TECHTALK

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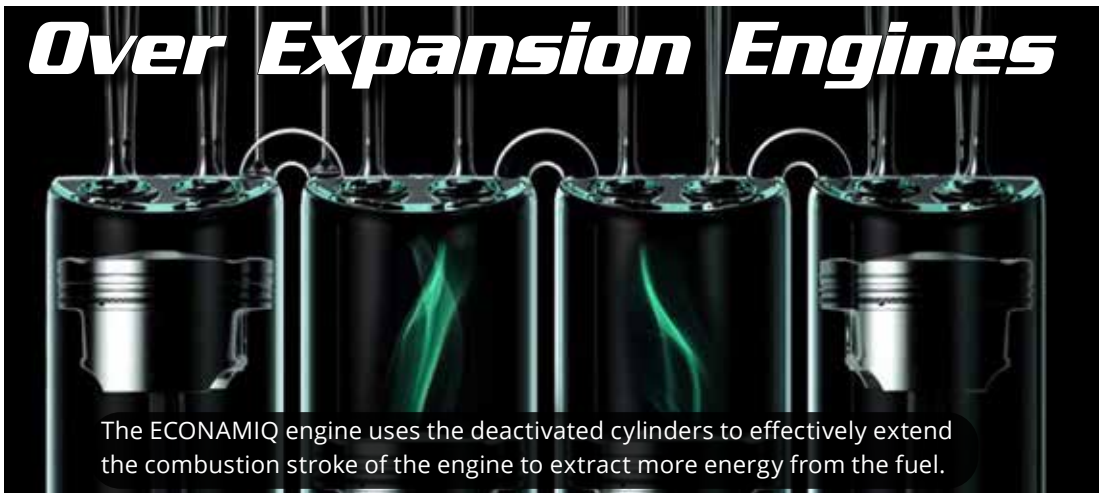
Over Expansion Engines

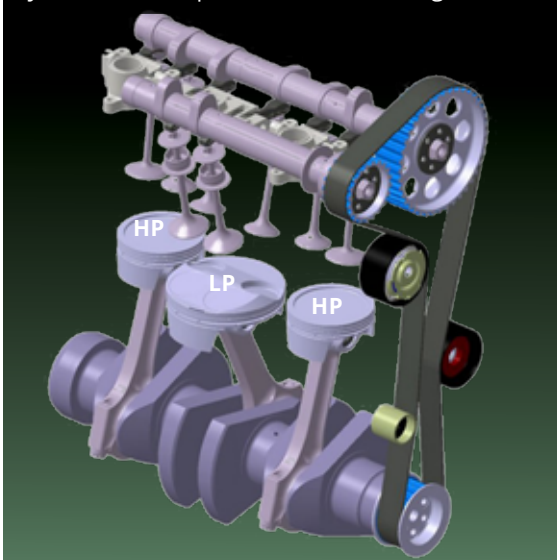


The ECONAMIQ engine uses the deactivated cylinders to effectively extend the combustion stroke of the engine to extract more energy from the fuel.

Over the history of engine designs, there have been many variations in engine operating cycles all with their advantages and trade-offs in the pursuit of increasing thermal efficiency. However, a significant percentage of the energy in the fuel still passes out the exhaust. Now one company is using cylinder deactivation systems in conjunction with a modified cylinder head to over expand the exhaust gases which extracts the heat and energy that would usually be wasted.

Over expansion, like all new ideas, is an old concept. In the golden age of marine steam engines, high-pressure steam passed through cylinders of increasing size until the last usable part of the expanding steam had been used to push the ship forward. In more modern automotive contexts, the typical four-stroke internal combustion engine has had its valve timing modified to shorten the compression stroke and increase the combustion stroke to extract more efficiency. These engines are called Atkinson-cycle engines and are used in many hybrid cars today. However, they are limited by the four-stroke cycle. An extra stroke is needed to extract more power.

The 5-stroke engine had two cylinders operating on the 4-stoke cycle. The middle cylinder over expanded the exhaust gases.

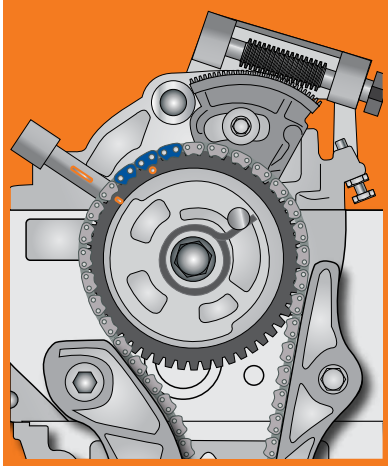


Gerhard Schmitz invented the 5-stroke engine in 2000. This experimental engine utilises two fired cylinders (High Pressure - HP) operating on a conventional 4-stroke cycle which alternately passes exhaust into a central expansion cylinder (Low Pressure - LP), at which point the exhaust gases perform further work. The prototype has shown a 10% improvement in fuel efficiency over a conventional engine of the same size. However, this engine has not been picked up by any manufacturers for mass production.

Recently, Dutch start-up company ECONAMIQ has developed another way to over expand exhaust gases by incorporating cylinder deactivation systems. These systems are a common feature in many modern engines, which disable cylinders under low load conditions, to effectively reduce the capacity of the engine which reduces emissions and fuel usage. When power is required, all cylinders are reactivated.

Featuring

Mitsubishi Outlander 4J11 / 4J12: Timing Chain Replacement



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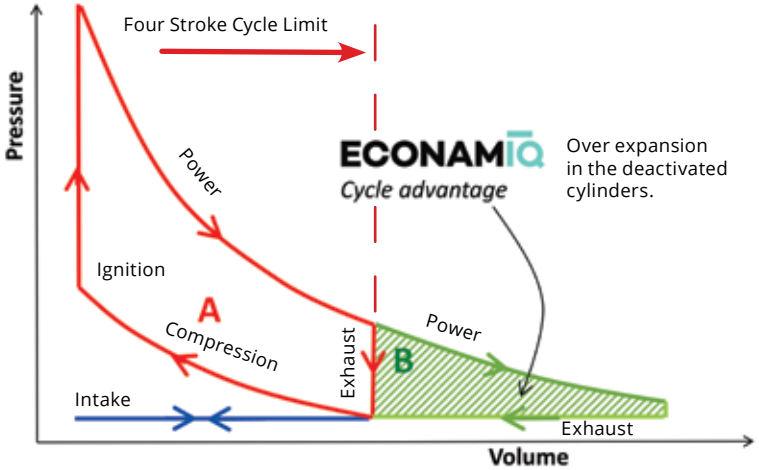
The ECONAMIQ principle uses the deactivated cylinders in a similar way to the 5-stroke engines middle low-pressure cylinder. There are extra passages and valves in the ECONAMIQ engines cylinder head to allow exhaust from the two outer cylinders, to pass into the middle two deactivated cylinders. This will effectively extend the combustion stroke of the engine.

There is a valve between the two middle cylinders to allow them to act together as a single-cylinder with a larger surface area, which more efficiently extracts power from the lower pressure exhaust gases. Under high load conditions, the valves in the head close, all four cylinders are activated and will operate on the four-stroke cycle so the engine can provide the driver with high performance.

ECONAMIQ Engine Stroke Verses Pressure Graph

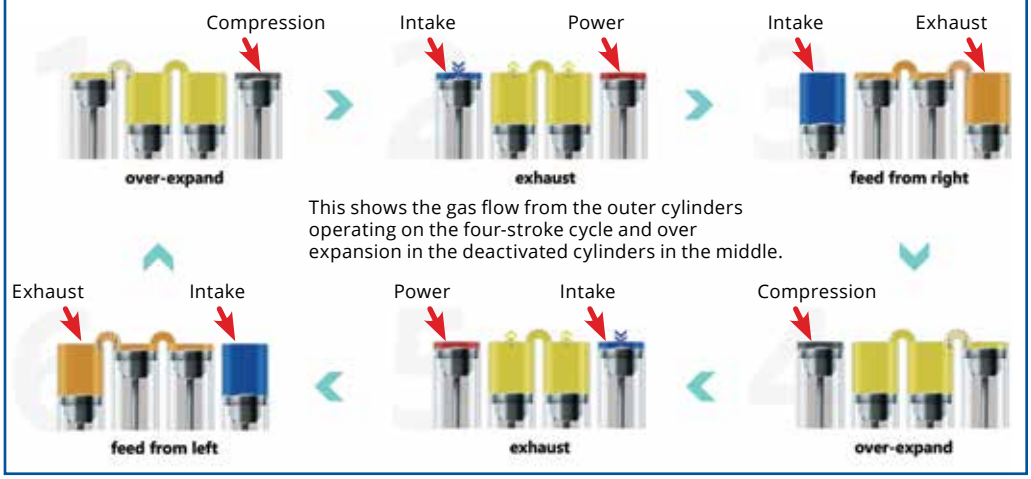
The red line indicates a typical four-stroke engine cycle showing pressure and volume. The green line shows how the ECONAMIQ cycle allows the power stroke to be extended to capture more energy.



The advantages of this concept is the relative ease in which it can be integrated into existing four and eight-cylinder engines with minimal changes required. It also builds on existing cylinder deactivation and variable valve timing systems.

Due to the internal exchange of exhaust gasses, the ECONAMIQ principle ensures that the engine reaches operating temperature faster, resulting in more efficient engine operation and the heater inside the vehicle will start working sooner.

ECONAMIQ Stroke Cycle Showing Over Expansion



Hybrid vehicles would especially benefit since the rapid engine warm-up and high-efficiency cycle that ECONAMIQ offers, would reduce fuel consumption during power-assisted operation or battery charging. Also, engine vibrations are reduced during cylinder deactivation.

The ECONAMIQ engine is still in the developmental phase, and work still needs to be done to implement these innovations. However, the efficiency and performance that this technology could provide would be very desirable to many vehicle manufacturers.

Image and Content Source: ECONAMIQ & Ilmor

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VACC MOTORTECH Launch Night Highlights

VACC Technical Advisory Service team assisting members to find the information they need on VACC's MotorTech. Everyone is very focused.

Wednesday the 11th of December 2019 saw the official launch of VACC Technical Services new MotorTech offering at a member's information evening held at VACC House in Melbourne.

After light refreshments and the opportunity to do some networking, VACC President Fury Bortolotto opened proceedings by offering a warm welcome to all in attendance. VACC CEO Geoff Gwilym then went onto explain how MotorTech will be at the forefront of VACC's Technical offerings. As it will help guide the chamber into the future and ensuring it's members continue to have access to a comprehensive wealth of up to date technical service and repair information. Managing Director of Haynes Australia Ian Whitefield spoke about the synergy between VACC and Haynes as well as the excitement around being able to offer the new Haynes suite of professional products alongside VACC's traditional offering in the new MotorTech application for the Australian market.

Bernard Murray, General Manager of Technical and Programs, then gave a demonstration on how to navigate the MotorTech website, highlighting examples of the new information that is now available and outlining its benefits to members.

After the demonstrations and handing out of various door prizes, members were offered the chance to try the MotorTech system for themselves. Computer workstations were made available, and members of VACC's Technical Services Team were on hand to assist members with the system and to guide them to the vehicles or information that they were interested in. Of particular interest was the new Haynes Pro VESA guided diagnostics system to which many members commented on the power of the system and how it will enhance their ability to diagnose those tricky electrical faults.

Tours of VACC's Technical Library were a popular part of the evening with many members reporting that they were unaware of how big the library is, and the amount of information available to them with one phone call to the Technical Advisory Service.

After the demonstrations and having used the MotorTech system, many members committed and signed up to MotorTech on the night. All attendees were in the running to win a free 12-month subscription to MotorTech - Diagnostics which is the premium level of subscription and includes the full suite of VACC and Haynes products.

The lucky winner was Paul McNamara of Paul Mac Repairs Pty Ltd in Shepparton.

In the coming months, VACC is planning on running similar member nights around Victoria and Tasmania. These nights will offer all members the chance to experience the power of MotorTech for themselves, so keep an eye out for when the MotorTech Team will be in your region and make sure it's a night you don't miss.

VACC's CEO Geoff Gwilym explaining how VACC Technical Services is launching into a new era with a product offering that will change the automotive technical information game in Australia.

Mitsubishi Outlander 4J11 / 4J12: Timing Chain Replacement

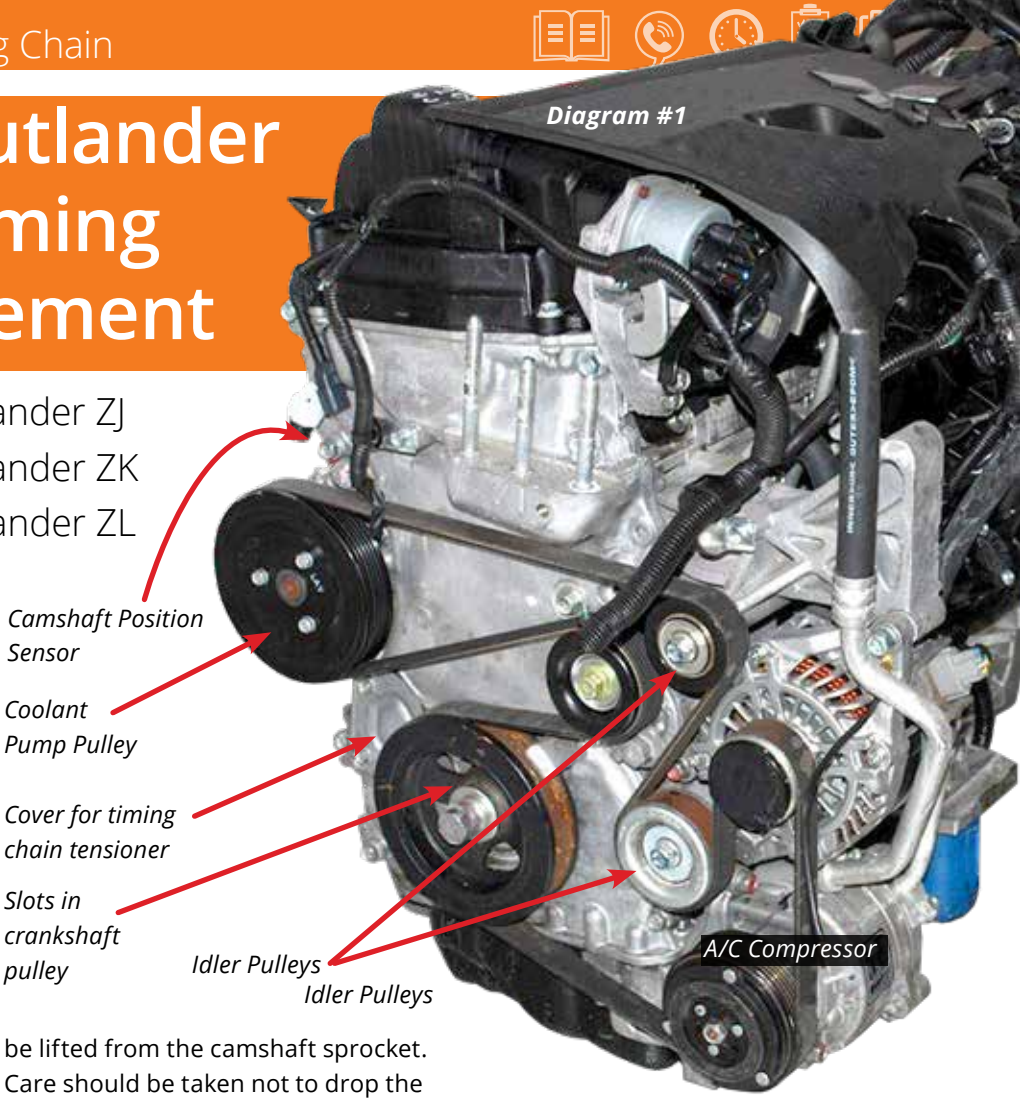
2012 – 2015 Mitsubishi Outlander ZJ
2015 – 2017 Mitsubishi Outlander ZK
2017 – 2019 Mitsubishi Outlander ZL

The 4J1 family of engines have been on Australian roads since 2012, and VACC's Technical Advisory Service is now starting to receive calls requesting repair procedures, one of which is the timing chain replacement. The 2.0L 4J11 and the 2.4L 4J12 are mechanically similar. However, there are some slight differences which I will highlight in this article.

In the April 2019 issue of Tech Talk page 4667, I gave an overview of the Variable Valve Timing and Variable Valve Lift systems of these engines which operate uniquely, and requires a complicated procedure and specialised tools to adjust the valve clearances. Luckily, the valve timing and the timing chain layout is relatively simple and requires no special tools to align the valve timing.

The 2.0L 4J11 has a chain-driven oil pump via a separate chain, fitted behind the timing chain. There are no timing marks as the oil pump is not timed to the engine. The 2.4L 4J12 has balance shafts and an oil pump integrated into the same unit which must be timed to the engine to prevent unwanted vibrations.

NOTE: If you are only replacing the cylinder head, it is possible to remove the timing chain without removing the timing cover and oil pan. There is an access hole in the timing cover to allow you to release the timing chain tensioner and to remove the tensioner which will allow the timing chain to be lifted from the camshaft sprocket. Care should be taken not to drop the tensioner bolts inside the engine. ***See Diagram #1, #6 and #8***



The times guide in Haynes Pro Data Tech indicates that a timing chain replacement on a 4J11 should take approximately 5.3 hours. This would be similar for the 4J12 engine.

Disassembly

1. Turn the ignition OFF.
2. Disconnect the battery.
3. Raise the vehicle and remove the splash cover from under the engine.
4. Drain the engine oil and remove the oil filter.
5. Remove engine cover, two bolts.
6. Remove PCV and breather hoses from the valve cover.
7. Remove wiring harness connectors to the ignition coils.
8. Remove the ignition coils.
9. Remove spark plugs to make the engine easier to turn over.
10. Remove the Valve Lift Control Motor. ***See Page 4667***
11. Remove the Valve Lift Control Motor bracket. ***See Page 4667***
12. Remove the valve cover. **NOTE:** Remove the cover in the direction of the spark plug tube to avoid damaging the spark plug tube oil seal.
13. Remove the valve cover gasket and discard.
14. Remove the camshaft position sensor from the rear side of the timing cover. ***See Diagram #1***
15. Loosen the three bolts for the coolant pump pulley. ***See Diagram #1***
16. Remove the serpentine belt (see Tech Online for the procedure). ***See Diagram #1***

Diagram #2

Timing Chain Layout.

- 4J12 engine shown
- 4J11 timing marks are the same

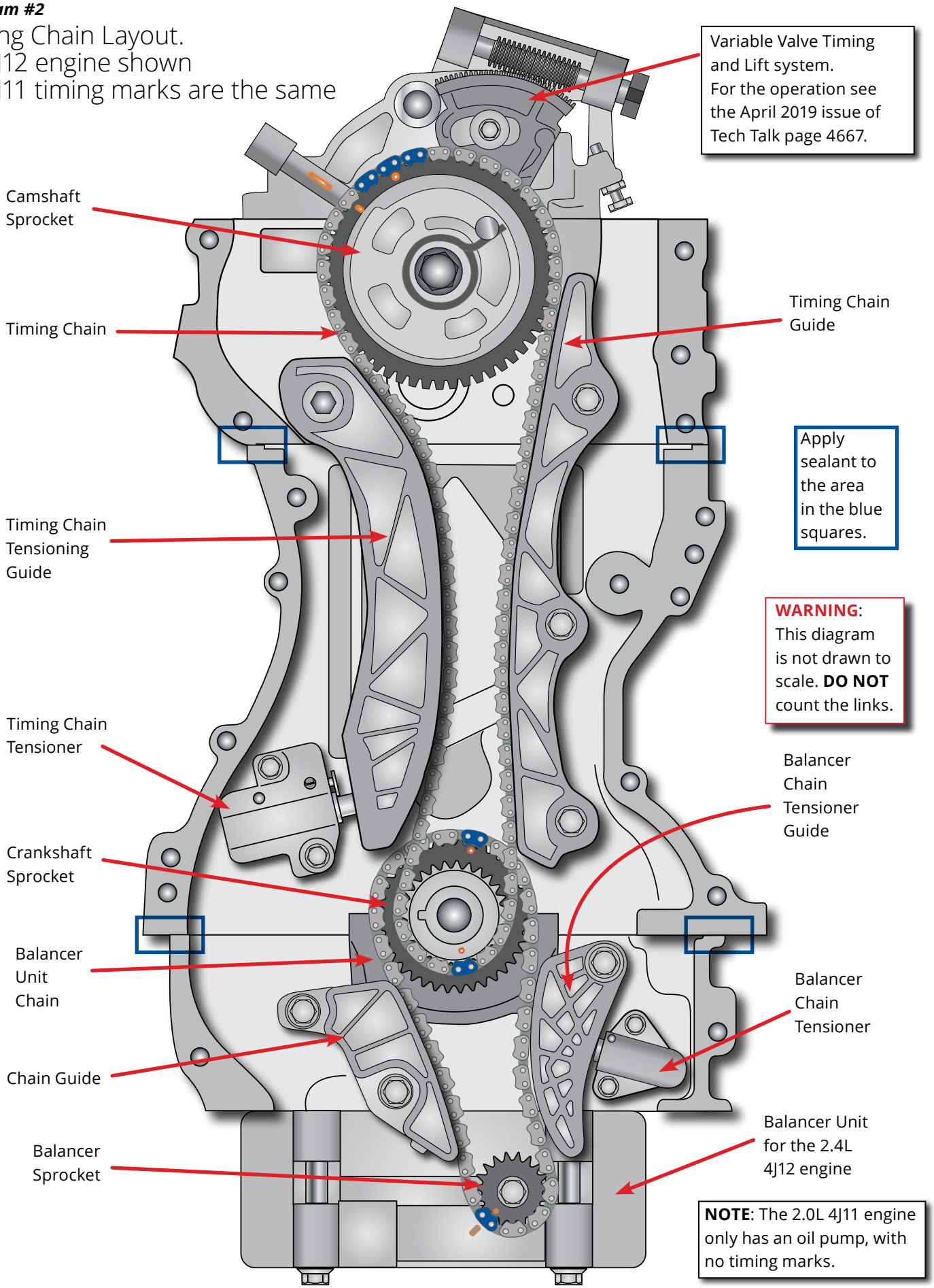
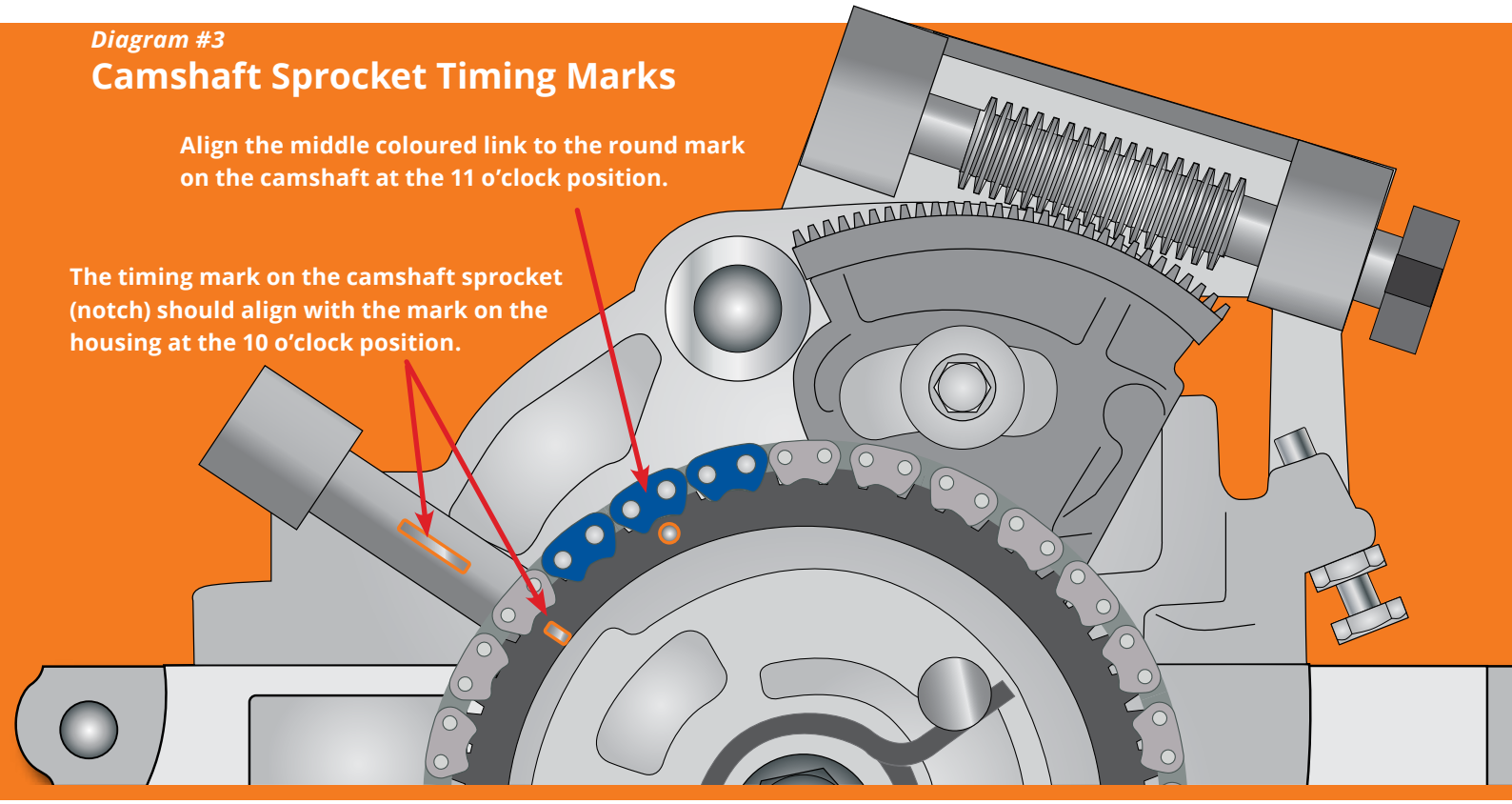


Diagram #3

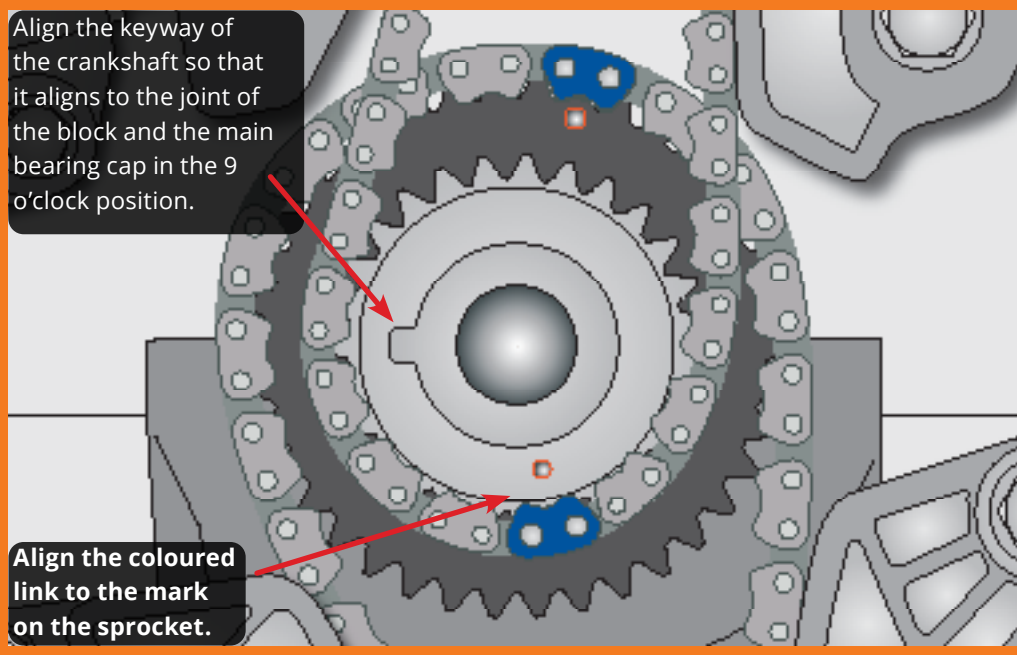
Camshaft Sprocket Timing Marks



17. With an appropriate locking tool engaged in the slots in the crankshaft pulley. Hold the crankshaft, then loosen the bolt for the crankshaft pulley. ***See Diagram #1***
18. Remove the bolt and washer, then the crankshaft pulley should slide off.
19. Remove the A/C compressor and move it aside, three bolts. ***See Diagram #1***
20. Remove the A/C compressor bracket, three bolts.
21. Remove the coolant pump pulley, three bolts. ***See Diagram #1***
22. Remove both serpentine belt idler pulleys. ***See Diagram #1***
23. Remove the serpentine belt tensioner, two bolts. ***See Diagram #1***
24. Remove the alternator. ***See Diagram #1***
25. Remove the alternator mounting bracket.
26. Fit an engine support brace to the engine and support the engine's weight.
27. Remove the engine mount on the front of the engine, three nuts and three bolts.
28. Remove the bolts from the oil pan, then use an appropriate tool to cut through the sealant to remove the oil pan from the engine.
29. Remove the bolts from the timing cover. ***See Diagram #8***
30. Gently pry at the corners shown to release the timing cover from the engine. ***See Diagram #8***

Diagram #4

Crankshaft Sprocket Timing Marks



31. Once removed pry out the timing cover seal and discard.

Timing Chain Removal

1. Temporarily install the crankshaft pulley to the crankshaft and use this to turn the engine clockwise.
2. Turn the engine to ensure that the keyway of the crankshaft aligns to the joint of the block and the main bearing cap in the 9 o'clock position. The timing mark on the camshaft sprocket (notch) should align with the mark on the housing at the 10 o'clock position. The engine should now be at TDC for No.1 cylinder. ***See Diagram #3 and #4***

   NOTE: There is a circular timing mark on the camshaft sprocket at the 11 o'clock position at TDC that is used to align coloured links on the timing chain on assembly. The links are not required to align with this mark for the engine to be aligned at TDC for No.1 cylinder. ***See Diagram #3***
3. Remove the crankshaft pulley.
4. Using a small pick or screwdriver release the ratchet via the hole in the timing chain tensioner. ***See Diagram #6***
5. Push the plunger of the tensioner into the tensioner body, insert a 1.5 mm drill bit or Allen key into the hole to lock the tensioner in the retracted position. ***See Diagram #6***
6. Remove the timing chain tensioner, two bolts. ***See Diagram #6***
7. Remove the timing chain tensioner guide, one bolt. ***See Diagram #2***
8. Remove the timing chain guide, three bolts. ***See Diagram #2***
9. The timing chain should now be able to be removed from around the sprockets.
10. Clean all parts, then inspect for wear and damage.

Diagram #5

Balance Shaft Unit Chain Layout

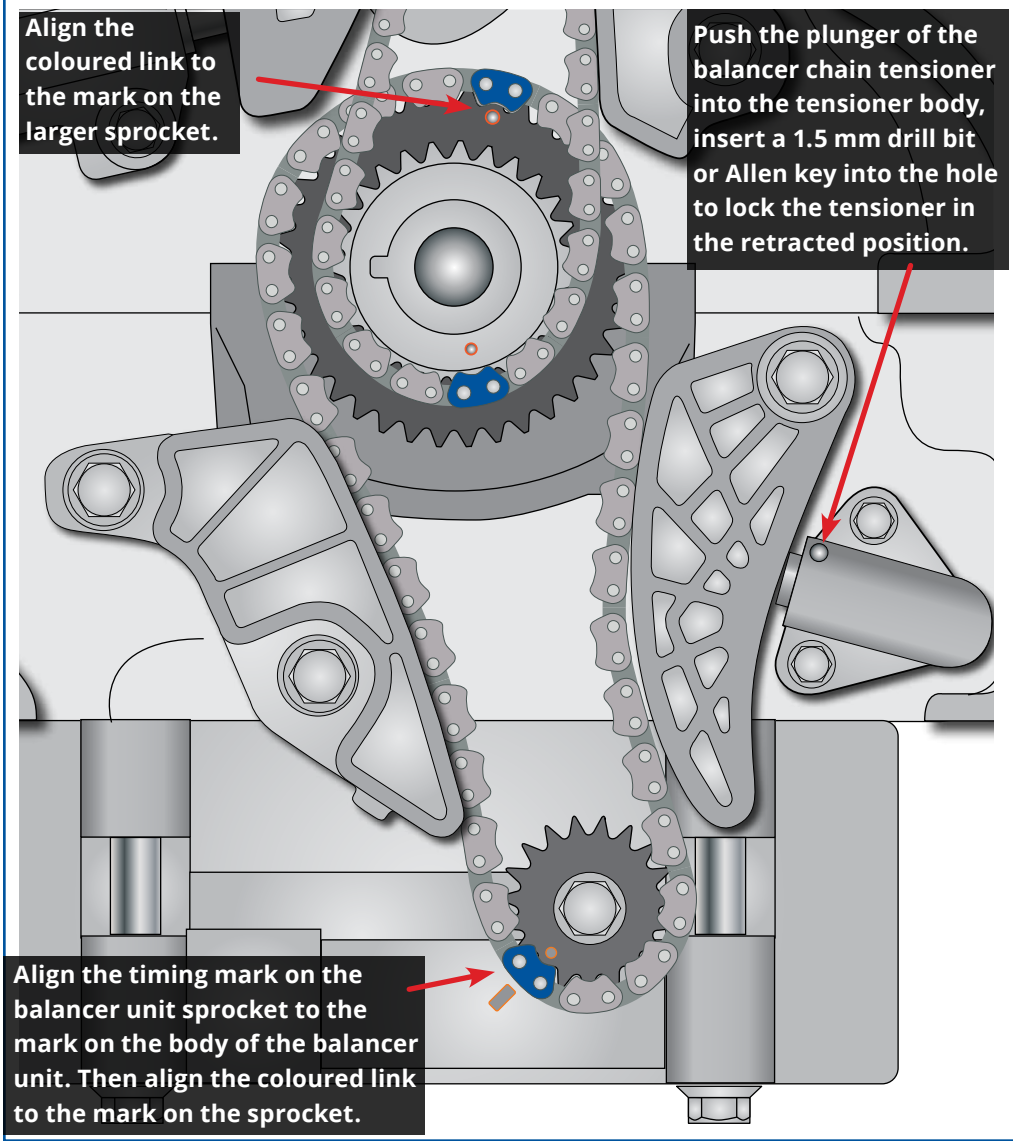
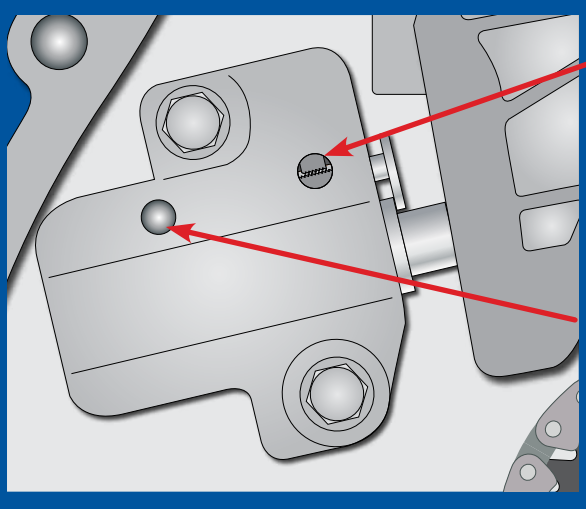
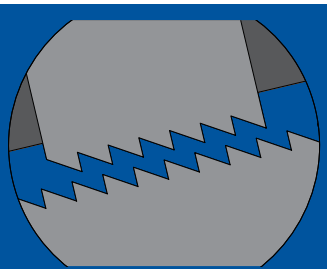


Diagram #6

Timing Chain Tensioner



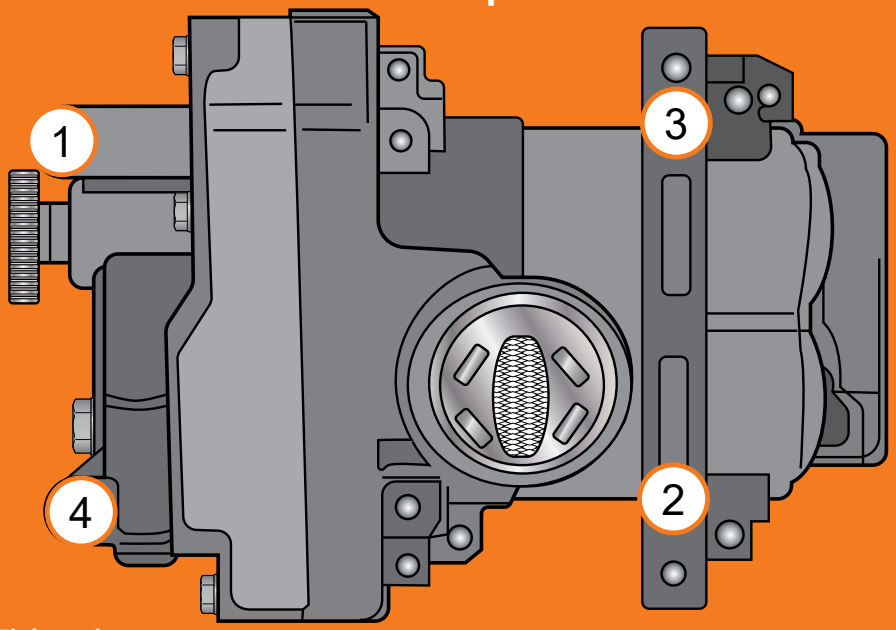


Using a small pick or screwdriver to release the ratchet via the hole in the timing chain tensioner.

Push the plunger of the tensioner into the tensioner body, insert a 1.5 mm drill bit or Allen key into this hole to lock the tensioner in the retracted position.

Diagram #7

Balance Shaft and Oil Pump Unit



Tighten in sequence to
1st: 20 Nm, 2nd: 44 Nm, 3rd: Loosen all the bolts, 4th: 20Nm, 5th: +135°.

4J12 Balancer Unit Chain Removal

1. Push the plunger of the balancer chain tensioner into the tensioner body, insert a 1.5 mm drill bit or Allen key into the hole to lock the tensioner in the retracted position. ***See Diagram #5***

   WARNING: If not locked in correctly, the plunger may come out, and parts might be lost.
2. Remove the tensioner, two bolts. ***See Diagram #5***
3. Remove the balancer chain tensioner guide, one bolt. ***See Diagram #5***
4. Remove the other balancer chain guide, two bolts.
5. Remove the four mounting bolts from the balancer unit. ***See Diagram #7***
6. Remove the balancer unit and slide the chain and the crankshaft sprocket from the engine.
   NOTE: It is possible to remove the balance shaft chain from the balance shaft unit with the timing chain and timing cover still in place. You will have to remove the oil pan, which will give you enough room to remove the chain tensioner and guides.

4J11 Oil Pump Chain Removal

1. Fit a cable tie to hold the chain in place on the sprocket.
2. Remove the spring-loaded chain tensioner, one bolt.
3. With an appropriate holding tool fitted into the holes in the oil pump sprocket, remove the oil pump sprocket bolt.
4. Remove the oil pump sprocket and chain.
5. Clean all parts, then inspect for wear and damage.

4J11 Oil Pump Chain Installation

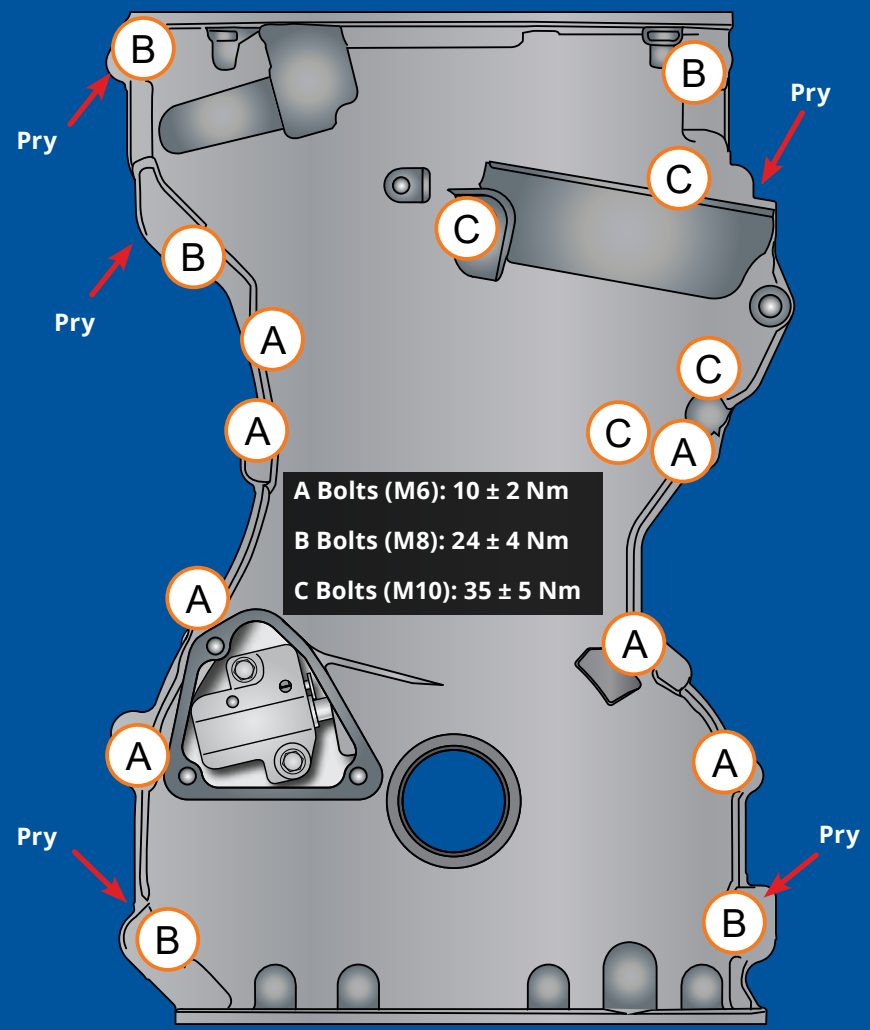
1. Fit a new crankshaft sprocket if required, ensuring that the sprocket and crankshaft have been degreased and both keys are fitted correctly.
2. Fit the new chain over the crankshaft sprocket.
3. Fit the oil pump sprocket into the chain.
4. Mount the sprocket onto the pump.
5. With an appropriate holding tool fitted into the holes in the oil pump sprocket, tighten the centre bolt to **23 Nm**.
6. Refit the spring-loaded chain tensioner and tighten the bolt to **10 Nm**.

4J12 Balancer/Oil Pump Unit Chain Installation

1. Clean the inside of the oil pan.
2. Place the new balancer / oil pump unit into the oil pan and then fill the pan about two thirds full of clean engine oil of the correct specification for the engine.
3. Pour approximately 50 ml of oil into the inlet of the oil pump, then rotate the unit four times in a clockwise direction.
4. Allow the unit to soak for a while before installation.
5. Ensure that the crankshaft is positioned so the key way is aligned to the joint of the block and main bearing cap at the 9 o'clock position. ***See Diagram #4***
6. If a new crankshaft sprocket is required, ensuring that the sprocket and crankshaft have been degreased, and both keys are fitted correctly.
7. Fit the new balancer unit chain over the crankshaft sprocket with the blue coloured link aligned to the mark on the larger sprocket. ***See Diagram #5***
8. Align the timing mark on the balancer unit sprocket to the mark on the body of the balancer unit. ***See Diagram #5***
9. Place the chain over the balancer sprocket, aligning the blue coloured link with the mark on the sprocket. ***See Diagram #5***

Diagram #8

Timing Cover



10. Fit the crankshaft sprocket over the crankshaft with the chain and balancer unit as one assembly, ensuring that all timing marks and links are still aligned. ***See Diagram #5***
11. Apply engine oil under the heads and on the threads of the four balancer unit bolts.
12. Then tighten them in sequence to the tensions shown. ***See Diagram #7***
13. Refit the chain guide and tighten the two bolts to **10 Nm**.
14. Refit the tensioning guide and tighten the pivot bolt to **10 Nm**.
15. Refit the chain tensioner and tighten the two bolts to **10 Nm**.
16. Remove the locking pin and ensure that tension is being applied to the chain. ***See Diagram #5***

Timing Chain Installation

1. Ensure that the timing mark on the camshaft sprocket (notch) is aligned with the mark on the housing at the 10 o'clock position. ***See Diagram #3***
2. Ensure that the crankshaft keyway is aligned with the joint of the cylinder block and the main bearing cap at the 9 o'clock position. ***See Diagram #4***
3. The new timing chain should have three blue coloured links together, and one single blue coloured link.
4. Align the single blue link with the timing mark on the crankshaft sprocket at the approximate 5 o'clock position. ***See Diagram #3***
5. Align the middle blue coloured link out of the three links with the circular timing mark on the camshaft sprocket at the 11 o'clock position. ***See Diagram #3***
6. Fit the timing chain guide with three bolts and tighten them to **11 Nm**.
7. Fit the timing chain tensioner guide and tighten the pivot bolt to **11 Nm**.
8. Fit the timing chain tensioner and tighten the bolts to **11 Nm**.
9. Remove the locking pin and ensure that tension is being applied to the chain. ***See Diagram #6***

   NOTE: The following step is not in the workshop manual. However, it is good workshop practice and might save some time. Temporarily fit the crankshaft pulley and centre bolt. Turn the engine over slowly by hand for two full revolutions in the clockwise direction and ensure that it turns easily. Recheck that the timing marks realign and that the chain tension is correct. **NOTE:** The links on the chain will not realign.
10. If everything is correct, remove crankshaft pulley and proceed with the reassembly. If not, rectify any issues.

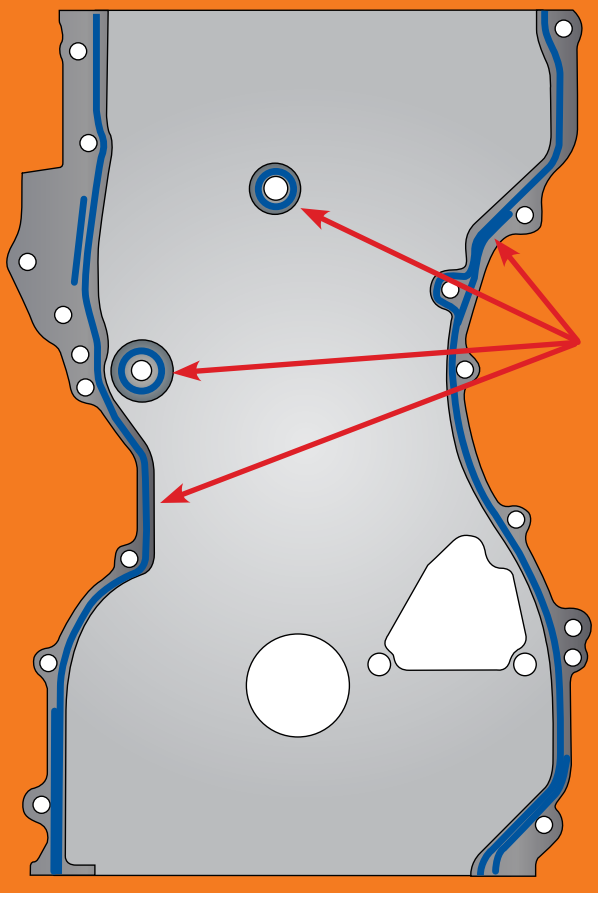
Reassembly

1. Ensure that all sealing surfaces are free of old sealant, dirt, oil and damage. Degrease all surfaces.

   NOTE: After degreasing, it is likely that the oil that has soaked into the head gasket will start to emerge, so apply fresh sealant as soon as possible after cleaning to this area.

Diagram #9

Timing Cover Sealant Application



Apply a 2.5mm bead of sealant to the sealing surfaces of the timing cover. Apply an extra bead of sealant over the joints between the head and the block and the block and the ladder frame.

2. Apply a 2.5mm bead of sealant to the sealing surfaces of the timing cover. Apply an extra bead of sealant over the joints between the head and the block, and the block and the ladder frame. ***See Diagram #2 and #9***

   NOTE: Fit the timing cover within 10 minutes of applying sealant.

3. Fit the timing cover. There are three different torque specifications for the bolts. ***See Diagram #8***
4. Fit a new timing cover seal.
5. Clean all sealing surfaces for the oil pan.
6. Apply a 2.5 mm bead of sealant to the oil pan and fit it within 10 minutes of application.
7. Tighten the M6 bolts to **10 Nm** and the M8 bolts to **31 Nm** evenly.
8. Fit a new gasket to the valve cover.
9. Apply sealant to the joints of the timing cover to the cylinder head and the corners of the "D" seal at the rear of the head.
10. Install the valve cover by angling the cover up on the exhaust side so you can slide the spark tubes into the seals in the cover without damaging them. Once the cover is all the way down the tubes, position it horizontally to the head, then press it down onto the sealing surface. ***See page 4667***
11. Tighten the valve cover bolts in two stages and in sequence. 1st: **3 Nm**, 2nd: **5.5 Nm**. ***See page 4667***
12. Refit the crankshaft pulley. Apply oil under the head of the bolt and the threads. While holding the pulley with an appropriate tool, tighten the bolt in three steps as follows:
    1st: **210 Nm**,
    2nd: **Loosen completely**,
    3rd: **210 Nm**
13. Refit the front engine mount. Tighten the bolts to **50 Nm** and the nuts to **66 Nm**.
14. Refit the alternator bracket to the block. Tighten the three bolts to **44 Nm**.
15. Refit the alternator and tighten the bolts to **44 Nm**.
16. Refit the serpentine belt tensioner and tighten the bolts to **22 Nm**.
17. Refit the serpentine belt idlers and tighten bolts to **44 Nm**.
18. Refit the coolant pump pulley and tighten the bolts to **9 Nm**.
19. Refit the serpentine belt as shown in ***Diagram #1***. See Tech Online for procedure.
20. Refit the camshaft position sensor to the timing cover. Tighten the bolt to **11 Nm**. ***See Diagram #1***
21. Refit the Valve Lift Control Motor bracket and the Valve lift control motor. ***See page 4667***
22. Refit spark plugs and tighten to **25 Nm.**
23. Refit ignition coils and tighten the bolts to **9 Nm**.
24. Refit all other components in reverse order.
25. Fit a new oil filter and refill the engine with oil.
26. Reconnect the battery.
27. Start engine.
28. Check for oil and coolant leaks.
29. Test drive.
30. Recheck for oil and coolant leaks.
31. Check for DTC's and clear or repair as required.

For more information on Mitsubishi Outlander, log on to VACC's MotorTech or call VACC's Technical Advisory Service.

Hyundai & Kia: Shift Lock Systems

2006 - onward Hyundai

2006 - onward Kia

VACC's Technical Advisory Service has been receiving calls on various Hyundai and Kia vehicles with the six-speed automatic transmission from 2006 onwards. Customers are reporting that the shift lever will not go into or out of Park. There seems to be a few different possibilities to cause this problem, and this article will give you some of the options.

The A6 six-speed automatic transmission is used in many models and has an identification code which varies depending on which engine it is paired with and their maximum torque requirements. The A6GF1 coded transmission could be fitted to a 1.2L, 1.6L, 1.8L or 2.0L engines. The A6MF1 and A6MF2 could be mated with a 2.0L to 2.4L engine. The A6LF1, A6LF2 and A6LF3 are used on engines with 3.3L, 3.5L, 3.8L and 4.0L capacities. The basic mechanical layout of these transmissions is very similar with different clutch components used depending on the application.

The shift lever assembly uses a cable to move a selector shaft mounted on top of the transmission. This shaft also moves the inhibitor switch that is mounted below the lever. The shaft then actuates the selectors inside the transmission and activates the Park lock to prevent the vehicle from rolling away. ***See Diagram #2 and #5***

These vehicles have an ignition key interlock system which will prevent the ignition key from being removed unless the transmission is in the Park position. Since about 2010 many manufacturers have fitted their vehicles with shifts lock systems, which means that the driver must depress the brake pedal to move the shift lever from Park (P) or Neutral (N) into Reverse (R). These shifts lock systems use a solenoid in the shift lever assembly to lock or release the lever depending on the brake pedal position. Many vehicles require the transmission to be in Park and the brake pedal depressed for the key to be removed from the ignition.

Diagram #1

In some models, there will be a button to press. In others, you will have to remove the cover then press down on the button inside to unlock the shifter.

Shift Lock Manual Override

As this system is electrically controlled there is usually a manual override to get the transmission out of Park if the battery has gone flat.

Hyundai and Kia vehicles have two possible systems to release the shift lock. One has a button near the shifter, which will release the shifter. The other system has a small cover which must be removed, then a screwdriver or the ignition key can be inserted into the hole which will release the shifter. Check the owner's manual for specific instructions. ***See Diagram #1 & #2***

You should check that the manual release mechanism works and that the shifter can move freely once released. This should indicate that there are no mechanical problems which leaves electrical issues.

Diagram #2

Shift Lock Solenoid

There are different designs of gear shift assemblies, but they all will have a shift lock solenoid that will look something like the one shown.

Diagram #3

Wiring Overview (most models will be similar in operation)

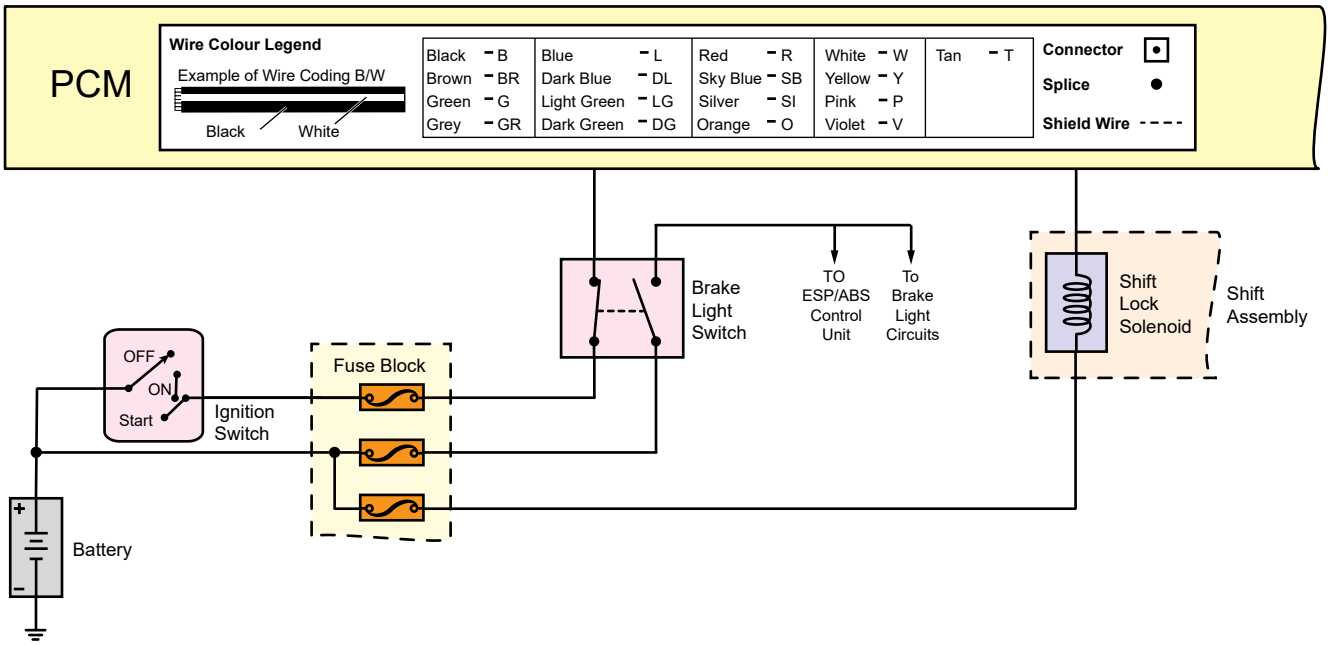


Diagram #4

Brake Light Switch

The brake pedal switch is mounted under the dashboard. There are different designs, but they should all operate the same with two sets of contacts.

The brake pedal free play should be between 3.0 – 8.0mm. The brake light switch should have 1 – 2 mm clearance from the brake pedal when at rest. Adjust the lock nuts to achieve the correct clearance.

Brake Light Switch

The brake light switch used with this system has two sets of contacts. One is normally open and the other normally closed. The normally open set of contacts is used for the brake lights and signals to the ESP or ABS control units. The normally closed contacts are used to tell the PCM the brake pedal position, this input is used for various things, one of which is to decide when to actuate the shift lock solenoid. ***See Diagram #3***

A quick test is to check if the brake lights are working. If not, there is a problem in the circuit that needs to be addressed.

Second would be to check the live data with a compatible scan tool for both contact sets of the switch. You should be able to see the voltage in both circuits and see them change as the pedal is pressed and released. If the circuits are not operating correctly, you should check for battery voltage at the switch and that the voltage is passing through when the switch is in the correct state. If not, check the fuses and wiring for shorts and open circuits. Repair and replace components as required.

If the brake light switch has to be replaced, the clearance will need to be adjusted. The brake pedal free play should be between 3 – 8mm. The brake light switch should have 1 – 2 mm clearance from the brake pedal when at rest. ***See Diagram #4***

Shift Lock Solenoid

There may be a fault in the circuit for the shift lock solenoid. Check the fuse and power supply to the solenoid and for continuity between the solenoid and the PCM.

There is no available resistance specification for the shift lock solenoid but it should be very low, and the solenoid should activate when the terminal to the PCM is earthed.

Shift Cable

If you have attempted to use the manual shifter release procedure and the shifter will not move from or into Park easily or smoothly, there could be some mechanical problems. ***See Diagram #2 and #5***

The quick way to check if the shift cable is running smoothly is to disconnect it at the transmission end. Depending on the vehicle, it might make it easier to remove the battery for easy access.

Diagram #5
Inhibitor Switch

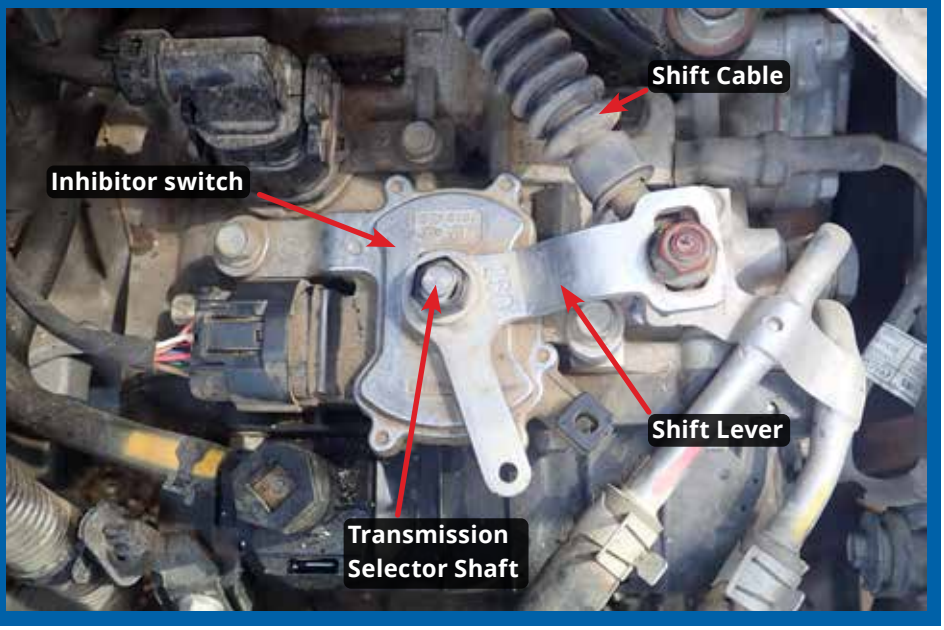


Diagram #6
Selector Shaft

The select shaft (shown above) in these transmissions have been known to become stiff and eventually seize in vehicles with high mileage or in coastal environments.

If you remove the inhibitor switch, you might be able to free it up with penetrating oil.

If not, there may be a problem inside the transmission.

Over the years the transmission designs have evolved to have a seal around the shaft which may prevent this issue.

Once released, and the manual shifter release procedure engaged, the shifter should move freely. If not, there is a problem in the cable or shifter assembly. ***See Diagram #2***

Seized Selector Shaft

If the shift assembly and the cable are OK, next test is to see if the selector lever on top of the transmission can be moved easily through its entire range, if not, this is where the fun starts. In older vehicles with high mileage, it is not unheard of the for the selector shaft to bind up and eventually seize. ***See Diagram #6***

There are reports in the trade that this shaft can be freed up. First, the selector lever and the inhibitor switch need to be removed from the top of the transmission. Then with your preferred brand of penetrating oil, spray around the shaft while trying to move it gently. This might take some time and patience. Some suggest starting the engine and allowing it to warm the transmission helps, others suggest a very quick and gentle application of heat to the transmission housing around the shaft frees it up. Do this at your own risk, as it might damage seals or O rings inside the transmission. If the shaft does not free up, you might have an issue inside the transmission.

If you have a customer's vehicle which is getting old, it might pay to do some preventative maintenance, and give this shaft a spray while moving the shifter to avoid it binding and seizing.

Problems with shift lock systems are common in many vehicles, and their operation is similar across many makes and models (e.g. Holden Cruze).

For more information on Hyundai and Kia vehicles, log on to Tech Online and Haynes Pro via VACC's MotorTech or call VACC's Technical Advisory Service.

We would like to thank Jack and the team at Korean Spares for allowing us access to their vehicles for the images in this article.
(03) 9359 0177
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Digital Automotive Oscilloscopes: Beginners Buyers Guide

Oscilloscopes have been a part of the automotive repair industry since World War II, and modern digital oscilloscopes are now an essential diagnostic tool for profitable workshops. However, there are many brands and styles of automotive oscilloscopes available at various price points, and they are not all made equally. This article will give you a basic overview of the specifications you need to understand to choose the right tool for your workshop needs.

An oscilloscope, also known as a 'scope' in informal terms, is an instrument used to test electronic devices through electronic signals produced by a circuit. The scope displays signals as a graph showing a relationship between two or more variables on the vertical (Y) and horizontal (X) axis. The X-axis normally displays time, whereas the Y-axis displays the voltage. The graph can be described in terms of several properties including amplitude, frequency, wavelength and others. If you know what you are looking at you can see the problems (future articles will cover how to read the waveforms).

The first automotive oscilloscope was the 'Igniscope' electronic ignition tester. It was produced in the 1940s and used a Cathode Ray Tube (CRT, like in an old TV) to display the voltages in the primary and secondary ignition circuits. Many technicians may still have and use tune up machines built in the 1960s or '70s which incorporate cathode ray oscilloscopes (CROs) to display analog signals. However, we are now in the digital age.

Digital Storage Oscilloscopes (DSOs) can capture and store signals for closer inspection, which the earlier systems could not. DSOs use an analog-to-digital converter (ADC) to change measured voltages over time into digital data.

Just as various vehicles can have different engines which can provide different performance (e.g. engine capacity or kW output, etc.), DSOs have different specifications that will give you a clue to their capabilities. Some are high-performance models, others are not, even though they seem to all look the same. When you are shopping around for a DSO, or a salesman comes knocking, here are some of the specifications you need to understand to make an informed choice.

BANDWIDTH

Bandwidth is defined as a range within a band of frequencies or wavelengths. Without adequate bandwidth, your oscilloscope will lack the speed to be able to see high-frequency changes. Amplitude will be distorted, edges will vanish, details will be lost, and you may not see the problem.

There seems to be a golden rule that states that to reliably and accurately measure signals, you require five times the bandwidth capacity. Essentially, this means that if you have a 100 MHz signal you want to measure, you will need a 500 MHz oscilloscope to ensure that you're correctly capturing and measuring the signal. At a bare minimum, your scope needs to be at least twice as fast as the signals that you plan to view.

20 MHz seems to be an adequate speed for most automotive diagnostics. However, for high speed digital serial communications, you will require a scope bandwidth of 500 MHz or more. For oscilloscopes, more bandwidth is better, as without it all the other bells and whistles in the oscilloscope will mean nothing.

CHANNELS

Your average television can pick up more than one TV signal but can only display one at a time. Oscilloscopes can be designed to have one, two, four or more channels and can play the incoming signals one at a time or displayed them all on the screen at once. These units will have more ports to allow for extra leads to be plugged in so more circuits and signal can be displayed.

More channels allow you to check signals against one another. A good example is to diagnose crank and cam correlation diagnostic codes. You can read the crank and cam signals and see how many degrees out of sync they are, or not. This will quickly check if there is a timing chain or belt problem.

More channels mean a more expensive unit. It is recommended to at least get a two-channel unit.

SAMPLING RATE

Sampling rate refers to how frequently a digital oscilloscope takes a snapshot or sample of the signal, similar to the frame rate on a movie camera.

The faster an oscilloscope samples (i.e., the higher the sample rate), the greater the resolution and detail of the displayed waveform and the less likely that critical information or events will be lost.

The sampling rate is measured in samples per second (S/s), which are specified in mega (a factor of one million) or giga (a factor of one billion) samples per second (MS/s or GS/s). To be sure that you see any transient events in the waveform, it's better to have four to five times the required sample rate. A minimum sample rate of 20 MS/s should be OK for most diagnostic applications. But faster is better.

Most oscilloscope specifications give two different sample rates. The first (typically a larger sample rate) assumes you're using half of the available channels. The second assumes all channels are used, which means if you're only using one channel of a two-channel scope, you will have a higher sampling rate.

MEMORY DEPTH

Memory depth or Max Memory Depth is how many samples of the signal can be stored to the DSO's memory. The more samples stored, the higher the sample rate. In other words, deep memory allows users to maintain the DSO's maximum sampling rate across a longer selection of time recording.

Memory depth could be specified in Mpoints or kpoints. Over 50 Mpts is good, but more is better. Some units have expandable memory so you can add more later.

HANDHELD OR LAPTOP

Some DSO's are self-contained hand-held units, others need to be plugged into a computer, commonly a laptop. If it needs a computer, this is an added cost, and it will have to have enough performance to match your scope.

You will have to assess how and where you will be using the scope to choose the correct unit for your needs.

SCOPE & SCAN TOOL COMBINED

There are some products which incorporate an oscilloscope and scan tool into one unit. This sounds like a good idea, but it might limit your diagnostic options.

These products may not allow you to use the scope and scan tool at the same time. It is recommended to have a high-quality scan tool to actuate circuits and a scope to record the signals.

Any piece of diagnostic equipment is a waste of money if it sits in a cupboard and never gets used. If you invest in a DSO, set it up in a way that it is fast and easy to access. If you have an older generation of tune-up machine, attach the DSO unit to the gantry with its leads attached, upgrade the computer and add a big monitor.

This will make it easy to set up and impress your customers and others in the trade.

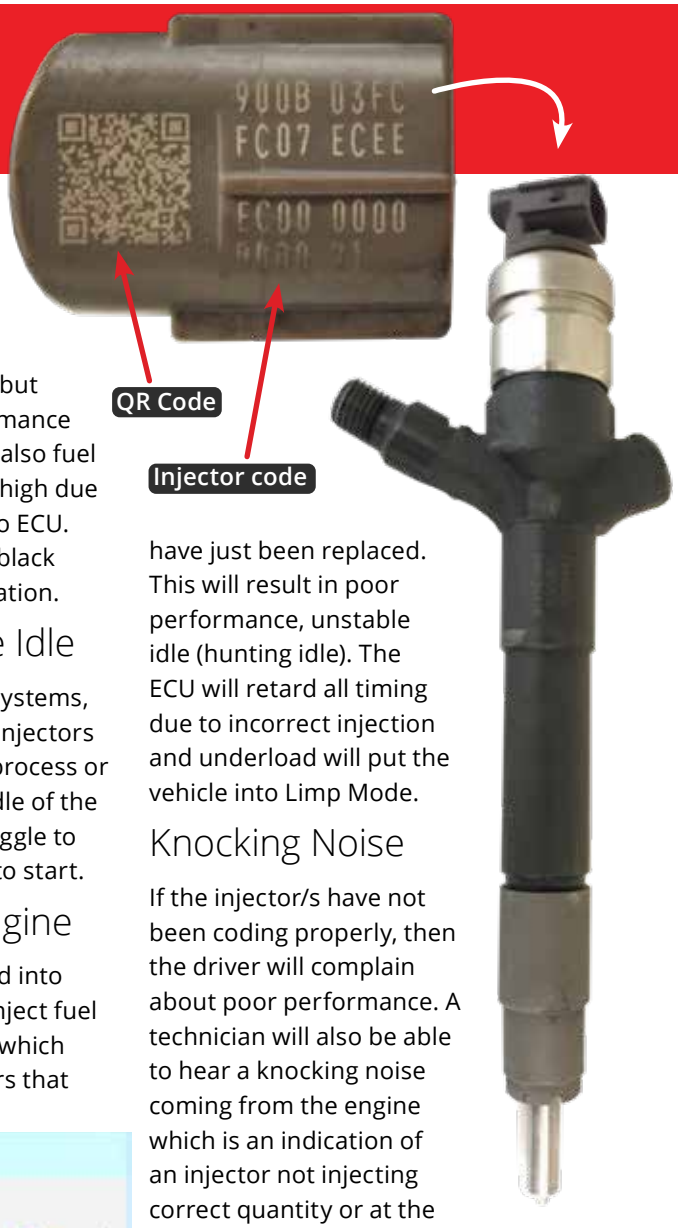
EASE OF USE

Some companies will allow you to download their software for free. This allows you to run through the demo signals to see how the unit would work before investing. Some are more user friendly than others.

These are only some of the details to consider when comparing the different types of automotive oscilloscopes. Hopefully, this will assist you in selecting a tool that may become an asset to your business. There will be more oscilloscope articles in the future.

Ask an EXPERT...

Injector Coding



The purpose of injector coding is to ensure that the ECU knows the injectors tolerances, so that it can adjust fuel quantity offsets accordingly into its base map.

When an injector goes through the OE test, it generates a unique code which identifies the injector tolerance range of the needle and also nozzle assembly fit. This process enables the ECU to vary the fuelling accordingly and optimises the performance of the engine.

Denso injectors all require coding done correctly (some earlier releases may not need to be coded). The typical length of the code for each injector will be between 16 and 24 alphanumeric characters depending on vehicle type. The code will be found on the injector connector head and usually will be accompanied with a QR Code for easy scanning if your workshop has a QR code reader.

When the injectors are not coded into the ECU properly, the vehicle may encounter the following issues.

Performance

In some vehicles, if the coding is not done right, the car can be driven away, but the driver will notice performance issues at times of need and also fuel consumption could be very high due to incorrect coding known to ECU. This can result in excessive black smoke under heavy acceleration.

No Start / Unstable Idle

Mostly in the newer diesel systems, it's almost vital to code the injectors correctly using the correct process or the result will be unstable idle of the vehicle. The vehicle will struggle to keep idle RPM and be hard to start.

Poor or Hunting Engine

If the injectors are not coded into the ECU, then the ECU will inject fuel according to the old coding which would belong to the injectors that have just been replaced. This will result in poor performance, unstable idle (hunting idle). The ECU will retard all timing due to incorrect injection and underload will put the vehicle into Limp Mode.

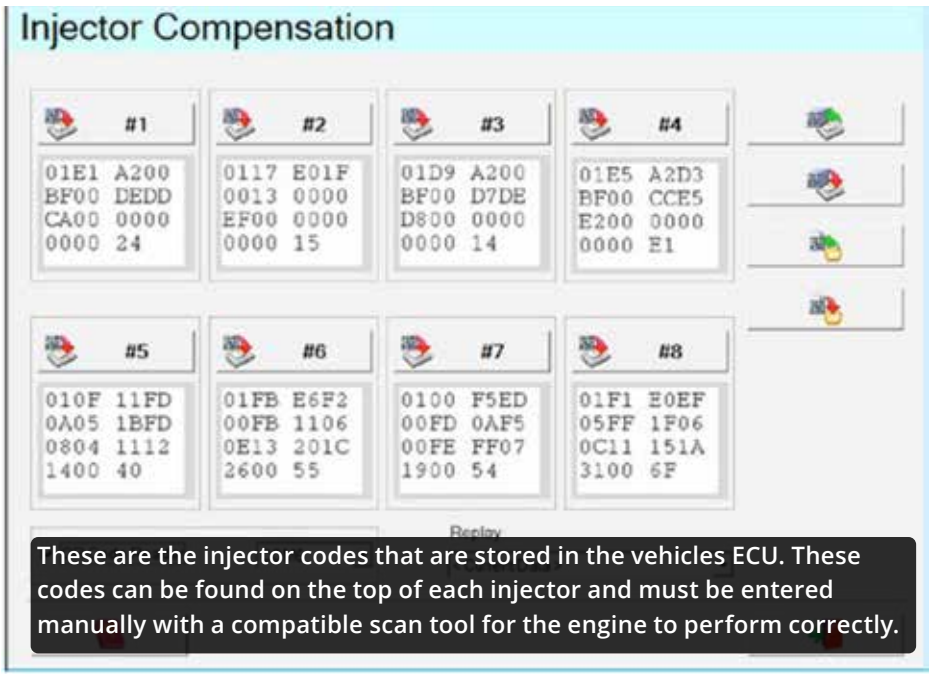
Knocking Noise

If the injector/s have not been coding properly, then the driver will complain about poor performance. A technician will also be able to hear a knocking noise coming from the engine which is an indication of an injector not injecting correct quantity or at the right time.

MIL Light ON

Whenever the ECU can't compensate or deems a certain amount of compensation as a fault, the ECU will illuminate the MIL light on the dash. Hopefully, the driver takes the vehicle to a workshop ASAP, so no further damage is done to the engine.

A compatible scan tool is required to code injectors to the ECU.



These are the injector codes that are stored in the vehicles ECU. These codes can be found on the top of each injector and must be entered manually with a compatible scan tool for the engine to perform correctly.

For technical support or further information go to: www.denso.com.au