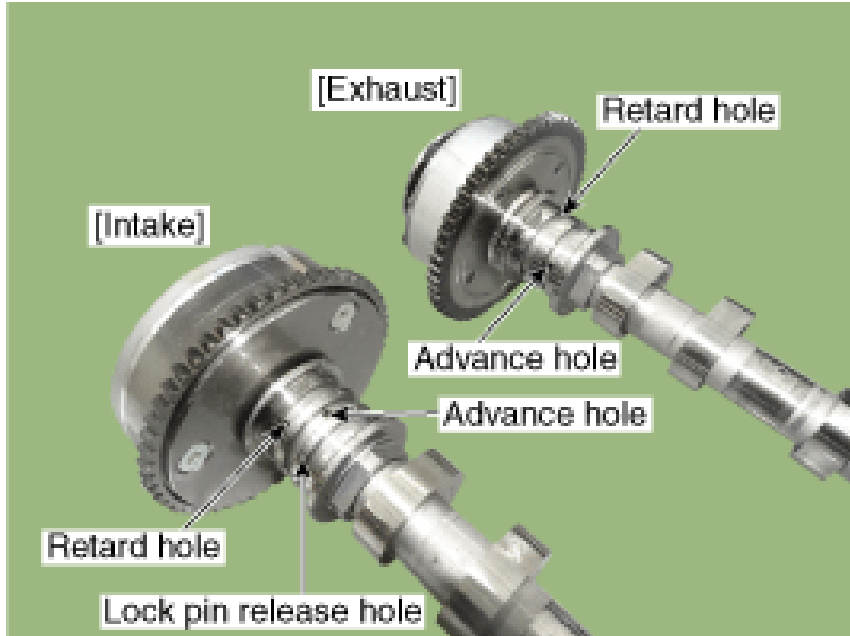
- Remove the camshafts.

Continuously variable valve timing (CVVT) Assembly

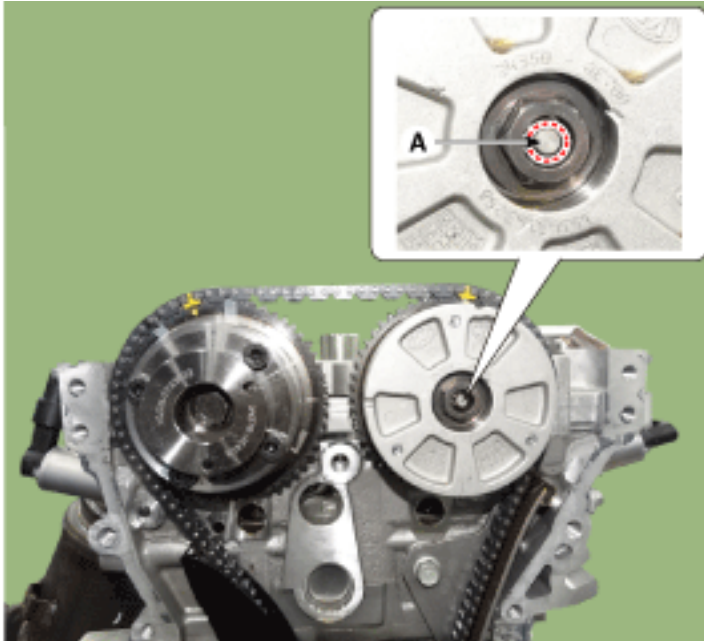
- Inspect the CVVT for smooth rotation. Clamp the camshaft using a vise. Be careful not to damage the cam lobes and journals in the vise. Check that the CVVT is locked by turning it clockwise or counterclockwise. It must not rotate. Intake CVVT : Seal one of the two advance holes in the camshaft journal with tape. Exhaust CVVT : Seal one of the two retard holes in the camshaft journal with tape. Intake CVVT : press the center of the valve bolt (A). Apply approx. 50 kPa (0.5 kgf /cm², 7 psi) of compressed air into the lock pin release

hole to release the lock. Exhaust CVVT : Apply approx. 150kPa (1.5kgf /cm² 21psi) of compressed air into the unsealed retard hole to release the lock. Cover the oil paths with a piece of cloth when applying compressed air to prevent oil from spraying. Intake CVVT : With compressed air applied, rotate the CVVT into the advance direction (counterclockwise) within its phasing range and check that the CVVT turns smoothly. Exhaust CVVT : With compressed air applied, rotate the CVVT into the retard direction (clockwise) and check that the CVVT turns smoothly. CVVT phasing range Intake : 40° (20° advance and 20° retard from the initial position) Exhaust : 20° ± 1° (from the most advanced position to the most retarded position) Intake CVVT : Move to the center to check that lock pin closes well. Rotate the CVVT into the most retarded position (clockwise) and then check that the CVVT is locked. Exhaust CVVT : Rotate the CVVT into the most advanced position (counterclockwise) and then check that the CVVT is locked.

- Clamp the camshaft using a vise. Be careful not to damage the cam lobes and journals in the vise.
- Check that the CVVT is locked by turning it clockwise or counterclockwise. It must not rotate.
- Intake CVVT : Seal one of the two advance holes in the camshaft journal with tape. Exhaust CVVT : Seal one of the two retard holes in the camshaft journal with tape.

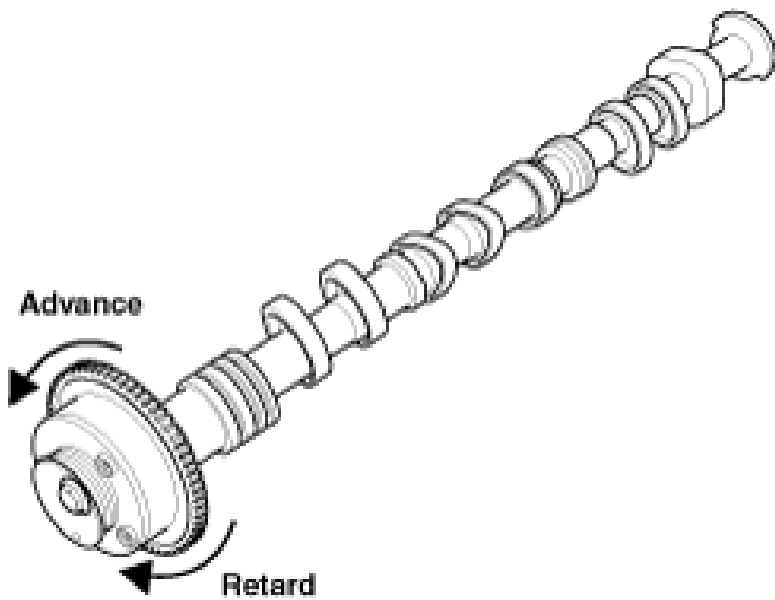


- Intake CVVT : press the center of the valve bolt (A). Apply approx. 50 kPa (0.5 kgf /cm², 7 psi) of compressed air into the lock pin release hole to release the lock. Exhaust CVVT : Apply approx. 150kPa (1.5kgf /cm² 21psi) of compressed air into the unsealed retard hole to release the lock. Cover the oil paths with a piece of cloth when applying compressed air to prevent oil from spraying.
- press the center of the valve bolt (A).
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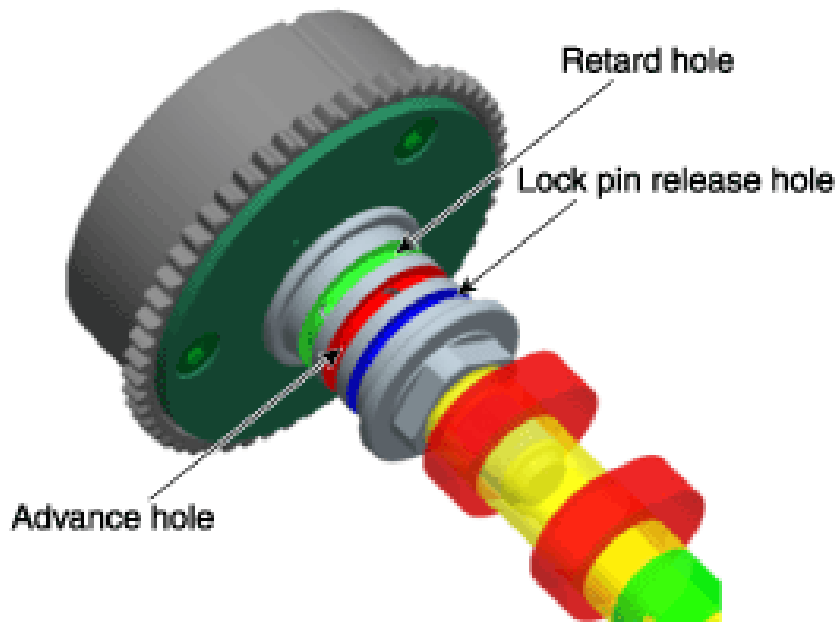


Cover the oil paths with a piece of cloth when applying compressed air to prevent oil from spraying.

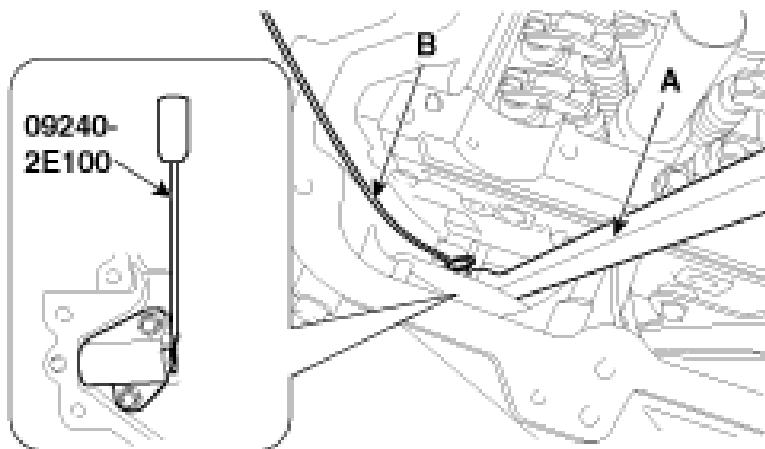
- Cover the oil paths with a piece of cloth when applying compressed air to prevent oil from spraying.
- Intake CVVT : With compressed air applied, rotate the CVVT into the advance direction (counterclockwise) within its phasing range and check that the CVVT turns smoothly. Exhaust CVVT : With compressed air applied, rotate the CVVT into the retard direction (clockwise) and check that the CVVT turns smoothly. CVVT phasing range Intake : 40° (20° advance and 20° retard from the initial position) Exhaust : 20° ± 1° (from the most advanced position to the most retarded position)



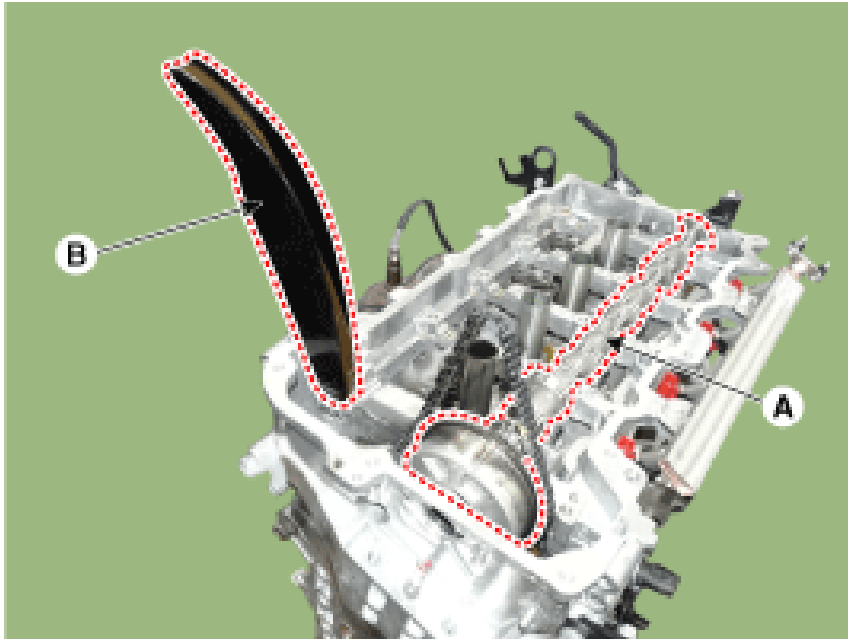
- Intake CVVT : Move to the center to check that lock pin closes well. Rotate the CVVT into the most retarded position (clockwise) and then check that the CVVT is locked. Exhaust CVVT : Rotate the CVVT into the most advanced position (counterclockwise) and then check that the CVVT is locked.
- Move to the center to check that lock pin closes well.
- Rotate the CVVT into the most retarded position (clockwise) and then check that the CVVT is locked.
- Rotate the CVVT into the most advanced position (counterclockwise) and then check that the CVVT is locked.



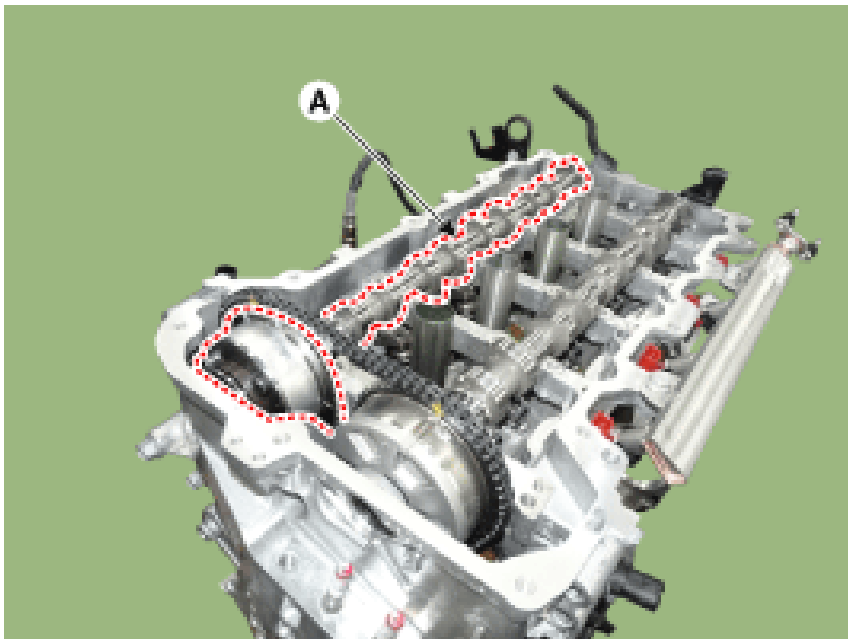
- Installation
- Install the CVVT assembly (A) to the camshaft. Tightening torque : 64.7 - 76.5 N.m (6.6 - 7.8 kgf.m, 47.7 - 56.4 lb-ft) When installing the CVVT assembly bolt, hold the camshaft with a wrench to prevent the camshaft from rotating.
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- When installing the CVVT assembly bolt, hold the camshaft with a wrench to prevent the camshaft from rotating.
- Compress the piston of the tensioner using a handy bar (A) and then insert a stopper pin (B) into the hole on the tensioner to hold the compressed piston.



- Place the intake camshaft (A) and then insert the tensioner arm (B) along the timing chain.



- Place the exhaust camshaft (A). The timing marks of each CVVT sprocket should be matched with timing marks (painted link) of timing chain when installing the timing chain.

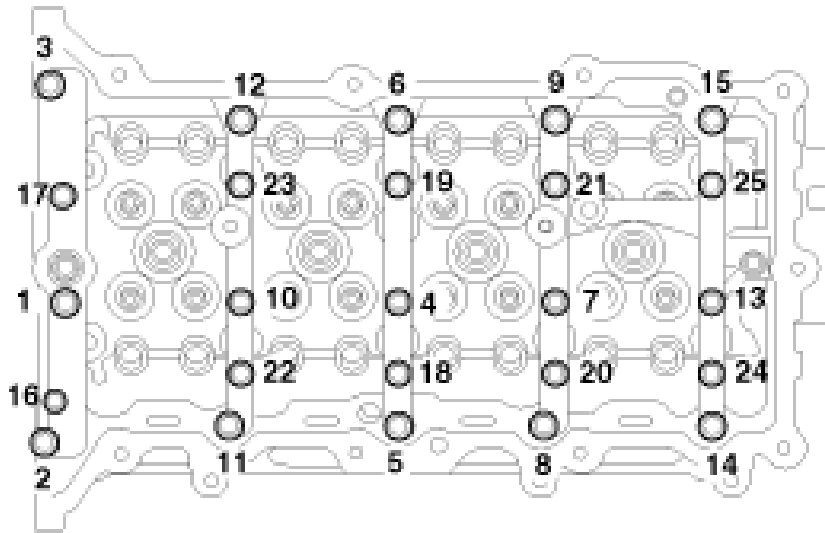


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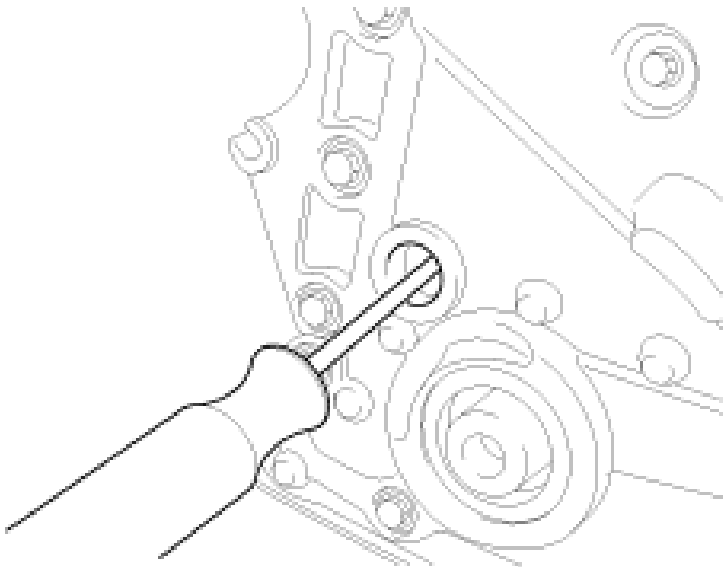
- Install the camshaft bearing caps. Tighten the bolts, in several passes, in the sequence as shown.

Tightening torque M6 bolts : 11.8 - 13.7 N.m (1.2 - 1.4 kgf.m, 8.7 - 10.1 lb-ft) M8 bolts : 18.6 - 22.6 N.m (1.9 - 2.3 kgf.m, 13.7 - 16.6 lb-ft) Be careful not to change the position and direction of bearing caps.



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- Be careful not to change the position and direction of bearing caps.
- Using a suitable tool, move the tensioner arm to align the tensioner bolt hole with the service hole.



- Install the tensioner arm bolt (A). Tightening torque : 18.6 - 22.6 N.m (1.9 - 2.3 kgf.m, 13.7 - 16.6 lb-ft)
- Remove the stopper pin from the tensioner.
- Turn the crankshaft two turns in the operating direction (clockwise), and then check that the TDC marks of the CVVT sprockets are in straight line on the cylinder head surface.
- Install a service plug bolt (A) with a gasket. Tightening torque : 29.4 - 39.2 N.m (3.0 - 4.0 kgf.m, 21.7 - 28.9 lb-ft) Do not reuse the service plug bolt and gasket.
- Do not reuse the service plug bolt and gasket.
- Do not reuse the service plug bolt and gasket.
- Install the intermediate lock CVVT actuator (A). Tightening torque : 8.8 - 9.8 N.m (0.9 - 1.0 kgf.m, 6.5 - 7.2 lb-ft) Always use new actuator bolts. The residue inside of the chain-cover bolt hole should be disposed before locking. The actuator bolts should be locked to the regulated torque.
- Always use new actuator bolts. The residue inside of the chain-cover bolt hole should be disposed before locking. The actuator bolts should be locked to the regulated torque.
- Always use new actuator bolts.
- The residue inside of the chain-cover bolt hole should be disposed before locking.

- The actuator bolts should be locked to the regulated torque.
- Install the other parts reverse order of removal.

CVVT Oil Control Valve (OCV) - Specifications (Article 44159)

- Specification

[Bank 1 / Intake] #1 , [Bank 1 / Exhaust]

Item Specification

Coil Resistance (Ω) 9.4 - 10.4 [20°C (68°F)]

[Bank 1 / Intake] #2

Coil Resistance (Ω) 10.8 - 12.8 [20°C (68°F)]