ENGINE

SECTION EH

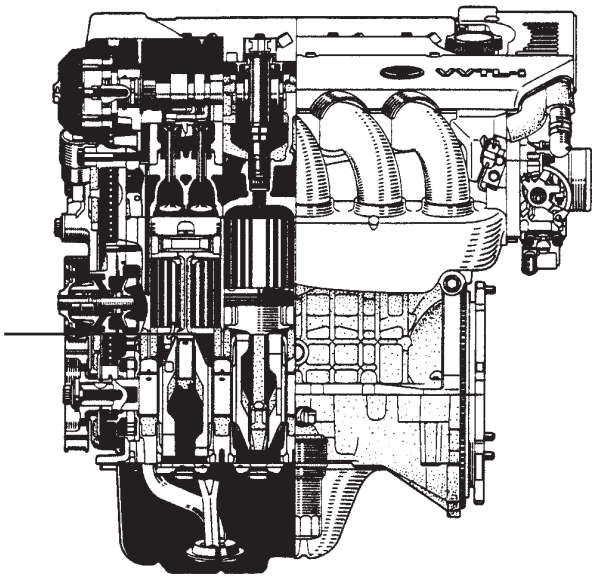
See also 2ZZ/1ZZ engine repair manual; E120T0327J (Toyota publication)

See also 1ZR FAE engine repair CD; T000T1523F (Toyota publication)

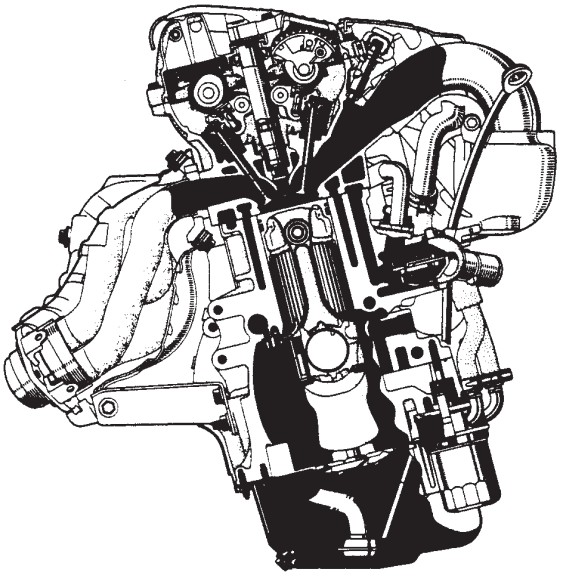
See also 2ZR FE engine repair CD; T000T1530F (Toyota publication)

Engine Sections (2ZZ-GE)

From LH side



From front



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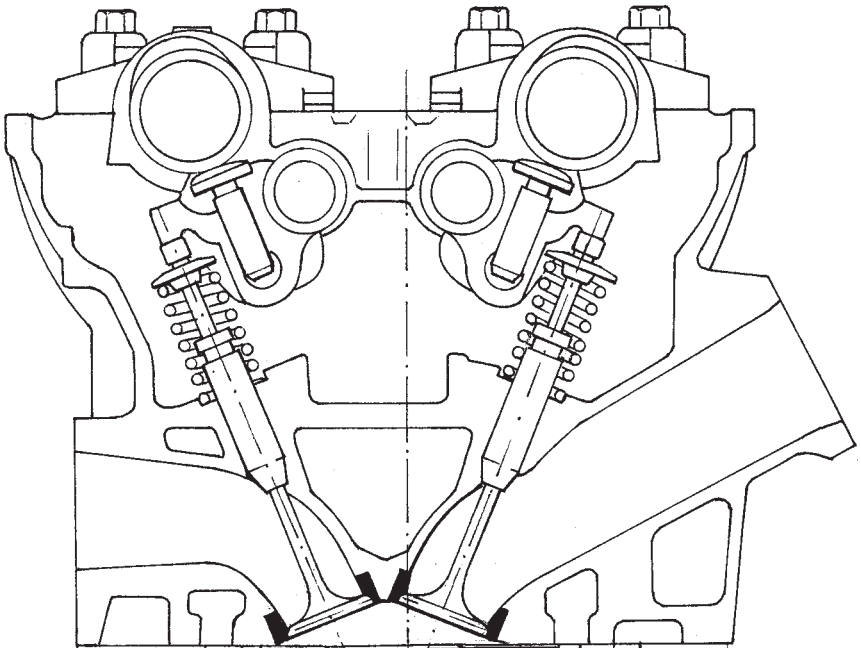
Cylinder Head Section

Exhaust side



Inlet side

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EH.1 - GENERAL DESCRIPTION; 2ZZ-GE

The 1.8 litre, 16 valve four cylinder engine used in the Lotus 2005 model Elise is supplied by Toyota Motor Corporation, and is designated '2ZZ-GE'. The engine number is stamped on the rear end of the cylinder block, exhaust side, and is followed by '2ZZ'. A full overhaul procedure for this engine family is contained in the separate Toyota publication under part number E120T0327J.

The lightweight alloy cylinder block uses no separate cylinder liners, but has the integral cylinder walls constructed from MMC (Metal Matrix Composite). The forged steel crankshaft is supported in five cast iron main bearing caps which are integrated into a single piece alloy main bearing panel bolted to the bottom of the block. A pressed steel sump is fitted below the main bearing panel. The iron and tin coated pistons, fitted with three piston rings, are mounted via fully floating gudgeon pins to forged steel connecting rods which use two bolt big end caps around the crankpins. The cylinder head houses four valves per cylinder, with inlets arranged at 43° to the exhaust valves, and incorporates laser clad alloy valve seats welded into the cylinder head. At the front of the engine, a single row chain, automatically tensioned by spring and oil pressure, is used to drive the two overhead camshafts which incorporate VVTL-i (Variable Valve Timing and Lift-intelligent) to advance and retard the inlet camshaft timing under electro/hydraulic control, and increase the lift of both inlet and exhaust valves at high engine speed (see later).

A trochoid type oil pump, driven directly by the front end of the crankshaft supplies an oil gallery along the left hand side of the crankcase, from which are fed the crankshaft main bearings, then the big ends, and via oil jets, the underside of the pistons. The gallery also feeds a drilling up to the cylinder head for the two camshafts, and the VVTL-i mechanism, with the chain tensioner fed from the exhaust cam drilling. The main gallery also feeds the oil filter, vertically mounted on the left hand side of the cylinder block. The timing chain is lubricated via an oil jet directly from the oil pump, and by oil draining down through the timing chest.

The water pump is mounted at the left hand front of the block and is driven by a multi-rib serpentine auxiliary belt from the crankshaft. Coolant is pumped into the front of the cylinder block and head, and when the thermostat is closed, returns to the pump via a by-pass gallery in the cylinder head and block. When the thermostat opens, the by-pass route is closed off, and a greater volume of coolant flows via the heater matrix, and throttle body as well as through the engine cooling radiator.

The die-cast aluminium intake manifold draws air from a single throttle body with cable controlled butterfly valve, into a plenum chamber from which the four intake ports are fed by individual tubes. A twelve hole fuel injector is mounted in the top of each of the four intake ports in the cylinder head, with fuel supplied via a one-way flow system with a pressure regulator contained inside the fuel tank. The Direct Ignition System (DIS) uses separate high tension coils mounted directly onto each of the four spark plugs, with timing control by the engine management ECU.

VVTL-i (Variable Valve Timing & Lift - intelligent)

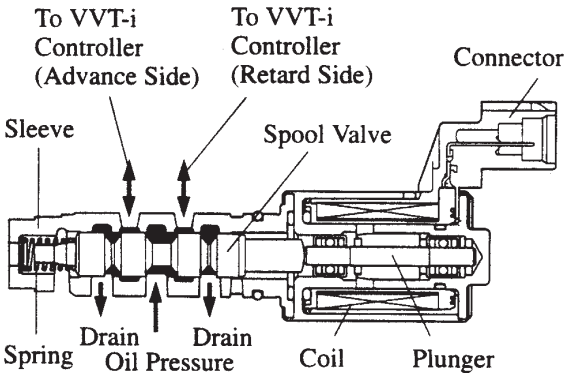
This system features two elements:

Variable Valve Timing

In order to allow the inlet valve timing to be advanced or retarded to the benefit of particular running conditions, the inlet camshaft is provided with a hydraulic hub connecting the chain sprocket to the inlet camshaft. The hub comprises a housing fixed to the sprocket and a four vane rotor fixed to the camshaft. The rotor is contained within the housing with the rotor vanes dividing each of the four chambers in the housing into two volumes, an advance and a retard side. Each of the chamber volumes is supplied with pressurised engine oil from a spool valve under ECU control. By varying the relative pressure of the two oil volumes, the positional relationship of the camshaft to the sprocket can be altered. The ECU monitors engine speed, intake air volume, throttle position and water temperature to determine the optimum cam phasing for the particular running conditions, and modulates the duty cycle to the oil control (spool) valve until the desired timing is achieved, as determined by reference to the crankshaft and camshaft sensors. Duty cycles greater than 50% cause the timing to be advanced, and duty cycles less than 50% retard the timing. When the target timing is achieved, a 50% 'holding' duty cycle is applied. The oil control valve is mounted at the left hand front of the cylinder head and feeds oilways within the head connecting with the inlet camshaft immediately behind the hydraulic hub.

When the engine is stopped, the inlet cam timing is set at full retard, to allow easy starting. To allow time for oil pressure to build after engine start up, a spring loaded lock pin engages at full retard to mechanically lock the hub, until normal oil pressure releases the pin automatically.

The table shows the basic timing strategy for different operating conditions:



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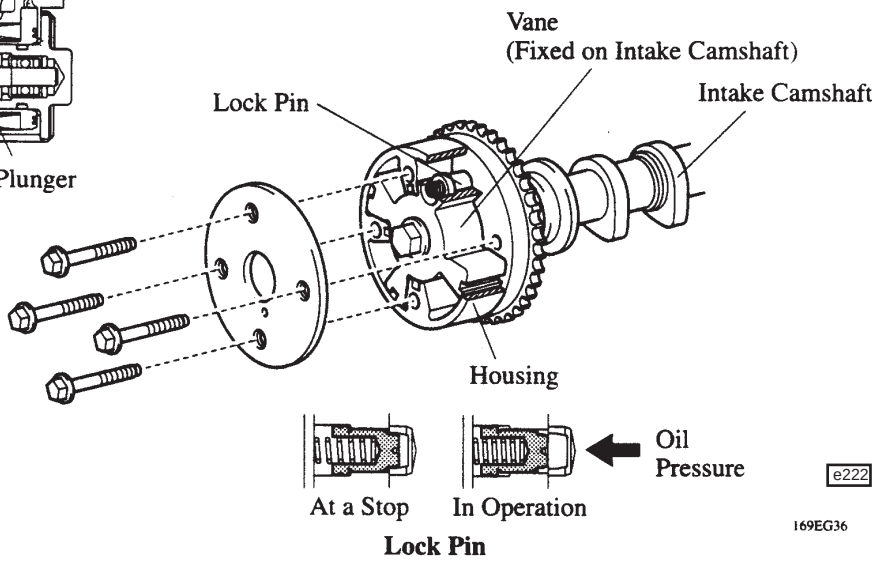

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Lock Pin

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Operation State	Range	Valve Timing	Objective	Effect
During Idling	1	TDC, IN, EX, Latest timing	Minimizing overlap to reduce blow back to the intake side	Stabilized idling rpm Better fuel economy
At Light Load	2	IN, EX, To retard side	Decreasing overlap to eliminate blow back to the intake side	Ensured engine stability
At Medium Load	3	IN, EX, To advance side	Increasing overlap to increase internal EGR for pumping loss elimination	Better fuel economy Improved emission control
In Low to Medium Speed Range with Heavy Load	4	IN, EX, To advance side, BDC	Advancing the intake valve close timing for volumetric efficiency improvement	Improved torque in low to medium speed range
In High Speed Range with Heavy Load	5	IN, EX, To retard side	Retarding the intake valve close timing for volumetric efficiency improvement	Improved output
At Low Temperatures	–	IN, EX, Latest timing	Minimizing overlap to prevent blow back to the intake side for reduction of fuel increase at low temperatures, and stabilizing the idling rpm for decreasing fast idle rotation	Stabilized fast idle rpm Better fuel economy
Upon Starting/ Stopping the Engine	–	IN, EX, Latest timing	Minimizing overlap to minimize blow back to the intake side	Improved startability

Note that compromises are involved in the programming of inlet cam timing, since advancing the valve opening point also advances the valve closing point, when the ideal might be to advance the opening and retard the closing points. For any particular engine running conditions, the timing is adjusted to optimise either the valve opening point and overlap period, or the valve closing point, whichever provides the most benefit.

The range of inlet cam timing available is from:

Opening 33° BTDC, Closing 15° ABDC)
to;) with standard (low speed) valve lift
Opening 10° ATDC, Closing 58° ABDC)
or;
Opening 58° BTDC, Closing 54° ABDC }
to; } with high speed valve lift (see below)
Opening 15° BTDC, Closing 97° ABDC }

Variable Valve Lift

Both inlet and exhaust camshafts are machined with two cams for each cylinder, a low lift cam and a high lift cam. Each low lift cam actuates, via a low friction roller, a rocker arm which connects with a pair of inlet or exhaust valves. The corresponding high lift cam actuates a spring loaded tappet housed within the rocker arm, and under low speed conditions, has no effect on valve operation due to the clearance between the bottom of the tappet and the rocker arm.

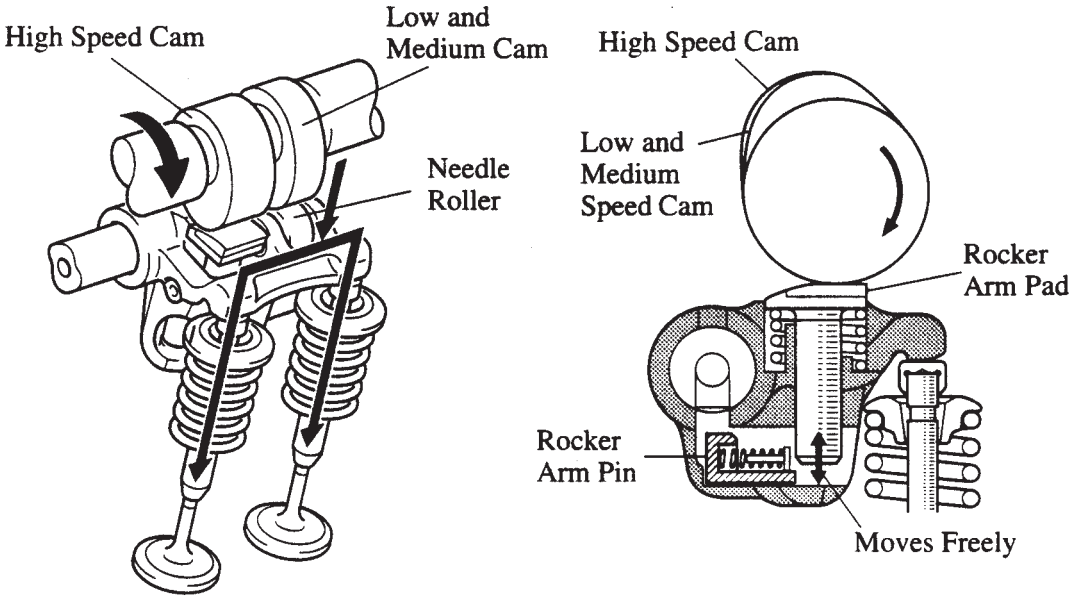
When engine speed reaches 6,000 rpm at normal running temperature, the ECU operates a spool valve on the back of the cylinder head to close an oil return line, and raise oil pressure within the rocker pivot shaft and passages within each rocker. This increased oil pressure is sufficient to overcome the spring loading of a packer pin contained within each rocker arm, which is then forced between the bottom of the high speed cam tappet and the rocker arm. Each high lift cam then controls valve operation, with the rocker being lifted clear of the low speed cam. The higher valve lift for both inlet and exhaust valves in conjunction with the variable valve timing, provides greater efficiency and power output at high engine speeds.

Standard (low speed) valve lift: - inlet; 7.25 mm
- exhaust; 7.25 mm
High speed valve lift: - inlet; 11.4 mm
- exhaust; 10.0 mm

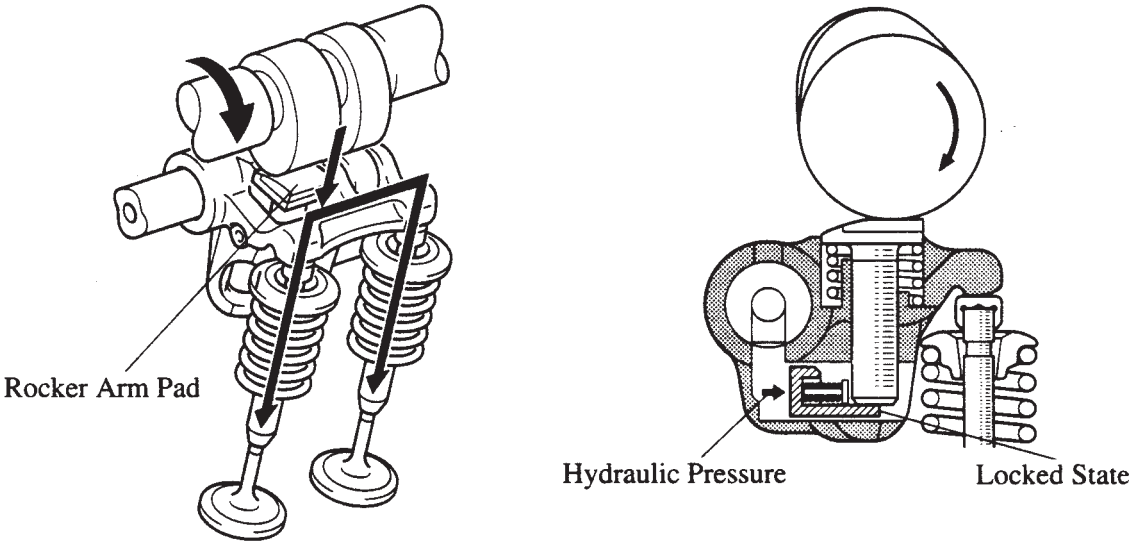
Note that engine speed is limited to 6,000 rpm until normal running temperature has been attained.

Illustrations overleaf.....

Low and Medium Speed



High Speed



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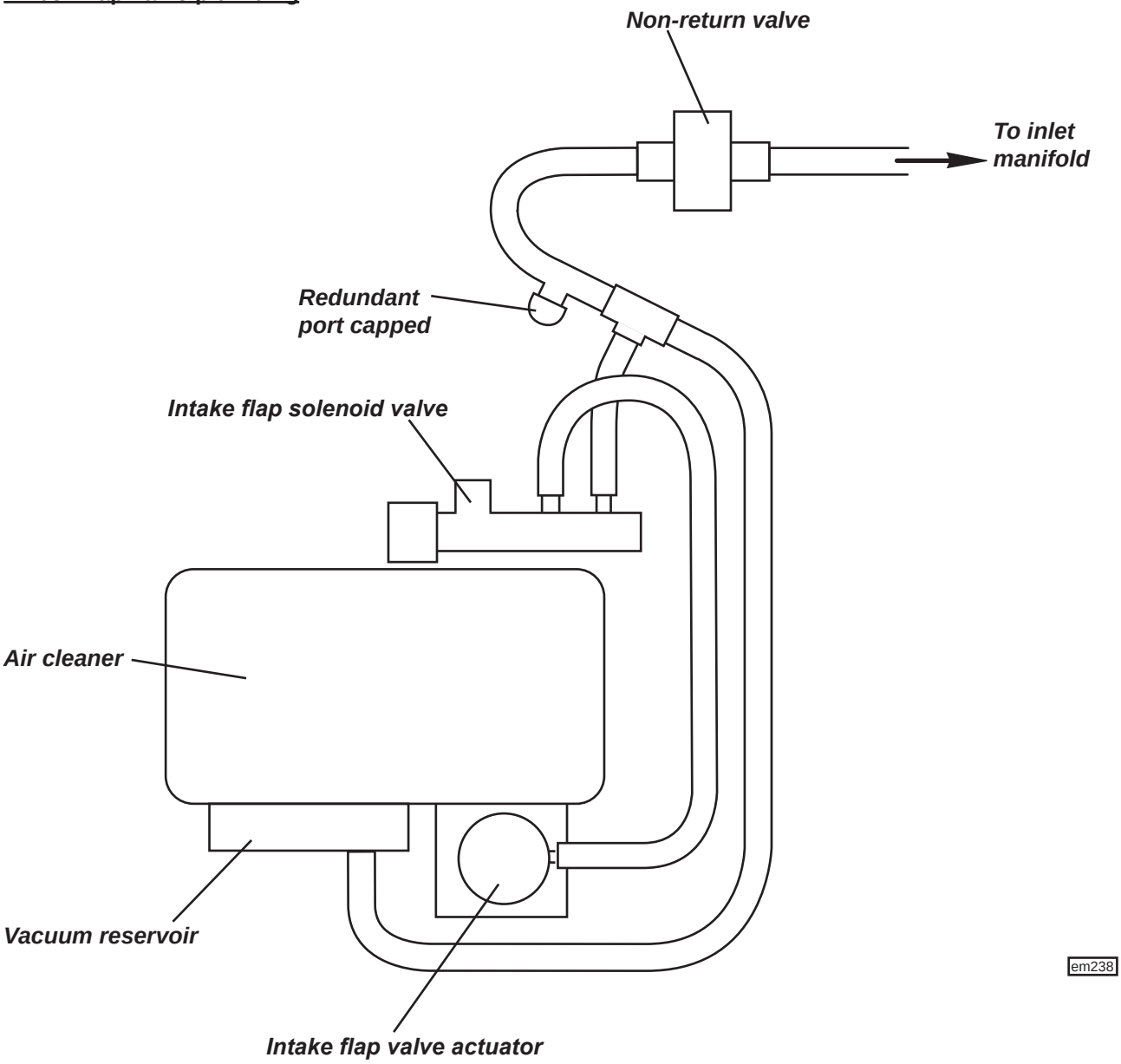
Airbox Flap Valve

In order to reduce airflow restriction into the airbox at periods of high demand, and also to provide an acoustic enhancement, the ECU, when switching to high valve lift mode, also opens a flap valve in the underside of the airbox body. This butterfly valve is sprung open, and is closed by a vacuum actuator supplied from the inlet manifold. The vacuum supply uses an in-line non-return valve and a reservoir incorporated into the front face of the airbox body to maintain flap closure during periods of low inlet depression. A solenoid valve mounted on top of the airbox, and connected into the vacuum capsule line, is energised by the ECU when appropriate to ventilate the capsule and open the valve.

Airbox flap valve plumbing



Overhaul Notes

1. Timing Marks (2ZZ only)
   Take care when setting the engine to its 'timing' postion. Crankshaft at TDC, inlet cam pulley mark facing inwards on centreline, exhaust cam pulley mark facing inwards but ONE TOOTH COUNTERCLOCKWISE from centreline.

2. Valve Clearances
   a) It is unlikely that valve clearances will require adjustment unless components are replaced. A single forked rocker arm is used to operate a pair of valves, which are shimmed during manufacture for equal clearance. Routine service clearance checks should be made between the cam and roller follower. Only if a valve or rocker arm is replaced need the clearance between individual valves and the rocker arm be measured. Adjustment procedure is detailed in the text.
   b) When using the shim adjustment special tool, before removing a shim from a valve stem, ensure that the oil drain passages on the exhaust side of the head are blocked with paper towel. Shims are easily dropped and may fall down the drain passages into an oil gallery in the crankcase, requiring engine removal to retrieve.

3. Stretch Bolts
   The cylinder head bolts, big end bolts and main bearing cap bolts are 'stretch' type with an angular tightening procedure. The bolts should be measured to determine their suitability for re-use. Measure length or diameter as specified in the text. Note that the big end bolts are 8.7 to 8.8 mm standard diameter, with 8.5 mm minimum.

4. Timing Chain Tensioner
   The maintenance free timing chain tensioner uses spring tension and engine oil pressure in conjunction with a non-return ratchet mechanism to maintain chain tension. A pivotted hook on the tensioner body is provided to aid assembly, by enaging with a pin on the spring plunger to hold the assembly retracted whilst fitting. After fitment to the timing cover, the engine is then turned backwards so that the chain forces the plunger into the tensioner body, which action pushes the hook into a disengaged position and allowing tension to be applied on resumption of normal rotation. The ratchet mechanism prevents subsequent plunger retraction.

5. Bearing Shell Size Coding
   Note that the main bearing shells and big end shells are selective thickness dependent on journal and housing size. Pistons are one size only. No reboring or crankshaft grinding is permitted.
   Main bearing housing size codes are stamped onto the cylinder block, and crankshaft journal size codes on the crank. If necessary, Plastigage can be used to deterime oil clearance. Big end codes are stamped only on the connecting rod caps. Service replacement shells will also be marked on the back with the size code.

6. Knock Sensor (2ZZ only)
   The knock sensor used for Lotus applications is an annular type fitted over an M8 stud, with the retaining nut tightened to 20 Nm. Note that the 1ZZ engine does not use a knock sensor.

7. VVT Unit Refitment
   The variable valve timing unit mounted on the front of the inlet camshaft, is secured in the fully retarded position when the engine is stopped, by a spring loaded pin. When fitting the unit to the camshaft and tightening the retaining bolt, it is essential that no torque is applied to the sprocket, or damage could be caused to the locking pin. Ensure that the dowel pin in the camshaft front flange is correctly located in the corresponding slot in the VVT hub before inserting the retaining bolt. Hold the camshaft **only** with a spanner on the flats provided, and tighten the retaining bolt to 54 Nm.

EH.1a - SUPERCHARGER OPTION; 2ZZ-GE

To provide customers with the option of an Elise package with enhanced engine performance, a M45 unit Magnusson supercharger installation specifically tailored for the Elise using the 2ZZ-GE VVTL-I engine was introduced at '08MY and called the Elise SC. By dispensing with the chargecooler as used on supercharged versions of the Exige, vision is maintained through the rear window. The Elise SC supercharger uses a shorter Eaton rotor pack compared with the Exige (M62), and is mounted in a similar position, but in order to optimise packaging on the Elise,

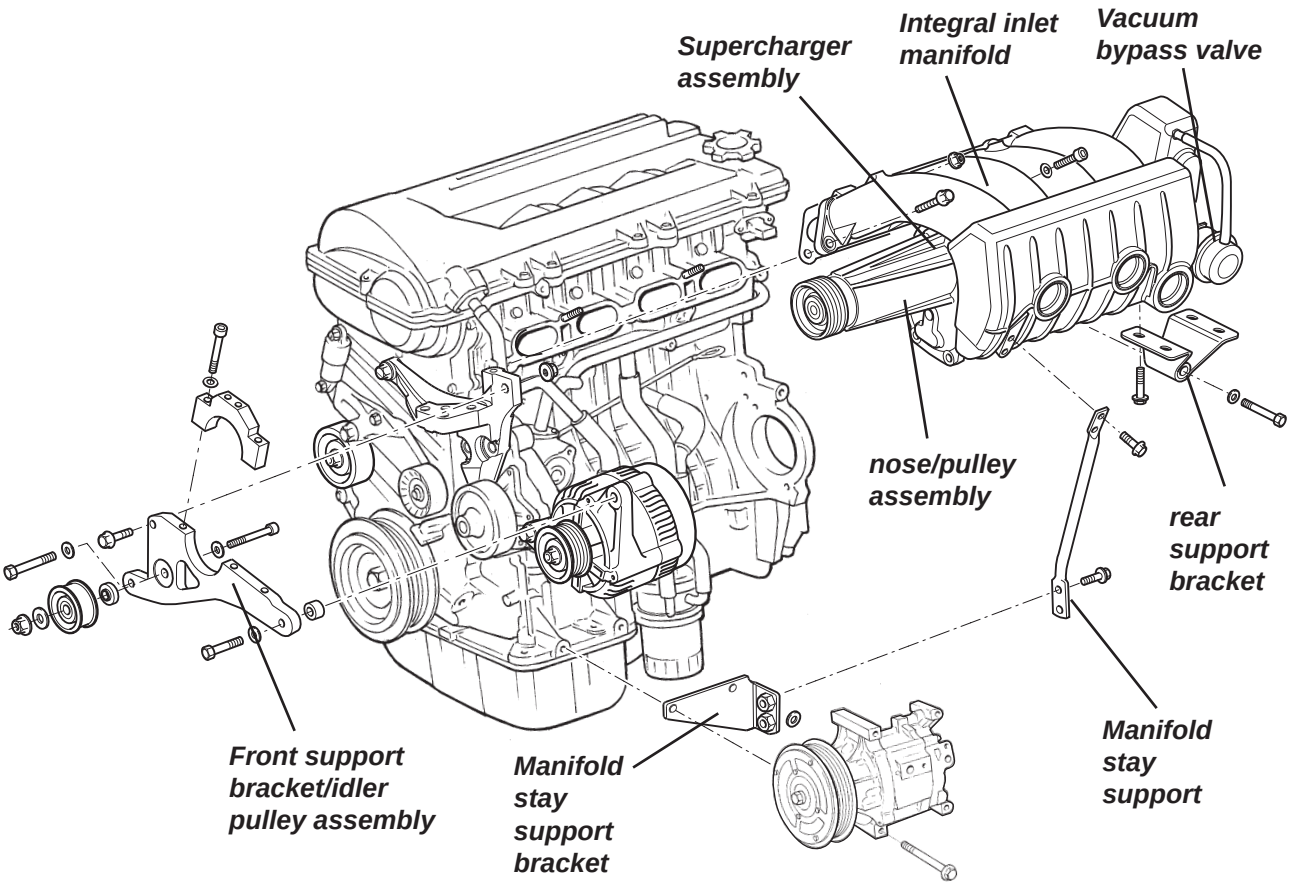
Lotus has designed the supercharger housing to be integral with a new inlet manifold. This arrangement, by minimising intake tract length and manifold volume, has maintained the rapid throttle response of the Elise R, with only a small engine weight penalty.

By optimising supercharger rotor size, using high flow fuel injectors, higher rated spark plugs and astute programming, the power output of the Elise SC is increased from the 192 ps of the Elise R to 220 ps and approaches the 221 ps of the chargecooled Exige S. Torque is also increased from the 181 Nm of the Elise R to 210 Nm (Exige S; 215 Nm).

The switching point for the high lift cams is unchanged from the Exige S, and varies between 4,500 and 6,200 rpm dependent on engine load. Similarly, operation of the airbox flap valve is common with Exige S, with a single switching point at 4,500 rpm.

The tighter supercharger belt run radii compared with the Exige S, requires that the auxiliary drive belt be renewed at the first occurring since last service of 24 months/18,000 miles/30,000 km (USA: 12 months/15,000 m).

Note: Although the engine internals, cylinder head and engine block are the same as used in the naturally aspirated vehicles; certain ancillary items have been modified to accommodate the supercharger fitment, such as but not limited to: auxiliary drive belt, dipstick tube, oil breather pipe, fuel injector cover.



The assembly is additionally supported to the engine block by a front and rear mounts.

Front support: A 2-piece bracket asssembly is bolted around the front pulley nose and is bolted to the front of the engine. The support also provides a mounting for an additional axillary drive belt pulley as well as a new upper mounting point for the alternator assembly.

Rear support: A bracket fixed to the underside of the supercharger is bolted to the engine block.

Manifold stay support: Additional support is provided with a single piece stay bolted at its upper mount to the integral inlet manifold and at its lower mount to stay support bracket. The stay support bracket is retrained between the engine block and A.C compressor.

The supercharger assembly is self contained and features helix twisted rotors to minimise output pressure variations, and maintenance free gearing and bearings, requiring no externally sourced lubrication.

Bypass Valve
A vacuum actuated bypass valve is fitted within the inlet plenum to prevent the affects of compressor surge which is caused when the supercharger is creating boost but the butterfly valve in the throttle body is closed.

Vacuum within the supercharger plenum acts on the diaphragm and shaft within the externally mounted actuator capsule which is connected to the bypass valve. The vacuum within the plenum varies dependant on engine speed/throttle openings etc, moving the diaphragm shaft and bypass valve within the supercharger inlet housing accordingly.

A proportion of air that would have been pressurised by the rotors is diverted from the rotors and circulates around the inside of the supercharger casing ensuring only the boosted air required is drawn through the rotors and directed to the inlet manifold via the intercooler.

Under throttle opening conditions/hard acceleration the vacuum within the inlet housing decreases closing the bypass valve, allowing more air to be drawn in through the rotors.

M45 Retrofitment Kits
Supercharger retrofitment kits including modified items required which may be fitted to both naturally aspirated Elise and Exige are available from the Lotus Cars Aftersales Department. The various kit numbers available are specific to both vehicle model year and market.

When fitted correctly 2006-2008MY kit fitment results in an identical hardware specification vehicle as the 2008MY European homologated Elise S/C and emissions of converted vehicle being identical to an OEM production version.

Note: Retrofitment Kits are only suitable for 2ZZ engines, and will not fit either 1ZZ or 1ZR powertrains.

Supercharger Removal

1. After performing the Fuel Pressure Relief Procedure as described in section EH.4, release the retaining clip securing the fuel tank pipe to the fuel rail hose pipe joint which is located on the coolant header tank bracket.

2. Release 3 x cap head fixings securing Injector harness cover and remove cover.

3. Disconnect the battery – see service notes section MP.7 for further information.

4. Remove undertray – see service notes section AA.2 for further information.

5. Raise vehicle – see service notes section AA.1 for further information.

6. Remove Auxiliary drive belt from supercharger pulley - for further details, refer to section CH in the Engine Repair Manual (E120T0327J).

7. Release M6 nut from alternator positive electrical cable (nut under rubber boot) retain nut. Disconnect wiring plug from alternator.- for further details, refer to section CH in the Engine Repair Manual (E120T0327J).

8. Disconnect harness connector to VVT oil control valve.

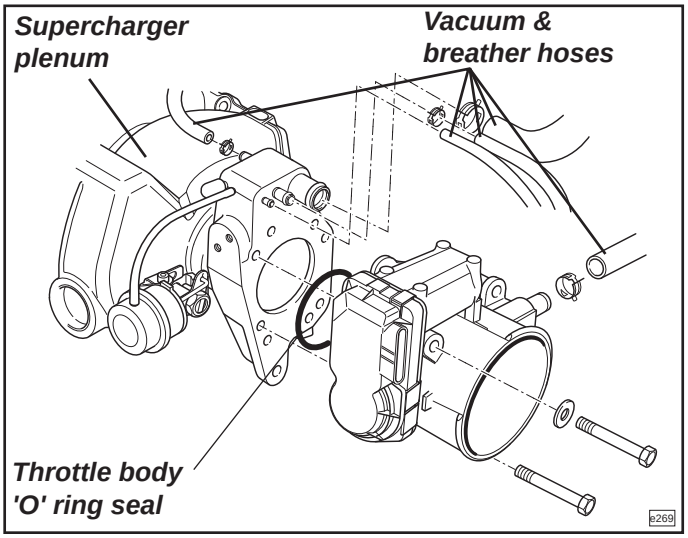
9. Remove Air intake hose between the throttle body and air filter casing.

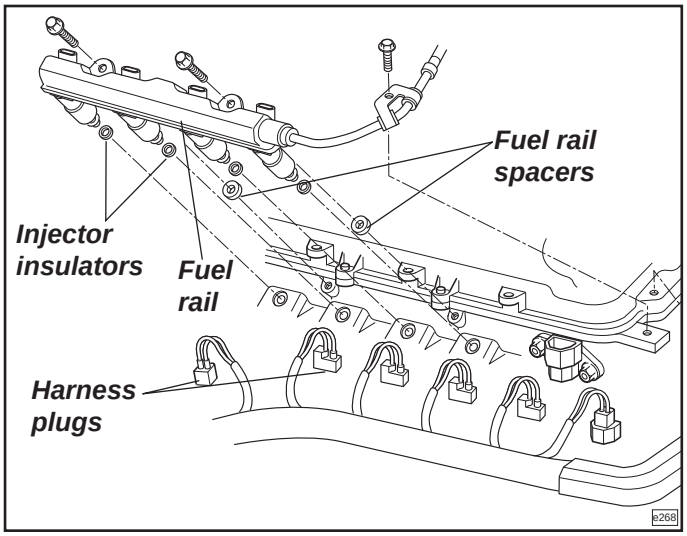
10. Release and remove M8 bolts (4) securing the throttle body to supercharger and pull the assembly away from the supercharger, ensuring to collect the throttle body to supercharger 'O' ring seal. (This will avoid unnecessarily disrupting of the engine coolant system by disconnecting the bypass hoses attached to the throttle body).

11. From the intake side of the supercharger plenum disconnect:
    - Brake vacuum servo hose
    - Airbox vacuum reservoir hose
    - Purge valve hose (also release M6 x 10mm socket headed bolts (2) securing evaporator hose pipe ‘P’ clips to inlet manifold, secure hose to one side).
    - Engine Breather hose.

12. Fuel Rail
    - Disconnect the harness plugs from 4 x injectors and connector at either end of cylinder head. the harness may be “tie wrapped” in place. Cut and discard tie wraps as necessary.
    - Release 2 x M8 fuel rail bolts.
    - Release fuel rail pipe fixing (M6).
    - Release wiring harness fixing (M6).
    - Pull up fuel rail with injectors attached.
    - Collect injector insulators (4) from cylinder head and fuel rail spacers (2).

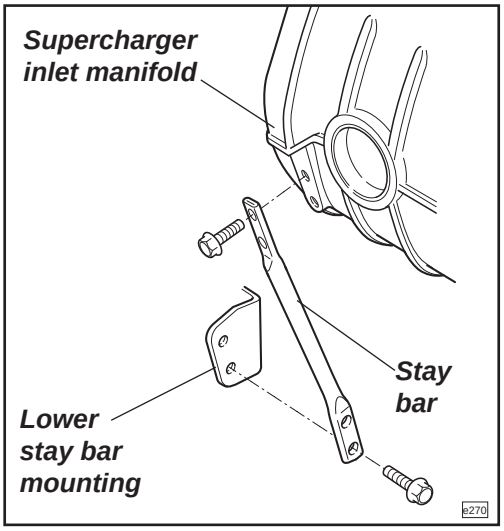
      CARE POINT: There will still be fuel in the fuel rail.

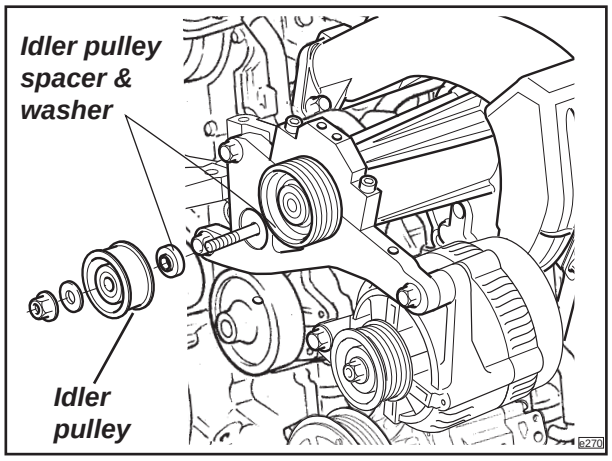




13. Supercharger Mounting Brackets

- ***Stay bar:*** Remove lower M8 x 20 (2) stay bar bolts from the lower bracket which is located between the engine block and a.c compressor, then remove upper M8 x 20 (2) M8 bolts securing the stay bar to superchargers inlet manifold and remove.

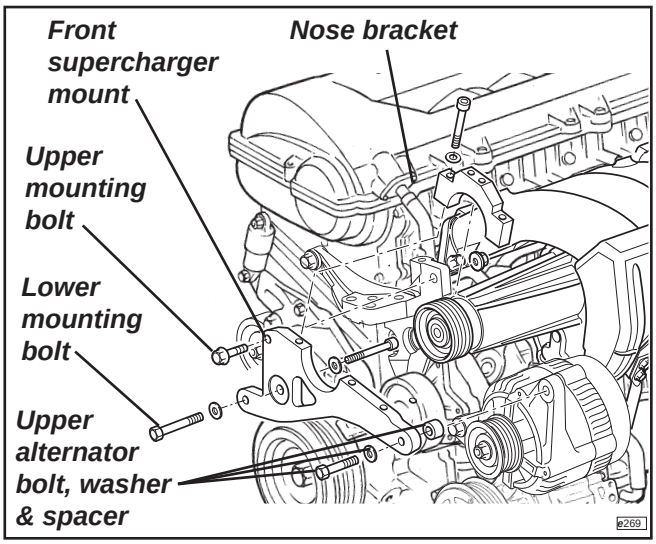




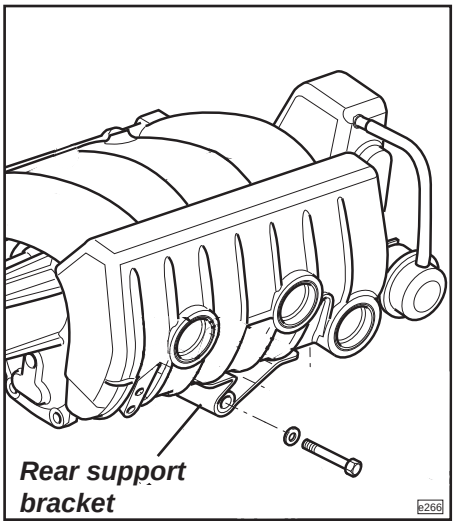
- ***Front supercharger bracket:*** release the M10 nut and washer securing idler pulley on front bracket bolt and remove ensuring to also collect spacer and M10 washer also located behind pulley wheel.

- Release the lower M10 x 60 mounting bolt & washer, upper M10 x 35 mounting bolt and M8 x 45 upper alternator bolt and remove along with washer and alternator spacer.

- Loosen lower alternator mounting bolt so that the alternator may be moved away from the supercharger.



- ***Rear support bracket:*** Release M10 x 60 bolt and washer securing rear support bracket to engine block.



14. Loosen the supercharger manifold to cylinder head fixings in the order listed below:
- Release outer M8 x 30 bolts (2)
- Release inner M8 nuts (2)
- Release central manifold M8 x 30 cap head screw and washer.

15. Remove all manifold to head fixings then carefully pull the supercharger assembly away from the cylinder head until it clears the 2 retaining studs and withdraw the assembly and manifold gasket from the engine bay.

Refitment

Preparation before fitment:

- Loosen M8 x 16 bolts (4) securing supercharger rear support bracket to supercharger so that they can be turned by finger.

- Release M6 bolts (2) from the supercharger front nose bracket and remove bracket from supercharger nose.

- Fit new inlet manifold gasket, positioning onto the 2 inner inlet manifold studs.

- Refit supercharger, sliding into position onto the head using the 2 inner manifold studs.

Fitment:

- Insert central manifold M8 x 30 cap head screw and washer, finger tighten ONLY. The supercharger must be allowed to move side to side.

- Fit inner M8 nuts (2) to studs in head, again finger tighten ONLY.

- Fit outer M8 x 30 bolts (2), again finger tighten ONLY.

- Fit the front nose support bracket onto supercharger nose and re-fit M6 bolts and washers (2), finger tighten ONLY.

- Fit lower M10 x 60 bolt plus washer and upper M10 x 35 bolt & nut.

- Tighten only enough to pull the supercharger nose bracket up to the engine mount (torque tighten at a further stage).

- Fit M8 x 45 bolt, washer and alternator spacer, finger tighten ONLY.

- Pull supercharger hard onto supercharger nose bracket.
  NOTE: There should be no gap between supercharger and nose bracket.

- Remove M6 bolts from bracket, apply medium strength threadlock replace and re-tighten to 10Nm.

- Inlet manifold fixings
  Torque 5 x M8 supercharger fixings to 25Nm.
  NOTE: Work from the centre fixing outward.

- Torque the 2 M10 front supercharger nose mounting bolts to 45Nm, torque top alternator fixing to 24Nm.
  NOTE: Torque top alternator fixing before bottom alternator fixing. Torque the bottom Alternator fixing to 24Nm.

- Fit M10 washer and shouldered spacer onto idler pulley bolt. (Small end/shoulder towards the pulley).

- Fit idler pulley onto bolt, followed by M10 washer & M10 nut, torque to 24Nm.

- Refit stay bar to lower bracket and inlet manifold using the M8 x 20 flanged head bolts (4), torque to 24Nm.

- Fit M10 x 60 bolt and M10 washer to rear supercharger support bracket, torque to 48Nm, then torque the M8 x 16 flanged headed bolts (4) securing the bracket to the supercharger to 24Nm.

- Refit or replace as necessary the auxiliary drive belt.
  Turn engine over clockwise via crank pulley bolt. Check belt tracking on idler pulley. Belt MUST run central on idler pulley.

Note: To adjust belt tracking, remove belt undo M10 nut, turn idler approx 45°making sure that whole assembly turns. Re-tighten and re-torque to 24Nm, Re-fit belt. This process may need repeating to achieve desired belt alignment.

- Re-fit fuel rail, with injectors, insulators and spacers, re-fit 2 x M8 bolts, torque to 24Nm.
- Re-connect injector harness plugs.
- Reconnect harness connector to VVT oil control valve
- Refit wiring harness fixing (M6).
- Fit new cable ties to harness in same position as original ties removed.
- Re-connect electrical connectors onto throttle body.
- Fit new throttle body gasket.
- Re-fit throttle body M8 throttle body fixings and washers, torque to 24Nm.
- Re fit the airbox to throttle hose and re-tighten band clamps. Re-connect engine breather and vacuum pipes to inlet plenum.
- Refit M6 X 10 socket head bolts for evaporative pipe 'P' clips into threads in inlet manifold.
- Check integrity of all connections and ensure all wiring and pipe work is securely fastened and clear of chaffing/fouling on adjacent components.
- Fit injector cover use M6 fixings (3), torque to 10Nm.
- Connect battery & start engine.

The supercharger belt MUST run centrally on the idler pulley both with the engine off and with the engine RUNNING. Ensure the belt is central on the pulley with the engine off. As pictured. Start the engine ensure the belt remains central on the idler pulley.

If the belt is running less than 1mm clearance from the belt guide, as pictured, the idler pulley will require adjustment. To adjust belt tracking, undo M10 nut, turn idler, re-tighten and re-torque to 24Nm.

Once the belt tracks centrally (up to +1mm from guide) allow to idle for at least 5 minutes. Check for any air, oil and exhaust leaks.

EH.2 - GENERAL DESCRIPTION; 1ZZ-FE

The Elise S, introduced in May 2006 uses the Toyota '1ZZ-FE' engine instead of the '2ZZ-GE' fitted in the Elise 111R. The two engines are similar in basic architecture, with the 2ZZ having been derived from the 1ZZ, and whilst the overhaul procedures are largely common, many of the principal components are different. This section identifies the main differences between the two engine types.

Valve Mechanism

The 1ZZ uses the same VVT-i 'intelligent' variable intake valve timing system as used on 2ZZ, but without the intake and exhaust variable valve lift feature. Valve clearance adjustment via selective cam followers rather than 'top hat' shims. Airbox flap valve programmed to open at 5,000 rpm. Lower rpm limits (see below).

Dimensions

The bore and stroke differ between the two engines, although the capacity difference favours the 2ZZ by only 2cc. The 1ZZ is more undersquare with dimensions of 79.0 x 91.5mm producing 1794cc (2ZZ: 82.0 x 85.0 = 1796cc). The angle between intake and exhaust valves on the 1ZZ is 10° less at 33°, to permit a compact cylinder head without the requirement to accommodate variable valve lift. The compression ratio is dropped from 11.5 to 10.0:1.

Cylinder Block

The open deck alloy cylinder block of the 1ZZ uses dry, thin wall, non-replaceable, cast iron cylinder liners (2ZZ uses integrated MMC cylinder walls).

Manifolds

The inlet manifold is moulded in plastic to reduce weight and heat transference, and incorporates a resonator feature to optimise gas pulsations for mid-range performance. A unique adaptor is used to link the manifold to the electronic throttle body which differs from the 2ZZ and other 1ZZ types.

The simplified exhaust manifold and downpipe dispense with the divider plate used on the 2ZZ.

Cooling System

The cooling system is largely unchanged, with all 1ZZ cars using the oil/water heat exchanger and no front mounted oil coolers. The throttle body is heated as previously, although the feed and return connections differ in detail and no in-line throttle body thermostat is used.

Technical Data

			1ZZ-FE	**2ZZ-GE** (reference)
Capacity			1794 cc	1796 cc
Bore			79.0 mm	82.0 mm
Stroke			91.5 mm	85.0 mm
Valve control			VVT-i	VVTL-i
Compression ratio			10.0:1	11.5:1
Compression pressure (250 rpm, normal run temp.)		- new	1500 kPa (218 psi)	1400 kPa (203 psi)
		- min.	1000 kPa (145 psi)	1000 kPa (145 psi)
Spark plugs	- type		NGK BKR5EYA-11 Denso K16R-U11	NGK IFR6A-11
	- gap		1.0 ± 0.05mm	1.1 mm
Peak power (1999/99/EC)			100 kW (136 PS) @ 6,200 rpm	141 kW (192 PS) @ 7,800 rpm
Peak torque (1999/99/EC)			172 Nm @ 4,200 rpm	181 Nm @ 6,800 rpm
Maximum continuous engine speed			6,800 rpm	8,000 rpm
Maximum transient engine speed			7,150 rpm	8,500 rpm
Exhaust emissions (Euro 4 & LEV 1)	- CO		0.23 g/km	0.42 g/km
	- HC		0.050 g/km	0.078 g/km
	- NOx		0.0217 g/km	0.0121 g/km
	- HC + NOx		0.0717 g/km	0.07921 g/km
	- CO_2 (combined)		196 g/km	208 g/km

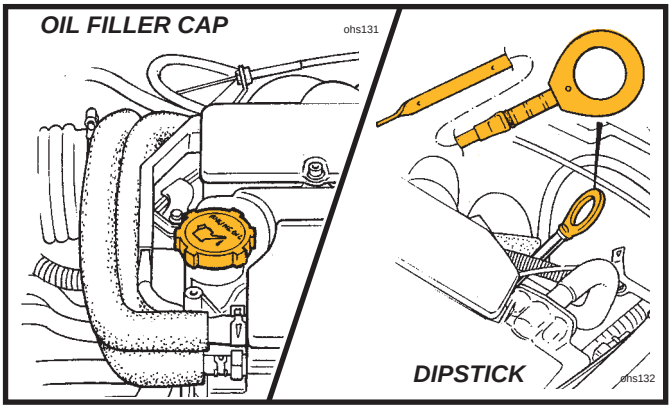
EH.3 - MAINTENANCE OPERATIONS - 2ZZ & 1ZZ

Engine Oil Level Check
The engine oil level should be checked regularly, such as every two or three fuel stops, and the oil level maintained near the top mark on the dipstick. It is especially important to keep a check on the oil level during the vehicle's first 1,000 miles (1,600 km), as both the fuel and oil consumption will be prone to some variance until the engine components have bedded in.

The best time to check the level is when the oil is warm, such as during a fuel stop. Ensure that the car is parked on a level surface and that a few minutes have elapsed since stopping the engine to allow oil to drain back into the sump. If the engine is stopped before reaching normal running temperature, the oil will not drain back so readily, and the dipstick will display an artificially low reading.

Dipstick: The dipstick is identifiable by its yellow loop handle, and is located at the right hand front of the engine. Withdraw the dipstick, and wipe with a paper towel. Replace the dipstick, if necessary feeding the blade into the tube with the fingers, before pressing firmly to ensure that the handle is fully seated. Withdraw the dipstick again to inspect the oil level, which should lie between the two dimples on the end of the stick.

The oil level should be maintained at the upper of these two marks in order to provide optimum engine protection.



Topping Up: If topping up is necessary, unscrew the oil filler cap from the left hand end of the cam cover. Add a suitable quantity of the recommended engine oil (see 'Recommended Lubricants') taking care not to spill any oil onto engine or electrical components; use a funnel if necessary.

The difference between high and low dipstick marks is equivalent to 1.5 litre. Allow several minutes for the oil to drain through to the sump before re-checking the oil level.

Do NOT overfill, or lubrication will be degraded and consumption increased as the oil becomes aerated. Refit the filler cap, turning clockwise until secure.

Engine Oil Change
The use of high quality oil, renewed at the specified intervals, is the key to engine longevity and sustained performance. Adhere strictly to the engine oil and filter change intervals specified in the Maintenance Schedule. For access to the engine sump and filter, the engine bay undertray must first be removed. This is most easily achieved with the vehicle raised on a garage hydraulic lift, or alternatively, parked over an inspection pit.The drain plug is located at the rear of the sump, and should be removed to drain the sump immediately after a run when the oil is warm and the impurities are still held in suspension.

WARNING: - Take all suitable precautions to guard against scalding from the hot oil.

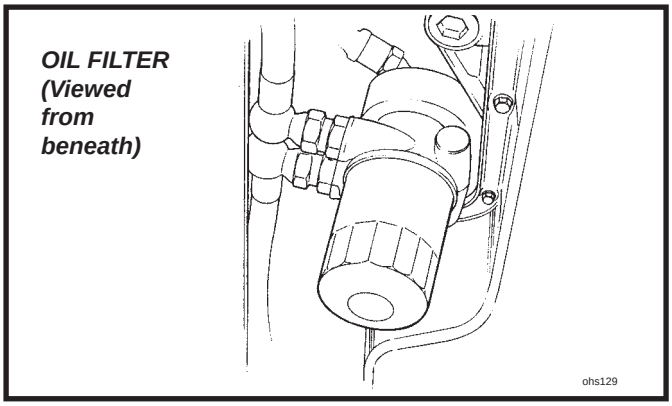
Allow the oil to drain completely before cleaning the drain plug, fitting a new sealing washer, and tightening securely. Refill with the recommended lubricant via the oil filler on the camshaft cover, to the top mark on the dipstick, allowing several minutes for the oil to drain through to the sump before checking the level. Take care not to overfill. Refit the oil filler cap securely, and check the oil level again when the engine is fully warm (see above).

Oil Filter
The canister type oil filter is vertically mounted at the front of the engine, and is accessible from beneath after removal of the engine bay undershield. The filter should be renewed along with the engine oil, at intervals

specified in the Maintenance Schedule.

WARNING: Take all suitable precautions to guard against scalding from the hot oil.

Remove the filter by turning in a counterclockwise direction, if necessary using an oil filter wrench, and dispose of safely.



Ensure that only a Lotus specified filter is fitted, as parts with identical outward appearance can contain different internal features. Before fitting a new filter, clean the mating face on the engine, and smear the new seal on the filter with clean oil. Add a small amount of clean engine oil into the filter, screw onto its spigot and tighten BY HAND sufficiently to make a secure seal, typically 2/3 to 3/4 of a turn after the sealing faces have made contact.

Overtightening using a filter wrench may damage the canister and/or complicate subsequent removal. Start the engine and check for oil leaks. Re-check the security of the filter, further tightening by hand if necessary. Check the oil level (see above) when the engine is fully warm.

Oil Coolers

The foregoing oil change procedure does not disturb the oil quantity contained in the twin oil coolers and associated pipework, but is considered perfectly satisfactory for routine maintenance operations. In instances of major engine failure where the oil system may be contaminated with metallic debris, all oil cooler lines should be thoroughly flushed out and the oil cooler radiators replaced.

If the oil cooler circuit is drained or replaced, the following procedure should be adopted to fill the cooler system before starting the engine:

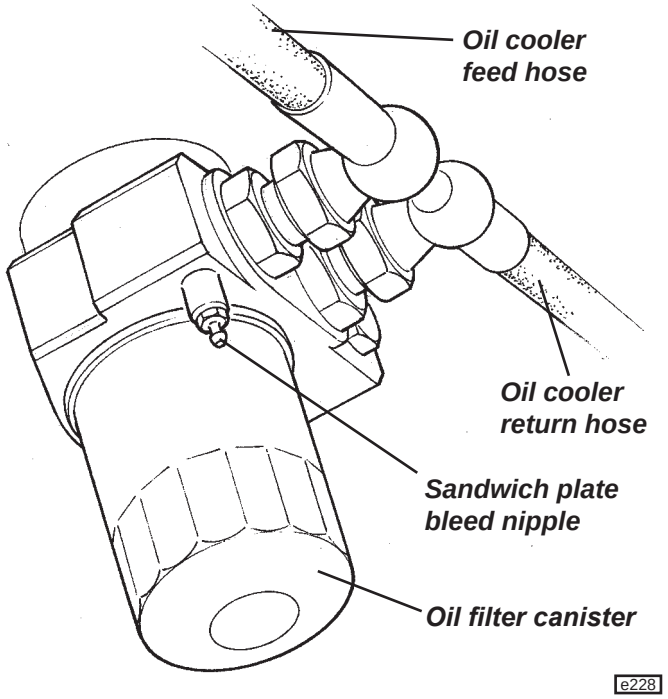
1. Attach a tube to the bleed nipple on the sandwich plate between oil filter and engine block, and lead into a catch tank. Open the bleed nipple.

2. Disconnect the outlet hose from the top of the LH oil cooler, and pour engine oil into the cooler until oil reaches the bleed nipple (approx. 2.5 litres). Close the bleed nipple, tightening to 8 Nm.

3. Connect the LH cooler outlet hose and tighten to 40 Nm.

4. Add a further 0.7 litres of oil into the engine to accommodate the volume of the return hose between LH oil cooler and engine.

5. After starting the engine, restrict running to idle speed for a minimum of 5 minutes, to allow the oil cooler lines to be purged of air. Stop engine and re-check oil level.



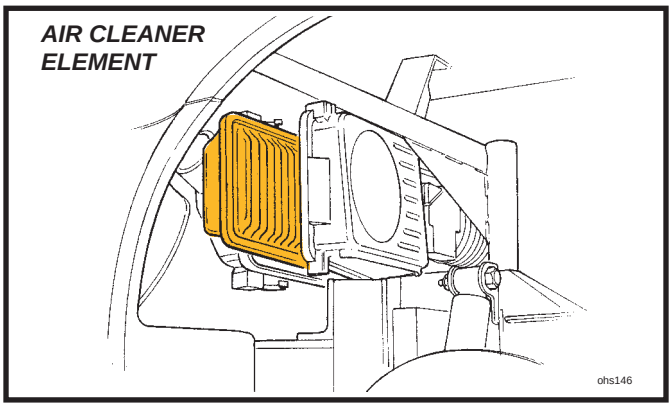
Note: For cars fitted with an Accusump pressurised oil storage canister, refer to section 'Exige SC'.

Air Cleaner Element

The air filter should be inspected at intervals dependent on the operating conditions. When the vehicle is operated in a relatively clean environment, the element should be renewed at intervals specified in the Maintenance Schedule, but where a dusty or smog laden atmosphere prevails, or other factors contribute to filter contamination, more frequent replacement will be required dependent on the level of pollution.

A disposable folded paper type air cleaner element is fitted in a housing at the left hand front of the engine bay. For access to the element, the left hand rear wheel and wheelarch liner must first be removed. Before opening the air cleaner housing, the wheelarch area should be cleaned to reduce the possibility of filter or housing contamination with road dirt.

To open the filter housing, release the two spring clips at the outboard end of the housing, and hinge open sufficiently to allow the element to be withdrawn.



Clean the inside of the housing, including the joint faces, taking care not to contaminate the ‘clean’ engine side of the assembly. Fit the new filter element into position with the shallow side facing the 'clean', engine side of the housing. Ensure that the hinge lugs at the inboard end of the housing are correctly engaged before closing the housing and securing with the two spring clips. Refit the wheelarch liner and rear wheel.

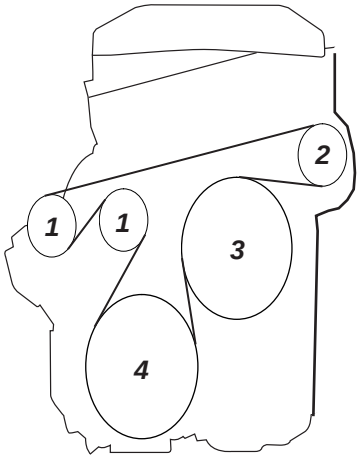
Auxiliary Drive Belt

A single multi-rib serpentine type belt is used to transmit drive from the crankshaft to the water pump, alternator and a.c. compressor, with a slave pulley fitted in place of the power steering pump used in other applications. A hydraulically damped, spring loaded tensioner arm applies tension to the back of the belt, and is maintenance free. The belt itself should be inspected for condition at each service interval, and if it exhibits any evidence of physical damage, cracking, fraying, perishing, abrasion or contamination, it should be replaced. In the case of oil or coolant contamination, the cause must be identified and rectified, and each of the pulleys must be thoroughly degreased before the new belt is fitted.

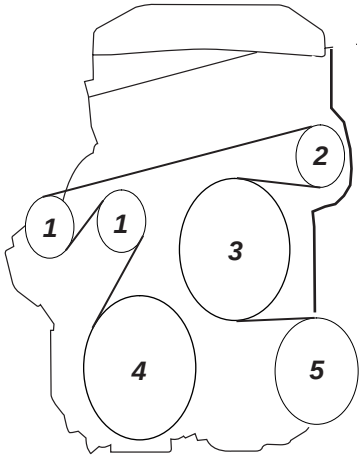
For further details, refer to section CH in the Engine Repair Manual, but note that only a six-sided socket should be used on the cast boss on the tensioner arm. Due to the manufacturing draft angle of the casting, a twelve point socket is liable to cause damage.

Drive Belt Pulley Routes

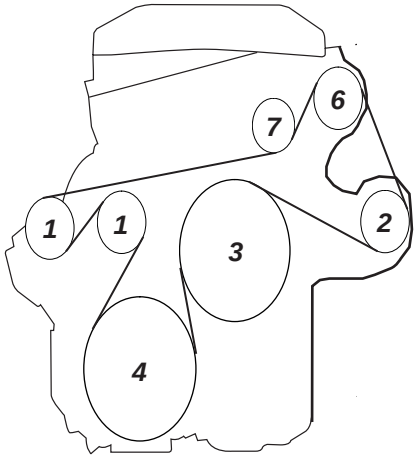
*Naturally Aspirated Non A.C**



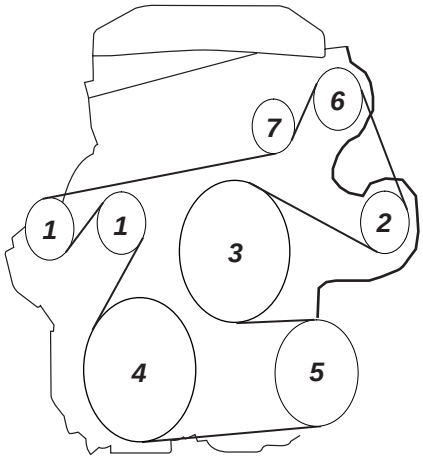
*Naturally Aspirated with A.C option**



*Supercharged Non A.C***



*Supercharged A.C option***



* 2ZZ & 1ZZ powertrains
** 2ZZ only

Spark Plugs

The ignition system uses a distributorless ignition system (DIS) which employs an individual high tension coil for each of the four spark plugs. Each coil is mounted directly onto its spark plug using an integral connector and is secured to the cam cover with a single screw. The spark plugs use small diameter centre electrodes made of iridium for long life and high performance, and require changing only at 54,000 mile (90,000 km) intervals (naturally aspirated vehicles only). For further details, refer to section IG in the Engine Repair Manual.

Please note that spark plug service change intervals are different for supercharged engines, please see service schedule checklist contained within service notes section OI for further information.

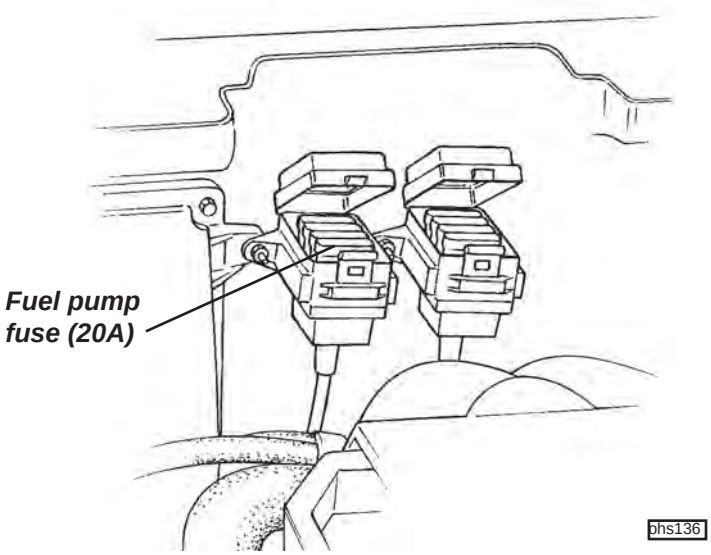
EH.4 - ENGINE REMOVAL/REPLACEMENT

It is recommended to remove the rear clamshell prior to powertrain removal in order to improve access, and to reduce the possibility of paint damage. The engine may be removed from above, with or without the transmission. The following procedure applies to the engine/transmission assembly, but to avoid disturbing the suspension, refer to sub-section FJ.5 to separate the engine from the transmission before withdrawing the engine alone.

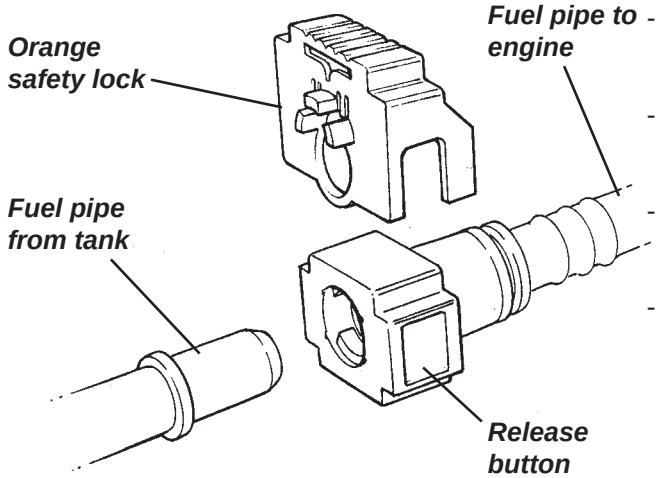
Fuel Pressure Relief Procedure

This procedure should be used prior to disconnecting any part of the fuel line.

- Pull out the fuel pump fuse (no. R1 on the left hand side of the engine bay bulkhead, as shown), start the engine, and run until it stops from starvation. Crank the engine for a further few seconds.
- If the engine is a non-runner, pull out the fuel pump fuse, and crank the engine for 20 seconds to minimise residual fuel pressure.
- Disconnect the battery.
  It is recommended first to release the quick fit connector located to the rear of the coolant header tank:
- Release the retaining clip securing the pipe joint to the header tank bracket.
- Slide the orange coloured safety lock to allow access to the connector release buttons.
- Surround the pipe joint with a shop towel to absorb fuel contained in the pipework before pressing the release buttons and separating the joint.



WARNING: Be aware of the possibility of full pressure retention in the fuel line caused by a system fault.



- Before re-making the joint, ensure that the orange safety lock is fitted onto the pipe connector in the orientation shown in the illustration.
- Push the male pipe end fully into the female connector until a click is heard. Pull on the pipe to ensure complete engagement.
- Slide the orange safety lock over the connector to prevent accidental pressing of the release buttons.
- Secure the pipe/connector using the pipe clip on the header tank bracket.

1. Remove the engine bay undertray and diffuser, both rear road wheels and the rear clamshell (see sub-section BR.7).

2. On a.c. cars, recover refrigerant and disconnect both a.c. hoses from the pipes at the rear of the RH sill.

From beneath the car:

3. Drain coolant, transmission oil and, if necessary, engine oil. Diconnect the coolant inlet hose from the thermosat housing and cap both apertures. Disconnect the two oil cooler hoses from the sandwich plate and cap all ports and hoses.

4. Disconnect the exhaust manifold from the downpipe.

5. Release the gear cable routing clips from beneath the engine. Disconnect the earth braid between chassis and transmission.

6. Release the clutch slave cylinder from the transmission housing and support aside.

7. Release the steady mounting between the front of the engine and the chassis, and between the rear of the engine and the subframe.

From above:

8. Release the gearchange cables from the transmission by removing the 'R' clips retaining the inner cable eyes, and the 'C' clips retaining the outer cables.

9. Disconnect the air intake hose between air cleaner and intake plenum, and release the brake servo vacuum hose from the intake plenum.

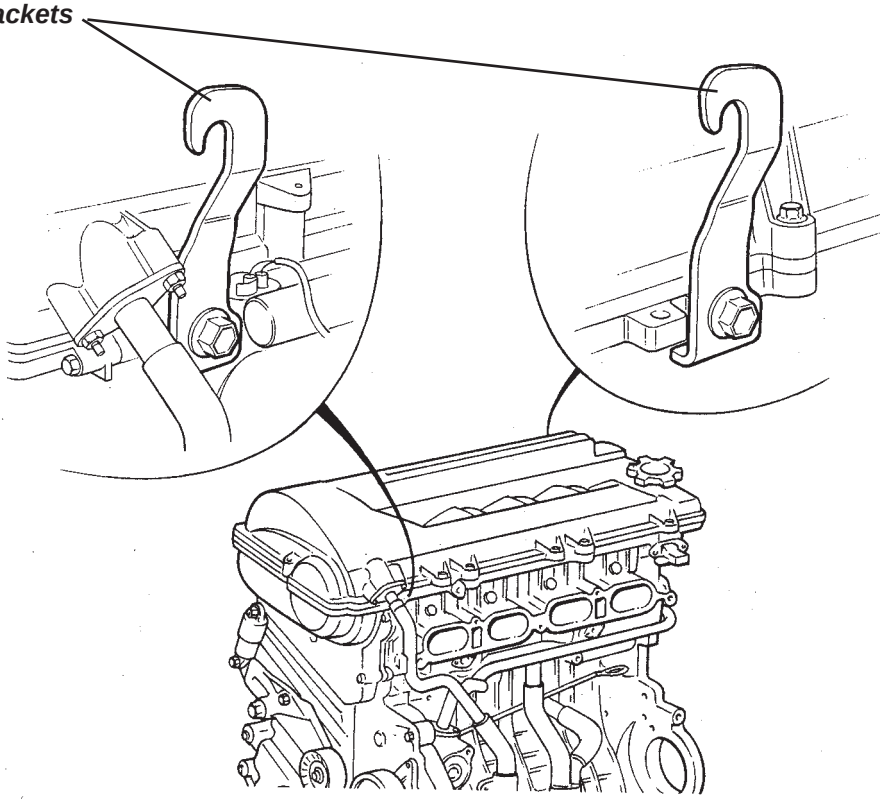
10. Disconnect the throttle cable. Disconnect the radiator feed hose and heater feed hose from the rear end of the cylinder head. Disconnect the heater return hose from the water rail, and the two hoses and electrical connector from the header tank. Disconnect the re-circ. pump hose to the chassis pipe, and release the electrical connector. Unplug the engine harness. Release the header tank bracket from the subframe, and remove the bracket complete with tank and recirc. pump. Release the purge pipe from the throttle body.

11. Remove the LH driveshaft from the transmission:
Release the top ball joint plinth from the LH hub carrier noting and retaining the camber adjustment shims, and separate the toe-link ball joint separated from the carrier. The driveshaft inboard joint is retained in the transmission by a round section circlip. The joint may be removed by applying a shock pull to the C.V. joint body using a slide hammer with a forked end. Take great care not to damage the output oil seal on withdrawal.
CAUTION: Do NOT attempt to remove the inboard C.V. joint from the transmission by pulling on the driveshaft. The balls of the inboard joint are restrained for transit purposes only, by a circlip at the end of the ball tracks. Applying an extension force to the joint will damage the balls and require joint replacement. Apply pressure only to the outer body of the joint. Do not allow the brake hose to be stetched or stressed, and support the driveshaft after withdrawal to protect the shaft joints and hub carrier. Cap the driveshaft aperture in the transmission.

12. Remove the RH driveshaft from the transmission:
Release the top ball joint plinth from the RH hub carrier noting and retaining the camber adjustment shims, and separate the toe-link ball joint separated from the carrier. The right hand driveshaft incorporates a bearing for the extension shaft and it is this which retains the shaft in the transmission. Remove the two bolts ecuring the bearing bracket, and withdraw the complete shaft assembly taking great care not to damage the ouput oil seal. Do not allow the brake hose to be stetched or stressed, and support the driveshaft after withdrawal to protect the shaft joints and hub carrier. Cap the driveshaft aperture in the transmission.

13. Fit two engine lifting brackets T000T1437S to the left hand front and right hand rear of the cylinder head. Sling support the power unit before releasing the RH and LH engine mounting brackets.

Engine lifting brackets



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17. Carefully hoist the power unit from the car, whilst monitoring for any remaining connections.

Refit the unit in reverse order to removal with the following notes:

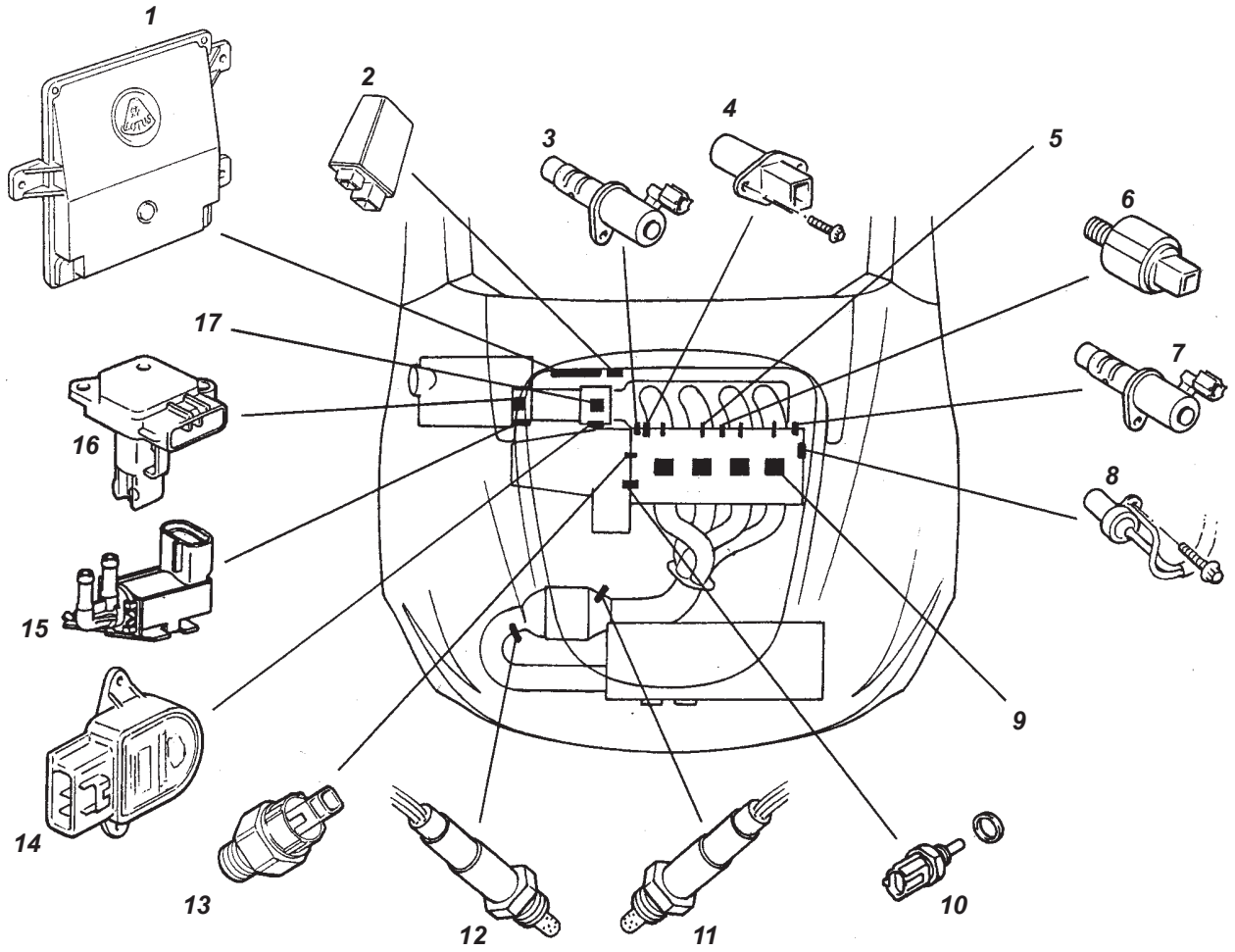
- Before re-fitting a driveshaft, first renew the round section circlip on the end of the left hand inboard joint spigot shaft, and lubricate the circlip with grease. Also, check the condition of the transmission output seal, and renew if necessary. Lubricate the lip of the seal with transmission oil, and grease the corresponding shoulder on the driveshaft (C.V. joint) spigot, to reduce the danger of damaging the seal on assembly.
- Carefully insert the driveshaft into the transmission, with, on the left hand shaft, the two ends of the circlip positioned lowermost, and rotate the shaft if necessary to engage the splines. Press the inboard joint outer until a click indicates the engagement of the retaining circlip, if necessary using a brass drift and hammer. Pull on the body to ensure its security. On the right hand shaft, fit the bolts securing the extension shaft bearing to the engine mounted bracket, and torque to 64 Nm.
- Refer to section DH for rear suspension assembly details.
- For coolant refilling procedure, refer to section KH.
- For transmission details and gear cable adjustment, refer to section FJ.

EH.5 - SPECIAL TOOLS

The following engine special tools are available under Lotus part number:

Engine Lift Bracket	T000T1437S	2 off
Bolt, engine lift bracket	T000T1440S	2 off
Oil Filter Wrench	T000T1441F	1 off
Valve Clearance Adjuster Set	T000T1442F	1 off
Crankshaft Pulley Holding Tool	T000T1443F	1 off
Flange Holding Tool	T000T1444F	1 off

EH.6 - ENGINE MANAGEMENT COMPONENT LOCATION - 2ZZ



Key to engine management component location drawing

1. Electronic Control Unit (ECU).
2. Multi-function relay unit.
3. Oil control valve for variable valve lift.
4. Camshaft position sensor.
5. Fuel injector.
6. Knock sensor.
7. Oil control valve for variable valve timing.
8. Crankshaft position sensor.
9. Plug top coil.
10. Coolant temperature sensor.
11. Pre-catalyst oxygen sensor.
12. Post-catalyst oxygen sensor.
13. Oil pressure switch.
14. Throttle position sensor.
15. Vacuum solenoid for intake flap valve.
16. Mass airflow sensor.
17. Idle Air Control (IAC) valve (prior '06 M.Y.)

For component replacement procedures, refer to manual B120T0327J. For diagnostic codes, refer to Section EMP.

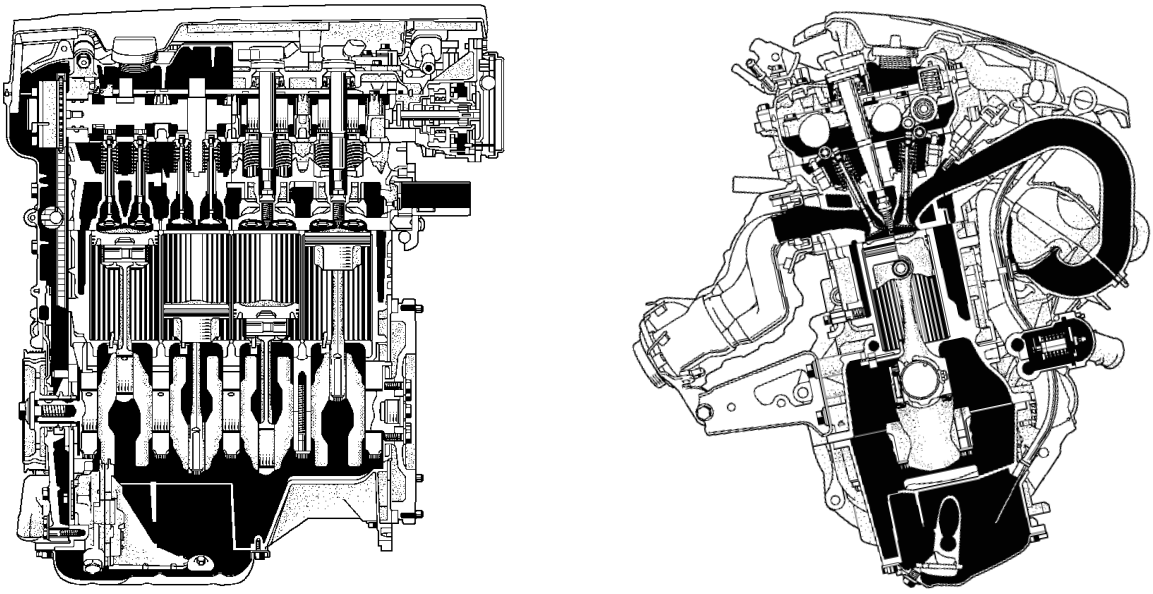
EH.7- ELISE IZR SUPPLEMENT

The 1.6 litre Elise announced. in January 2010 replaces the 1.8 litre Elise S model, and uses the Toyota 1ZR FAE engine, but controlled by a type T6 Lotus ECU (also used on Evora), programmed by Lotus. This engine is similar in many respects to the 1ZZ and 2ZZ families, but is further optimised for fuel efficiency and meets Euro 5 emission standards. Features include Variable Valve Timing - intelligent (VVT-i) for both inlet and exhaust camshafts, in order to enhance power at both low and high engine speeds, and a VALVEMATIC system to vary the inlet valve lift in order to reduce pumping losses, minimise noxious emissions and optimise fuel economy. Engine throttling is controlled by a combination of inlet valve lift and a single butterfly valve at the inlet plenum intake.

Other architectural features include a valve angle narrowed to 29° for a compact cylinder head, and a crankshaft/cylinder axis offset (*désaxé*) of 8mm to reduce piston side thrust on the power stroke.

Engine Sections

From LH side ***From front***



1ZR

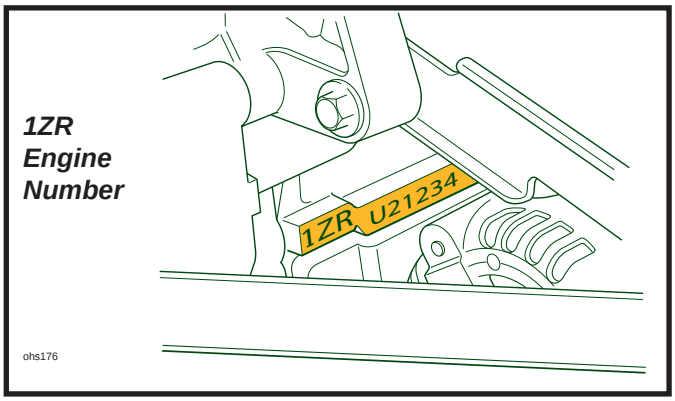
The Acoustic Control Induction System (ACIS), uses a bulkhead within the intake plenum to divide each of the four intake tracts into two sections. For each tract, an intake air control valve under common control, provides either a long or short tract length dependent on engine speed and throttle opening. This feature optimises power output at both low and high engine speed ranges.

Engine Data:

Capacity		1598 cm^3
Bore/stroke		80.5 mm/78.5 mm
Power/torque:		100 kW (136 PS, 134 hp) @ 6,800 rpm; 160 Nm (118 lbf.ft) @ 4400 rpm.
Combined fuel consumption:		6.14 litres/100 km (46 mpg).
Exhaust emissions CO_2:		155 g/km
Engine management:		Lotus T6 controller (as Evora) with Lotus programming.
Valve control:		VVT-i variable timing of both inlet and exhaust cams; VALVEMATIC variable lift system for the inlet valves.
Engine speed control:		Intake plenum throttling at low engine speeds; inlet valve lift and intake plenum throttling at high speeds.
Max. engine speed:		6800 rpm continuous; 7000 rpm transient.
Spark plugs:		Denso SC20HR11
Spark plug gap:		1.0 to 1.1mm
Compression	- std	1373 kPa (14.0 kgf/cm2, 199 psi) or higher
	- min	1079 kPa (11.0 kgf/cm2, 156 psi)
	- max. diff.	98 kPa (1.0 kgf/cm2, 14.2 psi)

Notes

- Valve lift actuator driven off tail of inlet camshaft. Vacuum pump driven off tail of exhaust camshaft to supply brake servo and engine management functions.
- Long reach M12 spark plugs requiring 14mm socket wrench.
- New 'clip-on' cosmetic engine cover.
- No requirement or provision for oil coolers.
- The engine number is stamped on the left hand front of the cylinder block, alongside the alternator, and is prefaced by ‘1ZR’.

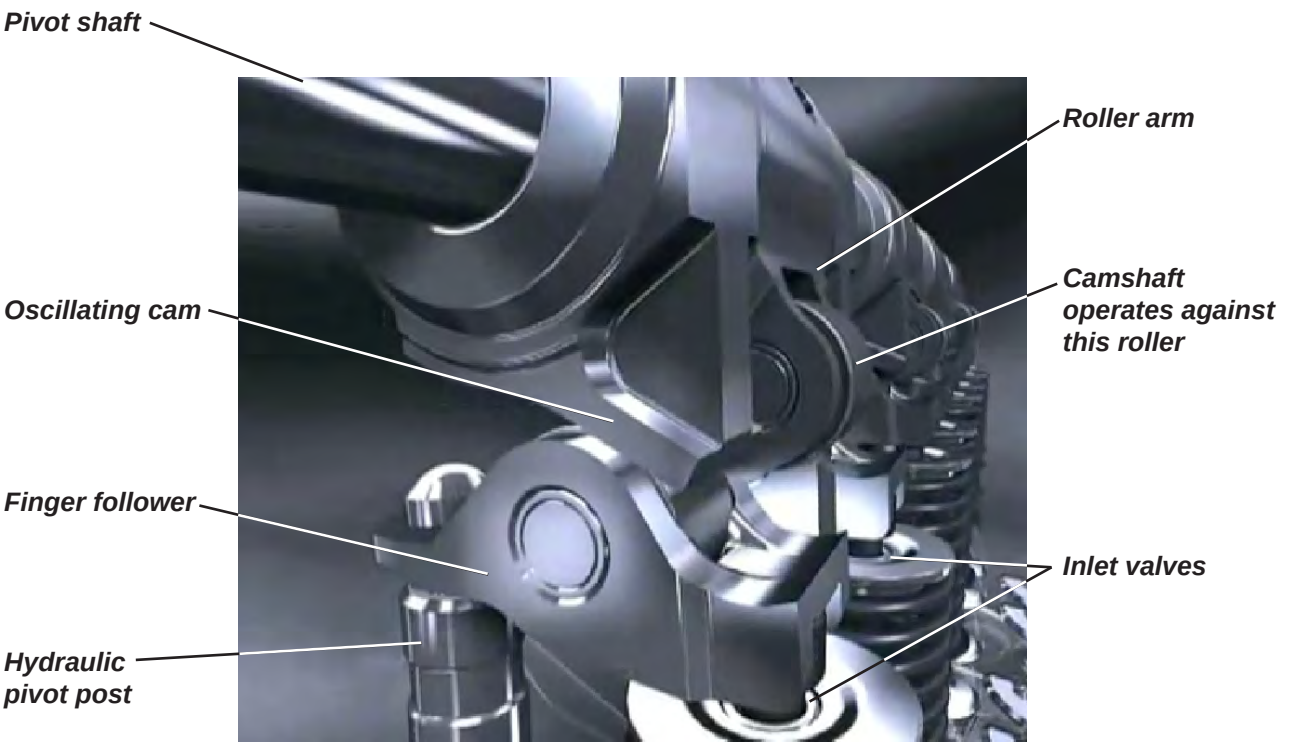


1ZR Engine Number

VALVEMATIC System

The principle of the VALVEMATIC system is that a conventional inlet camshaft with a single (rotary) cam for each cylinder operates a roller arm on a pivot shaft. On each side of the roller arm is an oscillating cam, each of which opens, via a finger follower, one of two conventional inlet valves for that cylinder. The two valves are operated at all times as a pair. The connection between the roller arm and the two oscillating cams is made via a common pivot sleeve machined with three separate sections of helical splines, which correspond with splines in the bores of the roller arm and oscillating cams. By sliding the sleeve axially, within the roller arm and cams, the opposite helix angle used for the cams compared with that for the roller arm, results in a phase shift between arm and cams.

Valves shown at full lift (camshaft omitted for clarity)



A 'lost motion' damper ensures that the roller arm stays in contact with the rotary cam profile at all times. The position of the oscillating cams at the start of a valve opening event however, is dependent on their phasing with the roller arm. In the low lift mode, where the cams are phased counterclockwise in relation to the roller arm as viewed from the rear, the finger follower roller is in contact with the base circle of the oscillating cam, which must turn through a large part of its range before the cam starts to lift the valve, resulting in only the first portion of the cam profile being used. In high lift mode, the oscillating cams are phased clockwise in relation to the roller arms such that the cam profile immediately starts to lift the valve as soon as the roller arm is depressed by the rotary cam, continuing then to utilise the full profile of the oscillating cam for maximum lift.

The concomitant variation in valve timing as the lift changes, is managed by the separate VVT-i system (see earlier).

Auxiliary Belt Tension
The auxiliary belt tension on the 1ZR FAE engine is set manually by adjusting the alternator position. An adjusting screw for this purpose is provided on the alternator strap, and may be utilised after slackening the strap anchor and clamp bolts, and the alternator lower pivot bolt.

Belt tension should be set using a frequency meter between the water pump and alternator pulleys:
New belt; 110 Hz (± 5 Hz). Used belt; 90 - 100 Hz.

Alternatively, a force meter can be used on the lower belt run between the crankshaft and water pump:
New belt; 700 - 800 N. Used belt; 550 - 770 N.

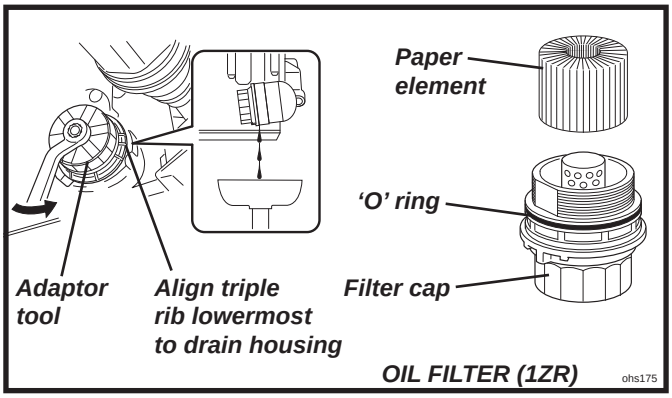
If no meter is available, apply firm thumb pressure to the midpoint of the belt run between water pump and alternator, and measure the deflection:
New belt; 7 - 8 mm. Used belt; 8 - 10 mm.

Engine Lubrication
For optimum engine protection, the oil level should be maintained towards the dipstick top mark, not be allowed to fall below the mid-point. If driving on a closed circuit track, or exploiting maximum cornering capability, it is especially important to maintain at the upper marking. Adding approximately ½ litre will raise the level from the mid-point to the upper mark.

- The oil filter is a cartridge type paper element similar in concept to the Evora, and is mounted at the right hand rear of the engine, accessible from beneath after removal of the engine bay undertray.

- Make provision for collecting the small amount of spilled oil before fitting adaptor tool T000T1441F over the cap to release the security catch, and allow it to be unscrewed using a 17mm wrench, or 3/8 inch square drive.

- Release about 4 turns before positioning the triple rib feature on the cap lowermost; this will aid draining of the oil from the filter housing. Then complete the removal of the cap, and dispose of the paper filter element and cap 'O' ring safely.



- Clean the oil filter cap and inside of the filter housing. Carefully fit a new 'O' ring (supplied with the new filter) into its groove on the cap and smear with clean engine oil before inserting a new filter element and refitting the cap, taking care to avoid cross-threading, and ensuring that the 'O' ring is not displaced. Using adaptor tool T000T1441F, tighten the cap to 25 Nm.

Engine Repair
An engine repair CD is available under part number T000T1523F. For a technical overview, choose:
- New Car Features
- 2008/11 Update
- New Features
- 1ZR-FAE and 2ZR-FAE Engine

Then select from the drop-down menu as required.

For repair procedures, choose:
- Repair Manual
- Engine
- scroll down past diagnostic codes to find 1ZR-FAE ENGINE MECHANICAL in left hand column.

EH.8 - ELISE 2ZR SUPPLEMENT

The 1.8 litre Elise S launched in June 2012 uses the Toyota 2ZR-FE 4-cylinder engine meeting the current Euro 5 emission standards. The Toyota original equipment inlet manifold is not used but is replaced with a Magnuson R900 supercharger assembly (utilising Eaton TVS Technology ™) featuring an integral air to water charge cooler and inlet manifold. The original equipment alternator bracket is not used but is replaced with modified bracket/ pulley assembly to accommodate the revised drive belt run required for the supercharger pulley. The original equipment oil filter housing is also replaced and fitted with a Lotus developed filter housing incorporating oil line adapters and a thermostat assembly.

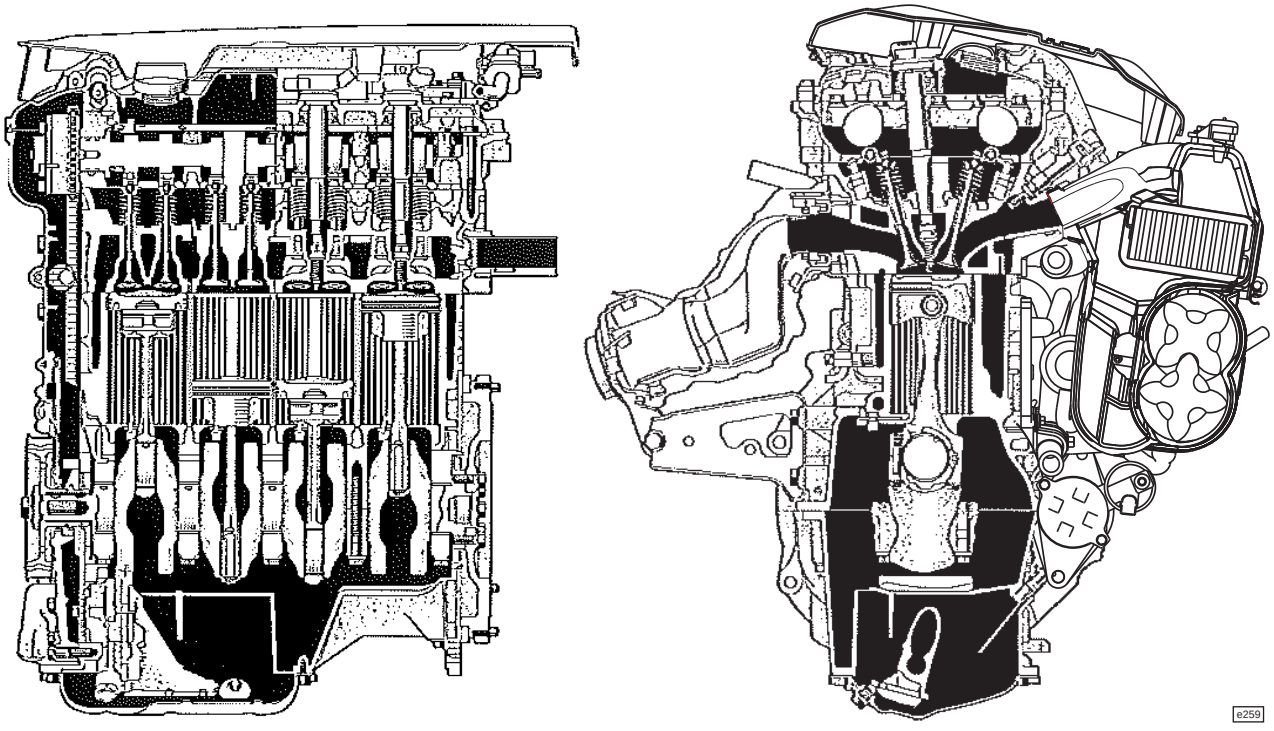
This engine is similar in many respects to the 1ZR-FAE engine used on the 1.6 Elise introduced at '11MY and utilises Variable Valve Timing - intelligent (VVT-i) for both inlet and exhaust camshafts but is NOT fitted with VALVEMATIC system and instead reverts back to using a conventional electronic throttle assembly.

The cartridge type paper element originally specified for the 2ZR-FE engine is not fitted to the Lotus oil filter housing but instead is replaced with the same canister type filter as used on the 1ZZ engine assembly.

Please note: Due to the fitment of a Lotus designed oil filter housing, if an engine replacement becomes necessary, the housing fitted to a 2ZR-FE service replacement engine must be discarded and replaced with the Lotus modified housing assembly.

Engine Sections

From LH side ***From front***



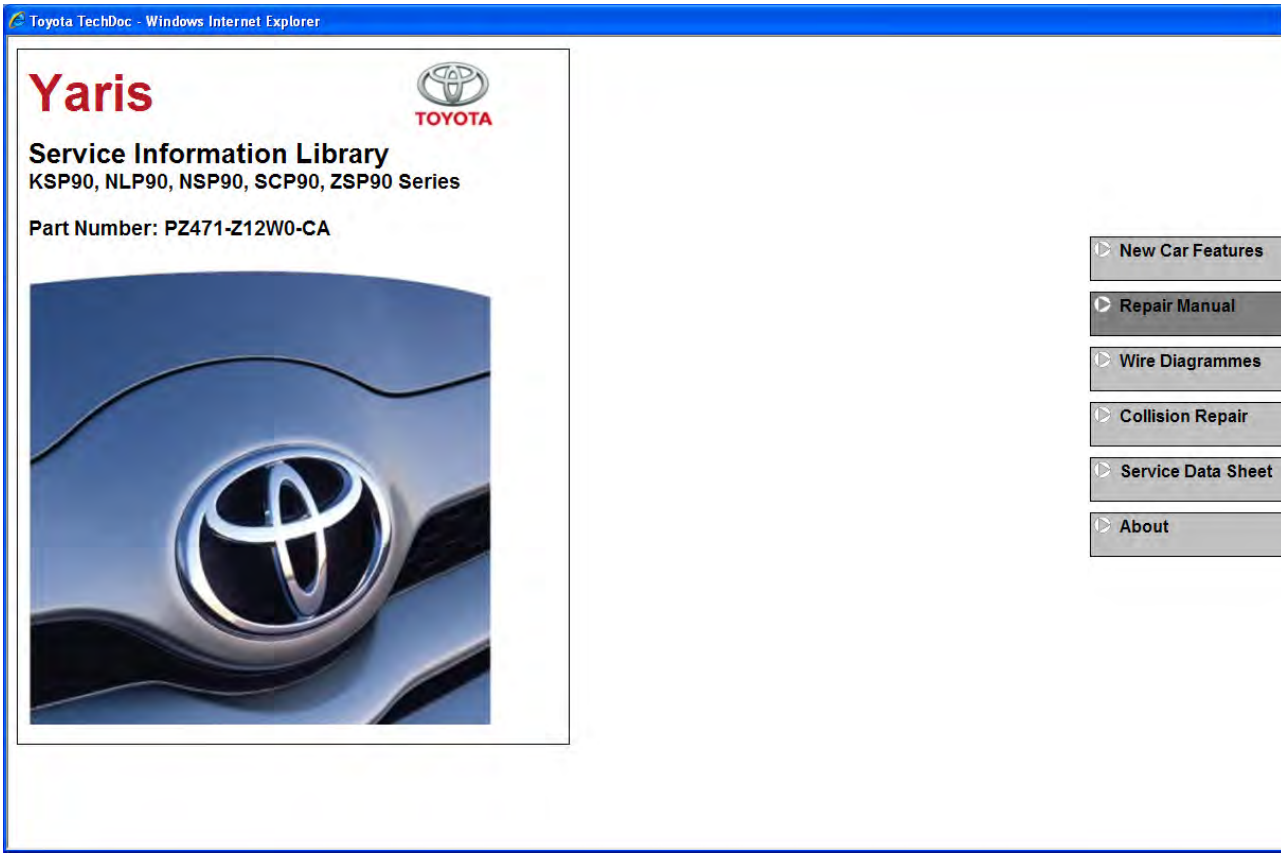
Engine Data:
Please refer to service notes section TDP or supplementary engine repair manual CD disc part number T000T1530F for full information.

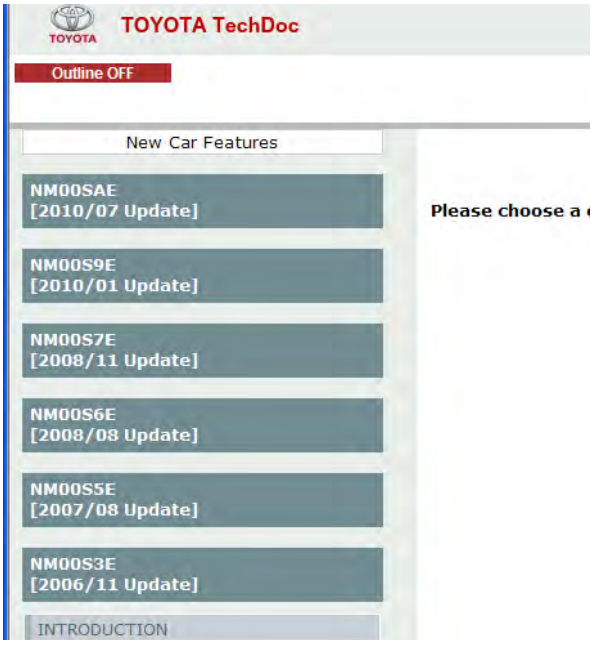
For general information relating to the 2ZR-FE engine select 'New Car Features' from the Home Page, then select:

NM00S3E (2006/11Update)>New Features>2ZR-FE Engine

For specific engine repair information relating to the 2ZR-FE engine select 'Repair Manual' from the home page, then select 'Engine' and scroll down to the relevant engine model code option for the 2ZR-FE engine.

'Home' Screen display of T000T1530F CD disc



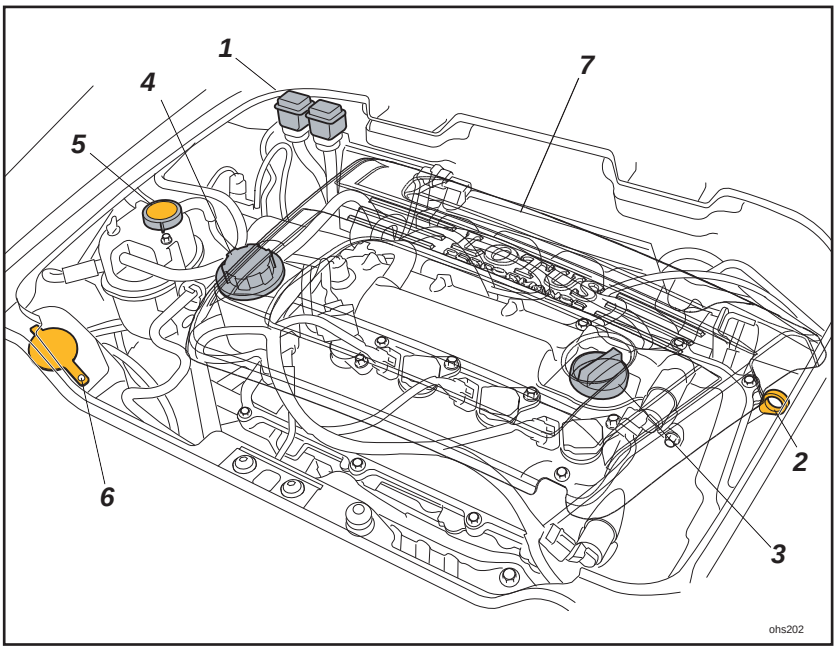


New Car Features Display

Engine Repair Manual Display

Engine Bay Overview

1. Engine compartment fuses
2. Engine oil dipstick
3. Engine oil filler cap
4. Charge cooler coolant reservoir
5. Engine coolant header tank
6. Windscreen washer reservoir
7. Engine cover panel



Engine Cover Panel
A lightweight cosmetic panel is fitted onto the top of the engine.

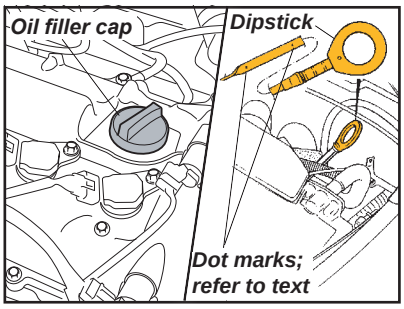
To remove: Pull upwards to release the four rubber sockets.
To refit: Centre the oil filler cap in the panels cut-out, and press down over each peg.

Engine Oil Level Check
The engine oil level should be checked regularly, such as every two or three fuel stops, and the oil level maintained near the top mark on the dipstick. It is especially important to keep a check on the oil level during the vehicle's first 1,000 miles (1,600 km), as both the fuel and oil consumption will be prone to some variance until the engine components have bedded in.

Note: If driving on a closed circuit track, or exploiting maximum cornering capability, it is especially important to maintain at the upper marking.

The best time to check the level is before starting a cold engine, if you have to check the level when the oil is warm, such as during a fuel stop ensure that the car is parked on a level surface and that a few minutes have elapsed since stopping the engine to allow oil to drain back into the sump. If the engine is run but stopped before reaching normal running temperature, the oil will not readily drain back into the sump, and the dipstick will display an artificially low reading.

Dipstick: The dipstick is identifiable by its yellow loop handle, and is located at the right hand front of the engine. If access to the dipstick is required when the engine is hot, be aware of the many hot surfaces in the engine bay and wear appropriate protective clothing to prevent burn injuries.



Withdraw the dipstick, and wipe with a paper towel. Replace the dipstick, if necessary feeding the blade into the tube using the towel, before pressing firmly to ensure that the handle is fully seated up to the collar. Withdraw the dipstick again to inspect the oil level.

Topping Up: If topping up is necessary, unscrew the oil filler cap located on the top of the camshaft cover towards the front of the engine. Add a suitable quantity of the recommended engine oil - see service notes section TDQ for information, taking care not to spill any oil onto the engine or electrical components; use a funnel if necessary and clean up any spillage. Allow several minutes for the oil to drain through to the sump before re-checking the oil level. Refit the filler cap, turning clockwise until secure.

NOTICE: Do NOT overfill, or lubrication will be degraded and consumption increased as the oil becomes churned and aerated. The catalytic converter may also be damaged by oil content in the exhaust gas.

Any track oriented car fitted with an Accusump oil reservoir requires a specific oil level checking procedure; see handbook supplement LSL528.

Engine Oil Change

The use of high quality oil, renewed at the specified intervals, is the key to engine longevity and sustained performance. Adhere strictly to the engine oil and filter change intervals specified in the Maintenance Schedule – see service notes section OI for further information.

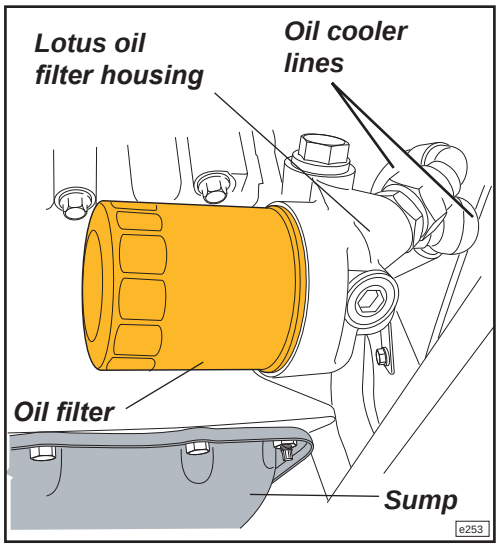
For access to the engine sump and filter, the engine bay undertray must first be removed. This is most easily achieved with the vehicle raised on a garage hydraulic lift. The drain plug is located at the rear of the sump, and should be removed to drain the sump immediately after a run when the oil is warm and the impurities are still held in suspension.

WARNING: - Take all suitable precautions to guard against scalding from the hot oil.

Allow the oil to drain completely before cleaning the drain plug, fitting a new sealing washer, and tightening securely. Refill with the recommended lubricant via the oil filler on the camshaft cover, to the top mark on the dipstick, allowing several minutes for the oil to drain through to the sump before checking the level. Take care not to overfill. Refit the oil filler cap securely, and check the oil level again when the engine is fully warm (see above).

Oil Filter

The canister type oil filter is horizontally mounted at the rear of the engine, and is accessible from beneath after removal of the engine bay undershield - see service note section AA. The filter should be renewed along with the engine oil, at intervals specified in the Maintenance Schedule.



WARNING: Take all suitable precautions to guard against scalding from the hot oil.

Remove the filter by turning in a counterclockwise direction, if necessary using an oil filter wrench, and dispose of safely. Ensure that only a Lotus specified filter is fitted, as parts with identical outward appearance can contain different internal features. Before fitting a new filter, clean the mating face on the engine, and smear the new seal on the filter with clean oil. Add a small amount of clean engine oil into the filter, screw onto its spigot and tighten **BY HAND** sufficiently to make a secure seal, typically 2/3 to 3/4 of a turn after the sealing faces have made contact.

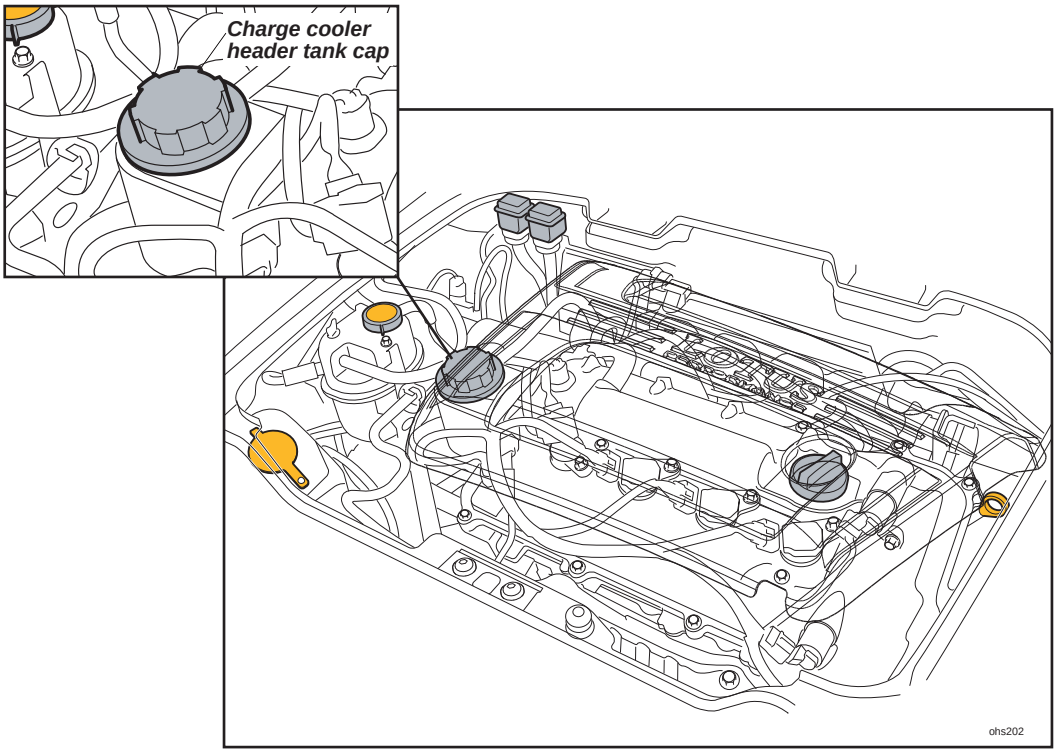
Overtightening using a filter wrench may damage the canister and/or complicate subsequent removal. Start the engine and check for oil leaks. Re-check the security of the filter, further tightening by hand if necessary. Check the oil level when the engine is fully warm.

Oil Cooler

The foregoing oil change procedure does not disturb the oil quantity contained in the oil cooler and its associated pipe work, but is considered perfectly satisfactory for routine maintenance operations. In instances of major engine failure where the oil system may be contaminated with metallic debris, all oil cooler lines should be thoroughly flushed out and the oil cooler radiator replaced.

Charge Cooler Reservoir
To maintain optimum performance, supercharged air is cooled before it enters the engine using an air to liquid charge cooler system.

The charge cooler system utilises its own dedicated coolant circuit with a coolant reservoir mounted on the left hand side of the engines cylinder head.



The reservoir is identified by its black filler cap which has no visual markings or labels attached.

Under normal circumstances it should not be necessary to add any coolant.

NOTICE: If underfilled, optimum charge cooling will not be achieved, premature wear to the charge cooler systems electrically operated pump may also occur.

Coolant Level Check
Although the system is not pressurised, the coolant may still reach temperatures in excess of 50ºC (122ºF), so caution should still be taken when checking the level.

Ensure the vehicle is on a completely level surface, turn off the engine to deactivate the charge cooler pump and unscrew the reservoir cap.

There are no level marks incorporated into the coolant reservoir, topping up is not required if the reservoir is ½ to ¾ full of coolant.

WARNING: Coolant is hazardous to your health and to animals and may be fatal if swallowed.
Keep coolant out of reach of children.
Clean up spilled coolant and do not leave in open containers.

Topping up: Top up until the reservoir is approximately ½ to ¾ full, refit the cap, and turn clockwise until secure.

Anti-Freeze/Coolant Mixture
The charge cooler system uses the same specification and mixture ratio as the engine cooling system. In order to maintain protection from freezing damage and metal corrosion, use only an approved coolant mixture (see

recommended lubricants section for specification).

NOTICE: No other type of coolant should be mixed with the coolant type specified in the recommended lubricants section of this handbook, or degradation of the cooling system may result.

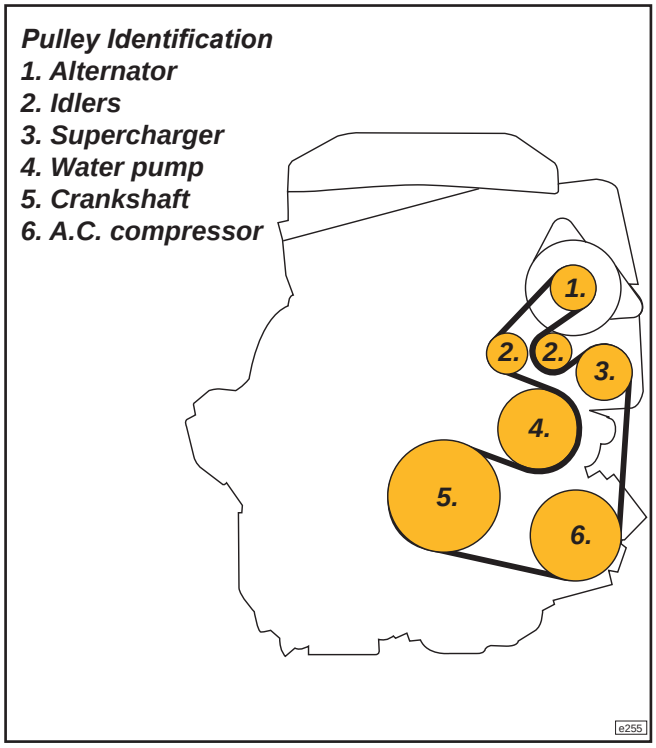
NOTICE: Using an incorrect coolant mixture may result in expensive damage to the engine and/or other components caused by overheating, freezing or corrosive effects. Such damage is not covered by the New Vehicle Warranty.

Auxiliary Drive Belt
A single multi-rib serpentine type belt is used to transmit drive from the crankshaft to the water pump, alternator, a.c. compressor (if fitted) and supercharger assembly.

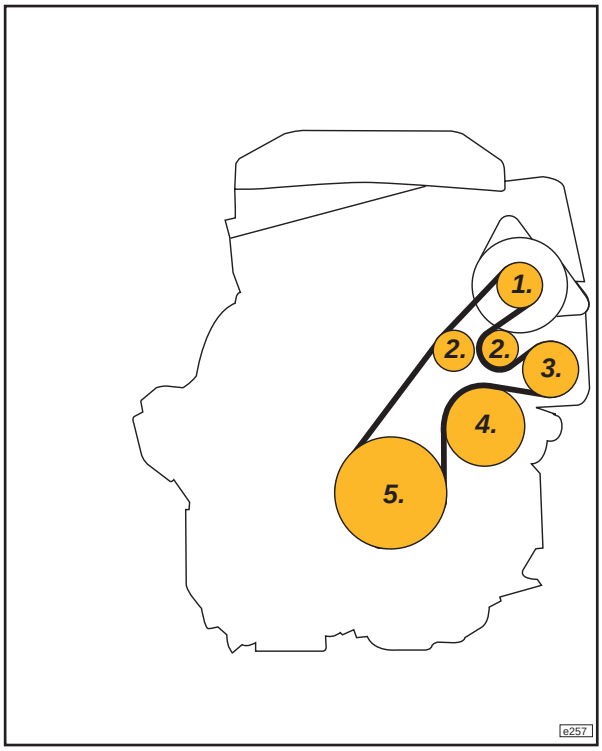
Replacement Intervals
Because of the high load placed on the belt due to the supercharger fitment, the drive belt should be renewed at the specific time/mileage intervals as listed in the service schedule – see service notes section OI for further details.

Drive Belt Pulley Route

Vehicles fitted with A.C option



Non A.C option

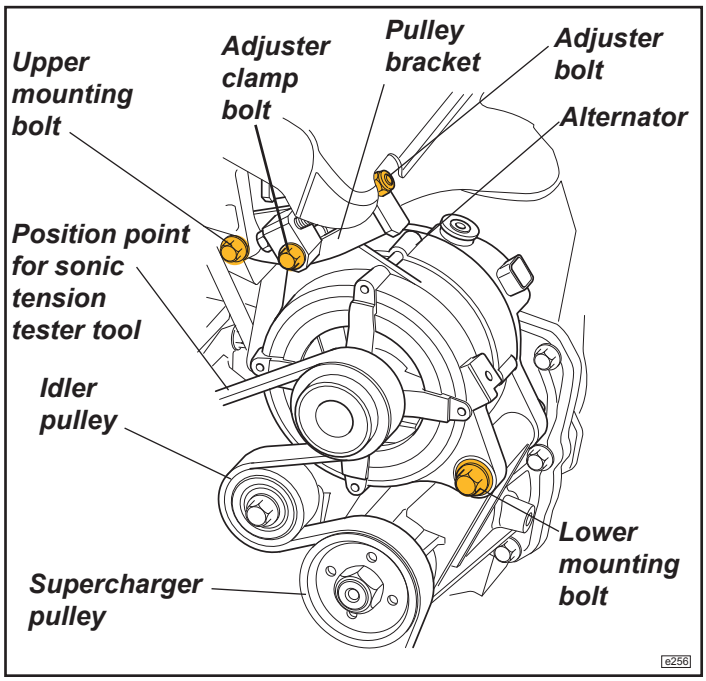


Drive Belt Inspection
The drive belt should still be inspected for condition at each service interval, and if it exhibits any evidence of physical damage, cracking, fraying, perishing, abrasion or contamination, it should be replaced. In the case of oil or coolant contamination, the cause must be identified and rectified, and each of the pulleys must be thoroughly degreased before the new belt is fitted.

Drive Belt Tension
The belt tension is set by a manual adjuster bar mechanism attached between the side of the engine and the top of the alternator housing.

Loosening the alternators upper and lower fixings bolts will allow the assembly to pivot on its mounting bracket.

Turning the adjusting bolt clockwise or anti-clockwise within the adjuster bar mechanism will then move the alternator either closer or further away from the engine so increasing or decreasing the drive belt tension.



Drive Belt Adjustment

1. Loosen the upper, lower and adjuster clamp alternator mounting bolts.

2. Tighten or loosen the block adjustment bolt on the pulley bracket as required to increase/decrease the tension on the belt until there is approximately ¼ of a turn of movement in the longest run of the belt (which is between the alternator pulley and idler pulley).

3. Using a sonic tension meter check, flick the belt on the run between the alternator pulley and the idler pulley bracket and check the frequency recorded. The tension for a new belt should produce a frequency of 175-180 Hz and 170-175 Hz for a used belt.

   Note: if renewing the belt, tension should be checked after 2 engine revolutions.

4. If the tension is incorrect then adjust the block adjustment bolt and retest. Repeat this process until the correct frequency is achieved.

5. Tighten the upper alternator mounting bolt and the adjuster clamp bolt (torque 25Nm) and lower mounting bolt (torque 45Nm).

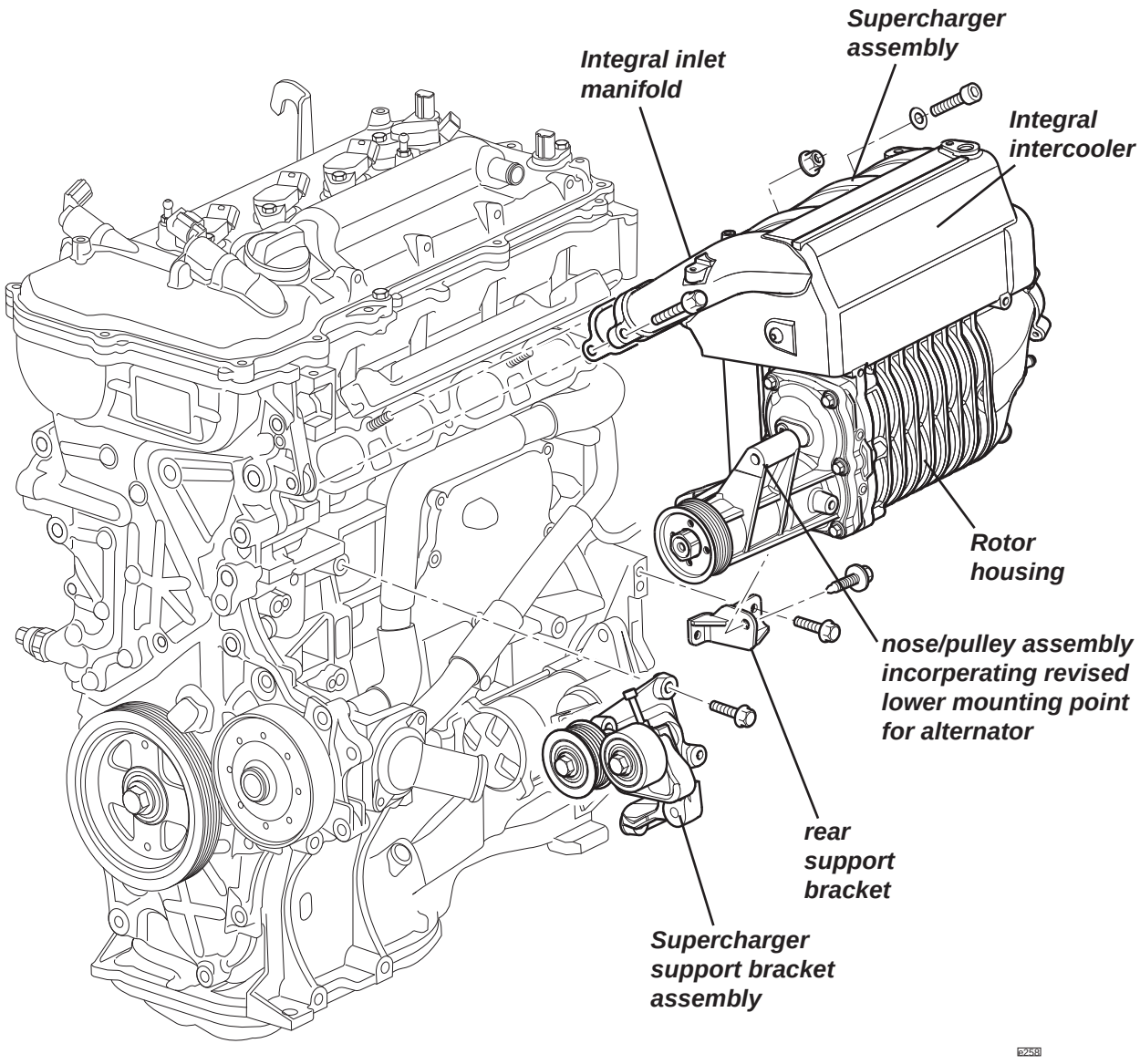
6. Carry out a final frequency check on the belt, if the frequency is incorrect, loosen the fixings and repeat steps 1 - 5.

Spark Plugs

The ignition system uses a distributorless ignition system (DIS) which employs an individual high tension coil for each of the four spark plugs. Each coil is mounted directly onto its spark plug using an integral connector and is secured to the cam cover with a single screw. The spark plugs use small diameter centre electrodes made of iridium for long life and high performance, and require changing only at 36,000 mile (58,000 km)/4 yearly intervals.

For further details, refer to the 2ZR-FE Ignition sub section which can be found within the engine repair manual section of the CD disc, part number T000T1530F.

Supercharger Assembly



The original equipment manifold supplied with the 2ZR-FE engine is not fitted to the 2012 model year Elise S, but is replaced with a Magnuson R900 supercharger assembly (utilising Eaton TVS technology ™) which is linked to an integral inlet manifold via an air to water charge cooler.

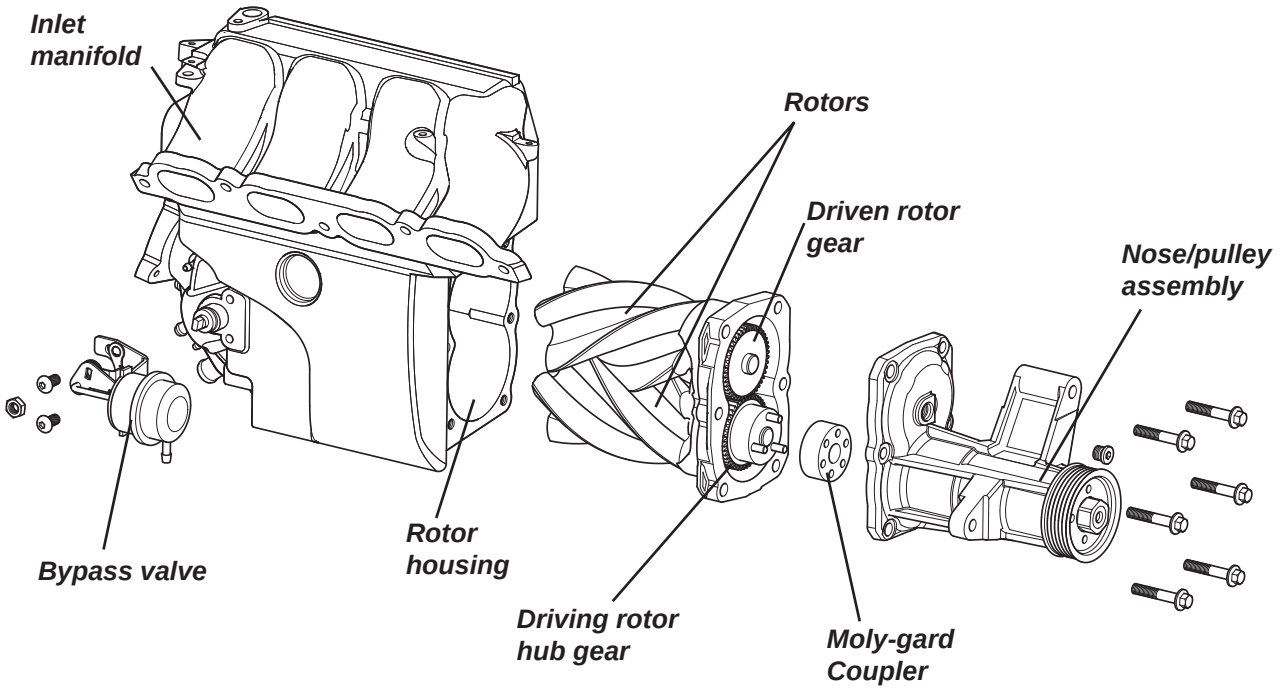
The twin 4 lobe rotors contained within the supercharger assembly displace 0.9 litres of air per revolution providing up to 0.8 bar of boost pressure.

The assembly is additionally supported to the engine block by a front and rear mounts.

Front support: A bolt passing through the timing case, idler support bracket assembly and into casting lug on the superchargers 'nose' assembly supports the front of supercharger assembly.

Rear support: A bracket located above the starter motor, bolted to the engine block supports the rear of the supercharger.

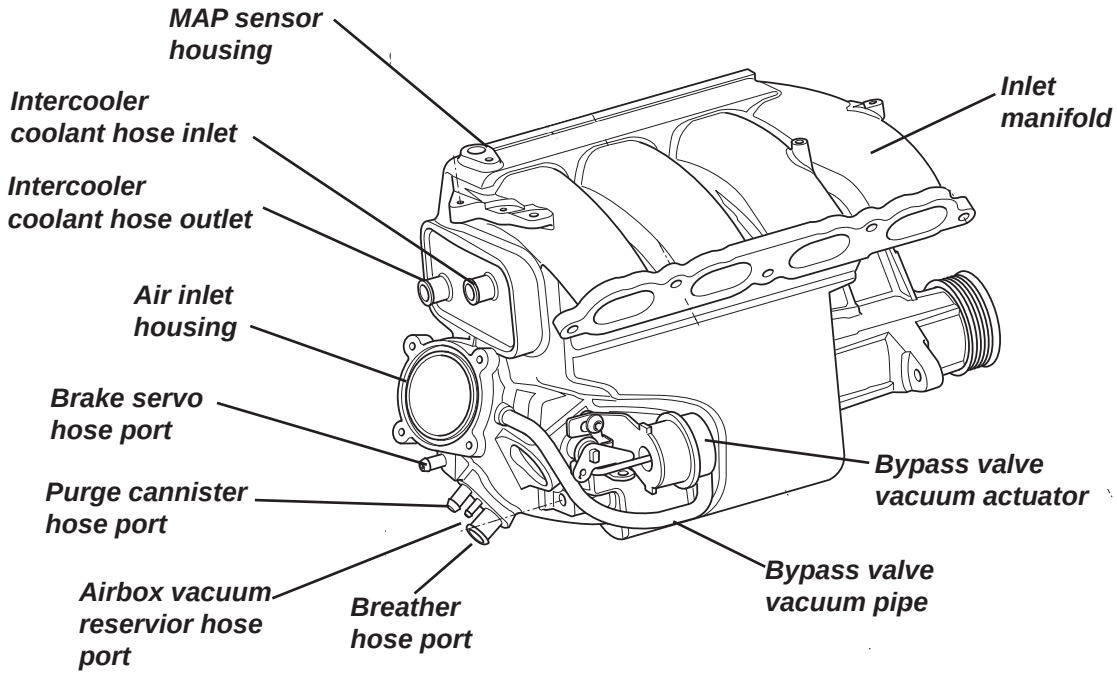
The supercharger assembly is self contained and features helix twisted rotors to minimise output pressure variations, and maintenance free gearing and bearings, requiring no externally sourced lubrication.



Opposing pegs (3 on the pulley shaft hub and 3 on the rotor hub drive gear) slide into 6 evenly spaced holes on a moly-gard coupler to transmit drive from the engines serpentine belt to the driving rotor.

The driving rotor hub gear is in permanent mesh with the driven rotor hub gear allowing both rotors to rotate and pull air through the meshing lobes via the supercharger inlet port.

The pressured air exits the rotor housing and is forced through passages in the integral water intercooler which reduces the intake airs temperature and increases its density before entering the inlet manifold.



Bypass Valve
A vacuum actuated bypass valve is fitted within the inlet plenum to prevent the affects of compressor surge which is caused when the supercharger is creating boost but the butterfly valve in the throttle body is closed.

Vacuum within the supercharger plenum acts on the diaphragm and shaft within the externally mounted actuator capsule which is connected to the bypass valve. The vacuum within the plenum varies dependant on engine speed/throttle openings etc, moving the diaphragm shaft and bypass valve within the supercharger inlet housing accordingly.

A proportion of air that would have been pressurised by the rotors is diverted from the rotors and circulates around the inside of the supercharger casing ensuring only the boosted air required is drawn through the rotors and directed to the inlet manifold via the intercooler.

Under throttle opening conditions/hard acceleration the vacuum within the inlet housing decreases closing the bypass valve, allowing more air to be drawn in through the rotors.

Bypass actuator vacuum valve

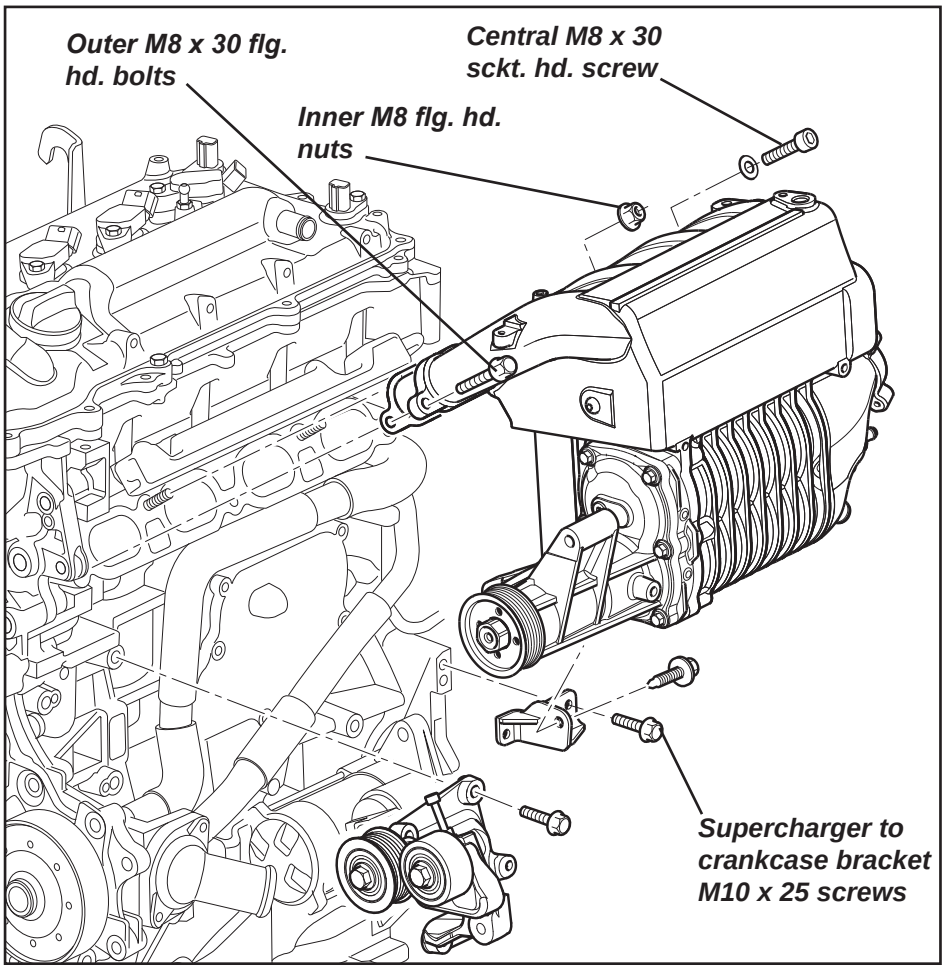
Testing
- Disconnect the vacuum tube at the inlet port located on the inlet plenum behind the throttle body assembly.
- Connect a suitable vacuum pump/tester to the end of the tube and apply vacuum until the actuator fully retracts opening the bypass valve within the supercharger.
- The valve should remain closed whilst the vacuum is applied.
- If the actuator fails to retract fully or slowly releases with vacuum applied, then the source of the leak must be identified and rectified.

Removal
- Remove supercharger assembly – refer to next page
- Disconnect vacuum tube from valve
- Remove M8 x 12 socket headed bolts retaining the valve to the supercharger body.
- With the vacuum valve now loose, unhook the valves shaft from the bypass spindle.
- Unhook the valves shaft from the bypass spindle and withdraw the assembly.

Refitment
- Is the reverse of removal but the bypass valve within the plenum must be set to the correct position.
- Hook the shaft of the vacuum valve onto the bypass spindle
- Apply Loctite 242 around the first 2 threads of the retaining bolts and refit the valve to the supercharger assembly, (torque 24Nm).
- Loosen the locknut and adjust the set screw on the bypass valve stop until the valve is in the fully closed position.
- Once in the fully closed position, turn the set screw ¼ of a turn anticlockwise and tighten the locknut.
- Refit the supercharger assembly.

TMAP Sensor
A Manifold Absolute Pressure (TMAP) sensor is positioned on top of the supercharger housing measuring the temperature and pressure of the boosted air before it enters the manifold. Data received from the TMAP sensor is used to alter the ignition timing as required to provide optimum engine performance.

Supercharger Removal



After performing the Fuel Pressure Relief Procedure as described in section EH.4, release the retaining clip securing the fuel tank pipe to the fuel rail hose pipe joint which is located on the coolant header tank bracket.

1. Disconnect the battery – see service notes section xx

2. Remove undertray – see service notes section AA.2 for further information.

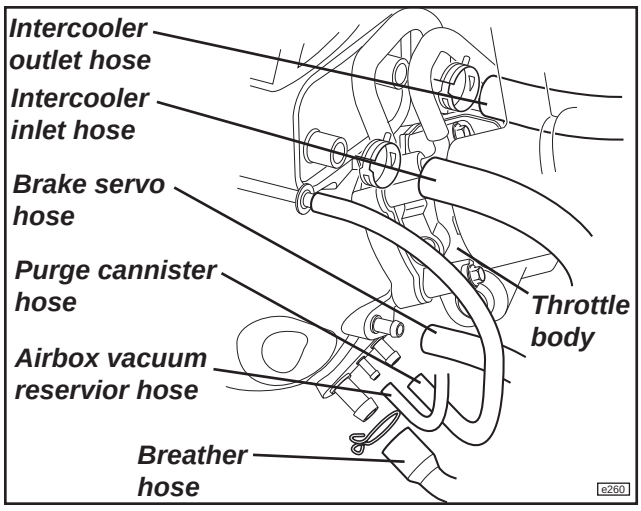
3. Raise vehicle – see service notes section AA.1. For further information

4. Disconnect the MAP sensor connector harness (located on the top of the manifold).

5. Disconnect intercooler hose at its connection to the electric circulation pump (attached to rear of chassis) and allow the coolant to drain in a suitable container.

6. Remove Air intake hose between the throttle body and air filter casing

7. From the intake side of the supercharger plenum disconnect:
   - Brake vacuum servo hose
   - Airbox vacuum reservoir hose
   - Purge valve hose (also unclip the hose from the side of the supercharger assembly)
   - Engine Breather hose



8. Disconnect the intercooler feed and return hoses from their connections at the supercharger.

9. Remove the 4 x M8 bolts (torque to 10 Nm) securing the throttle body to supercharger and pull the assembly away from the supercharger, ensuring to collect the throttle body to supercharger 'O' ring seal. (This will avoid unnecessarily disrupting of the engine coolant system by disconnecting the bypass hoses attached to the throttle body).

10. Release the 3 bolts (torque 20Nm) securing the fuel rail assembly to the engine, remove the fuel rail with the injectors and collect the 2 rail spacers and 4 injector vibration insulators (see Toyota CD disc T000T1530F for further information).

11. Remove auxiliary drive belt from supercharger pulley - see drive belt adjustment information on page 27 for further information.

12. Remove alternator terminal retention nut, (torque 10Nm) safely secure alternator wiring away from engine and disconnect the harness plug.

13. Release the bolt securing the bolt (torque 20Nm) securing the alternator adjusting bar to the engine and remove.

14. Remove the lower alternator mounting bolt securing it to the supercharger nose assembly and withdraw the alternator from the vehicle.

15. Remove the M8 x 1.25 x 75 screw and nyloc nut securing the supercharger nose pulley to the idler pulley bracket.

16. Remove the M10 x 25 screw securing the rear of the supercharger to crankcase bracket.

17. Loosen the supercharger manifold to cylinder head fixings in the order listed below:

    - The 2 outermost LH and RH M8 x 30mm flanged manifold bolts securing the supercharger to the cylinder head.

    - The 2 inner M8 flanged headed nuts.

    - The central M8 x 30 socket cap screw.

18. Once all the fixings are loose, remove 2 outer bolts and central screw before removing the inner nuts from the cylinder head studs.

19. Carefully pull the supercharger assembly away from the cylinder head until it clears the 2 retaining studs and withdraw the assembly and manifold gasket from the engine bay.

Refitment

Is the reversal of removal except:

- Fit a new inlet manifold gasket onto the engine manifold studs and then carefully fit the supercharger onto the studs

  Care Point: Ensure the vacuum bypass hose is not trapped and is routed around the rear supercharger bracket.

- Apply a small quantity of Permabond A130 to the manifold studs and refit the nuts hand tight only.

- Apply a small amount of Loctite to the central manifold screw and outer manifold bolts, again fitting hand tight only at this stage.

- Refit the M8 x 1.25 x 75 screw and nyloc nut securing the supercharger nose pulley to the idler pulley bracket

fitting hand tight only at this stage.

- Refit the M10 x 25 screw securing the rear of the supercharger to crankcase bracket, again fitting hand tight only at this stage.

- Once all the above fixings listed are in place check that there are no ancillary engine components fouling between the engine and the supercharger, ensure that support bracket pulleys are inline and that the faces of the supercharger manifold and cylinder head are mating correctly.

Torque tighten the fixings in the order listed below:

1. Supercharger nose pulley to the idler pulley bracket (tighten bolt 1st and then the nut and torque 20Nm).

   Manifold fixings in order:
   A. Central socket headed screw
   B. Inner flanged nuts
   C. Outer flanged headed bolts

   Note: all supercharger manifold to cylinder head fixings torqued to 20Nm.

2. Supercharger to crankcase bracket screw (torque 45Nm).

- Refit the remaining engine ancillary components in reverse order of removal.

  Note: Apply a small quantity of Permabond A130 sealant to the fuel rail spacer bolts (2) before re-installing.

- Top up coolant for the intercooler at its reservoir assembly,

Coolant top up procedure:
- Start and run the engine to activate intercooler pump which will bleed the intercooler coolant circuit.

- Release bleed screw located on the coolant return hose positioned at the join for the reservoir overflow connection.

- Run the engine, topping up the intercooler circuit with coolant until a steady flow of coolant runs out of the bleed port, refit bleed screw.

- Stop adding coolant once the reservoir level remains stable between ½ to ¾ full.

- Refit reservoir cap.

EH.9 - SUPERCHARGER MAINTENANCE

Except for the items listed below and the bypass vacuum valve, there are no other individual service parts available for the supercharger assemblies.

Front pulley removal/renewal (MP62 type only)
Front nose/pulley removal/renewal
Moly-gard coupler inspection/renewal

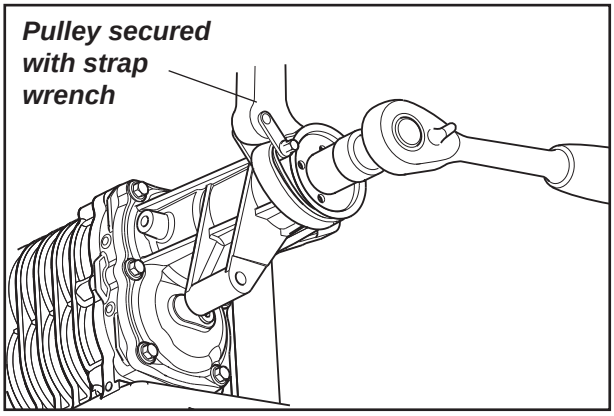
Pulley removal/renewal

To remove:

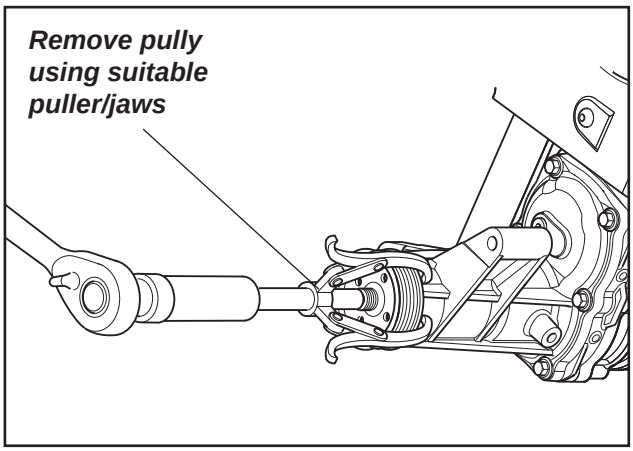
Note: The pulley can only be removed from the Exige S (2ZZ - 4 cylinder powertrain) fitted with the production Magnuson MP62 supercharger with separate inlet manifold.

1. Remove supercharger from engine assembly. Refer to service notes Exige Supercharged supplement (S/C).

2. Hold the pulley with a strap wrench and remove the 18mm flange nut from the input shaft.



3. Remove the pulley from the shaft by using a suitable multi-jawed extractor, placing the extracting force against the end of the shaft only.



To refit

- Align the pulley keyway with the woodruff key on the input shaft, ensuring that the side of the pulley with the greater offset/longer neck is facing to towards the supercharger body.

  Do not use a hammer or mallet to install or remove the pulley onto the shaft as this will damage the supercharger.

- With the pulley positioned on the shaft, keep the pulley from rotating by using a strap wrench. An assistant or a clamp to hold the strap wrench is helpful in this step. Use the shafts 18mm flanged lock nut to push the pulley into position on the shaft and retain it. Torque the nut securely to 61Nm.

Supercharger nose/pulley assembly removal/refitment

Exige S MP62, Elise SC MP45 & Elise S R900 supercharger assemblies

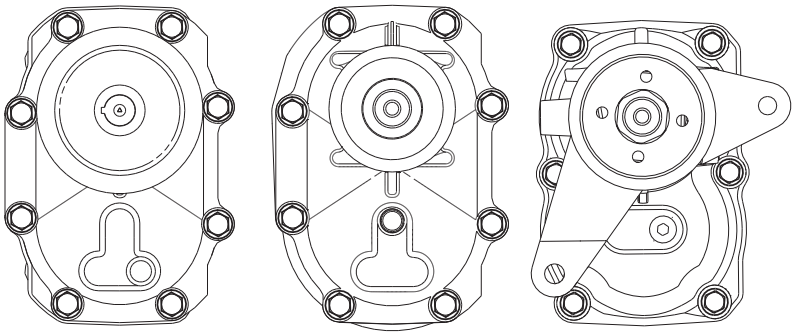
To remove:

1. Remove supercharger from engine assembly. For Elise SC and S refer to previous pages, for Exige S fitted with MP62 supercharger refer to service notes supplement (S/C).

2. Remove the 8 bolts (MP62 supercharger) 6 bolts (MP45 & R900 superchargers) securing the pulley nose to supercharger body.

Nose/pulley cover bolt configuration

Exige S MP62 ***Elise SC MP45*** ***Elise S R900***



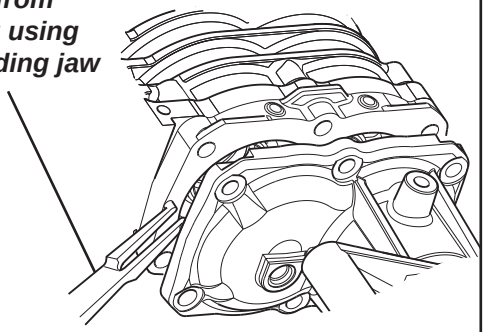
3. Even with the bolts removed, the pulley/nose may not separate from the supercharger bearing plate due to the two alignment dowels and the gasket sealant. To separate the nose from the bearing plate use a pair of expanding jaw pliers between the two flanges shown in the illustration on the base of the supercharger.

   Do not attempt to separate these two components by prying between the two mating faces, as this will damage the faces which may cause oil leaks, potentially resulting in further supercharger damage.

4. On the top of the supercharger are two more locations at the corners of the nose, where the expanding pliers can be used to separate the nose from the bearing plate.

   Note it is recommended to place some shop towelling under the supercharger to catch the supercharger oil during this procedure.

Separating pulley nose cover from casing using expanding jaw pliers

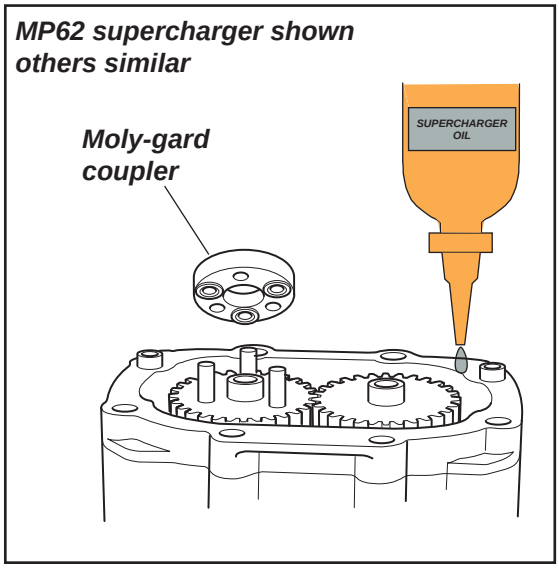


5. Clean the two mating faces of any remaining gasket sealant before starting re-assembly. Note the alignment dowels shown in this photo.

6. Remove the Nyla-Guard coupler from the drive gear pins and inspect it for wear or damage. Replace the Nyla-Guard as needed.

7. Fill the gear case cavity in the bearing plate with 120 millilitres of Magnuson Products Supercharger oil using the pre-measured bottle supplied in the service kit (as listed in the Elise/Exige Service Parts Lists.

MP62 supercharger shown others similar



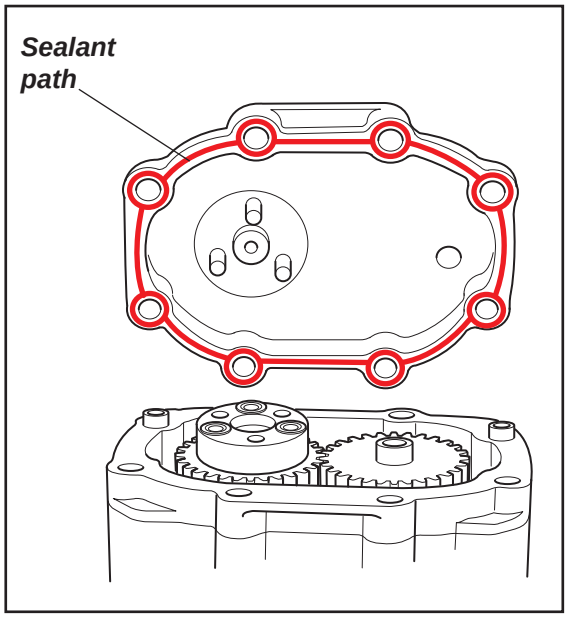
8. Apply the Loctite Gasket Sealant to the sealing face of the nose pulley assembly as shown in red.

9. Install the Nyla-Guard coupler on to the drive gear pins. Align the drive pins of the input shaft with the remaining holes in the coupler.

10. Place the nose assembly onto the supercharger.

    Note that the nose will not immediately mate with the bearing plate face. Carefully align the dowels in the bearing plate with the corresponding holes in the nose assembly. The case bolts will pull the two surfaces together.

    If you are re-using the original case bolts, you will need to clean the threads and re-apply Loctite 242 Threadlocker to them. New case bolts will have the 242 already applied.

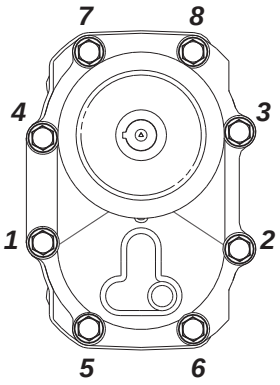


11. Install the eight case blots and tighten them evenly in the pattern shown around the nose assembly.

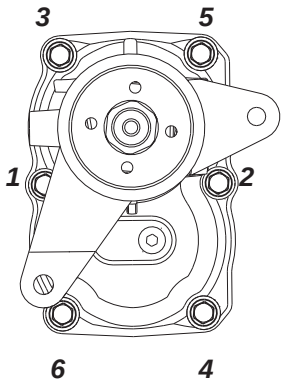
12. Torque the eight supercharger case bolts to 27Nm. in the pattern shown. Install the oil service plug, tighten it securely.

Nose/pulley cover bolt tightening sequence

Exige S MP62
Elise SC MP45



Elise S R900

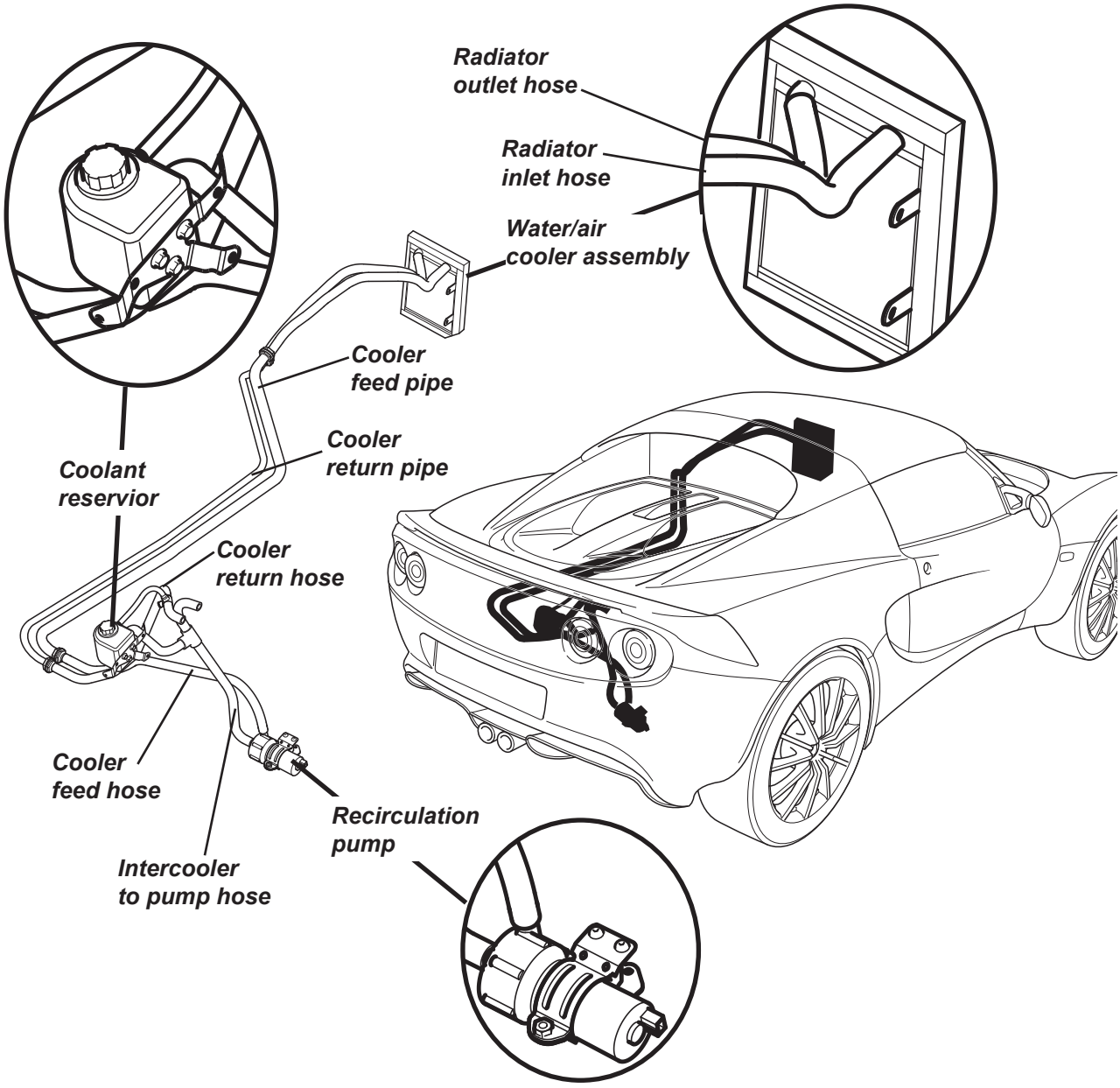


EH.10 - CHARGE COOLER; 2ZR-FE

Charge Cooler Operating Principles
To regulate the coolant temperature, charge cooled coolant is circulated (via an electrically operated pump) to a single front mounted coolant/air cooler radiator which is positioned to the left hand side of the engine cooling radiator ahead of the left hand front road wheel.

Coolant Reservoir
The charge cooler system utilises its own dedicated sealed coolant circuit with a coolant reservoir mounted on the left hand side of the engines cylinder head allowing added coolant to enter the circuit via the intercooler to charge pump hose connected to the base of the reservoir casing.

Charge Cooler Radiator
The charge cooler radiator is positioned within an aperture in LH radiator housing so that it may receive cooling air directed from the LH front intake grille. The cooler is fixed to the LH side of the crash structure using an 'L' shaped bracket. Mounting bracket screws pass through the bracket, crash structure and a nutplate positioned on the inner surface of the crash structure additional support.



Coolant Circuit

A coolant hose connected between the integral intercooler and pump draws charged coolant through the pump to the front mounted charge cooler radiator via a cooler feed hose which is connected to feed pipe running through the LH sill.

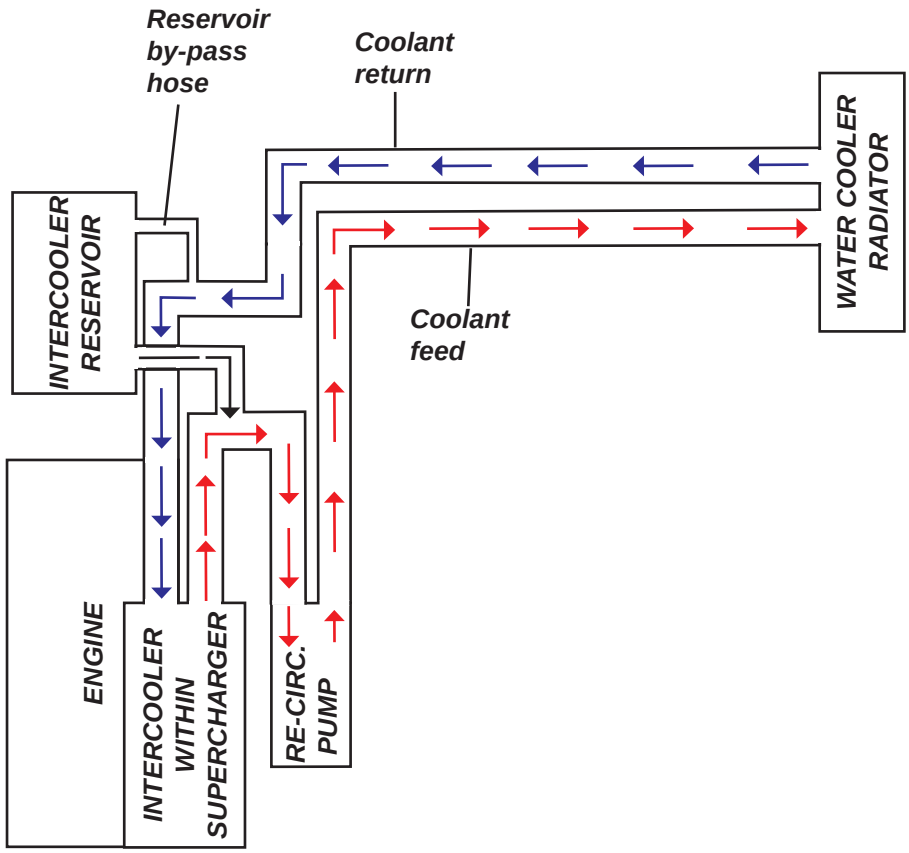
The sill pipe terminates at the front of the LH front body side sill where it is connected to a front feed hose. The feed hose is connected the inboard radiator inlet, coolant circulates through the radiator before exiting through the outboard radiator outlet.

The coolant return hose connected to the radiator outlet allows coolant to return to the intercooler via a return pipe also position in the LH sill and rear return hose connecting the return pipe to the integral intercooler.

The rear return hose also incorporates an air bleed screw as well as an overflow/expansion pipe connected to the top of the coolant reservoir casing.

Charge Cooler Circuit

Charged coolant →
Cooled coolant →



Charge Cooler Pump
Charge cooler system utilises a 12V/60W constant flow pump which can circulate coolant at a rate of 20 litres per minute. The pump is mounted to centrally to the chassis rear crossmember.

The pump is powered via the fuel pump relay and is activated with the ignition on/engine running. The pump is sealed and does not require any routine servicing or maintenance.

Removal

1. Remove coolant reservoir cap.

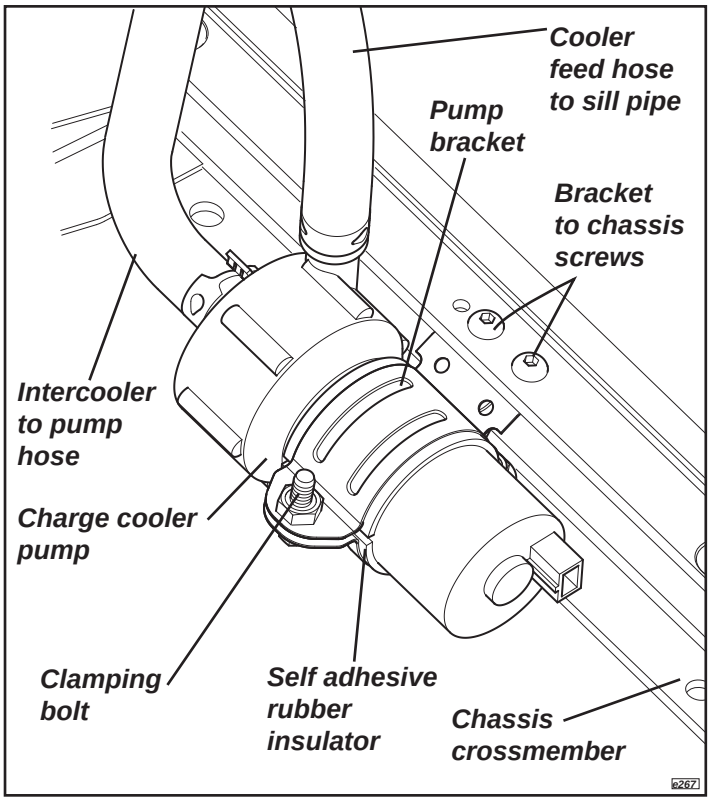
2. Disconnect wiring harness connector at pump.

3. Place a suitable container under the vehicle,

4. Using suitable grips compress and release the spring clamps securing the intercooler to pump and radiator feed hoses, remove the hoses from the pump and drain coolant into the container.

5. Release the M8 x 20 (3) socket button headed screws securing the pump bracket to the chassis rail.

6. The pump/bracket may now be removed from the chassis rail.



Refitment/renewal
Is the reversal of removal except:
- If renewing pump, release M8 x 20 clamping bolt securing the pump to the bracket.
- Ensure rubber isolator transferred to new pump.
- Slide bracket over new pump (but do not tighten at this stage).
- Fit pump/bracket assembly to chassis ensuring the pump orientation is correct (radiator feed hose outlet should be approximately vertical but allow clearance between outlet and chassis rail.
- Tighten chassis to bracket socket headed screws to 15Nm.
- Tighten bracket clamping bolt to 15Nm.
- Refit the intercooler to pump and radiator feed hoses onto the pump compress spring clips and slide them back into position.
- Reconnect wiring harness to pump.
- Fill coolant reservoir with coolant, - see capacities in service notes section TDQ for specification and mixture ratio.
- Start and run the engine.
- Periodically open bleed screw located on intercooler return hose until all air is expelled, then close screw.
- Top up the reservoir until it is approximately ½ to ¾ full, refit the cap, and turn clockwise until secure.