REPAIR MANUAL

MIGHTY MUSCULAR
SCORPIO
Nothing else will do

SCORPIO REFRESH M-HAWK
SUV & SC/DC

Mahindra



MAIN MENU

INDEX

ALL INFORMATION CONTAINED IN THIS MANUAL IS MOST UP-TO-DATE AT THE TIME OF PUBLICATION. HOWEVER, SPECIFICATIONS AND PROCEDURES ARE SUBJECT TO CHANGE WITHOUT NOTICE. THIS MANUAL IS STRICTLY MEANT FOR RESTRICTED INTERNAL CIRCULATION WITHIN M&M AUTHORIZED DEALER SERVICE CENTERS.

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M Hawk 2.2 L

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Description

The 2.2-liter Turbocharged and intercooled common rail direct injected diesel engine with a bore 85 and stroke of 96 mm develop 88 KW(120 HP) at 4000 RPM and a torque of 290 Nm at 1800 RPM.

A variable geometry turbocharger controls the boost to 2.2 bars. The compressed air is cooled by the charged intercooler which is mounted upstream of the turbocharger. The cooled air enters the inlet manifold's plenum and it enters the Aluminium cylinder head through the inlet valves having an angle.

The piston features re-entrant type combustion chamber and having ferrous ring insert in the Top ring groove. A 3-ring pack is used. The top ring is asymmetrical barrel face and with CKS coating and keystone shape. The 2ndring is taper faced. The 3rd is conformable Oil Ring.

The forged connecting rod is connected to induction-hardened crankshaft. The small end of the connecting rod is trapezoidal shaped to reduce the mass as well as to ensure higher loading. The crankshaft is induction hardened with the filets hardened & ground. The flywheel has a shrunk fit ring gear and also a ball bearing to act as pilot for the gearbox input shaft. The front end is having a rubber molded dampener pulley

The high pressure pump & camshaft are chain driven. There are two overhead camshafts (Inlet and exhaust). The valves are actuated through HFF & RLA (hydraulic tappets). There are four valves per cylinder. This ensures that the charge fill as well as the purging is optimum.

Trouble Shooting

Refer to the Service diagnosis chart. Additional tests & diagnostic procedures may be necessary for specific engine complaints that cannot be isolated using only the diagnostic chart.

Information concerning the additional checks is provided within the following diagnostic.

Cylinder compression pressure Test

The results of the cylinder compression test can be utilized to diagnose several engine malfunctions.

Before carrying out the compression test ensures that the battery is in good working condition. Otherwise the indicated pressures may not be valid for diagnostic purpose.

- Remove all the injectors.
- Fit the dummy injector (MST Tool) and connect it with the compression gauge.
- Disconnect the engine RPM sensor or phase sensor connector so that the engine does not start.
- Crank the engine.
- Note the compression value should be 30 bars.
- Repeat the procedure for the other cylinder.
- Refer to the Specification for the value.

Engine cylinder Head Gasket Failure Diagnosis

A leaking engine cylinder head gasket usually results in loss of power, loss of coolant and engine misfiring, overheating and poor fuel economy.

An engine cylinder head gasket leak can be:
A. Between adjacent cylinders
Or
B. Between a cylinder and adjacent water jacket.

Cylinder head gasket failure between cylinders is indicated by Loss of power and /or engine misfiring.

Cylinder head gasket leaking between a cylinder and coolant passage results in coolant foaming or overheating and loss of coolant indicate leakage in engine water jackets.

Cylinder to Cylinder Leakage Test

Check the cylinder compression pressure as already explained. Leakage between cylinders will be result in drop of compression pressure by nearly 50 to 70% in the affected cylinders.

Cylinder to Water jacket Leakage Test

- Remove the radiator cap.
- Warm up the engine and allow it to warm up until the engine thermostat opens.
- If large combustion /combustion pressure leak exist, bubbles will be visible in coolant.
- If bubbles are not visible, install a radiator pressure tester and pressurize the cooling circuit. If a cylinder is leaking combustion pressure into the water jackets then the tester's needle will pulsate with every combustion stroke of the cylinder.

Symptom	Causes	Remedial action
Engine will not start & emit black smoke	1. Air intake obstructed	✓ Replace the element. ✓ Check for free operation of Turbocharger.
	2. Defective injectors	✓ Replace
	3. Lack of compression.	✓ Check compression pressure.- if low check for valve seat ,rings & liner wear
	4. Cylinder head gasket failure	✓ Replace the cylinder head gasket.
	5. Engine timing- Valve	✓ Check timing chain.
	6. CR system	✓ Refer diagnostic manual.
Noisy engine & black smoke.	1. Faulty injectors.	✓ Replace injectors
	2. Loose main bearings	✓ Tighten the main bearings.
	3. Broken parts	✓ Inspect and replace the broken parts.
	4. EGR valve stuck open mechanically	✓ Check the EGR valve & replace if required
Engine does not give full power.	1. Air intake restricted.	✓ Replace air cleaner element if required.
	2. Clogged fuel filter.	✓ Replace filter.
	3. Defective injectors.	✓ Replace
	4. Air leaks in pressure line after turbocharger(Turbo to intercooler, intercooler & intercooler to intake manifold)	✓ Plug the leaks, replace hose or clip if required.
	5. Fuel return pipe to tank blocked.	✓ Locate the kink/block in return pipe and rectify.
	6. Valve leak	✓ Check the compression, re-lap if required.
	7. Turbocharger damaged.	✓ Get the Turbocharger repaired at authorized TEL dealer.
	8. Gas leaks between exhaust manifold & cylinder head.	✓ Replace gaskets.
	9. Leaking exhaust system.	✓ Tighten the TC mounting bolts. Replace gasket if required.

	10. Exhaust gas leak between turbo & manifold.	✓ Correct the leak
	11. Gas leak between EGR pipe joints	✓ Change the gasket or the hose.
	12. EGR pipe leak.	✓ Replace the pipe.
	13. Fuels supply line kink creating restriction.	✓ Remove the restriction.
	14. Compression leak.	✓ Check compression.
	15. Jammed piston rings	✓ Replace piston rings.
	16. Viscous fan continuously engaged.	✓ Check the VFD as outlined in cooling. Replace if required.
	17. Vacuum leak to the VGT actuator causing the delayed VGT operation	✓ Check the vacuum leak and rectify. Please note that the VGT operation is sensitive to vacuum leak.
	18. Check CR system	✓ Refer the diagnostic manual
Noisy engine & high smoke (White/ Grey)	Cylinder head gasket defective. Worn out or damaged valve seats. Leaking injector holder	✓ Replace the cylinder head gasket. ✓ Lap the valve seats or regrind. ✓ Tighten the injector holder.
Black smoke.	1. Air intake restricted.	✓ Check for hoses, replace air cleaner element.
	2. Defective injectors	✓ Check injectors.
	3. Air leaks.	✓ Check for leaks between Turbocharger to intercooler, intercooler & intercooler to inlet manifold.
	4. EGR valve stuck open	✓ Check the EGR valve
	5. Restricted exhaust system.	✓ Remove restriction or replace parts.

	6. Gas leak between exhaust manifold & cylinder head. 7. Worn out rings, liners & valves. 8. Improper vacuum connection for EGR valve	✓ Replace manifold gasket or parts. ✓ Overhaul engine. ✓ Check & correct
Excessive oil consumption	1. Cracked vacuum line hoses. 2. Clogged air filter element. 3. Restriction in air intake to compressor duct. 4. Restrictions in turbocharger oil drain line. 5. Restriction in crankcase breather. 6. Damaged oil separator 7. Turbocharger damaged. 8. Worn out rings, liners, and valves. 9. External oil leaks 10. Leakages through inlet manifold mounting face allowing dust entry. 11. Bend/kink in any of the oil return pipe's/vacuum hoses. 12. Defective vacuum pump.	✓ Check the vacuum line from the alternator to the EGR valve - check for leaks, crack. And vacuum line to the VGT actuator. Replace cracked hoses. ✓ Replace element. ✓ Locate & remove restriction. ✓ Remove the restriction in the drainpipe. ✓ Check the crankcase ventilation & rectify. ✓ Replace the oil separator ✓ Change oil, filter, service the Turbocharger & use recommended oils & drain intervals. Follow the recommended procedure while shutting down. ✓ Repair Turbocharger. ✓ Overhaul engine. ✓ Stop the external oil leakages. ✓ Change the vacuum hoses. ✓ Change the manifold gasket or replace the manifold.

		✓ Remove the bend or kinks. ✓ Replace the vacuum pump.
Blue smoke.	1. Clogged air filter element. 2. Restriction in air intake to compressor duct. 3. Air leak between the Turbocharger to intake manifold. 4. Excess oil. 5. Wear in valve seal. 6. Wear in piston rings & liner. 7. TC oil seal leaks	✓ Replace element. ✓ Locate & remove restriction. ✓ Locate the leaks, change hose or clamp if required. ✓ Correct the oil level. ✓ Check the valve stem seals, replace if required. ✓ Check the compression pressure, replace rings & liners. ✓ Check the Turbocharger if defective get it attended.
White smoke.	1. Improper timing 2. Defective cylinder head gasket. 3. Restriction in fuel supply	✓ Check sprockets & chain for wear. Rectify ✓ Replace the cylinder head gasket. ✓ Remove the restrictions.
Starter will not work or only cranks slightly	1. Electrical complaints. 2. Check water level. 3. Hydrostatic lock	✓ Refer the electrical section. ✓ If water level reduced drastically then check for hydrostatic lock. ✓ Remove the water in the cylinder and find the cause for water entry.

Starter will not crank the engine.	1. Weak battery. 2. Corroded or loose battery connection 3. Faulty starter. 4. Improper earthing.	✓ Check the battery specific gravity. ✓ Clean & tighten battery connections. ✓ Repair starter. ✓ Rectify earthing.
Noisy valves	1. Thin or diluted oil. 2. Low oil pressure. 3. Worn HLA 4. Worn valve guides. 5. Excessive run out of valves seats 6. Oil thickening 7. Aeration in oil	✓ Change oil. ✓ Check the oil level. ✓ Replace the HLA. ✓ Replace the valve guides. ✓ Grind valve seats and valves. ✓ Replace oil & find the reasons of thickening, rectify. ✓ Follow the de-aeration procedure.
Oil pressure drop	1. Low oil level. 2. Defective oil pressure sensor. 3. Clogged oil filter. 4. Clogged oil cooler 5. Clogged oil strainer. 6. Pressure relief valve in oil filter bracket stuck. 7. Oil leaks- internal 8. Worn parts in oil pump. 9. Excessive bearing clearances 10. Thin or diluted oil. 11. Excessive bearing clearance.	✓ Check engine oil level. ✓ Install new sensor. ✓ Replace filter. ✓ Clean the oil cooler. ✓ Clean the strainer. ✓ Clean the valve & bore and assemble. ✓ Check the gasket between the block & front cover or any of the MOG plugs ✓ Replace the worn parts or pump. ✓ Check bearing clearances. ✓ Change oil to correct viscosity. ✓ Replace the bearing ✓ Remove the valve, inspect, clean & refit.

	12. Oil pump relief valve stuck. 13. Oil pump suction tube loose, bent or cracked. 14. Sealant blocking the suction 15. Oil pump cover warped or cracked	✓ Remove sump, inspect the parts & replace. ✓ Check for sealant at the face of the suction pipe. ✓ Install new pump.
Oil leaks	1. Worn oil seals 2. Misaligned or deteriorated gaskets. 3. Loose fastener, broken or porous metal parts	✓ Replace seals. ✓ Replace gasket. ✓ Tighten fastener ✓ Repair or replace.

Care of the System

The performance of the engine is dependent on ensuring that the following maintenance is carried out as per the schedule without fail.

Accessory Belt: The belt system employs an auto tensioner. Hence no tension adjustment is required. The belt for the HVAC is having a manual tensioner. This needs to be checked at every 10,000 KMs & readjusted if required. The manual tensioner bearing needs to be replaced at every 80,000 Km

Air cleaner: The element should be replaced at every 40,000 KMs or when red indicator band shows. For the detailed procedure, **refer to the Air Intake System.**

Oil: The oil should conform to **CH4** grade and with a viscosity Index of SAE 15W40. It should be kept in mind that in the turbocharger engine the oil has to have do an additional load of lubricating and cooling the Turbocharger shaft If any oil of lower specification is used it can break down under the high thermal load at the turbine end of the shaft especially during the hot shutdown.
This oil grade also ensures that the oil consumption is within the desire limits. **Use Maximile Supreme** Grade of oils. The Oil change intervals are first at 5000 KMs. & then subsequently every 15000 KMs.

Cooling system: Ensure that no leakages are present. For details of the coolant and ratio refer the **Cooling System.**

Turbocharger: The engine is having a Variable Geometry Turbocharger. This turbocharger helps in maintaining a good power curve at low speeds also.

EGR: The following additional check points have to follow during scheduled maintenance.

- Check for any exhaust gas leakage through sealing faces, EGR pipe. Formation of any black soot indicates leakage.
- Check the vacuum hoses for any leaks, cracks.
- Retighten all nuts and bolts as per the recommend torque.

As this engine is equipped with **HLA with RFF** (Hydraulic tappets)**; Tappet setting** is not required.

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In Car Repairs

The in car repairs which can be carried out are:

Accessory belt removal & Refitment

VFD Assembly with Fan Blade removal

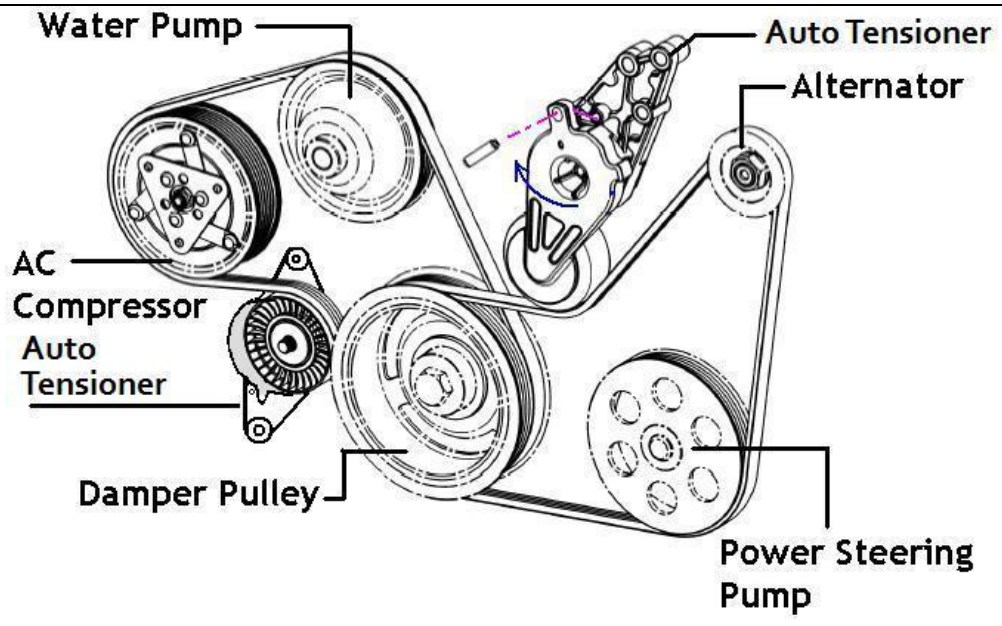
High Pressure pump Removal

Oil filter changing

Turbocharger removal & Refitment

Cylinder head gasket Replacement

Accessory belt Remove & Refit –

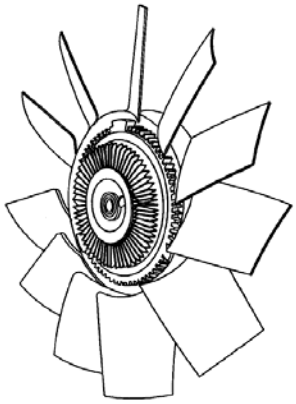
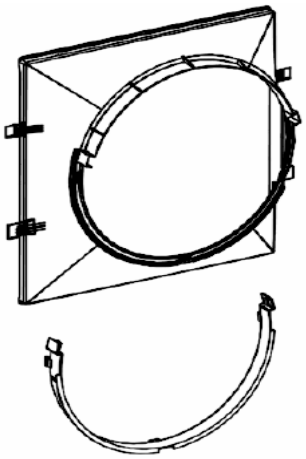


Using the special tool, rotate the auto tensioner in the direction shown in the figure. Lock the auto tensioner in that position using a pin.
Remove the auto tensioner mounting bolts & remove the belt tensioner.

Note – Check the auto tensioner free arm position. Ensure that end of travel is not reached.

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Fan Blade & Viscous Fan Drive Removal & Assembly –

	Do not remove the accessory belt before removing the nut.
	Loosen the fan nut. **Note that the threads are anticlockwise threads. Hence to loosen then the direction of rotation has to be clockwise when viewed from front.** **Do not tamper or service the center portion of the fan.**
	Remove the radiator shroud & remove the fan.
The fan blade assembly and the VFD assembly can be removed together.	

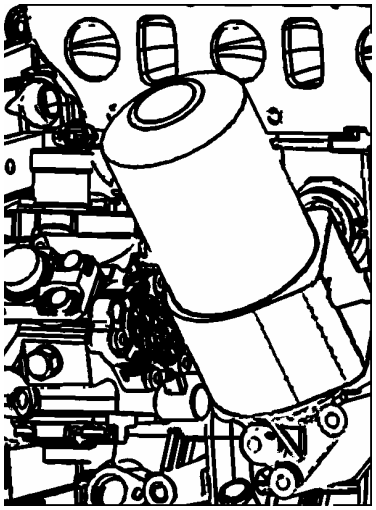
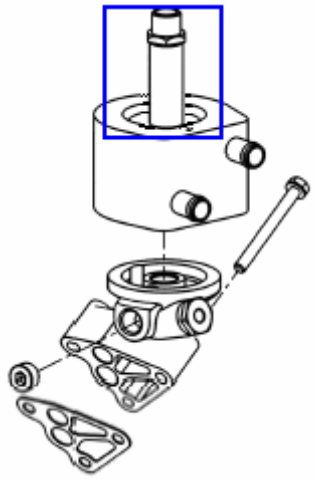
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High Pressure Pump Removal & Refitment –

To replace the high pressure pump; it is advisable to remove the engine out from vehicle.

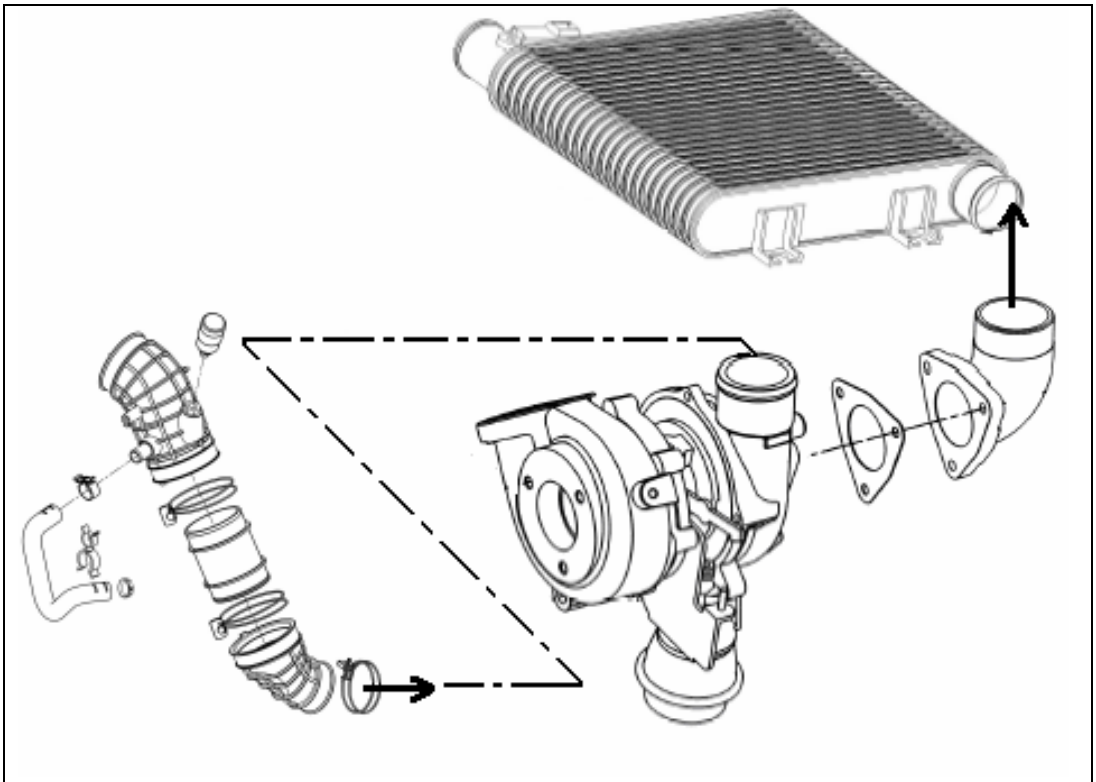
Follow the steps explained in the chapter **Removal of the Engine.**

Oil filter removal & refitting

	Remove the oil filter using the Wrench – Special tool.
	After removal, ensure that the central stud is fully tight. It can work out loose while removal of the filter. If it has worked loose then tighten it to torque of 25-30 Nm (18-22 lb-ft)
While fitting the new oil filter. Apply oil on the "O" rings. Tighten by hand only.	

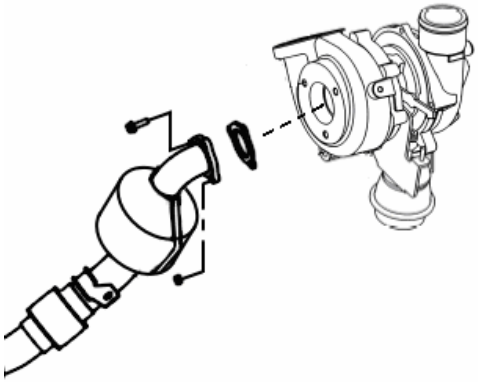
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Turbocharger removal & Refitment



Remove the air intake hose to turbocharger & the outlet hose from turbo charger to Intercooler.

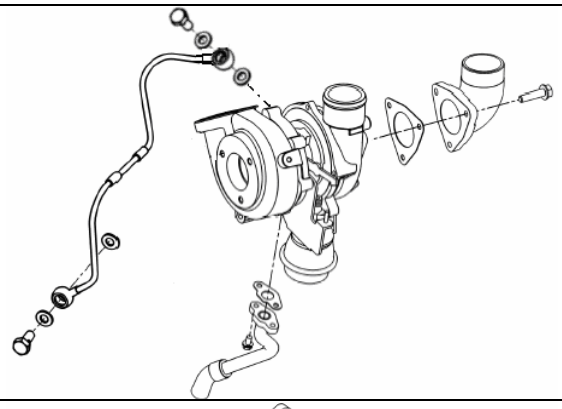
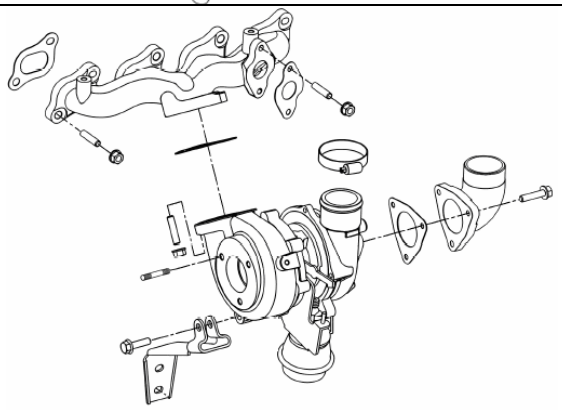
Please cover the opening of the turbocharger to avoid accidentally dropping any foreign object.
Do not apply oil to the hoses while fitment.



Remove the exhaust pipe from the turbocharger.

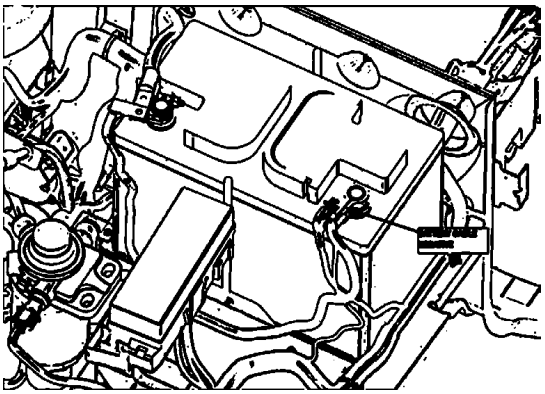
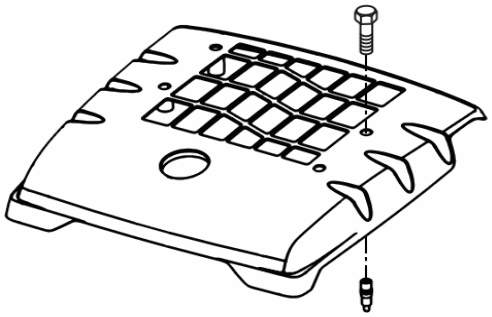
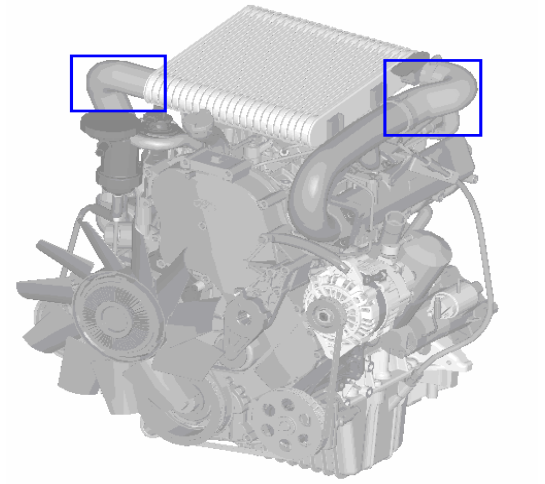
Note - It is recommended to apply rust cleaning spray (WD 40) in the nuts before attempting to remove otherwise, the stud is tending to break.

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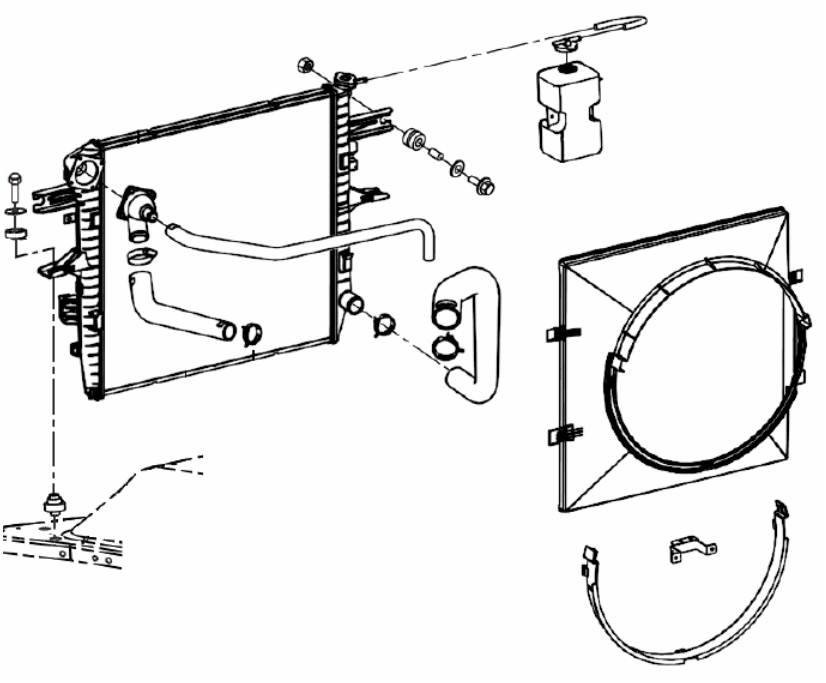
	Remove the oil feed pipe and the oil return pipe to turbo.
	Loosen & remove the turbo charger support bracket. Remove the turbocharger mounting fasteners from exhaust manifold.

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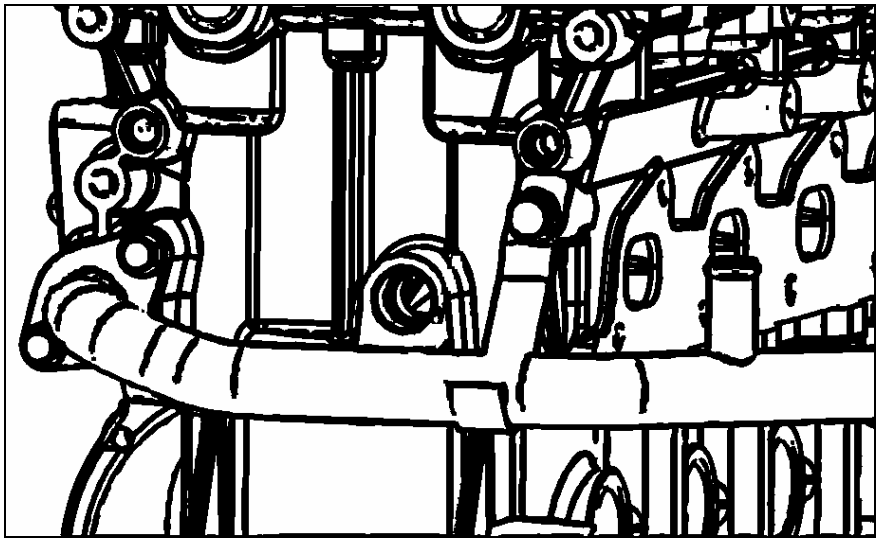
Cylinder Head Gasket Removal & Refitment

	Disconnect the battery cables & remove the battery.
	Remove the NVH cover.
	Remove the Intercooler hoses & the intercooler.

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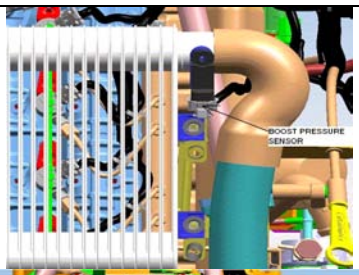


Loosen & Remove the radiator drain cock. Collect the coolant -if the coolant is clean; then it can be reused.
Remove the hose fastened on the Front cover.

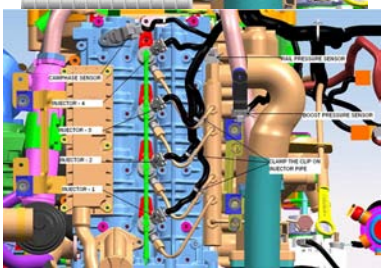


Loosen & remove the water collector pipe from the head.

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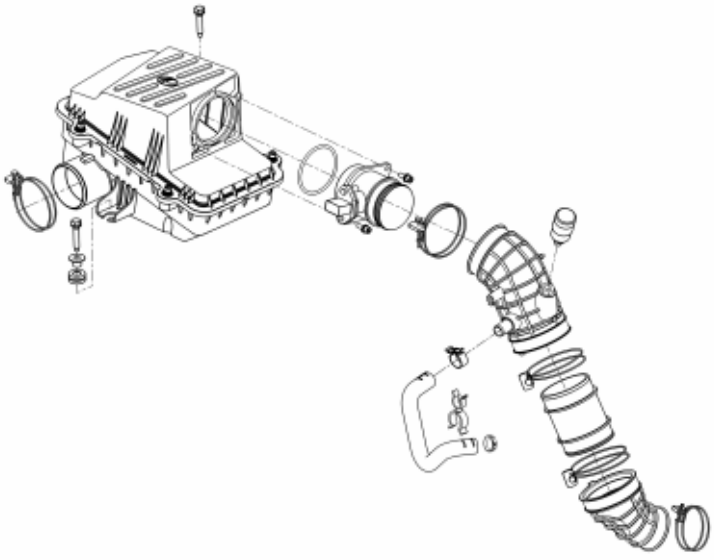






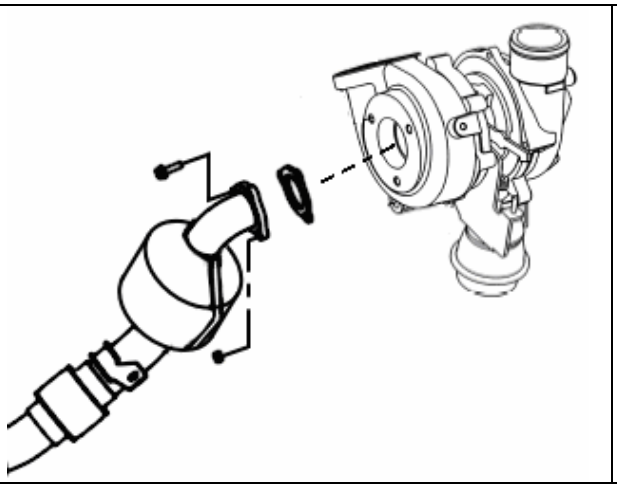
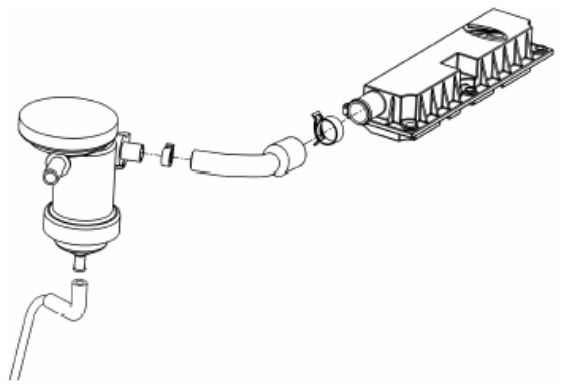
Remove the electrical connections of:

- Sensors (HFM, Cam Phase Sensor, Boost Pressure Sensor)
- Water temperature sensor & Oil Pressure Switch
- Connection to Injectors, Modulator etc.
- Alternator connections

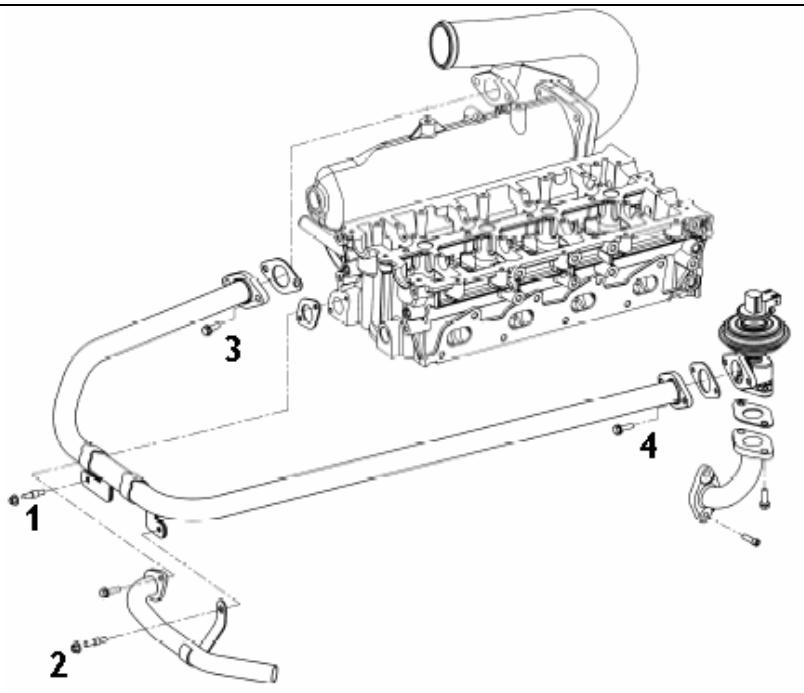


Remove the air cleaner assembly.
Remove the hose connection from the Turbocharger end TC to intercooler.

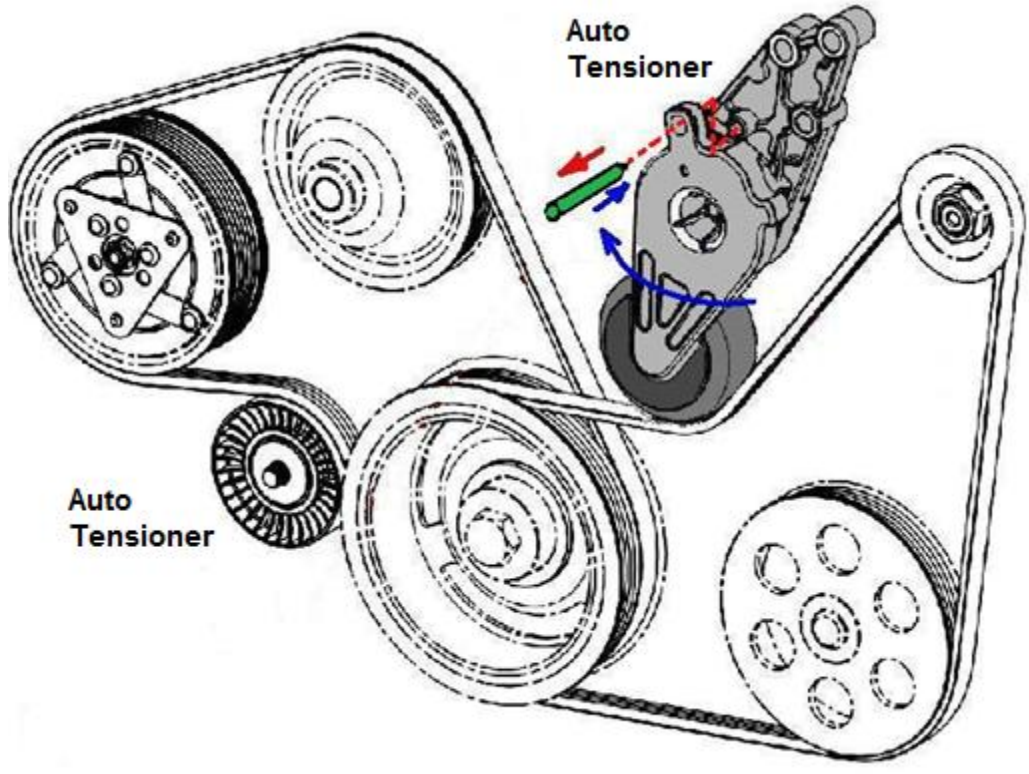
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	Remove the exhaust pipe at the Turbocharger outlet elbow.
Remove the vacuum hose from the vacuum pump in alternator to booster.	
	Remove both the oil separators. (Labyrinth & Cyclone)

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Remove the EGR pipe mounting clips & in the sequence as shown in figure.



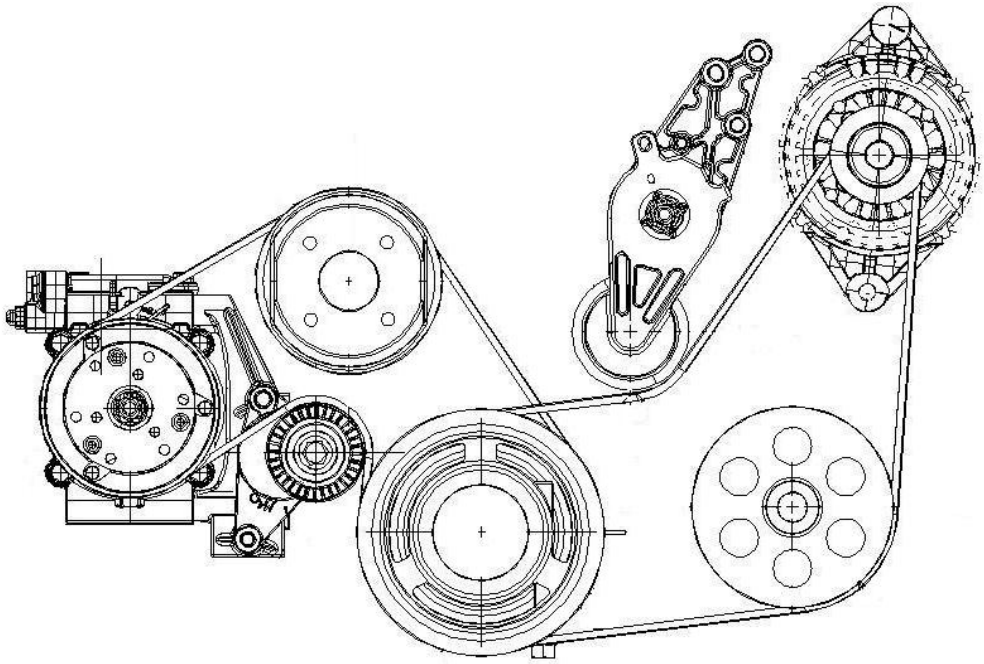
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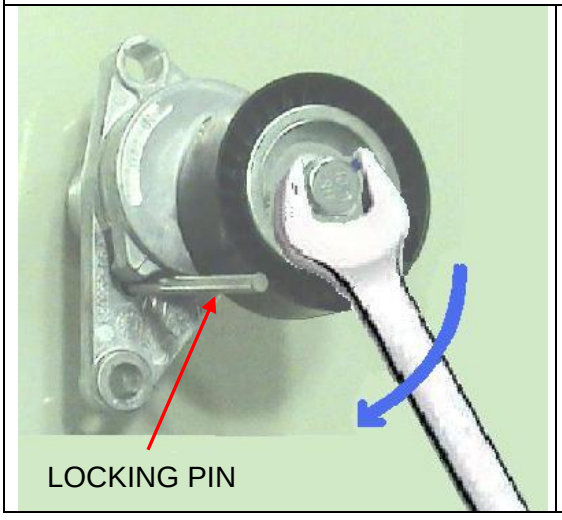
Using the special tool, rotate the auto tensioner in the direction shown in the figure.

Lock the auto tensioner in that position using a locking pin. Remove the drive belt.

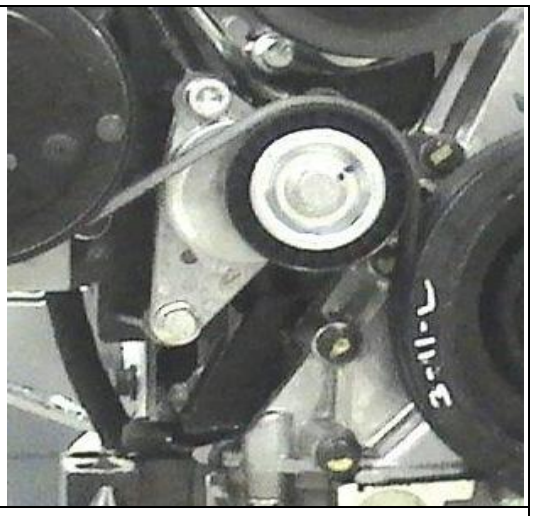
Remove the locking pin and release the auto tensioner.

Remove the auto tensioner mounting bolts. Auto tensioner can take out.





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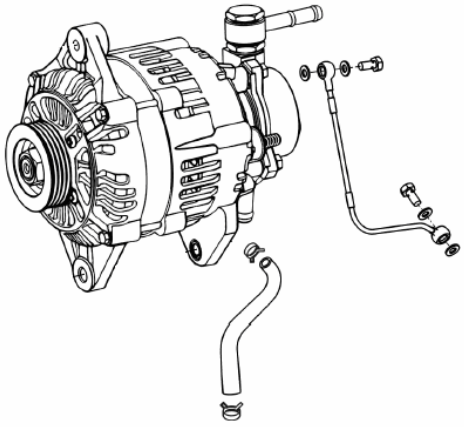


Using the spanner tool, rotate the auto tensioner in the direction shown in the figure.

Lock the auto tensioner in that position using a pin. Remove the drive belt.

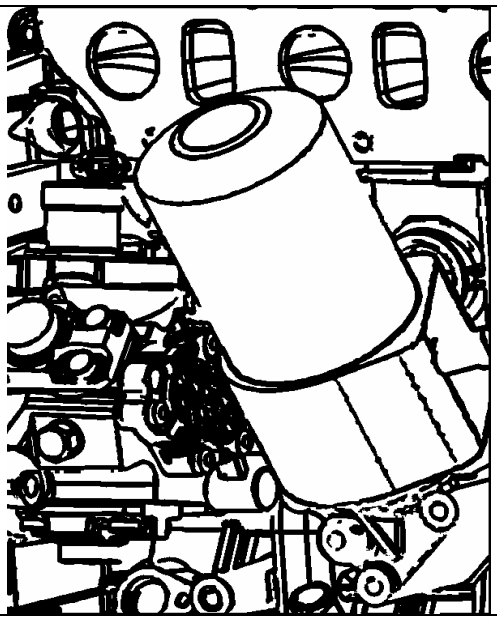
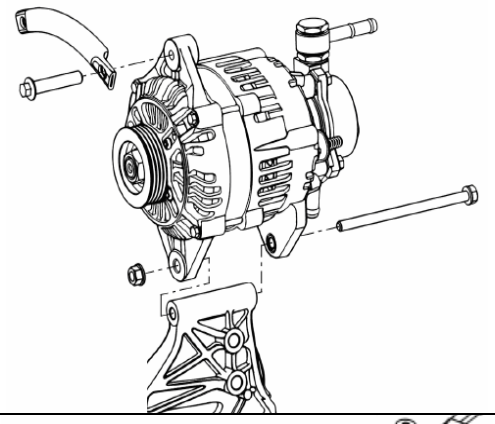
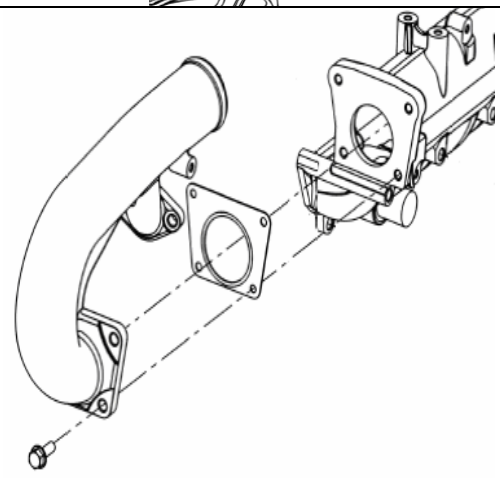
Remove the locking pin and release the auto tensioner.

Remove the auto tensioner mounting bolts & remove the auto tensioner.

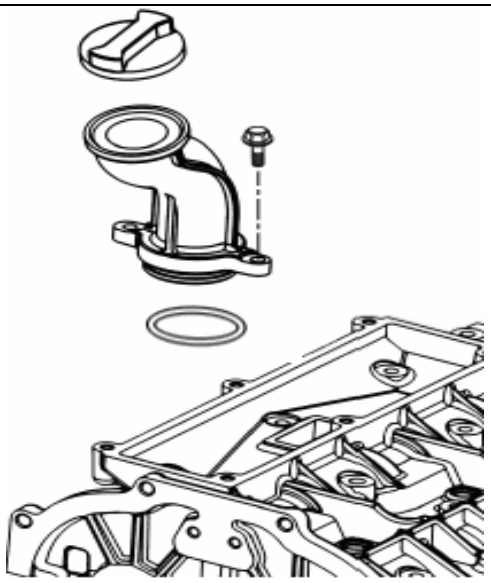
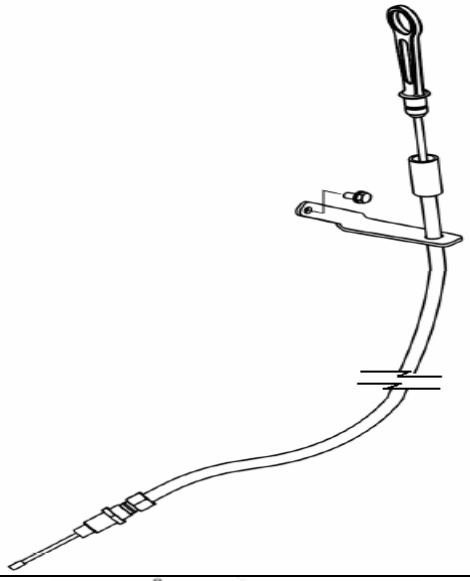
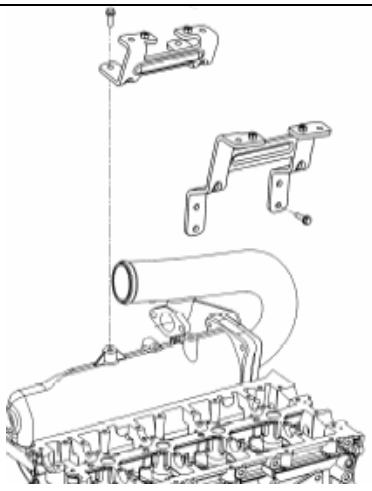


Remove the lubrication oil lines connected to the alternator vacuum pump from vacuum pump end.

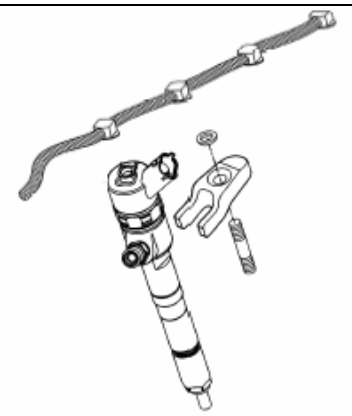
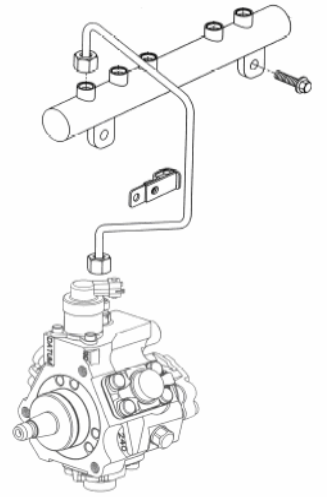
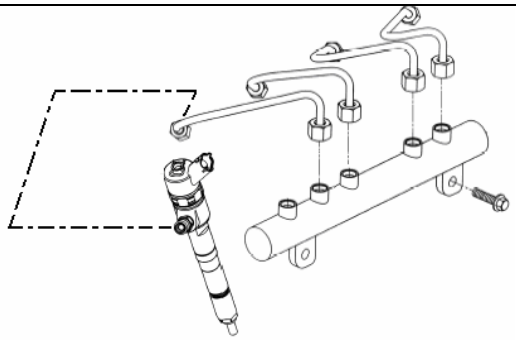
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	Loosen & remove the oil filter.
	Loosen & Remove the alternator mounting bolt & the alternator brace. Remove the alternator.
	Loosen & remove Air Intake pipe.

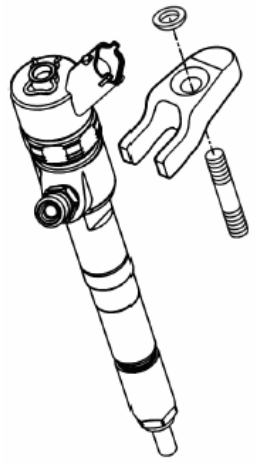
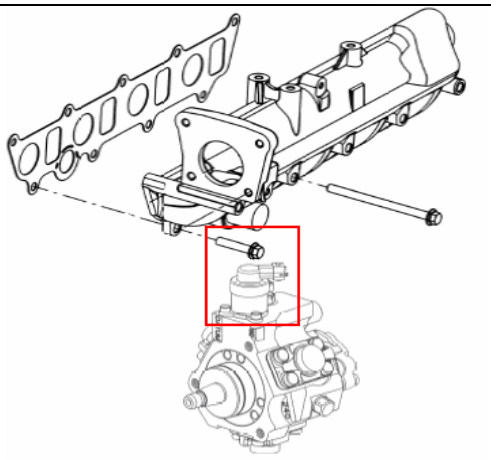
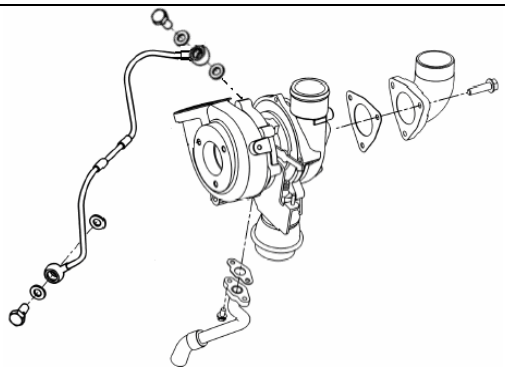
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	Loosen & remove the oil filler neck.
	Remove the dip stick & remove the dip stick clamp bolt & the dip stick guide.
	Loosen & remove the Intercooler bracket mounting bolts & remove both the intercooler brackets.

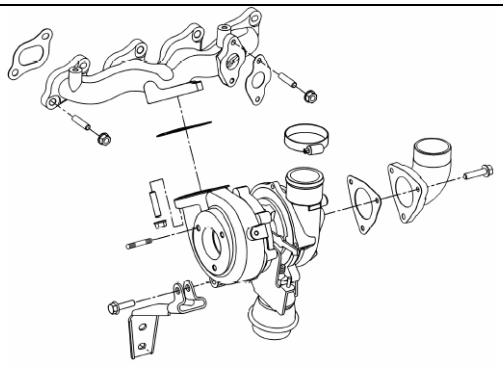
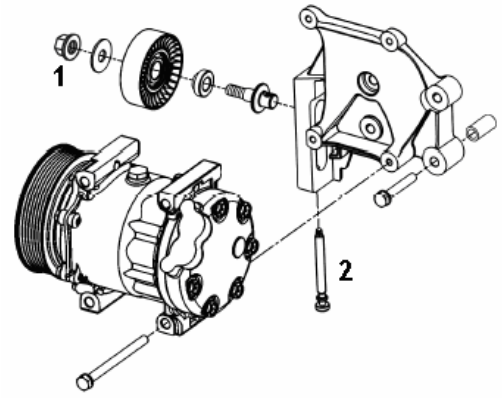
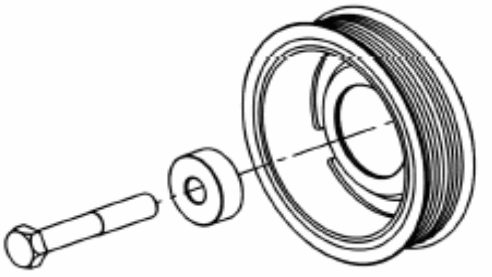
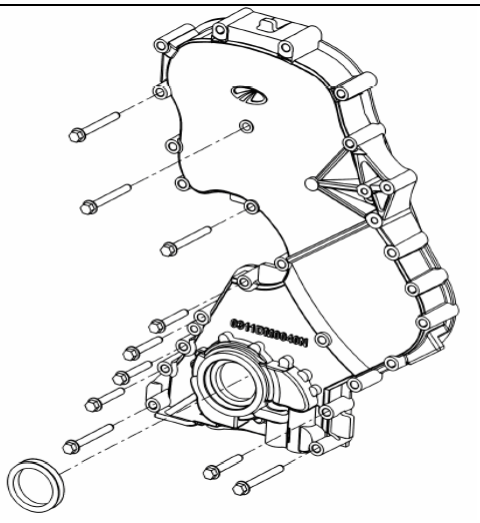
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	Remove the leak off pipes from the injector.
	Remove High Pressure pipe from HPP to common rail.
	Loosen & remove the high pressure pipes from common rail & injector. It is advisable to loosen the high pressure pipes from Common Rail end first.

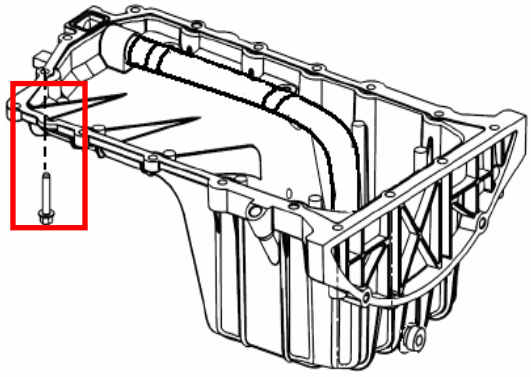
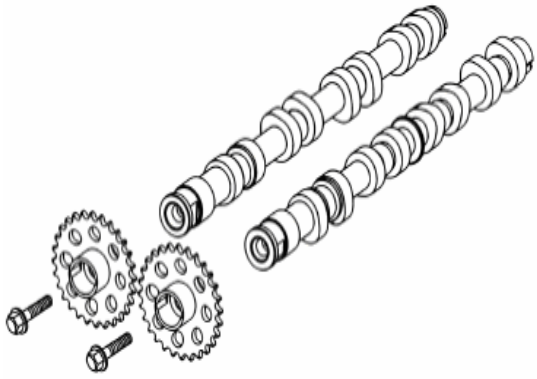
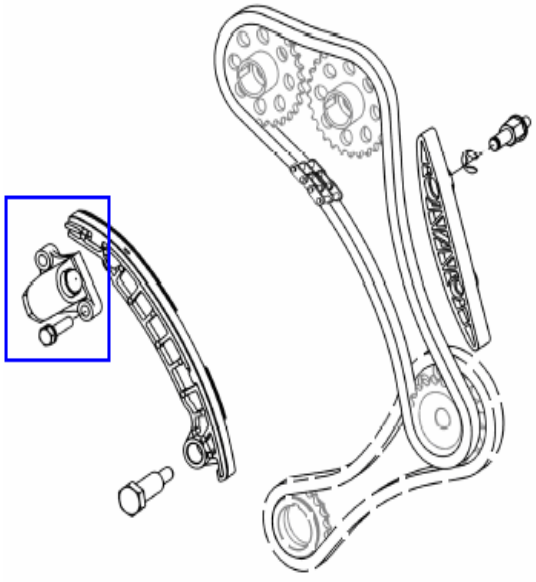
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	Loosen & remove the injector holding clamps & remove the injector.
	Loosen & remove the intake manifold mounting bolts. Care must be taken while removing the Inlet Manifold Mounting bolt near the EMPROP. It is advisable to use an open ended spanner to loosen the particular bolt.
	Loosen & remove the Oil supply lines to turbocharger. Note – It is recommended to remove the lock clip of the Oil Return Line at the cylinder block end first & then the oil supply line inlet to the turbocharger.
	Loosen the Turbocharger Mounting bolt from the support bracket & the support bracket mounting bolts from the block. Loosen & remove the Turbocharger mounting bolts from exhaust manifold.

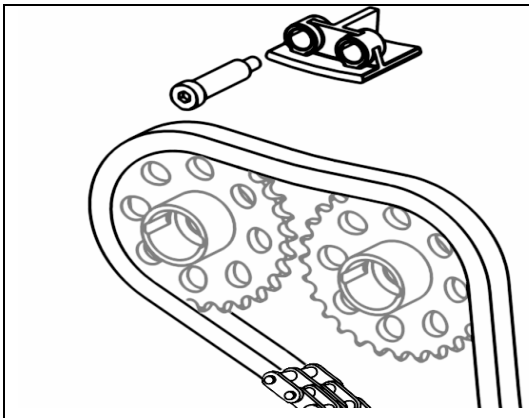
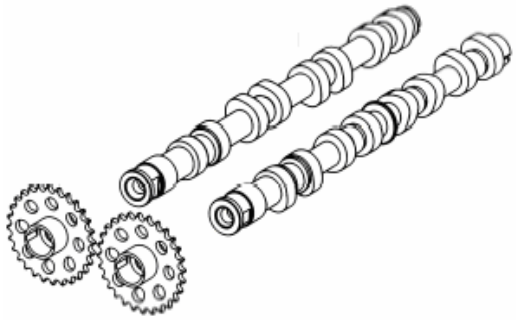
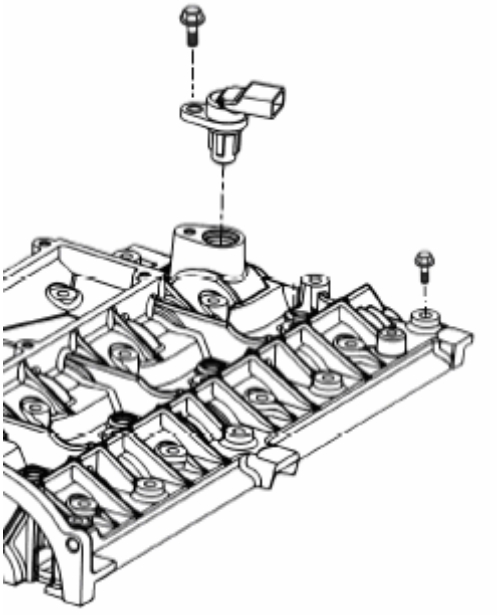
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	Loosen the tensioner pulley nut. Loosen the lock nut of the AC belt tension setting bolt. Loosen & remove the AC belt tension setting bolt. Remove the AC belt.
	Loosen & remove the damper pulley bolt & the damper pulley. Care must be taken while handling the damper pulley.
	Loosen & remove the front cover bolts. Remove the front cover.

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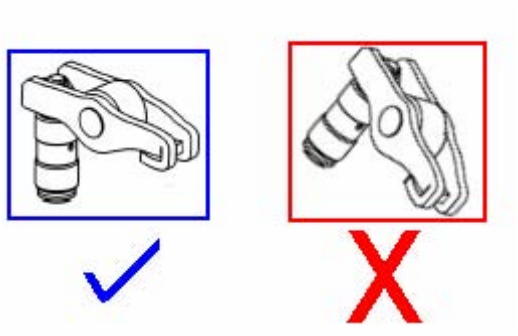
	To remove the front cover; 3 Nos. bolts should be removed from the front side of the oil sump.
	Loosen the cam sprocket bolt.
	• Loosen & remove the secondary (Upper) tensioner. • Remove the chain guides by removing the ‘e’ clips.

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	Loosen & remove cam to cam chain guide.
	Remove the bolt & remove the cam sprocket. Remove the bolt & remove the other cam sprocket.
	Loosen & remove the cam cover bolts. Remove the cam cover. ⚠ If the cam phase is not dismantled from cam cover; care must be taken while handling the cam cover.
	Lift & remove both the cam shafts.

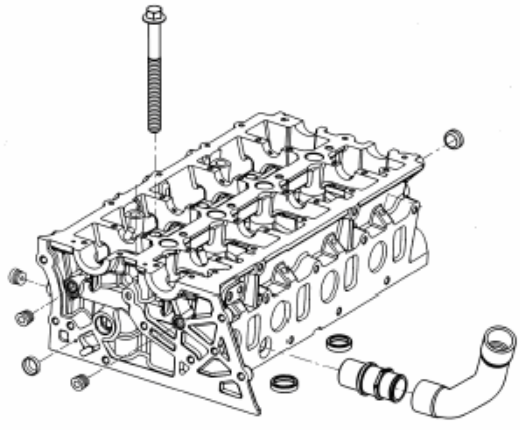
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Lift out the HLA & RFA assembly. Place the HLA & RFA in straight upward position in a clean tray.

Ensure that the HLA & RFA are kept in straight upward direction in the head assembly if not removed.



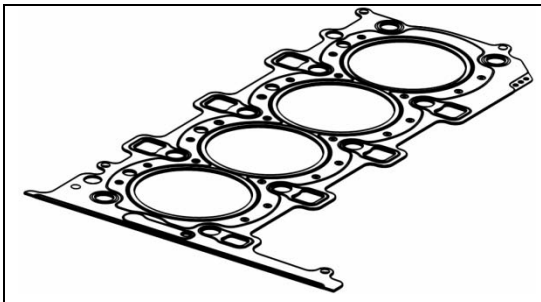
Loosen & remove the water outlet pipe.

Loosen & remove the head bolts.

It is advisable to follow the tightening sequence for loosening the bolts.

Remove the head assembly.

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	Remove the Head Gasket.

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Working principle of the various subsystems of the Engine –

The various subsystems are:

Turbocharger: Please refer to the **Air Intake System** section.

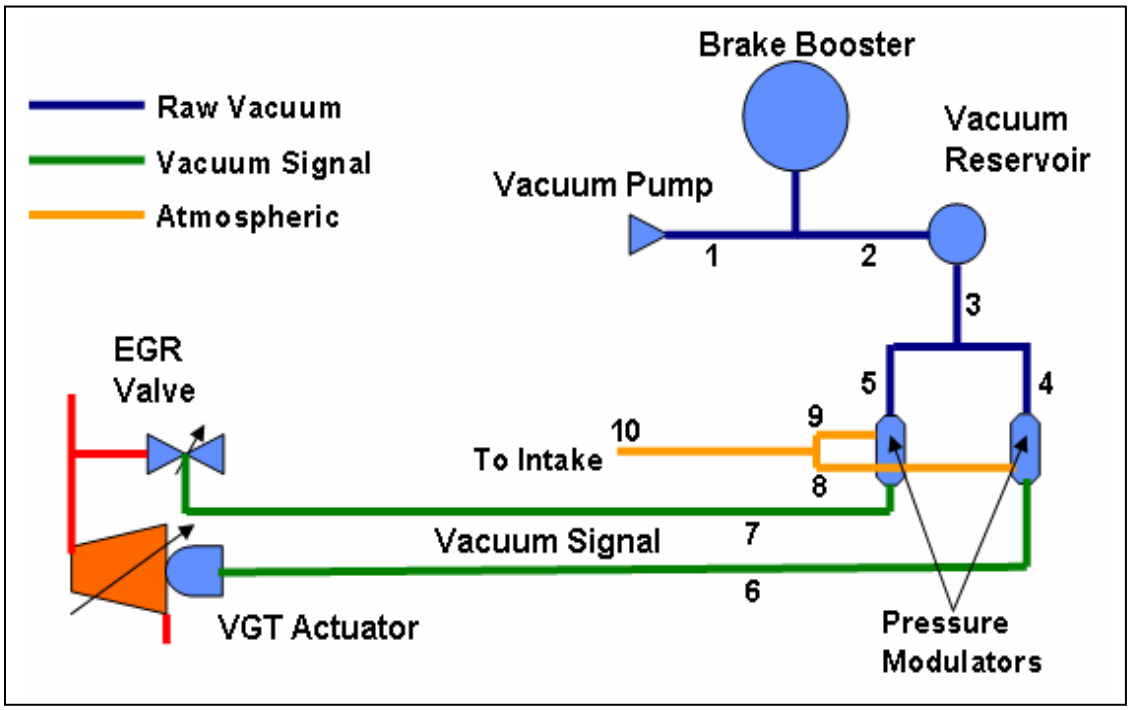
Exhaust Gas Recirculation

Crankcase ventilation

Oil circulation

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Working Principle of Exhaust Gas Recirculation –



During acceleration and in higher loads the combustion chamber temperatures increase. The high combustion temperatures increase the NOx generation. The higher percentage of NOx generated in the combustion chamber come out through the tail pipe in the atmosphere.

To reduce the amount of NOx coming through the tail pipe the EGR system adds exhaust gases into the fresh air that is going into the combustion chamber. Since the exhaust gas is already burnt hence when mixed with fresh air acts an inert gas. Thus when the exhaust gas mixed with fresh air enters the combustion chamber, it performs a dual role. The first role it does is that it reduces the amount of oxygen available for combustion. The second role that it acts is as a heat absorbent/heat sink.
The net effect is that it reduces the combustion temperatures. This results in lower amount of NOx being generated.

To control the amount/percentage of exhaust gases to be circulated back to the combustion chamber an ECU is used. The ECU monitors the coolant temperature, altitude, engine speed, and accelerator pedal position and the air flow. Based on the above parameters the ECU operates a switch that in turn controls the amount of vacuum going to the EGR valve. The amount of vacuum applied controls the lift of the EGR valve.

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EGR Valve

Remove the EGR valve and check it valve-sticking, deposition of carbon etc. If excess carbon deposits and sticky valve noticed then it should be cleaned with a suitable solvent, so that the correct valve seat is ensured.

After cleaning the valve blow air from the bottom side of the valve and check for any leakages.

EGR Pipe

Remove the EGR pipe and check for gas leakage, damages etc. Clean the gasket seating area from any carbon deposits burrs etc. Spray WD 40 rust cleaning spray on the nut.

To check the pipe for any leakages, close one end of flange and from other end blow air at 2 bars. Dip the pipe in water and observe if any leakage is observed. If any leaks are observed then the pipe has to be replaced. Do not attempt to weld/ seal the leakage joint

Vacuum Modulator Valve

It does not require any maintenance. However please check and confirm that that the line from the modulator to air cleaner is clean and the hole at the air cleaner hose end is not choked.

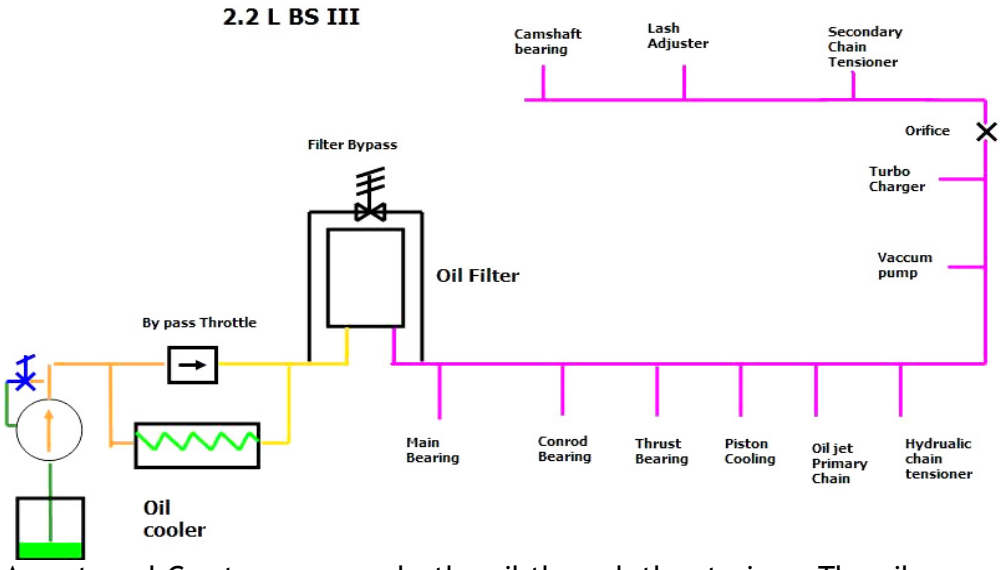
Working principle of Crankcase Ventilation System –

The ventilation system is closed ventilation type. A hose connects the sump assembly to the oil separator. There are two oil separators in series. First the oil vapor goes to the labyrinth oil separator. In the labyrinth- The oil goes through the labriyanth, the oil collected drops down. The excess pressure acts below the diaphragm. The diaphragm is acted from below by the crankcase pressure and from top the suction by air cleaner. A spring also acts on top of the diaphragm. Once the pressure exceeds the diaphragm lifts and the excess crankcase oil and vapor pressure goes to the cyclonic oil separator. Here again the mixture is separated and oil drained back to the sump while the vapor is fed back to the air suction pipe – in between the air cleaner and the turbocharger.

Certain amount of oil will be carried from the oil separator to the Air inlet hose, which is normal. However if it is excessive please look for all the causes mentioned in the high blow bye.

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Oil circulation system –



An external G rotor pump sucks the oil through the strainer. The oil pump is driven by the rotor, which is mounted, on the crankshaft. The oil pump is mounted in the front cover.

The oil goes to the oil filter. The oil cooler is located in between the oil pump and the oil filter. The oil cooler is provided with a bypass throttle.

After cooling the oil goes through the oil filter and is delivered to the main oil gallery.

Oil is supplied to the main bearing con rod bearing, thrust bearing and the piston cooling jets. In the front of the block the oil is given to the secondary chain, chain tensioner, the vacuum pump and the turbocharger.

The oil supply to the secondary chain tensioner, the camshaft bearing and the HLLA is after an orifice

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Dismantling & overhauling of the Engine –

Comprise of 5 steps:

Removal of the engine

Dismantling

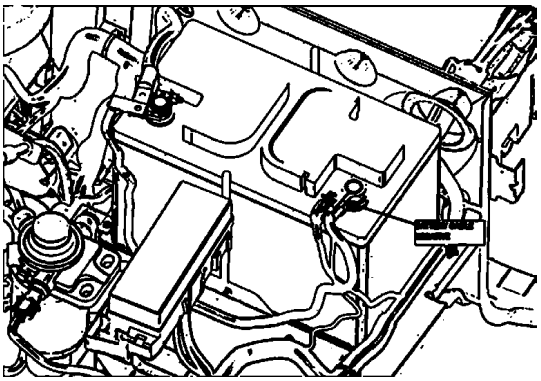
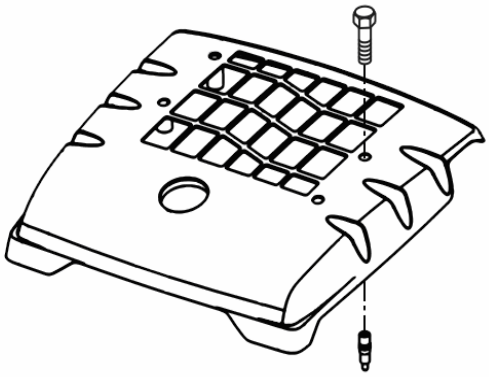
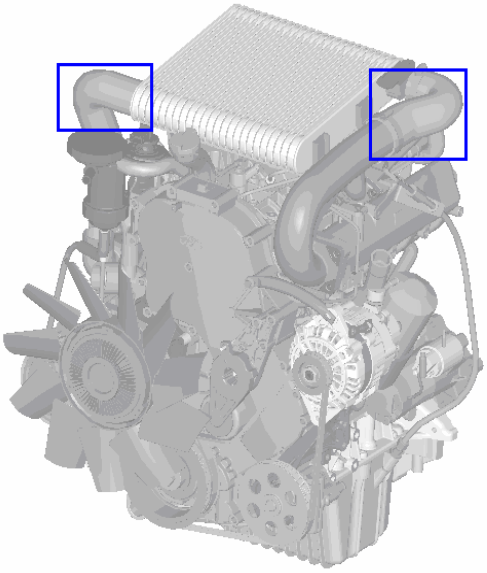
Inspection

Assembly

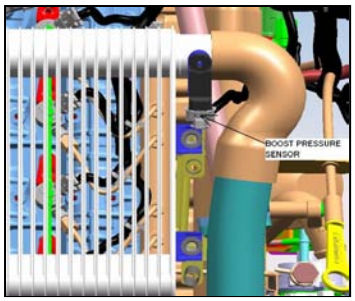
Testing

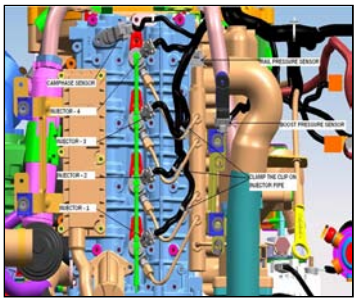
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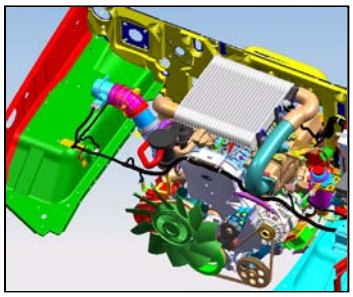
Removal of the engine from the vehicle -

	Disconnect the battery cables & remove the battery.
	Remove the NVH cover.
	Remove the Intercooler hoses & the intercooler.
Remove the bonnet.	
Remove the radiator drain cock. Collect the coolant -if the coolant is clean, so that it can be reused.	

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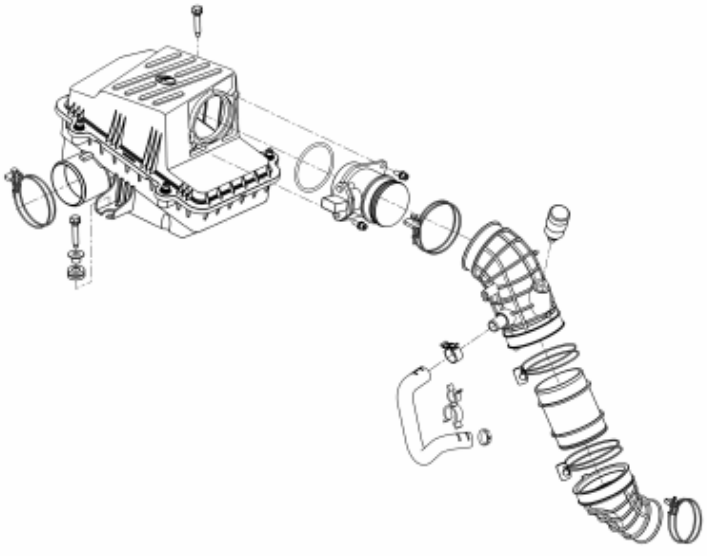






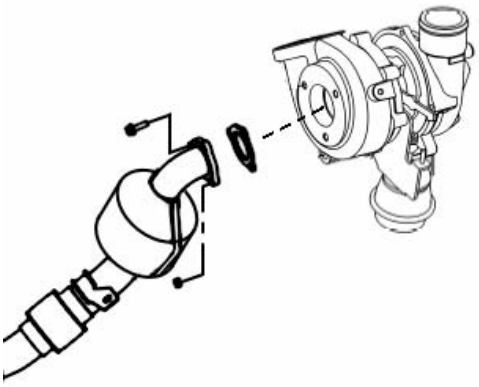
Remove the electrical connections of:

- All sensors (HFM, Cam Phase Sensor, Crankshaft Speed Sensor, Boost Pressure Sensor etc.)
- Water temperature sensor & Oil Pressure Switch etc.
- Connection to Injectors, Modulator etc.
- Alternator & Starter connections

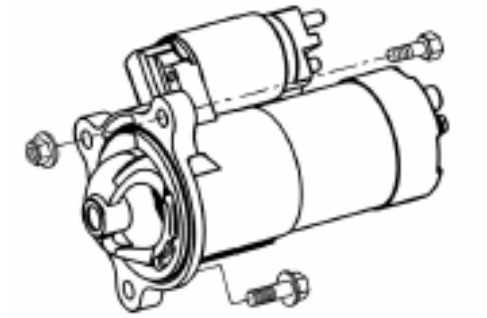


Remove the air cleaner assembly.
Remove the hose connection from the Turbocharger end TC to intercooler.

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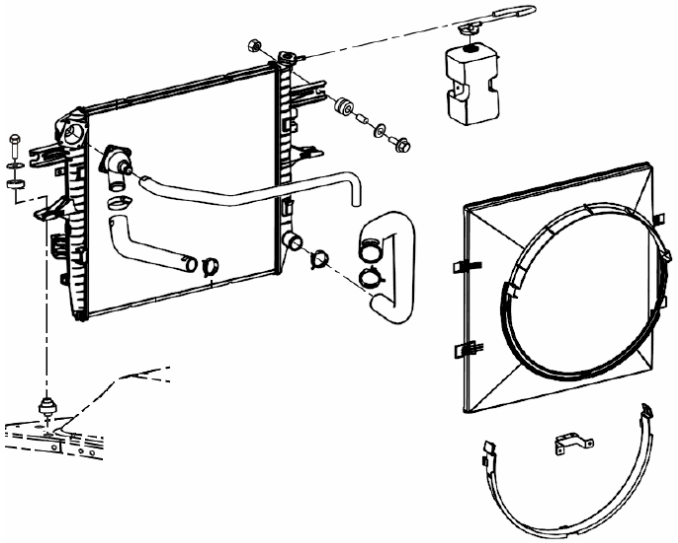


Remove the exhaust pipe at the Turbocharger outlet elbow.



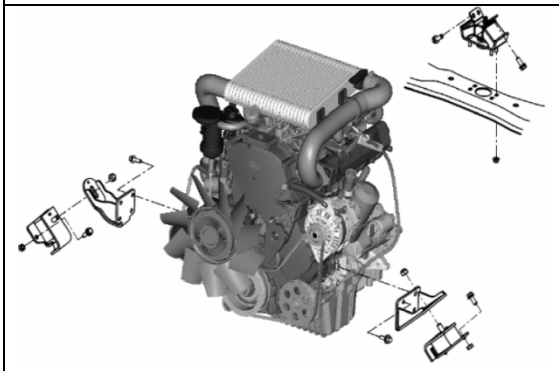
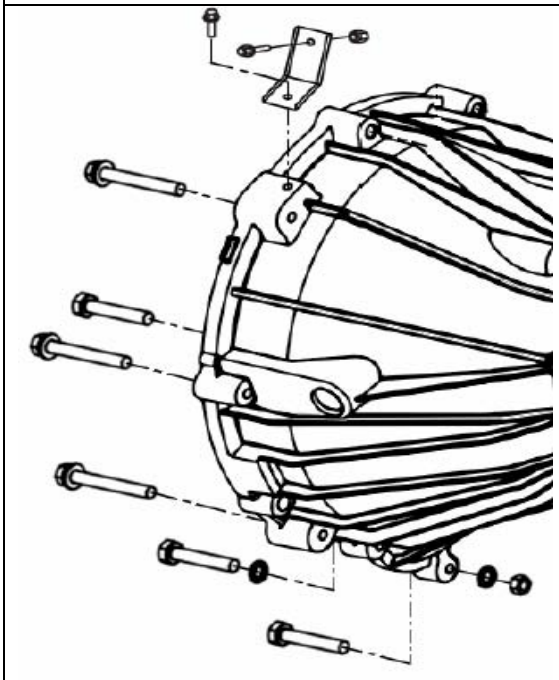
Remove the starter motor.

Remove the fuel lines from filter to High Pressure Pump & return to fuel tank.



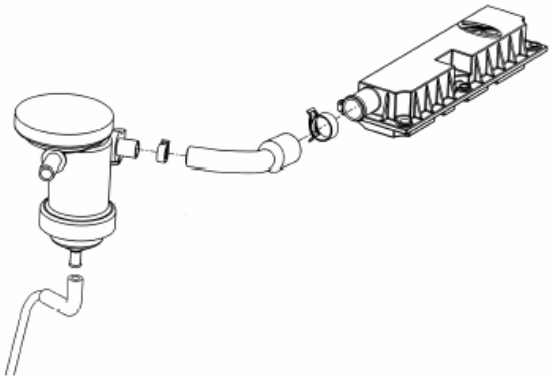
- Remove hoses connecting the water pump to radiator.
- Remove the hose connected from the water pump to heater and also the heater return line.
- Remove the fan shroud.
- Remove the radiator.

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Remove the power steering connection hoses from the power steering pump.	
Remove the pipes connecting from AC compressor suction and discharge lines.	
Remove the vacuum hose from the vacuum pump in alternator to booster.	
Drain the oil from the sump.	
Attach lifting device.	
	Remove the front insulators mounting bolts.
	Remove the gearbox mounting bolts.
Pull out and lift the engine from the engine compartment.	

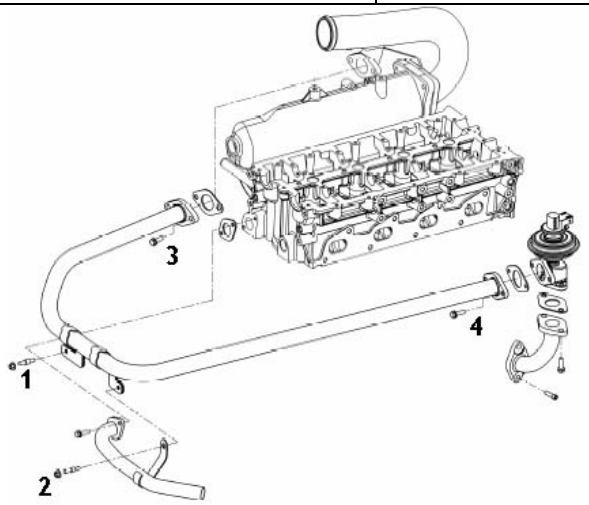
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Dismantling -

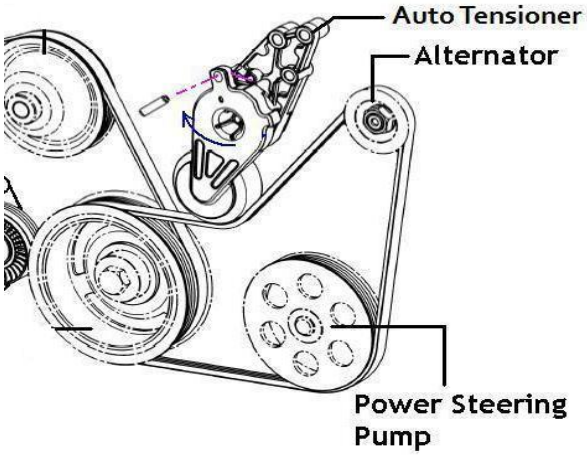


Mount the engine on the Engine stand.

Remove both the oil separators. (Labyrinth & Cyclone)



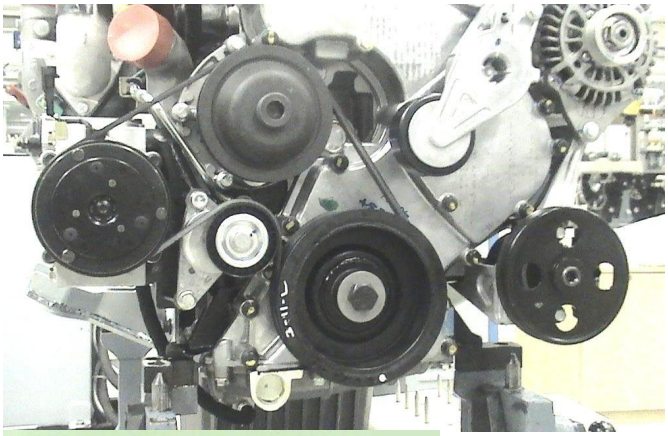
Remove the EGR pipe mounting clips & in the sequence as shown in figure.



Using the special tool, rotate the auto tensioner in the direction shown in the figure. Lock the auto tensioner in that position using a pin. Remove the drive belt.
Take out the lock pin & release the Auto tensioner. Remove the auto tensioner

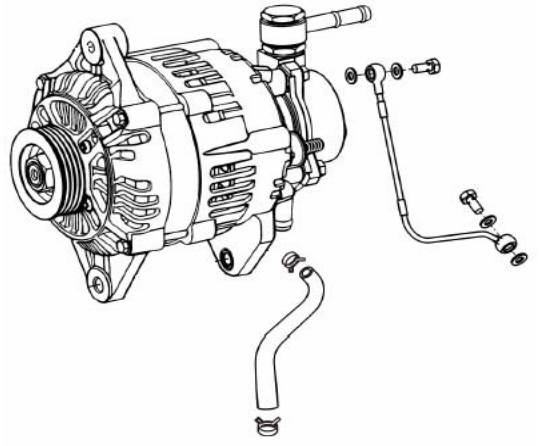
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mounting bolts & remove the belt tensioner.



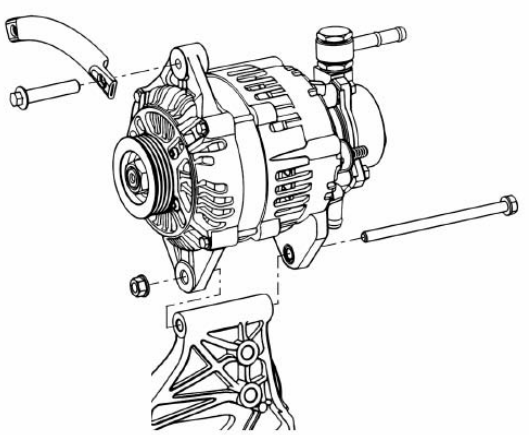
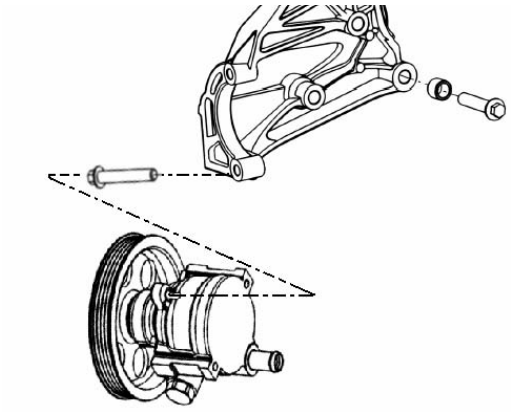
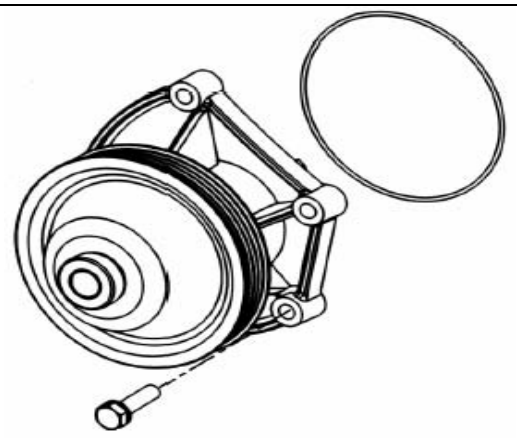


Using the spanner, rotate the Auto Tensioner in the direction shown in the figure. Lock the Auto Tensioner in that position using a pin.
Remove the belt.
Take the locking pin out & release the Auto Tensioner.
Remove auto tensioner assembly by removing its 2 nos. mounting bolts.

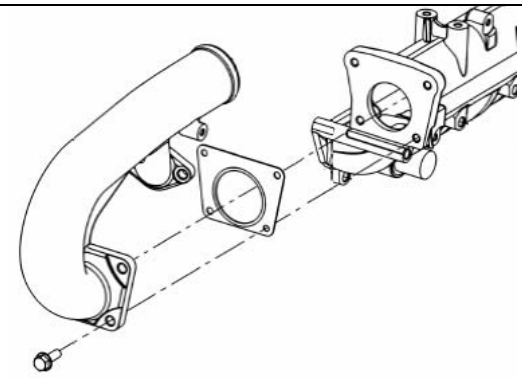
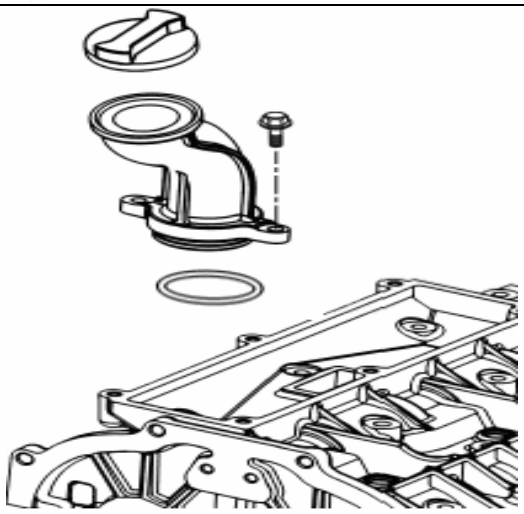
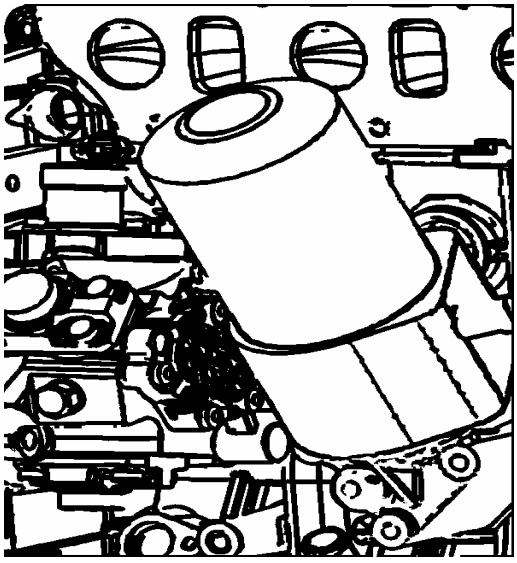


Remove the lubrication oil lines connected to the alternator vacuum pump from vacuum pump end.

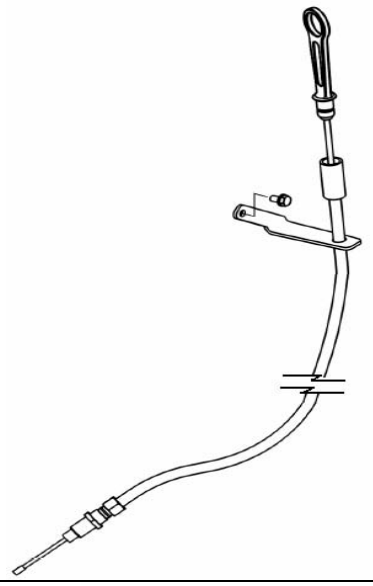
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	Loosen & Remove the alternator mounting bolt & the alternator brace. Remove the alternator.
	Loosen & remove the power steering pump mounting bolts. Remove the power steering pump.
	Loosen & remove the water pump mounting bolts & remove the water pump.

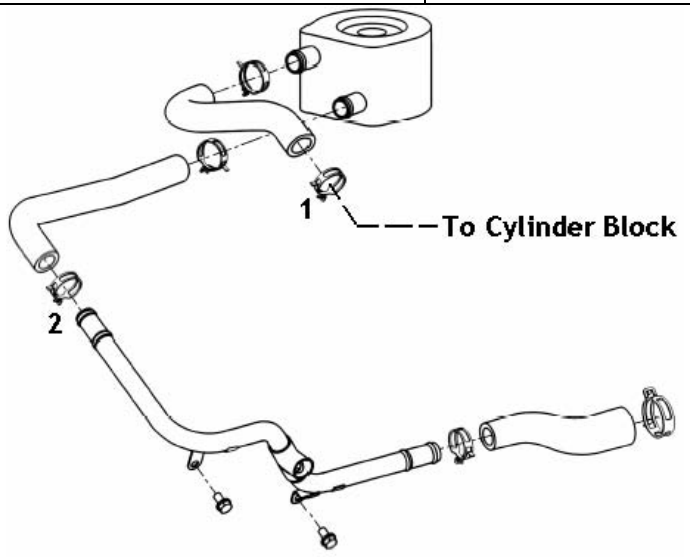
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	Loosen & remove Air Intake pipe.
	Loosen & remove the oil filler neck.
	Loosen & remove the oil filter, using filter wrench.

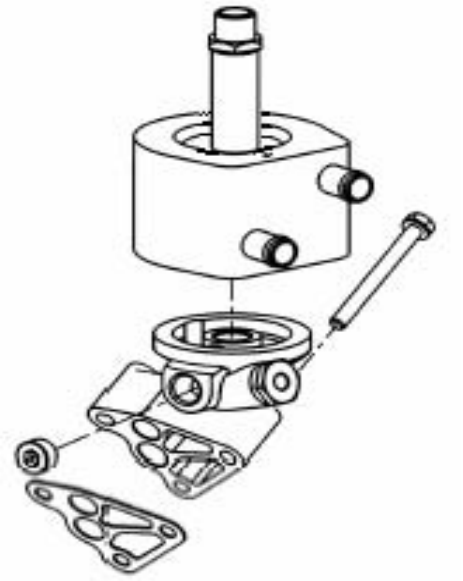
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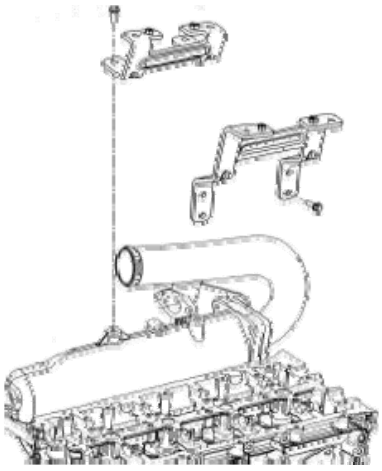
Remove the dip stick & remove the dip stick clamp bolt & the dip stick guide.



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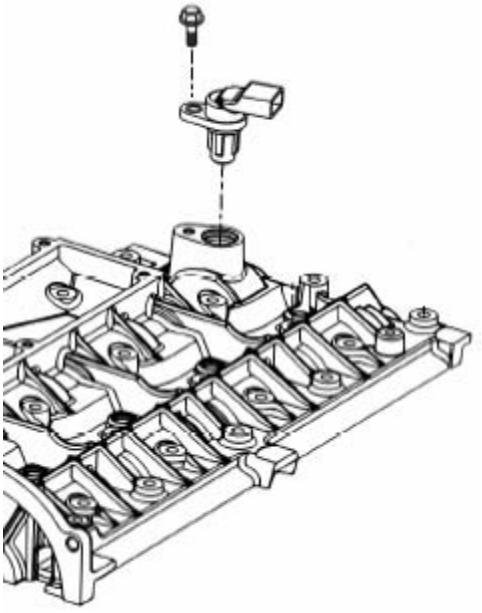
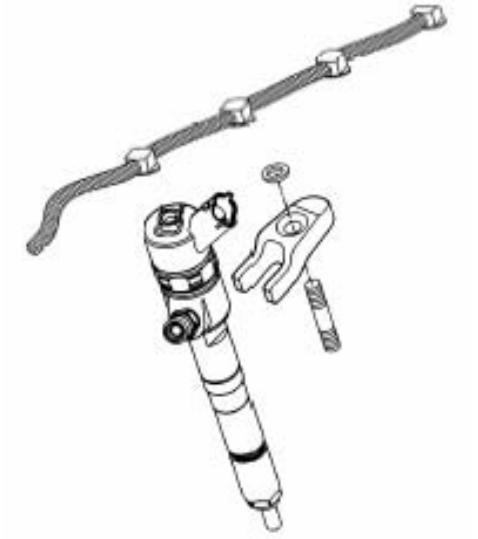


Disconnect the coolant pipe clips connected to the oil cooler.
Loosen & remove the Oil Filter Body mounting bolts & remove the Oil Filter Body.

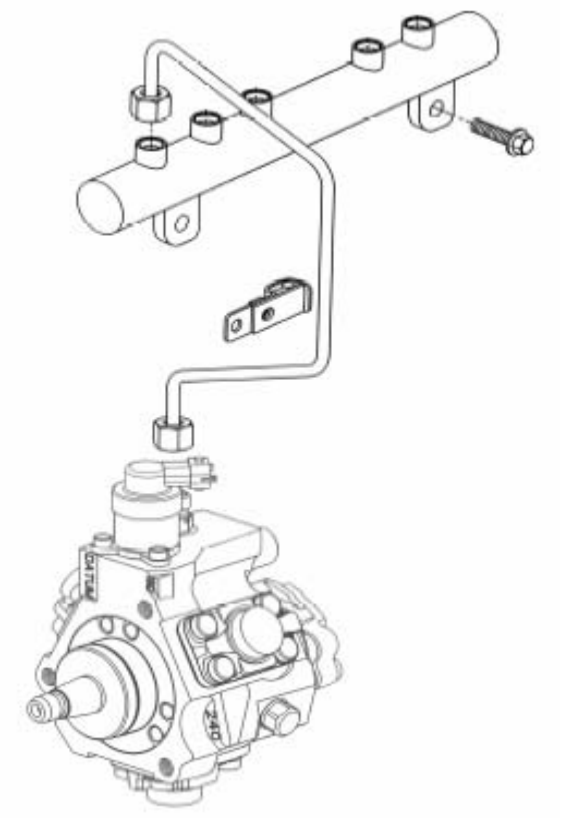
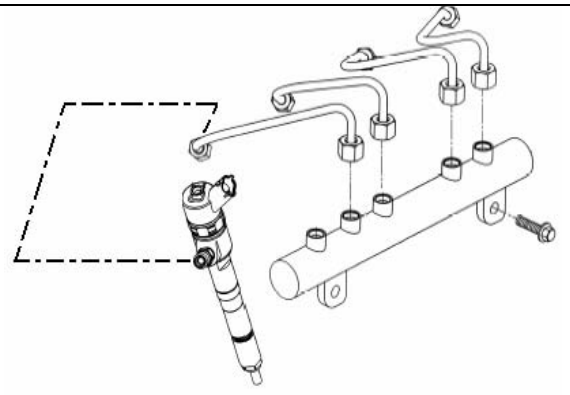


Loosen & remove the Intercooler bracket mounting bolts & remove both the intercooler brackets.

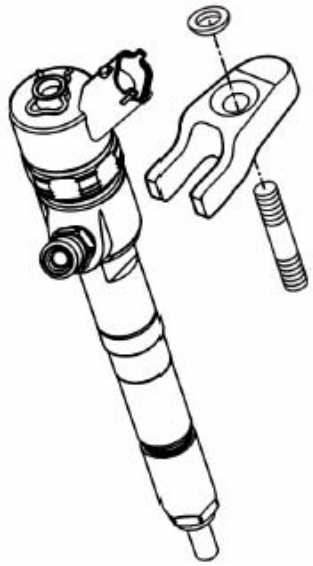
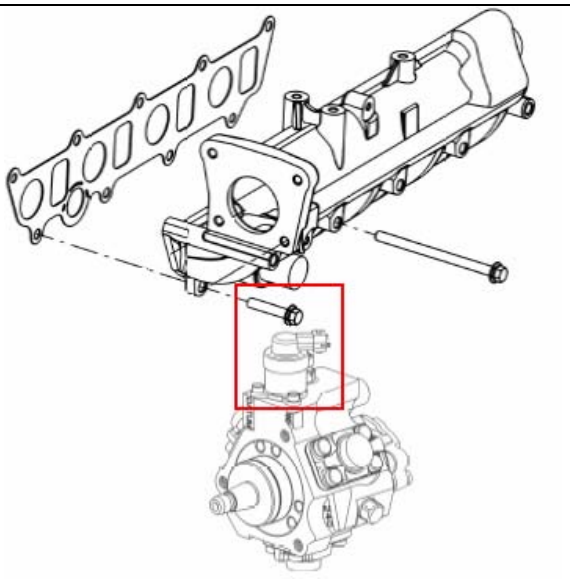
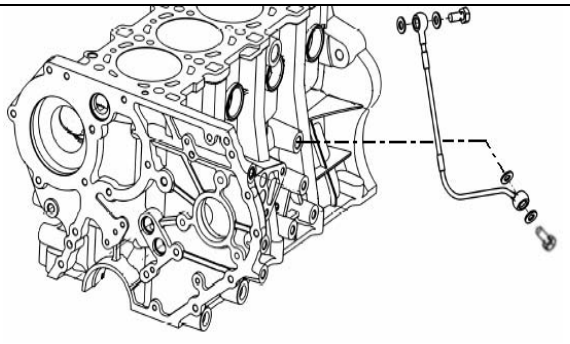
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	Loosen & remove the Cam phase sensor.
	Remove the leak off pipes from the injector.

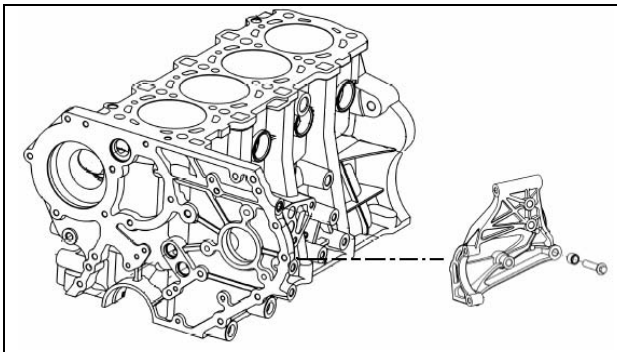
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	Remove High Pressure pipe from HPP to common rail.
	Loosen & remove the high pressure pipes from common rail & injector. It is advisable to loosen the high pressure pipes from Common Rail end first. Remove the common rail assembly.

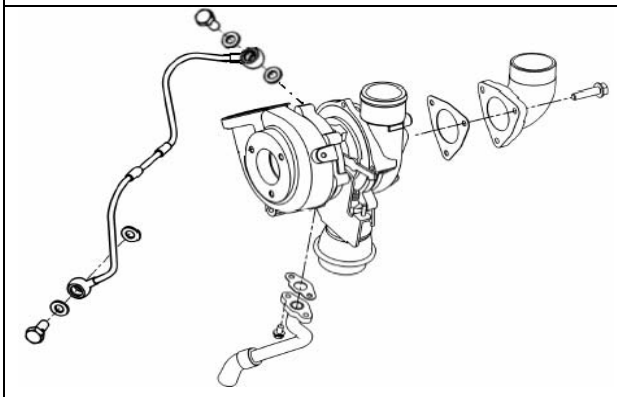
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	Loosen & remove the injector holding clamps & remove the injector.
	Loosen & remove the intake manifold mounting bolts. Care must be taken while removing the Inlet Manifold Mounting bolt near the EMPROP. It is advisable to use an open ended spanner to loosen the particular bolt.
	Remove the oil supply line to the alternator from the cylinder block.

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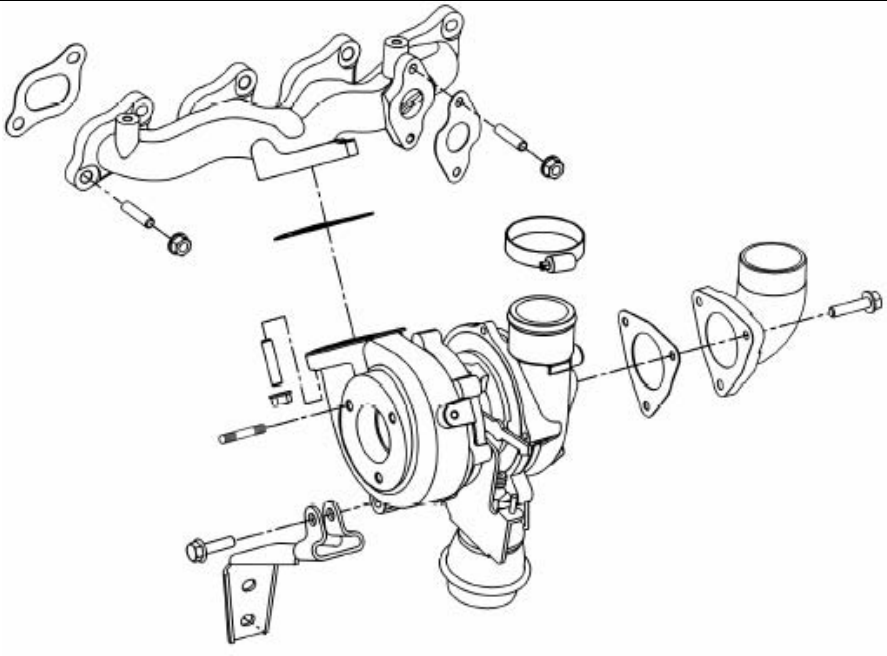


Remove the power steering pump bracket from the cylinder block.



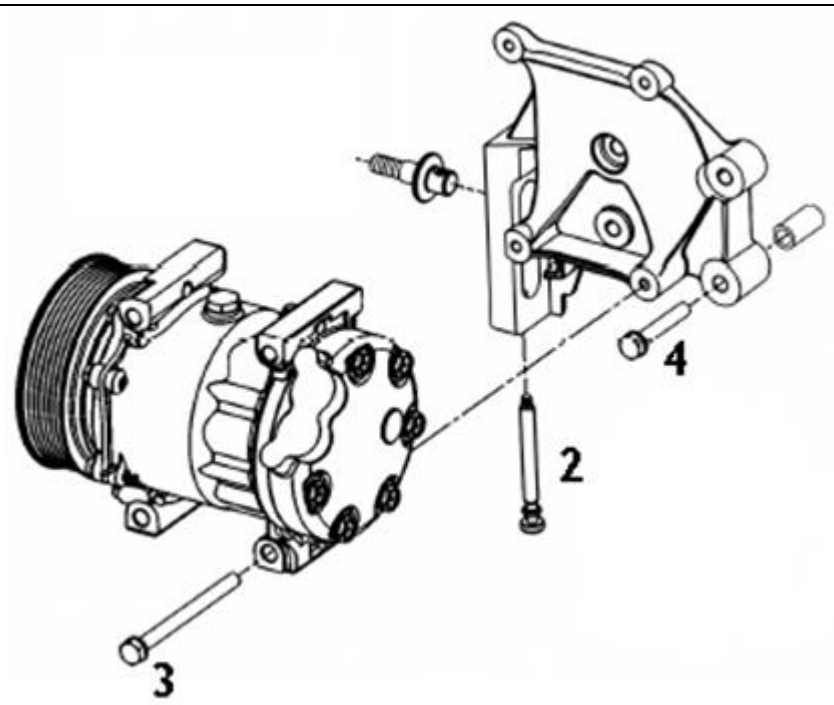
Loosen & remove the Oil supply lines to turbocharger.

Note – It is recommended to remove the lock clip of the Oil Return Line at the cylinder block end first & then the oil supply line inlet to the turbocharger.

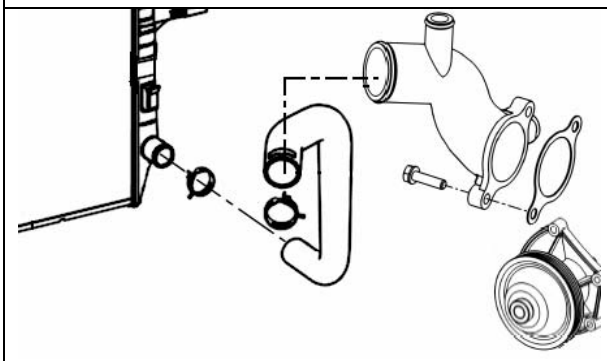


Loosen the Turbocharger Mounting bolt from the support bracket & the support bracket mounting bolts from the block.
Loosen & remove the Turbocharger mounting bolts from exhaust manifold.

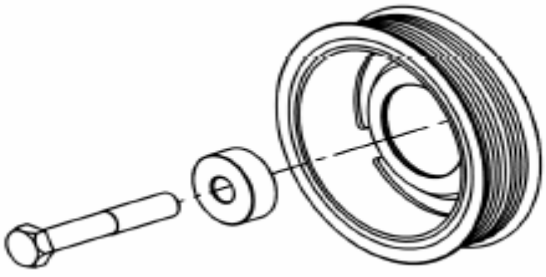
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Rotate the auto tensioner and lock by using locking pin. Remove drive belt. Remove lock pin to release auto tensioner. Remove auto tensioner by removing mounting bolts.
Loosen & remove the AC compressor mounting bolts & remove the compressor.
Loosen & remove the AC compressor mounting bracket bolts & remove the mounting bracket.

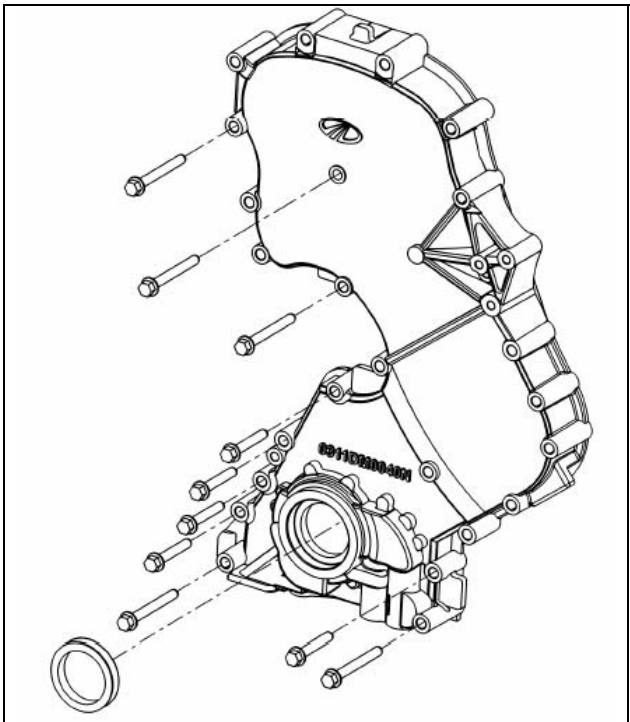


Remove the flexible pipe clip & remove the pipe from water inlet pipe to oil cooler.
Remove 2 Nos. clamping bolts & remove the metal pipe from cylinder block.
Loosen & remove the water inlet pipe with metal pipe from the cylinder block.

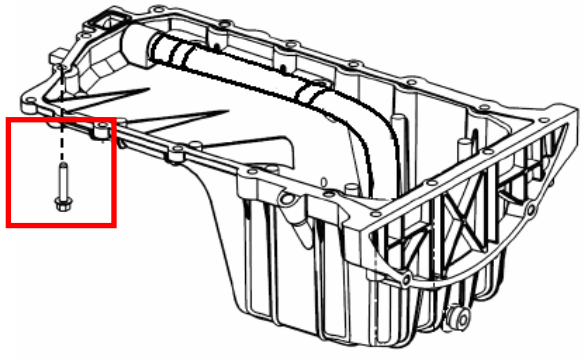


Loosen & remove the damper pulley bolt & the damper pulley. Care must be taken while handling the damper pulley.

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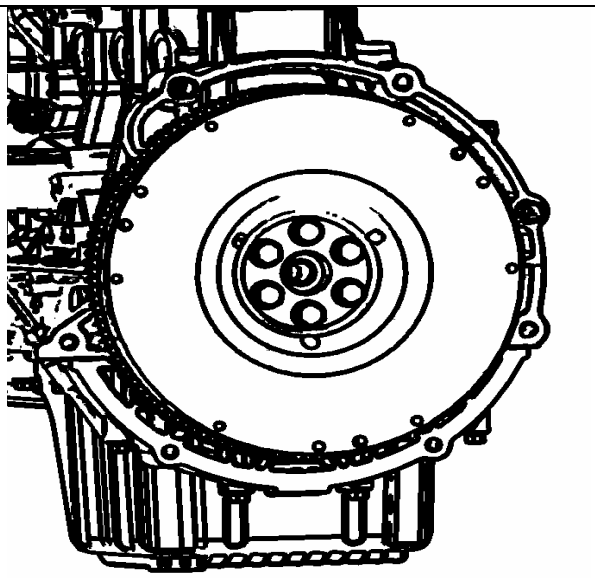
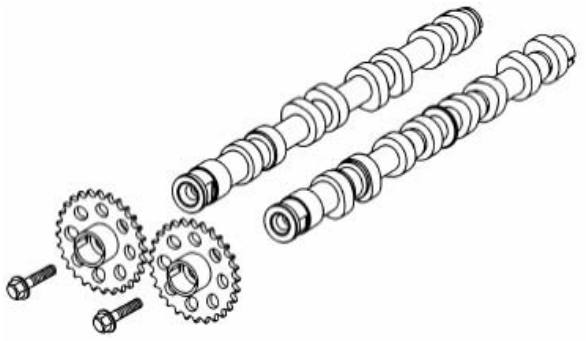
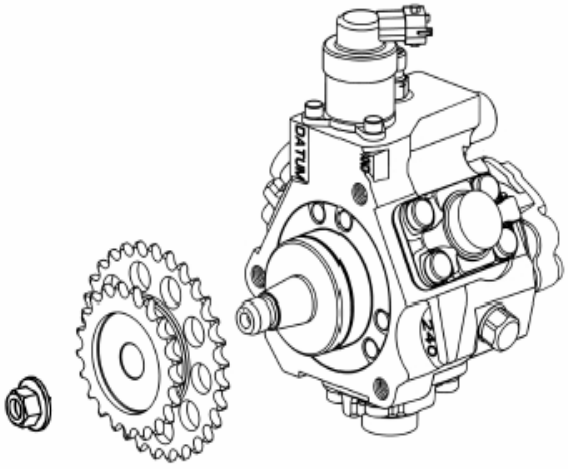


Loosen & remove the front cover bolts. Remove the front cover.

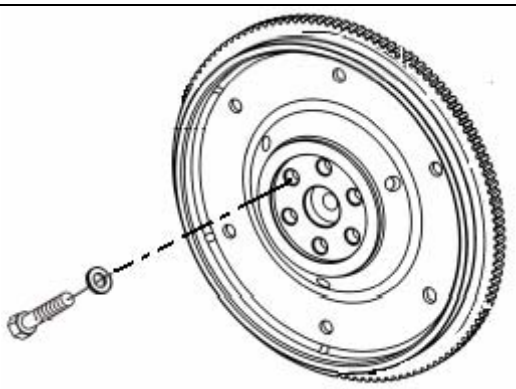


To remove the front cover; 3 Nos. bolts should be removed from the front side of the oil sump.

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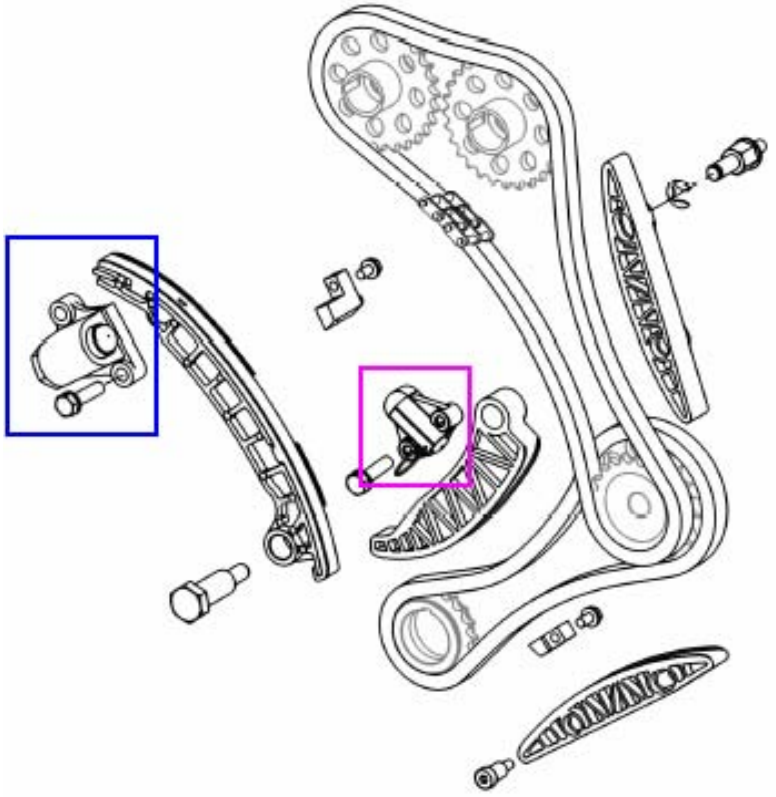
	Lock the flywheel using the MST. Note - Do not remove the MST from flywheel.
	Loosen the cam sprocket bolt.
	Loosen the HPP sprocket nut.

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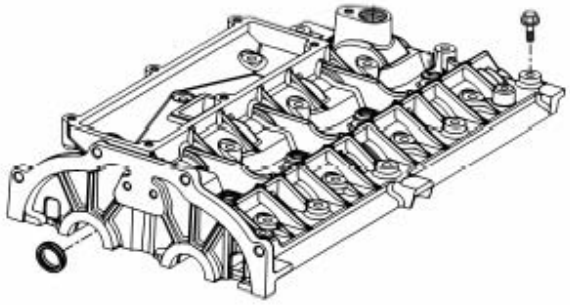
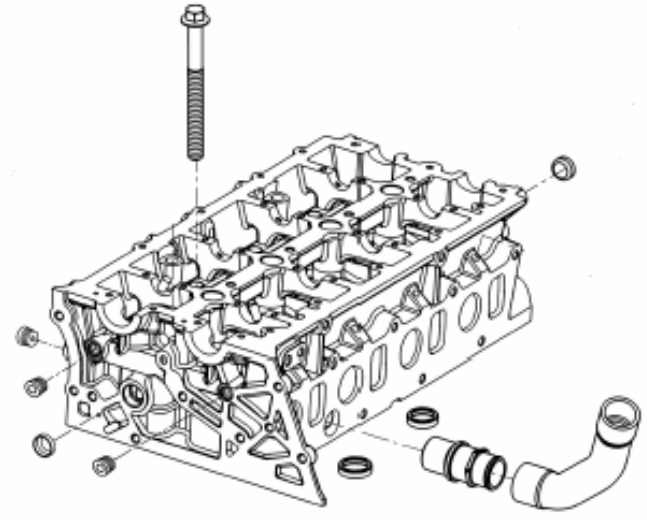
Loosen & remove the flywheel bolts.

Remove the MST.



- Loosen & remove the secondary (Upper) tensioner.
- Remove the chain guides by removing the ‘e’clips.
- Press & lock the primary (Lower) tensioner. Loosen & remove the mounting bolts & the tensioner.

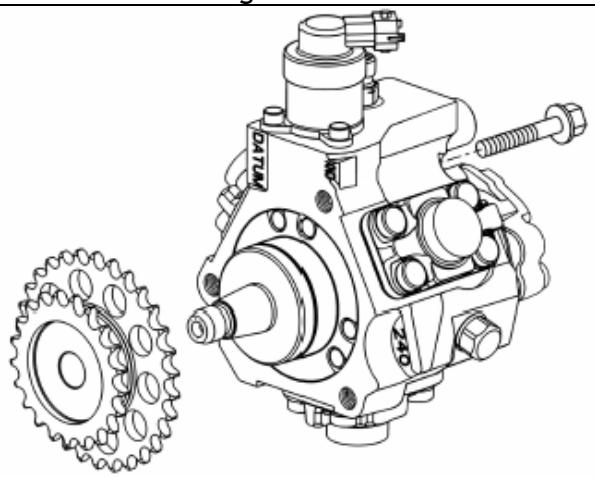
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	Remove the bolt & remove the cam sprocket. Remove the bolt & remove the other cam sprocket.
	Loosen & remove the cam cover bolts & remove the cam cover.
	Lift & remove both the cam shafts.
	Lift out the HLA & RFA assembly.
	Loosen & remove the head bolts.

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Note – It is advisable to follow the tightening sequence for loosening the bolts.
Remove the head assembly.
Remove the Head Gasket.

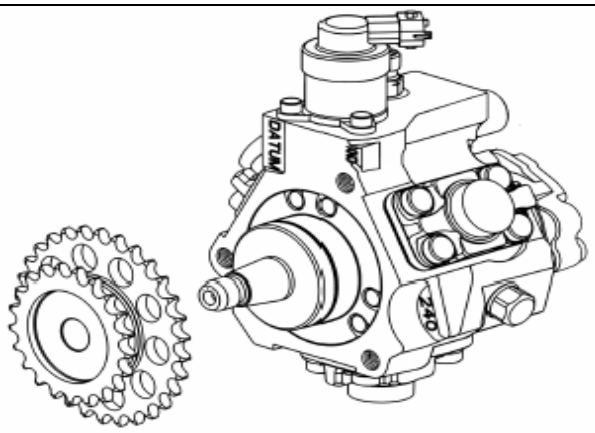
Remove the head gasket.



Loosen the HPP mounting bolts.



Do not remove the mounting bolts.

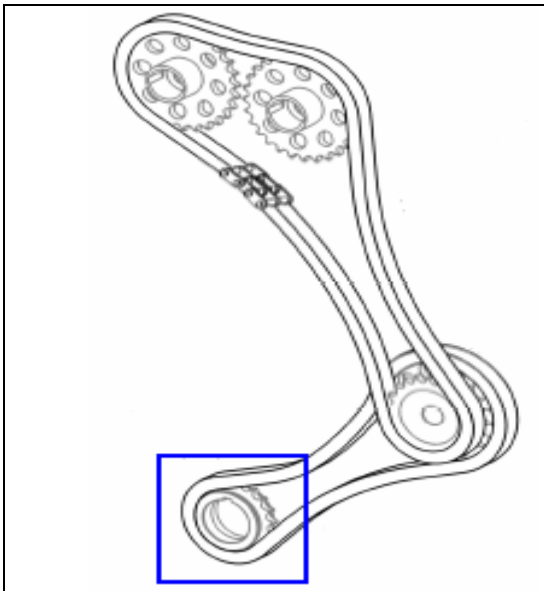
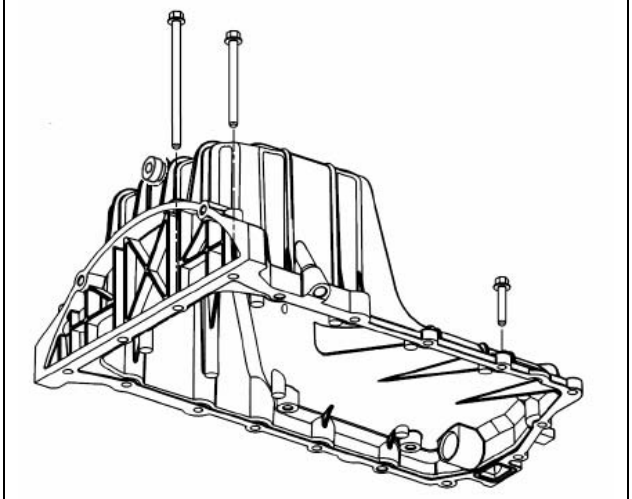
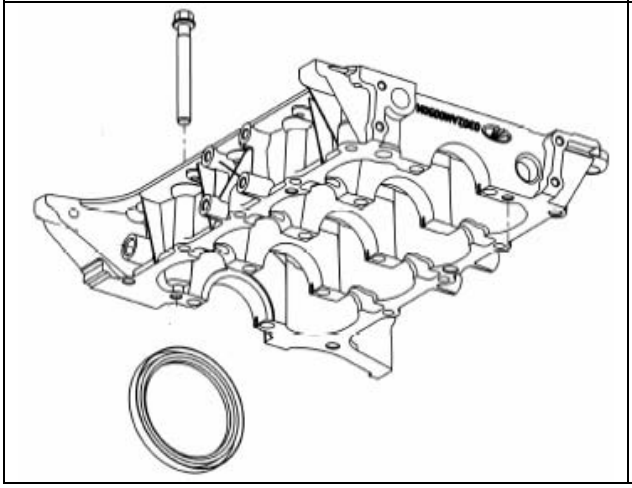


Remove HPP sprocket using the MST

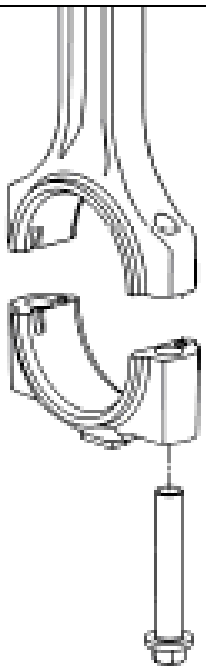
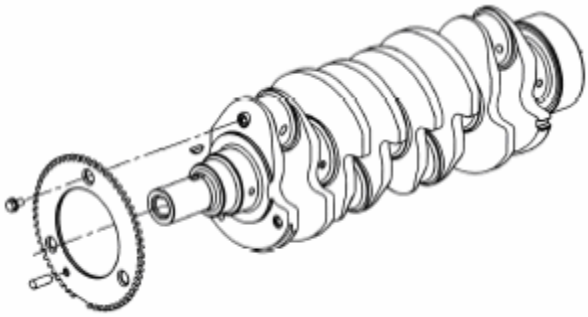
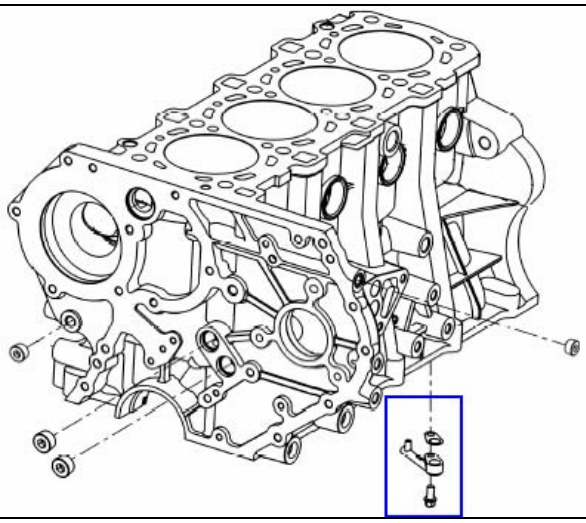
Remove the timing chain.

Remove the HPP mounting bolts & remove the HPP.

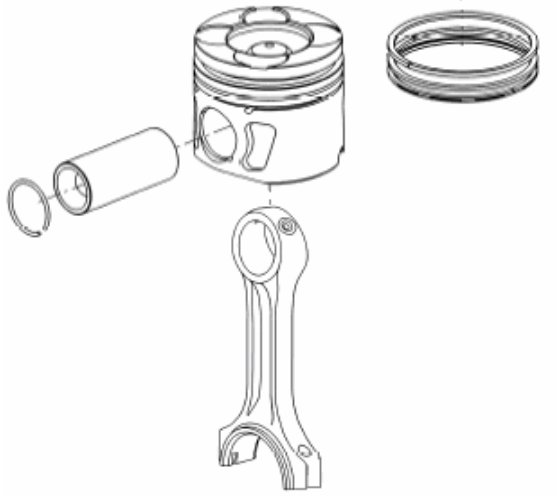
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	Remove the timing chain & remove the crank sprocket.
Loosen & remove the Crankshaft Speed Sensor.	
	Invert the engine. Loosen & remove the Oil Sump bolts.
	Loosen & remove the Bed Plate bolts & the Bed Plate. Loosen & remove the rear seal retainer & remove the rear seal.

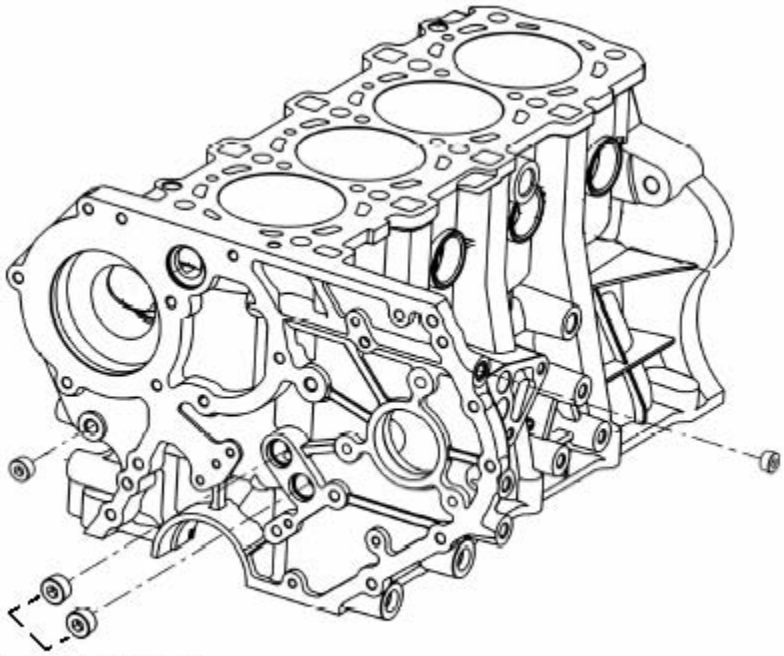
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	Loosen & remove the connecting rod cap bolts & caps.
	Lift out the crank shaft assembly with toner ring.
	Loosen & remove oil jet bolts & remove the oil jets.

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Tap & remove the pistons with connecting rods.

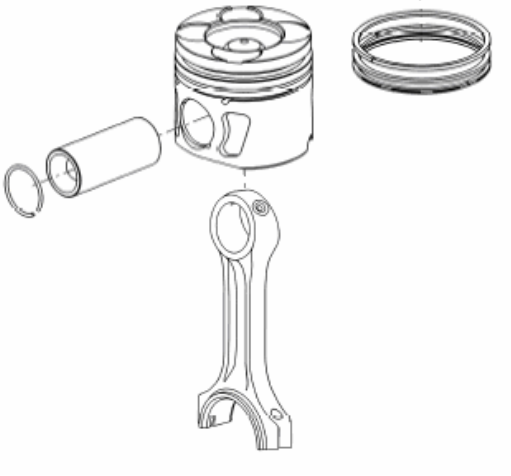
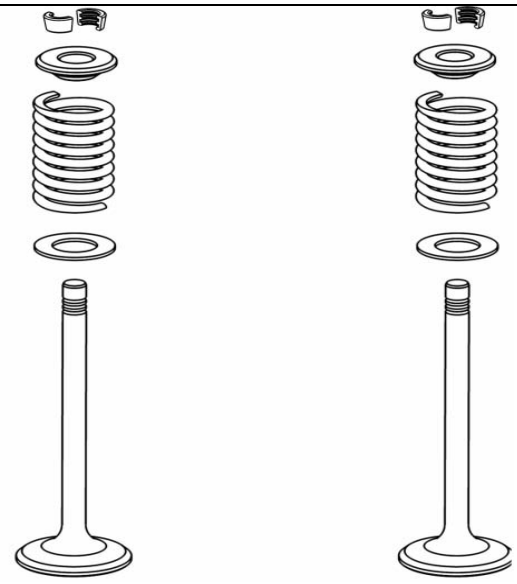


Main Oil Gallery Plugs

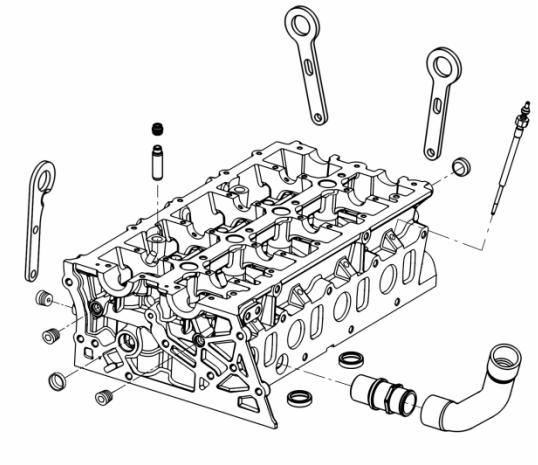
Loosen & remove the main oil gallery & auxiliary oil gallery plugs.

While fitting the Oil Gallery Plugs; Loctite is applied. So while removing care must be taken to use proper sockets so that the head will not get damaged.

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	Remove the circlip & tap the gudgeon pin out. Remove the piston rings.
Dismantling of the Head Assembly	
Loosen & remove the Engine Lifting hooks.	
	Remove the Valve Spring locks. Remove the Retainer Valve Springs – Upper, remove the Valve Springs & the Valve Springs Retainer - Bottom. Remove Inlet & Exhaust Valves. Note – If the valves are to be used again; mark the valves according to the respective cylinder.

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	Separate the Water outlet pipe & the nipple. Remove the valve seals. Remove the Valve guides & valve seats using appropriate tools & method. Remove the Oil Gallery Plugs.

Inspection -

All the components should be inspected for wear. Any components, which are beyond the wear limits, have to be replaced.

Over & above the wear limits: The following points also need to be ensured.

Piston: Check for scuffing/scoring on the skirt. A hard thick layer of carbon lacquer on top land is acceptable. (If the thick layer is present on the piston check that the liner does not have scuffing)

However scuffing of the top land and skirt giving indication of overheating which is not acceptable.

Parent Bore: Any scoring on the parent bore is not acceptable.

Crankshaft: Check for scoring on the main as well as connecting rod journal. If scoring is nominal and will not the increase the oil clearance then the crankshaft can be used in, as it is condition.

However if it is unacceptable then the journal has to be ground up to service limits only.

Any deep groove in the rear end oil seal seating area is unacceptable. It will result in oil leaks.

Valve: If valve tip is worn out/ ridged then not acceptable

Main bearing and connecting rod bearing — If the scoring is nominal and oil clearance is not affected, then it can be reused. However if flaking /peeling of the bimetal in any particular zone only is present then use new shell. Look for foreign particle embedded, deep scratches.

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Dampener pulley rubber bonding – Inspect for any gap between the rubber ring and the outer/inner ring, Cracks on ring. Any deep groove in the front oil seal seating area is unacceptable. It will lead to leakages.

If any deterioration of rubber or gap noticed between the ring and the rubber replace the dampener pulley.

It is suggested that the dampener pulley be replaced at every 3, 00,000 KMs.



While measuring the inner diameter of the connecting rod big end and main journal please take the measurements after torque tightening only. For measurement purpose the torque should be 35±3 Nm +60°. Do not reuse this bolt

If line boring of the crankshaft's journal in the block is done to rectify any ovality. Then please ensure that the material from block half is not removed. In absence of taking this precaution the piston will move up. It will change the compression, influencing the performance. In the worst case the valves can hit the piston.

Assembly –

The assembly sequence is the reverse of the dismantling procedure.
To obtain a good life of the rebuilt unit absolute cleanliness of the parts is taken as a prerequisite and also the fact that all the parts have been inspected.

The additional points which are mentioned are necessary to give you the engine life same as the original engine.

Bolts: The following bolts are recommend to be replace every time they are opened-if the Maximum length exceeds the specification. However the connecting rod bolt has to be changed every time without exception.

The bolts have to be tightened by base torque then 2 stage angular torques. The angular torque's ensures that the bolts are torque tightened up to yield point. And the 2 stage ensures that the clamping load for each bolt is within a very close tolerance.

Cylinder head bolts - 10 no --Maximum length 136.6/135.4 mm
Main Bearing Bolts - 10 no Maximum length 90.6/89.4mm
Connecting rod bolt s- 8 no replace every time
Flywheel bolts - 6no Maximum length 29.58/30.42 mm

Cylinder block – Top face -- Ensure that the tapping for the cylinder head bolt as well as the crankshaft's main journal is fine. Ensure that no water or oil after cleaning is in the bolt holes (esp. the cylinder heads.). If found please remove them, if necessary using cotton cloth (not cotton waste).

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If the oil /water is not removed then it is possible that while tightening the bolt. It may not allow complete tightening of the bolts and one will get a false reading.

Cylinder head gasket –

It is a multi layer steel gasket type. Do not use any oil or shellac on the cylinder head gasket or on the block face or the cylinder head face. The gasket has to be fitted dry.
The gasket can be assembled any face up or down. However it is suggested that the face with the numbers should be facing up.

Piston & Rings –

While fitting the piston rings ensure that the rings end gap are staggered in 120°.
The first ring end gap should not be on the thrust axis but the minor axis i.e. on the gudgeon pin axis. Please note that the first ring is keystone shaped hence the top mark has to face up. The 2nd ring is taper faced. The face, which should be on the top, has to be facing up. The 3rd ring is the conformable type oil ring. It can be assembled either way.
While assembling the piston on to the liner- apply clean oil liberally on the liner surface.

Bearing shells –



The bearing shells are marked with Red & Yellow paint mark according to the clearances. The bearing shells need a selective assembly for optimum performance of the engine.
While dismantling when the shells are removed from the Cylinder Block as well as the Bed Plate; please note the colour & while assembly the bearing shells marked with same colors are to be fitted at the respective position.

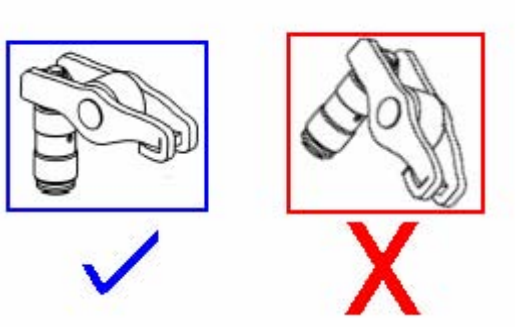
Before fitting the bearing shell ensure that the parent bore of the block/connecting rod are clean.

Wipe with a clean cloth the back end of shells before assembling on to the block or connecting rod.
Ensure that the bearing shells are located properly in the notches.

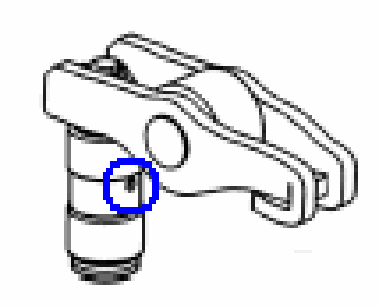
Oil seals –
Ensure that
- ✓ All the oil seals are fitted using the dolly MST.
- ✓ Always ensure that the lip is coated with grease before fitment.
- ✓ Apply engine oil on the outside diameter of seal. The receiving bore should be free of burrs, dent.

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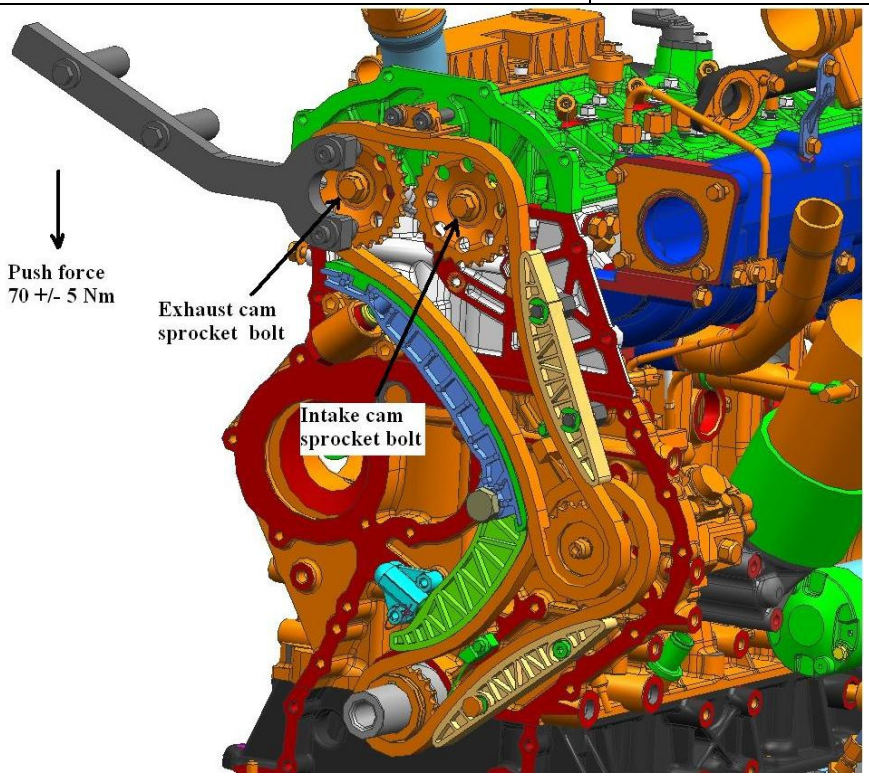
Assembly Tips –



Whenever the HLA & RFF assembly is removed from the head or stored or while handling; should be kept in straight direction.

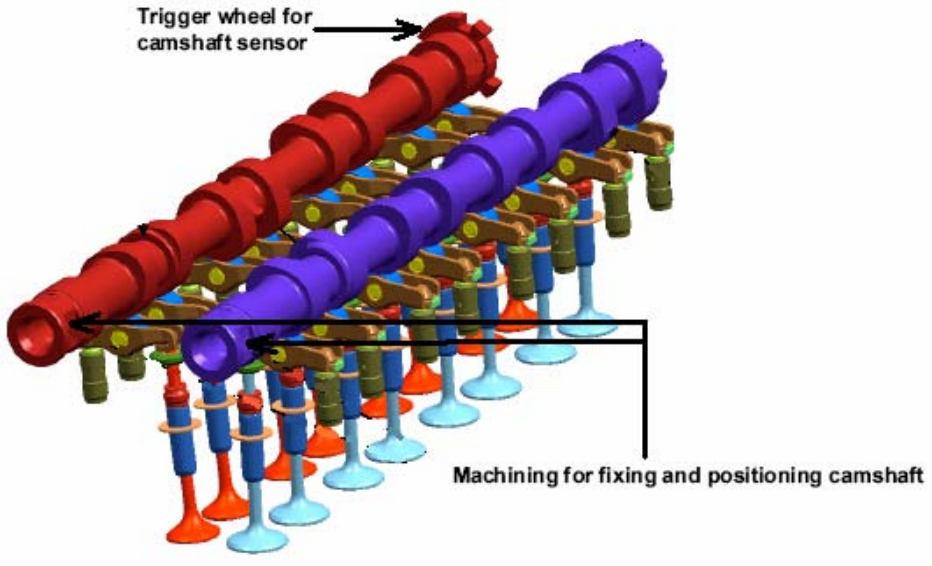


Before assembling the HLA & RFF back fill oil using a syringe through the hole shown in the sketch.

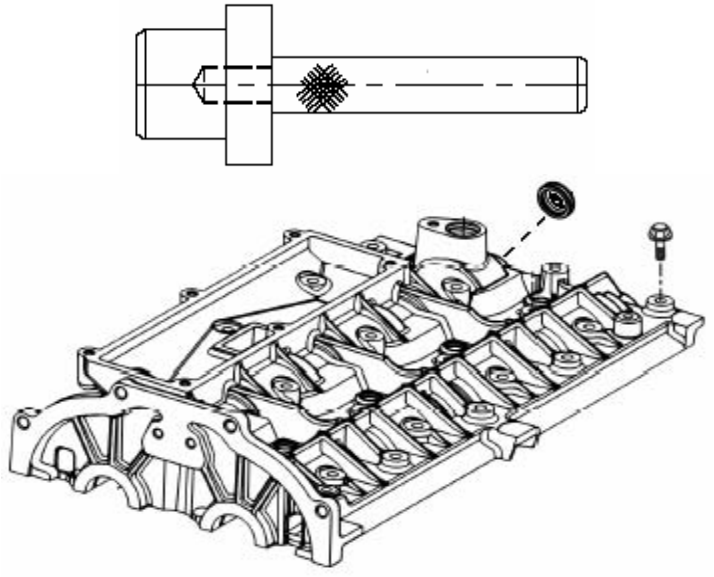


While tightening the cam sprockets (Exhaust & Inlet); use the special tool as shown to avoid the rotation of cam sprocket.

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The Exhaust Camshaft can be identified easily because of the trigger wheel for the Camshaft sensor.
Also please note that while assembly the machined portion on both the camshafts should be in vertical direction as shown in the sketch.

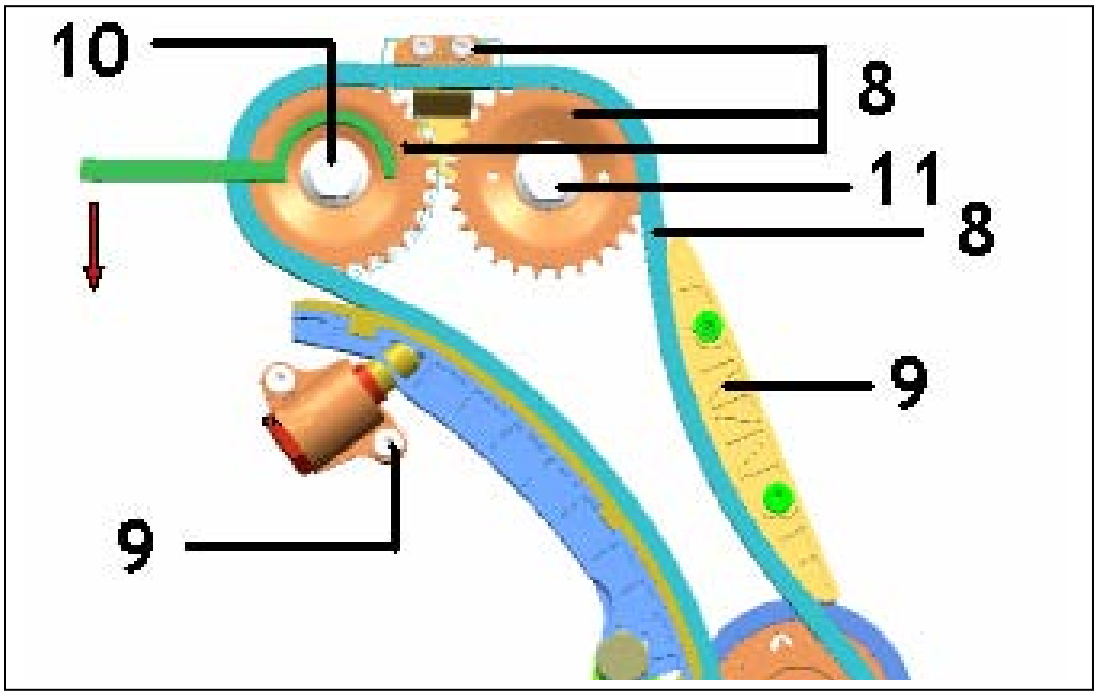


This tool has to be inserted in the Stefa plug hole & then cam cover to be assembled & torque tightened.
After torqueing the locator is to be removed & then mount the Stefa plug using the dolly adaptor.

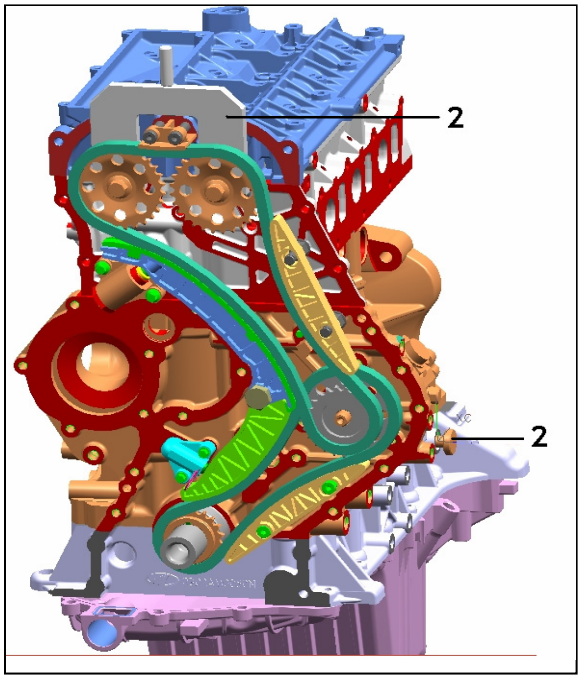
Note - This practice has to be followed in service because this avoids oil leakage in Stefa plug joint.

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Timing Procedure -



1. Rotate the engine in such a way that the crank shaft key comes at 12’o clock position (Facing towards the camshafts) as shown in fig.



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2. Fit the camshaft locking tool & the crankshaft locking pin as shown in the sketch above.

3. Assemble the crankshaft sprocket, HPP sprocket & the primary chain. Hands tighten the sprocket bolts.

4. Assemble the primary chain guide & Primary Chain Tensioner.

5. Assemble the floating chain guide.

6. Release the primary chain tensioner.

7. Tighten the bolt of HPP Sprocket to the specified torque.

8. Assemble the Inlet & Exhaust camshaft sprockets, Cam to Cam chain guide & Secondary chain. Do not tighten the Camshaft sprocket bolts.

9. Assemble the Secondary Chain Guide & Secondary Chain Tensioner. Release the Primary Chain Tensioner by rotating the bolt.

10. Turn & hold the Exhaust Cam Camshaft Sprocket against the tightening direction with the help of the tool as shown in figure above & tighten the bolt of Exhaust Camshaft Sprocket to the specified torque.

11. Tighten the bolt of Intake Camshaft Sprocket to the specified torque.

- Remove the tool for locking the Camshaft.
- Assemble the Front Cover & assemble the bolts. Tighten the front cover bolts to the specified torque & following the specified sequence.
- Assemble the flywheel. Torque tightens the Flywheel Bolts following the specified sequence. Lock the flywheel using the flywheel locking tool.
- Remove the Crankshaft Locking Pin from the Block.
- Fit the Damper Pulley & tighten the bolt to the specified torque.
- Remove the Flywheel Locking Tool.

Cylinder head

While assembling the cam cover, first fit the dolly and then assemble the cam cover, after that fit the end seals. Then only tighten the cam cover as per the sequence given in the Sequence section. If the dolly is not used then the probability of oil leak through the seals is high. The risk is that the oil leak from the seals facing the fire wall is difficult to observe during normal inspection. While inspection from bottom the oil leak may be confused with transmission leak.

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Oil separator

Please ensure sealant application in between the oil separator and the cylinder head in the seating areas only

Testing –

After the engine is reassembled in the engine stand; it is recommended that:

The engine is assembled back to the vehicle. All the connections are made.

- ✓ Start the engine
- ✓ Run at idle for 5 minute. Observe for leaks.
- ✓ Drive the vehicle at 50% of the maximum speed in each gear for about 10 to 30 KMs each (Approx.)
- ✓ Hand over the vehicle to customer to drive with speed limitation for 2000 KMs.
- ✓ After 5000 KMs. Readjust the fan belt and tappet clearance. Change the engine oil.

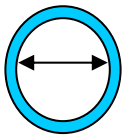
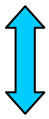
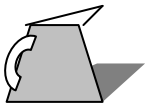
DO NOT RUN THE ENGINE WITHOUT LOAD FOR HOURS FOR BEDDING IN. THIS PROCESS ONLY HARMS THE ENGINE.

RUNNING THE ENGINE WITHOUT LOAD CAUSE RING FLUTTERING AND DAMAGE TO RINGS AS WELL AS LINERS.

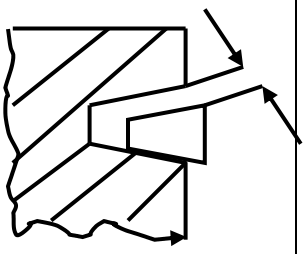
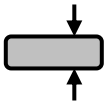
RUNNING THE ENGINE AT IDLE FOR PROLONGED TIME HAS SERIOUS CONSEQUENCES ON MAJOR ENGINE COMPONENTS

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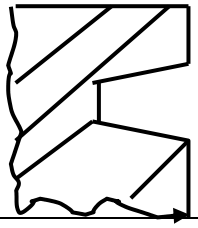
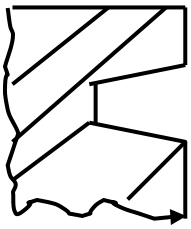
Specifications & Wear Data –

Figure	Description	Value
	**Bore**	85 mm
	**Stroke**	96 mm
	Power- Max	88 kW (120 HP) @ 4000 rpm
	Torque-Max	290 Nm@1800 rpm
	Firing Order	1-3-4-2
	**Direction of rotation**	Clockwise from fan side
	Compression Ratio	18.5
	Compression Pressure	Standard Service Limit bar
	Piston	Re-entrant Bowl
	Piston Pin	Full floating. Surface hardened & ground. Offset by 0.3 mm
	**Oil grade & Quantity**	API grade CH4 Viscosity Index 15W40 6 liters Maximile Supreme

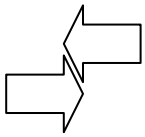
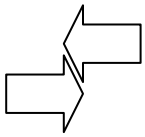
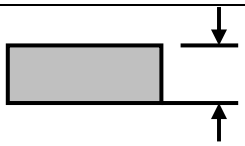
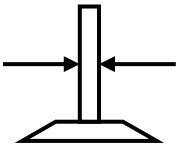
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Figure	Description	Value
	Inlet valve OPENS CLOSES	BTDC ABDC
	Exhaust Valve OPENS CLOSES	BBDC ATDC
	Oil filter bypass opening pressure	bar
1.0+/-0.2 kg/cm2	Relief valve opening pressure (for gear drive engines only)	bar
low idle: 1.5 bar, oil temp 90 degrees C high idle: 4.5-5.5 bar, oil temp 90 degrees C	Oil pressure at Idle (60~80°C) Max speed(60~80°C)	bar
	Piston ring to groove clearance 1st ring 2nd ring 3rd ring	Standard Service Limit Diametrically : 1.2-2 1.2-2.4 0.7-1.5
	Piston ring end gaps 1st ring 2nd ring 3rd ring	 0.25-0.4 0.4-0.6 0.25-0.5
	Gudgeon pin O.D ϕ	31.00-0.006
	Connecting rod - Small end bush I.D ϕ in assembled condition	Standard 31.00 (+0.041 / +0.025)
	Gudgeon pin to connecting rod small end bush clearance.	Standard Service Limit 0.025 to 0.047

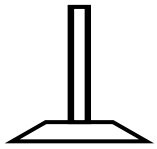
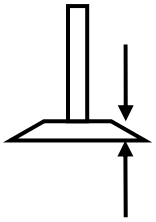
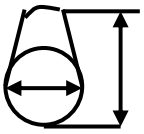
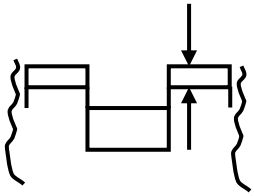
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Figure	Description	Value
	Gudgeon pin to piston pin hole clearance	Standard Service Limit 0.009 to 0.021
	**Piston to Bore clearance**	
	**Piston weights grading** **A** **B** **C** **D** **E**	A: 594-599 GMS B: >599-604 GMS C: >604-609 GMS D: >609-614 GMS
	Connecting rod grading as per weights **F** **G** **H** **I** **J** **K** **L** **M** **N** **O** **P** **R** **S** **T** **U** **Recommended for service replacement**	FOUR CONNECTING ROD WEIGHT ASSEMBLIES OF ONE ENGINE WILL HAVE WEIGHT DIFFERENCE OF 5 GM MAXIMUM WEIGHT OF ONE CONROD ASSEMBLY (CONROD, BOLT, BEARING, BUSH)= 950 +/- 12.5 GMS
	Connecting rod bend or twist	BEND AND TWIST: PARALLELISM OF SMALL END ID 0.06/100 WRT BIG END ID

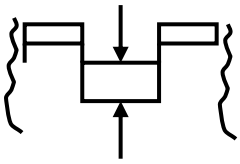
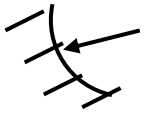
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Figure	Description	Value
	**Connecting rod end play**	Standard Service Limit 0.1-0.3
	**Crankshaft end play**	Standard Service Limit 0.1-0.3
	Crankcase top surface distortion	Top surface flatness: 0.04 and 0.02/100
	Cylinder head bottom face distortion	Bottom face flatness: 0.1 and 0.03/100X100
	**Height of cylinder head from top to bottom face**	124
	**Rocker lever bush I.D (in pressed condition)**	22.0
	Rocker shaft O.D	21.98/21.980
	Rocker to shaft clearance	Standard Service Limit 0.02/0.06 0.2
	Push rod bent	Standard Service Limit ≤ 0.25 0.4
	Valve spring **Free Length** **Squareness** **Installed Load/Installed length**	Standard Service Limit 47.16 1.5 max Load: 204.0 +/- 10.2 N, Length: 34.5
	Valve seat angle	90.0 0/+0.15' degrees
	**Valve stem O.D** **Inlet** **Exhaust**	 5.98 +/-0.008 5.96 +/-0.008

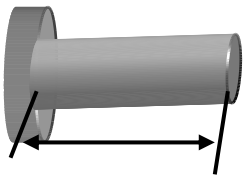
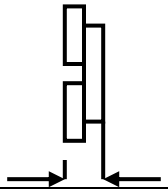
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	**Valve to Valve guide clearance** **Inlet** **Exhaust**	 0.012-0.142 0.032-0.168
	**Thickness of the valve head**	
	Chain **Crank Sprocket** **Idler Sprocket** **HPP Sprocket**	 20 teeth NA 21 and 30
	**Difference between Cam height & base circle diameter** **Inlet** **Exhaust**	 3.71 4.01777
	**Camshaft Bush I.D**	
	Camshaft Journal O.D	24.0 (-0.04 / -0.053)
	Camshaft bush to cam journal clearance	Standard 0.02/0.075 Service Limit 0.1
	Camshaft bend	
	**Crankshaft pin** **OD** **Roundness/Ovality** **Cylindricity /Taper**	Standard Service Limit 50.981-50.996 0.008 0.005

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Figure	Description	Value
	Main Bearing oil clearance	Standard Service Limit
	Undersize of the c/s crank pin OD **0.25mm US** **0.50 mm US** **0.75 mm US**	Dimensions of the crankpin.
	**Crankshaft journal OD** **Roundness/ Ovality** **Cylindricity/ Taper**	Standard Service Limit Yellow: 61.986-61.993 Red: 61.993-62.000 0.005 0.008
	Undersize of the c/s journal pin OD **0.25mm US** **0.50 mm US** **0.75 mm US**	Dimensions of the journal
	Crankshaft bend 	Standard Service Limit FILLETS ARE HARDENED. DO NOT ATTEMPT TO STRAIGTEN
	**Crankshaft fillet radius**	Standard Service Limits 3.0 mm typical
	Crankshaft Hardness Minimum	surface hardness: 50+5 all case areas are effective case depth is at HV450
	Connecting rod Bearing oil clearance	Standard Service Limit 0.026-0.069

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Figure	Description	Value
	**The Maximum length of bolts after which they cannot be used** Cylinder head bolts Main Bearing Bolts Connecting rod Flywheel bolts length	 Can be used 3 times Can be used 3 times Can be used 3 times
	Thermostat **Starts opening at** **Fully opens at** **Lift**	NA
	Water pump pulley ratio	0.76 (WP pulley runs faster than damper pulley)
	**Flywheel** **Width from Mounting face to clutch face**	31.5+/-0.15
	Flywheel **Flatness** **Runout**	Standard Service Limit 0.05 0.05
	Cylinder Head warpage Limit	0.1 mm.

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Lubricants & Sealant -

Mahindra Maximile Supreme or any other engine oil conforming to API grade CH4 or above and a viscosity Index of 15W 40.

RTV silicone sealant - RHODOSEAL. Part number 0024532 to be used:

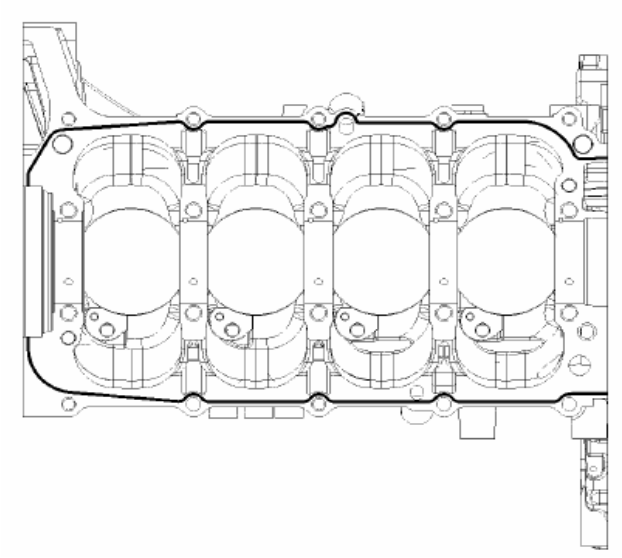
- **Between Rear oil seal retainer & Block**

Rust cleaning solution (For the Turbocharger mounting nuts):

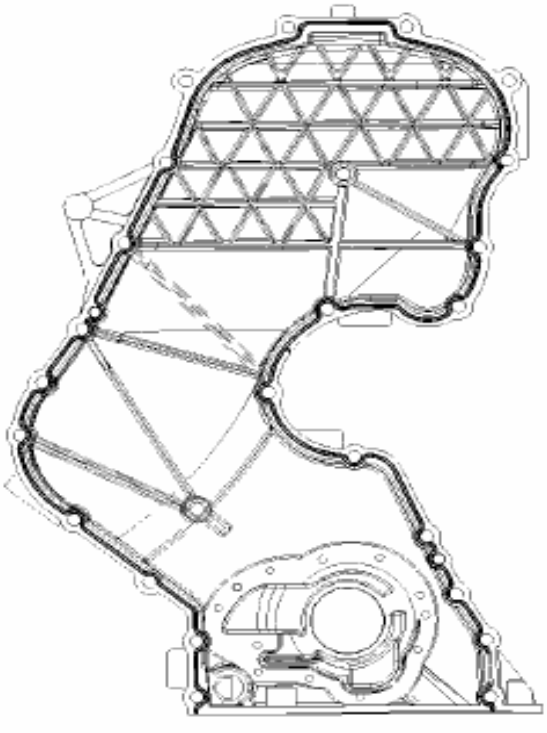
Brand Name: WD-40---
Manufacturer- WD-40 COMPANY

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Sealant Application Pattern -

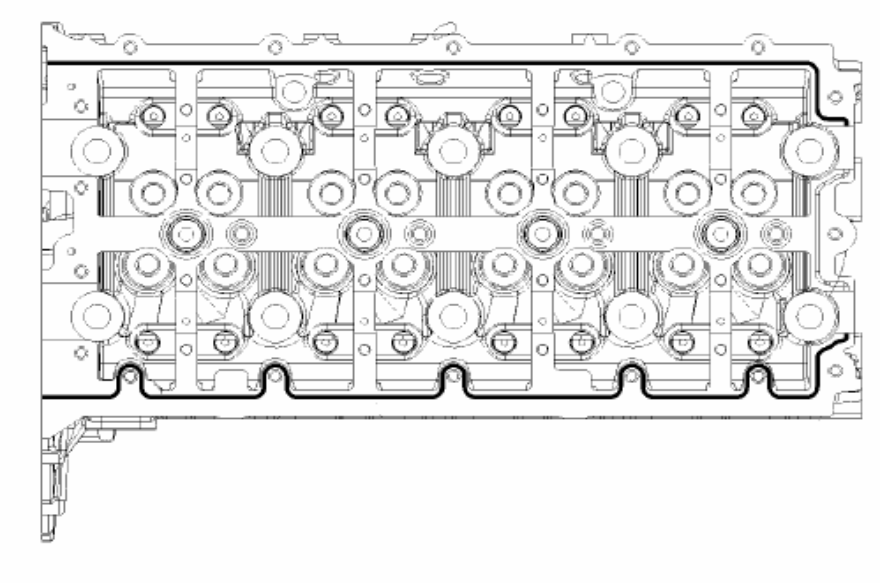


Sealant between Cylinder Block & Bed Plate - Loctite 574

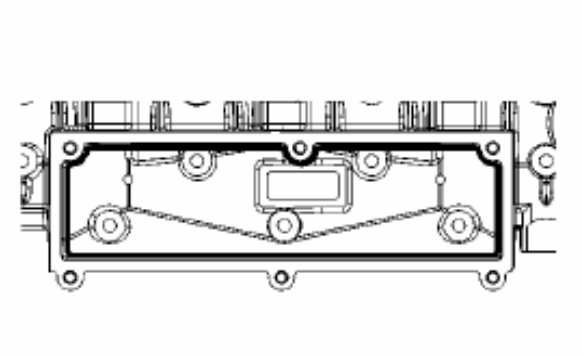


Sealant on Front Cover - Loctite 5900

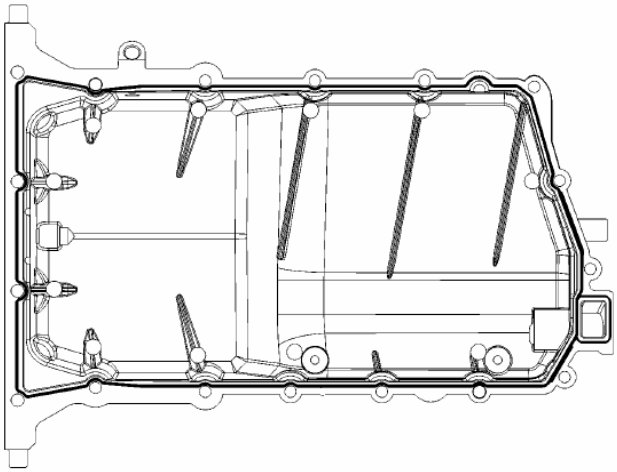
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Sealant between Head & Cam Cover – Loctite 574

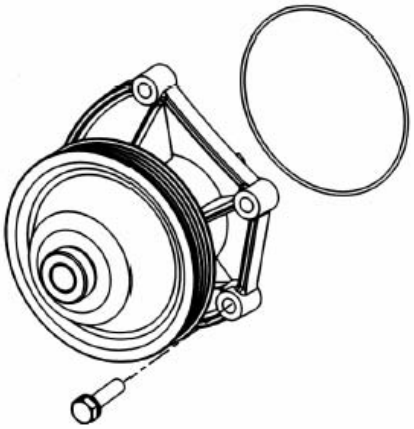


Sealant between Cam Cover & Oil Separator – Loctite 5900



Sealant On Oil Sump – Loctite 5900

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Water Pump 'O' Ring - Loctite 401

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Tightening Torques –

Description	Torque Value
Head Bolts	65 ± 3Nm + 90°
Bed Plate bolts	50 ± 2 Nm
Main Bearing bolts	65 ± 3 Nm + 2 X 60°
Connecting Rod caps	35 ± 3 + 60°
Flywheel	50 Nm + 60^0
Damper Pulley	150 + 65^0
HPP Mounting Nut	10- 12 Nm
Trigger wheel to Crank	15-20 Nm
Speed Sensor Mtg. bolt	10-12 Nm
Oil Jets mtg. bolts	10 -12 Nm
HPP sprocket lock nut	72.5 ± 2.5 Nm
HP pipe nut – Rail End	27 ± 2 Nm
HP pipe nut – Injector End	27 ± 2 Nm
Viscous Fan clutch nut	50-60 Nm
Injector holding clamp nuts	25 ± 3 Nm
Injector holding studs	22.5 ± 2.5 Nm
Common Rail Mounting Bolts	25 ± 3 Nm
HP pipe Pump to Rail – Pump End	10-12 Nm
HP pipe Pump to Rail – Rail End	10-12 Nm
Front cover Bolts	25 ± 3 Nm
Water Pump Bolts	25 ± 3 Nm
Water Outlet Pipe from Water Pump	10-12 Nm
Water Inlet pipe from Head to Radiator	10-12 Nm
Alternator Bracket bolts	30 ± 35 Nm
Chain Guide Bolts	10 ± 1 Nm
Chain Tensioner (Primary) Bolts	25 ± 3 Nm
Chain Tensioner (Secondary) Bolts	25 ± 3 Nm
Cam to Cam Chain Guide	10 Nm
Cam Sprocket Bolts	85 ± 95 Nm
Oil Filter Cartridge	11±1Nm
Dip Stick Guide	18 Nm
Oil Filter body	25 ± 3 Nm
Alternator oil supply line – Banjo End	15 ± 20 Nm
Alternator oil supply line – Block End	18 Nm
Power Steering Pump Mtg. Bolts	25 ± 3 Nm
Exhaust Manifold Mtg. Bolts	25 ± 3 Nm
Turbocharger Mtg. studs on exhaust manifold	25 ± 3 Nm
Turbocharger Oil supply pipe – Banjo End	10-12 Nm
Turbocharger Oil supply pipe – Block End	10-12 Nm
Turbocharger Oil drain Banjo Bolt	25 ± 3 Nm
EGR Mtg. nuts	25 ± 3 Nm
AC compressor Mtg. Bracket Bolts	25 ± 3 Nm
AC compressor Mtg. Bolts	35 ± 3 Nm

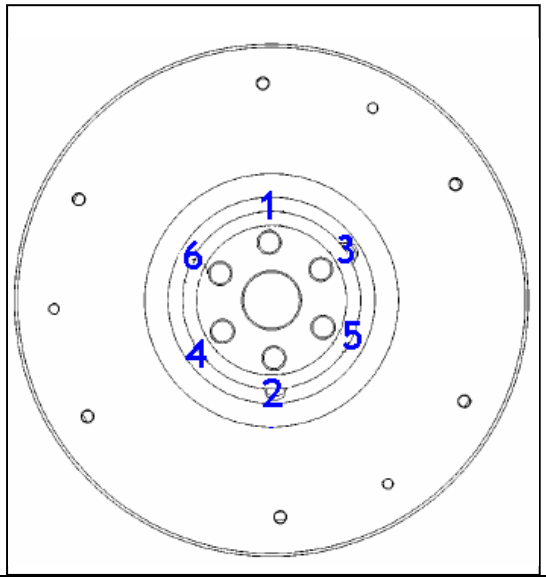
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Intercooler Mtg. Nuts	17.5 ± 2.5 Nm
Intercooler dampers	17.5 ± 2.5 Nm
AC compressor on bracket	25 ± 3 Nm
Automatic belt tensioner Mtg. nuts	25 ± 3 Nm
Bolts – Mtg Inlet Manifold	25 ± 3 Nm

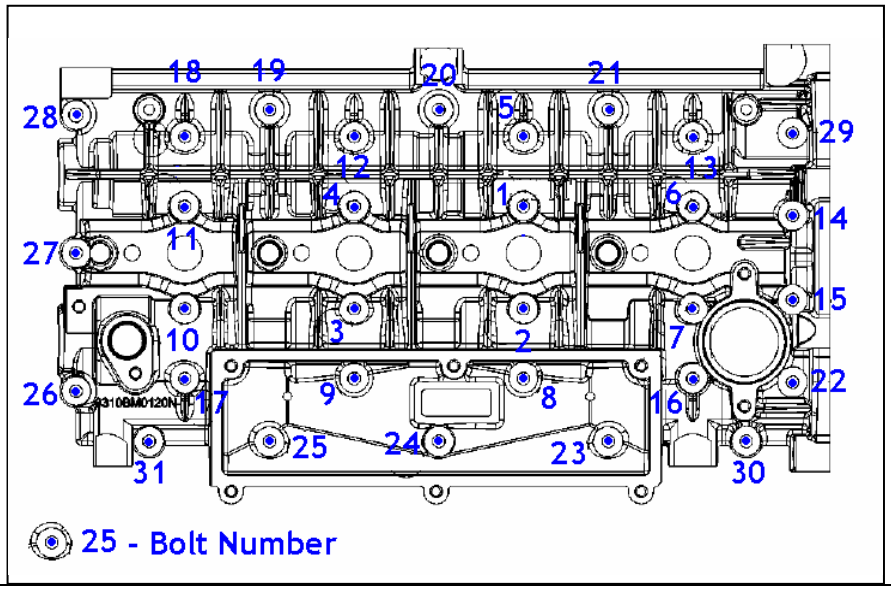
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Torque Sequence -

Flywheel Bolts

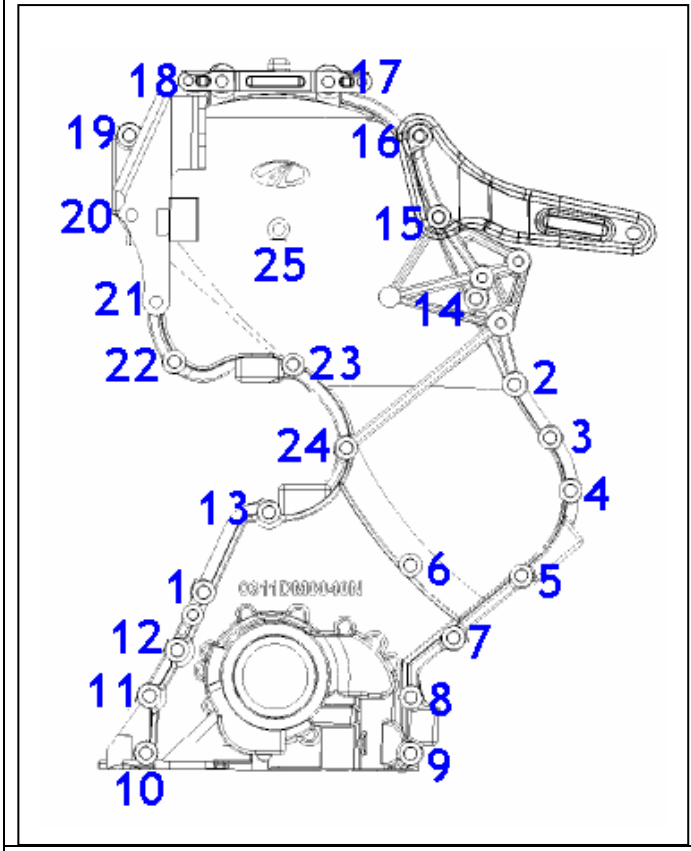


Cam Cover Bolts

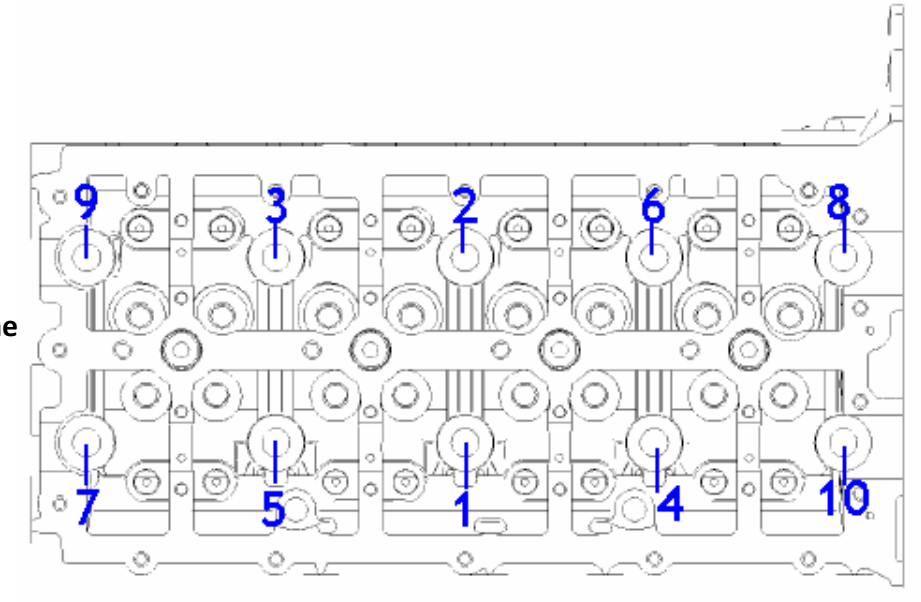


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Front Cover

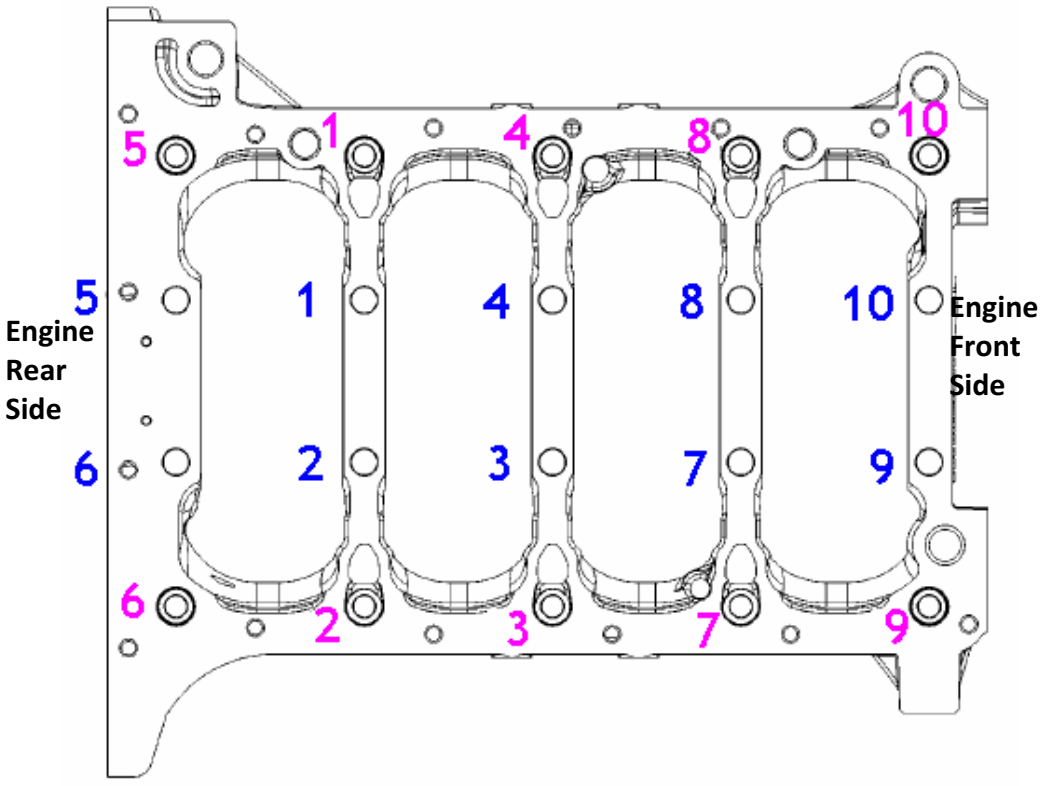


Head Bolts



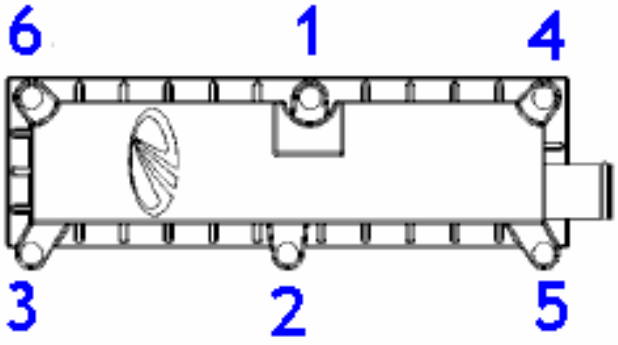
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Cylinder Block & Bed Plate Bolts



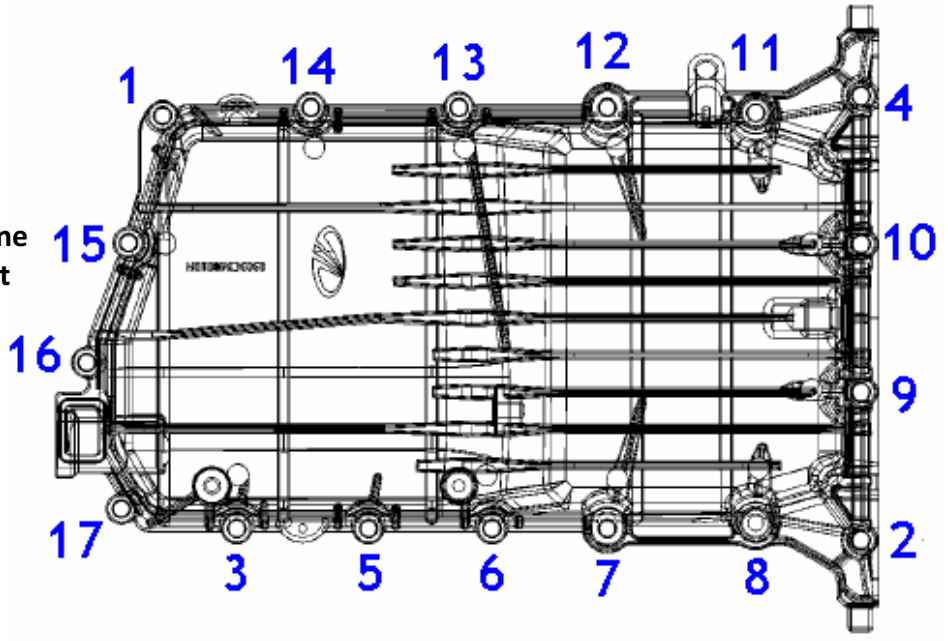
Main Bearing Bolts
Bed plate Bolts

Oil Separator Bolts

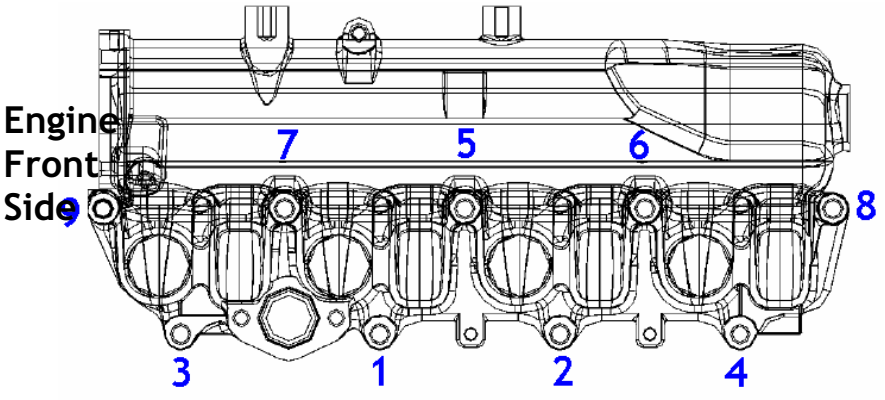


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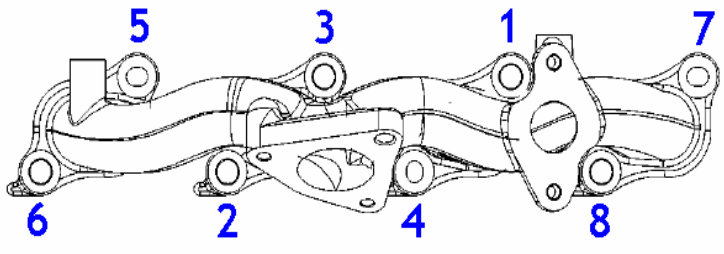
Oil Sump



Inlet Manifold



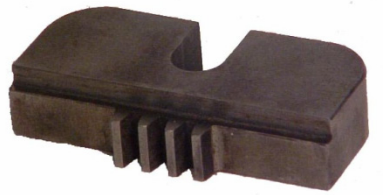
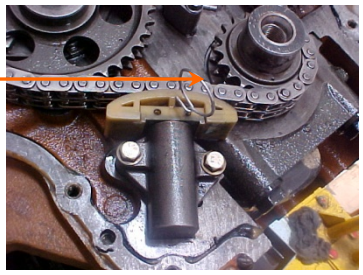
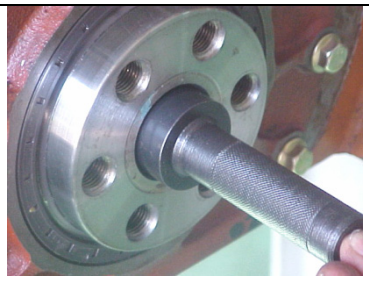
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Exhaust Manifold

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Special Tools -

Description / Part No. / Sketch	Usage View
Flywheel Lock MST 271 	
Lock Pin for Chain Tensioner MST 273 	
Drift Flywheel Bearing MST - 544 	
Wrench Oil Filter Remover MST - 545 	
Cylinder Head Bolt Deep Socket MST 588 	

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Air Intake System- M-Hawk

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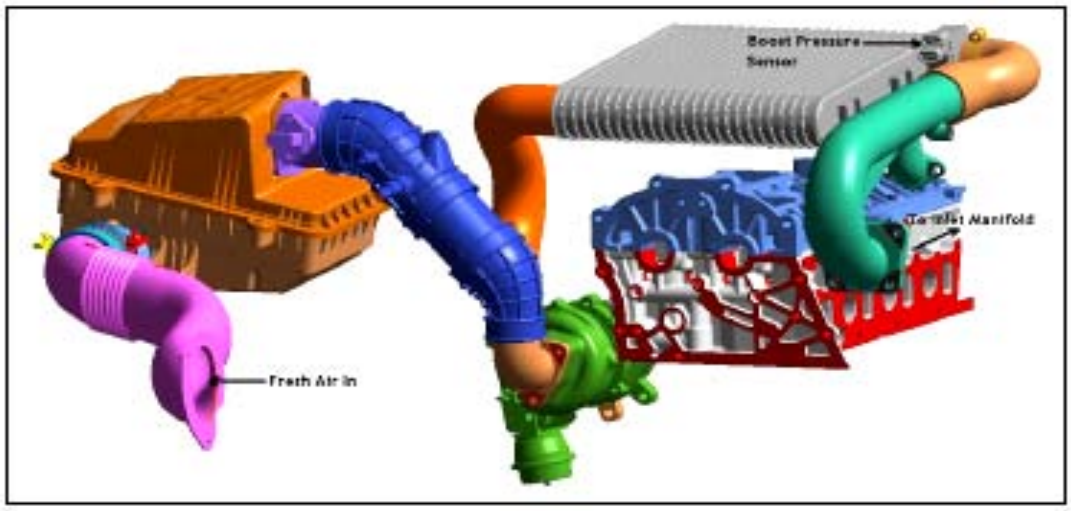
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Tightening Torques

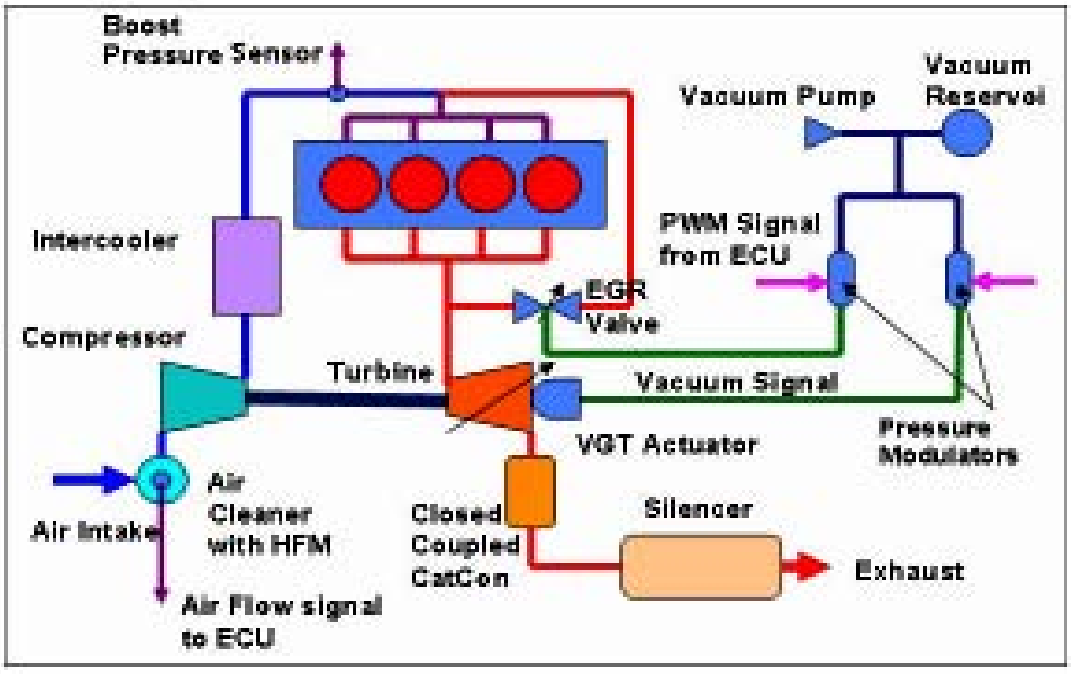
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Description

The air is sucked through a foam type air cleaner. The air enters the air cleaner housing at the bottom and leaves at the top.
The air cleaner is made up of 5 different layers of foam. Each layer is having different cleaning efficiency.



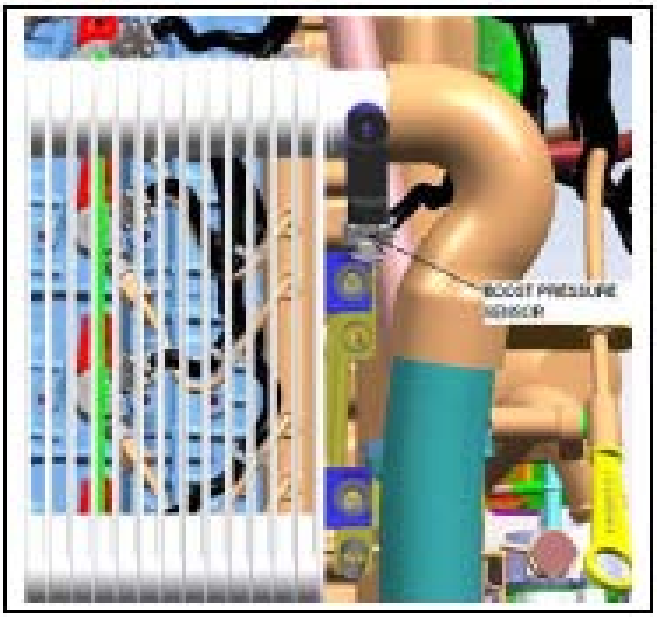
After filtration the air goes to the turbocharger.
The line diagram of the air intake circuit is given below –



A HFM sensor is attached to the outlet of the air cleaner. The air to the turbocharger passes through HFM. The HFM measures the air mass going to the engine. The quantity

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of the air going is used to compute the fuelling. The HFM also measures the air temperature.
After the HFM and before turbocharger there is a service indicator. In case of mechanical one, red band appears in choked condition.



The variable geometry turbocharger controls the boost. A boost pressure sensor fitted on the outlet of the intercooler measures the boost. The boost signal is given to the engine ECU. Based on the load, engine speed, temperature, the ECU controls the boost by manipulating the variable geometry TC. The compressed air is cooled by the charge Intercooler, which is mounted on the engine. The cooled air enters the inlet manifolds.

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Trouble Shooting -

Symptom	Causes	Remedial action
Engine does not start & emits black smoke	Air intake obstructed	✓ Check whether service indicator light glows or red band appears and replace element if light is on /red band appears. ✓ Refer to the care of the system also ✓ Check for free operation of Turbocharger
Engine does not give full power.	1. Air intake restricted. 2. Air leaks in system after turbocharger 3. Air leak in pipe - manifold to FIP 4. Boost pressure control valve stuck in open condition. 5. Boost pressure pipe/hose assembly damaged 6. Turbocharger damaged.	✓ Replace element ✓ Plug the leaks, replace hose or clip if required. ✓ Replace the hose or tighten ✓ Correct the control valve & find the cause ✓ Check the pipe, washer & rectify. ✓ Get the Turbocharger repaired at authorized TEL dealer.
Black smoke.	1. Air intake restricted. 2. Air leaks.	✓ Check for hoses, replace element. ✓ Check for leaks between Turbocharger & inlet manifold ✓ Remove restriction or replace parts.
Excessive oil consumption	1. Clogged air filter element. 2. Restriction in air intake to compressor duct. 3. Air leak between the Turbocharger to intake manifold. 4. Restrictions in turbocharger drain line. 5. Restriction in crankcase breather. 6. Thick oil/sludge or	✓ Replace element. ✓ Locate & remove restriction. ✓ Locate the leaks, change hose or clamp if required. ✓ Remove the restriction in the drainpipe. ✓ Check the crankcase ventilation & rectify.

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	coke in the turbocharger's central housing 7. Turbocharger damaged.	✓ Change oil, filter, service the Turbocharger & use recommended oils & drain intervals. Follow the recommended procedure while shutting down. ✓ Repair Turbocharger.
Whining noise clearly audible after 2000 RPM	1. Indication of air leak esp. in between: Turbocharger to inlet manifold.	✓ Tighten the clamps at the intercooler inlet and outlet. ✓ Tighten the clamps at the Turbocharger inlet & outlet. ✓ Check the hoses for leak. ✓ Check & replace the pipe to and from intercooler.

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Care of the System

The air cleaner element should be replaced every 40,000 KMs or if service indicator light glows under normal driving conditions.

Under extremely dusty conditions replace earlier than above.

It should be noted that if the engine is run with clogged air cleaner, then it will lead to seepage of oil from turbocharger into the air intake system.

Ensure that the recommended engine oil only is used and the specified drain intervals are maintained.

To achieve an optimum cooling of the compressed air it is vital that the vehicle's number plate position is not changed and/ or an oversize number plate does not block the aperture for the air draft for the intercooler.

The Turbocharger & boost control valve does not require any special maintenance. However check the boost pressure pipe for proper fitment (connection from compressor to boost valve). Damage, cracks, chips at ends, etc.

Check the operation of the waste gate valve by blowing compressed air with 2.0 bars in the valve hose. The valve should open, pressing the turbocharger stem and opening the exhaust valve (flap valve)

Check the oil separator system, in particular for any leak in vacuum leak. As any vacuum leak will lead to a high-pressure build up and then it will go through the intake system and give a signal of high blow by or be confused with compressor oil leak.



Do not attempt to disturb length of the waste gate controlling actuator rod.

If the Turbocharger is removed, please do not lift the turbocharger using the actuator rod as a lifting handle.

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In Car Repairs

Air cleaner Removal

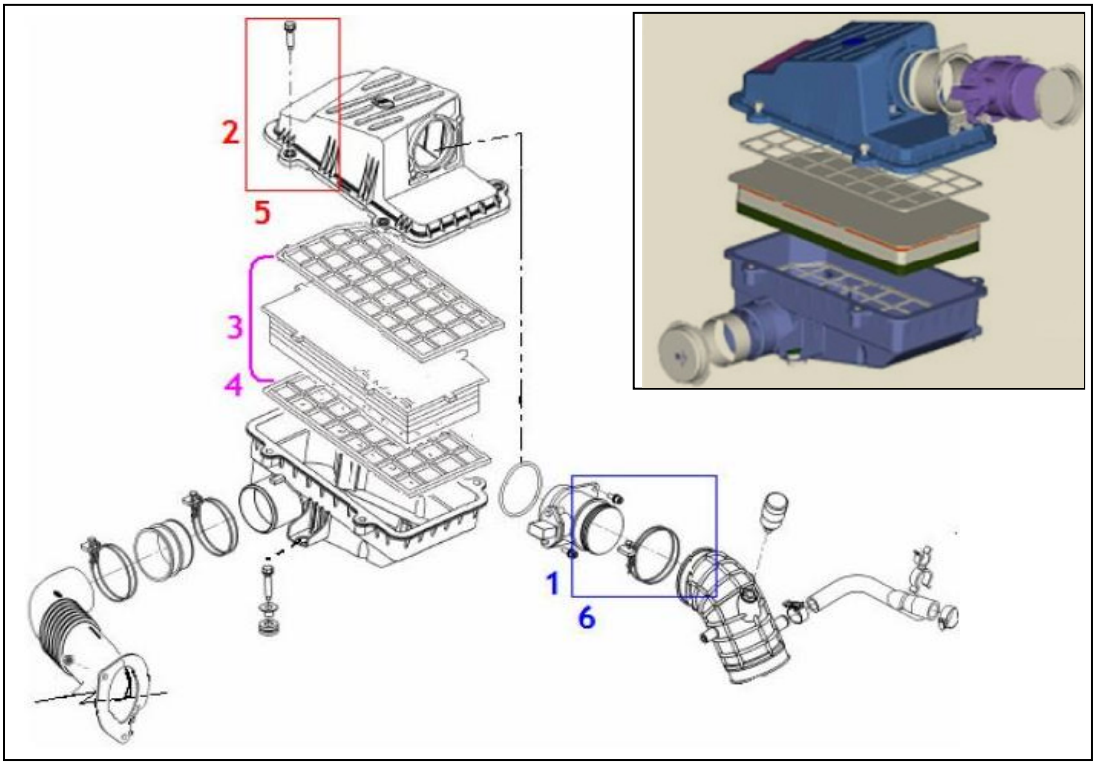
Cleaning the element.

Turbocharger removal & Refitment.

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Air cleaner Servicing -

Replacing the filter element -



AIR FILTER ELEMENT – REPLACE

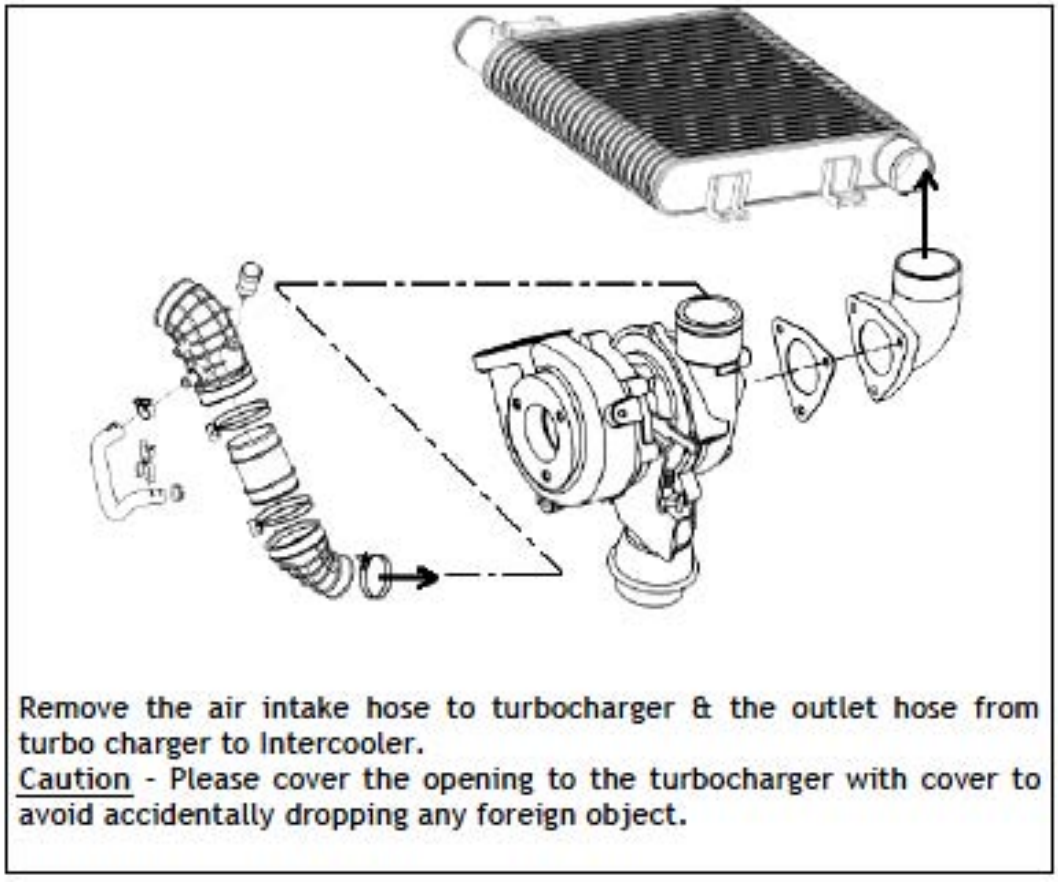
Refer illustration shown above –

1. Open the clean and dirty sides hose clip & remove the hose.
2. Open the Air cleaner Top cover bolts.
3. Remove the Air filter element along with grates and clean the bottom bowl.
4. Separate the top as well as bottom grates and replace the air filter element; assemble the grates & put the assembly back in place. Position the new element properly. Take care of lug projections.
5. Assemble the top cover & tighten the top cover bolts diagonally.
6. Assemble the clean hose on the air cleaner outlet-Air Mass Sensor neck and tighten the hose clip.

The cleaning of the element is not recommended under any circumstances.
Do not wring the foam.
Do not use if foam is cut, torn or foam layers are separated.

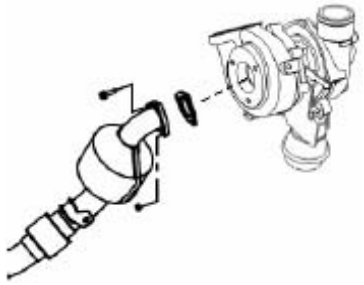
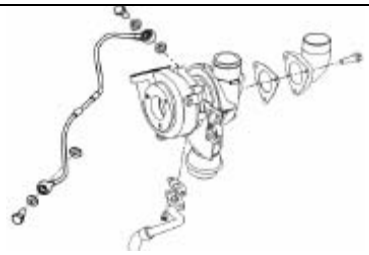
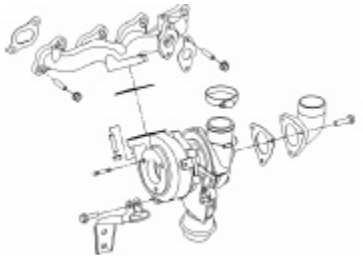
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Turbocharger removal & Refitment



Remove the air intake hose to turbocharger & the outlet hose from turbo charger to Intercooler.
Caution - Please cover the opening to the turbocharger with cover to avoid accidentally dropping any foreign object.

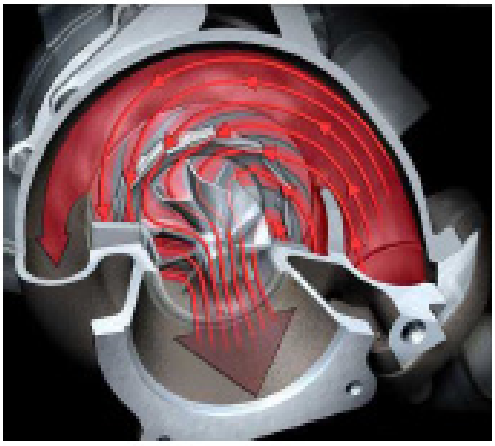
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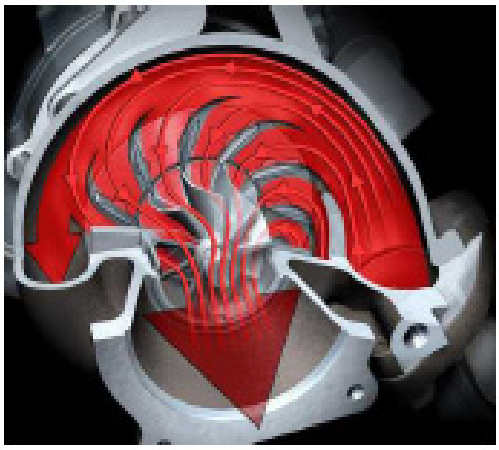
	Remove the exhaust pipe from the turbocharger. **Note - It is recommended to apply rust cleaning spray (WD 40) in the nuts before attempting to remove Otherwise, the stud will come off.**
	Remove the oil feed pipe and the oil return pipe to turbo.
	Loosen & remove the turbo charger support bracket. Remove the turbocharger mounting fasteners from exhaust manifold.

Working Principle, Inspection & Fitment procedures of the Turbocharger –

The Turbocharger is basically an axial inflow air compressor, which is driven by an exhaust gas driven turbine. The exhausts gases coming out of exhaust manifold impinge on the turbine blade give the drive to turbine shaft. At the other end of the turbine shaft the compressor is assembled. The whole assembly is supported on a floating bush. The bush gets an oil supply directly from the engine and has oil film between the shaft and bearing as well as the bush and the central housing.
The exhaust gases from the Turbine impinge on the turbine blade & rotate the shaft. The compressor blades at the other end suck the air from the air filter. After compression the temperature of the compressed air increases thus reducing the air density. Hence if the air is cooled and then the air density increases thus helping in getting more power as well as improve emissions. The compressed air is sent to the intercooler, which is mounted on the top of the engine. Hence the incoming ram air through the scoop on the bonnet also cools the compressed air and gives it to the intake manifold.

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The turbocharger is matched to give an optimum boost for the desired engine speed band. A vacuum controller controls the boost. Also the boost pressure sensor mounted on the Intercooler Outlet pipe monitors the boost.
As the name indicates the Variable Geometry Turbocharger provides variable boost according to the needs.
This is achieved by changing the fins position using the vacuum controller. The ECU constantly monitors the signals from the boost pressure sensor & signals from the other sensors & accordingly controls the vacuum going to the modulator which in turn controls the vacuum controller.
The above two pictures shows the fins fully closed & fully open. When the fins are fully closed the boost is the highest & when they are fully open the boost is at minimum.

Inspection
✓ Inspect the suction side (i.e. up to the air cleaner) for oil traces. In a close crank case ventilation system it is normal to have oil in this area. These oil particles are carried from blow bye of the engine, which gets condensed from gas to oil. Look for any undue gumming of oil, hard carbon particles in this area. If such an observation is present then all the causes for excess blow symptoms have to be checked and eliminated.
✓ Inspect the compressor and turbine blades for any damage caused by foreign object. The inspection can be done through the compressor housing inlet and turbine housings outlet.
✓ Inspect the blades outer edge and observe if any rubbing marks are noticed on the housing.
✓ Rotate the shaft wheel assembly by hand and check for freeness, and any binding.
✓ Push the shaft to side and rotate to check for wheel rub. It should turn smoothly.
✓ Lift both end of shaft up and down at the same time and feel for excessive journal bearing clearance. If clearance is normal then very little shaft movement will be detected.

✓**If all the above checks are satisfactory then the turbocharger can be reused.**

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✓**If the turbocharger parts are damaged, wheel rubbing marks present, shaft not rotating freely or binding or excessive journal clearance then the Turbocharger should be serviced.**
✓ Do not attempt to service or overhaul the Turbocharger. It should be done only at the authorized Turbo Energy Ltd service center. Any attempts to attend without the use of special tools or procedure can damage to turbocharger or personnel!

Turbocharger Installation –

Do not mishandle, tumbled, dropped or keep any ports open.

Check
The inlet connection & outlet exhaust connection to turbocharger for foreign material, cracks, blockages, sand particles, loose nuts etc. This check should be done more thoroughly if any damage has been noticed in compressor or turbine blades as under normal operating conditions the blades can damaged only if a foreign object hits them.
Check all the hoses and pipes from turbocharger outlet to intercooler and intercooler to inlet manifold for crack, aging, leaks. Check the hose clips for proper functioning. If in doubt – replace. The oil supply pipe should be checked carbon deposits, crack, distortions etc. Clean the supply pipe before fitting. Do not attempt to change the orientation of turbocharger and ensure the correct gaskets are used.
Do not reuse any of metallic gaskets even if they appear to be good. It will lead to leakage & drop in the performance of the engine.

Installation –

Once a new turbocharger is being installed

i. Fill fresh clean oil from the oil supplies port and after that give the shaft few rotations.
ii. Fit the supply pipe.
iii. Crank the engine till a steady stream of oil comes out through the drain pipe.



Do not crank the engine for too long.
Excessive cranking will result in emptying of the pump cavity causing the plunger to run dry.)

This will ensure that the oil supply line to Turbocharger is purged of any air pocket.

After this fit the return line from turbocharger to sump, taking care to avoid any kinks. With engine running condition, check the air, exhaust and oil connections for leaks.

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Specifications -

Description	Value
Turbocharger Model	K 04
Turbocharger specifications	K0 4-2075 ECD5.82
Turbocharger supplier	Turbo Energy Ltd.
Air velocity between the Air filter compressor inlet	35 M/sec
Air velocity between the compressor outlet and the inlet manifold	50 M/Sec (Max)
Maximum static back pressure at downstream of turbine	60mbar
Oil pressure at upstream of turbocharger	2.5 bar

Tightening Torque's -

Bolt location	Torque in Nm (Lb-ft)
Turbocharger Mounting stud/ nut	25 ± 3 Nm(18.4 ± 2 lb-ft)
Inlet manifold	25 ± 3 Nm(18.4 ± 2 lb-ft)
Air cleaner top cover bolts	4.5 Nm (3 lb-ft)
Air filter top cover allen bolt	4.5 ± 0.5 Nm 2.5 ± 0.5 Nm.
Hose clamps – air cleaner to manifold	4.5 ± 0.5 Nm.

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Cooling System

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Specifications & Coolant

Tightening Torques

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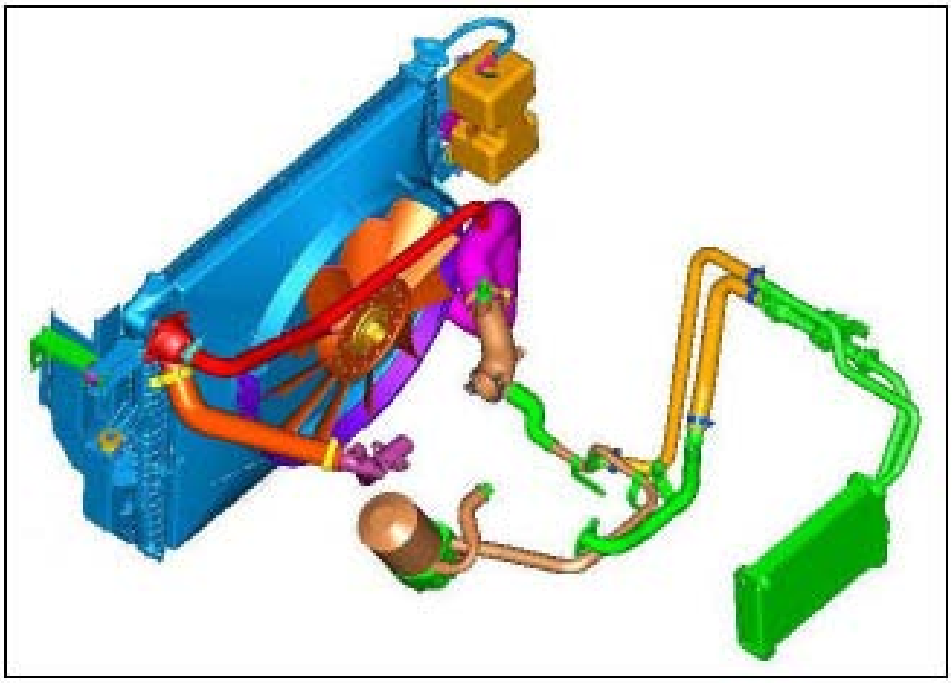
Description

The cooling system is designed to cater to the following functions:

- **Remove & dissipate excess heat from the combustion process.**
- To maintain the optimum temperature for complete and uniform combustion.
- To provide heating for the heater system.(In the models where the Heater is provided)

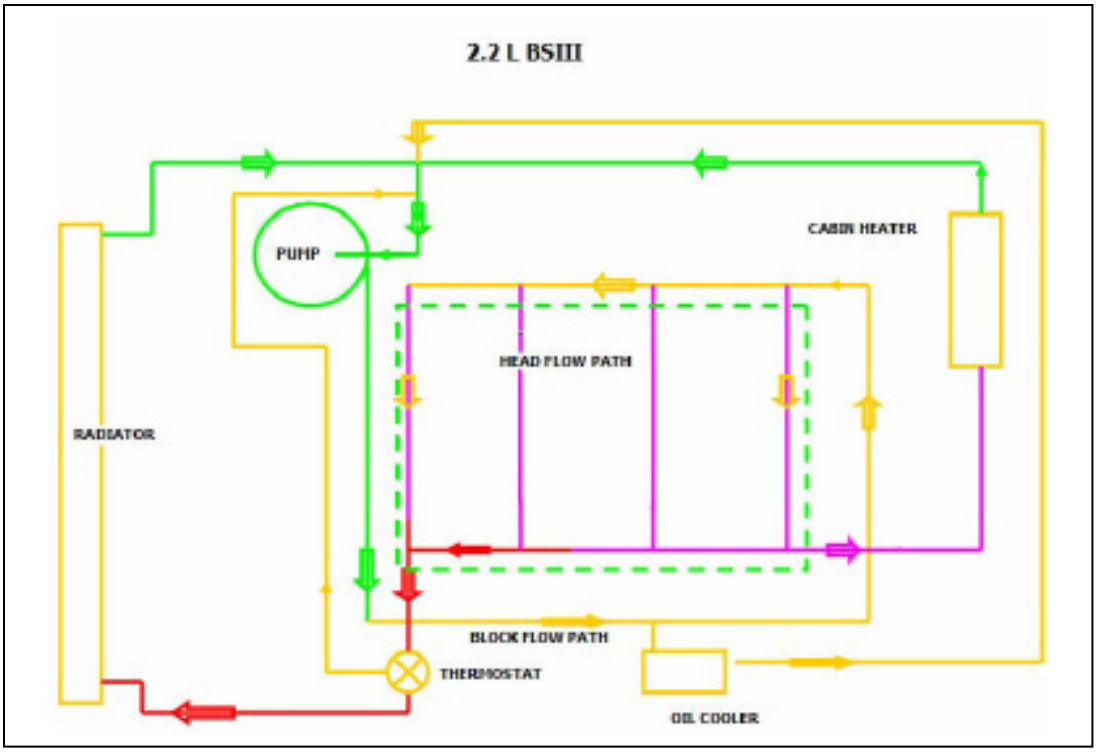
The cooling system includes the following components/ sub system:

- ✓ Radiator
- ✓ Radiator Pressure cap
- ✓ Coolant
- ✓ Cooling fan (Mechanical or Electrical)
- ✓ Fan drive
- ✓ Fan shroud, Thermostat
- ✓ Water pump
- ✓ Thermostat housing, cover thermostat, Recovery tank
- ✓ Hoses & their clamps.



The layout of the cooling system is shown in the sketch, above.
The functional system is shown in the block diagram.

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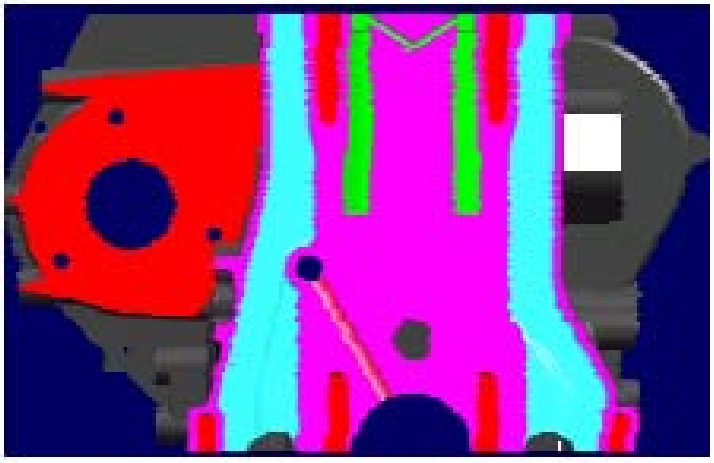


Broadly speaking the water flows from the water pump to the Front cover from the cover it goes to cylinder block and from the block to the cylinder head and then to the bottom of thermostat. In case the thermostat is closed, water goes through the bypass tube to water pump. Once the thermostat opens the water goes to the radiator and after getting cooled the water is again fed to the water pump. One pipe goes from the thermostat housing to the heater core of HVAC unit and then returns back.

Water pump & cover -

The coolant from the outlet elbow of the cross flow type radiator enters the inlet of the water pump. The centrifugal water pump delivers the water to the front cover from there to the cylinder block.

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Cylinder block & cylinder head –

In the block the water enters a main cooling passage which runs along the length of the block in one side (inlet manifold side). The top passage ensures that the maximum cooling is provided to the hottest zone of the cylinder liners i.e. the top portion.

At the same time a passage at the front end connect the inlet to another gallery at the bottom of the liner. In between the top and lower passage in the block the coolant flows between the block & liners due to the thermos siphon effect. The water then goes to the cylinder head and from there to bottom of the thermostat. One external pipe from the back end of the block goes to the oil cooler. The return pipe form the oil cooler is connected to the inlet of the water pump.

Radiator & No loss tank –

The radiator cap controls the system pressure to 0.9 bars. Once the pressure exceeds 0.9 bar the cap lifts off the seat and the coolant is allowed to escape into a no loss tank.

As the engine cools down the system pressure falls and vacuum is formed .The vacuum valve in the radiator cap opens and allows the water from the no loss tank to go back into the radiator. Thus the system does not have any coolant loss during normal operation.

Water for HVAC –

The hot water at the thermostat housing is diverted to the heater unit, which is located in the passenger compartment for the HVAC function.
The return from the heater is connected to the inlet of the water pump. It should be noted that a water valve near the heater/climate box controls the amount of the water, which enters the heater unit. The occupants determine the amount of the opening of the water valve. It will be full quantity when it is set is maximum heater mode and vary till the coldest mode where it will become nil as the valve will be fully closed

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Trouble Shooting -

Before going into the specifics of the cooling system it is worthwhile to find out under which driving conditions the complaints is present.

Some of the causes are:

Prolonged /excess idling

Very high ambient temperature

Slow traffic

Traffic jams

High speed

Steep Gradients

To avoid overheating under such conditions it will be worthwhile to:
Idle with the AC off. In case the temperature indicator needle is close to the red band. Increase the engine idling speed.

Symptom	Causes	Remedial action
Noise	*Fan shroud* 1. Fan contacting the shroud	✓ Reposition the shroud and inspect the engine insulators.
	Water pump 1. Loose water pump impeller. 2. Water pump bearing worn/ failure. 3. Loose mounting of pump	✓ Replace the water pump. ✓ Replace water pump. ✓ Tighten mounting bolt
	Belts 1. Belt loose 2. Glazed/stretched fan belt. 3. Rough surface on drive pulley. 4. Belt alignment	✓ Tighten belt ✓ Replace serpentine belt, ✓ Replace pulley.
	Alternator/Water pump 1. Alternator bearing failure	✓ Check the belt alignment & rectify.

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	Belt tension mechanism 1. Idler pulley bearing failure 2. Idler mounting bracket failure. 3. Tension bolt failure.	✓ Replace alternator bearing ✓ Replace idler bearing. ✓ Replace the idler bracket. ✓ Replace the tension bolt.
Coolant loss- boil over	Coolant 1. Overfilled recovery tank. 2. Insufficient coolant additive causing lower boiling points. 3. Additive deteriorated due to aging/ contamination. 4. Low coolant level. Hot shut down 1. Quick shut downs after a long and hot run. Leakage's 1. Leaks due to loose hose clamps. Loose nuts, bolts drain plugs, faulty hose or leaking radiators. Blockages 1. Casting flash in the block. 2. Casting flash in the cylinder head. 3. Blocked radiator causing under filling of the	✓ Reduce the coolant level. ✓ Add the additive. ✓ Replace the coolant ✓ Add coolant ✓ Allow the engine to run at idle for some time before stopping. ✓ Find the area of leaks , replace hose or if necessary the clamp also ✓ Pressure tests the system to check for leaks and then repair as necessary. ✓ The flash may be visible by removing the cooling system components or the core plugs. Repair or replace. ✓ Flush radiator.

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	cooling system. 4. Air trapped in system. 5. Air in the system causing occasional burping. 6. Faulty expansion bottle cap or pipe.	 ✓ Purge the system. ✓ Replace the cap/ pipe.
Coolant loss- boil over	Gas mixing 1. Cylinder head gasket failure. Pressurization 1. Defective radiator cap. Timing 1. Improper engine timing Belt 1. Slipping belts 2. Belt failure Water pump 1. Water pump shaft broken or damaged impeller. Thermostat 1. Faulty Thermostat. Hoses 1. Radiator hoses collapsed Fan 1. Cooling fan not engaging. Air flow 1. Air flow reduced to choked fins 2. Airflow reduced due to obstruction. **Vehicle** Brakes dragging.	✓ Replace the cylinder head gasket ✓ Replace the cap. ✓ Check the engine timing, FIP timing, injector pressure and also the tappet clearance. ✓ Adjust belt tension. ✓ Replace belt ✓ Replace water pump ✓ Replace Thermostat. ✓ Replace hoses. ✓ Check the functioning of the VFD replace if required. ✓ Clean the radiator fins. ✓ Remove the obstruction. ✓ Check the brake system.

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High Temperature Indication	*Improper indication* 1. Faulty sensor 2. Faulty gauge	 ✓ Replace the sensor. ✓ Replace the gauge.
Coolant entry into Crankcase or cylinder	1. Low cylinder head torque. 2. Faulty head gasket. 3. Blow hole in crankcase, head , liner	✓ Replace the cylinder head gasket, torque as per procedure. ✓ Replace the cylinder head gasket ✓ Replace the affected part.
Low Temperature Gauge Indication- Under cooling	1. Thermostat stuck open 2. Faulty sensor. 3. Faulty gauge.	✓ Replace thermostat. ✓ Replace sensor. ✓ Replace gauge.
Coolant reserve system inoperative	1. Coolant level low 2. Leak in system 3. Overflow tube clogged or leaking. 4. Recovery bottle vent blocked. 5. Radiator cap defective.	✓ Replenish coolant to FULL level. ✓ Pressure test to isolate & repair. ✓ Remove clogging ✓ Clean vent. ✓ Change the cap.
No coolant flow trough Heater Core	1. Restricted return inlet in water pump. 2. Heater hoses collapsed or restricted. 3. Restricted heater core. 4. Restricted outlet in the thermostat housing. 5. Heater valve controls not functioning. 6. Heater valve stuck.	✓ Remove restriction. ✓ Remove restriction or replace hose. ✓ Remove flash or restriction. ✓ Remove restriction. ✓ Repair controls. ✓ Repair or replace

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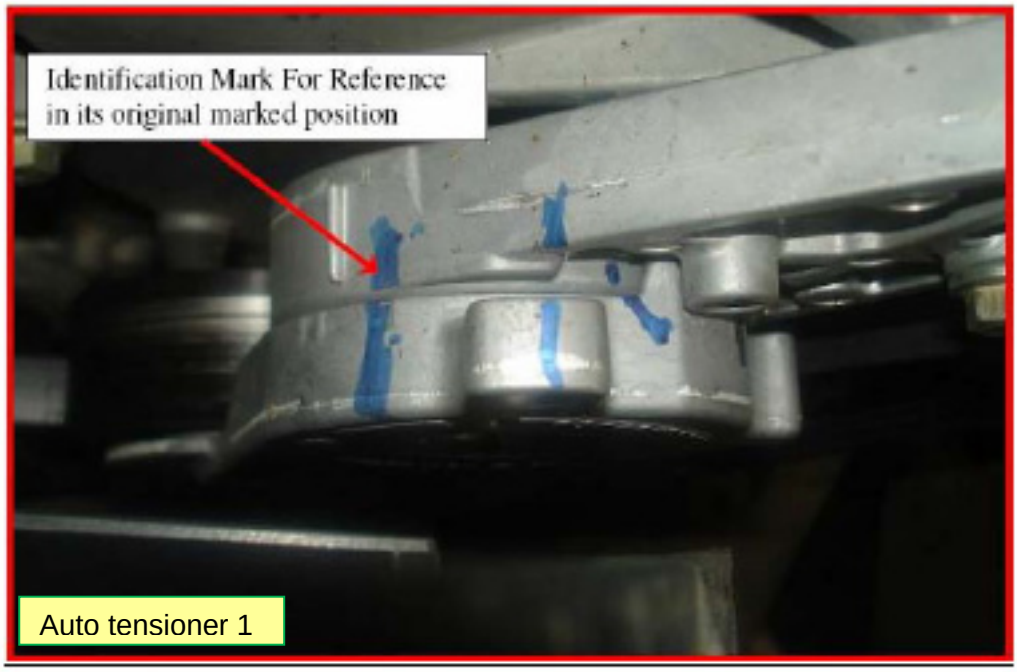
Care of the System -

The recommended coolant additive is given in the Recommended Coolant section.

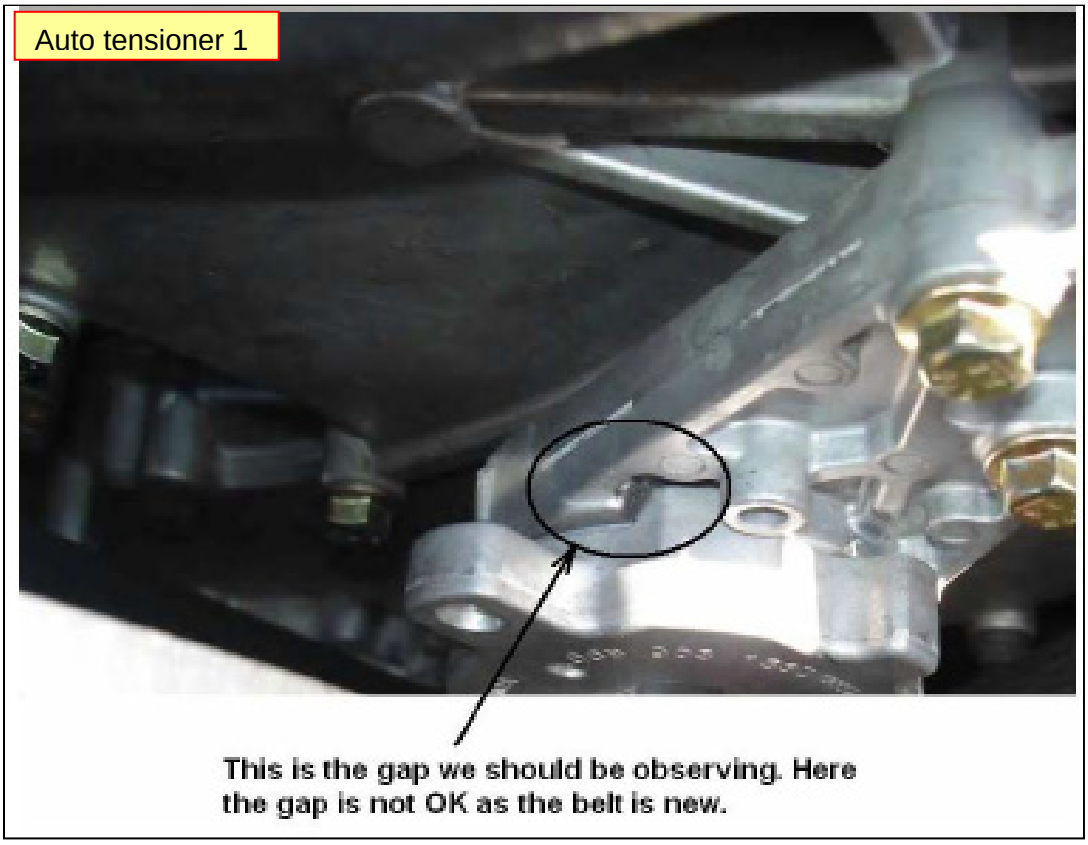
Note: While replacing the coolant or if the coolant level has come down due to any hose or water pump or radiator replacement/ leak. The replacement schedule is given in maintenance schedule.

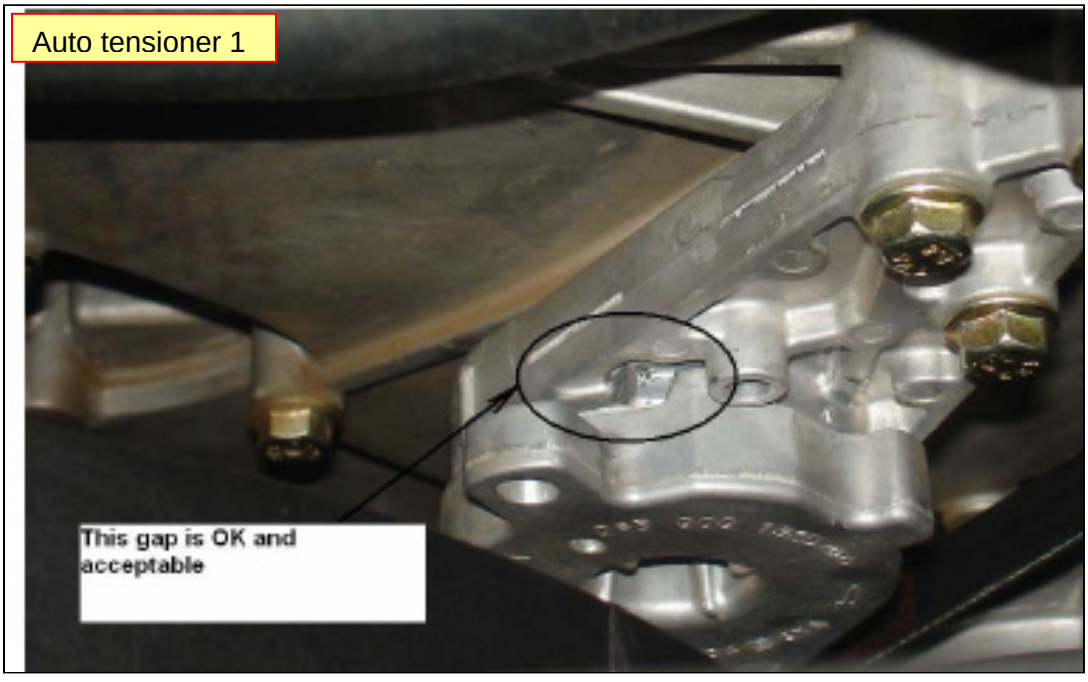
There are two Auto tensioners. One is mounted on Alternator-Power Steering drive belt. Another auto tensioner is mounted on AC Compressor-Water Pump drive belt.

1. Auto Tensioner (Alternator-Power Steering drive belt) - Check.
Refer below illustrations.

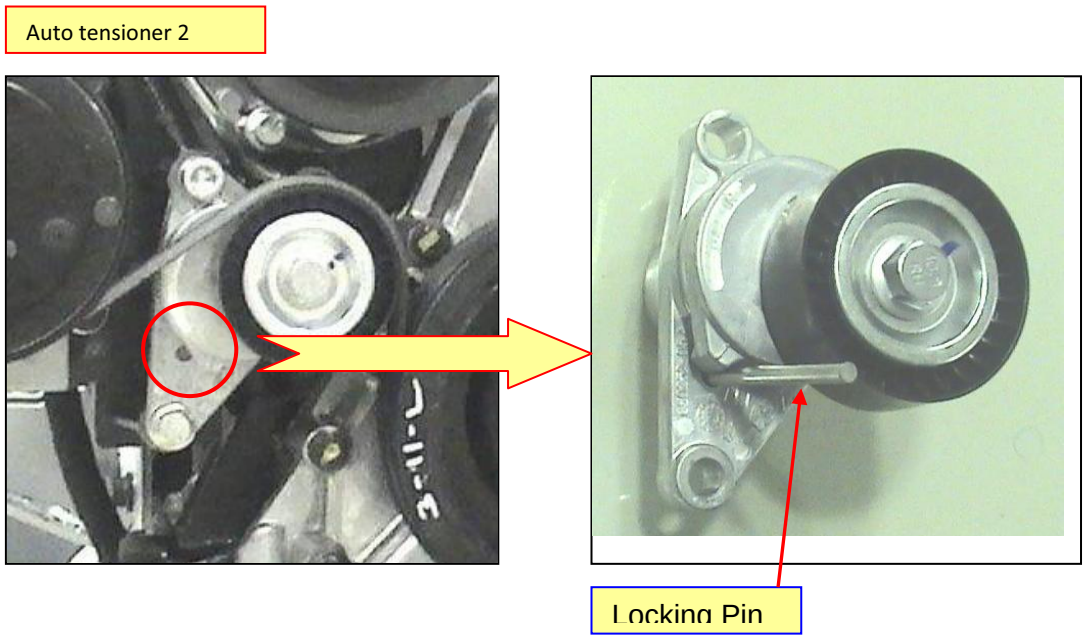


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2. Auto Tensioner (AC Compressor-Water Pump drive belt) -Check

Refer above illustrations. This auto tensioner is used for tensioning drive belt between Water Pump and AC Compressor. It is mounted on two bolts, upper mounting bolt is allen type bolt and lower one is flanged bolt.

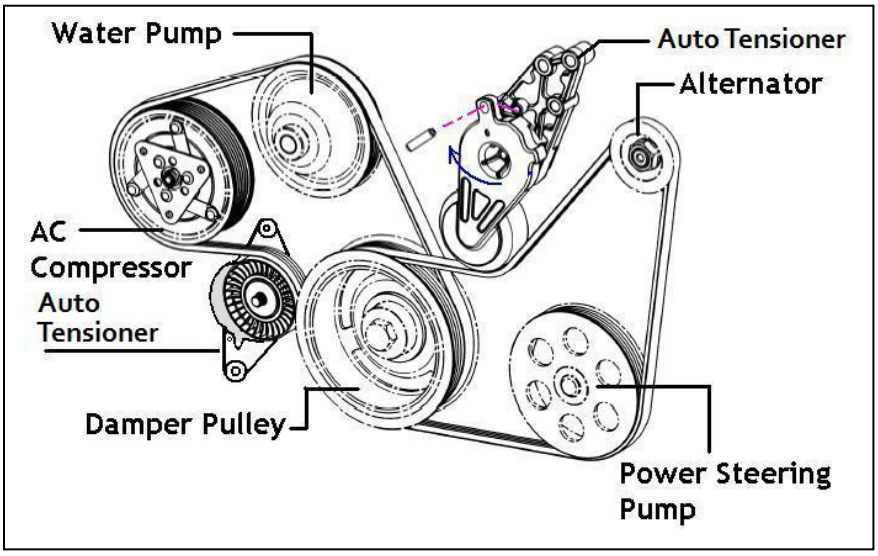
The auto tensioner to be rotate and locked with help of locking pin while removing drive belt. Check the lug position before and after fitting drive belt. If the deviation is too much the auto tensioner needs to be replaced. Replace auto tensioners at every 100000 KMs.

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In Car Repairs -

Water Pump Belt Replacement
Fan Blade & the viscous fan drive removal & fitment
Water pump removal
Radiator removal

Water Pump belt Remove & Refit -



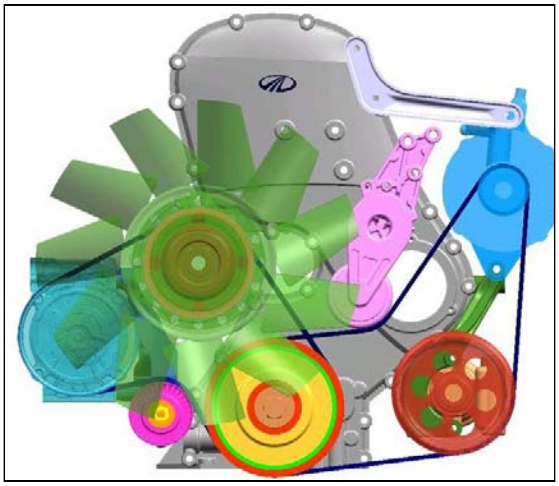
For removal of Water Pump drive belt –

1. Remove Alternator – Steering Pump Drive Belt & then,
2. Remove Water Pump – AC Compressor Drive Belt.

Refer below procedure for removal of drive belts,

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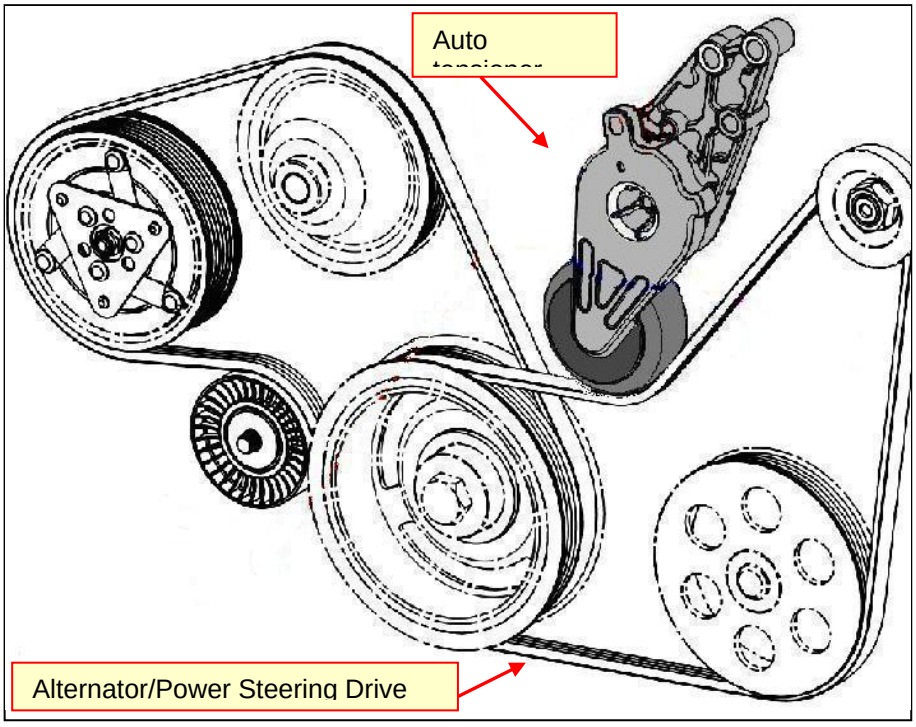
1. Accessory Drive Belt - Replace
(Alternator/Power steering Pump Drive Belt)



Removal Steps –

Refer illustration shown.

1. Remove NVH cover.
2. Remove Fan & shroud.
3. Turn Auto-tensioner in clockwise direction, as shown in sketch to loosen drive belt.
4. Remove accessory drive belt (on Alternator/Steering Pump).
   - Accessory drive belts to be replaced at every 100000kms.

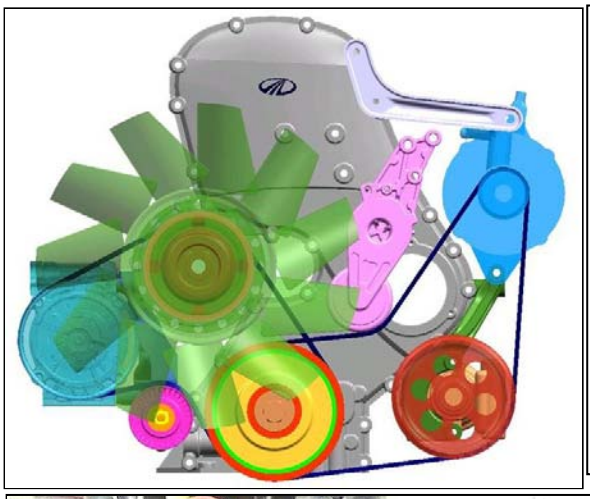


Assembly Procedure –

1. Refit accessory drive belt. Turn auto-tensioner in clockwise direction for ease of belt fitment.
2. Refit Alternator/power steering drive belt.
3. Check Power steering drive belt tension.
4. Refit Fan & shroud.
5. Refit NVH cover.

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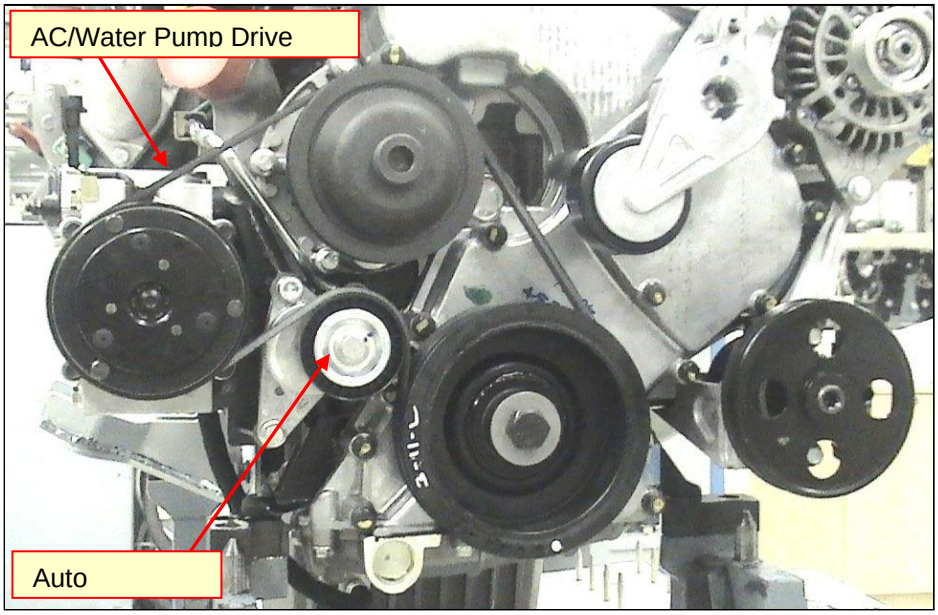
2. Accessory Drive Belt - Replace (AC/Water Pump Drive Belt)



Removal Steps –

Refer illustrations shown.

1. Remove NVH cover.
2. Remove Fan & shroud.
3. Remove Alternator/Power steering drive belt (Refer procedure).
4. Turn Auto-tensioner in clockwise direction, to loosen drive belt.
5. Remove AC/Water pump belt.

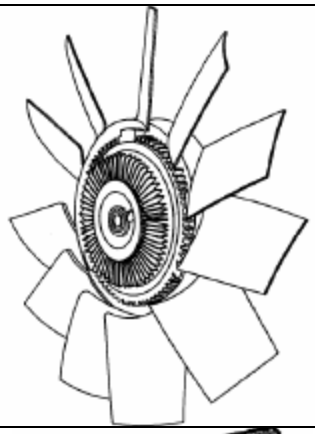
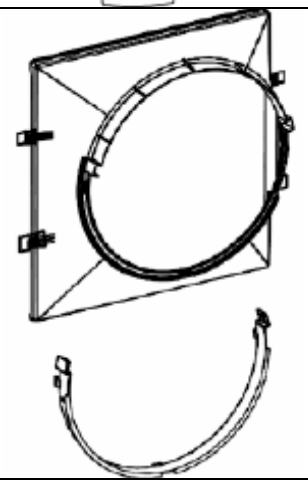


Assembly Procedure –

1. Refit accessory drive belt. Turn auto-tensioner in clockwise direction for ease of belt fitment.
2. Refit AC/Water Pump drive belt.
3. Check AC/Water Pump drive belt tension.
4. Refit Alternator/power steering drive belt (Refer procedure).
5. Refit Fan & shroud.
6. Refit NVH cover.
   - Replace Accessory drive belts at every 100000 KMs.

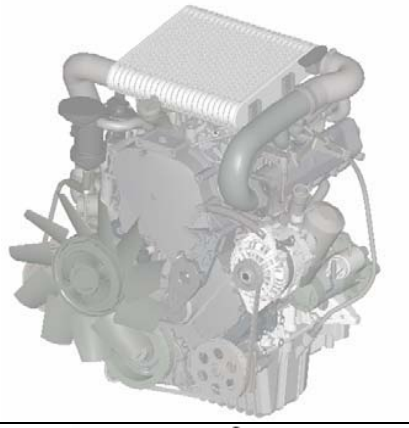
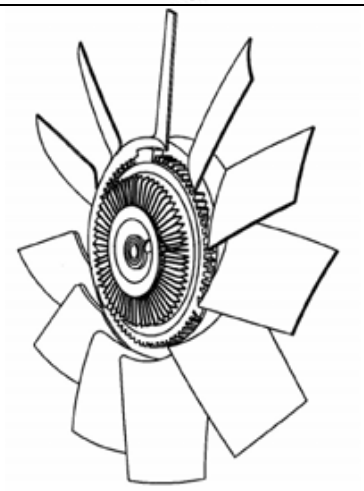
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Fan Blade & viscous fan drive assembly removal –

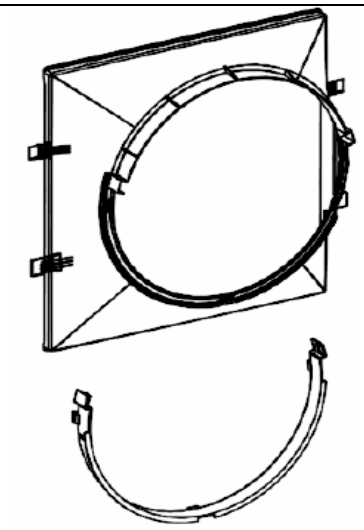
	Loosen the fan nut. **Note that the threads are anticlockwise threads. Hence to loosen; the direction of rotation has to be clockwise when viewed from front.** **Do not tamper or service the center portion of the fan.**
	Remove the radiator shroud & remove the fan.
The fan blade assembly and the VFD assembly can be removed together.	

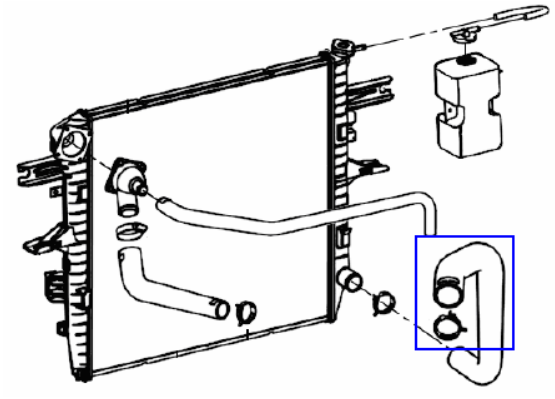
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Water Pump removal –

 	Remove the NVH cover.
	Loosen the fan nut. **Note that the threads are Anti clockwise threads. Hence to loosen the direction of rotation has to be clockwise when viewed from front.** **Do not tamper or service the center portion of the fan.**

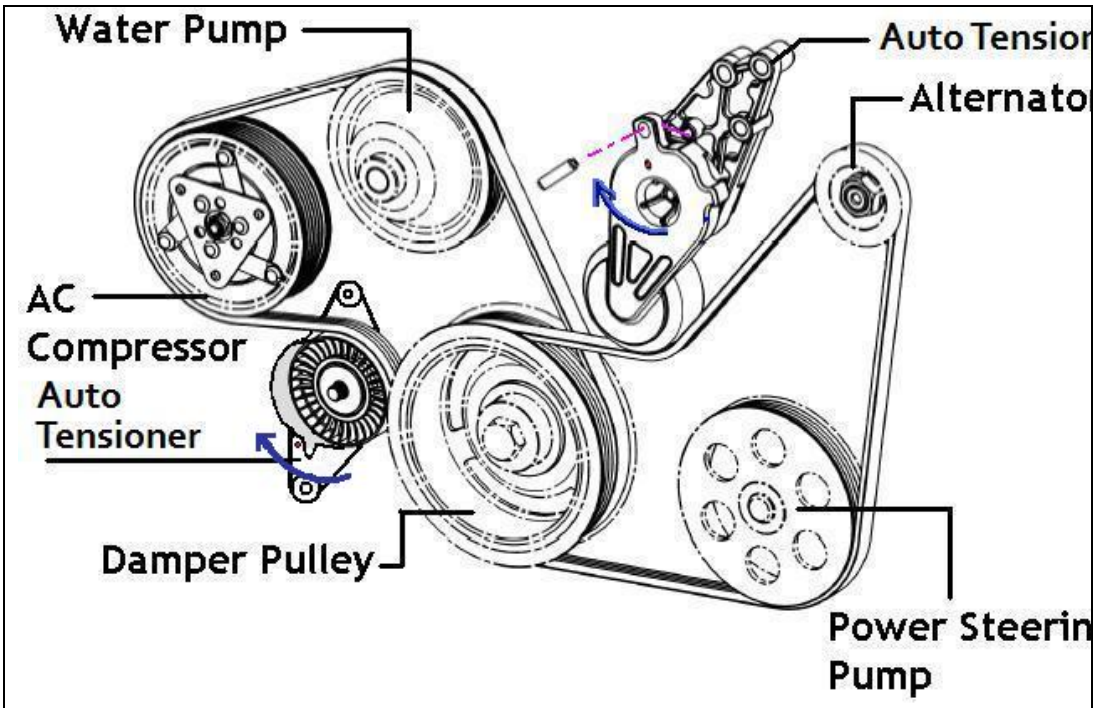
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	Remove the radiator shroud & remove the fan.

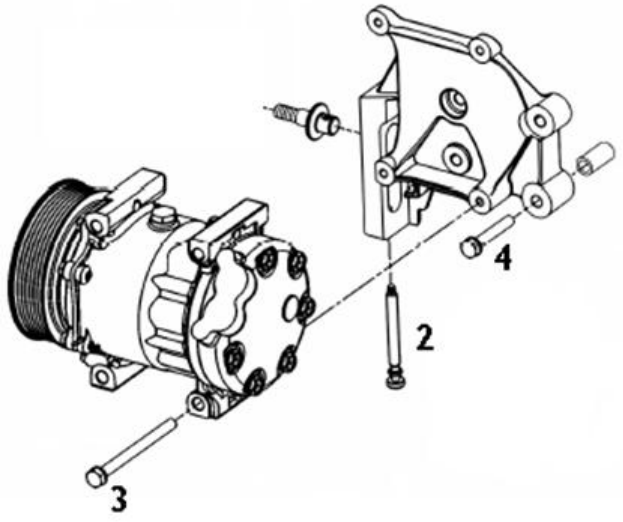


Disconnect the coolant hose connected from radiator to water pump inlet.

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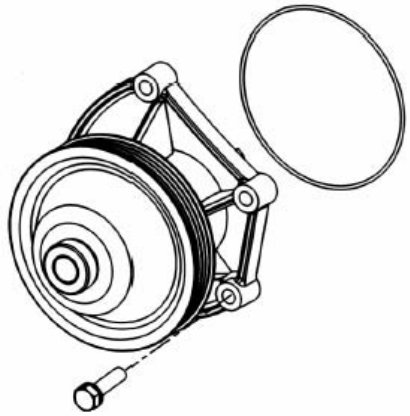


Using the special tool, rotate the auto tensioner in the direction shown in the figure. Lock the auto tensioner in that position using a locking pin. Remove the drive belt. Remove the lock pin and release the Auto tensioner. Loosen the auto tensioner mounting bolts & remove the auto tensioner.



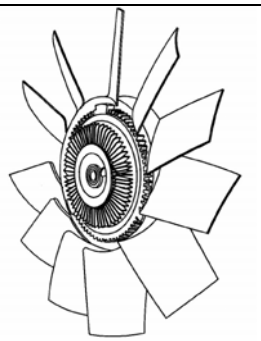
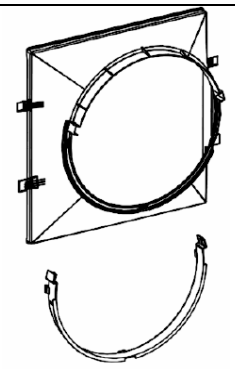
Rotate the auto tensioner and lock by using locking pin. Remove drive belt. Remove lock pin to release auto tensioner. Remove auto tensioner by removing mounting bolts.
Loosen & remove the AC compressor mounting bolts & remove the compressor.
Loosen & remove the AC compressor mounting bracket bolts & remove the mounting bracket.

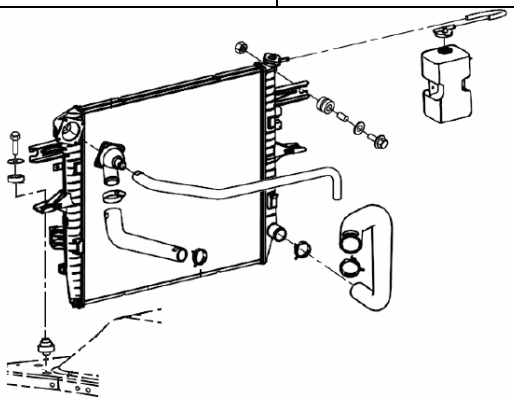
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	Loosen & remove the water pump mounting bolts & remove the water pump.

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Radiator Removal & Re-fitment –

	Loosen the fan nut. **Note that the threads are anticlockwise threads. Hence to loosen; the direction of rotation has to be clockwise when viewed from front.** **Do not tamper or service the center portion of the fan.**
	Remove the radiator shroud & remove the fan.



Drain the coolant from the radiator.
Disconnect the coolant hoses connected to the radiator.
Loosen & remove the radiator top cover.
Loosen & remove the Radiator Mounting bolts & remove the radiator.



Care must be taken while removing the condenser fastening bolts to the radiator as the AC gas pipes are routed through the same area.

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Dismantling & Assembly of the Cooling System

Water Pump
Viscous Fan Drive



Do not remove the radiator drain cock or the Engine coolant plate drain with the engine in hot condition.
Always remove the pressure on the system by removing the radiator cap before undertaking any work on the cooling system.
If the coolant is not contaminated then collect the coolant in a clean container so that it can be reused. Replace coolant as per recommendation

Water pump –
A centrifugal water pump is used to circulate the coolant through the water jackets, cylinder head, hoses and radiator. The water pump is belt driven by the engine main drive pulley. It ratio of pulley diameter ensures that the water pump rotates 1.30 times the engine speed.
The water pump impeller is pressed onto the shaft. The shaft is supported on two bearings that are integral to the shaft.
The water pump seal is located between the impeller and the housing.
The housing has a small hole to allow the seepage to escape. That also acts as an indication point if the water pump seal fails.
Water pump's removal & Refitment.
The water pump is not serviceable and has to be changed as an assembly.

Viscous Fan Drive Operation –
The viscous drive unit for the engine-cooling fan provides a means for controlling the speed of the fan relative to the temperature of the engine. The viscous fan unit is a type of fluid coupling, which drives the fan blade by means of silicone fluid There are two main components of the viscous fan drive: input (drive member), which consist of a threaded shaft passing through a bearing into the clutch plate and secured to the water pump. The output (driven) member comprises of the main body to which the fan is
attached, with the temperature sensing mechanism (bi- metal coil) and pump plates.

The fan drive has to be engaged only periodically, between 5 to 10% of the normal operating conditions because the rest of the time the vehicle cools itself by ram air-cooling.
To engage and disengage the fan drive the bi metal coil senses the air temperature behind the radiator. When a pre determined temperature is reached, the coil opens a valve, which allows the fluid to enter the drive area and due to centrifugal forces circulate to the annular drive area
There are two sets of annular grooves. , One in the drive clutch and the other in the drive body, a specific clearance being provided between two sets of grooves. When this clearance is filled with viscous fluid a shearing action caused by the speed

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differential between the two drive components, transmit the torque to the fan. The fluid is thrown to the outside of the unit by the centrifugal force from where it is re-circulated to the reservoir via the pump plate adjacent to the drive member.
If the engine sped is increased the amount of slip will also increase to limit the maximum fan speed.
When the air temperature from the radiator drops sufficiently, the bi metal coil closes the valve and prevents fluid entering the drive area. The fluid that is in the drive area will gradually pump out into the reservoir and the fan will return to an idle condition

Checking the VFD –
This procedure will only give an indication that the fan is cutting in and out, but will not be able to check the accuracy of the cut in temperature.
Depending on the level of the test equipment there are several ways to check if the fan is working correctly.

Using a non-contact tachometer –

1. Run the engine at idle without any load for approximately 3 minutes, for example at 2000 rpm, observer the fan drive speed. In the disengaged mode the fan speed will be approximately 800 rpm. By running for 3 minutes it will ensure that the fan drive has pumped out the silicone fluid into the reservoir and that the fan drive will be in the cut out (idle)
2. Either **(a)** blank the radiator by using a sheet of cardboard, which has a 15- cm hole, cut out of in line with the center of the fan drive. This will allow a flow of air on the bimetal coil and the cardboard will allow the radiator to heat up quickly. Keep a check on the vehicle temperature gauge and let the water temperature rise to about 105°C. this will ensure that the fan drive will engage **(b)** Using a commercial hot air blower, which will provide a hot air flow of at least 75°C, direct the air on to the centers of the fan drive through the radiator. Keep the hot air on for several minutes. This will cut the fan drive in, and the fan speed will increase. It is important that only a powerful blower is used so that the hot air should reach the fan drive after going the radiator at the correct temperature.
3. Once the fan drive has become engaged by either method (a) or (b). Check the fan speed with the non-contact tachometer. At 2000 rpm input speed the fan speed should be 1800 rpm.

Testing without a non-contact tachometer –

1. Use the same method explained in step 2, but this time listens to the noise level generated by the fan. With the fan in the idle condition the noise level should be very low, however when the fan speed increases in the engaged mode there will be a significant roar from the fan. This will clearly indicate if the fan drive is working.

   If the fan drive fails to engage during these tests, there is something wrong with the VFD (Viscous Fan Drive). The unit should be replaced. While returning the failed unit to Plant for vehicles under warranty take care to see that the unit is packed with the sensing coil facing down and sent in the same way. If

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this is not observed then the silicone fluid will flow down to bearing, damaging the bearing and also making it impossible to do any investigation.

Belt Diagnosis -

When diagnosing serpentine accessory drive belt,

Small crack that run across the ribbed surface of the belt from rib to rib are considered normal.

Cracks running along a rib are not normal

The correct belt tension is required to ensure optimum performance of the belt.

Do not apply any external means to reduce noise. Application of oil will reduce the belt life.

A detailed drive belt analysis is given below –

Symptom	Possible reasons	Correction
Rib chunking (One or more ribs has separated from belt body) - Chunking happens when several cracks in one area of rib move parallel to the cord line.	1. Foreign objects embedded in pulley groove 2. Installation damage. 3. Poor surface of grooves in pulley.	✓ Remove foreign objects from pulley grooves. Replace belt ✓ Replace belt. ✓ Clean pulley, replace if required.
Piling- happens when the material is sheared off the under cord and builds up in the groove.	1. Lack of tension 2. Misalignment of pulleys 3. Worn out pulleys 4. Excessive tension.	✓ Adjust tension ✓ Correct the alignment. ✓ Change pulley. ✓ Adjust tension
Rib or belt wear.	1. Pulley or pulley's misaligned. 2. Abrasive environment 3. Rusted pulley's 4. Sharp or jagged pulley groove tips. 5. Poor surface finish.	✓ Correct the alignment. ✓ Clean pulleys- replace if required. ✓ Change pulley. ✓ Replace belt.
Tooth shear	1. Low belt tension 2. Seizure of driven part. 3. Misalignment.	✓ Correct the tension. ✓ Replace belt. ✓ Align pulleys
Tooth Wear	1. Incorrect tension 2. Worn out pulleys	✓ Adjust tension. ✓ Change pulleys
Longitudinal Belt cracking (Cracks between two ribs.)	1. Belt has mis tracked from pulley groove. 2. Pulley groove tip has worn out the rubber to tensile member.	✓ Replace belt. ✓ Change pulley.
Belt slips	1. Belts slipping because of insufficient tension 2. Belt or pulley subjected to substances that	✓ Adjust belt tension. ✓ Clean pulleys.

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	reduce the belt life (oil, grease, ethylene alcohol) 3. Driven component's bearing failure. 4. Belt hardened and glazed from heat and excessive slippage.	✓ Replace the failed components. ✓ Replace belt
Groove jumping (belt does not maintain correct position on pulley)	1. Belt tensions either too high or too low. 2. Pulleys not within design tolerances. 3. Foreign objects in groove. 4. Pulley misalignment, 5. Belt cord line is broken.	✓ Adjust belt tension. ✓ Replace pulleys. ✓ Clean pulleys. ✓ Correct the alignment ✓ Replace belt.
Belt broken	1. Excessive tension. 2. Tensile members damaged during installation. 3. Severe misalignment. 4. Bracket pulley or bearing failure.	✓ Adjust belt tension ✓ Replace ✓ Correct the alignment ✓ Replace the failed component.
Noise Objectionable squeak, squeal rumble heard or felt while drive belt is in operation	1. Belt slippage 2. Bearing noise 3. Belt mis-alignment 4. Belt to pulley mismatch. 5. Driven component induced vibration 6. System resonant frequency induced vibration.	✓ Adjust belt. ✓ Replace the defective bearing. ✓ Adjust alignment. ✓ Use the correct belt. ✓ Vary belt tension within specifications. ✓ Replace belt.
Tensile failure	1. Tension sheeting contacting stationary object. 2. Excessive heat causing woven fabric to age. 3. Excessive installation tension. 4. Foreign body in drive. 5. Belt crimped due to improper handling. 6. Tension sheathing splice has fractured.	✓ Correct rubbing condition. ✓ Replace belt. ✓ Correct the tension. ✓ Replace pulley.

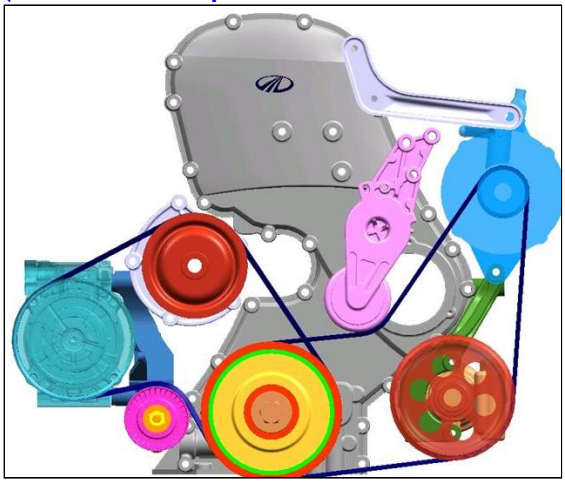
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Oil contamination	1. Oil leaks.	✓ Correct the oil leakage.
Cord edge failure (Tensile member exposed at edges of belt or separated from Belt body)	2. Excessive tension 3. Belt contacting stationary object. 4. Pulleys out of tolerance. 5. Insufficient adhesion between tensile member & rubber matrix.	✓ Adjust tension. ✓ Remove the stationary objects fouling. ✓ Replace pulleys. ✓ Replace pulley.

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ACCESSORY DRIVE BELT – INSPECT

(AC/Water Pump & Alternator/Power steering)



ACCESSORY DRIVE BELT TO BE CHECK FOR –

Refer illustrations below.

1. Abrasion
2. Cracking
3. Improper Install
4. Uneven Rib Wear
5. Misalignment
6. Chunk-out
7. Gravel penetration
8. Pilling







Refer illustrations shown.

1. **Abrasion** – Each side of belt appears shiny or glazed. In advanced stages, fabric becomes exposed.
2. **Cracking** – Small, yet visible cracks along the length of a rib or ribs.
3. **Improper Install** – A belt rib begins separating from the joined strands. If left unattended, the cover will often separate, causing the belt to loosen.





4. **Uneven Rib Wear** –
Refer illustration shown.
Belt shows damage to the side with the possibility of breaks in the tensile cord or rough edged ribs. A thumping noise may also be heard when running.

5. **Misalignment** –
Refer illustration shown.
Sidewalls of the belt may appear glazed or the edge cord may become frayed and ribs removed. A noise may result. In severe cases, the belt can jump off the pulley.

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Specifications -

Description	Value
Radiator capacity	2.15 liters
Cooling system capacity	10 liters
Coolant	GLYSANTIN G45-23
Ratio	30%
Coolant to be added after draining/flushing	2.79 liters
Radiator pressure	0.9 bar
Viscous Fan Drive - fan starts at (For reference only)	75°C of air temperature at Sensor Input speed – 3600 rpm
Viscous Fan Drive - fan stops at (For reference Only)	35°C of air temperature at Sensor Input speed – 1300 rpm
Input speed of Fan pulley	1.30 x Engine speed.
No of fan blades	11
Fan blade size	370 mm
Fan Belt tension	New installation –165 ± 2 Hz **Stabilized –134 Hz Min**
Fan Belt tension - Gates make	New installation –170 ± 5 Hz **Stabilized –140 Hz Min**

Tightening Torques -

Location	Torque in Nm
Viscous Fan clutch nut	50-60Nm

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Fuel System- CRDe

Contents

Description

Trouble Shooting

Care of the System

In Car Repairs

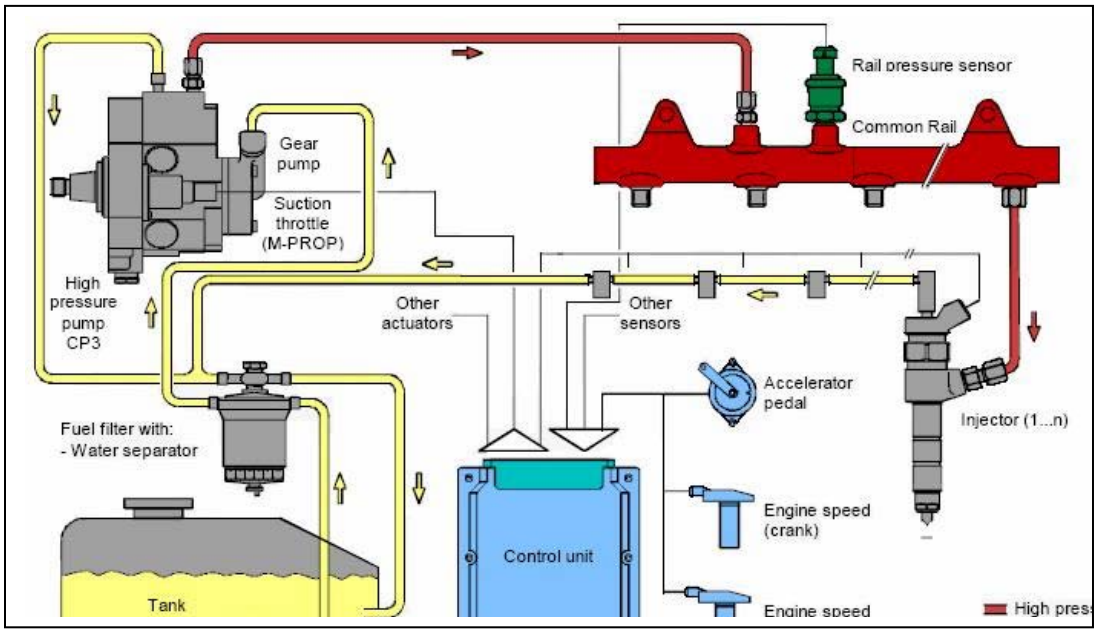
Dismantling, Inspection & overhaul of the Fuel Injection Equipment

Specification

Tightening Torque's

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Description



The fuel system can be divided into following subgroups.

- Fuel filling.
- Fuel supply from tank to High Pressure pump.
- High Pressure Pump & injectors including the High pressure pipes.
- Return line from High Pressure Pump to tank

The fuel is filled from the opening provided at rear left. The fuel cap is ventilated and threaded type. The cap is locked in place when further turning action result in clicking of the ratchet. The fuel tank lid is electrically operated. The switch is fitted on the centre bezel. While filling the tank, the air entrapped inside is vented by the vent tube, which is connected at the mouth of the inlet pipe. The venting is done from the highest point in the fuel tank. The fuel tank has a capacity of 58 litres.

During operation the fuel pump due to the vacuum created by the internal feed pump the fuel is sucked through the filter, to the high pressure pump.

The high pressure pump, pressurizes, & supplies the fuel to the common rail. The fuel then comes to the injectors.

The fuel back leak from injectors and return from HPP comes through return line.
The entire length of the fuel tank is protected at the bottom by a stone guard.

For the detailed understanding of the Common rail system, please refer the Common Rail System (CR System) explained separately.

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Trouble Shooting –

Symptom	Causes	Remedial action
Engine will not start & emit black smoke	• Clogged fuel filter/ fuel lines. • Defective injectors	✓ Change fuel filter ✓ Check fuel supply line. ✓ Refer diagnostic manual
Noisy engine & black smoke.	• Injector coking. • CR System	✓ Clean external coking ✓ Refer the diagnostic manual
Engine speed falls off.	• Clogged fuel filter/ fuel lines	✓ Change fuel filter ✓ Check fuel supply line. ✓ Refer diagnostic manual.
Engine does not give full power.	• Clogged fuel filter/ fuel lines • Defective injectors.	✓ Change fuel filter ✓ Check fuel supply line. ✓ Replace filters. ✓ Locate the kink/block in return pipe and rectify. ✓ Refer diagnostic manual
Black smoke.	• Defective injectors • CR system	✓ Check injectors. ✓ Refer diagnostic.
Engine will not start	• Weak battery • Corroded or loose battery connection • Faulty starter • CR system	✓ Check the battery specific gravity. ✓ Clean & tighten battery connections. ✓ Repair starter. ✓ Refer diagnostic manual.

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Care of the System -

The fuel injection system depends on supply of clean diesel fuel for the proper functioning of the fuel system.

To ensure that High Pressure Pump receives clean fuel all the times it is advisable that the fuel filter is replaced at the specified intervals.

The fuel filter should be changed at every 20,000 KMs. If the operating conditions are poor then reduce the change interval. The fuel filter is equipped with water separator. If the water level indication comes on in the instrument panel, then the water should be immediately drained.

The internal components of the High Pressure Pump depend on the lubricating properties of diesel for lubricating them. Hence, if water is present in the fuel then lubrication between the component break down and there is seizure.

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In Car Repairs –

The In Car repairs which can be carried out are:

Removal & Replacement of the fuel filer

Draining the water from the fuel filters.

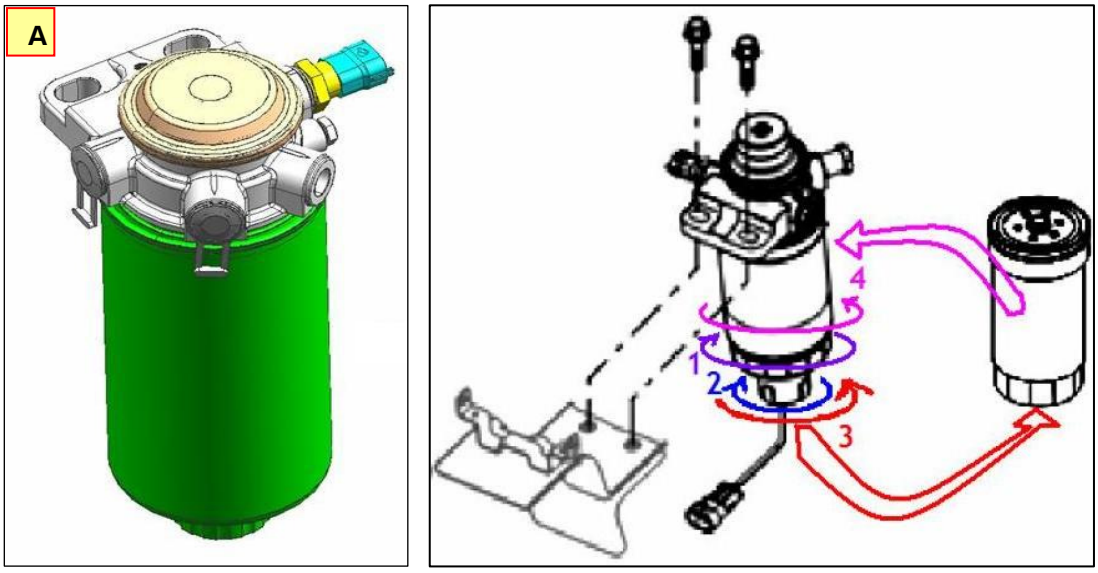
Removal & refitting injectors.

Removal & refitting the HPP

Removal of the fuel tank.

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FUEL FILTER - REPLACE



FUEL FILTER – REPLACE

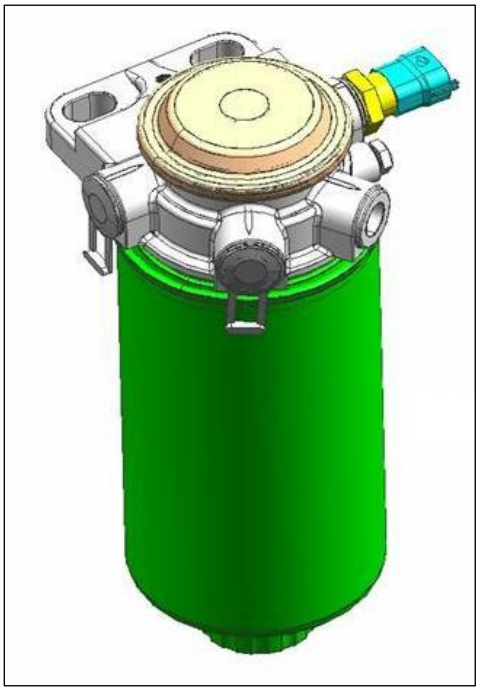
Refer above illustrations shown -

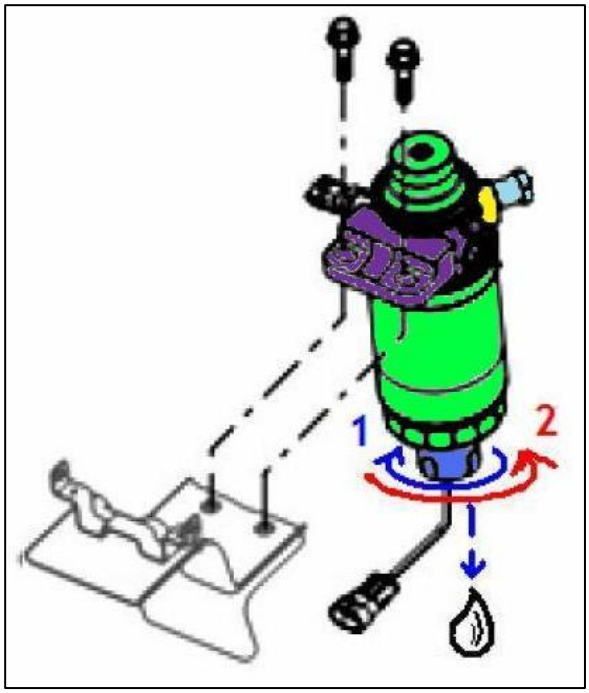
1. Remove the 'Water in Fuel Sensor' **[2]** at the bottom of the Fuel Filter element
2. Remove the Fuel Filter Element **[1]**
3. Fit a new fuel filter element and tighten it by hand **[4]**
4. Refit the "Water in fuel" sensor **[3]**
5. Remove the fuel tank cap
6. Switch the Ignition to 'ON' position
7. Bleed the system using hand primer and bleed screw on the banjo.

- Bleed the fuel system by operating the priming pump several times until you feel more resistance. The engine may take longer to start **[B]**.

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Fuel Filter - Drain Water Sediments





FUEL FILTER – DRAIN WATER SEDIMENTS

Refer above illustrations –

1. Loosen Water in Fuel Sensor at the bottom of the Fuel Filter by 2 turns **[1]**
2. Allow the Water accumulated in the filter to drain out.
3. Tighten the Water in Fuel Sensor **[2]**

- Drain water sediment from fuel filter at every 10,000KMs
- Fuel filter element to be replaced after every 20,000KMs.

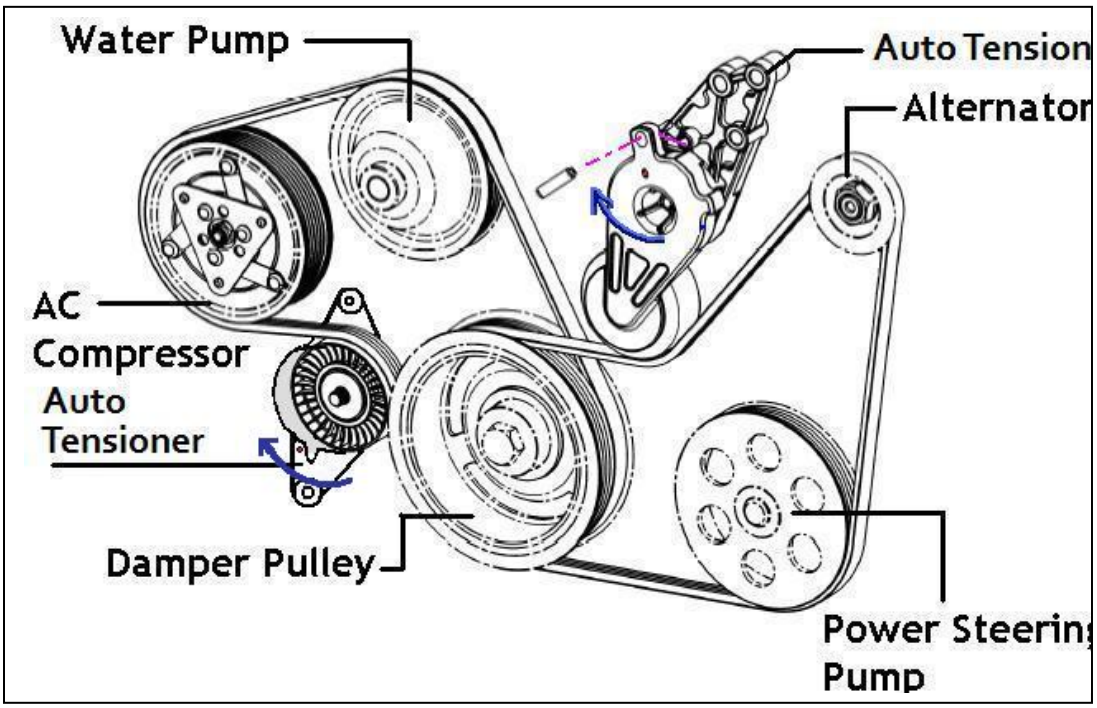
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Removal & refitting injector –

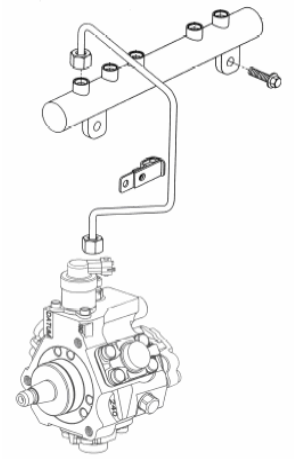
	Loosen the high-pressure pipes from both the common rail end & injectors.
	Avoid loosening only at one end as it can cause strain in the pipes, while removing the injectors
	Remove the leak off pipe.
	Remove the injector clamps.
	Remove the injector.
	While refitting, the injector use a new washer between the injector & cylinder head.(Thickness of washer should be 3mm)
	Avoid using two-injector washer. Normally it tends to happen if the older washer is not removed and has got stuck to cylinder head. It will change the injector tip height to change and affect combustion.

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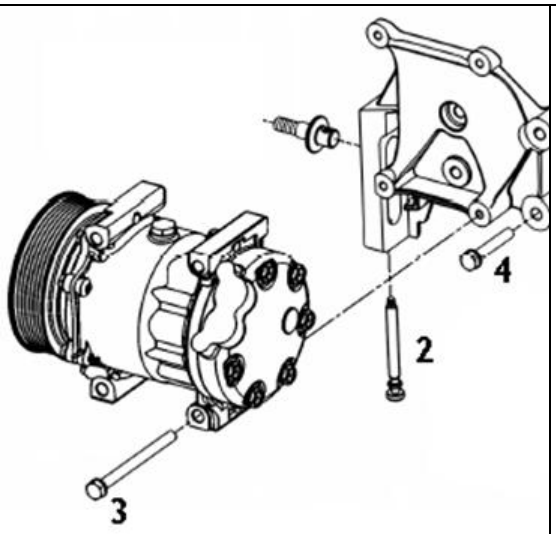
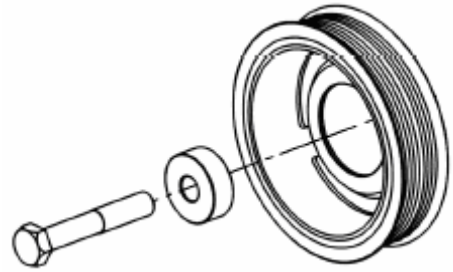
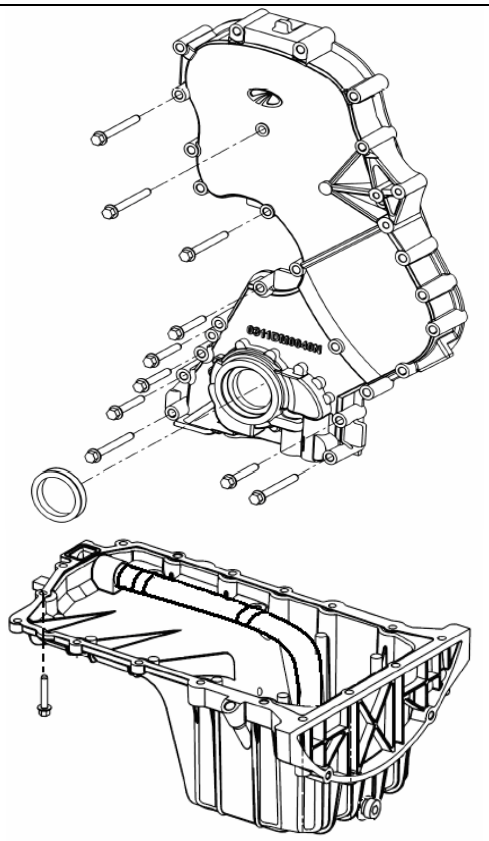
Removal & refitting the HPP -



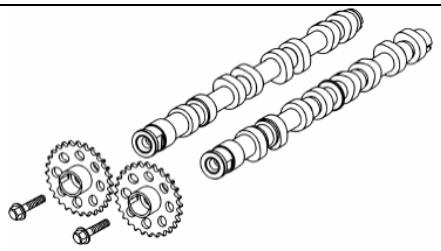
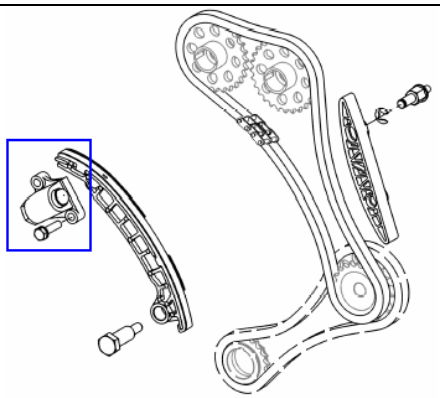
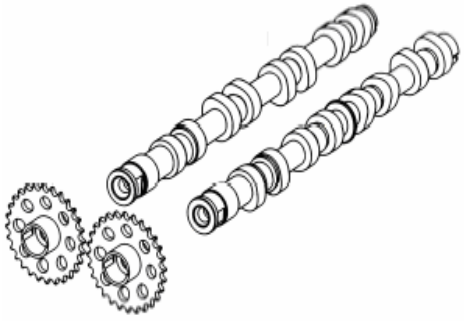
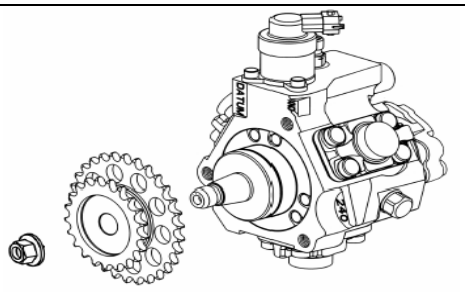
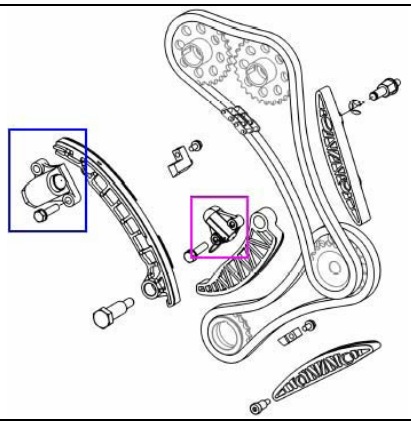
Using the special tool, rotate the auto tensioner in the direction shown in the figure. Lock the auto tensioner in that position using a pin. Remove the drive belts. Remove locking pin and release auto tensioner, remove it by removing mounting bolts.

	Remove High Pressure pipe from HPP to common rail

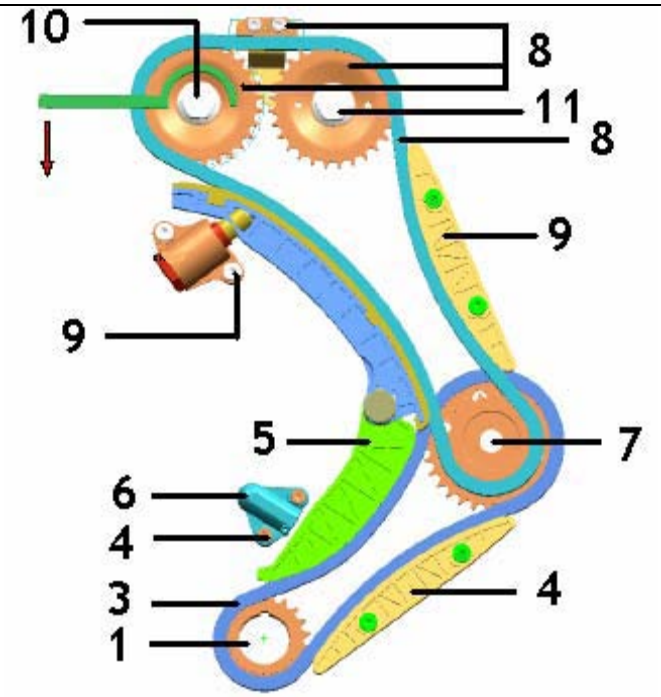
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	Rotate the auto tensioner and lock by using locking pin. Remove drive belt. Remove lock pin to release auto tensioner. Remove auto tensioner by removing mounting bolts. Loosen & remove the AC compressor mounting bolts & remove the compressor. Loosen & remove the AC compressor mounting bracket bolts & remove the mounting bracket.
	Loosen & remove the damper pulley bolt & the damper pulley. Care must be taken while handling the damper pulley.
	Loosen & remove the front cover bolts. Remove the front cover. To remove the front cover; 3 Nos. bolts should be removed from the front side of the oil sump.

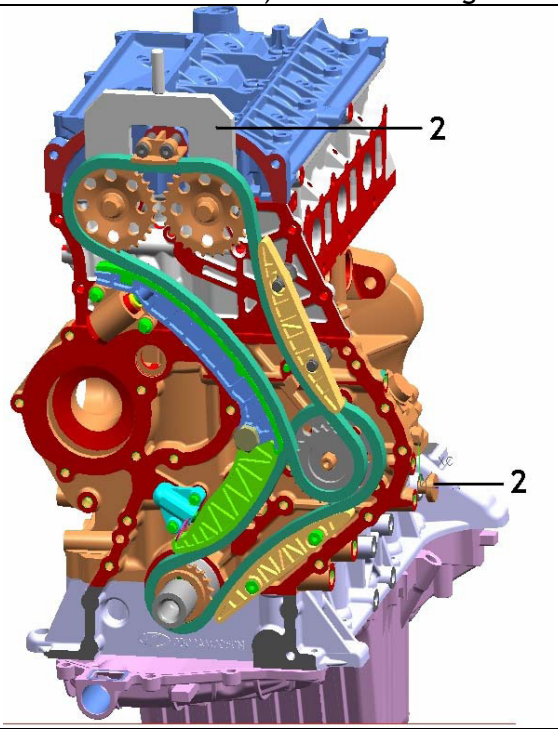
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	• Loosen the cam sprocket bolt.
	• Loosen & remove the secondary (Upper) tensioner. • Remove the chain guides by removing the 'e'clips. • Loosen & remove cam to cam chain guide.
	• Remove the bolt & remove the cam sprocket. • Remove the bolt & remove the other cam sprocket.
	•Loosen the HPP sprocket nut.
	• Loosen & remove the secondary (Upper) tensioner. • Remove the chain guides by removing the 'e'clips. • Press & lock the primary (Lower) tensioner. Loosen & remove the mounting bolts & the tensioner.

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1. Rotate the engine in such a way that the crank shaft key comes at 12'o clock position (Facing towards the camshafts) as shown in figure.



2. In the sketch above.
3. Assemble the crankshaft sprocket; HPP sprocket & the primary chain hand tighten the sprocket bolts.
4. Assemble the primary chain guide & Primary Chain Tensioner.

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5. Assemble the floating chain guide.
6. Release the primary chain tensioner.
7. Tighten the bolt of HPP Sprocket to the specified torque.
8. Assemble the Inlet & Exhaust camshaft sprockets, Cam to Cam chain guide & Secondary chain. Do not tighten the Camshaft sprocket bolts.
9. Assemble the Secondary Chain Guide & Secondary Chain Tensioner. Release the Primary Chain Tensioner by rotating the bolt.
10. Turn & hold the Exhaust Cam Camshaft Sprocket against the tightening direction with the help of the tool as shown in figure above & tighten the bolt of Exhaust Camshaft Sprocket to the specified torque.
11. Tighten the bolt of Intake Camshaft Sprocket to the specified torque.
• Remove the tool for locking the Camshaft.
• Assemble the Front Cover & assemble the bolts. Tighten the front cover bolts to the specified torque & following the specified sequence.
• Assemble the flywheel. Torque tightens the Flywheel Bolts following the specified sequence. Lock the flywheel using the flywheel locking tool.
• Remove the Crankshaft Locking Pin from the Block.
• Fit the Damper Pulley & tighten the bolt to the specified torque.
• Remove the Flywheel Locking Tool.

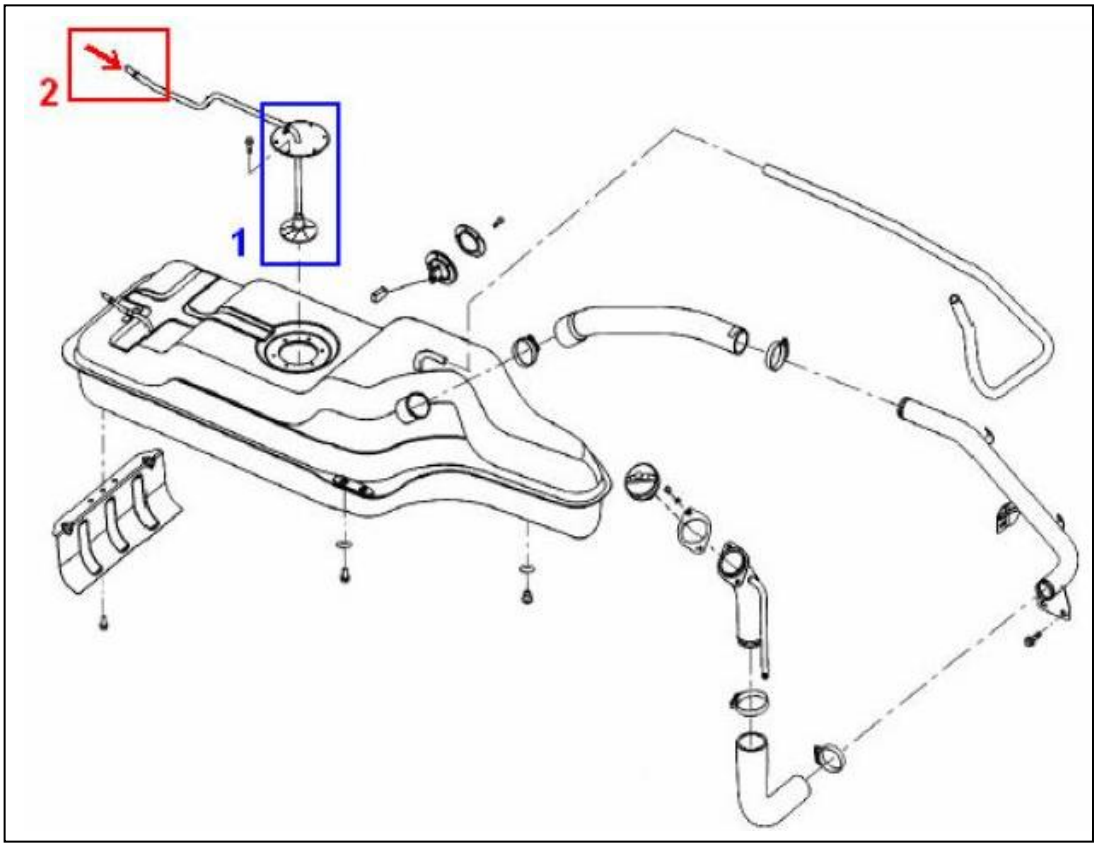
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Removal of the fuel tank –

- Disconnect the fuel tank supply hose and the vent hose.
- Disconnect the fuel supply and return hoses
- Disconnect the fuel gauges, tank unit electrical connection.
- Remove the skid plate.
- Remove the mounting 5 no bolts.
- Lower the fuel tank on to the transmission jack
- The assembly procedure is the reverse of the disassembly.

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Fuel Tank Strainer Cleaning –



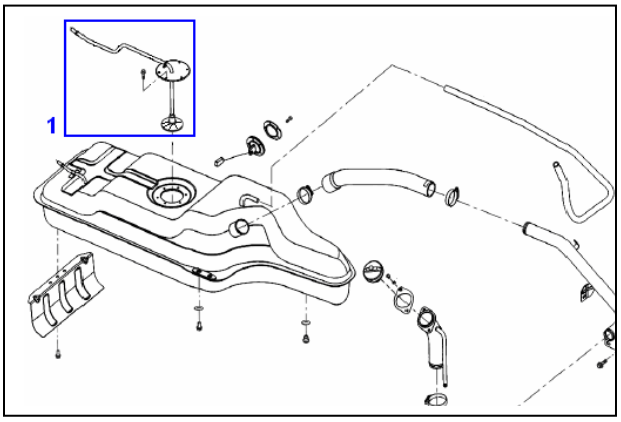
FUEL TANK & STRAINER – CLEAN

Refer illustration shown.

1. Drain fuel by removing drain plug.
2. Ensure for complete fuel drain and Refit the drain plug.**(27.5 ± 2.5 Nm)**
3. Disconnect the fuel lines – Main and return line hoses.
4. Disconnect the fuel filler hose and the breather hose
5. Disconnect the tank unit connector
6. Remove the fuel tank from the vehicle, refer sketch A and B.
7. Remove the 'Fuel Strainer with main line assembly' by removing the fastening bolts.
8. Blow the compressed air gradually with low pressure as per the direction indicated by the arrow in the illustration above.
9. Clean the fuel tank.
10. Refit the fuel tank and reconnect the main line, return line, filler hose, breather hose and tank unit connections.
11. Refill fuel in the fuel tank. (Fuel tank MAX capacity is @ **60** Litres.)

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Fuel Tank Strainer Replacement -



• Remove the Fuel Tank from the vehicle.
1. Take out the 'Fuel Strainer with main line assembly' by removing the fastening bolts. Replace the 'Fuel Strainer with main line assembly'.
• Clean the fuel tank. Complete the Fuel Tank Assembly & refit it on the vehicle.

Dismantling, Inspection & overhaul of the High Pressure Pump -

The HPP is non - serviceable.
Specifications -
Bosch CRS 2.2
HPP Type: CP1H
ECU: EDC 16C

Tightening Torque's -

Location	Torque in Nm
High pressure pipe nut on Rail	27 ± 2 Nm
High pressure pipe nut on pump	20 ± 2 Nm
High Pressure Pipe to injector	27±2 Nm
Injector holder clamping	25±3 Nm
Rail mounting on intake manifold	25±3 Nm

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Emission Control system

Contents

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Checking the System

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Description

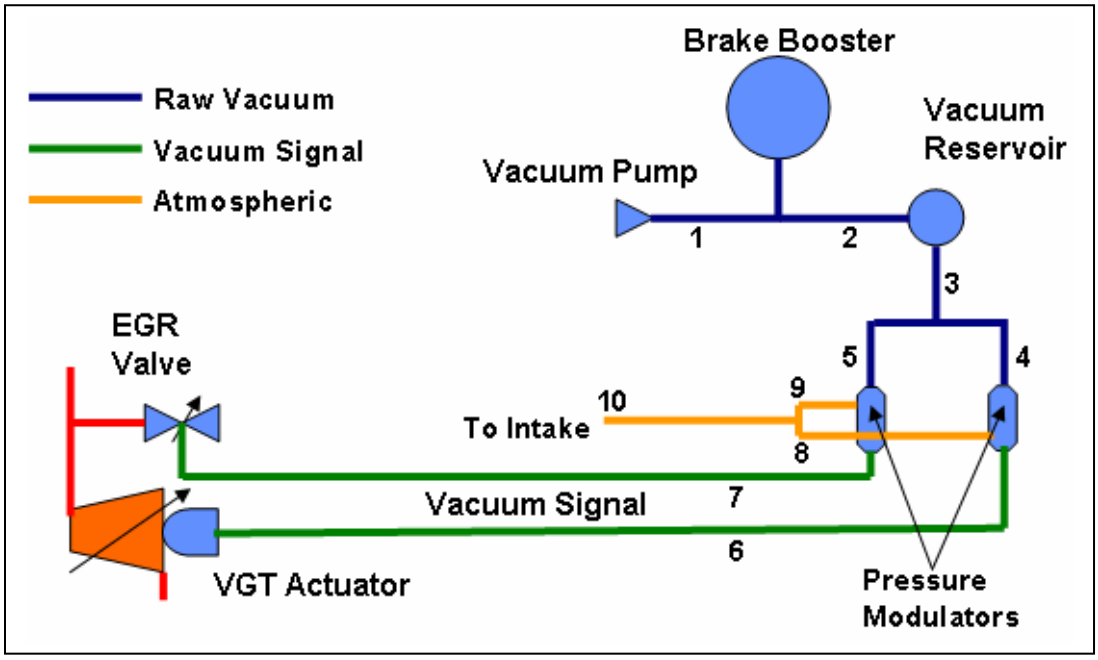
The M-Hawk engines meet the Euro III and Euro IV emission norms.

Overall, two systems are used.

Exhaust Gas re circulation

Closed crankcase ventilation

Working Principle of the Exhaust Gas Recirculation -



During acceleration and in higher loads the engine generates high combustion temperatures. The high combustion temperatures increase the NOx generation. The higher percentage of NOx generated in the combustion chamber come out through the tail pipe in the atmosphere.

To reduce the amount of NOx coming through the tail pipe the EGR system adds exhaust gases into the fresh air that is going into the combustion chamber. Since the exhaust, gas is already burnt hence when mixed with fresh air acts an inert gas. The role it does is that it reduces the amount of oxygen available for combustion. The net effect is that it reduces the peak combustion temperatures. This results in lower amount of NOx being generated.

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To control the amount/percentage of exhaust gases to be circulated back to the combustion chamber the ECU, which is already controlling the common rail functions, is used.

The ECU monitors the air flow, coolant temperature, attitude, engine speed, and accelerator pedal position. Based on the above parameters the ECU operates a switch that in turn controls the amount of vacuum going to the EGR valve. The amount of vacuum applied controls the lift of the EGR valve. The lift of the EGR valve is sensed.

Working principle of Crankcase Ventilation System –

The ventilation system is closed ventilation type.
The oil vapors from the rocker cover go to the labyrinth type oil separator, which is mounted directly on top of the cam cover. The outlet from the labyrinth is connected in series to a centrifugal type oil separator.

The collected oil is drained back to the sump. The gases enter the intake system in between the air cleaner and the turbocharger.

Certain amount of oil will be carried from the oil separator to the Air inlet hose, which is normal. However if it is excessive please look for all the causes mentioned in the high blow bye.

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Trouble Shooting

Symptom	Causes	Remedial action
Engine does not give full power.	1. Gas leak between EGR pipe joints. 2. EGR pipe leak. 3. EGR valve improper functioning. 4. Vacuum hose crack, loose, fallen off	✓ Change the gasket or the hose. ✓ Change the pipe. ✓ Check the EGR using the blink codes. Proceed appropriately. ✓ Ensure vacuum connections at vacuum modulator, reservoir, and alternator.
Noisy engine & high smoke	1. Cylinder head gasket defective. 2. Worn out or damaged valve seats. 3. Leaking injector holder. 4. Leakage at EGR Valve flange face, exhaust manifold and EGR pipe end.	✓ Replace the cylinder head gasket. ✓ Lap the valve seats or regrind. ✓ Tighten the injector holder. ✓ Confirm & check -Gasket condition - Bolt torque.
Black smoke.	EGR valve stuck open	✓ Check the EGR valve.
Excessive oil consumption	1. Cracked vacuum line hoses. 2. Restriction in crankcase breather. 3. Damaged oil separator 4. Bend/kink in any of the oil return pipe's/vacuum hoses.	✓ Check the vacuum line from the alternator to the EGR valve (for BSII)- check for leaks, crack. Replace cracked hoses. ✓ Locate & remove restriction. ✓ Check the crankcase ventilation & rectify. ✓ Replace the oil separator ✓ Change the vacuum hoses. ✓ Remove the bend or kinks.

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Care of the System

To meet the emission norms it is essential that the Fuel system, Air intake system & cooling system be maintained as per the schedule .For details refer to the particular section

Generally it is not appreciated that if the engine is running below the optimum temperature (happens when thermostat is removed then tailpipe emissions in particular the particulate increases (up to 30%). Similarly a wrong grade or poor quality of fuel increases the emissions. A blocked air cleaner or restriction in intake system increases the emissions

Oil separator system –

Check the hose connection at every 10,000 KMs for cracks, aging and leaks.

EGR –

On vehicles fitted with EGR system the following additional points check have to done during scheduled maintenance.

- Check for any exhaust gas leakage through sealing faces, EGR pipe. Formation of any black soot indicates leakage.
- Check the vacuum hoses for any leaks, cracks.
- Retighten all nuts and bolts as per the recommend torque.
- If the pipes are removed then it is essential that while fitting back new gaskets is used.

EGR Valve –

Remove the EGR valve and check it valve-sticking, deposition of carbon etc. If excess carbon deposits and sticky valve noticed then it should be cleaned with a suitable solvent, so that the correct valve seat is ensured.
After cleaning the valve blow air from the bottom side of the valve and check for any leakages.

To check for the functioning of the EGR valve apply vacuum on the vacuum connection of the EGR valve.

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EGR Pipe –

Remove the EGR pipe and check for gas leakage, damages etc. Clean the gasket seating area from any carbon deposits burrs etc. Spray WD 40 rust cleaning spray on the nut.

To check the pipe for any leakages, close one end of flange and from other end blow air at two bars. Dip the pipe in water and observe if any leakage is observed. If any leaks are observed then the pipe has to be replaced. Do not attempt to weld/ seal the leakage joint

EGR Actuator Controller (modulator)–

The solenoid switch does not require any maintenance. For any damage replace the component.

EGR ECU –

The EGR is controlled by the ECU controlling the Common rail.

However, like any ECU care has to be taken that if any welding work is being carried out on the vehicle then the battery terminals are removed.

Similarly, the practices of shorting the battery to check the battery have to be avoided. (It can cause a spike.). The practice of changing battery with a running engine is also not acceptable. Again, the resultant spike can damage the controller beyond repairs

Checking the System

EGR System –

Any errors in the EGR system be registered as a DTC code.
The DTC codes can be viewed by using the ***"Smart Tester"***.

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Clutch

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Clutch overhaul
Inspection
Specification & Wear Limit
Tightening Torques
Lubricant
List of the MSTs

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Description

The clutch disc is a single, dry type with cushion springs in the hub. The clutch disc's friction material is riveted to the hub.

The clutch cover is a diaphragm type with one-piece construction. A 240-mm clutch disc is used.

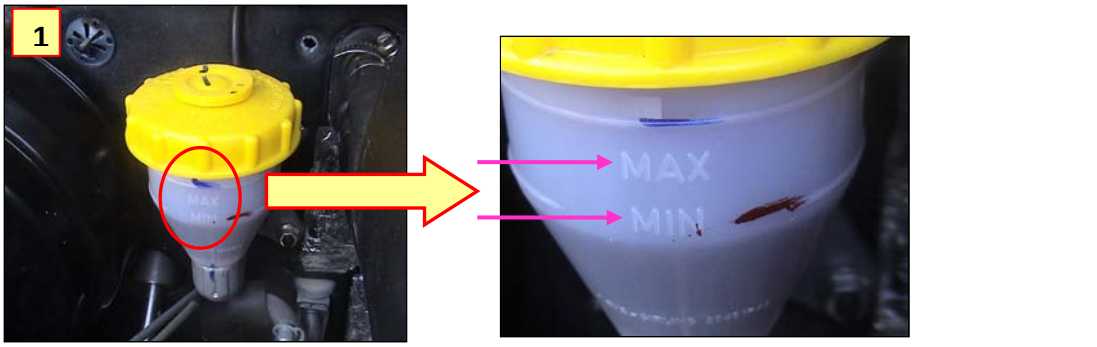
In the engaged position (when the clutch pedal is not pressed), the diaphragm spring of the clutch cover assembly holds the clutch pressure plate against the clutch disc. This enables the engine torque to be transmitted to the input shaft of the gearbox, without any slip / loss.

The clutch is hydraulically actuated with self-adjusting features. The complete actuation system comprises of a clutch master cylinder with integral reservoir. The master cylinder is connected to the clutch actuation or the slave cylinder by hydraulic pipe. The travel of the push rod results in linear movement of the release bearing through a release fork pivoted on a ball in the clutch housing.

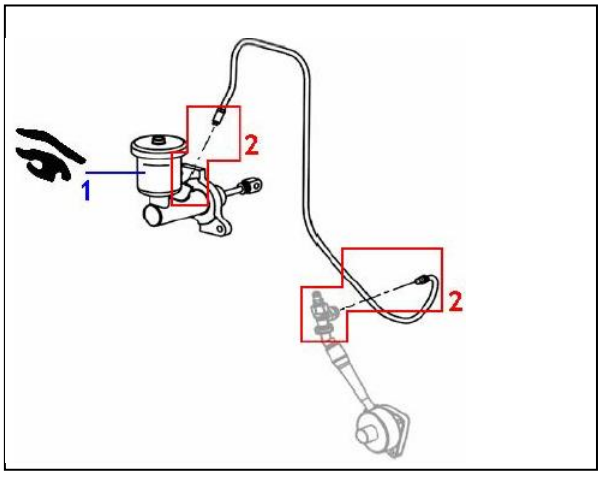
The clutch release bearing pushes the diaphragm spring center towards the flywheel. The diaphragm spring pivots at the fulcrum, relieving the load on the clutch plate. Steel spring straps riveted to the pressure plate cover pulls the pressure plate away from the clutch disc. When the clamping load on the clutch plate is relieved it slides on the splines of the input shaft away from the flywheel thus disengaging the engine torque from the input shaft & enabling the gears to be changed.

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CLUTCH FLUID - LEVEL & LEAK - INSPECT







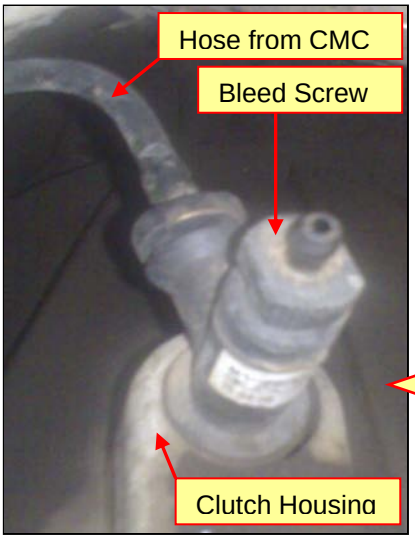
CLUTCH FLUID – LEVEL & LEAK - INSPECT

Refer above illustrations –

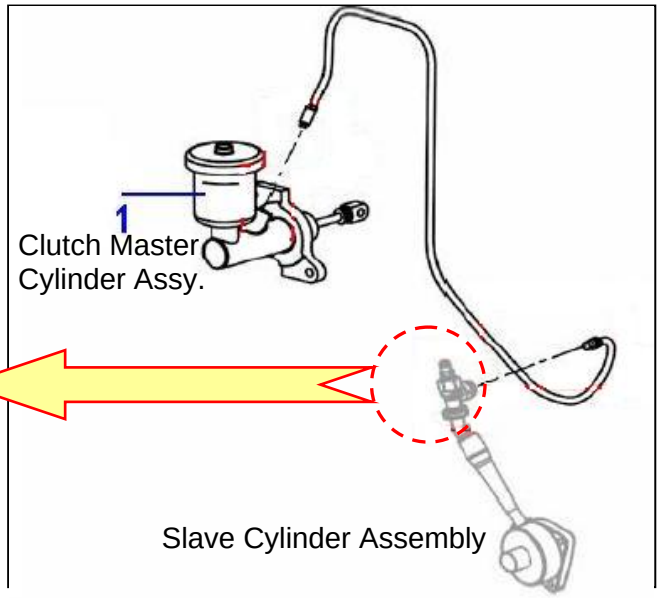
1. Check for Clutch Fluid Level up 'Max' mark on the brake/clutch fluid reservoir.
2. Check for Clutch Fluid leakage and correct fitment at all joints –
   - Hose connected from reservoir and Clutch master cylinder.
   - Clutch Master Cylinder inlet and outlet [1].
   - Clutch Bundy tube to flexible hose joint.
   - Clutch slave Cylinder inlet banjo [2].

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CLUTCH FLUID - REPLACE



***Concentric Slave Cylinder (CSC)**



CLUTCH FLUID – REPLACE (System Flush out & refill with fresh fluid)

Refer above illustration –

1. Remove the dust cap of the bleeder screw.
2. If the bleeding operation is done without connecting a tube and in the open air then the chance of air remaining trapped is high.
3. Connect bleeding tube, to bleeding screw on slave cylinder.
4. Ensure that the other end of the tube is fully immersed in the bottle having clean clutch fluid.
5. Fill the Reservoir clutch master cylinder up to the top level with recommended clutch fluid.
6. Operate clutch pedal **3 or 4** times slowly to the full stroke.
7. Holding the clutch in depressed condition rotate the bleed screw by **90** degree and allow all the air escape in to the container bottle.
8. Repeat the exercise till no air bubbles appears in the bottle.
9. During this operation ensure fluid level in reservoir.
10. Close the bleed screw properly.
11. Remove bleeding tube and place the dust cap on bleed screw.
12. Check the fluid level in container and be top up to the 'MAX' level.**[1]**

- Always use recommended fluid and do not mix different brand fluids.
- In case fluid reservoir replaced, clutch system needs to bleed.
- Clutch system fluid to be flush out and refill with fresh fluid at every)0kms or once in a year, whichever is earlier

*** Scorpio VLX is with CSC, SLE slave cylinder is outside-conventional.**

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Care of the System -

While topping up use the recommended fluid conforming to DOT3 standard /SAE J1703/IS 8654 specifications only. Avoid mixing different brands.

The clutch fluid is hygroscopic fluids hence tend to collect humidity. The humidity along with the brake fluid can cause acidic reaction & seizure of the master & slave cylinders. The clutch fluid should be replaced every 40,000 km or one in a year, whichever is earlier. The master & clutch cylinder seals to be replace every 50,000 KMs

Trouble Shooting -

Unless the cause of a clutch problem is extremely obvious, accurate problem diagnosis will require a road test to confirm that the problem exists. To find out the actual root cause of the problem the clutch will have to be dismantled and the failed parts examined to determine the cause.

During road test, drive the vehicle in normal operating speeds. Shift the gears and observe the clutch action. If chatter, grab, slip or improper release is experienced, remove & inspect the parts. However if problem is noise or hard shift then the problem may not be in clutch only but also the transmission or the driveline.

If the clutch slip is suspected then drive the vehicle in 1st or 2nd gear at the top speed (corresponding to the gear). Keeping the accelerator fully pressed; slowly apply the brake- with your left feet. If the engine stalls then the clutch is not slipping.

Clutch Problem Causes -

Fluid contamination is the most frequent cause of clutch malfunction. Oil, water on the clutch contact surface will cause faulty operation viz. Slip, grab, and judder.

During inspection check if any parts in the clutch are coated with oil or water splash from road.

Oil contamination indicates a leak at either rear main seal or transmission-input shaft. The oil leaks from either of these areas will normally coat the housing interior or clutch cover or flywheel. Heat buildup due to slippage between the clutch plate and the flywheel or the pressure plate can result into the leaked oil literally getting baked. Visually this will result in a glazed residue varying from amber to black.

Roads splash contamination will mean that the dirt water is entering the clutch housing either due to lose bolt or torn rubber boot.

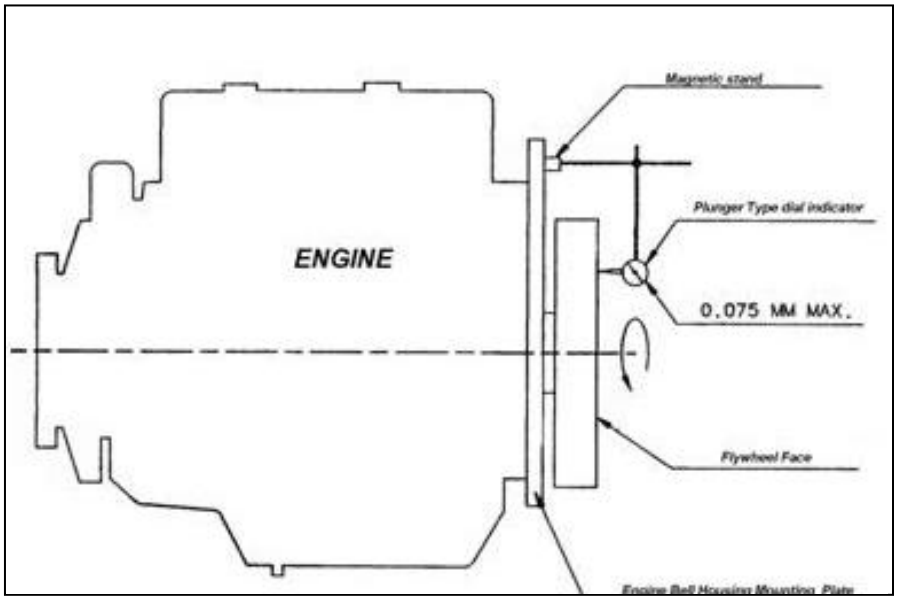
Clutch misalignment -

The clutch component i.e. the clutch plate, flywheel and the pressure plate have to be aligned with the crankshaft and the transmission input shaft. Misalignment caused

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by run outs/ war page will cause clutch to grab judder as well as improper release (also manifesting as hard gearshift).

Flywheel run out –



The flywheel run out needs to be checked whenever misalignment is suspected.
Flywheel run out should not exceed 0.10 mm.
To measure the run out mount the base of the magnetic dial gauge on the block. Locate the dial gauge's needle on the outer surface of the flywheel.

Some of the common reasons for excessive run out are –

- ✓ Heat warpage.
- ✓ Improper machining.
- ✓ Incorrect bolt tightening
- ✓ Foreign material on crankshaft flange or flywheel.
- ✓ Improper seating on crankshaft.

Clutch cover & Disc run out –

A warped cover or diaphragm spring will result in clutch grab and / or incomplete release of clutch plate.

If the clutch alignment tool is not used then the misalignment of the clutch plate can cause distortion of the cover and also disc damage.

The cover can also get misaligned due to improper tightening of the cover onto the flywheel. The only way to avoid is that the bolts must be tightened alternatively (diagonal pattern) and evenly i.e. 2 to 3 thread a time only.

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A noisy gearshift operation especially the 1st and 2nd gear can be due to clutch not getting disengaged completely. To check it, jack up the rear axle. Lift the axle till both the wheels are rotating freely.

Press the clutch pedal completely and start the engine, the wheels should not be spinning. Now slowly release the pedal till it has moved about 10 mm, the wheel should still not be spinning. If some spinning is noticed then it indicates improper lift of the pressure plate. First check the bleeding and the pedal travel then check for the pressure plate lift.

Clutch Housing Misalignment –

The clutch housing has to be aligned with the engine so that the input shaft is aligned with the crankshaft. Absence of this alignment results in clutch noise, incomplete release of the clutch plate. It can normally be judged by uneven wear of the finger and pilot bearing. In severe case it can also damage the spline of the input shaft and clutch hubs well as the clutch splines

Normally the clutch housing misalignment is a result of:
✓ Incorrect seating on the engine/transmission.
✓ Missing alignment dowel holes.
✓ Loose or missing mounting bolt.
✓ Mounting surfaces that are damaged/ not parallel.

To check the clutch housing misalignment bell housing run out will also need to be checked.

Clutch slippage:

Observation	Causes	Remedial action
Disc facing worn out.	1. Normal wear. 2. Clutch riding. 3. Insufficient diaphragm spring clamp load. 4. Faulty release mechanism. 5. Vehicle being driven despite slipping clutch. 6. Bad driving practice of allowing the clutch to slip far too long.	✓ Replace clutch disc ✓ Replace clutch plate ✓ Replace clutch plate & cover assembly. ✓ Replace , and bleed/ ✓ Customer to be informed. ✓ Customer to be informed.
Clutch disc facing contaminated with oil, grease or clutch fluid.	Leak at : 1. Crankshaft rear end oil seal 2. Leak through the input shaft	✓ Replace seal & disc. Clean cover assembly. ✓ Replace seal & disc. Clean cover assembly.

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	3. Excess amount of grease applied to the input shaft splines	✓ Apply less grease. Replace clutch disc. Clean cover assembly.
Clutch is running partially disengaged.	Release bearing carrier sticky.	✓ Replace bearing / carrier.
Flywheel height incorrect.	1. Improperly machined flywheel. 2. Excess machining done.	✓ Replace flywheel.
Wrong disc or pressure plate used.	Use the correct parts	✓ Replace the parts after comparison.
Clutch disc/ cover or diaphragm spring warped.	1. Improper tightening or loosening procedure. 2. Rough handling of clutch plate or cover assembly	✓ Replace the parts and tighten as per sequence. ✓ Replace the parts, ensure that the rough handling is avoided
Flywheel side clutch facing surface – torn/ nicked/ worn	Flywheel surface ,scored and having light notch	✓ Reduce the scoring and nicks by sand paper. Reduce if scoring deeper.
Clutch disc facing burnt. Excessive glazing of the flywheel & pressure plate.	1. Frequent operation under high loads or hard acceleration conditions 2. Frequent clutch riding by the driver.	✓ Roughen the flywheel face with sandpaper. Replace clutch plate & cover assembly. ✓ The driver has to be alerted to avoid repeat failure.
Clutch facing broken	Improper storage- clutch plate dropped prior to fitting.	✓ Replace.
Fouling marks on the torsion damper.	Improper fitment- assembled the wrong way around	✓ Rectify

Clutch grab/chatter:

Observation	Causes	Remedial action
Clutch disc facing contaminated with oil, grease or clutch fluid.	Leak at : 1. Crankshaft rear end oil seal. 2. Leak through the input shaft.	✓ Replace seal & disc. Clean cover assembly. ✓ Replace seal & disc. Clean cover assembly. ✓ Apply less grease.

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	3. Excess amount of grease applied to the input shaft splines	Replace clutch disc. Clean cover assembly.
Clutch disc / pressure plate warped. Disc facing show unusual wear	1. Incorrect or substandard parts. 2. Improper tightening or loosening procedure. 3. Rough handling of clutch plate or cover assembly	✓ Replace disc and cover with the correct parts. ✓ Replace the parts and tighten as per sequence. ✓ Replace the parts, ensure that the rough handling is avoided.
Partial engagements of clutch disc (One side worn – opposite side glazed and lightly worn.)	1. Clutch pressure plate position setting incorrect or modified 2. Clutch cover, spring or release fingers bent or distorted due to rough handling or improper assembly. 3. Clutch disc damaged or distorted. 4. Clutch misalignment.	✓ Replace clutch cover & clutch plate. ✓ Replace clutch cover & clutch plate. ✓ Replace clutch plate. ✓ Check alignment and run out of flywheel disc or cover. ✓ Replace the clutch plate & cover assembly (if required. Correct the alignment)
No fault found with clutch components.	Problem related to suspension or driveline components.	✓ Further diagnosis required. Check engine & transmission mounting insulators. U Joint, tyres, body attaching parts.
Clutch master cylinder or slave cylinder piston jammed/ scuffing.	Piston/ bore damaged or corroded	✓ Overhaul the master & slave cylinder.
Tangential strap connecting the pressure plate to the diaphragm cover broken.	1. Incorrect driving practice ✓ Mostly due to tow starting in 1st or 2nd gear Or ✓ Incorrect gear selection	✓ Advise the customer of the consequences.

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Improper clutch release:

Observation	Causes	Remedial action
Clutch disc warped.	New disc not checked before installation	✓ Check the new disc's run out & replace it.
Clutch plate is binding on the input shaft's splines.	1. Clutch disc hub splines damaged during installation. 2. Input shaft splines rough or damaged. 3. Corrosion or rust formation on splines of disc and input shaft.	✓ Replace the clutch plate. ✓ Replace input shaft is severely damaged. ✓ Replace the clutch plate. Replace the input shaft if the scaling can not be removed.
Clutch disc-facing sticks to flywheel.	Vacuum may form in pockets over rivet head. Occurs as clutch cools down after use.	✓ Drill 1/16 inch diameter hole through rivets and scuff sand the clutch disc facing.
Clutch will not disengage properly.	1. Low fluid in the clutch master cylinder. 2. Air in the hydraulic system 3. Clutch cover loose. 4. Wrong clutch disc. 5. Clutch cover diaphragm spring bent / warped during transmission installation. 6. Clutch disc fitted backwards.	✓ Top off the fluid and check for leaks. ✓ Bleed & refill the system. ✓ Tighten the bolts. ✓ Replace disc. ✓ Replace the cover assembly. ✓ Fit the clutch plate correctly the hub should be facing the pressure plate side & the flywheel side mark towards the flywheel
Bush worn out / damaged	Vibration / misalignment Clutch misalignment	✓ Fit new bearings & check for misalignments.

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Hard gear shift:

Observation	Causes	Remedial action
Brake fluid less and or contaminated	1. Leaks 2. Reservoir strainer missing	✓ Replace fluid. ✓ Stop leaks and avoid contamination.
Excessive clutch pedal free plays.	Wrong adjustment or lock nut loosening	✓ Adjust
Clutch plate warpage	1. Warpage due to handling or assembly. 2. Warpage due to misalignment.	✓ Replace

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In Car Repairs -

Adjustment of clutch pedal height

Clutch bleeding.

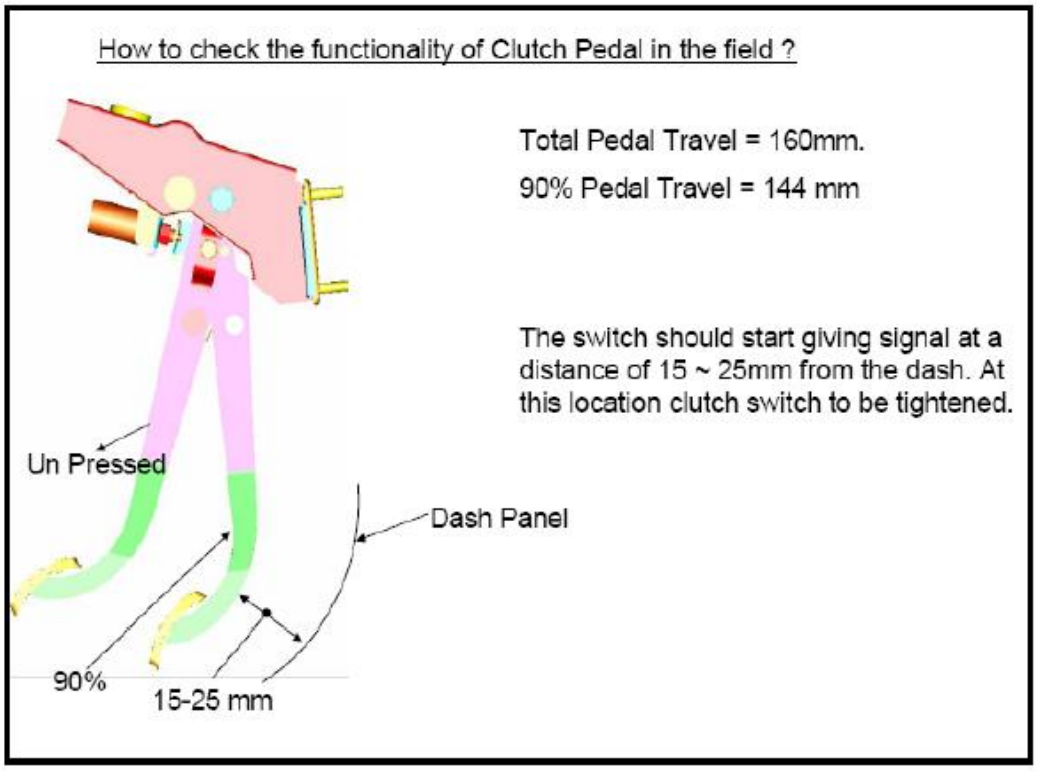
Adjustment of clutch pedal height -

 	Loosen the lock nut of master cylinder's push rod fork.
	Slide backs the dust cover.
	Rotate the master cylinder push rod till desired height of pedal is achieved.

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	Tighten the lock nut of push rod fork.
	Screw in pedal stopper bolt completely. Press pedal fully till the pedal bottoms on the floor.
	Now screw out the pedal stopper bolt till it touches the pedal lever, release pedal.
	Screw out the bolt further by one turn. Tighten the locknut.

Refer illustration given below and Recheck pedal height in case vehicle is equipped with **Engine Stop-Star (ESS) system**.



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Bleeding the clutch –

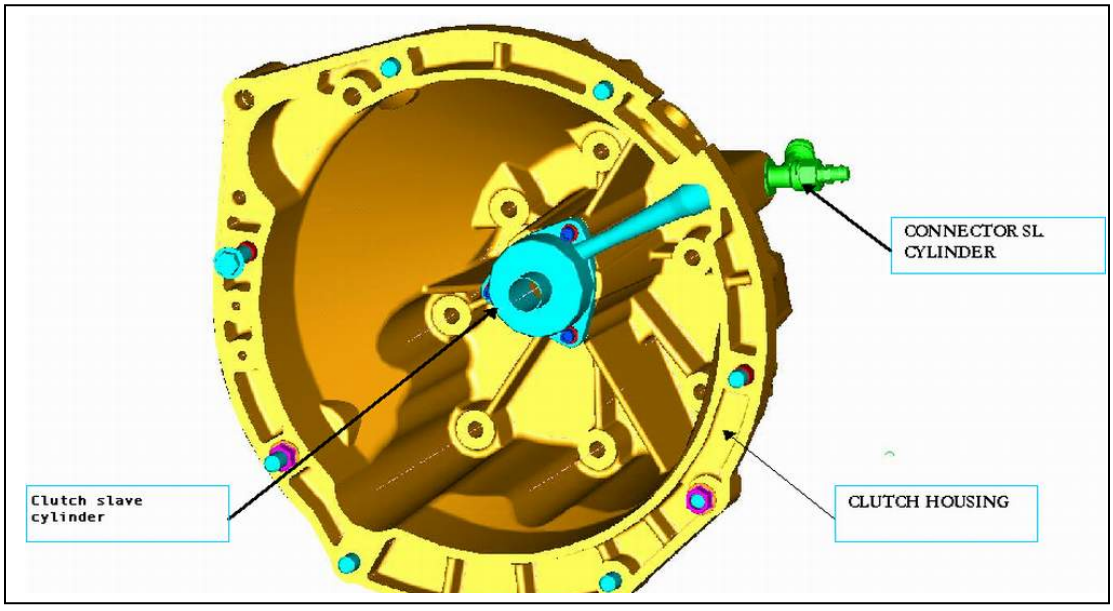
Remove the dust cap of the bleeder screw.	
	If the bleeding operation is done without connecting a tube and in the open air then the chance of air remaining trapped is high.
	Connect bleeding tube, to bleeding screw on slave cylinder. Ensure that the other end of the tube is fully immersed in the bottle having clean clutch /brake fluid.
	Fill the Reservoir clutch master cylinder up to the top level with recommended clutch fluid.
	Operate clutch pedal 3 or 4 times slowly to the full stroke. Holding the clutch in depressed condition loosen the bleeding screw on slave cylinder by ½ to ¾ turn and allow all the air escape in to the container bottle.
	Repeat the exercise till no air bubbles appears in the bottle.
	During this operation ensure fluid level in reservoir.
	Tighten the bleed screw properly.
	Remove bleeding tube and place the dust cap on bleed screw.
	Check the fluid level in container and need be top up to the ‘max’ level.

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Clutch Actuation Mechanism –

The clutch actuation is hydraulic actuation. The clutch pedal actuates a master cylinder. The hydraulic fluid is transmitted to the slave cylinder through a flexible pipe.

The clutch actuation mechanism does not have a fork and the pivot ball. The hydraulic concentric bearing is a unique design and incorporates the slave cylinder and the release bearing. The bearing is permanently attached to the slave cylinder piston. The hydraulic lines are permanently attached to the bearing assembly. The hydraulic line near the slave cylinder is fitted with a quick disconnect coupling.



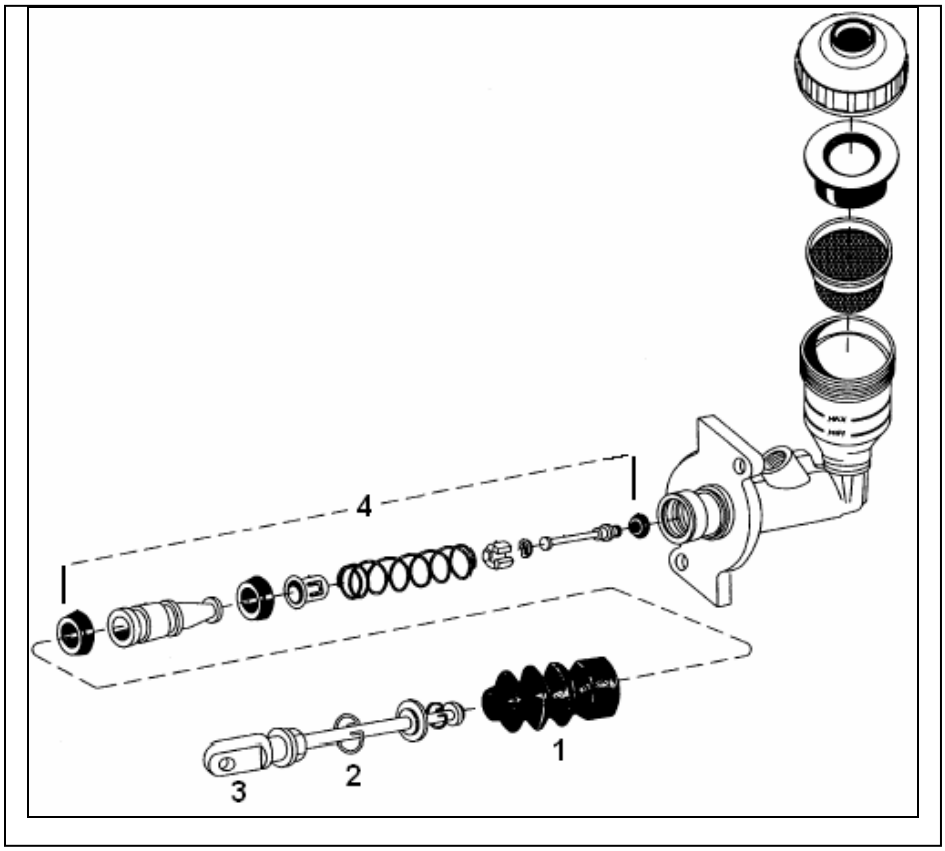
- Master cylinder overhaul
- Slave cylinder and Concentric bearing Overhaul

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Master cylinder overhaul -

	Remove the outlet pipe connection.
	Remove the clevis pin lock & the clevis pin.
	Remove the clutch push rod fork & the clutch pedal.
	Remove the master cylinder from the firewall.

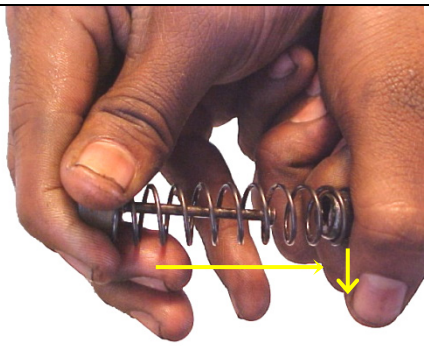
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1. Pull back the dust cover.
2. Remove circlip.
3. Remove the push rod assembly with retainer washer.
4. Remove the piston assembly by gently tapping the Clutch Master Cylinder body on a wooden block.

	Using a screwdriver, lift the leaf spring retainer. Remove spring assembly from plunger.

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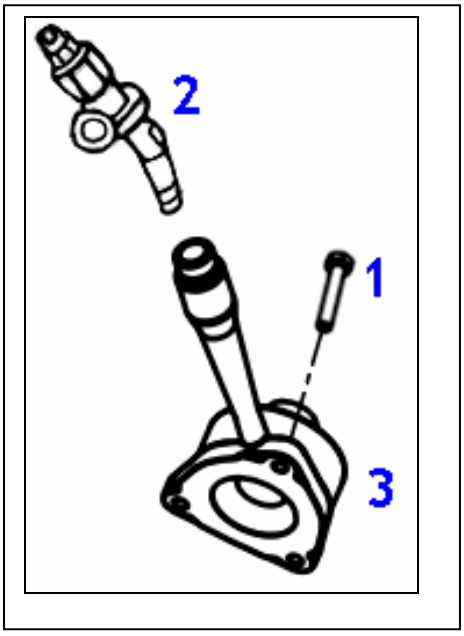
	Take care, while lifting the spring otherwise the spring and the stem will fall off.
	Compress spring to free valve stem from eccentrically positioned hole in the end face of spring retainer. This will separate spring retainer from valve stem.
	Remove spring, valve spacer and spring washer from the valve stem.
	(While assembling hold the spacer between fingers such that the valve stems hangs down vertically. Pull down the stem downwards as far as possible. Observe if the valve stem has moved freely upwards. If movement is not free replace valve spacer.)
	Remove the valve seal from the valve stem.
	The bore and the plunger should be checked for scoring, scuffing uneven wear marks, corrosion and excessive clearance between plunger & body
	Check the condition of dust cover for cut, deterioration if damaged replace.
	The assembly procedure is the reverse of the dismantling procedure. While fitting the plunger lubricate it with brake fluid.

The concentric bearing and the slave cylinder are serviced as an assembly only. It cannot be overhauled. The release-bearing portion of the assembly is permanently attached to the piston. The only time the concentric bearing should be replaced is when it is either leaking or obviously damaged. The bearing should not be changed just because the clutch disc or the pressure plate assembly is being replaced. Replace the bearing assembly only when it has failed.

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Replacing the Clutch Slave Cylinder -

To replace the Concentric Clutch Slave Cylinder; the transmission needs to be removed.
For the removal of transmission please refer to **'Clutch Overhaul'** section in this manual.



Dismantling -

1. Loosen & remove the 3 Nos. mounting bolts of the Concentric Slave cylinder.
   Note - The mounting bolts are 'Torx' type. Care should be taken to use the proper tools to avoid any damage to the mounting bolts head.
2. Separate the Bleeder – CSC & Concentric Slave Cylinder by removing the Quick Release Coupling.

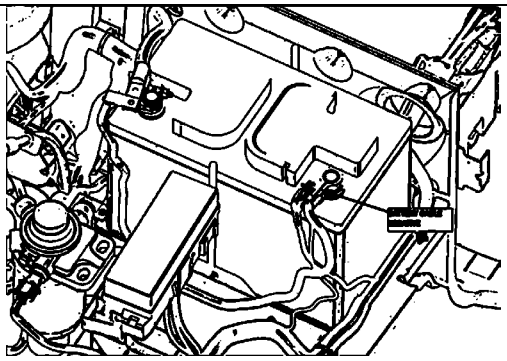
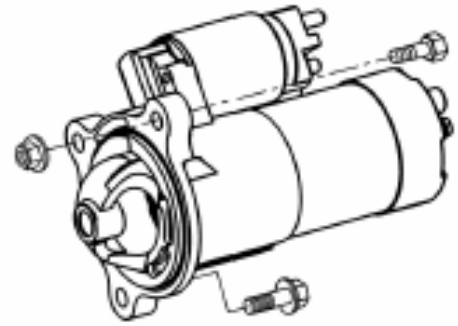
Assembly -

1. While fitting the new Concentric Slave Cylinder also separate the Bleeder – CSC & the Slave Cylinder.
2. Fit the Slave Cylinder in the Transmission & tighten the mounting bolts. Now connect the Bleeder – CSC to Slave Cylinder.
3. Fit the transmission back on the vehicle.
4. Connect the hydraulic pipe from CMC to CSC.
5. Bleed the System.

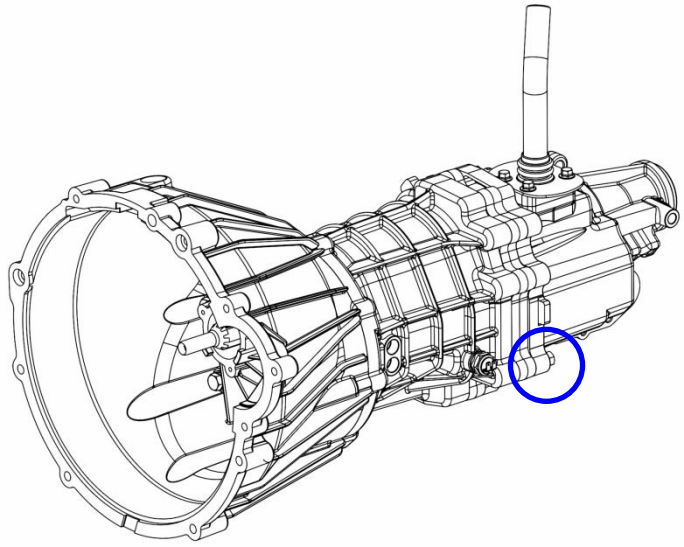
Note - While assembling, hand tighten the mounting bolts opposite to each other & torque tighten to the specified torque. Failing to do this can lead to adverse effect on release bearing life.

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Clutch overhaul -

	Block the front wheels, so that the vehicle does not move forward.
	Disconnect the negative cable of the battery.
	Remove the electrical connections to the starter motor. Remove the starter motor by removing the mounting bolts.
	Remove the Rear (Differential) End Propeller Shaft bolts – 4 Nos.
	Carefully pull the Propeller Shaft out from the transmission. **Note** - After the propeller shaft yoke is pulled, a bit of oil is expected to come out as the yoke itself is the guide for the oil seal.
Disconnect the speed sensor connection.	

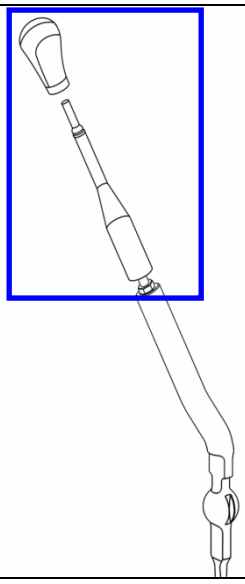
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Remove the electrical connection for the reverse lamp switch.

Support the engine suitably at rear end.

Remove the gearshift lever grommet.



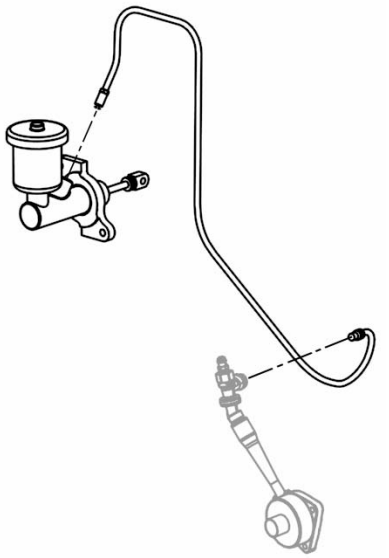
Remove the gear shift lever upper half.

Support the gearbox using a suitable stand.

Remove the gearbox mounting insulators.

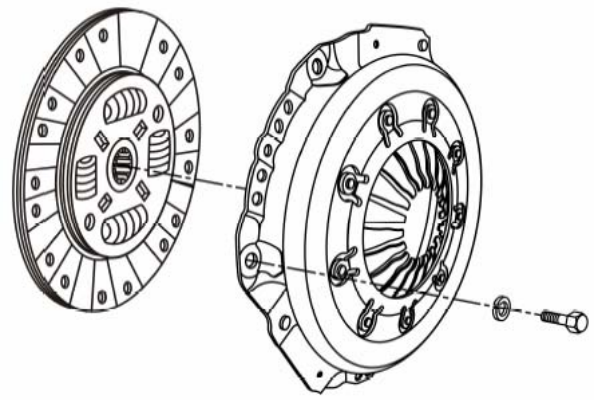
Remove the clutch housing fastening screws to the engine.

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Remove the hydraulic pipe connecting the Clutch Master Cylinder to Clutch Slave Cylinder.
Collect the Hydraulic Fluid. Do not allow the fluid to fall on painted surface.

Move the gearbox away from the engine.



If the cover assembly may be reused then loosen the cover bolts evenly and in tightening sequence to relive the spring tension equally.
The bolts should be loosened few threads at a time – so that the warping is avoided.
If the cover assembly is not going to be reused then this precaution is not essential.

If the pilot bearing has to be removed then the flywheel has to be removed and then the bearing removed using the MST no 543.
(To install the bearing MST no 544 has to be used.)

During assembly use the MST 546 to align the clutch plate while the cover is being tightened.

The assembly sequence is the reverse of the dismantling (except the precautions mentioned.)

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Inspection:

All the components should be inspected for wear. Any components, which are beyond the wear limits, have to be replaced.

Over & above the wear limits: The following points also need to be ensured.

Flywheel run out --

The flywheel run out needs to be checked whenever misalignment is suspected. Flywheel run out should not exceed than 0.10 mm

To measure the run out; mount the base of the magnetic dial gauge on the block. Locate the dial gauge's needle on the outer surface of the flywheel.

Some of the common reasons for excessive run out are:
- ✓ Heat warpage.
- ✓ Improper machining.
- ✓ Incorrect bolt tightening
- ✓ Foreign material on crankshaft flange or flywheel.
- ✓ Improper seating on crankshaft.

If the flywheel has been removed for resurfacing or replacing the pilot bearing then while fitting it back ensure that:

- ➢ No dirt and grease present on the mounting face (it can cause cocking & run out)
- ➢ The flywheel bolts have been replaced.
- ➢ Torque tightened as per sequence and also the angular tightening as per the specification is done.

Absence of any of these requirements may result in bolt loosening causing flywheel run out.

Clutch cover & Disc run out -

Check the clutch disc run out before fitting. It should be within the specifications. If it is more than the specification- use a different clutch plate.

A warped cover or diaphragm spring will result in clutch grab and / or incomplete release of clutch plate.

If the clutch alignment tool is not used then the misalignment of the clutch plate can cause distortion of the cover and also disc damage.

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The cover can also get misaligned due to improper tightening of the cover onto the flywheel. The only way to avoid is that the bolts must be tightened alternatively (diagonal pattern) and evenly i.e. 2 to 3 thread a time only.

Clutch Housing Misalignment –

The clutch housing has to be aligned with the engine so that the input shaft is aligned with the crankshaft. Absence of this alignment results in clutch noise, incomplete release of the clutch plate. It can normally be judged by uneven wear of the finger and pilot bearing. In severe case it can also damage the spline of the input shaft and clutch hubs well as the clutch splines

- Normally the clutch housing misalignment is a result of:
- Incorrect seating on the engine/transmission.
- Missing alignment dowel holes.
- Loose or missing mounting bolt.
- Mounting surfaces that are damaged/ not parallel.

Before fitting the clutch housing ensure that no dirt, debris or foreign parts are trapped between the mating surface of the transmission & the clutch housing.

Flywheel -

If the flywheel is found to be having minor scoring then it can be resurfaced. However the maximum allowed cut is 0.076 mm. If scoring is deeper than 0.0076 than the flywheel has to be changed. (Excessive material removal will cause the flywheel to either crack/ warpage after installation/ drop in clamping load and will affect the proper clutch release as the travel of release bearing gets affected.)

If the flywheel has been removed for resurfacing or replacing the pilot bearing then while fitting it back ensure that:

- No dirt and grease present on the mounting face (it can cause cocking & run out)

- The flywheel bolts have been replaced.

- Torque tightened as per sequence and also the angular tightening as per the specification is done.

Absence of any of these requirements may result in bolt loosening causing flywheel run out.

Starter ring replacement: Unless the provision of properly heating & fitting is available. It is not recommended to replace the starter ring. It is worthwhile to replace the ring along with the flywheel.

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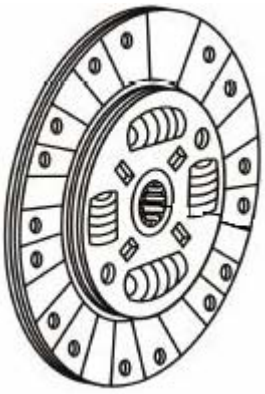
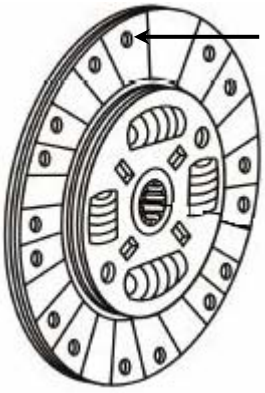


If the starter ring is only going to be replaced then:

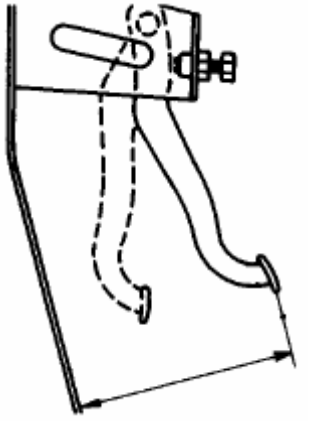
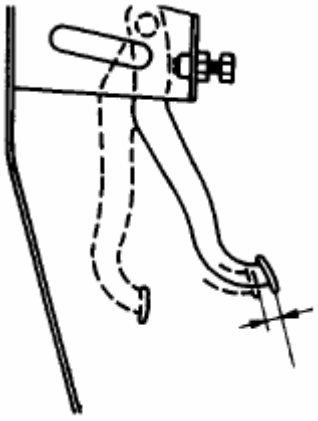
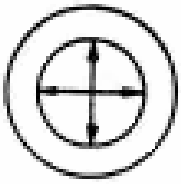
- Do not use a gas flame to cut. It can cause local overheating of flywheel.
- The ring gear has to be heated in an oven to get uniform expansion. (Nearly 191°C)
- Does not use flame to heat the ring – it can cause annealing of the ring teeth and premature failure.

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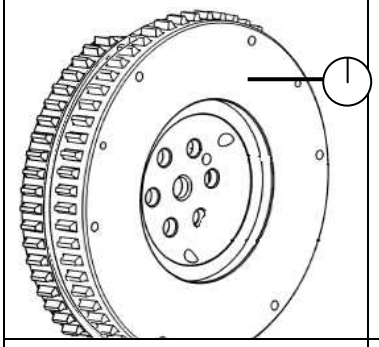
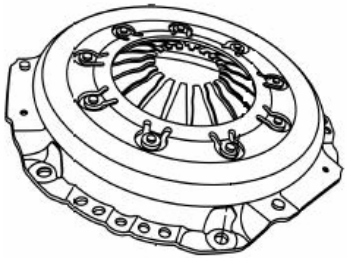
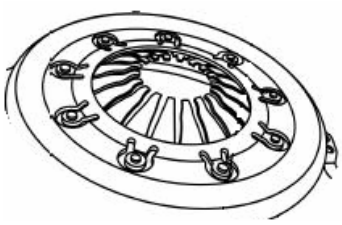
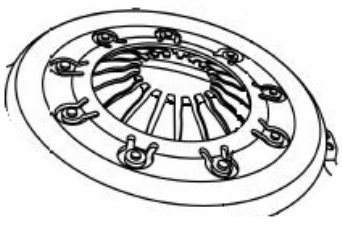
Specifications & Wear Limits –

Figure	Description	*Value*
	Clutch control type-	Hydraulic- self adjusting
	Pressure plate	**Diaphragm**
	**Clutch Disc** **Outer Dia (mm)** **Inner Dia (mm)**	240±1 160± 1
	Disc Thickness (mm)	8.8 mm (free)
	Clutch disc run out	0.8 mm Max
	**Minimum thickness from outer face to rivet head.**	0.4 mm
	Clutch pedal	Suspended Type
	Clutch pedal Ratio	7.4

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Figure	*Description*	*Value*
	**Clutch Pedal Height above carpet thickness of 10 mm.** **Total Pedal Travel** **90% Pedal Travel**	 160 mm 144 mm.
	**Clutch pedal free play (including push rod play at pedal top)**	5 to 6 mm
	**Master Cylinder Bore diameter**	19.05 mm
	Clearance between The piston & the bore (Both cylinders)	0.13 mm

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Figure	*Description*	*Value*
	**Flywheel** **Flatness** **Run out**	Standard Service Limit ≤ 0.05 0.1 ≤ 0.05 0.1
	Flywheel Width from Mounting face to clutch face	35±0.13
	Clutch release point from pedal full stroke end position	25 mm from Bottom position
	**Pressure plate finger height (mm)**	47.6 ± 1.0 mm
	**Diaphragm spring tip non alignment.(Max)**	0.8 mm (finger to finger)
	**Diaphragm spring finger wear**	Max depth 0.5 mm Max width 5 mm

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Tightening Torque's -

Location	Torque Nm (lb-ft)
Pressure plate bolts	32.5 ± 2.5 Nm (24 ± 2 Lb-ft)
Clutch pedal position Switch lock nut	25 Nm (18 Lb-ft)
Clutch master cylinder nut	25 Nm (18 Lb-ft)
Concentric Slave Cylinder bolts (CSC)	10Nm (7 Lb-ft)
Flywheel Bolts	50 Nm + 60° (36.80 Lb-ft + 60°)
Clutch pedal pivot bolt and nut	27.5 ± 2.5 Nm (20 ± 2 Lb-ft)

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Lubricant –

Specification: DOT3 standard /SAE J1703/IS 8654

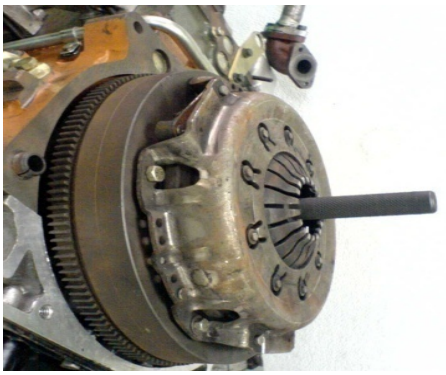
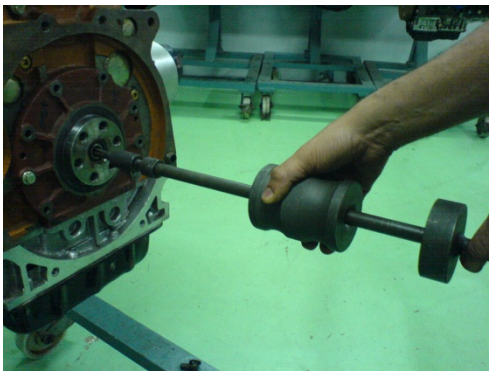
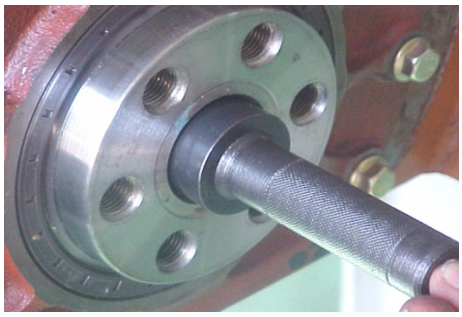
Hindustan Petroleum: HP Super Duty Brake Fluid

Castrol/ Girling Brake Fluid.

Indian Oil: Servo Brake fluid Super HD

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List of the MST -

Description/ Part No. / Sketch	Usage View
Master clutch plate assembly- diesel (aligner) MST 546 	
Extractor Flywheel bearing MST 543 	
Drift Flywheel bearing MST 544 	

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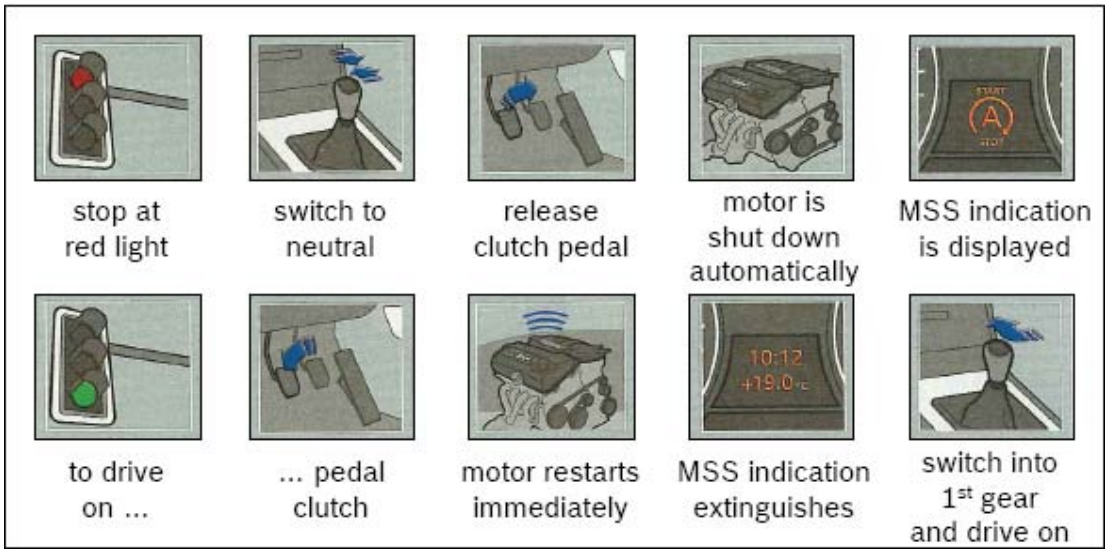
ESS (ENGINE STOP-START SYSTEM) -

System Description:

The following steps illustrate how the system functions.
• Vehicle has come to halt due to traffic signal / jam, is in neutral gear and the clutch pedal is fully released.
• The engine will shut down automatically after 2 seconds. Immediately after depressing
the clutch pedal fully, the indicator - - in the cluster will blink (till the engine stops) indicating that the engine is going to stop shortly.
• Once the engine stops, the indicator- - will glow continuously in your instrument cluster indicating that the engine has been stopped by the Micro Hybrid system.
• Once the Signal turns green, press the clutch pedal fully & engine starts immediately.
• The indicator in the cluster goes off indicating that engine has started again & you are ready to drive on with the vehicle.

Note:

To activate the micro hybrid system, ensure the switch located in the left side of the instrument panel is in pressed condition.



Note:

Do not attempt to swap EMS ECU with that of any other vehicle for the vehicle is enabled with Transponder based Immobilizer and hence vehicle will get immobilized.

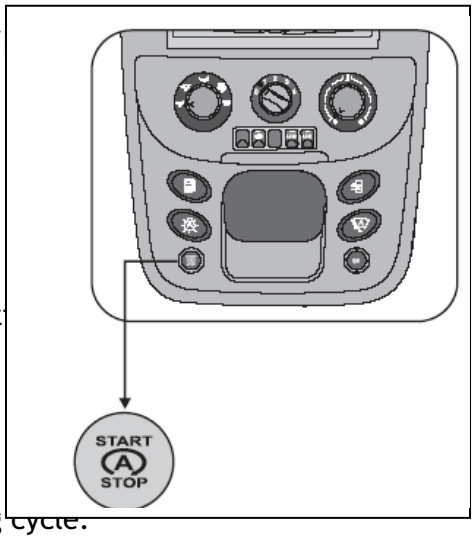
Also, if a lower version dataset (Micro Hybrid uses V76) is used on Micro Hybrid enabled vehicles will result in Starter Motor engaged continuously with Ignition ON.

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The following inputs are required for Start Stop system to function
1. Mode selection Switch condition
2. Bonnet switch condition
3. Gear box position
4. Clutch pedal switch position (10% & 90% switch)
5. Accelerator pedal input
6. Engine speed
7. Vehicle speed
8. Battery Condition
9. Fuel temperature
10. Coolant temperature

The Engine will automatically stop if all the below conditions are met

1) Mode Selection Switch in ON condition
i) For activating/deactivating the Start Stop function



2) Vehicle speed shall cross minimum of 2km/
i) For confirming the driving cycle start.

3) Engine Speed in Idling Range
i) For confirming vehicle stand still condition
ii) Engine idle speed: 800rpm

4) Vehicle Speed is zero
i) For confirming the vehicle stand still condit

5) Gear Box is in Neutral
i) For confirming vehicle neutral condition.

6) Battery Condition Healthy
i) To ensure sufficient power for next starting cycle.

7) Accelerator Pedal Not Pressed
i) For confirming vehicle stand still condition.

8) Bonnet remains closed
i) For working safely in the engine compartment when the vehicle in service.

9) Clutch pedal fully released
i) For confirming

Once all above conditions are satisfied, vehicle will automatically stop in two seconds. Whenever the system is going to turn off the engine, the start stop lamp in the cluster will blink. If the driver wishes to avoid stopping of the engine after the blink, a press of clutch or accelerator pedal will help to reset the timing. Once the engine is stopped by the start stop mode, start stop lamp in the cluster will be continuously ON.

The system will not stop the engine, when the battery charge goes below a certain threshold value so as to preserve the battery.

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The Engine will start automatically once the clutch pedal is fully pressed with below mentioned conditions -

1. Mode Selection Switch in ON condition
2. Engine Speed is zero
3. Vehicle Speed is zero
4. Gear Box in Neutral
5. Bonnet remains Closed
6. Clutch Pedal Pressed fully

S. No.	P-Code	Description	Parts to be Checked
1	P1704	Gear Neutral Signal is not plausible	1. GNS
2	P168E	Gear Neutral Signal is not plausible in Stand Still condition	1. GNS 2. Clutch 10% & 90% switches

Once the vehicle gets started, start stop lamp in the cluster will automatically goes off.

Error codes

This codes are only for reference – to view the code and rectification procedure, refer the EMS Diagnostic Manual

3	P170D	Starter power stage Short circuit to Battery
4	P1710	Starter power stage Excess Temperature
5	P1712	GNS Relay No Load
6	P1714	GNS Relay Sticking
7	P170A	Redundant Clutch Switch is not Plausible
8	P1AE9	Stop lamp power stage Short circuit to Battery
9	P1AEA	Stop lamp power stage Short circuit to Ground.
10	P1AEB	Stop lamp power stage No Load
11	P1AEC	Stop lamp power stage Excess Temperature
12	P1715	T50 always pressed

Battery Not Healthy:

1. Attempt to re-charge the battery and re-use
2. If recharging the battery is not successful replace the battery.

Note: Only 72Ah battery to be used

Starter motor failure:

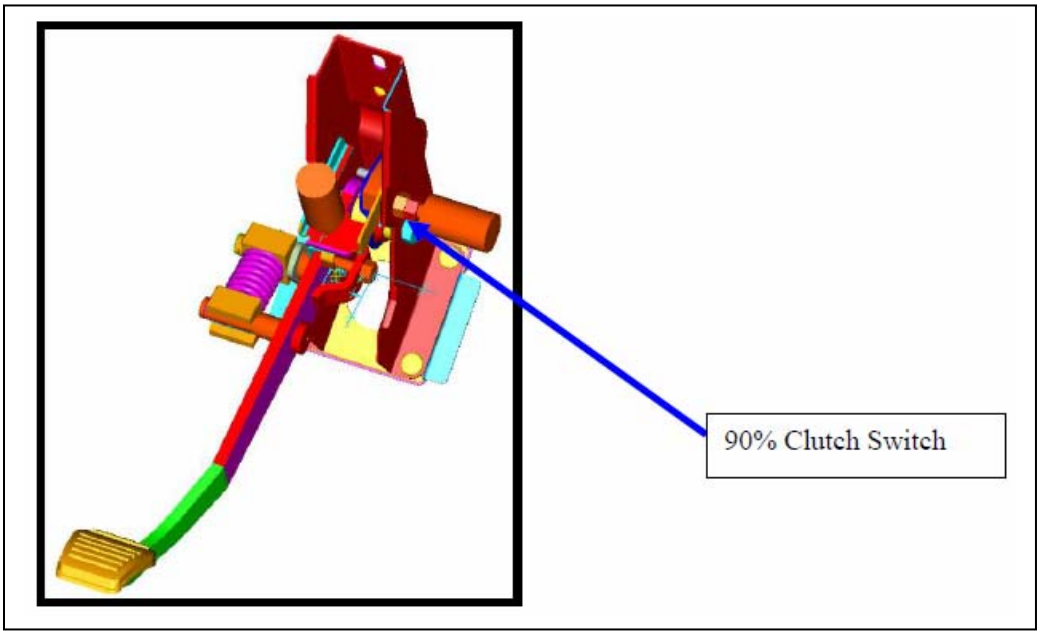
1. Check the ignition key for any struck. If there is a problem in the key replace ignition key and change the starter motor
2. Check for starter pinion damage if pinion damage is observed then replace the over running clutch assy.

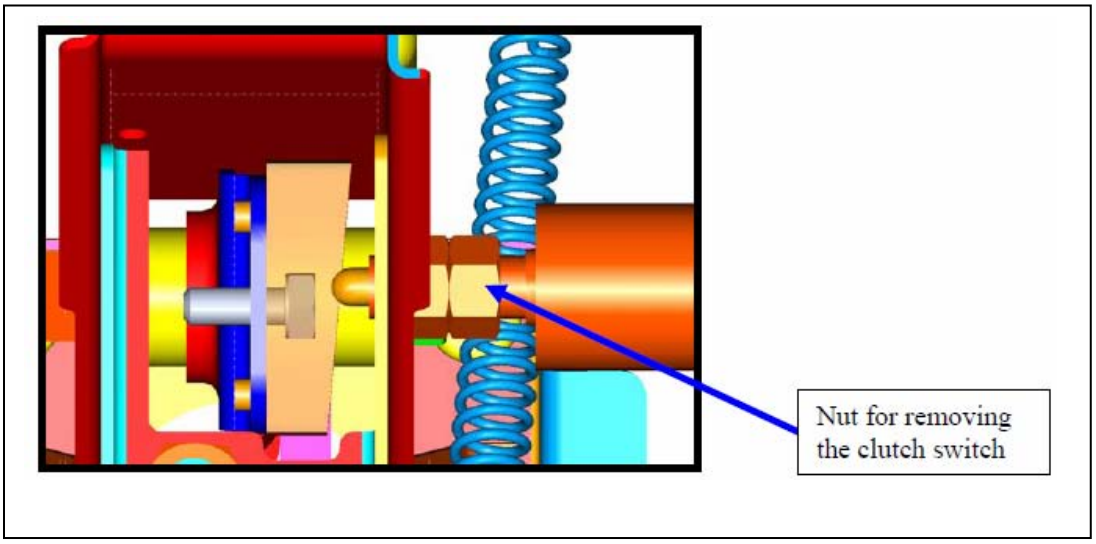
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NOTE: Starter motor used is different from vehicles which do not have Engine Start Stop since starter is subjected to more number of cranks. Only S78 Starter to be used for ESS application.

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Clutch Switch failure:





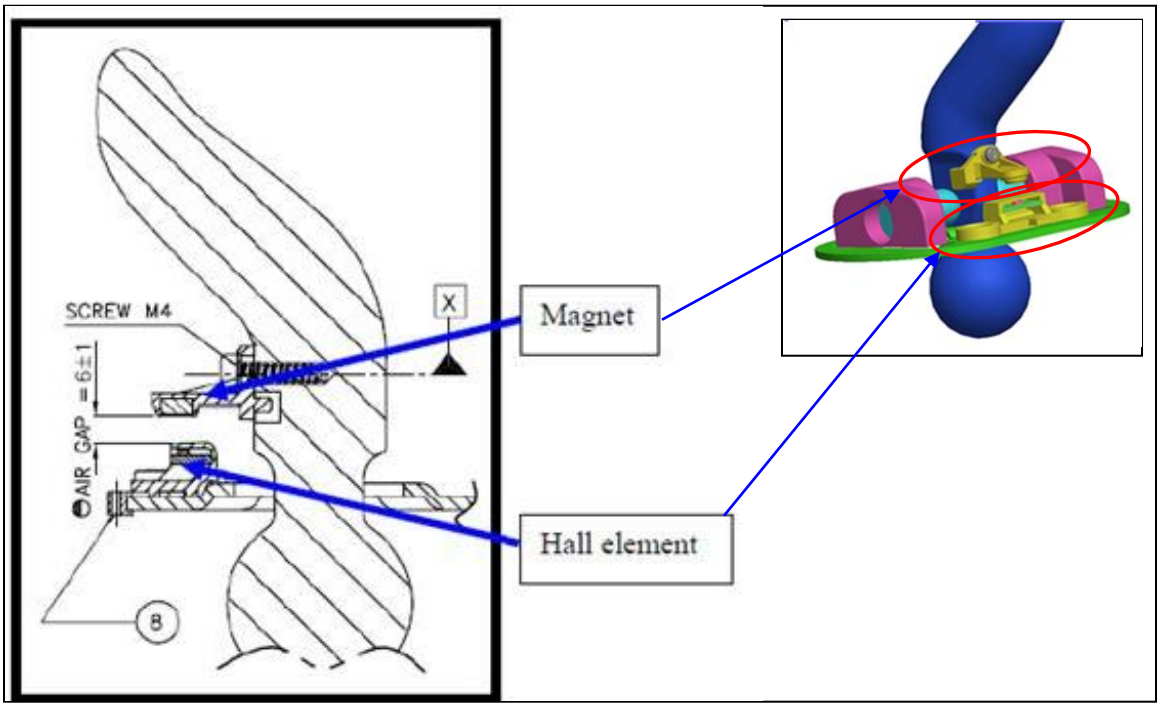
Clutch switch replacement:
Loosen the nut and remove the 90% clutch switch. Replace with new clutch switch. Adjust the switch for 90% clutch position. It can be done by checking the continuity in the switch contacts by pressing the clutch pedal for 90% of its travel. 90% clutch switch is NC switch. At 90% clutch travel, there should not be continuity between the contacts.
And the same procedure can be used for adjusting the clutch switch.

Note: Refer annexure for 90% clutch switch fitment / adjustment. GNS:

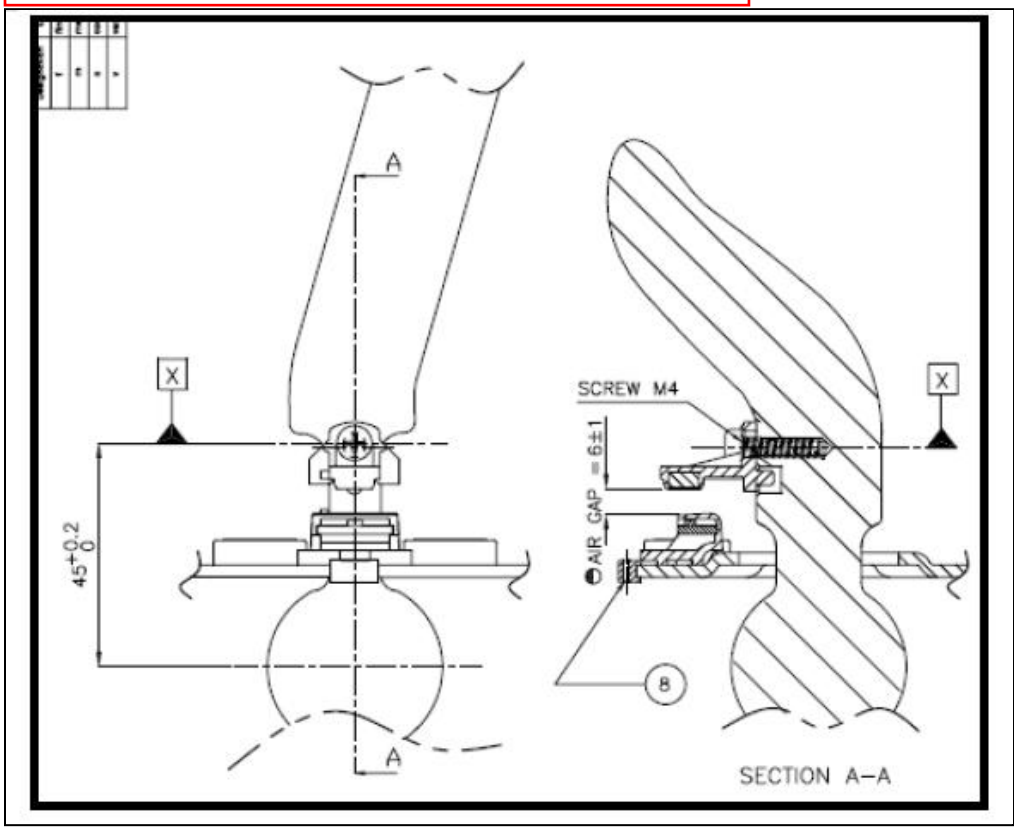
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The gap between sensor and magnet shall be 6±1mm. This gap has to be maintained within the specification to ensure the proper function of gear neutral sensor.

- **Gear Neutral Switch (GNS) fitment:** Refer illustrations below.

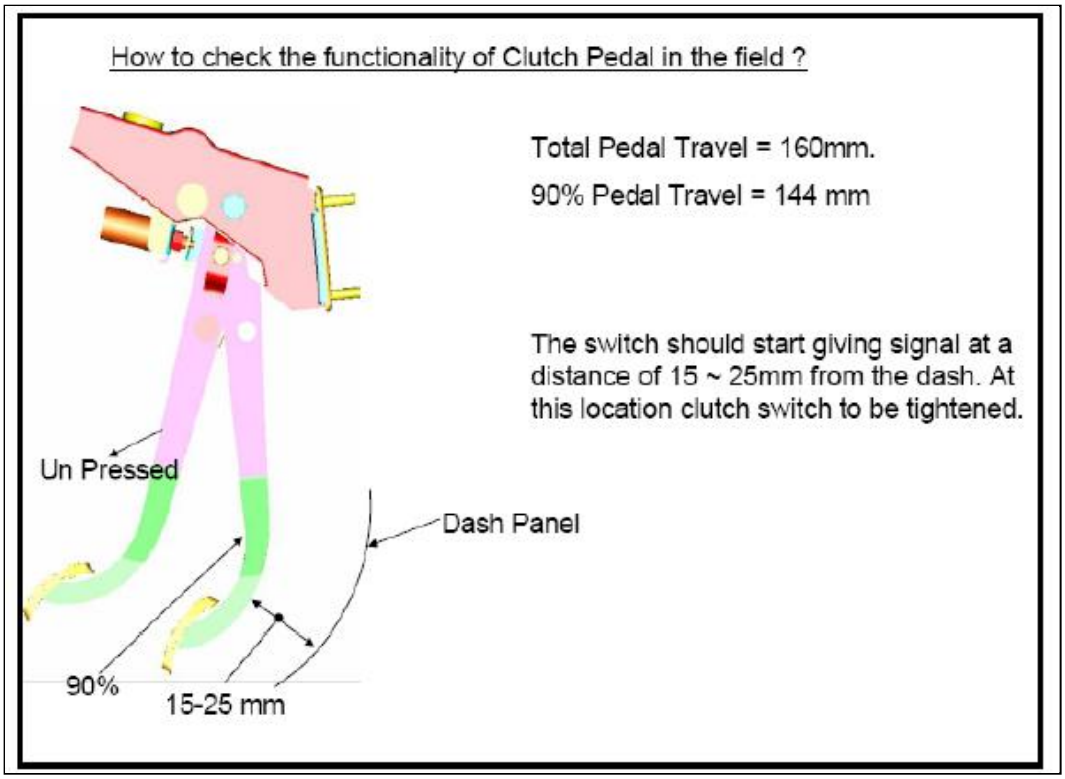


GNS Magnet and Hall Element fitment on Gear Lever



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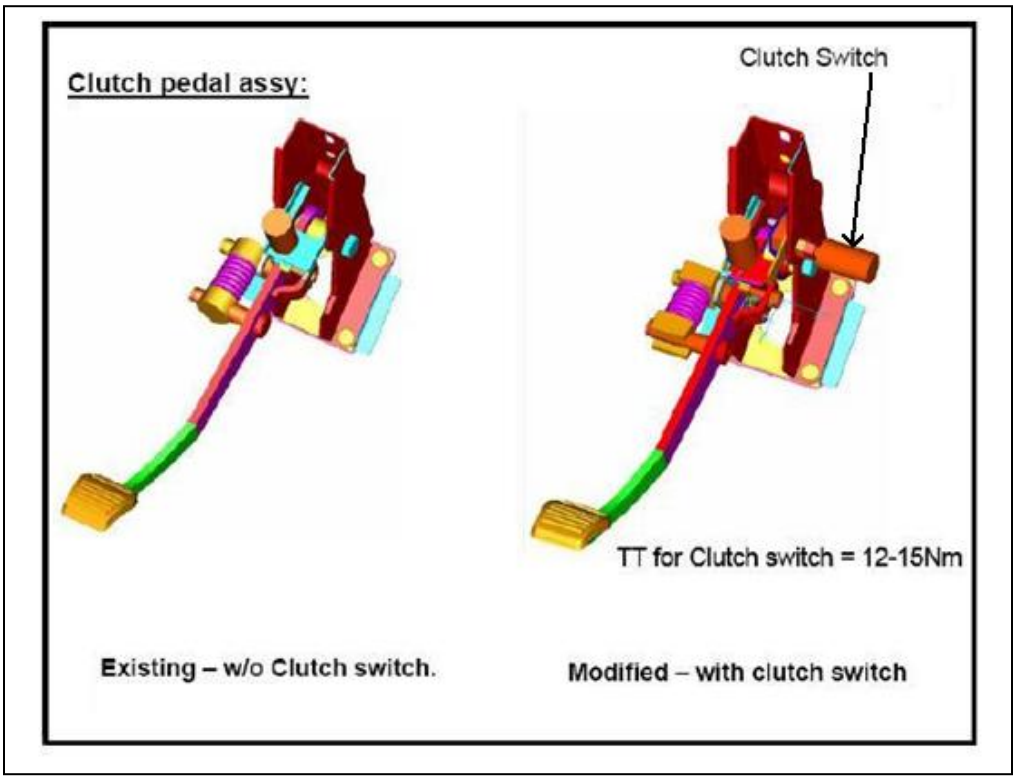
- **90% CLUTCH SWITCH FITMENT / ADJUSTMENT PROCEDURE:**



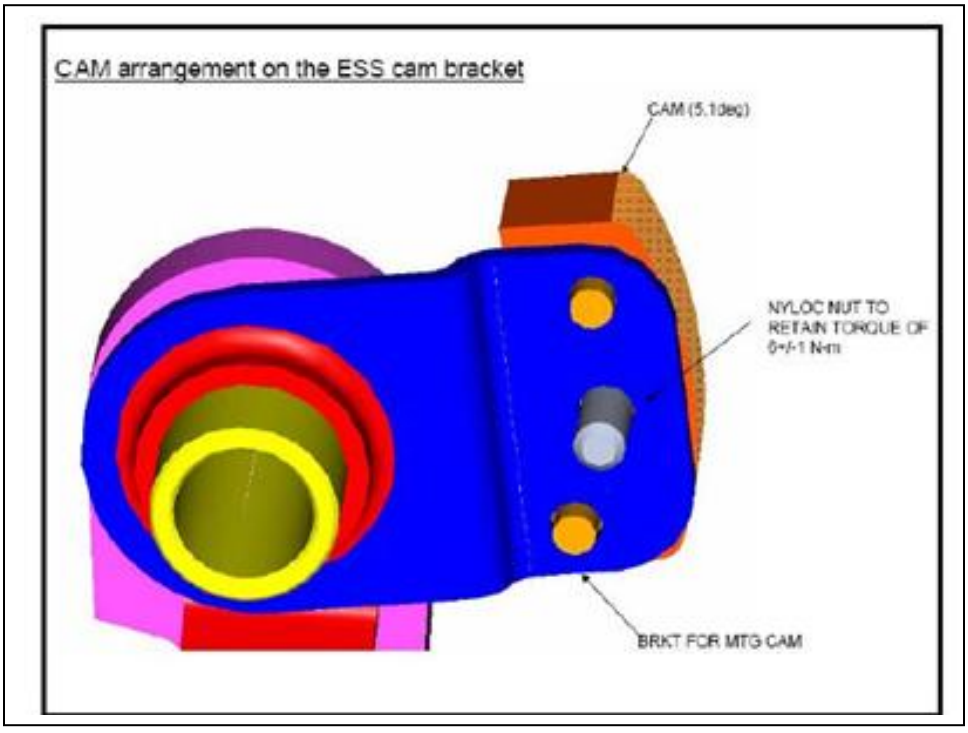


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Clutch Pedal Assembly -

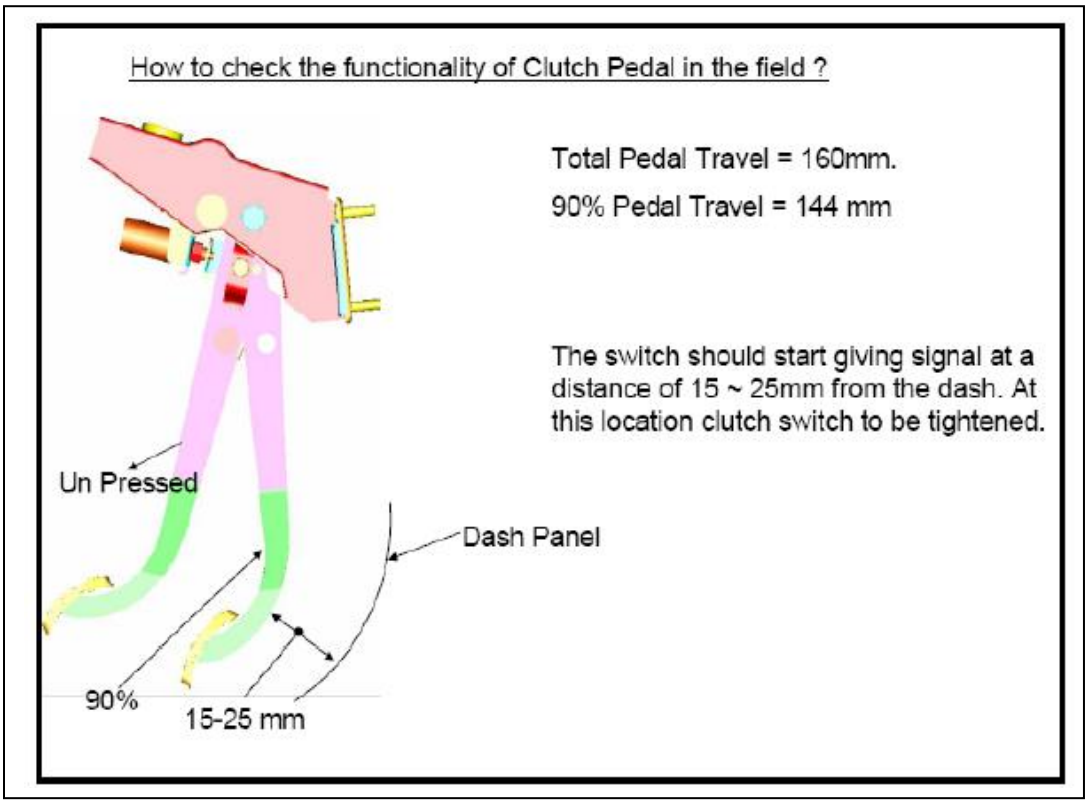


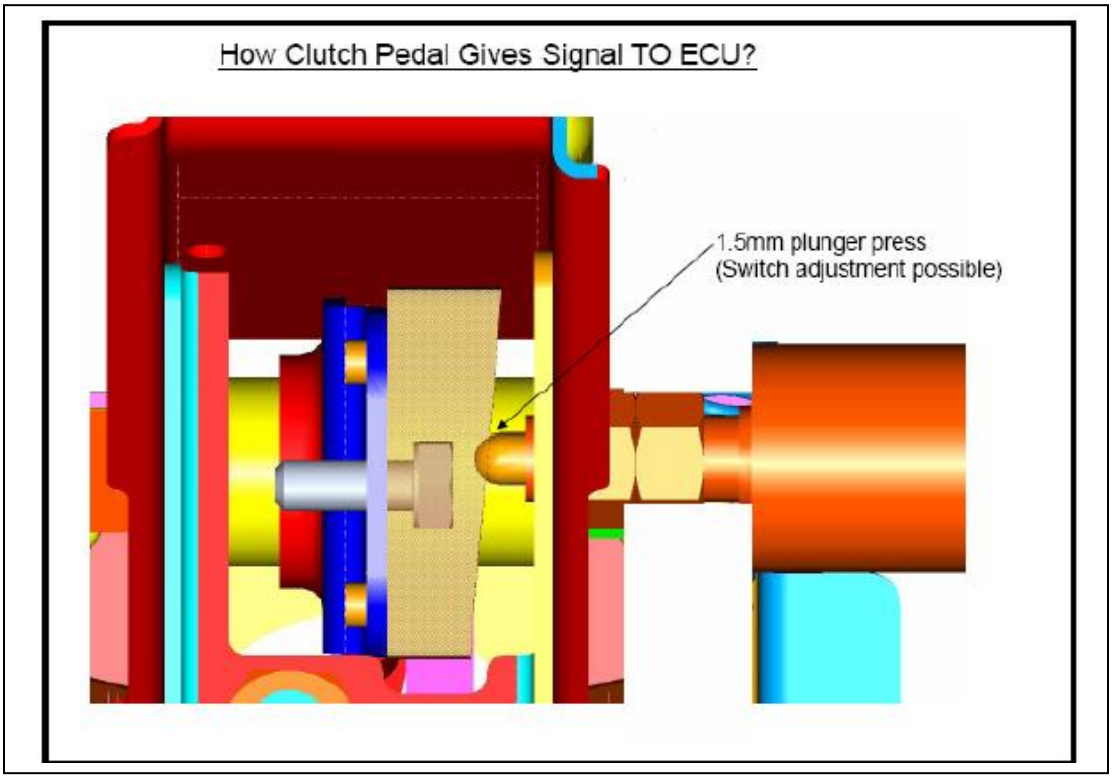
CAM arrangement on ESS Cam bracket -



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Clutch Pedal – Check for proper functioning





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Care of the system –

If a vehicle uses non standard or more then one floor mat. It may reduce the pedal travel which will lead to malfunction of ESS switch. Hence it is strictly recommended to have floor mat as recommended by M&M.

It is recommended to check the functionality of ESS switch once in every 5000 Kms of vehicle run.

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NGT 530R-2WD

Contents

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Care of the transmission

Service Diagnosis

Dismantling

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Special Tools

Specifications

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Description -

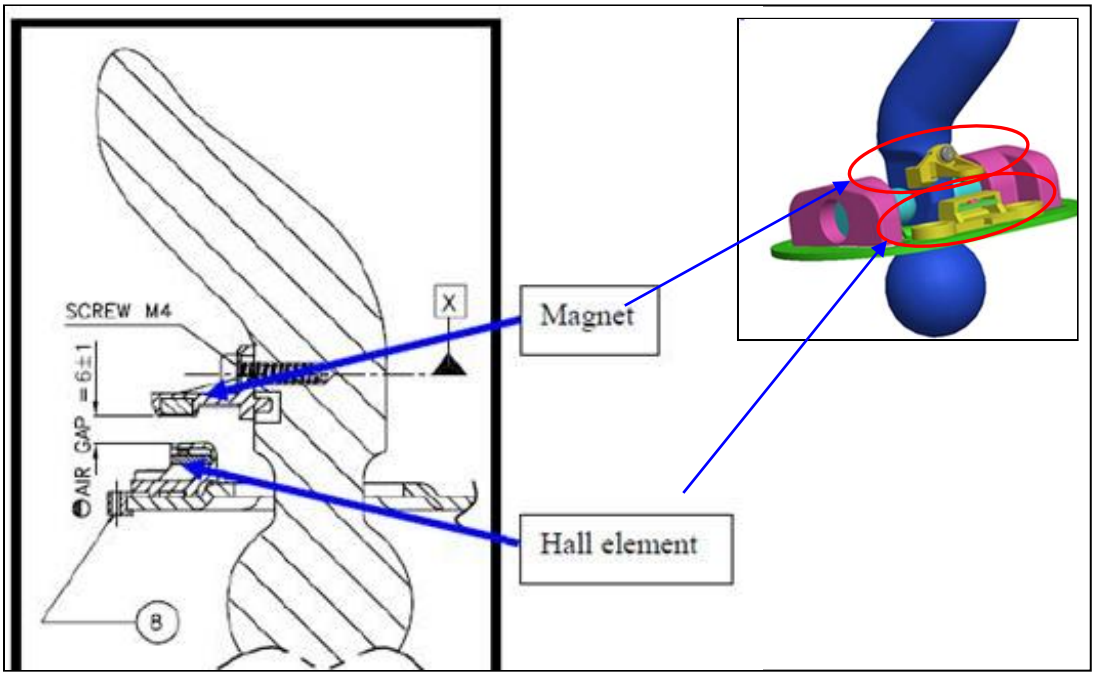
It is a 5-speed gearbox. The 1st & 2nd gear is having double cone type synchronizer while the 3rd, 4th & 5th are having strut type synchronization. The reverse gear is sliding mesh.

The gear selection is by a direct shift lever operating a 3-rail system. The accidental operation of two gears is avoided by an interlocking mechanism. To avoid vibrations passing on to the shift lever; the shift lever is two-piece with rubber isolation provided on to the top half.

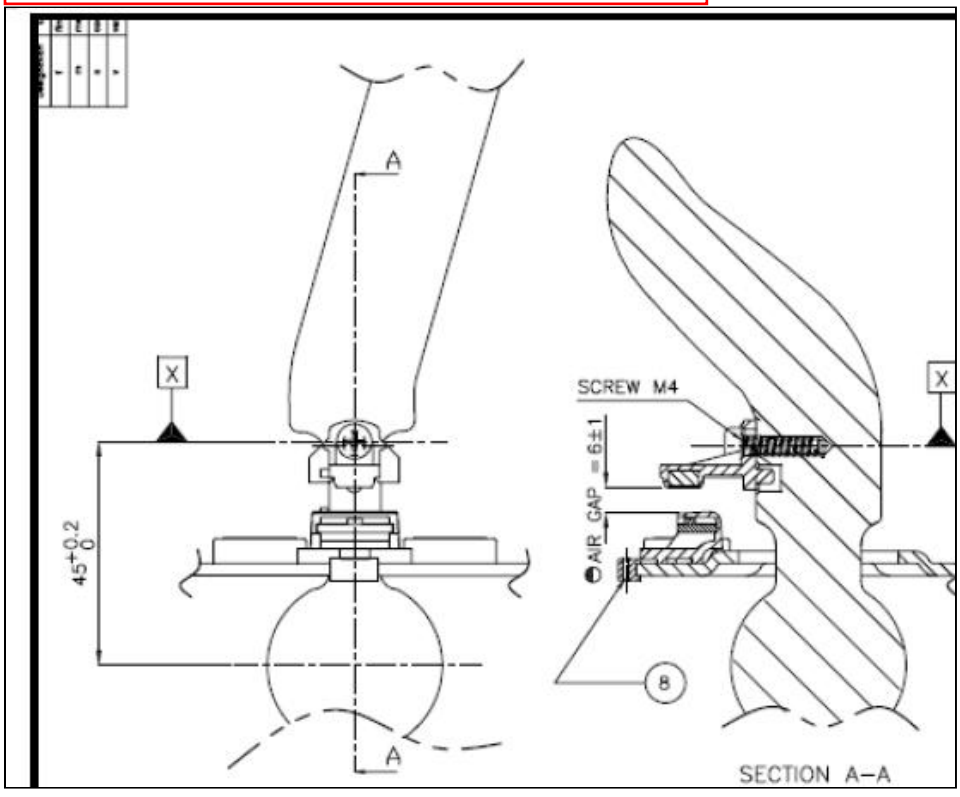
The gearbox housing is 3 piece aluminum with an intermediate plate. A skid plate protects the bottom of the gearbox. The Gearbox is mounted directly on the flywheel through the integral clutch housing and supported at rear on the cross member. The gearbox also has a gear neutral switch (GNS) which give signal to ECU when vehicle is in neutral gear position.

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Gear Neutral Switch (GNS) position on TM retainer plate -



GNS Magnet and Hall Element fitment on Gear



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Care of the transmission –

The lubricant level should be checked every 10000 KMs. with the vehicle un laden and on level ground. The lubricant level should be at the lower edge of the filler plug. Use lubricant meeting oils specification of GL 4 & viscosity 80W90.The brand names have been specified in the Operators Manual.
The lubricant should be changed at 5000 KMs, then at 40000 KMs and after that every 40000 KMs.

Service Diagnosis –

A low transmission lubricant level is generally the result of a leak, inadequate lubricant fill, or an incorrect lubricant level check.
Leaks can occur at the mating surface of the gear case, intermediate plate and adapter or extension housing or from the front/rear seals. A suspected leak could also be result of an overfill condition.
Leaks at the rear of the extension or adapter housing will be from the housing oil seal. Leaks at component mating surface will probably be the result of inadequate sealer, gaps in sealer, incorrect bolt tightening, or the use of a non-recommended sealer.
A leak at the front of the transmission will be from either the front bearing retainer or retainer seal. Lubricant may be seen dripping from the clutch housing after extended operation. If the leak is severe, it may also contaminate the clutch disc causing slip, grab and chatter.
A correct lubricant level check can be made only when the vehicle is level, use a two post or a four post hoist to ensure this. Also allow the lubricant to settle for a minute or so before checking. These recommendations will ensure that an accurate check and avoid an under fill or overfill conditions.

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Hard Shifting -

Hard shifting is usually caused by low lubricant level, improper or contaminated lubricants, component damage, and incorrect clutch adjustment or by a damaged clutch pressure plate or disc. Substantial lubricant leak can result in gear, shift rail, synchro and bearing damage. If a leak goes undetected for an extended period the first indications of a problem are usually hard shifting and noise. Incorrect or contaminated lubricants can also contribute to hard shifting.
The consequence of using non-recommended lubricants is noise, excessive wear, internal bind and hard shifting.
Improper clutch release is one of the most frequent causes of hard shifting. Incorrect adjustment of a worn damaged pressure plate or disc can cause incorrect release. If the clutch problem is advanced then it can result in gear clash during shifts. Incomplete travel of the clutch pedal due to restrictions at the end of stroke (upturned carpet, extra carpet or cover or bend clutch linkage can also cause improper clutch release and hard shift.)
Worn or damaged synchro rings can cause gear clash when shifting any forward gear. In some new or rebuilt transmissions, new synchro rings may tend to stick slightly causing hard or noisy shifts. In most conditions this will decline as the rings wear in.

Transmission Noise -

Most manual transmissions make some noise during normal operation. Rotating gears can generate slight whine that may only be audible at extreme speeds.

Severe obviously audible transmission noise is generally the result of a lubricant problem. Insufficient, improper or contaminated lubricant can promote rapid wear of gears, synchros, shift rail, forks and bearing's. The overheating caused by a lubricant problem can also lead to gear breakage.

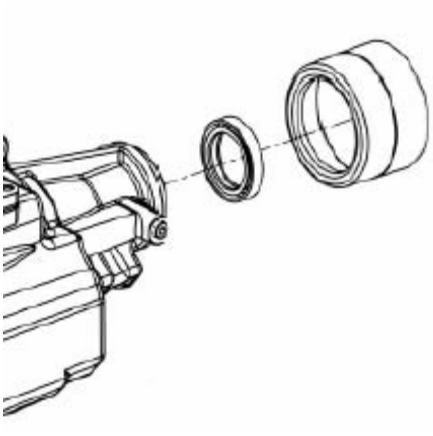
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Summarizing the common faults and their cause:

Problem	Possible Causes	Correction
Gear Whine	Low oil level Worn teeth gears Worn bearings	✓Top up oil. ✓Replace gears ✓Replace bearings.
Knocking or ticking	Chipped gear teeth Foreign matter inside transmission. Defective bearings.	✓Replace gears. ✓Remove the foreign matter and locate how the foreign matter came inside e.g. missing breather and rectify that also to avoid recurrence. ✓Replace the bearings.
Jumping out of gear	Defective detent springs. Worn out grooves in shift rail. Shaft misalignment. Worn dog teeth in gear Worn out fork/ fork pads Worn out synchronizer body.	✓Replace the detent springs. ✓Replace the shift rails. ✓Replace the gears ✓Replace the fork/ pads ✓Replace the body
Unable to select gear	Clutch defective Worn out selector mechanism	✓Rectify the clutch/ clutch withdrawal mechanism ✓Rectify the gear selector mechanism
Hard gear shifting	Clutch defective Improper or contaminated lubricants	✓Rectify the clutch/ clutch withdrawal mechanism ✓Replace the lubricant with the specified lubricant.

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Replacement of output shaft seal -

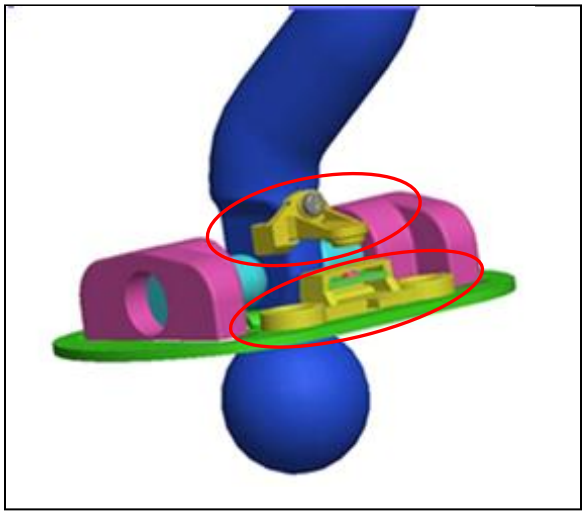
Remove the propeller shaft from the Rear (Differential) end & carefully pull the propeller shaft out from the transmission
 Tap the dust cover out with the help of a mallet. Remove the oil seal using a blunt edge screw driver or any other suitable tool. Note - Care must be taken not to damage the housing while removing the oil seal. Fit the new oil seal. The lip of the oil seal & the aluminum housing should be protected against any damage.

Removal of the transmission from the Vehicle -

Remove the top lever.
Remove the Rear (Differential) End Propeller Shaft bolts – 4 Nos.
Carefully pull the Propeller Shaft out from the transmission. **Note -** After the propeller shaft yoke is pulled, a bit of oil is expected to come out as the yoke itself is the guide for the oil seal.
Drain the transmission oil.
Loosen & remove the starter motor.
Remove the hydraulic pipe connecting the CMC to Clutch Slave Cylinder.
Loosen & remove the Clutch Housing fastening bolts.
Disconnect the speed sensor connection.
Disconnect the reverse lamp switch connections.
Loosen the cross member bolts & Remove the transmission.

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Removal of Gears Neutral Switch-



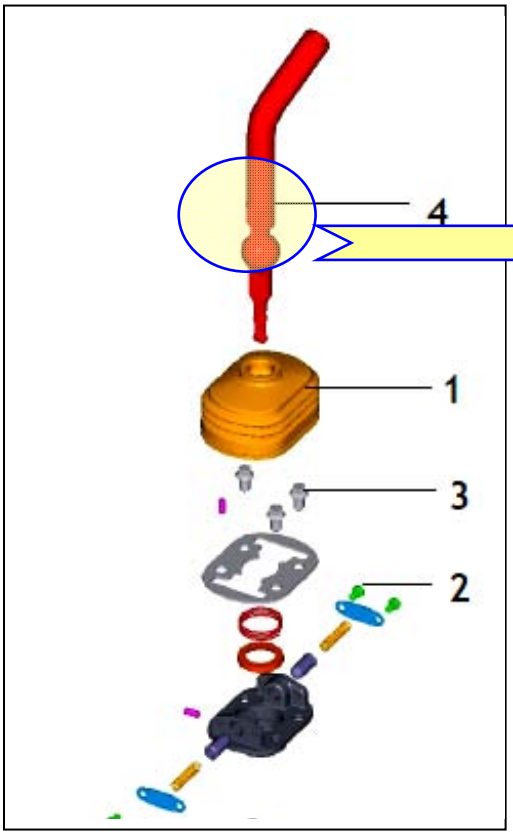
GNS Magnet and Hall Element fitment on Gear

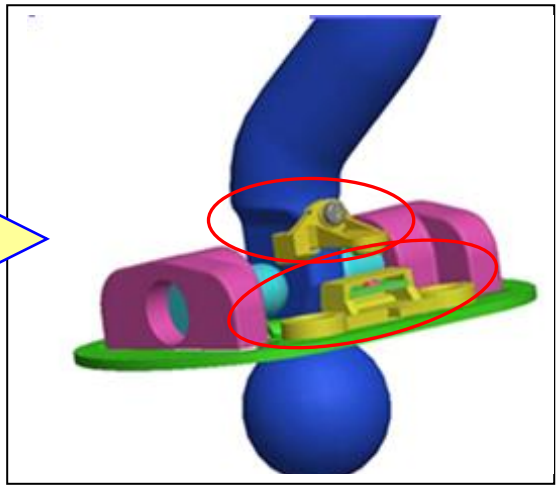
1. Remove the floor console.
2. Remove gear gaiter bezel assembly.
3. Remove shift lever grommet.
4. Remove spring retention plate pivot.
5. Remove neutral sensor.
6. Remove button lever.
7. Remove sensor mounted on gear bottom lever.

Note: Unless otherwise specified the assembly procedure / guidelines is the reverse of the disassembly procedure.

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Dismantling:



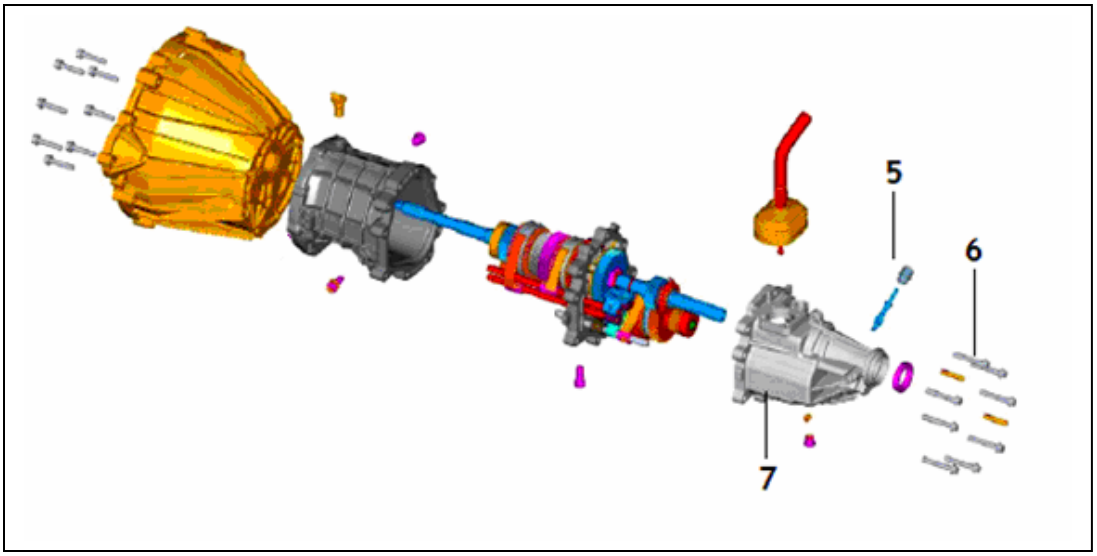


Gear Neutral Switch fitted on Lever

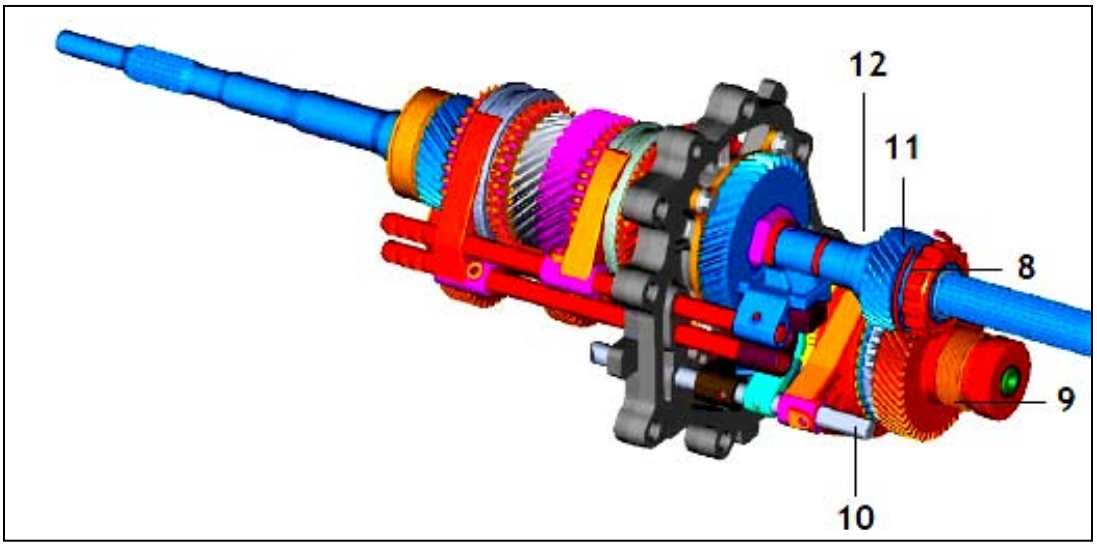
Removal Steps -

1. Remove the lock clip & remove the grommet.
2. Remove biasing cover plate bolts & springs. - 4 nos. (Check Point A)
3. Remove Lever retention bolts - 3 nos. Remove GNS socket and Gear Neutral Switch mounted on plate - 4 bolts.
4. Put the selector mechanism in neutral & remove lever assembly along with nylon bush.

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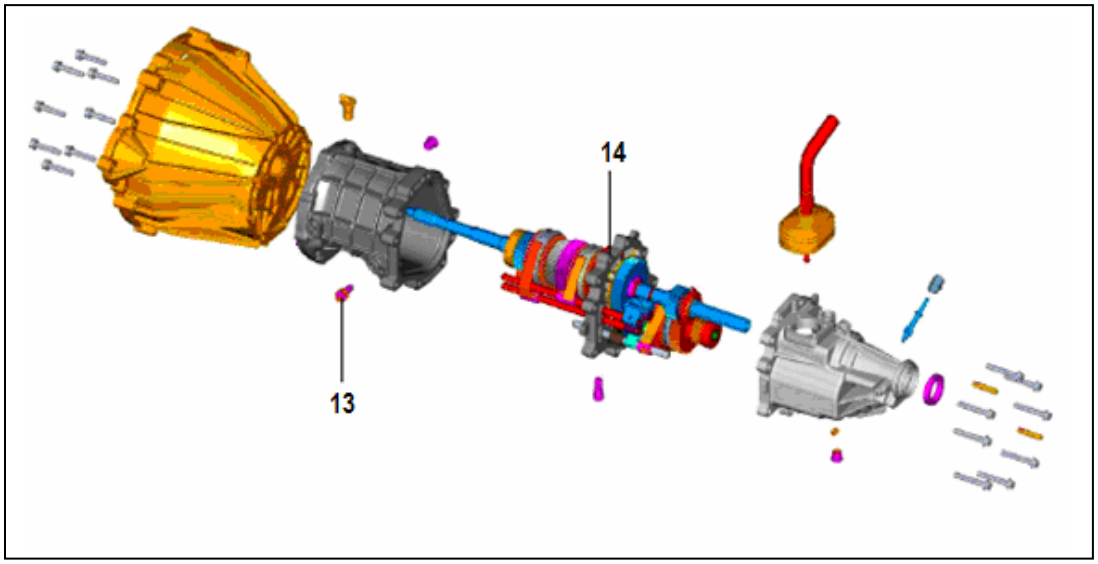


5. Remove the Speedo adaptor.
6. Loosen & remove the bolts fastening the Front housing – Intermediate plate & the Rear housing.

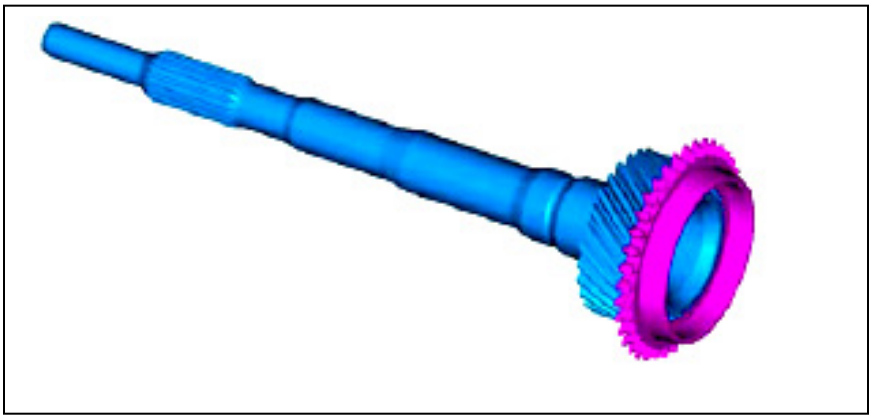


7. Remove the rear housing by tapping with the help of a mallet.
8. Remove the circlip in front of the 5th driven gear.
9. Remove the bearing inner race, shim, bevel gear on the 5th – Reverse sub shaft.
10. Remove 5th driving gear, synchro brass ring & the needle bearing.
11. Remove the roller bearing on the main shaft using MST.
12. Remove the 5th driven gear using MST. [SKF TMMP3/230 (puller) & TMMH 100 (for attachment]

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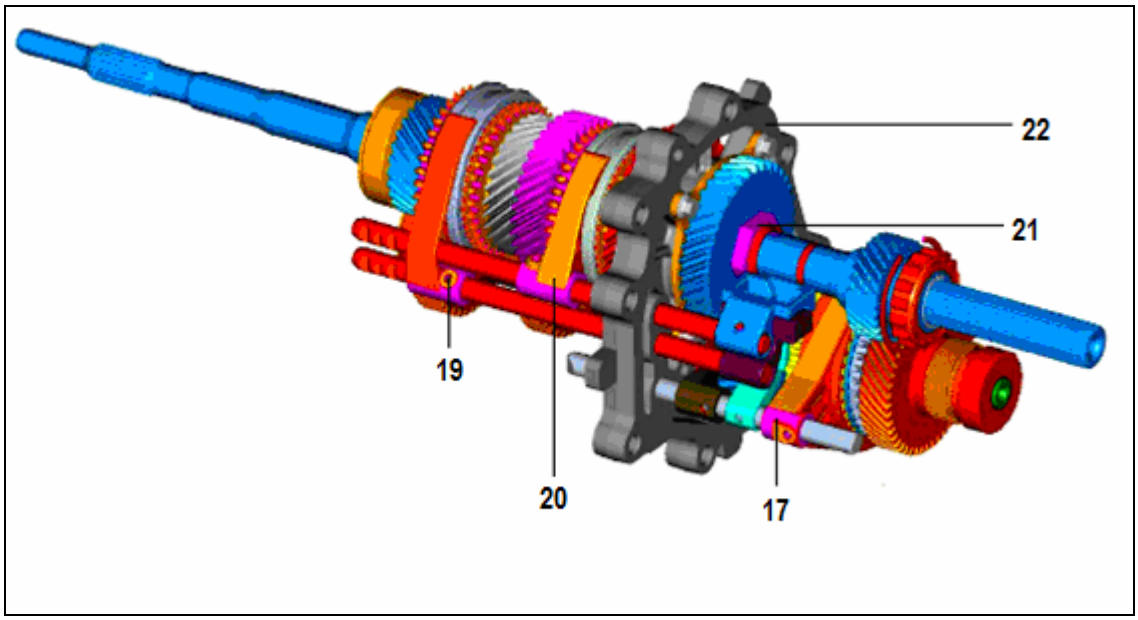


13. Loosen & remove the reverse switch.
14. Pull out the gear train from the front housing with intermediate plate.



15. Separate the Main drive gear from the main shaft.

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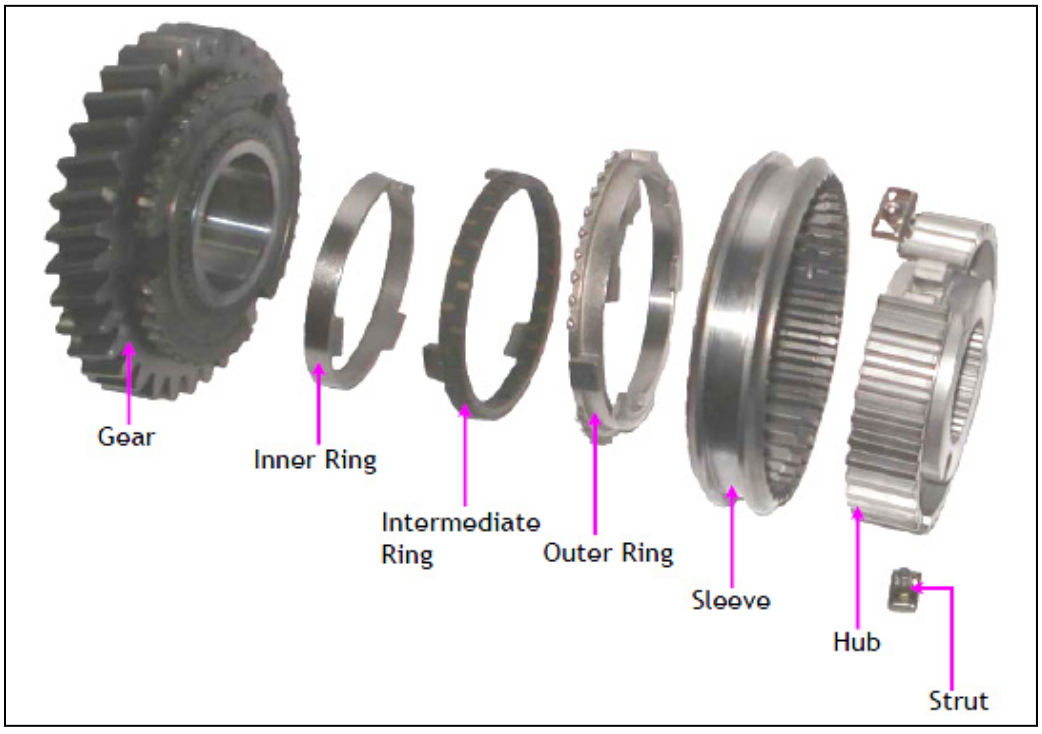


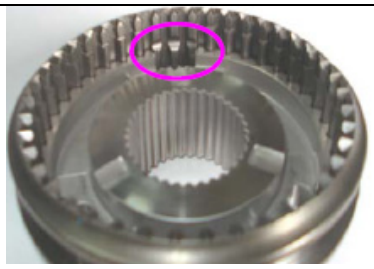
16. Loosen & remove the detent, ball & spring from the intermediate plate.
17. Remove the 5th – reverse rail fork & remove the 5th – reverse rail & fork assembly, idler gear, reverse sub shaft & synchro hub assembly.
18. Separate the Counter shaft from the intermediate plate.
19. Remove the 3rd – 4th shift rail split pin & remove 3rd – 4th shift rail & selector fork & plunger.
20. Remove 1st – 2nd shift rail split pin & remove the shift rail &fork.
21. Loosen & remove the nut in front of the reverse driven gear & remove the reverse driven gear from the main shaft.
22. Separate the intermediate plate from the main shaft.
23. Remove the main shaft pilot (small bearing towards clutch housing side) bearing.
24. Remove the circlip & Belleville washer.
25. Remove the 3rd – 4th synchro hub assembly, synchro brass ring & the 3rd gear. Separate the 3rd gear needle bearing.
26. Remove the taper roller bearing from the other end. Separate the 1st gear shim, 1st gear needle bearing, double cone synchro assembly, 2nd gear & the 2nd gear needle bearing.

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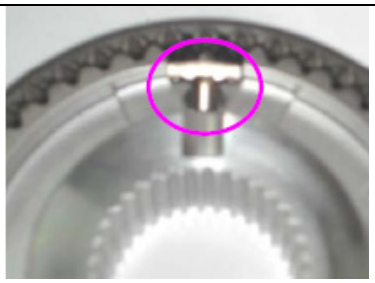
Dismantling of Double Cone Synchro Assembly –

The Double cone synchro which is used in this transmission assembly is serviced as a unit. If dismantled the assembly procedure is as below –



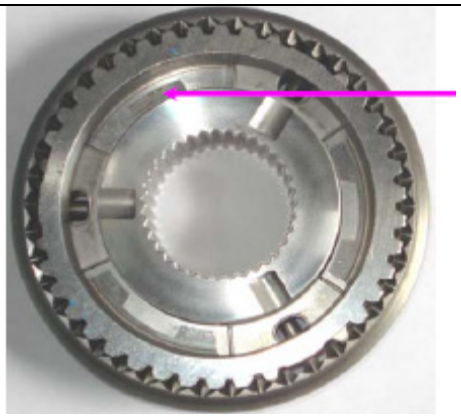


Place hub on the plain surface and install sleeve on to the hub as shown in the picture. Please ensure big groove comes exactly in center of the hub slot.

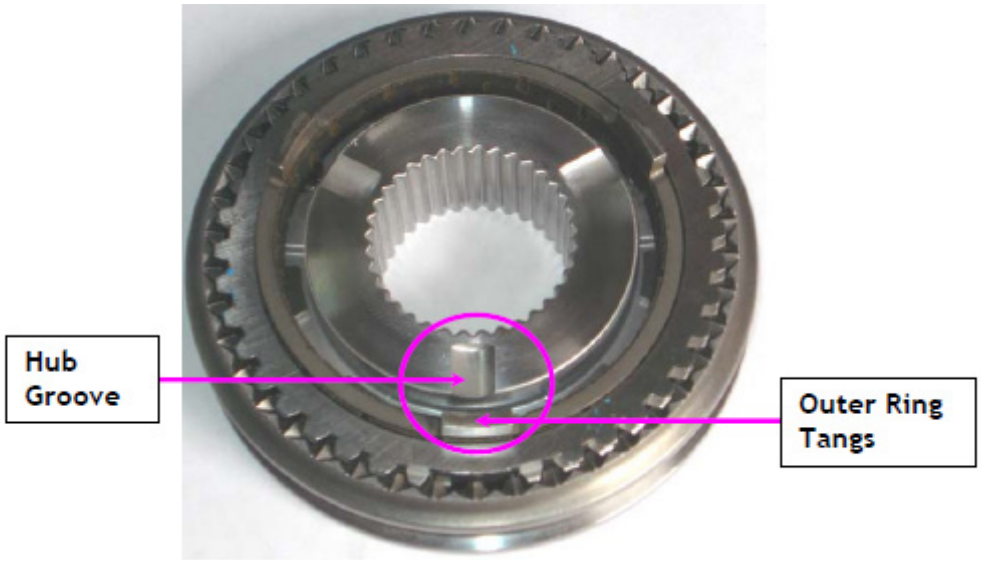


Place 3 nos. struts at each slot of the hub. Push struts against sleeve and slid in the grove. **Note:** Be careful, struts should not jump out of ring, causes injury.

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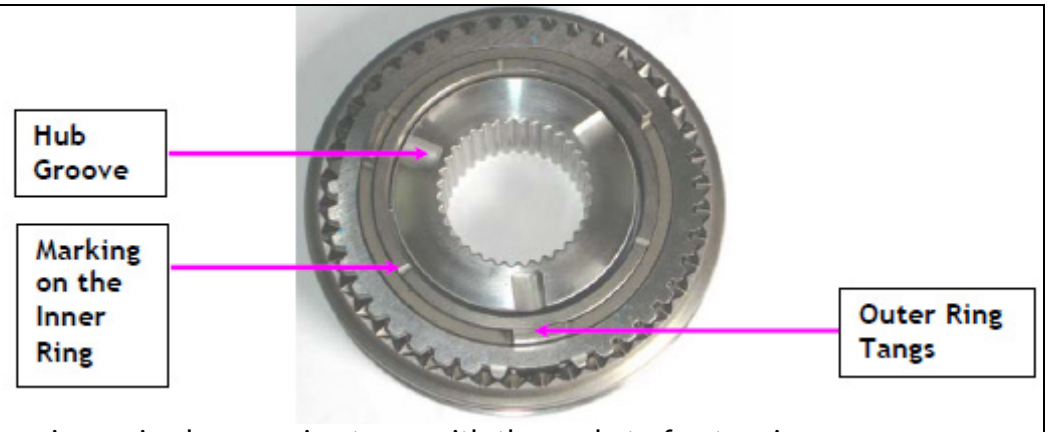


Place outer ring on the hub by engaging ring's projections in to hub pockets.



Place intermediate ring as shown in the picture, three tangs should face the grooves on the hub.

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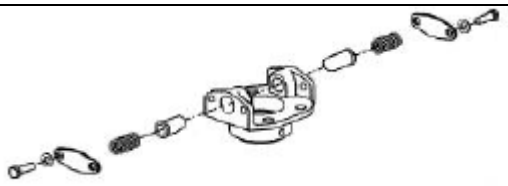
Place inner ring by engaging tangs with the pocket of outer ring.
For reference: marking on the inner ring should come exactly in center of groove on the hub.

	Please ensure that inner ring is seated properly in the Pocket of outer ring. Intermediate ring and inner ring should be almost at one level.
	Place 1st gear by engaging intermediate ring's tang with the three cuts on the dog plate of gear. Please ensure other synchronizer assembly remains in the same position.
	Invert the above whole assembly and put on to the Gear box shaft.

Put outer ring, intermediate ring, inner ring and 2nd gear as described above on the other side.

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Check Points –

	A) Remove the speedometer drive.  Failure to do may result in damage to bearing/ housing.
	B) Please note the fitment of the balls & the interlock pins. It is recommended that while assembly lightly smears the pin & balls with grease. This will avoid the ball or the pin falling down while assembly.
	Springs towards 1st / 2nd gear position is softer than 5th / reverse position

Cleaning & Inspection –

- Clean the transmission parts in solvent.
- Dry the housing gear mechanisms & shafts with compressed air.
- Do not use the compressed air to clean / dry the bearings. It can cause damage to raceways and rollers.

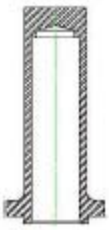
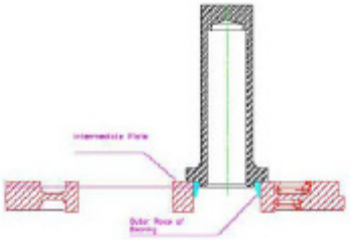
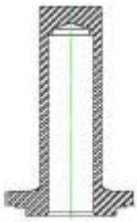
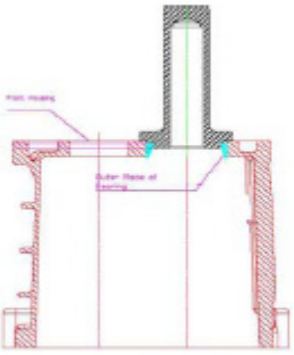
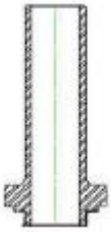
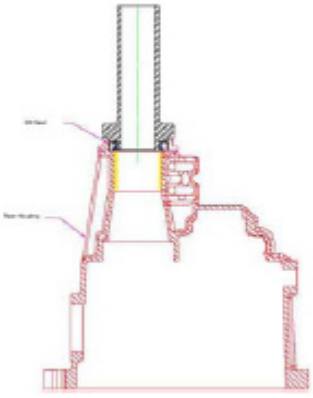
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Tightening Torques -

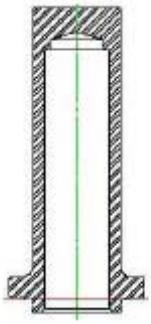
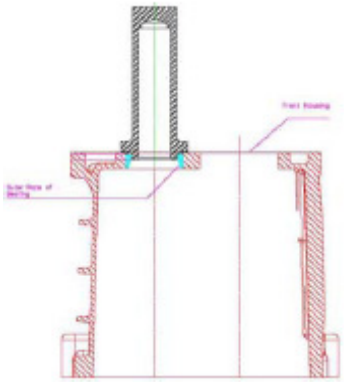
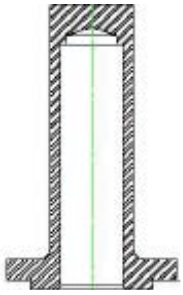
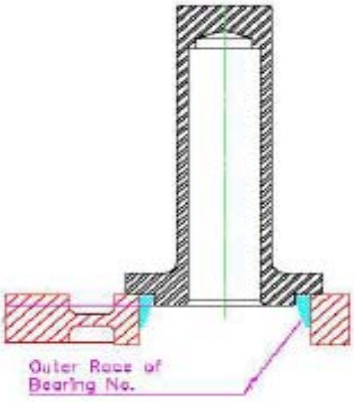
Description	Torque Nm
Plug - Shift Rail Poppet Spring	12.5 ± 2.5 Nm (9 ± 2 lb – ft)
Bolt / Nut – Clutch Hsg. To Main Hsg.	30 ± 5 Nm (22 ± 4 lb – ft)
Flange Bolt – Front, Intermediate & Rear Hsg.	35 ± 5 Nm (26 ± 4 lb – ft)
Drain plug	27.5 ± 2.5 Nm (20 ±2 lb- ft)
Filler plug	27.5 ± 2.5 Nm (20 ± 2 lb – ft)
Reverse light switch	27.5 ± 2.5 Nm (20 ± 2 lb – ft)
Bolt - Idler Shaft	43 ± 7 Nm (32 ± 3 lb – ft)
Bolt – Bearing Retainer Plate	31 ± 4 Nm (23 ± 3 lb – ft)
Lever Retention Bolt	24 ± 4 Nm (18 ± 3 lb – ft)
Speedometer Sleeve	35 ± 5 Nm (26 ± 5 lb – ft)

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Special Tools –

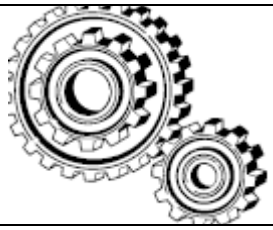
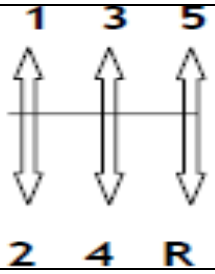
Description/ Part No./ Sketch	Usage View
Dolly to press outer race of Counter Shaft Brg. in Intermediate Plate 0703AD2720H007 	
Dolly to press outer race of MD Gear Brg. in Ft. Hsg. 070 AD2720H008 	
Dolly for pressing oil seal in Rear Hsg. 0703AD2720H002 	

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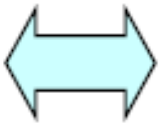
Dolly for pressing Outer Race of Countershaft Bearing 0703AD2720H005 	
Dolly fir pressing Outer Race of Output shaft Bearing in Intermediate Plate 0703AD2720H006 	

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Specifications -

Figure	Description	Value
	Type	Mechanical
	Description	NGT 530 R
	Gears	5 Forward and one reverse gear
	Gear shift	Direct shift with rubberized lever
	Gears	Helical- toothed
	Gear Engagement	Double Cone type synchronizer on 1st – 2nd , Block ring 3rd-4th pin type on 5th gear.
	Gear Ratio 1st 2nd 3rd 4th 5th Reverse	 3.778 2.087 1.379 0.789 3.524
	Oil grade/ quantity	80 W90 SYNCHRO
	Oil Capacity:	1.8 liters.

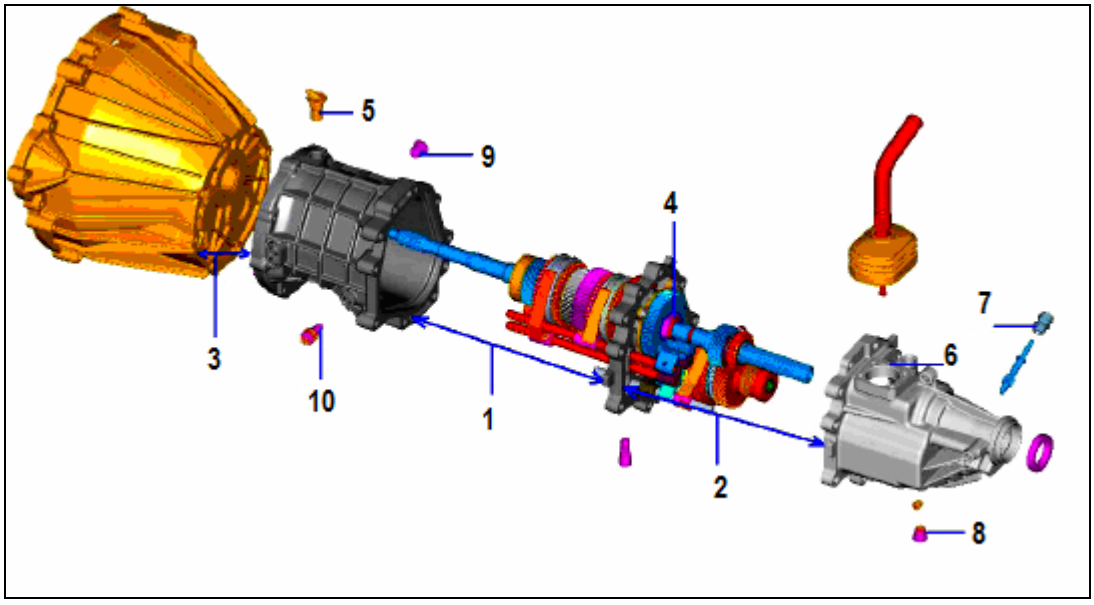
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	Counter shaft bearing	One ball bearing & one Cylindrical roller.
	Input Torque capacity	30 Kg-m
	Weight	45 Kg
	Play 1st 2nd 3rd 4th 5th	**Limit (mm)** 0.175 0.175 0.175 0.175 0.18
	Fork to groove clearances	0.6 to 1.2

Service Limit (mm)
0.375
0.375
0.375
0.375
0.3

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Sealants -



Sr No.	Location	Sealant / Thread Locks	Applicability NGT530 R -2 WD
1	Ft. Hsg. & Intermediate Plate	Loctite 5699	✓
2	Intermediate Plate & Rear Hsg	Loctite 5699	✓
3	Clutch Hsg. & Frt. Hsg.	Loctite 5699	✓
4	Output shaft Locknut	Loctite – 24185 Optional – ANR 138 Optional – Loctite 242	✓
5	Breather	Loctite 648	✓
6	Pivot & Rear Hsg.	Rhodorseal Optional – CAF -33 Pidiseal – 3P	✓
7	Speedo Sleeve & Rear Hsg.	Pedilite 171	✓
8	Drain Plug Threads	Pedilite 171 Optional – Loctite 577	✓
9	Filler Plug Threads	Pedilite 171 Optional – Loctite 577	✓
10	Reverse light switch Threads	Pedilite 171 Optional – Loctite 577	✓

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NGT 530R-4WD

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Description -

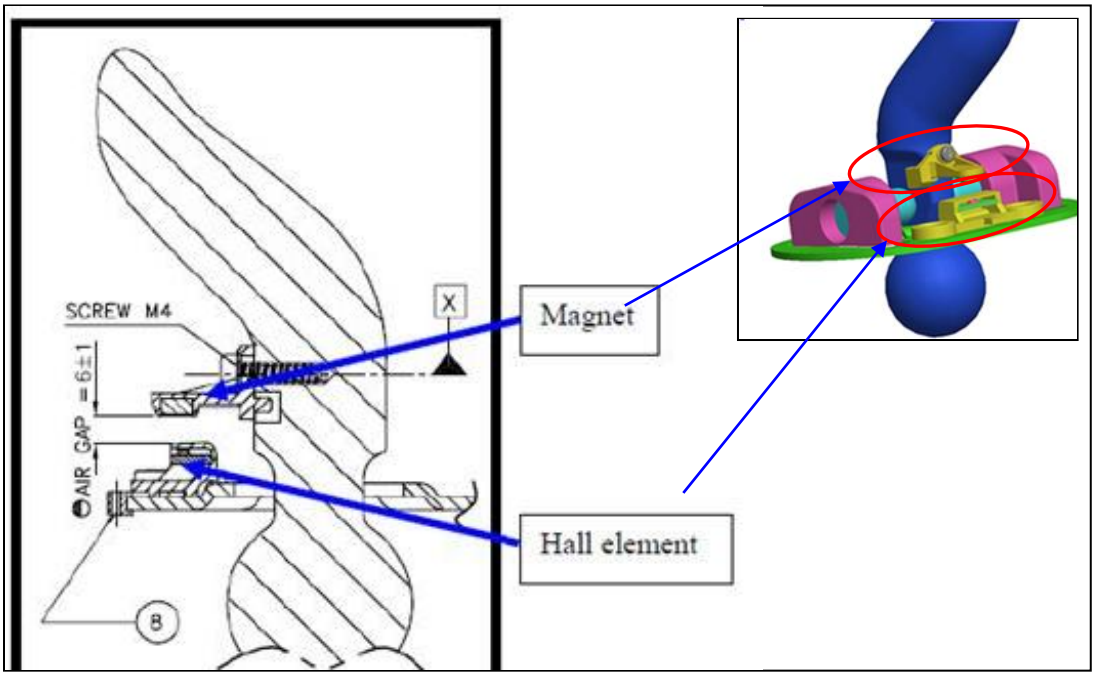
It is a 5-speed gearbox. The 1st & 2nd gear is having double cone type synchronizer while the 3rd, 4th & 5th are having strut type synchronization. The reverse gear is sliding mesh.

The gear selection is by a direct shift lever operating a 3-rail system. The accidental operation of two gears is avoided by an interlocking mechanism. To avoid vibrations passing on to the shift lever; the shift lever is two-piece with rubber isolation provided on to the top half.

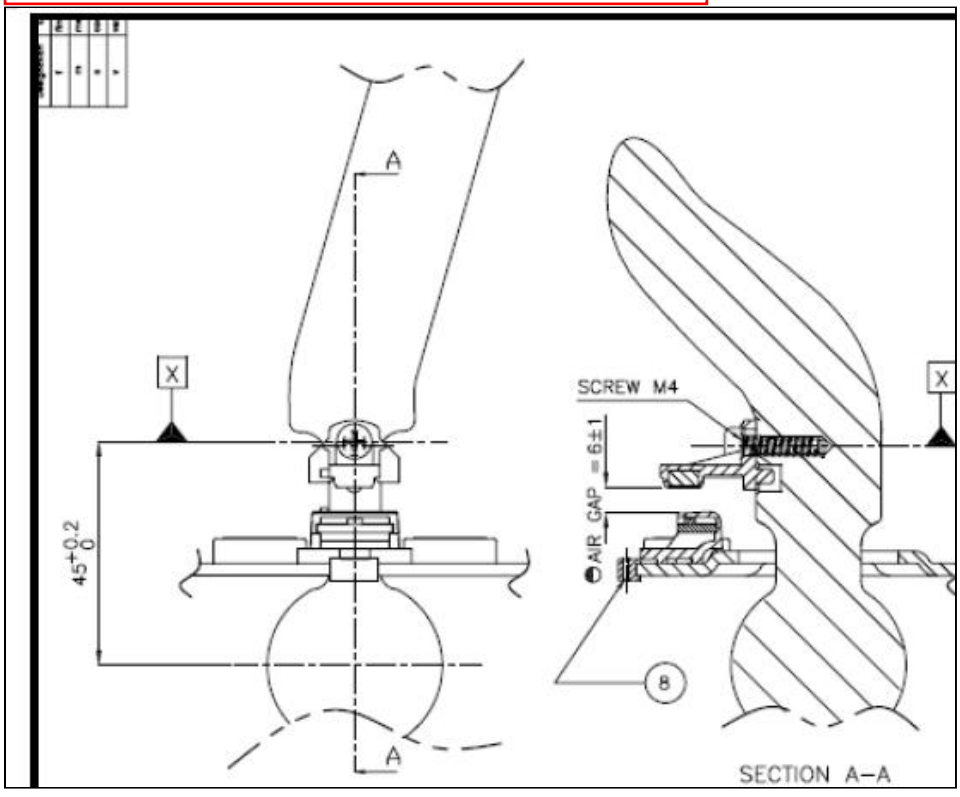
The gearbox housing is 3 piece aluminum with an intermediate plate. A skid plate protects the bottom of the gearbox. The Gearbox is mounted directly on the flywheel through the integral clutch housing and supported at rear on the cross member. The gearbox also has a gear neutral switch (GNS) which give signal to ECU when vehicle is in neutral gear position.

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Gear Neutral Switch (GNS) position on TM retainer plate -



GNS Magnet and Hall Element fitment on Gear



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Care of the transmission –

The lubricant level should be checked every 10000 KMs. with the vehicle un laden and on level ground. The lubricant level should be at the lower edge of the filler plug. Use lubricant meeting oils specification of GL 4 & viscosity 80W90.The brand names have been specified in the Operators Manual.
The lubricant should be changed at 5000 KMs, then at 40000 KMs and after that every 40000 KMs.

Service Diagnosis –

A low transmission lubricant level is generally the result of a leak, inadequate lubricant fill, or an incorrect lubricant level check.
Leaks can occur at the mating surface of the gear case, intermediate plate and adapter or extension housing or from the front/rear seals. A suspected leak could also be result of an overfill condition.
Leaks at the rear of the extension or adapter housing will be from the housing oil seal. Leaks at component mating surface will probably be the result of inadequate sealer, gaps in sealer, incorrect bolt tightening, or the use of a non-recommended sealer.
A leak at the front of the transmission will be from either the front bearing retainer or retainer seal. Lubricant may be seen dripping from the clutch housing after extended operation. If the leak is severe, it may also contaminate the clutch disc causing slip, grab and chatter.
A correct lubricant level check can be made only when the vehicle is level, use a two post or a four post hoist to ensure this. Also allow the lubricant to settle for a minute or so before checking. These recommendations will ensure that an accurate check and avoid an under fill or overfill conditions.

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Hard Shifting -

Hard shifting is usually caused by low lubricant level, improper or contaminated lubricants, component damage, and incorrect clutch adjustment or by a damaged clutch pressure plate or disc. Substantial lubricant leak can result in gear, shift rail, synchro and bearing damage. If a leak goes undetected for an extended period the first indications of a problem are usually hard shifting and noise. Incorrect or contaminated lubricants can also contribute to hard shifting.
The consequence of using non-recommended lubricants is noise, excessive wear, internal bind and hard shifting.
Improper clutch release is one of the most frequent causes of hard shifting. Incorrect adjustment of a worn damaged pressure plate or disc can cause incorrect release. If the clutch problem is advanced then it can result in gear clash during shifts. Incomplete travel of the clutch pedal due to restrictions at the end of stroke (upturned carpet, extra carpet or cover or bend clutch linkage can also cause improper clutch release and hard shift.)
Worn or damaged synchro rings can cause gear clash when shifting any forward gear. In some new or rebuilt transmissions, new synchro rings may tend to stick slightly causing hard or noisy shifts. In most conditions this will decline as the rings wear in.

Transmission Noise -

Most manual transmissions make some noise during normal operation. Rotating gears can generate slight whine that may only be audible at extreme speeds.

Severe obviously audible transmission noise is generally the result of a lubricant problem. Insufficient, improper or contaminated lubricant can promote rapid wear of gears, synchros, shift rail, forks and bearing's. The overheating caused by a lubricant problem can also lead to gear breakage.

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Summarizing the common faults and their cause:

Problem	Possible Causes	Correction
Gear Whine	Low oil level Worn teeth gears Worn bearings	✓Top up oil. ✓Replace gears ✓Replace bearings.
Knocking or ticking	Chipped gear teeth Foreign matter inside transmission. Defective bearings.	✓Replace gears. ✓Remove the foreign matter and locate how the foreign matter came inside e.g. missing breather and rectify that also to avoid recurrence. ✓Replace the bearings.
Jumping out of gear	Defective detent springs. Worn out grooves in shift rail. Shaft misalignment. Worn dog teeth in gear Worn out fork/ fork pads Worn out synchronizer body.	✓Replace the detent springs. ✓Replace the shift rails. ✓Replace the gears ✓Replace the fork/ pads ✓Replace the body
Unable to select gear	Clutch defective Worn out selector mechanism	✓Rectify the clutch/ clutch withdrawal mechanism ✓Rectify the gear selector mechanism
Hard gear shifting	Clutch defective Improper or contaminated lubricants	✓Rectify the clutch/ clutch withdrawal mechanism ✓Replace the lubricant with the specified lubricant.

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Replacement of output shaft seal –

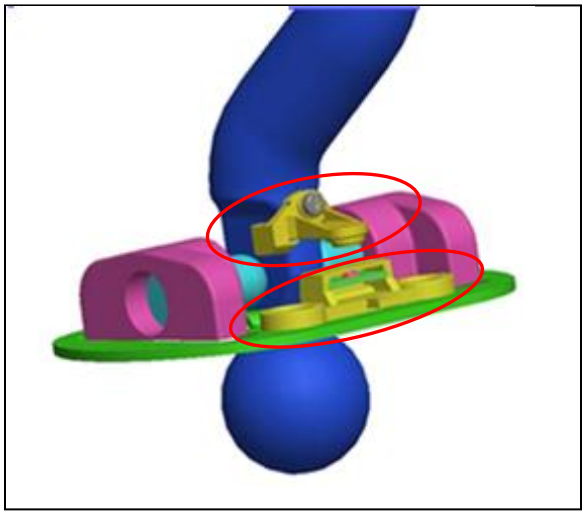
Remove the propeller shaft from the Rear (Differential) end & carefully pull the propeller shaft out from the transfer case.
Remove the oil seal using a blunt edge screw driver or any other suitable tool. Note - Care must be taken not to damage the housing while removing the oil seal. Fit the new oil seal.  The lip of the oil seal & the aluminum housing should be protected against any damage.

Removal of the transmission from the Vehicle –

Remove the top lever.
Drain the transmission oil.
Loosen & remove the starter motor.
Remove the hydraulic pipe connecting the CMC to Clutch Slave Cylinder.
Loosen & remove the Clutch Housing fastening bolts.
Disconnect the reverse lamp switch connections.
Loosen the cross member bolts & Remove the transmission

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Removal of Gears Neutral Switch-



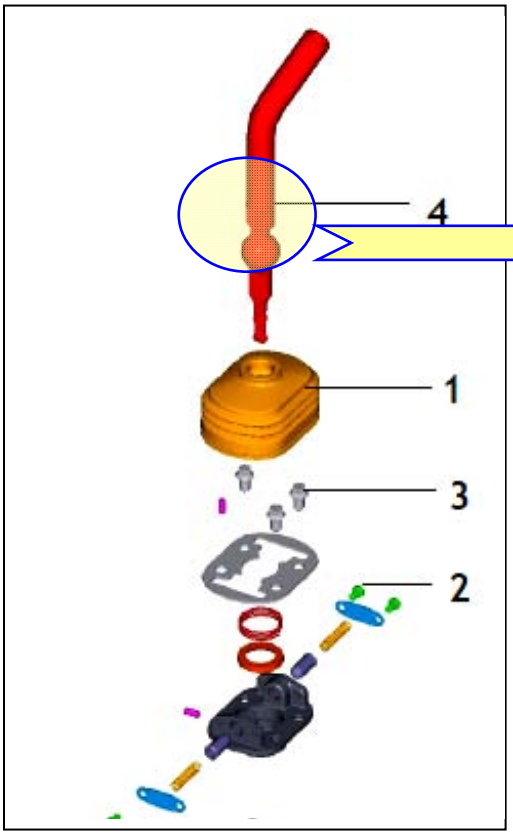
GNS Magnet and Hall Element fitment on Gear

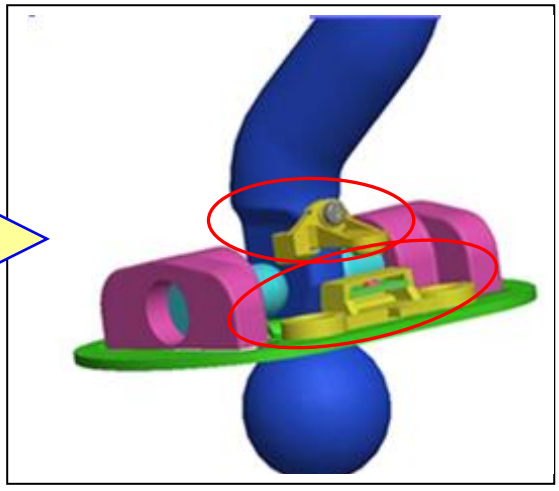
1. Remove the floor console.
2. Remove gear gaiter bezel assembly.
3. Remove shift lever grommet.
4. Remove spring retention plate pivot.
5. Remove neutral sensor.
6. Remove button lever.
7. Remove sensor mounted on gear bottom lever.

Note: Unless otherwise specified the assembly procedure / guidelines is the reverse of the disassembly procedure.

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Dismantling:



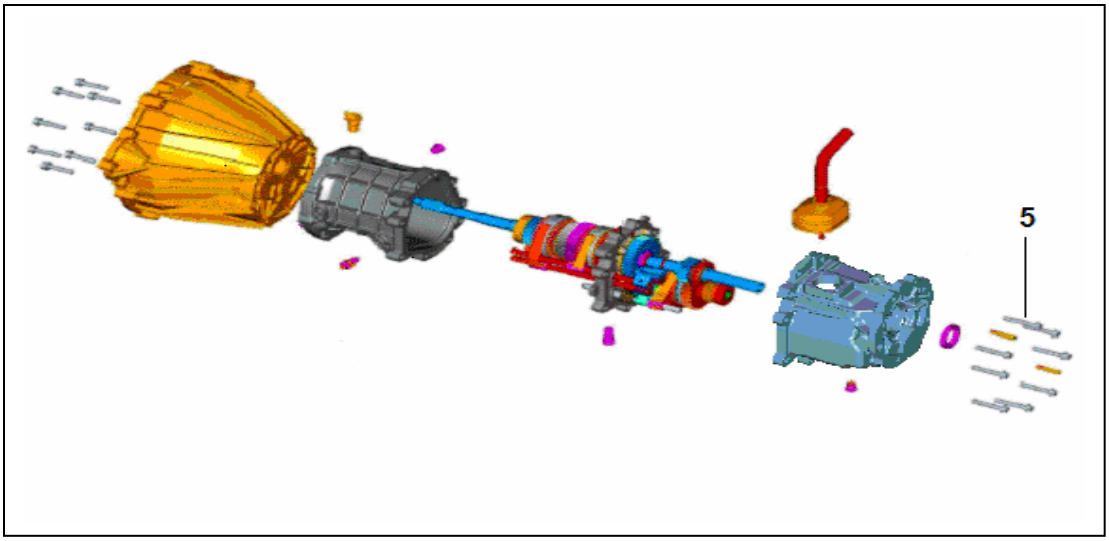


Gear Neutral Switch fitted on Lever

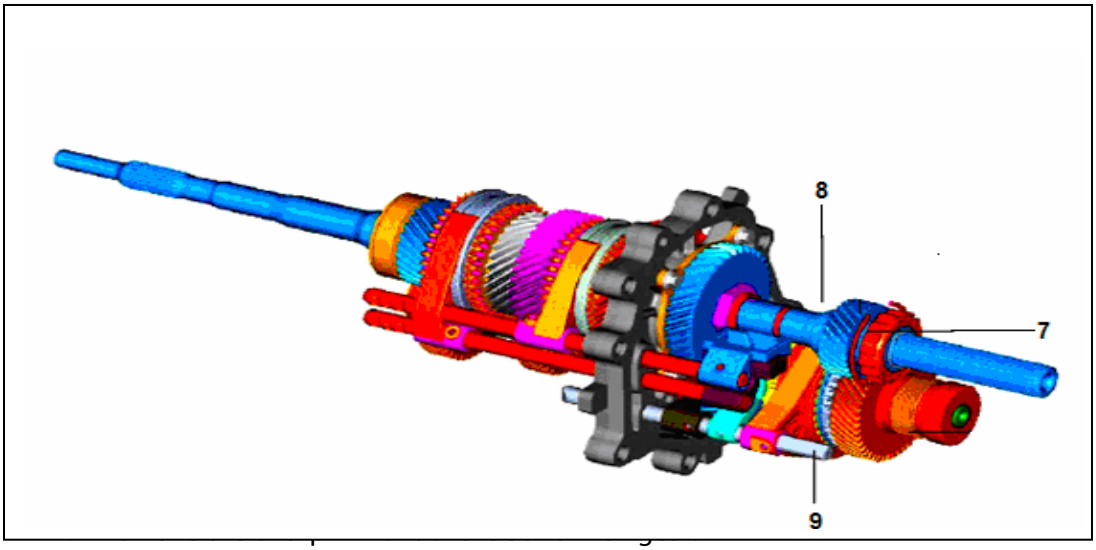
Removal Steps -

1. Remove the lock clip & remove the grommet.
2. Remove biasing cover plate bolts & springs. - 4 nos. (Check Point A)
3. Remove Lever retention bolts - 3 nos. Remove GNS socket and Gear Neutral Switch mounted on plate - 4 bolts.
4. Put the selector mechanism in neutral & remove lever assembly along with nylon bush.

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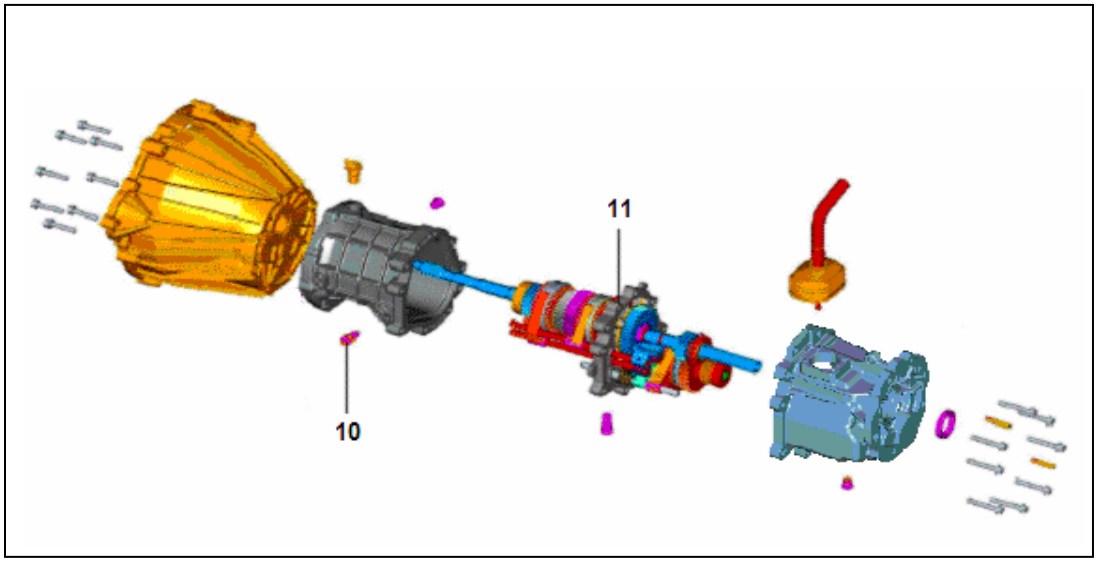


5. Loosen & remove the bolts fastening the Front housing – Intermediate plate & the Rear housing.
6. Remove the rear housing by tapping with the help of a mallet.

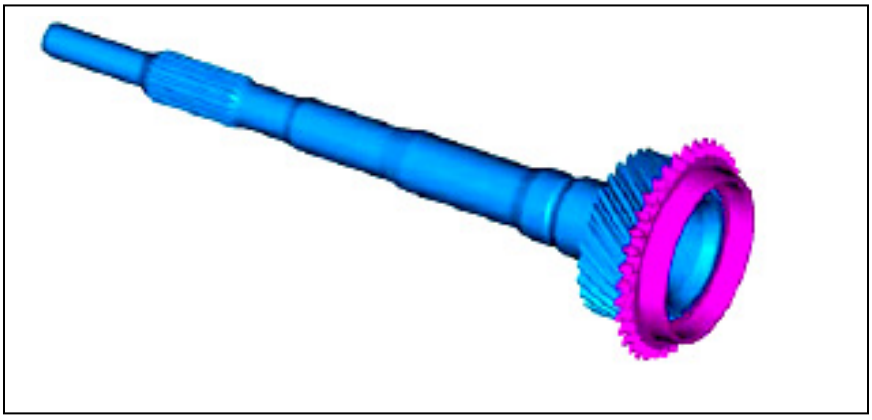


8. Remove the 5th driven gear using MST.
9. Remove 5th driving gear, synchro brass ring & the needle bearing.

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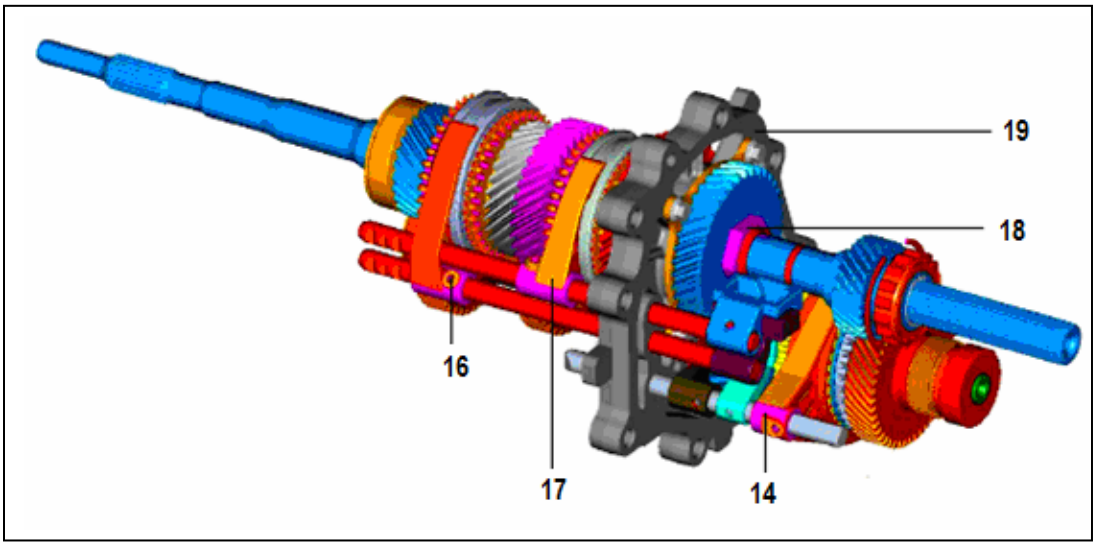


10. Loosen & remove the reverse switch.
11. Pull out the gear train from the front housing with intermediate plate.



12. Separate the Main drive gear from the main shaft.

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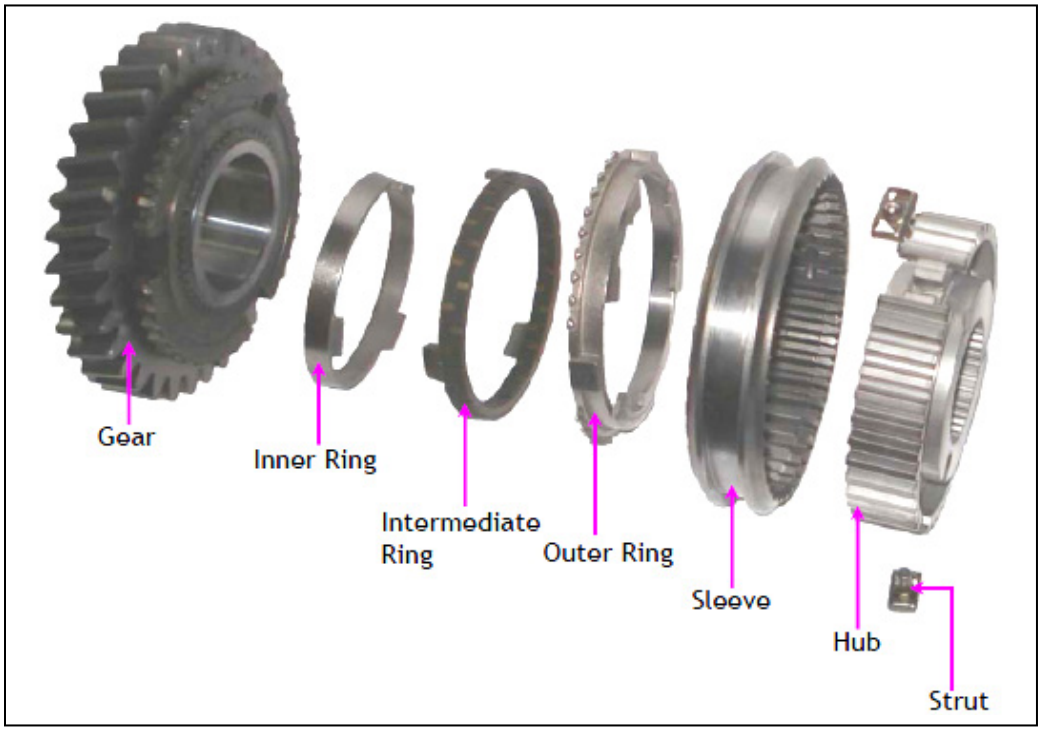


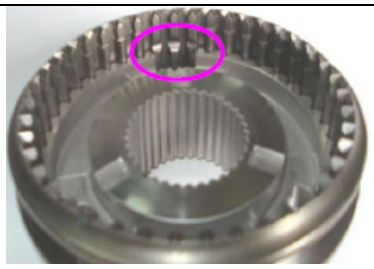
13. Loosen & remove the detent, ball & spring from the intermediate plate.
14. Remove the 5th – reverse rail fork & remove the 5th – reverse rail & fork assembly, idler gear, reverse sub shaft & synchro hub assembly.
15. Separate the Counter shaft from the intermediate plate.
16. Remove the 3rd – 4th shift rail split pin & remove 3rd – 4th shift rail & selector fork & plunger.
17. Remove 1st – 2nd shift rail split pin & remove the shift rail &fork.
18. Loosen & remove the nut in front of the reverse driven gear & remove the reverse driven gear from the main shaft.
19. Separate the intermediate plate from the main shaft.
20. Remove the main shaft pilot (small bearing towards clutch housing side) bearing.
21. Remove the circlip & Belleville washer.
22. Remove the 3rd – 4th synchro hub assembly, synchro brass ring & the 3rd gear. Separate the 3rd gear needle bearing.
23. Remove the taper roller bearing from the other end. Separate the 1st gear shim, 1st gear needle bearing, double cone synchro assembly, 2nd gear & the 2nd gear needle bearing.

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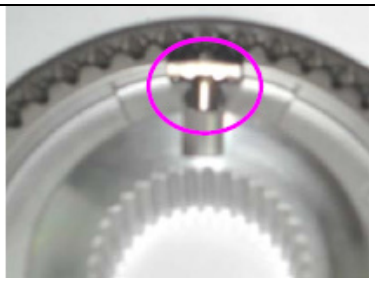
Dismantling of Double Cone Synchro Assembly –

The Double cone synchro which is used in this transmission assembly is serviced as a unit. If dismantled the assembly procedure is as below –



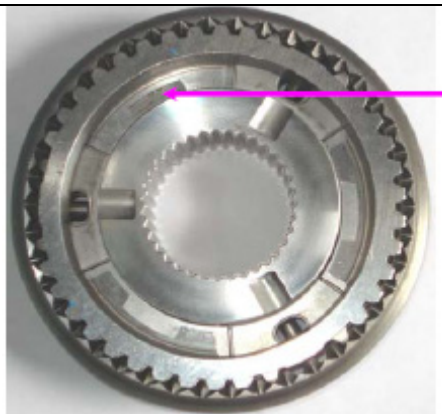


Place hub on the plain surface and install sleeve on to the hub as shown in the picture. Please ensure big groove comes exactly in center of the hub slot.

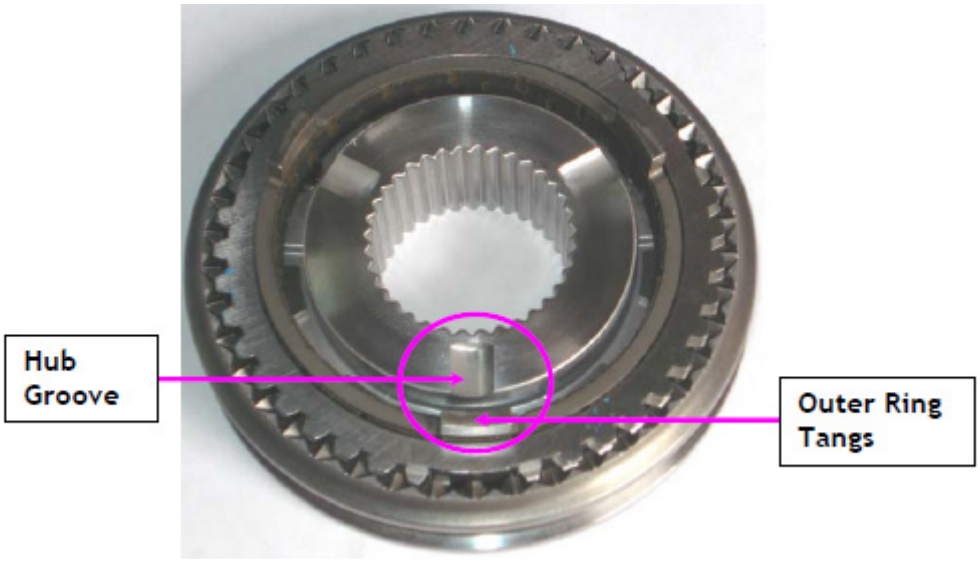


Place 3 nos. struts at each slot of the hub. Push struts against sleeve and slid in the grove. **Note:** Be careful, struts should not jump out of ring, causes injury.

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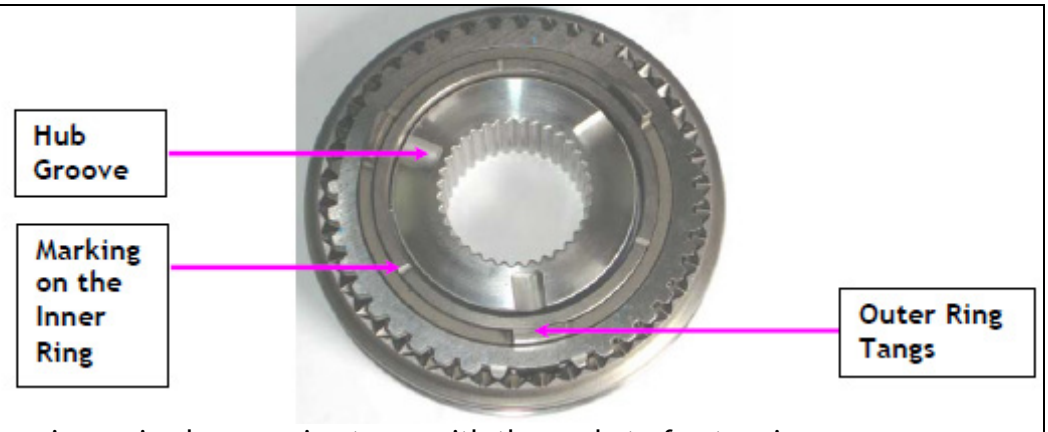


Place outer ring on the hub by engaging ring's projections in to hub pockets.



Place intermediate ring as shown in the picture, three tangs should face the grooves on the hub.

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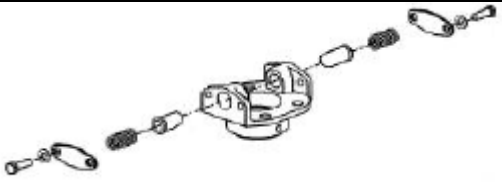
Place inner ring by engaging tangs with the pocket of outer ring.
For reference: marking on the inner ring should come exactly in center of groove on the hub.

	Please ensure that inner ring is seated properly in the Pocket of outer ring. Intermediate ring and inner ring should be almost at one level.
	Place 1st gear by engaging intermediate ring's tang with the three cuts on the dog plate of gear. Please ensure other synchronizer assembly remains in the same position.
	Invert the above whole assembly and put on to the Gear box shaft.

Put outer ring, intermediate ring, inner ring and 2nd gear as described above on the other side.

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Check Points –

	Please note the fitment of the balls & the interlock pins. It is recommended that while assembly lightly smears the pin & balls with grease. This will avoid the ball or the pin falling down while assembly.
	Springs towards 1st / 2nd gear position is softer than 5th / reverse position

.

Cleaning & Inspection –

- Clean the transmission parts in solvent.
- Dry the housing gear mechanisms & shafts with compressed air.
- Do not use the compressed air to clean / dry the bearings. It can cause damage to raceways and rollers.

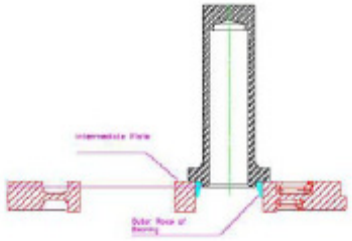
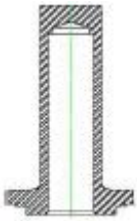
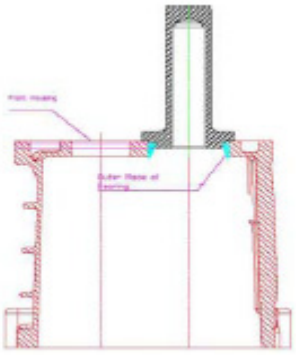
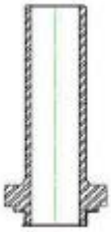
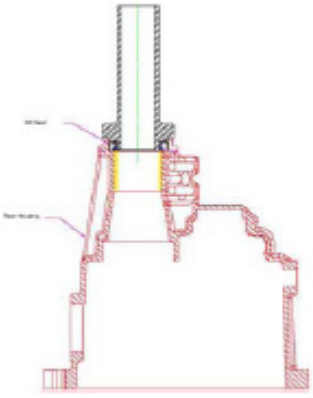
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Tightening Torques -

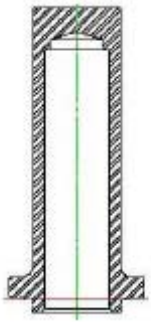
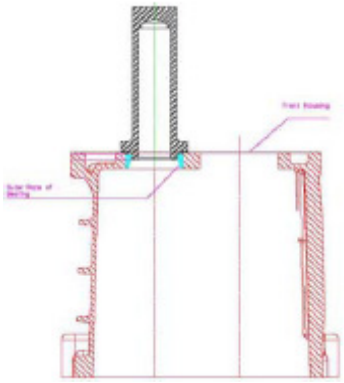
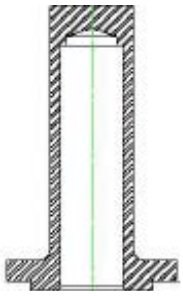
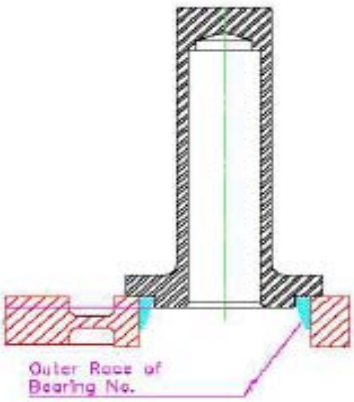
Description	Torque Nm
Plug - Shift Rail Poppet Spring	12.5 ± 2.5 Nm (9 ± 2 lb – ft)
Bolt / Nut – Clutch Hsg. To Main Hsg.	30 ± 5 Nm (22 ± 4 lb – ft)
Flange Bolt – Front, Intermediate & Rear Hsg.	35 ± 5 Nm (26 ± 4 lb – ft)
Drain plug	27.5 ± 2.5 Nm (20 ±2 lb- ft)
Filler plug	27.5 ± 2.5 Nm (20 ± 2 lb – ft)
Reverse light switch	27.5 ± 2.5 Nm (20 ± 2 lb – ft)
Bolt - Idler Shaft	43 ± 7 Nm (32 ± 3 lb – ft)
Bolt - Bearing Retainer Plate	31 ± 4 Nm (23 ± 3 lb – ft)
Lever Retention Bolt	24 ± 4 Nm (18 ± 3 lb – ft)

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Special Tools –

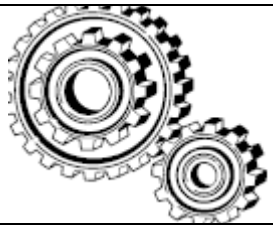
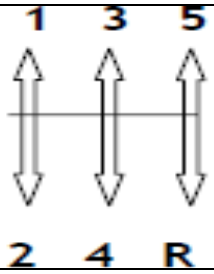
Description/ Part No./ Sketch	Usage View
Dolly to press outer race of Counter Shaft Brg. in Intermediate Plate 0703AD2720H007 	
Dolly to press outer race of MD Gear Brg. in Ft. Hsg. 070 AD2720H008 	
Dolly for pressing oil seal in Rear Hsg. 0703AD2720H002 	

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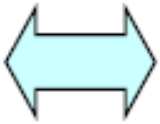
Dolly for pressing Outer Race of Countershaft Bearing 0703AD2720H005 	
Dolly fir pressing Outer Race of Output shaft Bearing in Intermediate Plate 0703AD2720H006 	

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Specifications -

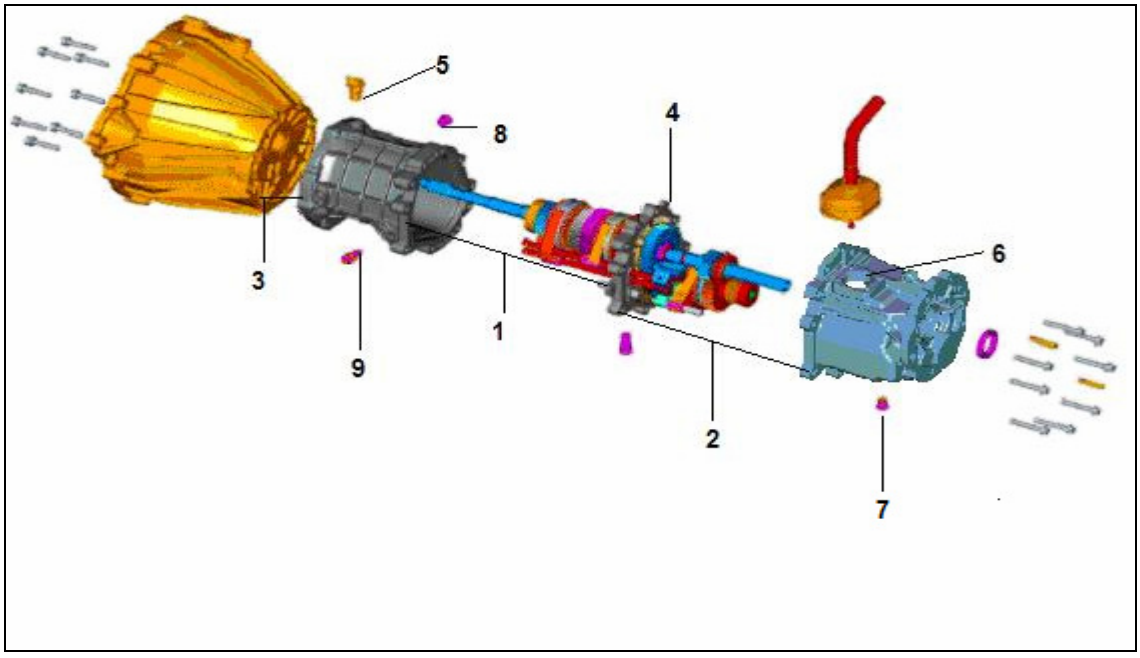
Figure	Description	Value
	Type	Mechanical
	Description	NGT 530 R
	Gears	5 Forward and one reverse gear
	Gear shift	Direct shift with rubberized lever
	Gears	Helical- toothed
	Gear Engagement	Double Cone type synchronizer on 1st – 2nd , Block ring 3rd-4th pin type on 5th gear.
	Gear Ratio 1st 2nd 3rd 4th 5th Reverse	 3.778 2.087 1.379 0.789 3.524
	Oil grade/ quantity	80W90 SYNCHRO
	Oil Capacity:	1.8 liters.

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	Counter shaft bearing	One ball bearing & one Cylindrical roller.
	Input Torque capacity	30 kg-m
	Weight	45 kg
	Play 1st 2nd 3rd 4th 5th	**Limit (mm)** / **Service Limit (mm)** 0.175 / 0.375 0.175 / 0.375 0.175 / 0.375 0.175 / 0.375 0.18 / 0.3
	Fork to groove clearances	0.6 to 1.2

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Sealants -



Sr No.	Location	Sealant / Thread Locks	Applicability NGT530 R -4 WD
1	Ft. Hsg. & Intermediate Plate	Loctite 5699	✓
2	Intermediate Plate & Rear Hsg	Loctite 5699	✓
3	Clutch Hsg. & Frt. Hsg.	Loctite 5699	✓
4	Output shaft Locknut	Loctite – 24185 Optional – ANR 138 Optional – Loctite 242	✓
5	Breather	Loctite 648	✓
6	Pivot & Rear Hsg.	Rhodorseal Optional – CAF -33 Pidiseal – 3P	✓
7	Drain Plug Threads	Pedilite 171 Optional – Loctite 577	✓
8	Filler Plug Threads	Pedilite 171 Optional – Loctite 577	✓
9	Reverse light switch Threads	Pedilite 171 Optional – Loctite 577	✓

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Automatic Transmission

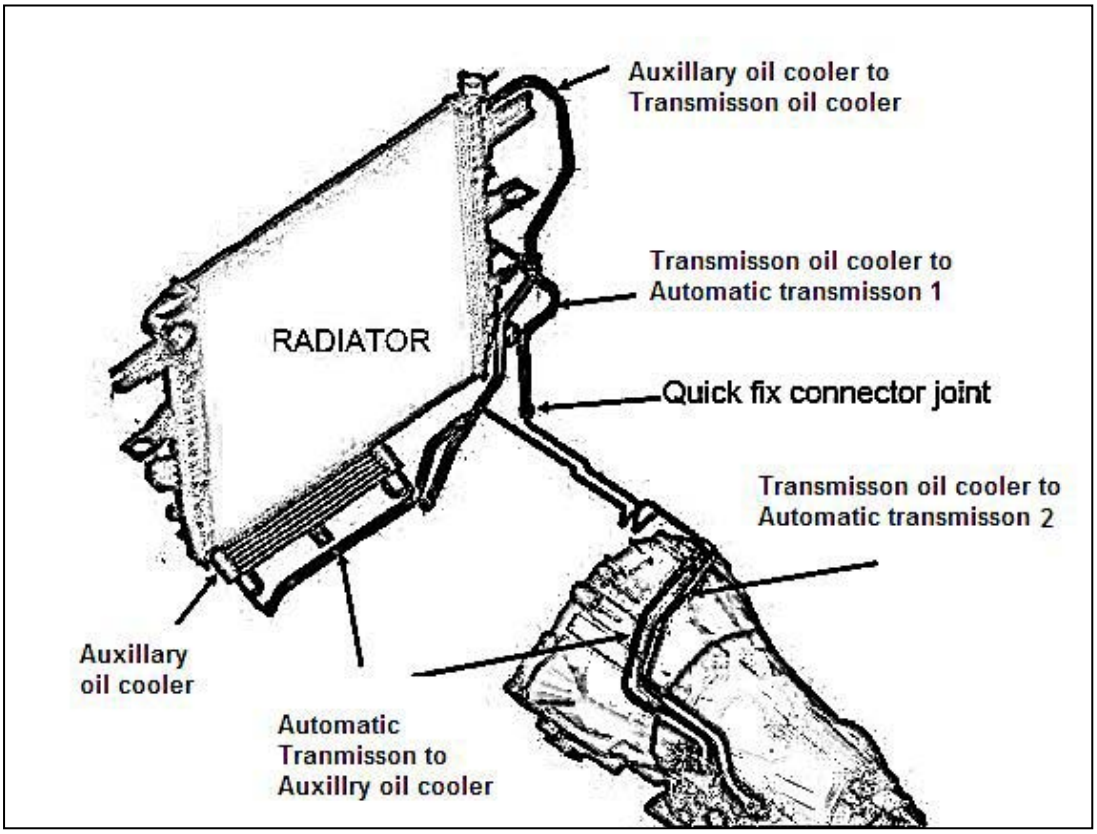
Contents

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Brief Description
Care of the System
In Car Repairs
Diagnostics
Major Repairs
Warranty & Other Information
Lubricants
Tourque Specification
Leatning & Resetting procedures
Special Tools/MST's
New Diagnostic Software Installation

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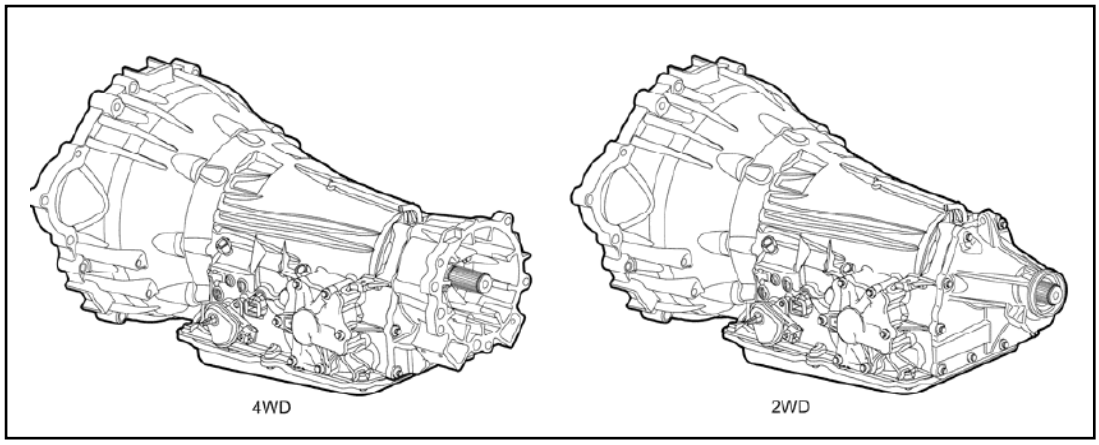
1. Layout of the System

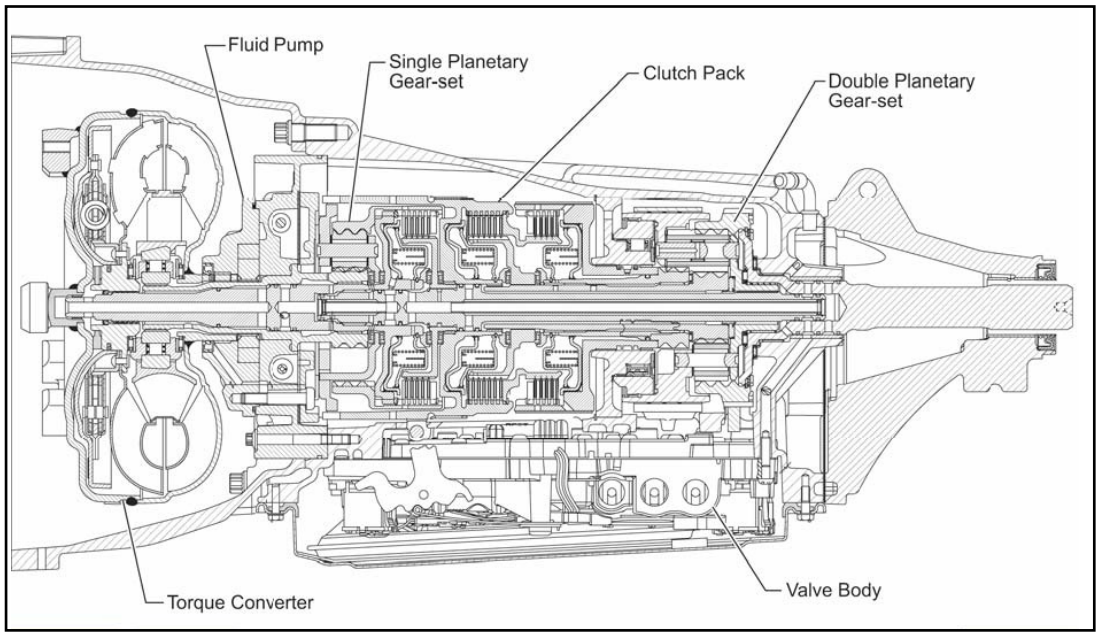
Scorpio Vlx/Vls



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2. Brief Description of the system





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General Information

The Model 79 six speed automatic transmissions is available in two variants: - 4WD and 2WD.

The transmission has the following features:

- Six forward speeds
- One reverse gear
- A torque converter with an integral converter lock-up clutch
- Electronic shift and pressure controls
- A single planetary gear-set
- A double planetary gear-set
- Two hydraulically controlled brake bands
- Three multi-plate clutches
- All hydraulic functions are directed by electronic solenoids to control
- Engagement feel
- Shift feel
- Shift scheduling
- Modulated torque converter clutch applications

The transmission contains fully synthetic automatic transmission fluid (ATF) and is filled for life- therefore it does not require periodic servicing. Engine power reaches the transmission via a torque converter with integral converter lock-up clutch. The six forward gears and one reverse gear are obtained from a single planetary set, followed by a double planetary set. The double planetary set used in the transmission is Ravingnaux type gear-set.

The Model 79 automatic transmission is electronically controlled. The control system comprises of the following elements:

- Transmission control unit (TCU)
- Embedded memory module (EMM)
- Input and output speed sensors
- Valve body unit comprised of four on/off solenoid valves and six variable bleed solenoids
- Torque converter

Gear selection is achieved by the control of automatic transmission fluid (ATF) flow and pressure, through the solenoids, to operate various internal clutches and band brakes. The TCU controls all the electrical components and gear selection, shift pressure and torque converter slip.

In the event of a system fault, the TCU provides for failure mode effect control (FMEC also called LIMP HOME) to maintain minimum functional operation of the transmission.

In the event of a total loss of control or electrical power, the basic transmission functions (Park, Reverse, Neutral and Drive) are retained. The 4th gear ratio with the torque converter clutch in the unlocked state is the retained without any electrical assistance.

The transmission also contains an external P, R, N, D selector shaft position sensor (inhibitor switch) and an internal transmission fluid temperature sensor. With manual mode applications, the TCU also requires information from the transmission gear selector (TGS)

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shift knob to determine when the driver has initiated a manual gear selection. The TCU communicates with other vehicle electronic control modules by the controller area network (CAN).

If a major fault develops, the transmission may automatically operate in "limp home" (failure) mode to enable the vehicle to be driven to an authorized dealer for repair. During "limp home" mode, the MIL indicator on instrument cluster will be set on and the transmission will operate with limited functionality. The level of functionality is dependent on the fault detected.

When in limp home mode, the MIL on the instrument cluster will be continuously ON. Limp home mode may also be engaged if the battery charge falls below 8V. If the transmission overheats, the shift patterns will automatically change to enable improved transmission cooling. During transmission overheat, the over temperature condition is indicated by the MIL until normal transmission operating temperature is reached.

Under extreme over-temperature conditions, the transmission will disable all shifting and remain in a neutral state until it has cooled to a safe level.

MIL indicator - 

Important Note:

In the event of a vehicle breakdown, the vehicle can be towed, provided the propeller shaft has been removed prior to towing. Failure to do this will lead to a failed transmission due to insufficient lubrication to transmission bearings.

Advanced Features

Early Downshifts with Hard Braking and Skip Shifts

When heavy braking is detected, the transmission downshifts early and skips gears to provide increased engine braking to provide gear selection for tip-in.

Gear Hold Going Uphill/Downhill

If the accelerator pedal is released when traveling uphill, upshifts are prevented to reduce busyness* on grades. If the accelerator pedal is released when traveling downhill, upshifts are prevented to enhance engine braking.

*Busyness: It is the state in which the gear selections changes so frequently according to sudden variation in the accelerator pedal inputs. This will cause reduce the ride comfort and put more stress on the transmission components.

Upshift Prevention with Fast-off Accelerator Pedal

Upshifts are prevented when the throttle is backed off very quickly to reduce busyness in sporty driving.

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Drive and Reverse Engagement

A soft engagement feature avoids harsh take up of drive when selecting Drive or Reverse. This is achieved by limiting engine speed and engine torque which results in a rapid, but progressive engagement of either Drive or Reverse when moving from the Park or Neutral positions. Drive and Reverse engagements from either Park or Neutral are performed in less than 2.2 seconds.

Drive gear engagement is inhibited when engine speed is >2000 rpm and the accelerator pedal position is >30%. Reverse engagement is prevented until engine speed is less than 1400 rpm and the accelerator pedal position is less than 12% and vehicle speed is less than 10 km/h.

Converter Clutch Lock-Up in All Gears

The transmission features converter clutch lock-up in all gears. This feature provides improved fuel economy and vehicle performance. It also improves transmission cooling efficiency when towing heavy loads at low speeds, e.g. in city driving or hill terrain.

Embedded Memory Module

The embedded memory module (EMM) is matched to the transmission's valve bodies during transmission assembly to ensure refined shift quality. The EMM is integrated into the input speed sensor which is mounted on the valve body in the transmission. The EMM is used to store data such as valve body calibration data and valve body serial number.

Upon installation, the TCU will download the data from the EMM and utilize this data in the operation of the transmission. Just as IQA codes gives the energizing time for injectors in EMS, the values stored in the EMM will give information about the delay in opening of each solenoid to the TCU and the value is being continuously updated throughout the life of the transmission. Since it is located in the transmission the data is not lost even if the TCU requires replacement. The new TCU can get the data from the old EMM and can give better performance.

Transmission Cooling

The transmission cooling system ensures rapid warm-up and constant operating temperature resulting in reduced fuel consumption and refined shift quality. It also includes a cooler by-pass within the hydraulic system to allow sufficient cooling and lubrication to the transmission drive train in the event of a blockage in the transmission cooler.

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Shift Strategy

Gear Change

Transmission gear change is controlled by the TCU. The TCU receives inputs from various engine and vehicle sensors to select shift schedules and to control the shift feel and torque converter clutch (TCC) operation at each gear change.

Coast down

Coast down downshifts occurs at 0% pedal when the vehicle is coasting down to a stop.

Torque Demand

Torque demand downshifts occur (automatically) when the driver demand for torque is greater than the engine can provide at that gear ratio. If required, the transmission will disengage the torque converter clutch (TCC) to provide added acceleration.

Manual Mode

When the lever is first moved to the manual "M" position, the transmission will select the lowest possible gear for the current driving conditions. The transmission will automatically up shift only after maximum engine speed is attained.



1. The vehicle should not/cannot be push started.
2. For towing the propeller shaft has to be disconnected

Failure to do so will cause permanent damage to the transmission and the torque converter. This is because the oil pump inside the transmission is only working if the engine is running. Without oil pump running- all components will seize.

3. Care of the system

Stall Test

Fluid level checking

Transmission Cooler & Oil Line Flushing

Stall Test

Stall testing can be performed on the Model 79 6 speed automatic transmission to determine if the transmission clutches can hold the full engine torque without slipping.

NOTE: Stall testing should not be performed for more than 10 seconds.

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To perform the transmission stall test, proceed as follows:

1. Apply the park brake.
2. Start the engine.
3. Depress the brake pedal.
4. Move the transmission gear select (TGS) lever to DRIVE position.
5. Fully depress the accelerator pedal for 6 seconds and observe engine speed.
6. Release the accelerator pedal.
7. Move the TGS lever to REVERSE position.
8. Fully depress the accelerator pedal for 6 seconds and observe engine speed.
9. If the engine speed goes more than 3000 rpm – Report to TEKline

Fluid Level Inspection

NOTE

As the temperature of the transmission fluid greatly affects the fluid level, this procedure must only be carried out with the transmission fluid temperature at 50°C. If the transmission fluid temperature is greater than 50°C and the correct procedure is not followed, the result could be a false reading of the fluid level.

Fluid level inspection must be carried out with the vehicle level.

Only Recommended Lubricant to be used.

1. Raise the vehicle on a certified hoist. Refer to the vehicle repair manual for the location of support points.
2. Place a drain container below the fluid level hole and remove the transmission fluid level plug .
3. If fluid starts to drain from the fluid level hole, reinstall the fluid level plug. If no fluid drains from the fluid level hole, fill the transmission until fluid starts to drain from the level hole and reinstall the plug.
4. Lower the vehicle.
5. Connect the diagnostic tool to the vehicle's diagnostic connector. Refer to the vehicle repair manual for information on connecting the diagnostic tool.
6. With an assistant observing the transmission fluid temperature with the scan tool, drive the vehicle for five minutes, or until the transmission oil temperature is just below 50°C.
7. Raise the vehicle on a certified hoist.
8. With the transmission gear select (TGS) lever in the neutral position, start the engine and allow running until the transmission fluid temperature reaches 50°C and then turning off the engine.
9. Place a drain container below the fluid level hole and remove the transmission fluid level plug. Allow transmission fluid to drain from the fluid level hole for 10 seconds.
10. Reinstall the fluid level plug and tighten the plug to the correct torque specification.

Transmission fluid level plug	Torque specification..... **30 – 35 Nm**

10. Lower the vehicle to the ground and road test the vehicle to check vehicle operation and for fluid leaks.

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Transmission Cooler and Hydraulic Line Flushing Procedure

(To be done if any of the following is replaced/new: Transmission/Oil cooler, Oil lines, and radiator)

NOTE

To prevent transmission damage due to contaminants being present in the transmission cooler and/or hydraulic lines, the cooler and lines must be flushed.

1. Raise the vehicle on a certified hoist. Refer to the vehicle repair manual for the location of support points.
2. Using compressed air, clear the cooler lines of any residual fluid.
3. Connect the front transmission cooler line to the transmission. (Refer to the section of in car repairs for the sequence)

Front transmission cooler line to transmission fitting torque specification..... **25 – 35 Nm**

4. Connect one end of a rubber hose to the end of the rear cooler line and place the other end in a suitable container to collect the transmission fluid as it is pumped out.

NOTE
Prior to starting the engine, check the transmission has been filled with transmission fluid.

5. Start the engine and run at idle for approximately 30 seconds or until 2.5 liter fluid comes out of the system. While the engine is running, pump transmission fluid into the transmission fluid level hole to compensate the amount of fluid pumped out.

6. Turn off the engine.

7. Remove the rubber hose from the transmission cooler line and connect the cooler line to the transmission.

Rear transmission cooler line to transmission fitting torque specification**..... 25 – 35 Nm**

8. Check the transmission fluid level.

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4. In-Car Repair

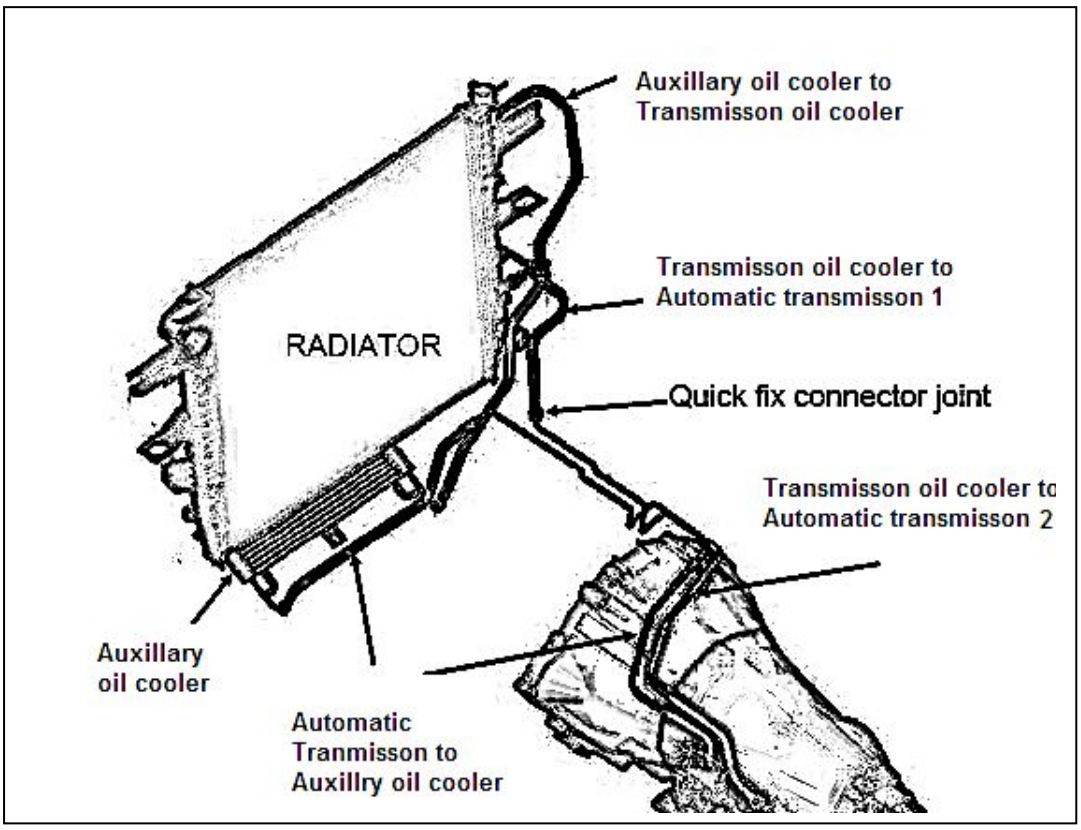
The following In-Car Repairs are recommended/allowed

- **Removal & refitting the oil cooler lines**
- **Removal & refitting the TGS assembly**
- **Removal & refitting the Transmission assy**
- **Replacement of Transmission Control Unit (TCU)**

Removal and refitting the oil cooler lines

Layout of the transmission, oil cooler and oil lines.

AOC – Auxiliary Oil Cooler
TOC – Transmission Oil Cooler

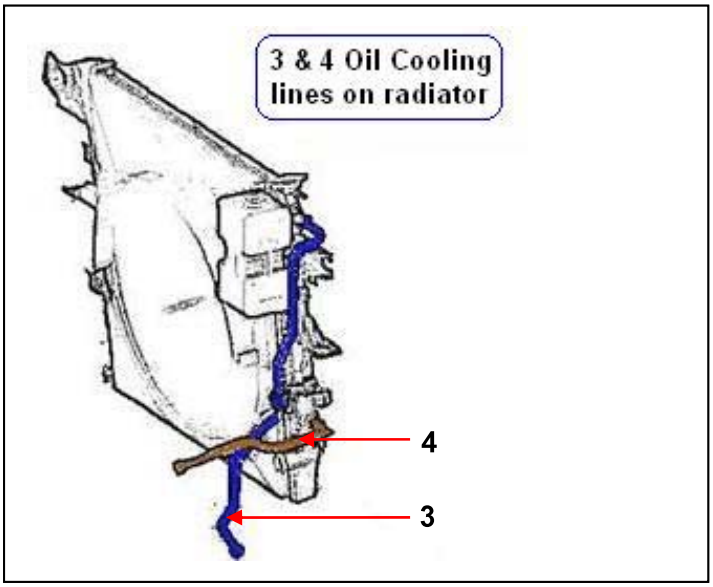


Note: The oil which gets drained while removing the oil cooler lines should not be reused. If reused, risk of transmission damage.

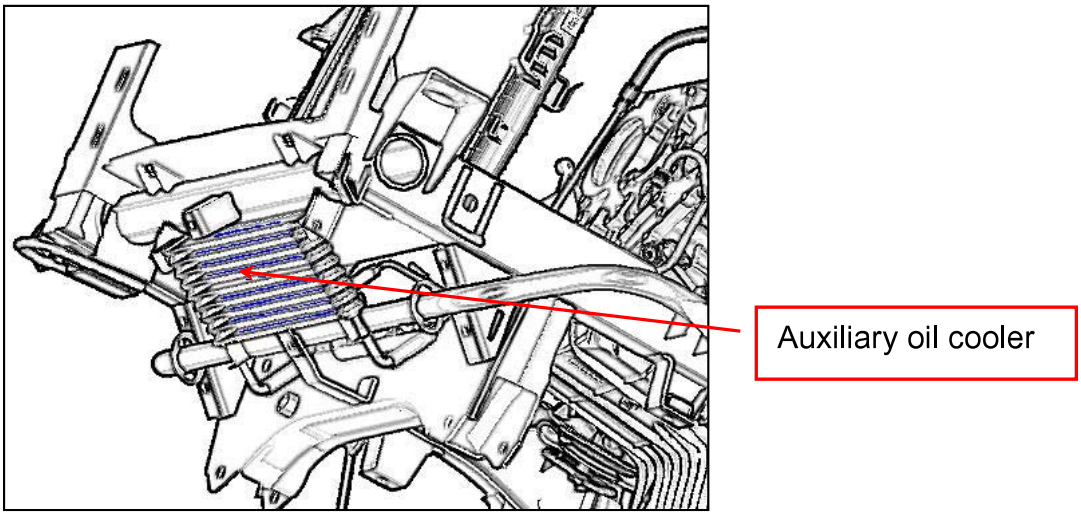
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Removal Steps -

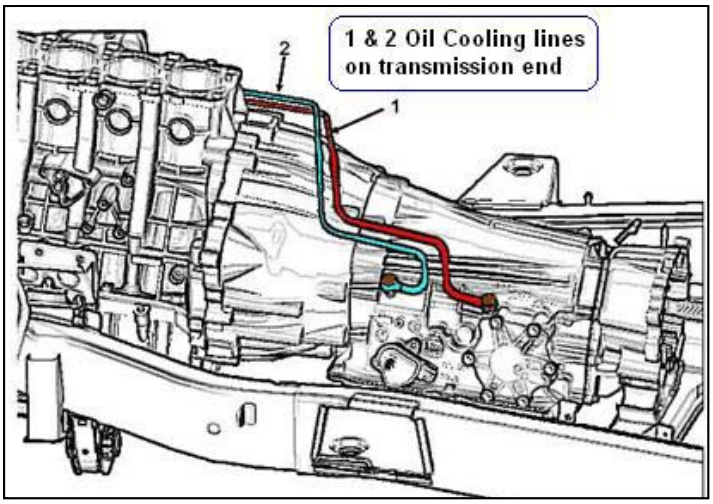
Remove the oil cooler lines from radiator side quick fit coupling



Remove the oil cooler pipes from the auxiliary oil cooler end

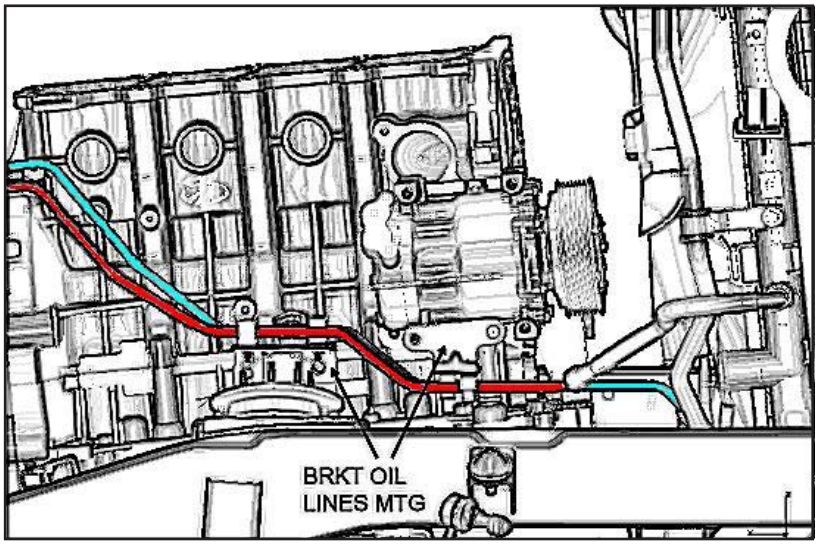


Remove the oil cooler lines from the transmission end

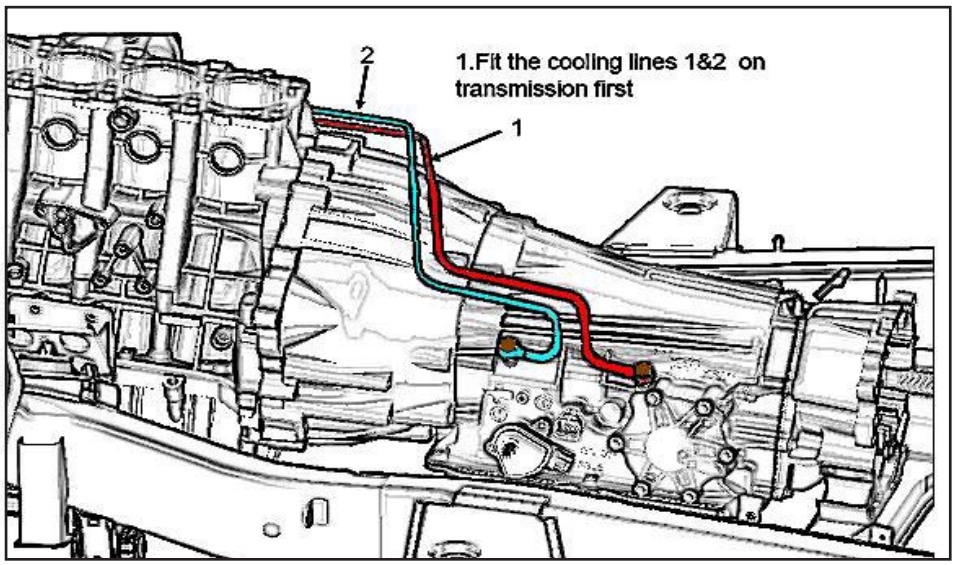


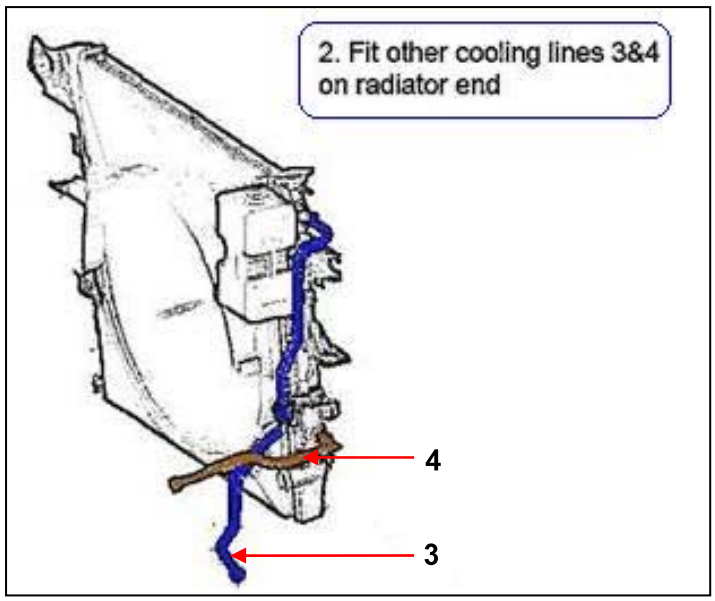
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The pipes should be disconnected from the clamping bracket.



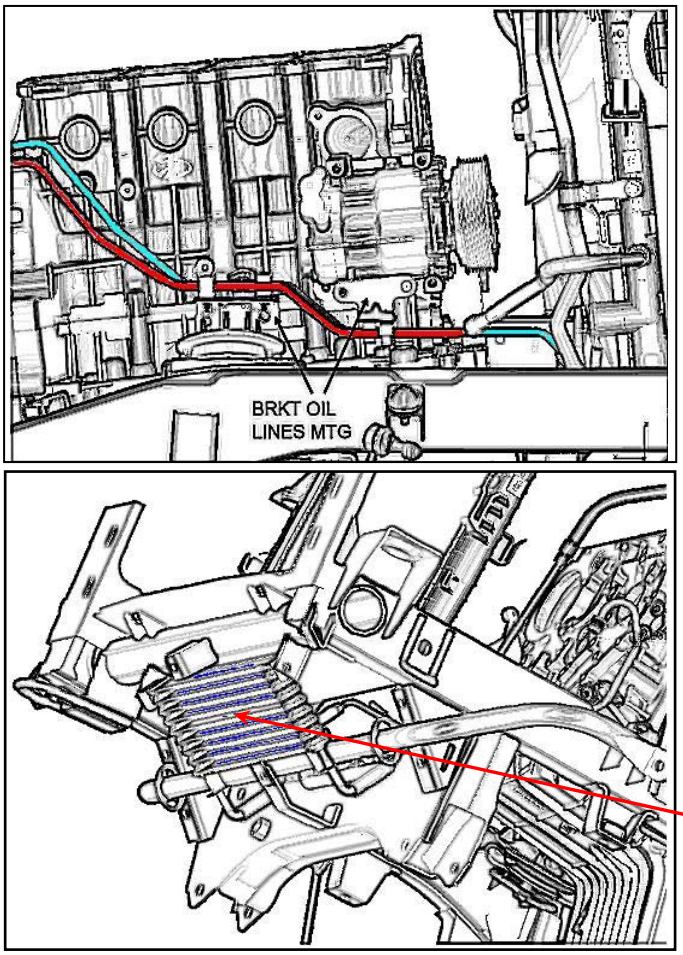
Re-Assembly steps





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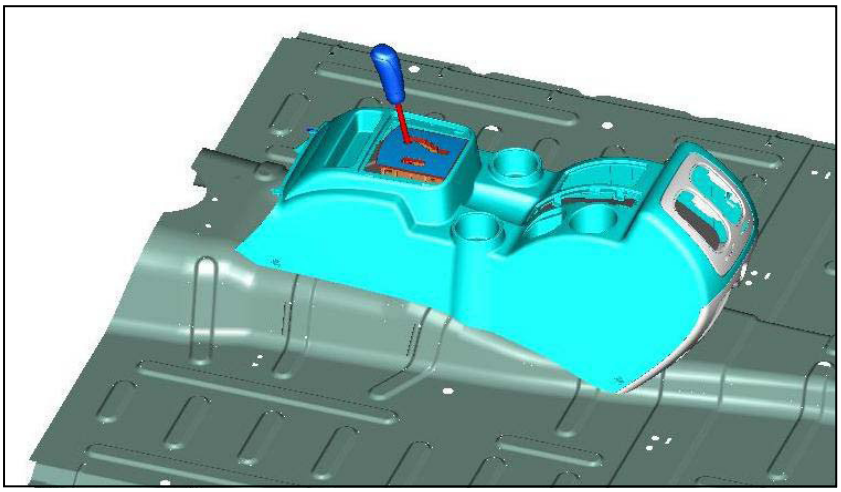
Right side view of the oil cooler lines mounting



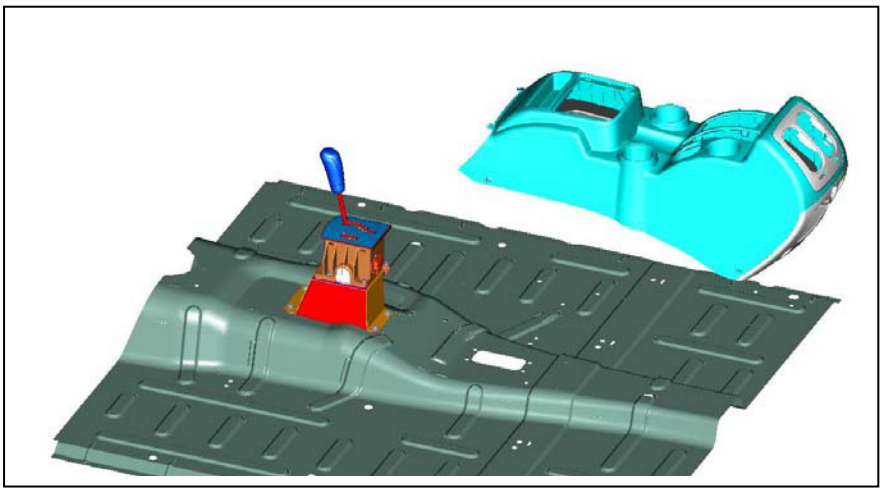
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Removal & Refitting of Transmission Gear Shift (TGS) Assembly

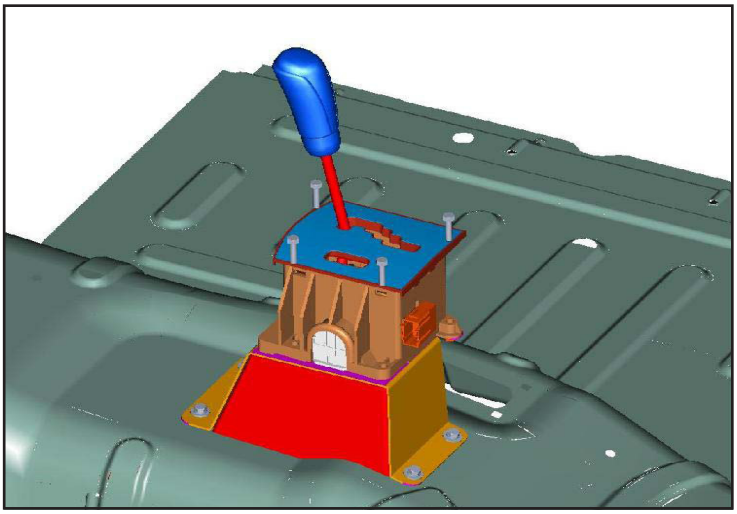
For removal of the TGS connections from the transmission follow these steps:



First remove the centre bezel assembly.

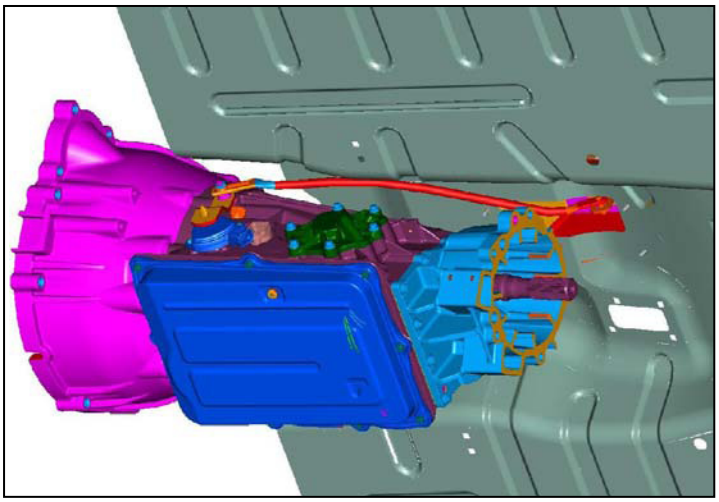


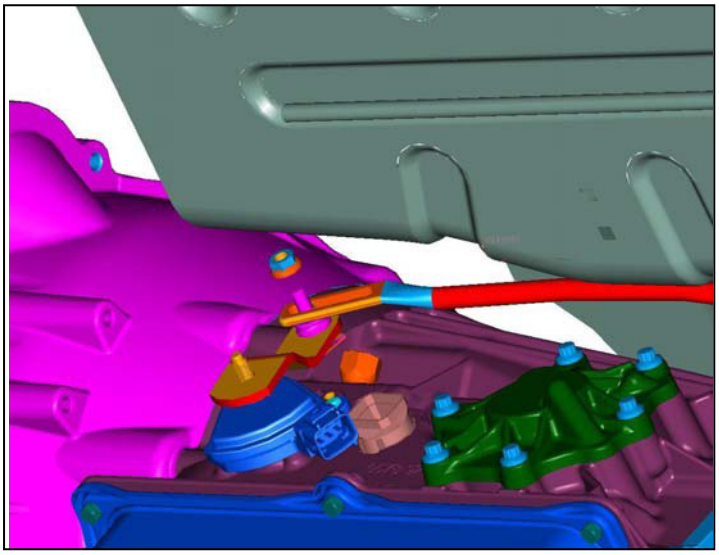
Then remove the transmission gear selector assembly.



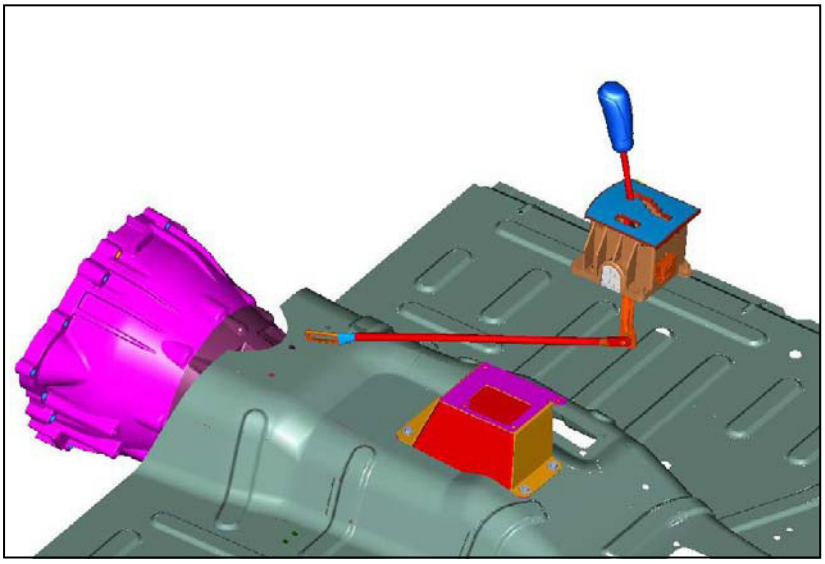
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Remove the linkage connected between the gear lever to Transmission end.



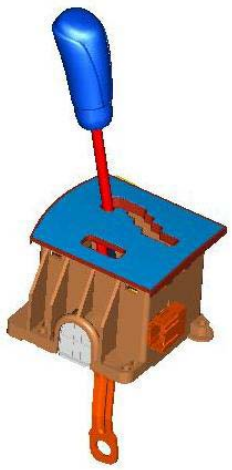


Remove the transmission gear selector assembly.



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Remove the linkage from the lever lower end.



4.2 Transmission removal procedure



Preparatory steps:

Removal of the oil cooler lines. (Only the transmission ends need to be removed for transmission removal.)

Note: The opening of the oil cooler line should be immediately blocked by the banjo bolt to avoid the oil leaking out**.**

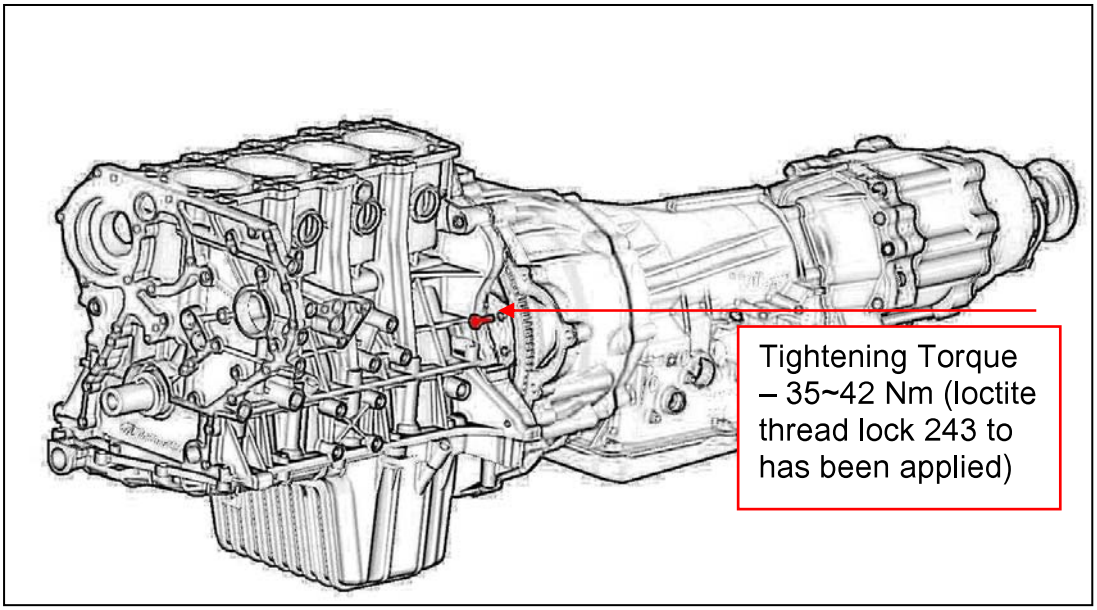
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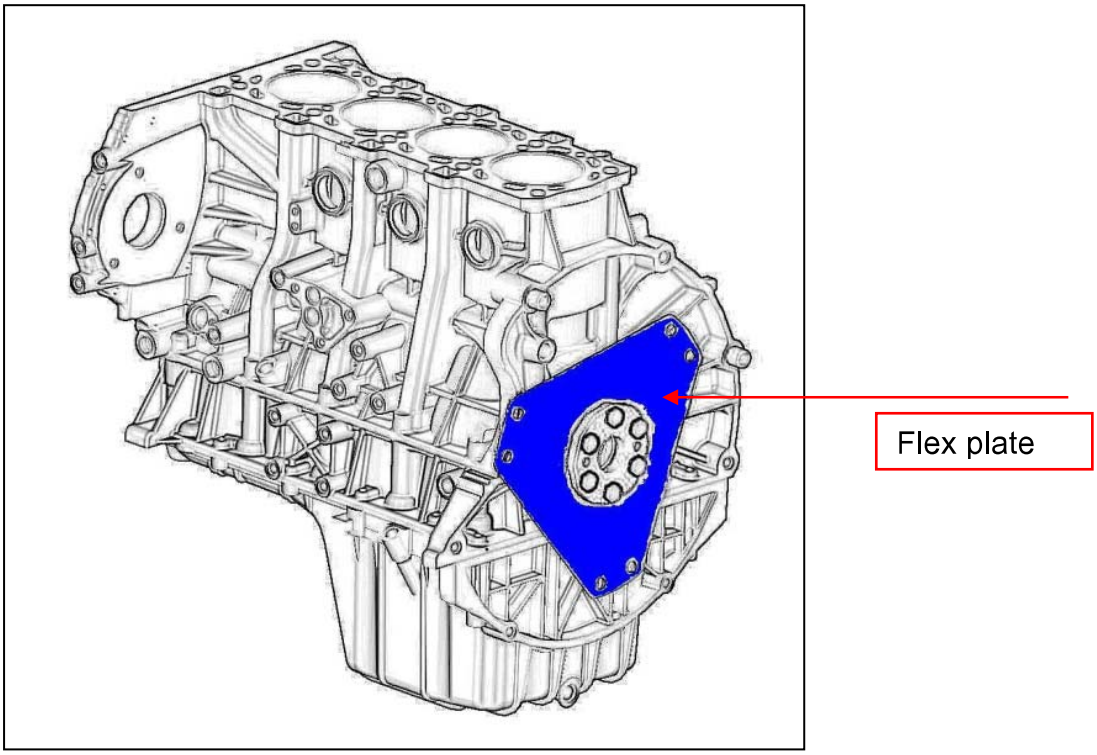
Removal & Refitting of Transmission Assy

After removing TGS, follow the steps:

1 Remove the starter motor
2 Remove the flex plate bolts (2 at a time) by rotating the engine.

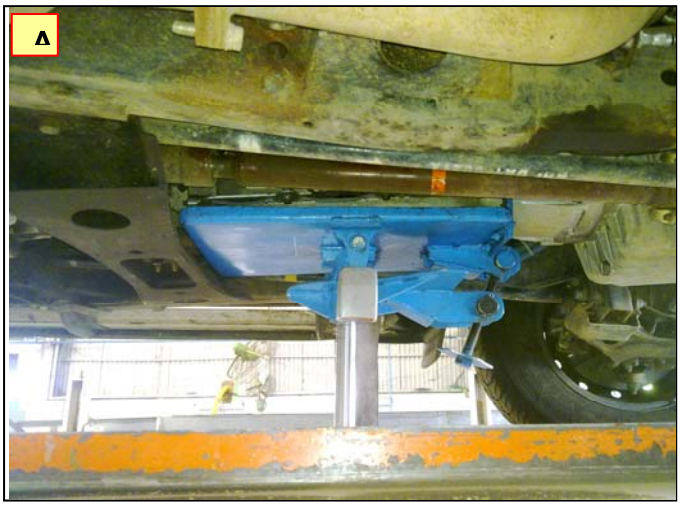
Note: Before removing this bolt, ensure that the bell housing bolts are **not removed**.





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3. Remove the gear box cross member and support the transmission with a support

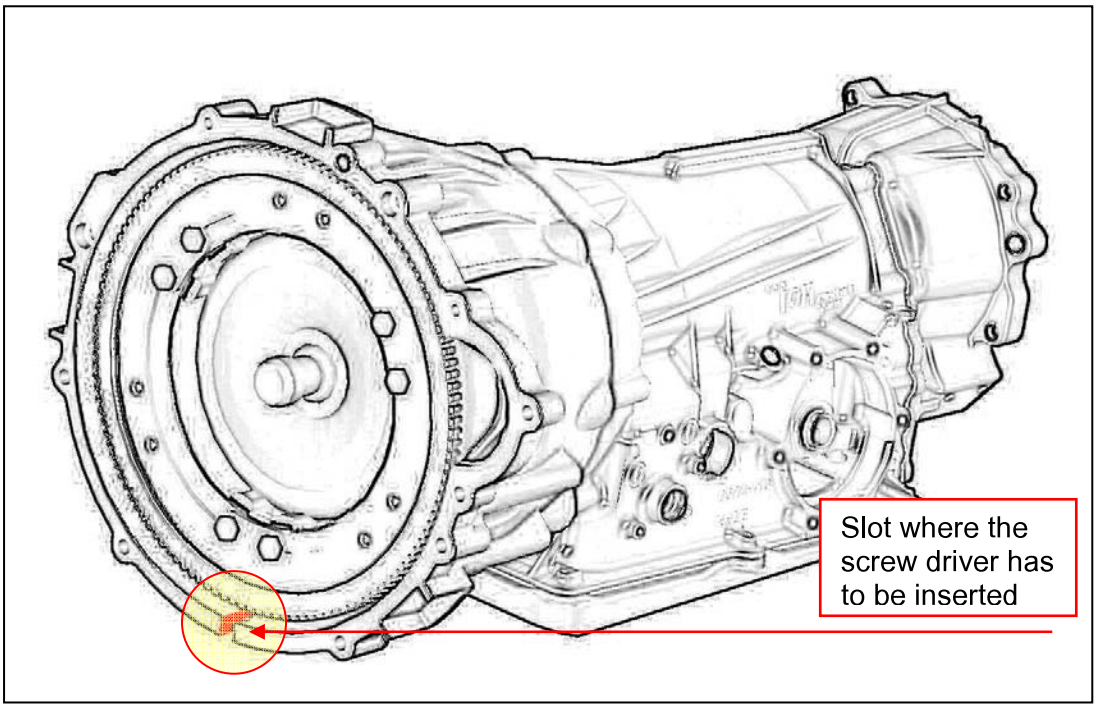




Refer above photos.

Photograph **[A]** shows Trolley underneath the transmission for support.
Photograph **[B]** Shows portable Trolley with hydraulic mechanism to support & lift Transmission assembly while disassembling and assembling on the vehicle.

Caution: If the jack and the support are not used, then the chances of damage are high. The weight of the Automatic transmission + Torque convertor is higher than the standard manual gearbox and hence the likelihood of the assembly being lowered suddenly and weight may rest on the sump, which can damage the valve bank.



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4. Remove the transmission along with the torque converter.

Note: While removing, insert a long screw driver from the bottom hole of the housing, and push the torque converter. This is essential as the Torque convertor should not be separated from the transmission. (If it does, then there is a strong possibility of the transmission oil leak from the contact face)

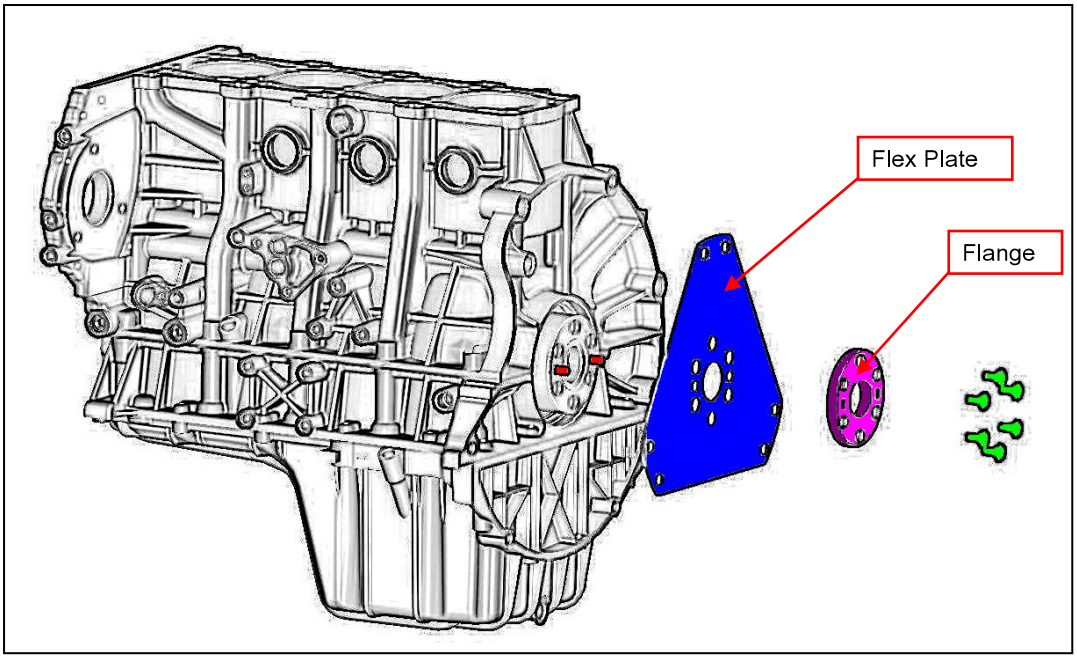
Post removal activity:

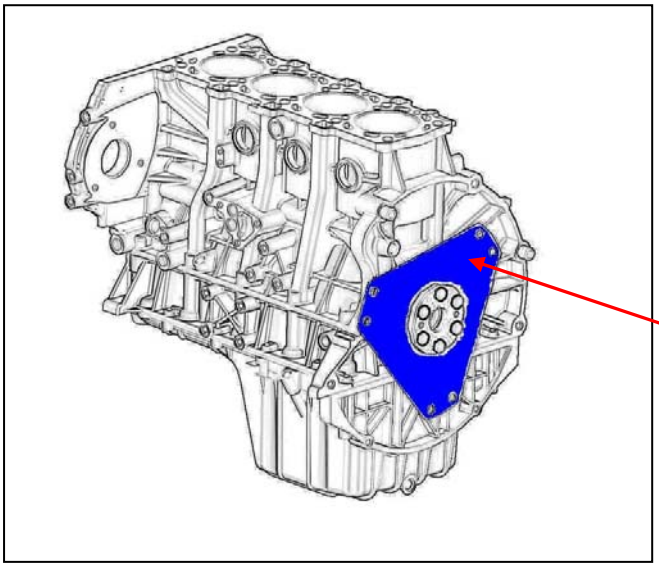
The gear box should never be left in the floor, resting on the sump. It has to be supported at front and rear end. This is critical – if the whole weight of the transmission comes to the sump. Then it can bend and damage the valve bank above that, making the whole transmission ineffective.

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Transmission Fitment Procedure

Fit the flex plate along with the flange to the crankshaft, using the dowels to locate the flex plate.



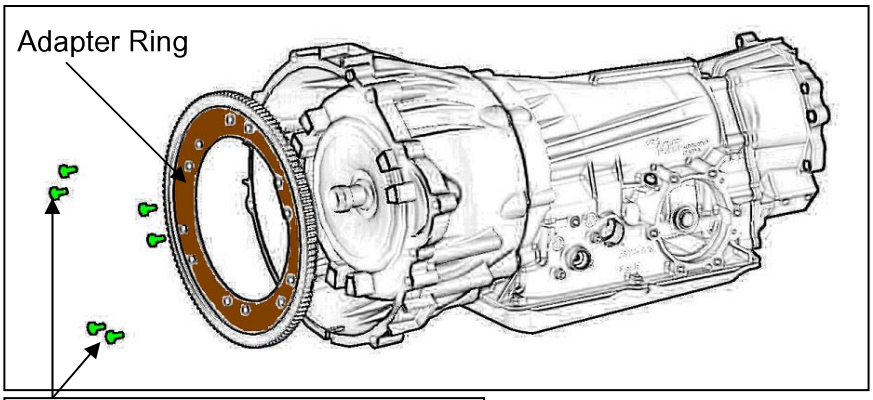


Flex plate mounting bolts

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Fit the Adaptor ring to the torque converter

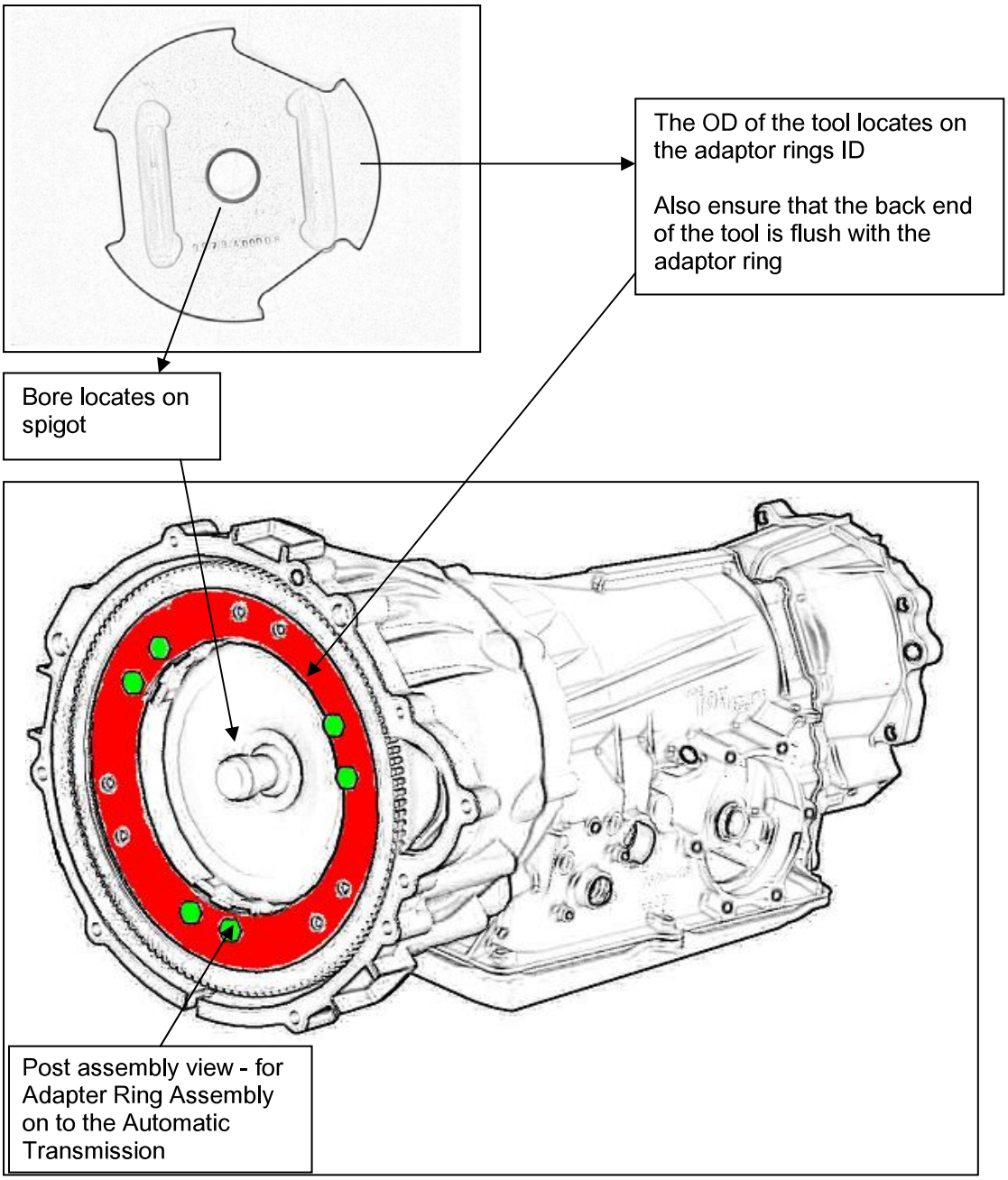
See the note for fitting the adaptor ring.

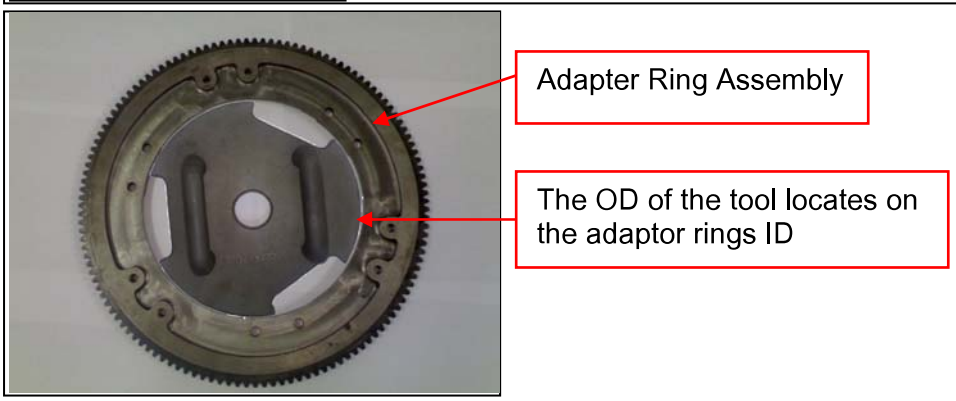


Flange Bolts M8x1.25x20 – 6 nos.
Part No : SF0202034 Tightening Torque – 35~42 Nm

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Note: Use the alignment tool to locate the adaptor ring to the Torque convertor. Not using it can cause errors due to lack of concentricity (failure of the flex plate or the bearing failures)

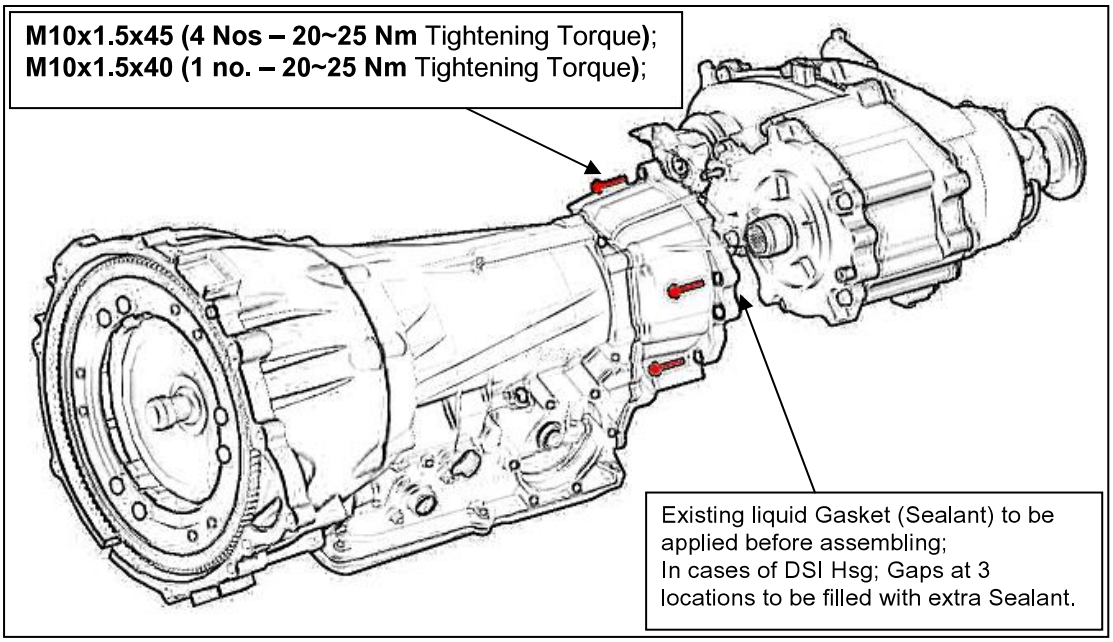




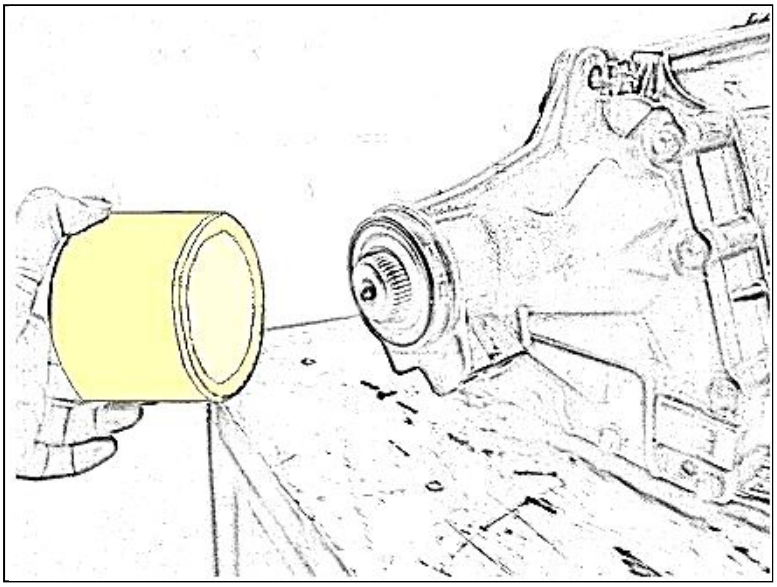
Refer above photo for the aligning tool – flush with the adaptor.

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For the 4WD: Refer illustration and torque values given below -



For the 2 WD
Before fitting the propeller shaft



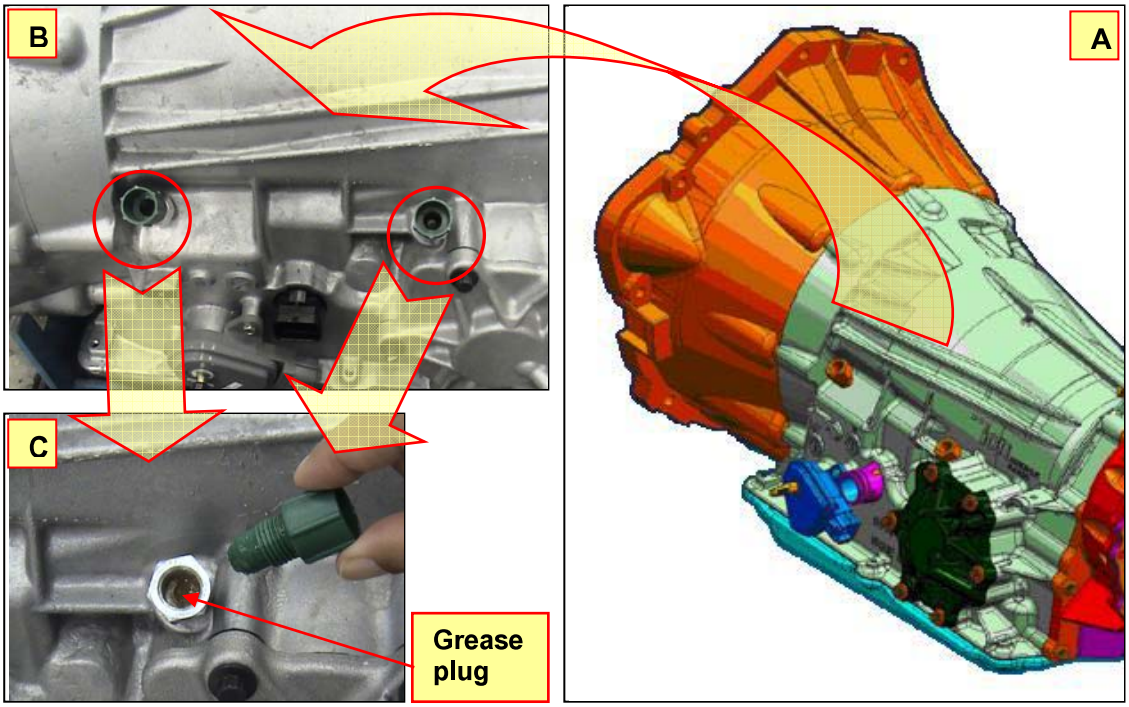


Fitment of Dust Cap on Automatic TM Rear end, before fitting Prop. shaft

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Note -

1. Ensure that the clamp holding the Torque converter (TC) to the transmission is removed only while fitting the transmission to the engine. This will prevent the TC to slide and fall down.
2. While removing the transmission ensure that the Torque converter + flywheel ring comes out as a set. (If the TC gets separated from the transmission then oil leakage can take place)
3. When the new transmission is received, then it has two plugs to cover the oil line port. The first plastic one should be removed and to be reused and fitted on the old transmission before sending it back.
4. There is also a grease plug. This grease plug is very unique and should not be attempted to be removed. Just fit the banjo bolt and use. After heating it will get melted and allow the oil to go to oil cooler.
5. Do not fill the old transmissions' plug with any grease. This grease is not available for retail. Use only the plastic plug
6. Send back the old transmission in the plastic capsule.



Refer above illustrations –

[A] & [B] Shows location for Oil cooler line connections where Plastic Caps plugged on new Transmission unit, before use. **[C]** Shows the Plastic caps and the Grease plugs filled in.

After refitting the new transmission, ensure that **TCU Reset/VIN flashing procedure** is carried out. Refer to Learning & resetting procedures, at the end of this manual.

Replacement of Transmission Control Unit (TCU)

While replacing TCU, ensure that the new TCU is with #03 printed in the label. After replacing the TCU, follow the **VIN Flashing/TCU reset procedure** as outlined in "Learning & Resetting Procedures" section.

Note – TCUs with label M79 or #02 are obsolete and should not be used

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5. Diagnostics

The TCU system generates an error code whenever it detects a malfunction in the system.

Please refer the **Diagnostic Manual MAN-00037/Sep 2008** for the brief description, actions and the possible cause for each error code.



The Transmission check lamp will be continuously ON in the event of any failure being recognized by the TCU.

6. Major Repairs

At present, no major repairs to the transmission and torque converter are allowed.

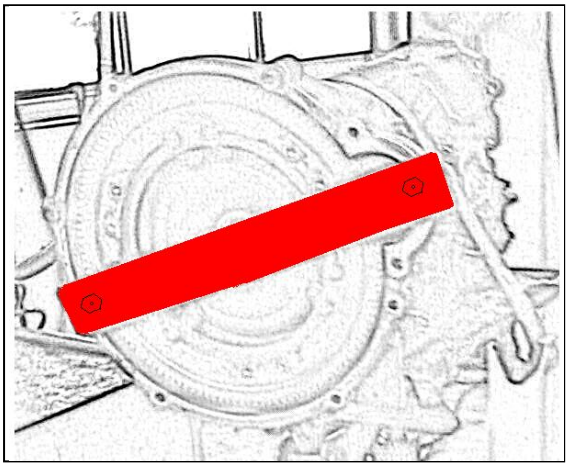
7. Warranty & Other Information

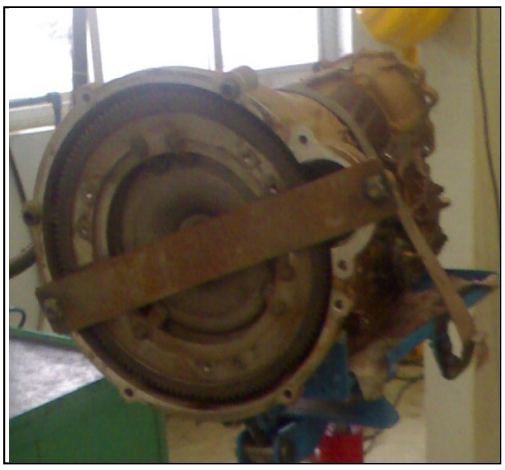
The failed unit needs to be returned back to the Parts Recall Centre, Nashik. While sending back the unit, please ensure that it is packed in the same packing capsule along with the oil.

The removed unit should never be allowed to lie on the floor. It should be supported at Torque converter and rear end. The transmission can get damaged if the precautions are not followed.

Ensure that the torque converter clamp (see figure below) is fitted before packing and dispatch.

Refer below sketch and photo for packing clamp fitment, while dispatching AT assembly.





All failures/complaints encountered on the Automatic transmission should be reported through **AtFR** format (Automatic Transmission Failure Report).

Replacement of any component (Transmission, TCU, TGS) requires **approval of the TEKline**. Please ensure that the CoTEK raises a TAR in the TEKnet website for approval, attaching the AtFR. While raising a warranty claim, the TAR # should be quoted on the warranty claim.

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8. Lubrication

Automatic transmission fluid: **Caltex PED 1712 ATF.**

Please note that this oil will not be commercially available in India. It has to be procured through M&M Spare Part department only.

Part number for the Automatic Transmission Fluid is **0701HJ0010N**

9. Torque Specifications

Transmission fluid level plug .....**30 – 35 Nm**
Front transmission cooler line to transmission connector ....**25 – 35 Nm**
Rear transmission cooler line to transmission connector ..... .**25 – 35 Nm**
Torque converter to drive plate bolt .....**40 – 42 Nm**
Transmission selector lever to cross shaft nut .....**14 – 20 Nm**

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10. Learning & Resetting Procedures

TCU Reset Procedure/VIN flashing

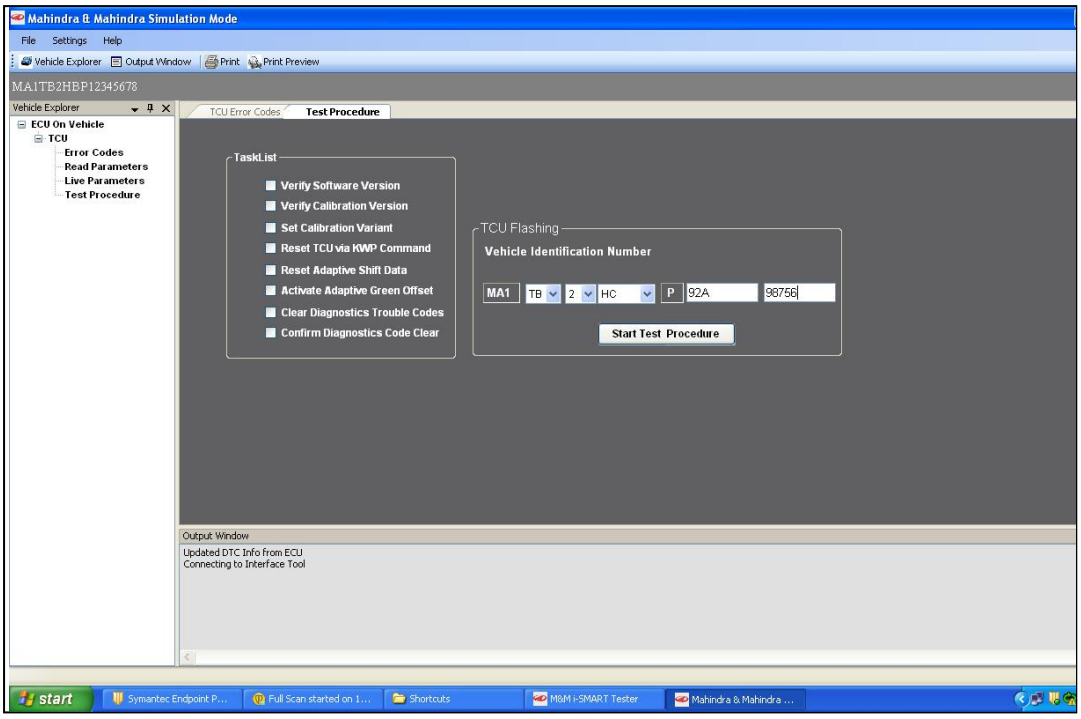
It is necessary to perform VIN Flashing when the transmission and/or TCU have been replaced. VIN flashing serves the following purpose in the two scenarios

1. TCU replacement: Data from the EMM is downloaded to the new TCU
2. Transmission replacement: The old TCU which is adapted to the old transmission is reset and makes it fresh and ready for the new transmission.

VIN Flashing procedure -

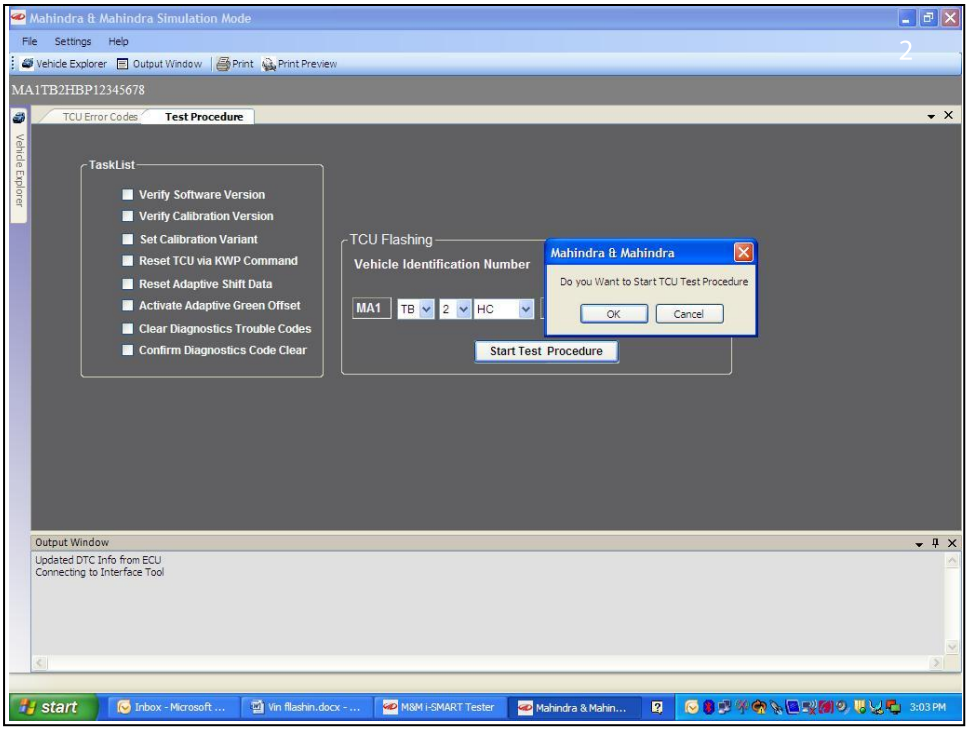
To perform VIN flashing, proceed as follows:

1. Connect the SMART tester to the vehicle
2. Open the TCU diagnostic tool **(Ref to TSB-00616/May 2009**)
3. Go to the tab Test Procedure tab and enter the VIN number as shown



4. Click on start test procedure to start VIN flashing and Green adoptive learning.
5. Click ok

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6. The process will start automatically step by step.
7. Once the process runs through all the check points, turn off the ignition and wait for 2 minutes before starting the vehicle.
8. Take a test drive of the vehicle with mixed driving pattern (gradual acceleration, sudden acceleration, coasting)
9. If the shifting is jerky* then **fast adoptive procedure** is to be done in the vehicle. Refer to the section on “Learning & Resetting Procedures” for carrying out fast adoptive.

***Jerk: Jerk can be defines as unsmooth engagement of gears. While shifting from N to D/R the complete vehicle shakes, which is clearly noticeable. While driving, jerks will be felt similar to sudden clutch release in manual transmission.**

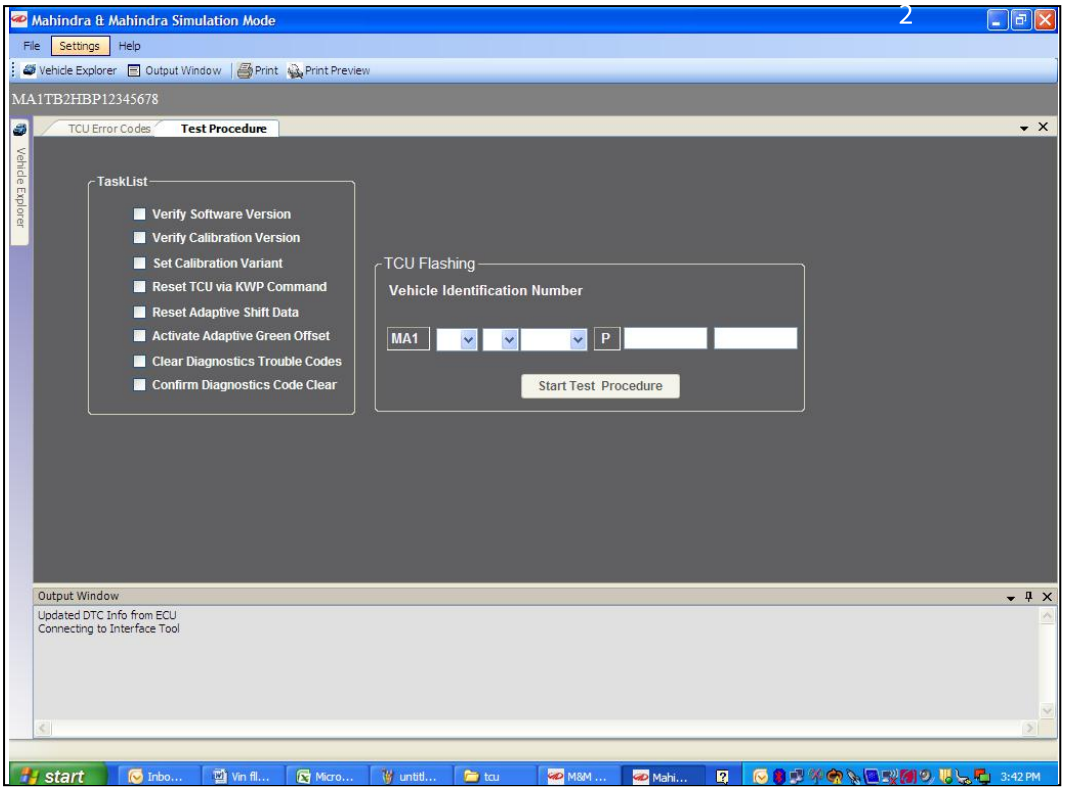
NOTE:

The following things are to be taken care of during the process.

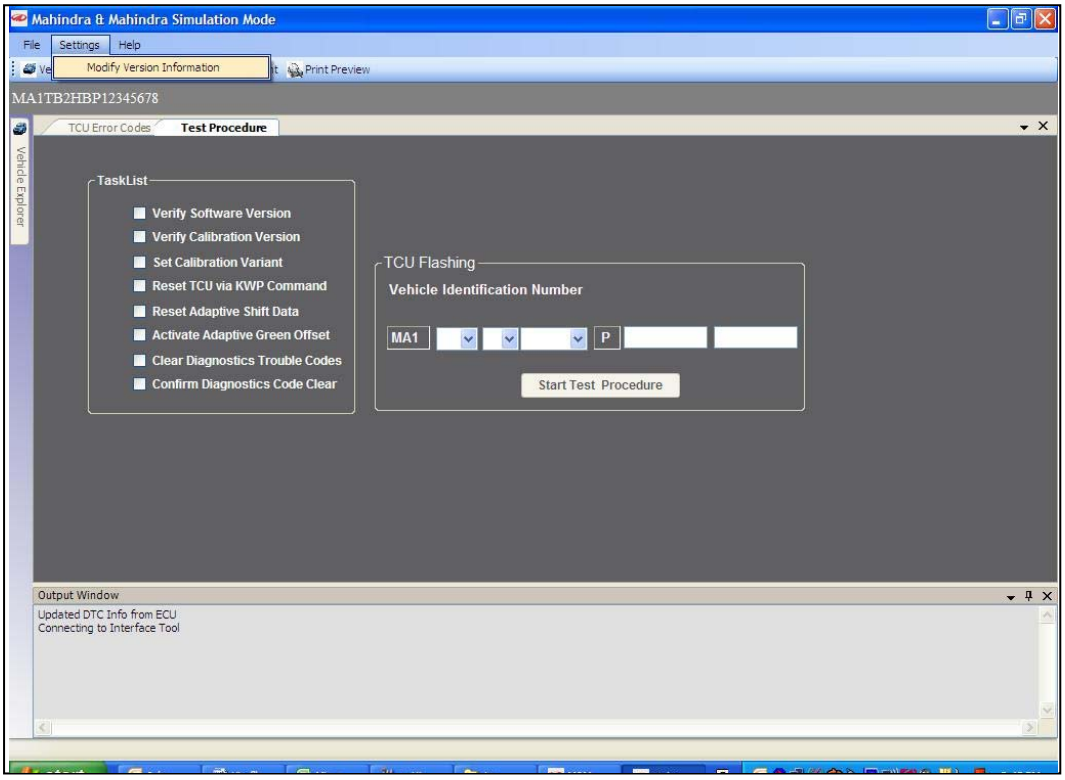
- If at the end of the process, if the tool shows that errors are still present, then go to the TCU error code screen and clear all the codes
- If at the beginning of the process, the tool shows that the software version is not compatible, then follow the below mentioned steps (this happens when the tool is being used for VIN flashing for the first time after installation)

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1. Click on settings

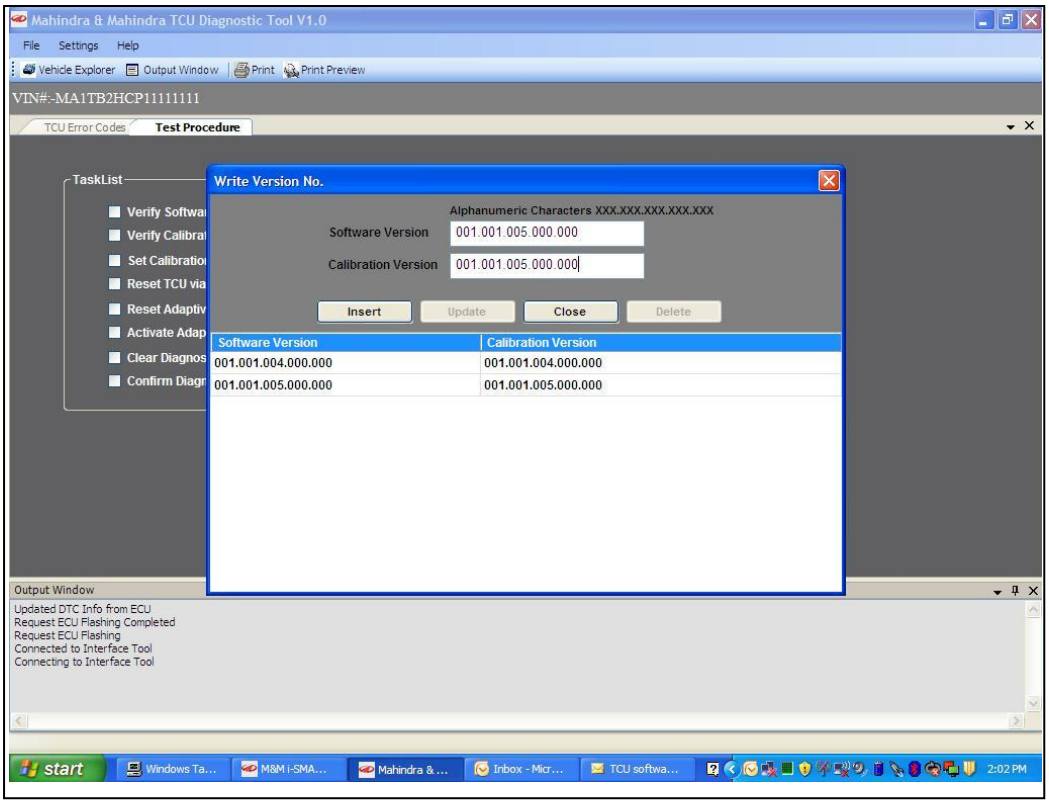


2. Select modify version information



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3. In the window which pops up, manually enter the Software Version and Calibration version as **001.001.005.000.000** and click update

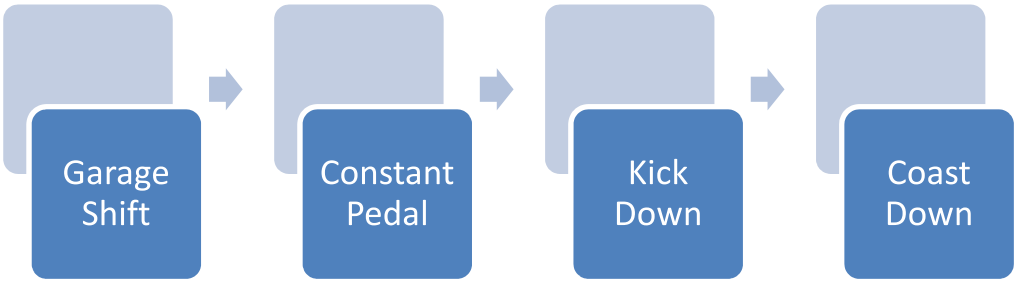


4. Go back to the VIN flashing procedure and do the VIN flashing.

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Fast Adoptive Learning Procedure

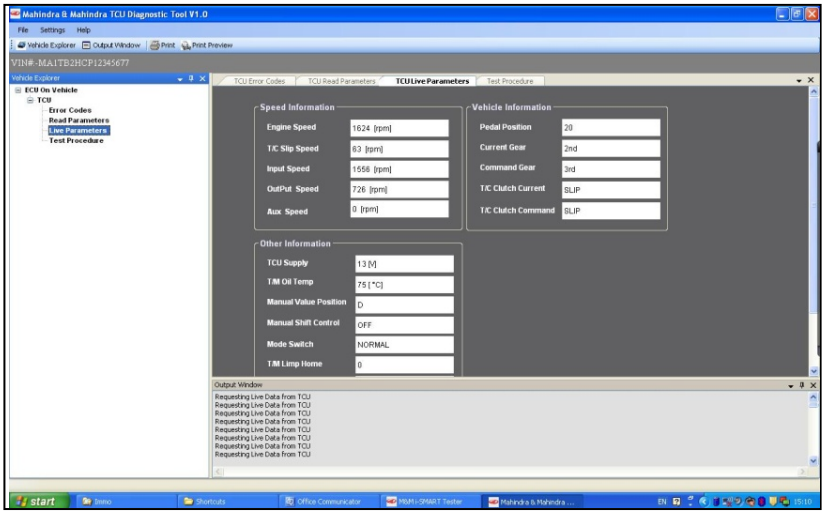
Fast adoptive learning is done to improve the quality of gearshift after TCU replacement, to avoid the jerks and flares during gearshifts, which can possibly be a customer complaint. The fast adoptive learning procedure has **4** phases –



A. Garage Shift

During the garage shift learning the following points are to be taken care of

- All the shifts prescribed in the below table should be in vehicle stand still condition, with engine running.
- No accelerator pedal input should be given during learning.
- Each step should be done 15 times



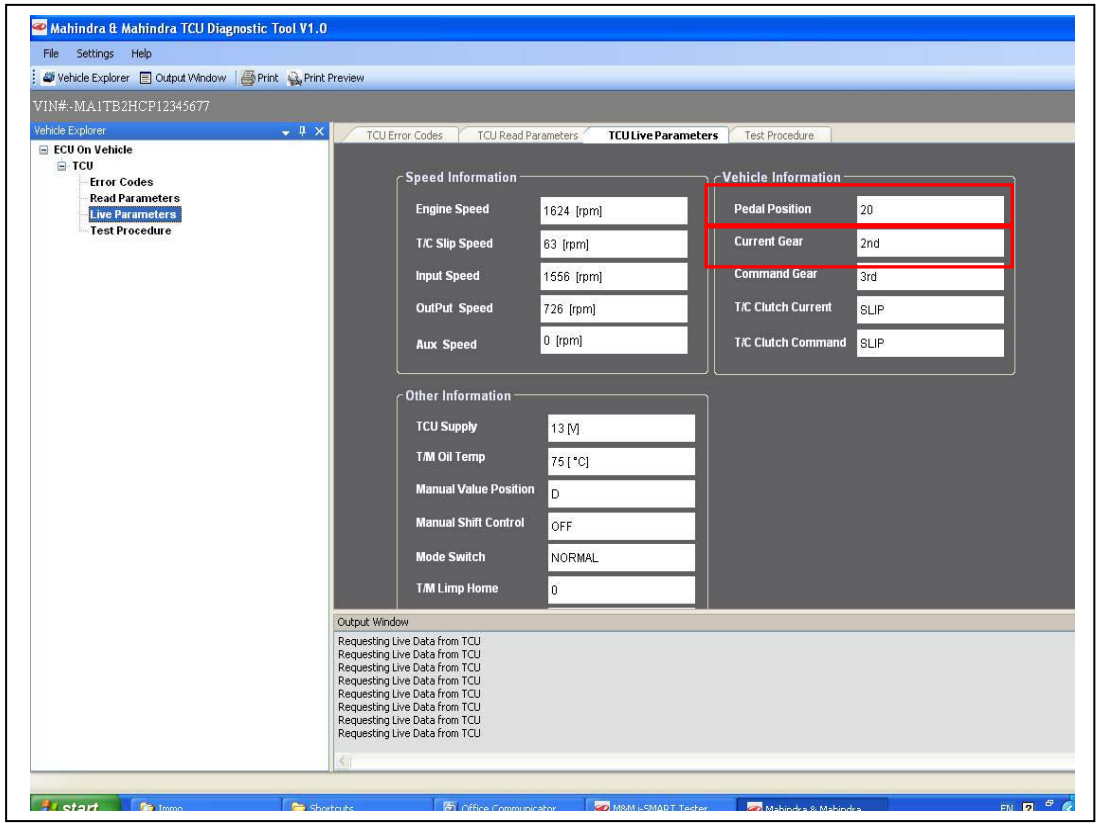
Step No:	Gear Selection Lever Position			Mode selection switch position
	From	To	To	
1	N	D	N	N mode
2	N	R	N	
3	D	R	D	
4	N	M	N	
5	D	M	D	
6	N	D	N	W Mode

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B. Constant Pedal

During constant pedal learning the following points are to be taken care of

- Maintain the accelerator pedal constant at points given in the table (± 2% allowable)
- Once the current gear reaches the specified gear in the table, leave the accelerator till the current gear comes down to 1st and start again.



Step No:	Accelerator Pedal Position	Maintain till current gear shifts up to
1	10%	4th
2	20%	5th
3	30%	6th
4	40%	6th
5	50%	6th
6	60%	6th
7	70%	6th
8	80%	6th
9	90%	6th
10	100%	6th

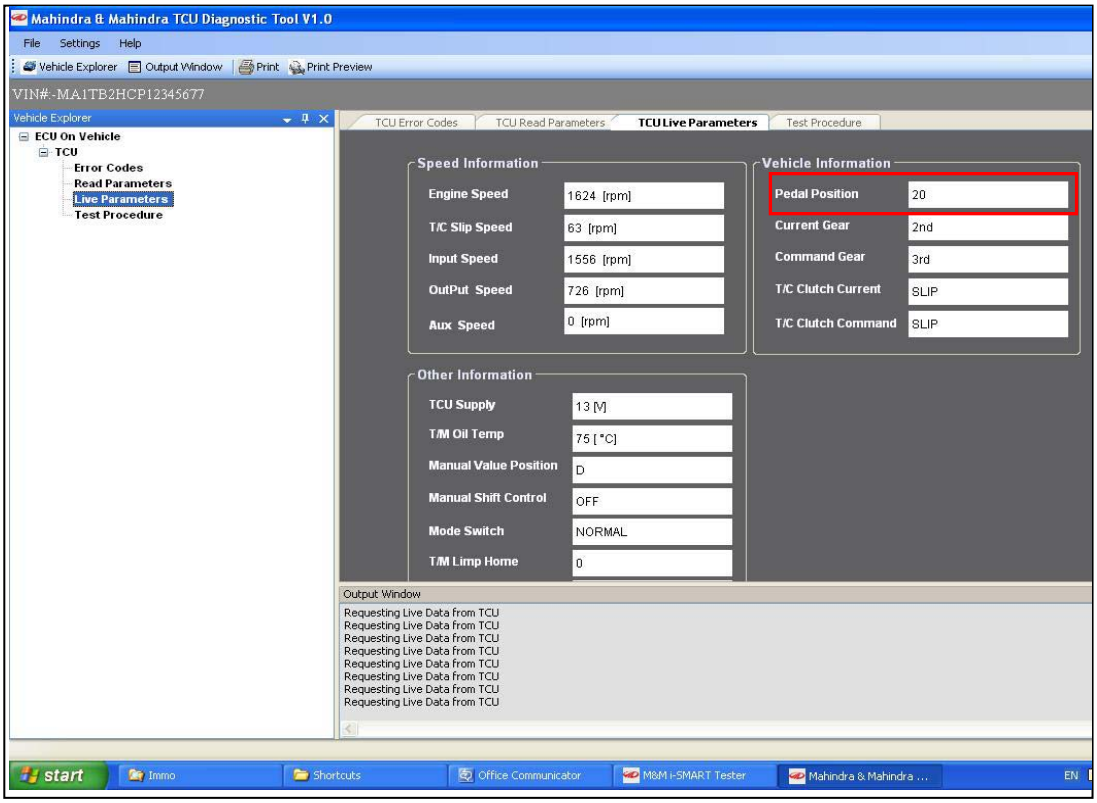
No of times each step to be done: 5 or until no jerk is felt during shifts

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C. Kick Down

During Kick Down learning, the following points are to be taken care of -

- After stabilizing the vehicle speed at the specified speed for each step, the accelerator pedal should be pressed fully instantaneously.
- Accelerator pedal should be kept pressed until the downshift and subsequent up shift happens.



Step No:	Maintain Constant Speed of (Kmph)	Slam down Accelerator pedal to
1	20	100%
2	30	100%
3	40	100%
4	50	100%
5	60	100%
6	70	100%
7	80	100%
8	90	100%
9	100	100%
10	110	100%
11	120	100%
12	130	100%

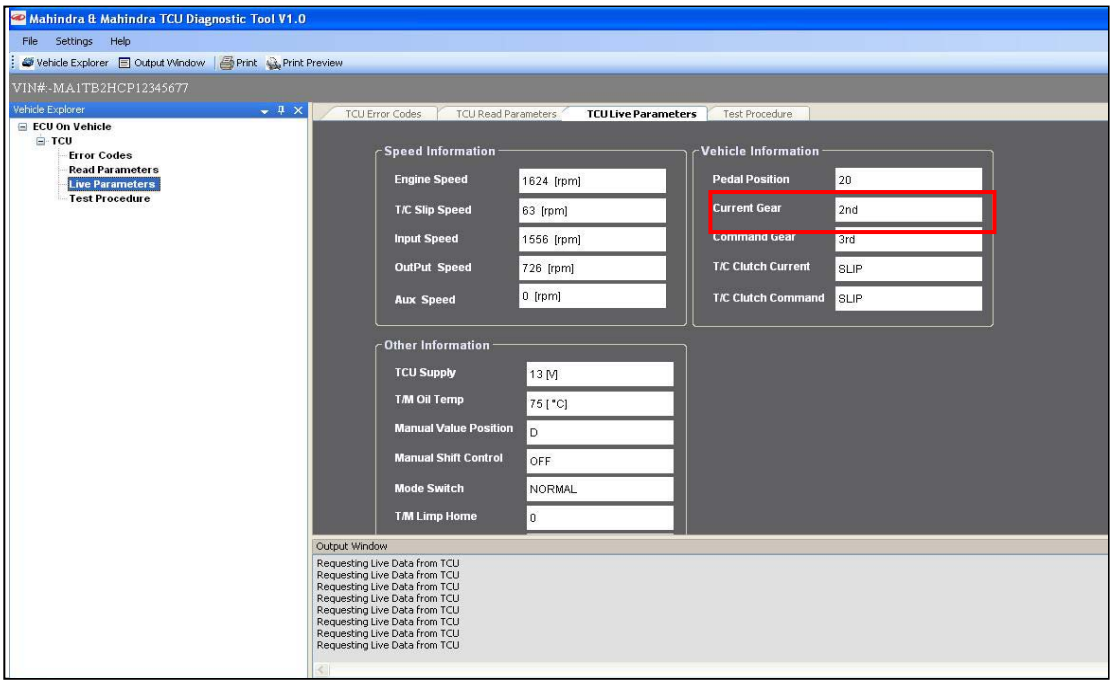
No of times each step to be done: 5 or until no jerk is felt during shifts

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D. Coast Down Learning

During Coast Down learning, following points are to be taken care of

- After attaining the constant speed specified in each step, the accelerator pedal should be completely released till the current gear shift down to 1st.



Step No:	Maintain Constant Speed of (Kmph)	Leave accelerator pedal completely till actual gear shifts down till
1	20	1st
2	30	1st
3	40	1st
4	50	1st
5	60	1st
6	70	1st
7	80	1st
8	90	1st
9	100	1st

No of times each step to be done: 5 or until no jerk is felt during shifts

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WARNING

- There should be two people in the vehicle while doing the adaptive leaning, one to drive the vehicle, and the other give instructions to the driver looking at the parameters in the laptop. **The driver should never attempt to do this procedure alone.**
- The person who will be driving the vehicle must be a very good driver as the exercise demands driving/maintaining the vehicle at high speeds.
- The transmission oil temperature should be maintained between 65 and 95 degree Celsius during the Fast Adoptive Learning procedure.

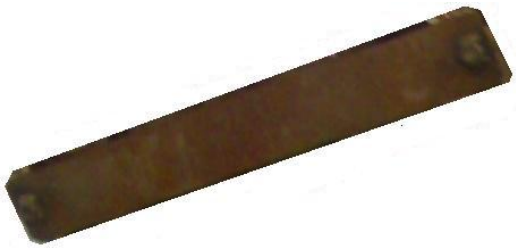
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FAST ADOPTIVE – VALIDATION SHEET

Stage	Step	Acc. Pedal position	Vehicle Speed	Current gear Shift		Note	Caution	
				From	To			
Garage Shift	1			N	D & back	N Mode	Repeat all steps 5 times or even more if jerks/flares are observed during gearshifts. Garage Shift to be done 15 times.	Oil temp should be maintained between 65 to 95 degrees C while performing the learning.
	2			N	R & back			
	3			D	R & back			
	4			N	M & back			
	5			D	M & back			
	6			N	D & back	W Mode		
Constant Pedal	1	10%			3rd	After the current gear reaches the specified gear let the vehicle coast.		
	2	20%			5th			
	3	30%			6th			
	4	40%			6th			
	5	50%			6th			
	6	60%			6th			
	7	70%			6th			
	8	80%			6th			
	9	90%			6th			
	10	100%			6th			
Kick Down	1	100%	20			Maintain the speed specified and floor the Acc. Pedal till the downshift and subsequent upshift happens.		
	2	100%	30					
	3	100%	40					
	4	100%	50					
	5	100%	60					
	6	100%	70					
	7	100%	80					
	8	100%	90					
	9	100%	100					
	10	100%	110					
	11	100%	120					
	12	100%	130					
Coast Down	1		20		1st	Maintain the speed specified and leave the Acc. Pedal till current gear shifts down to 1st.		
	2		30		1st			
	3		40		1st			
	4		50		1st			
	5		60		1st			
	6		70		1st			
	7		80		1st			
	8		90		1st			
	9		100		1st			

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11. Special Tools/ MST's

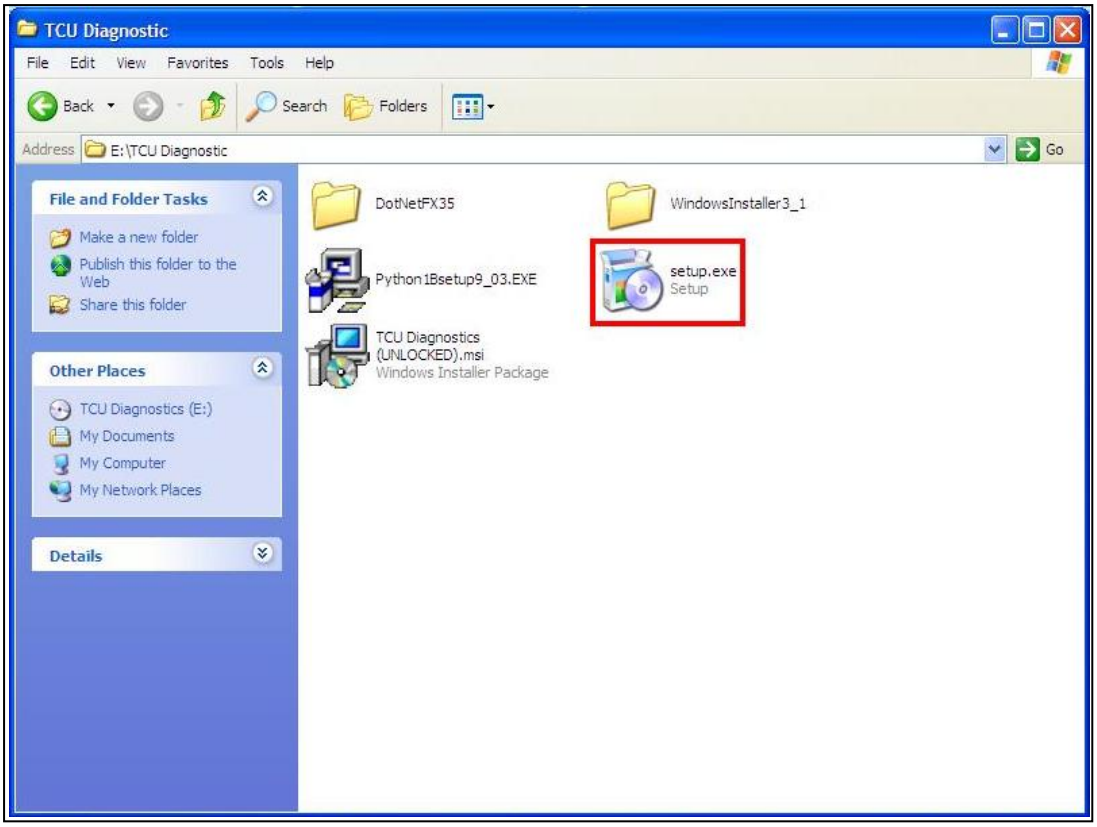
Sketch/ Description / Part No.	Usage View
 **ADAPTOR RING ALIGNMENT TOOL** **MST No. TSPLE0103**	 **Use the alignment tool to locate the adaptor ring to the torque convertor**
 **PACKING CLAMP** **(Comes along with new assy)**	 **Packing Clamp to be used while dispatching transmission assembly**

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12. DIAGNOSTIC SOFTWARE INSTALLATION

The Automatic Transmission Diagnostic Software needs to be installed in the SMART tester. For installation refer the following steps.

1. Insert the TCU Diagnostics CD in the CD drive.
2. Open the folder named “TCU Diagnostic” in the CD.
3. Double click the file Setup.exe - Refer below illustration.

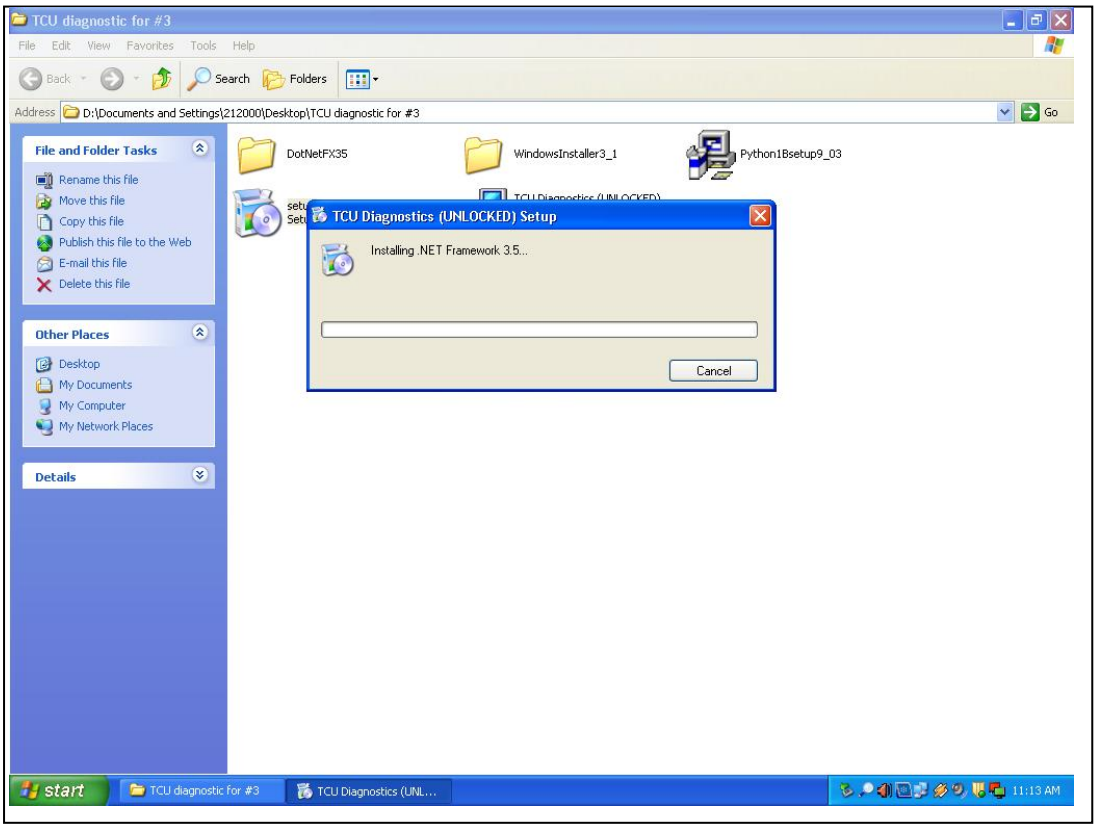


4. The setup will start installing the software by itself, and will guide you through rest of the installation.
5. Please refer **TSB 2009-100-TNO-00616** for further details

Note: TCU diagnostic software requires **.Net 3.5** (Dot Net) for working. The same is included in the installation package. The Setup will skip if it is already installed/ available in your System. Otherwise the first installation will be of .Net 3.5 which will take approx. **45 minutes.** The following *(Refer below snapshot)* window will be displayed for very long, creating an impression that the program is not responding.

Do not cancel the installation or disturb the system while the .Net 3.5 software is getting installed.

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Screen shot during Installation of **.Net 3.5**

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Transfer Case - Electric Shift

Contents

Description

Construction & Operation

Identification

Trouble Shooting

Removal from the vehicle

Dismantling

Cleaning & Inspection

Assembly

Tightening Torques

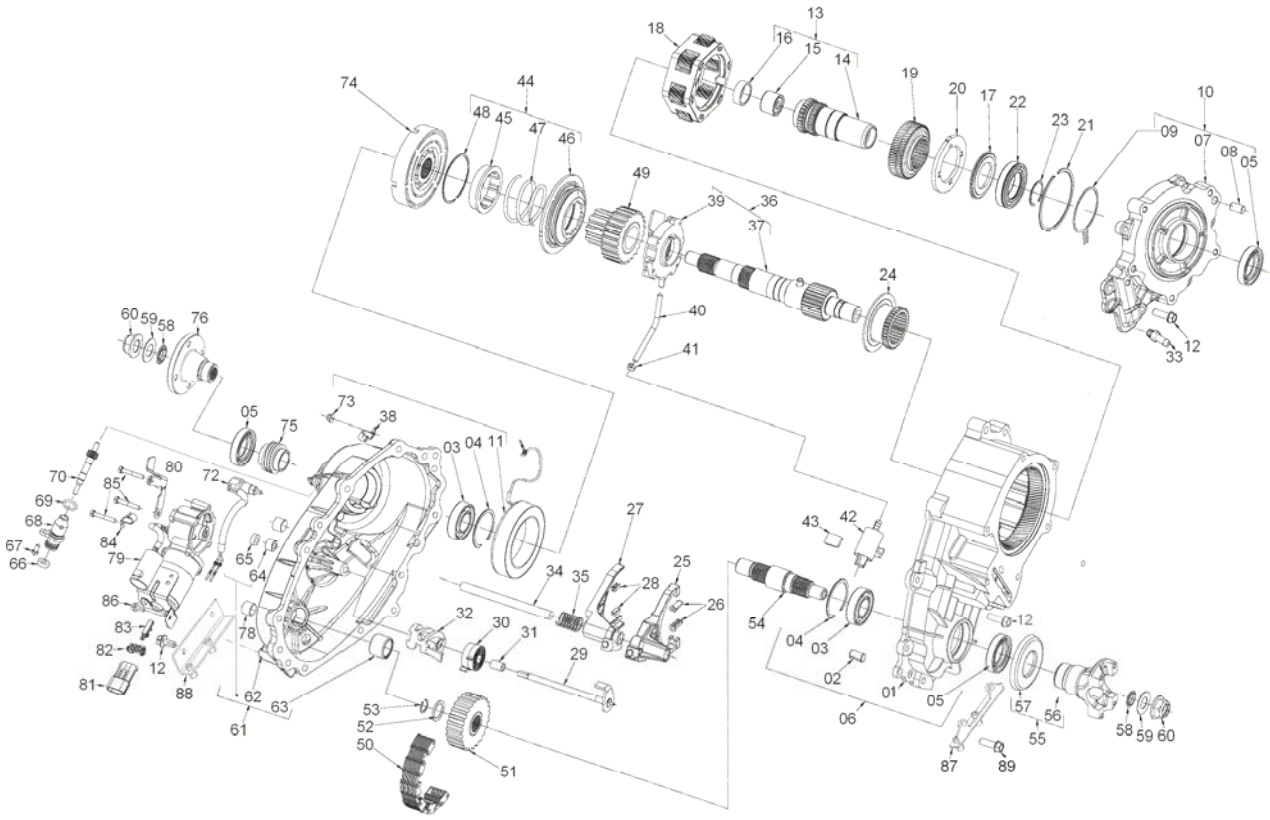
Special Tools

Specifications

Automatic Locking Hub

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Description –



Divgi-Warner's 4555 Transfer case is a two-speed, part-time electrical shift transfer case. The transfer case operates in a system. The system consists of:

1. Transfer case with Shift Motor, Speed sensor and Electric clutch.
2. Electronic Control Unit (ECU)
3. Mode selector switch and Indicator lights 4WH and 4WL on dash board
4. Harness to connect the above parts and power input.

The power is received by input shaft, which is coupled with output shaft of transmission gearbox by matching splines. There are two outputs, one for rear wheels and one for front wheels. Four selector positions are provided as follows –

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Position	Speed Ratio	Operation
2H - Two high position	1: 1	Only the two rear wheels are driven at 1: 1 speed ratio
4WH - Four high position	1: 1	All four wheels are driven at 1: 1 speed ratio
4WL – Four low position	2.48:1	All four wheels are driven at 2.48: 1 speed ratio

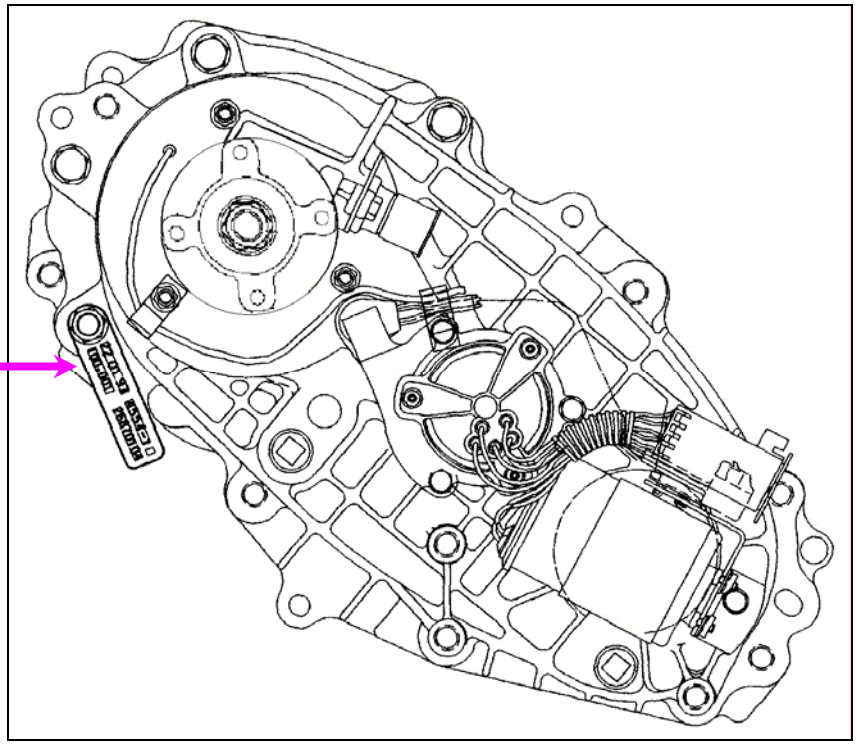
Construction & Operation –

Planetary gear set provides gear reduction. Power is transferred to the front wheel drive through a Morse HY-VO chain drive. Unit operates in an oil bath. An oil pump is used to provide positive lubrication to the planetary gear set and other upper output shaft components.
The different modes are obtained by rotating selector switch for selection. This in turn gives signal to Electronic Control Unit (ECU). ECU intelligently controls operations. It senses the conditions and shift transfer case in to the mode selected.
The control over the operations is obtained using Electronic Control Unit (ECU). It is housed below the driver's or co-driver's seat. Rotary switch is provided for selection of different modes –

2H – Two wheel high
4H – Four wheel high
4L – Four wheel low

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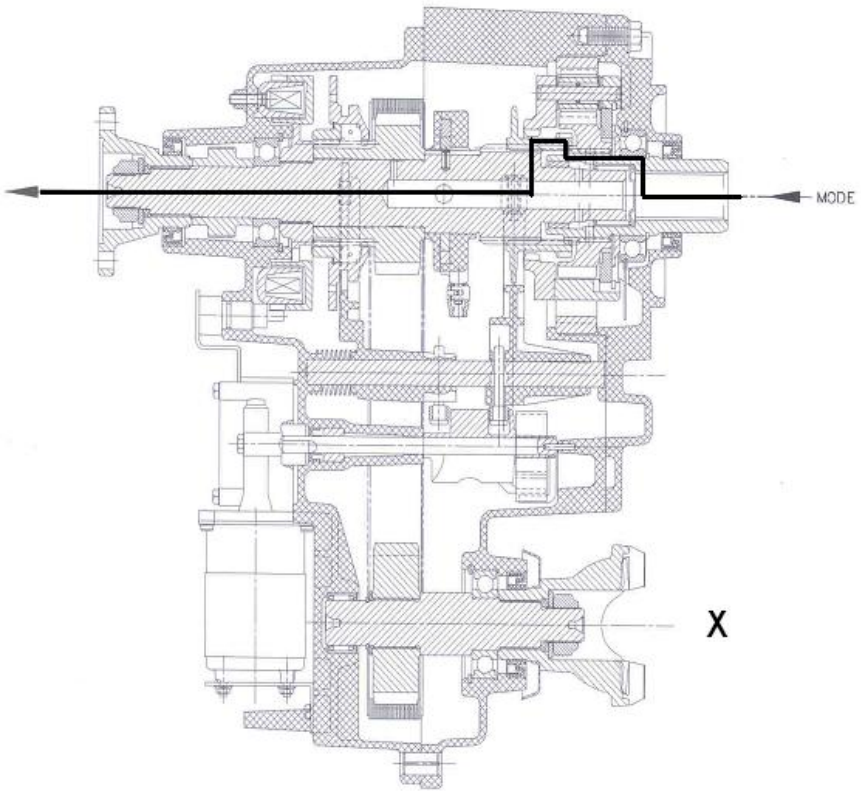
Identification -

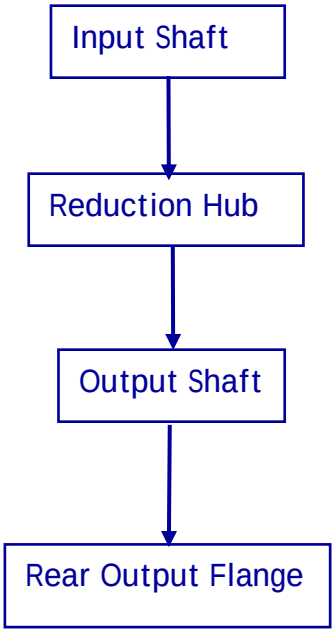


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Automotive Sector

- **Electric Shift Transfer Case in 2H Mode**

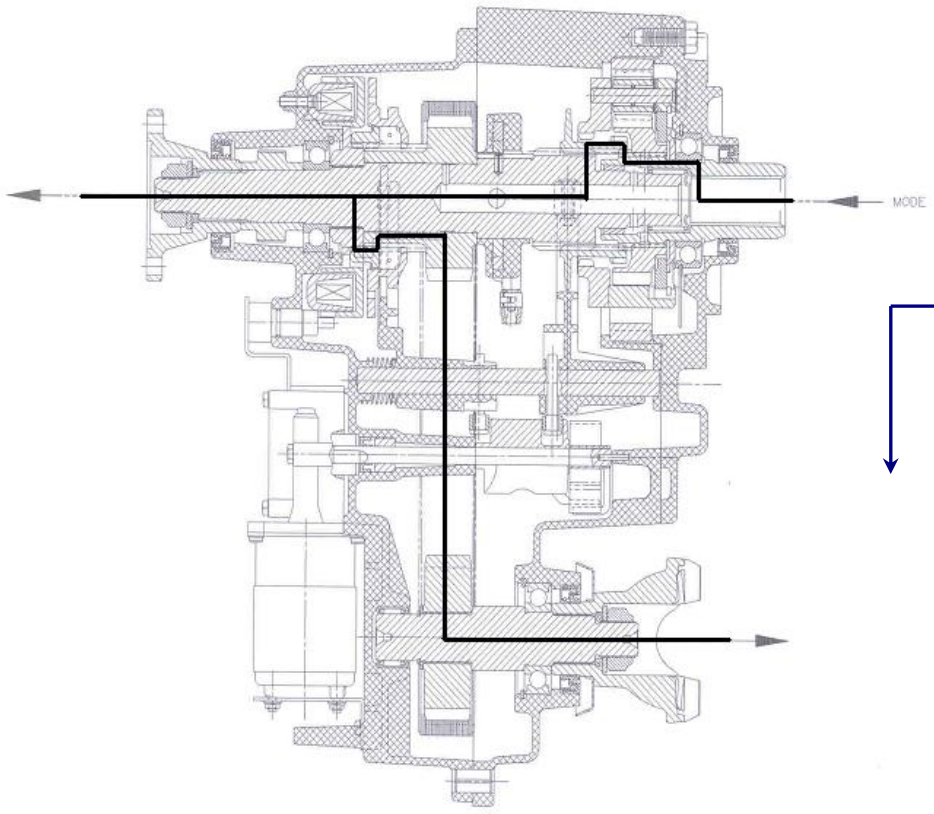


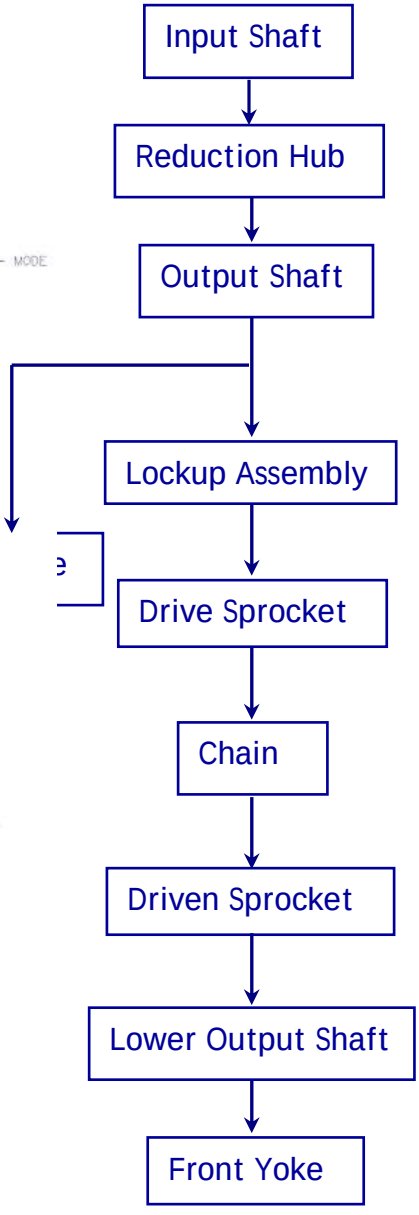


Only the two rear wheels are driven at 1: 1 speed ratio

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- **Electric Shift Transfer Case in 4H Mode**





➢ **Shifting from 2WD to 4WD**

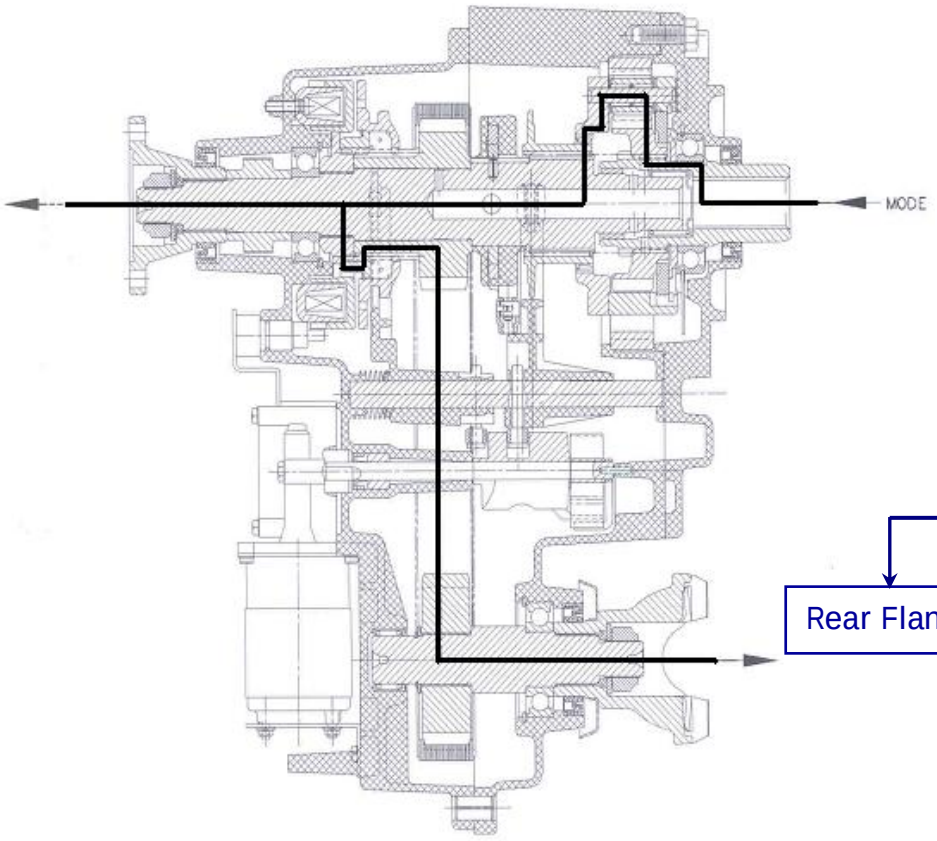
- Shift selector switch mode from 2H to 4H. 4WD HI indicator light will turn On.
- Shifting is possible during driving.

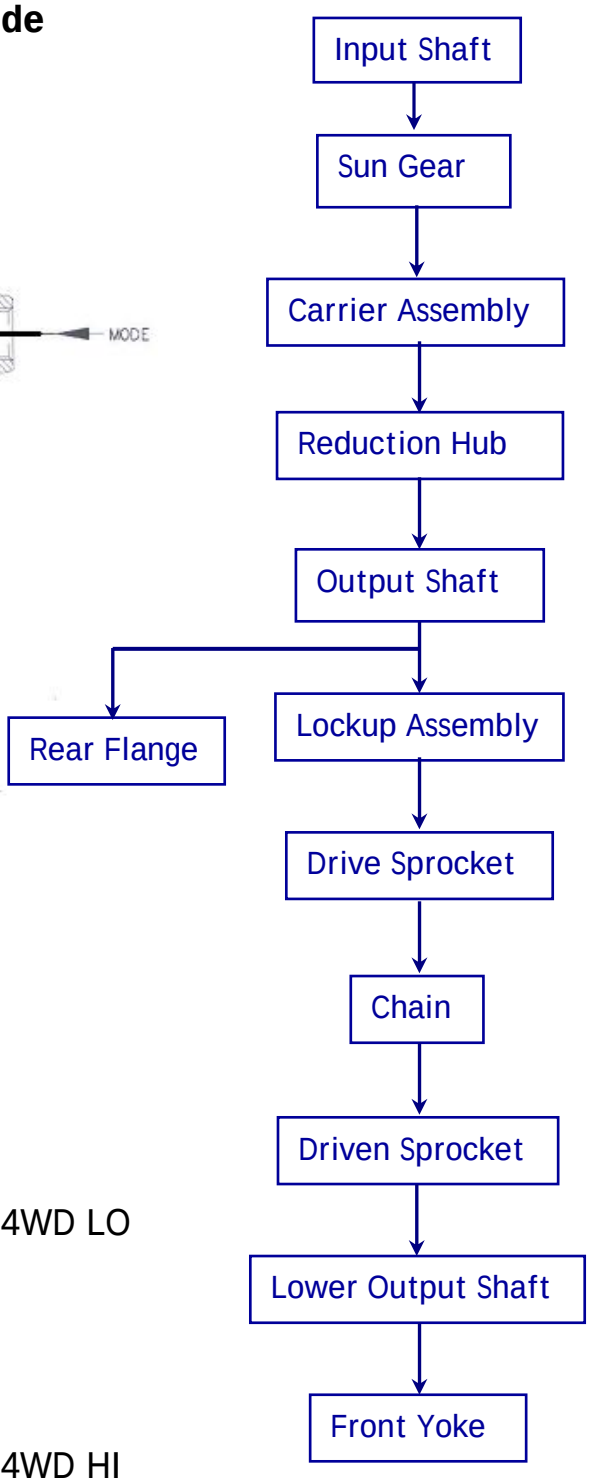
➢ **Shifting from 4WD to 2WD**

- Shift selector switch mode from 4H to 2H. 4WD HI indicator light will turn Off
- Shifting is possible during driving

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- **Electric Shift Transfer Case in 4L Mode**





➢ **Shifting from 4H to 4L**

- Stop the vehicle
- Apply clutch paddle
- Shift selector switch mode from 4H to 4L. 4WD LO indicator light will turn On

➢ **Shifting from 4L to 4H**

- Stop the vehicle
- Apply clutch paddle.
- Shift selector switch mode from 4L to 4H. 4WD HI indicator light will turn On

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Trouble Shooting –

Symptom	Causes	Remedial action
Electric shift problems	1. Faulty or damaged ECU, speed sensor, clutch or internal wiring	✓ Refer to self diagnosis
	2. Damaged or worn shift cam, hub, fork and rail shaft	✓ Overhaul and check for wear and damage. Replace if necessary
No front wheel drive when Shifted to 4WD.	1. Broken drive chain	✓ Check internal parts and replace if necessary
Noise in 4WD operation.	Oil level lower than minimum required.	Drain old oil and replace with Specified oil.
Make sure noise is coming from Transfer case and not from clutch, transmission, drive shaft, Automatic locking hubs or other Components.	Loosened bolts or mounting parts	Re-tighten as specified.
	Noisy transfer case bearings	Disassemble bearings and parts and check for wear or damage. Replace if necessary.
	Noisy gears	Check for wear and damage Including speedometer gear and replace if necessary
	Worn or damaged sprockets or drive chain	Disassemble and check for wear and damage. Replace if necessary
	Incorrect tyre pressure.	Adjust tyre pressure.

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Transfer case oil leakage	Cracked transfer case.	Replace the case.
	Leakage from other parts.	Clean case and parts and check for leakage.
	Breather clogging.	Remove breather barb and clean it. Replace if necessary.
	Oil level higher than required or improper brand of oil being used.	Use specified oil. Adjust oil level
	Loosened sealing bolts.	Re-tighten.
	Improper brand of sealant or improperly applied sealant	Use specified sealant and retighten.
	Worn or damaged oil seal	Replace oil seal

Care of the System –

Oil level Check – Every 10,000 Kms.
Oil replacement interval - Every 40,000 Kms.

Checking the Oil Level –

- Clean the oil level plug and surrounding area.
- Remove the oil level plug and check whether oil is dripping out.
- If oil is not dripping out, oil level must be below the required level. Add specified oil to bring it to the level when it starts dripping out.
- Tighten the oil level plug.

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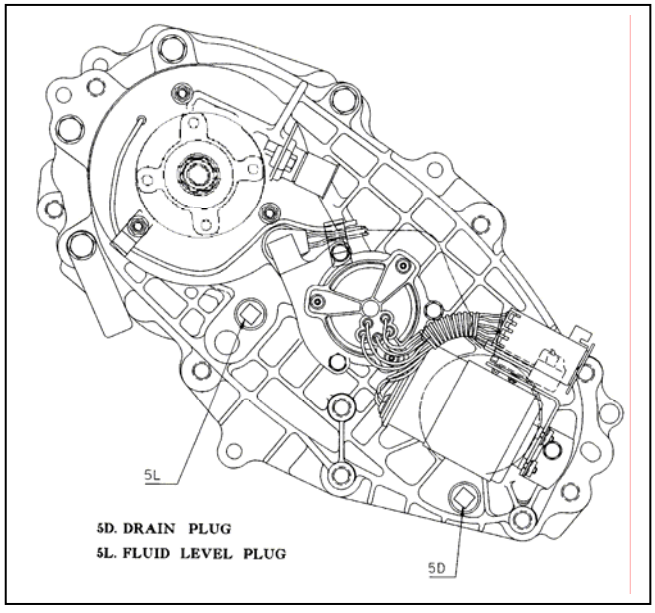
Precautions –

Before checking or removing the oil, warming up the transfer case is necessary. This should be done by driving the vehicle for some time.

Do not use an impact wrench to open or tighten the drain and oil level plugs. This may damage the threads in the transfer case.

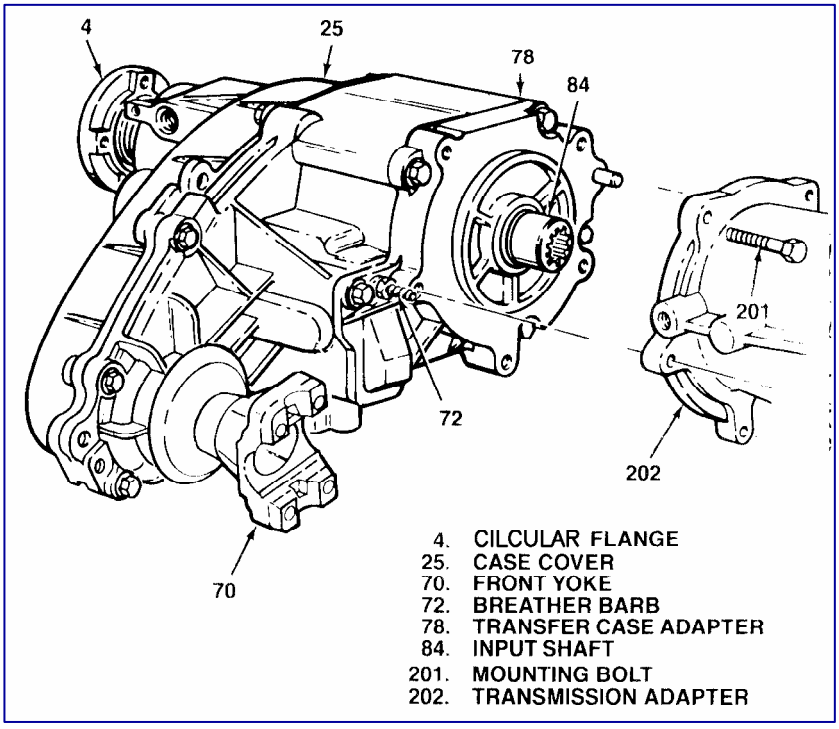
Changing the Oil –

- Clean the oil level plug, drain plug and surrounding area.
- Place a container to collect oil, under the transfer case.
- Remove the drain plug.
- Remove the oil level plug.
- Let the oil drain out.
- Tighten the drain plug.
- Fill new oil through oil level plug, till it begins to drip out.
- Tighten the oil level plug.



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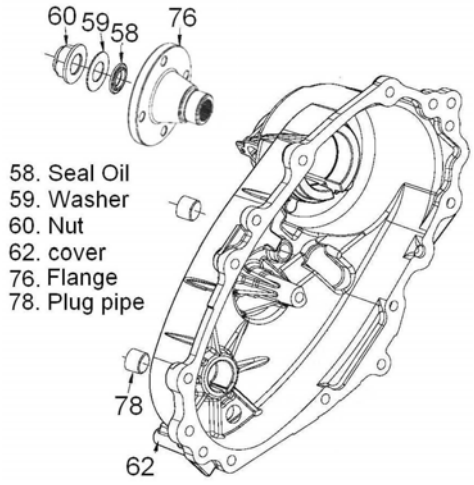
Removal & fitting on the vehicle –



1. Disconnect the wiring harness connection from the T/case
2. Lift up the vehicle.
3. Remove transfer case drain and fluid plugs. Drain all fluid and reinstall plugs.
4. Remove the breather tube.
5. Disconnect speedometer cable connector and switch connector.
6. Support the transfer case with the jack and disconnect the front and rear propeller shafts from the transfer case
7. Remove the transfer case by removing the mounting nuts, attaching the transfer case to transmission.
8. Remove the tuner assembly & tuner brackets.

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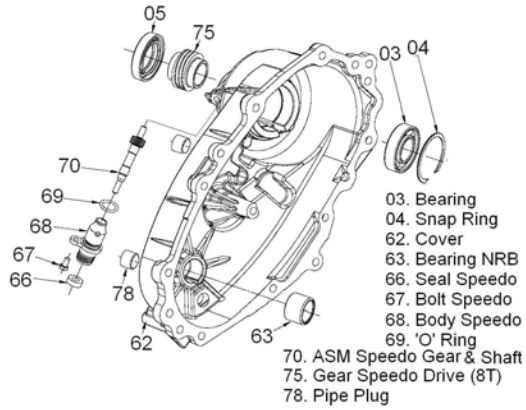
Dismantling -





Disassembly – Rear Flange.

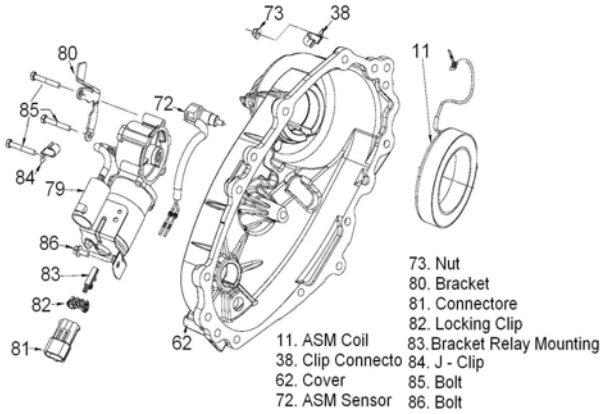
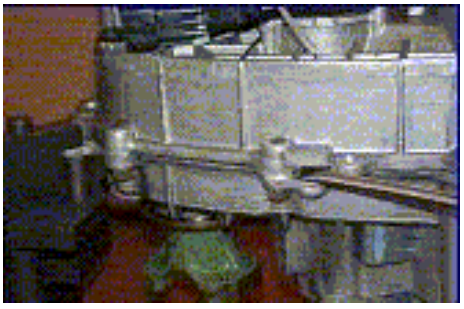
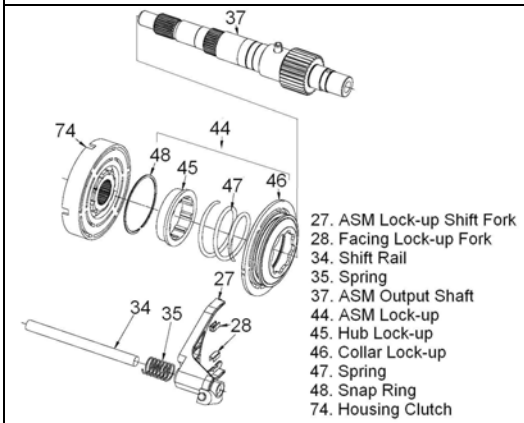
- Position the Transfer case on repair fixture.
- Holding the flange by flange holder, remove the nut and washer and then remove the flange with the help of puller.
- Remove the oil seal from the shaft.
- Remove the two oil plugs from the cover.



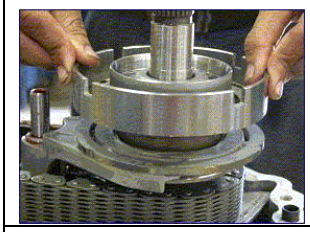
Disassembly - Assembly Cover (Motor, Speed sensor, Clutch coil and Speedo Gear.

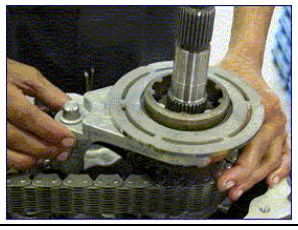
- Remove bolts and remove Assembly Motor, Speed sensor bracket and speed sensor.
- Separate clutch coil wire terminal from the connector and pull out from the sleeve.
- Remove the bolt and remove Speedo body and separate Assembly Speedo driven gear & shaft and Speedo body.

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	• Remove oil seal and Speedo drive gear.
 73. Nut 80. Bracket 81. Connectore 82. Locking Clip 83. Bracket Relay Mounting 84. J - Clip 85. Bolt 86. Bolt 11. ASM Coil 38. Clip Connecto 62. Cover 72. ASM Sensor 	• Remove the 9 bolts and identification tag. • Pry at the bosses provided on the cover and the case to break the sealant bond of the cover and the transfer case in such a way that the metal surface is not damaged. • Remove the snap ring and pull out the ball bearing from the cover. • Remove clutch coil from the cover. • Pull out the needle bearing from the cover. • Remove the magnet from the slot in the case. • Remove the return spring. • Clean and remove the sealant of the cover and case. Be careful not to damage the metal surface.
 27. ASM Lock-up Shift Fork 28. Facing Lock-up Fork 34. Shift Rail 35. Spring 37. ASM Output Shaft 44. ASM Lock-up 45. Hub Lock-up 46. Collar Lock-up 47. Spring 48. Snap Ring 74. Housing Clutch	**Disassembly – Lock – up Shift Part** • Remove clutch housing from output shaft. • Together slid 2W-4W lock up assembly and lock up fork from output shaft and separate fork assembly and Remove the two shift fork facings from the shift fork

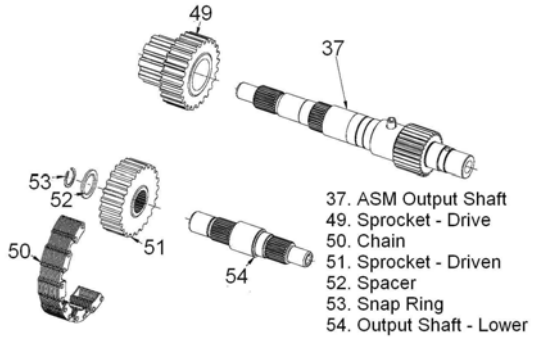
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assembly, if required.

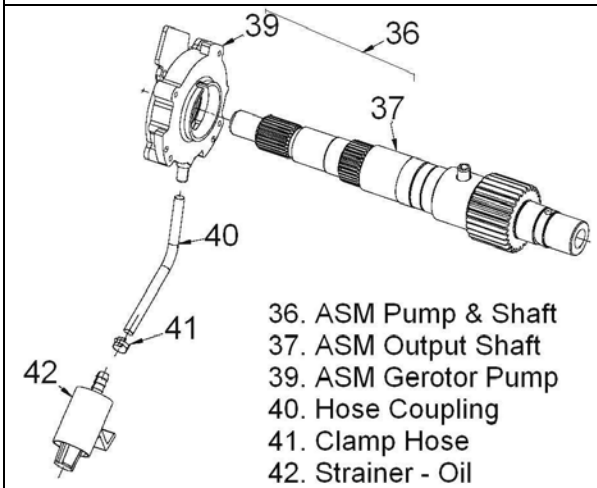
- To dismantle 2W-4W lockup assembly remove snap ring, lock up hub return spring from lock up collar.





Disassembly – Chain Drive

- Remove snap ring and spacer from the output shaft.
- Remove drive chain, driven sprocket and drive sprocket from the output shaft at a time.
- Separate the chain and sprocket when removing the assembly.

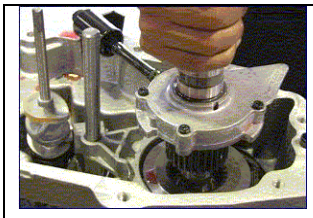
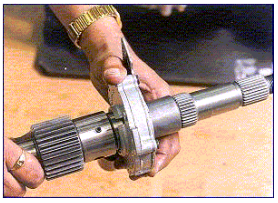
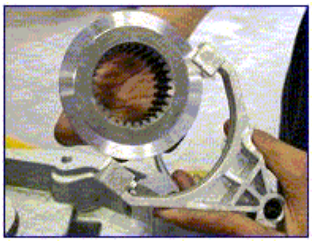
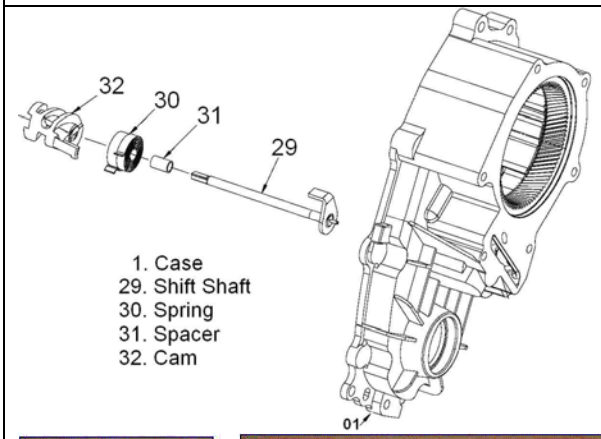
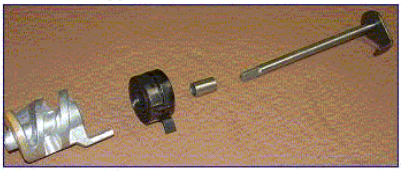


Disassembly – Gerotor Pump

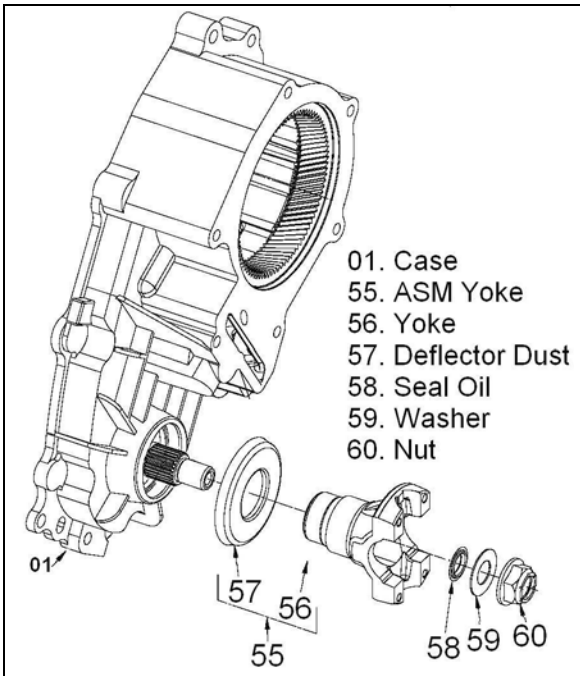
- Remove the coupler from the case.
- Remove Assembly output shaft and gerotor pump.
- Loosen the hose clamp and remove the hose coupling from the pump housing
- Remove hose clamp, hose coupling and strainer

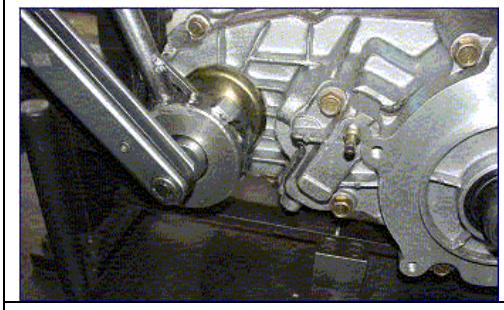
- Slide the Gerotor pump of the

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 	output shaft and remove the output shaft. Gerotot Pump is not serviceable, ifrequired replace pump as assembly.
 	**Disassembly – Reduction Shift Parts** • Remove rail shaft from the case. • Remove the reduction hub and reduction fork assembly from the case • Remove the two shift fork facings from the shift fork assembly, if required.
  	**Disassembly – Electrical Shift Cam Parts** • Remove ASM shift shaft from the case. • Separate Cam, spring, Spacer and shift shaft by pulling outward.
	Disassembly – Yoke & Output Shaft • Holding the end yoke with the yoke holder remove the nut,

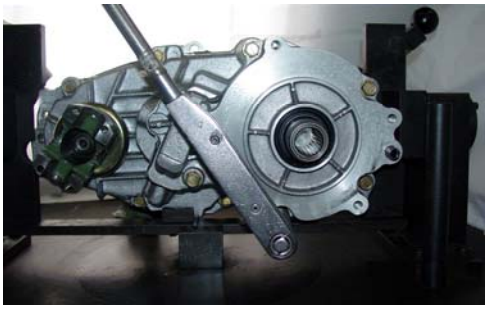
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washer and then pull out the front yoke assembly. Remove seal oil.

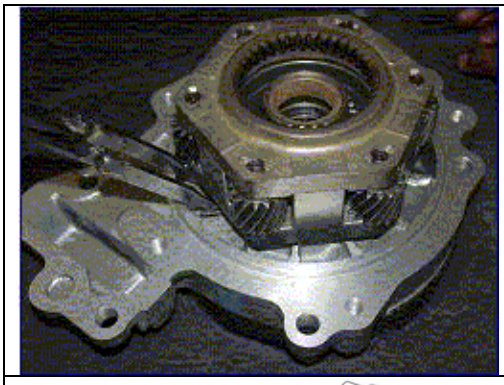
- Remove the out put shaft.
- Press deflector from the yoke only if replacement is required.



Disassembly – Adaptor , Input Shaft & Carrier Assembly

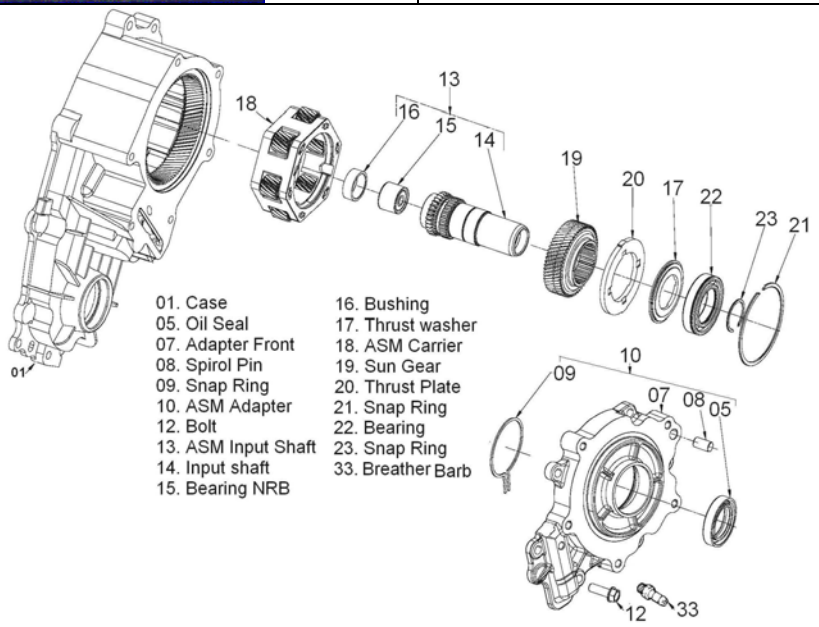
- Remove the breather barb.
- Remove the six bolts of adapter.
- Remove the adapter by separating the adapter sealer bond (pry front adapter, take care not to damage the adapter or the case).
- Remove the adapter assembly, input shaft assembly and carrier gear

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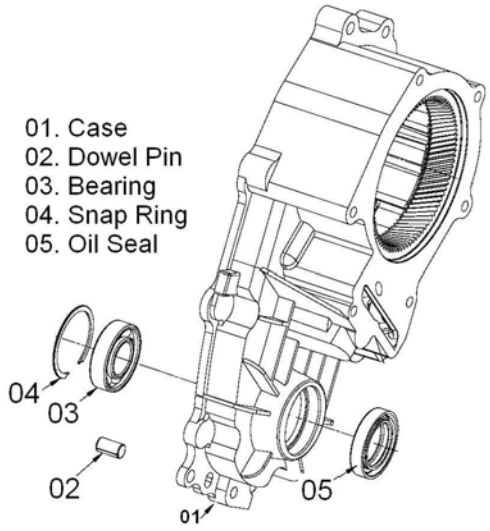
assembly. (Expanding long ends of the snap ring ; separate the carrier and input shaft assembly from the adapter.).

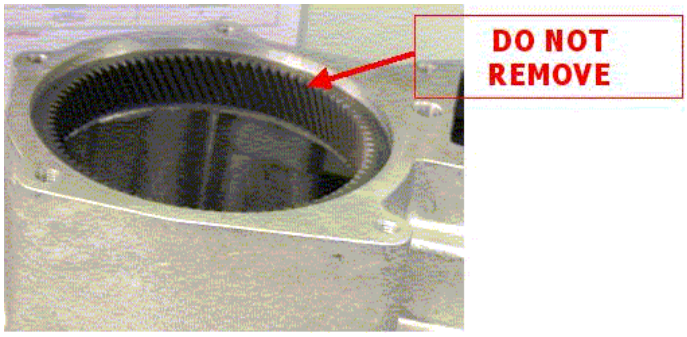
- Remove snap ring and oil seal from front adapter.



1. Remove snap ring and pull out Assembly Input shaft and sun gear from Assembly Carrier.
2. After removing retaining ring, pull out the bearing and thrust washer from input shaft.
3. Remove the needle bearing and sleeve bearing from input shaft assembly, if required.

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Disassembly - Case

- Remove the oil seal.
- Remove the retaining ring and bearing.
- Remove the dowel pins from transfer case, if required.
- Do not remove ring gear from the case.

Cleaning –

Note: Before cleaning, check the magnet for the presence of metal particles, which indicate internal chipping of the transfer case.

- Using a cleaning solvent, clean the old oil and dirt deposits
- After cleaning dry the parts with low-pressure (20 psi maximum) compressed air.
- Lubricate the ball bearings and needle bearing with ATF oil.
- Protect lubricated bearings from dust.

Inspection –

Note: Always replace the hose coupling, O-ring and oil seal with new parts.

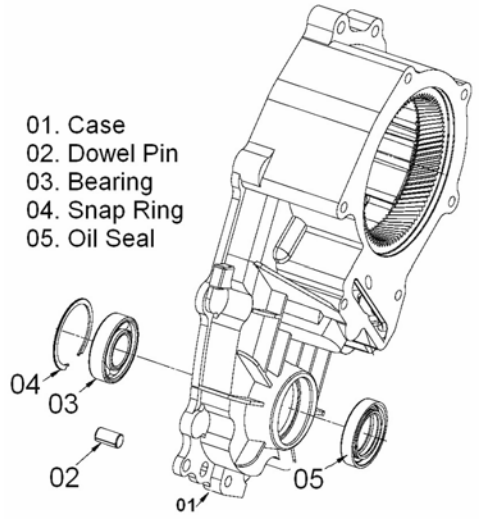
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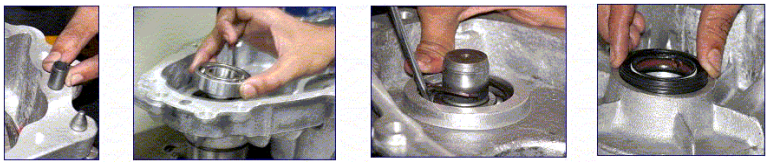
- Visually check all the parts for damage.
- Referring to normal gear tooth face, specifically inspect the uneven wear and chips of gear tooth. Replace or repair if necessary.

Assembly –

CAUTION

Do not use hammer to drive in the oil seal and bearing. Use special tools for assembly.
Use a Torque Wrench to tighten threaded parts.
Torque values are specified in the torque chart.
Lubricate bearings, O-rings, bushings and matching metal parts before assembly (with oil).



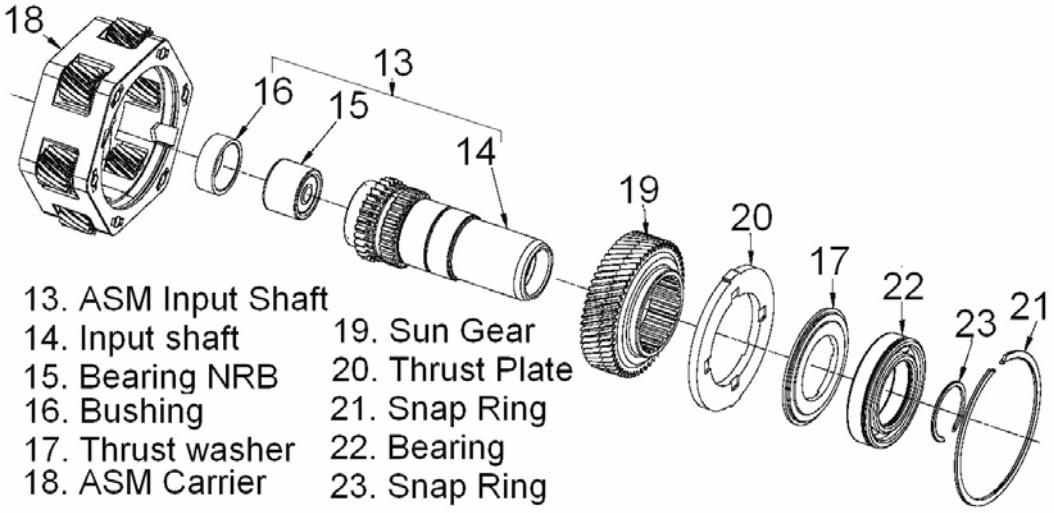


Assembly – Case

- Insert the two new dowel pins.
- Press the ball bearing into the case and install the retaining ring (snap ring).
- Install the new oil seal, by pressing it into the case.

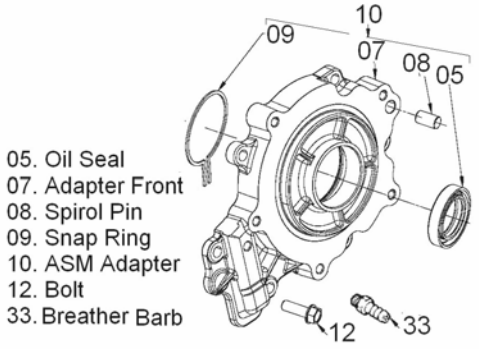
Make sure that all parts are correctly and firmly installed into the case.

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Assembly – Adaptor, Input Shaft & Carrier Assembly

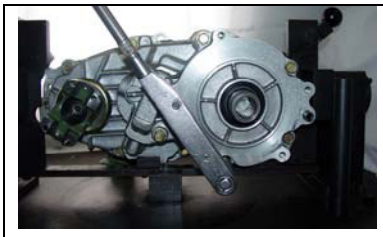
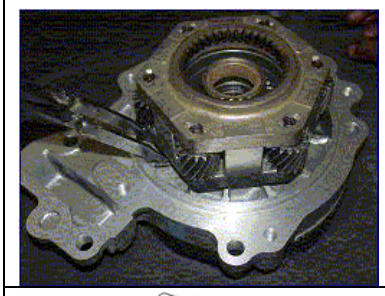
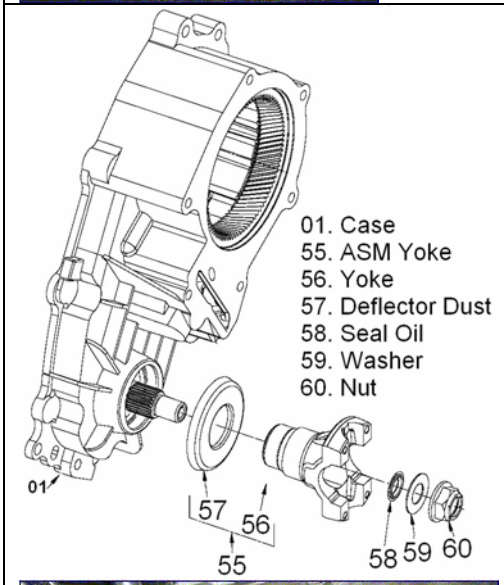
- Press the needle bearing and the new sleeve bearing into the input shaft (if removed).
- Install the sun gear onto the input shaft and put thrust plate, thrust washer and press the bearing onto the input shaft.
- After pressing the bearing, install the retaining ring.
- Insert the above assembly into the planet carrier. (Ensure that planet carrier assembly on the work bench is such that the retaining rings' mounting groove faces upward).
- Install the retaining ring to the planet carrier.

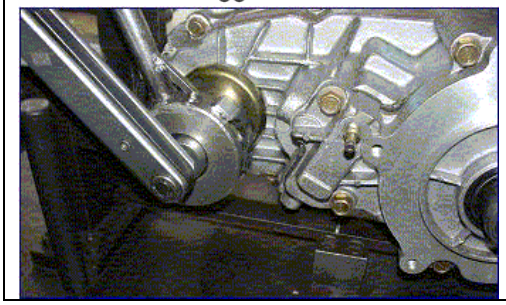


Assembly – Adaptor, Input Shaft & Carrier Assembly

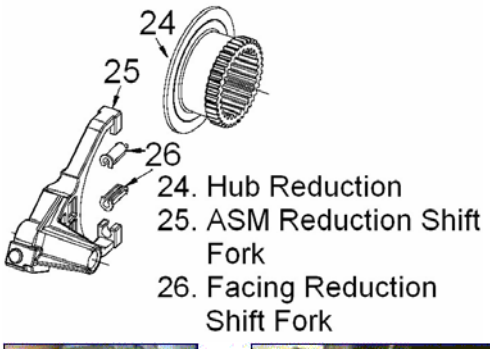
- Press the spiral pin into the front adapter.
- Press the oil seal into the front adapter.
- Invert front adapter assembly. Install snap ring by make sure that snap ring is correctly installed into the groove.
- Position the input shaft assembly over front adapter

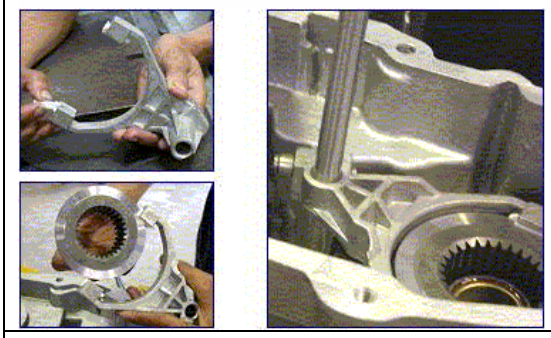
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<table>
<tr>
<td> 
  </td>
<td>and engage into bearing groove by expanding the ends of snap ring (Push Input shaft and carrier assembly in to the front adapter.).
• Apply 1.6 mm bead of sealant on the mounting face for the transfer case and tighten the six bolts.
• Install the breather barb.</td>
</tr>
<tr>
<td> 

  </td>
<td>Assembly – Yoke
• Position the output shaft in transfer case and install the end yoke assembly, seal, washer and nut.
• Holding the end yoke with the help of yoke holder, tighten the nut up to specified torque
• Turn the fixture for further assembly.</td>
</tr>
</table>

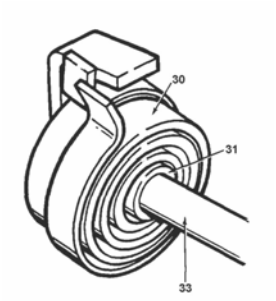
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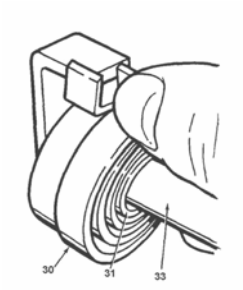


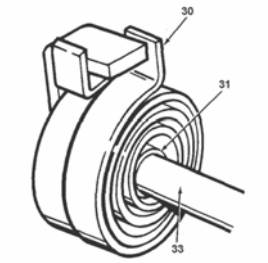


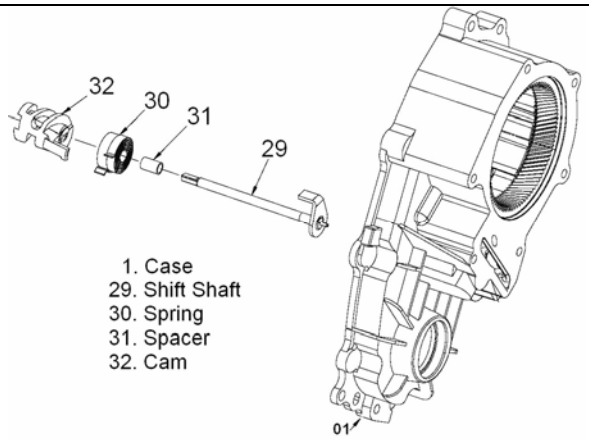
Assembly – Reduction Shift Parts

- Install the two forks facing on the reduction shift fork assembly.
- Install the reduction hub in to the fork.
- Install reduction hub and fork in to the planet carrier.
- Insert shift rail in reduction fork bore, to match with case bore.









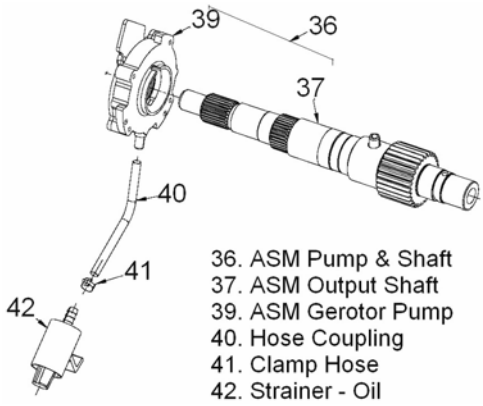
Assembly – Electrical Shift Cam Parts

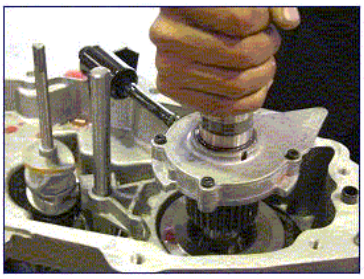
- Insert spacer into torsion spring ,insert the shift shaft into the spacer. Slide electric cam on to the shift shaft.
- Slide the torsion spring and spacer to the right of the shift shaft and

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position the end of the first spring to fix on the drive tang.

- Position the cam on the second spring and rotated anticlockwise. Push the end of the second spring to left with cam and fix it on the drive tang.
- Install the electric shaft cam in to the case.

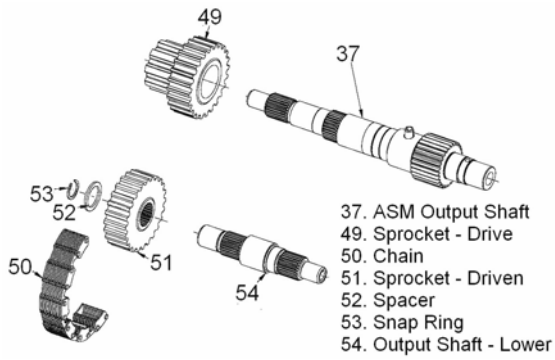






Assembly – Assembly Output Shaft & Gerotor Pump

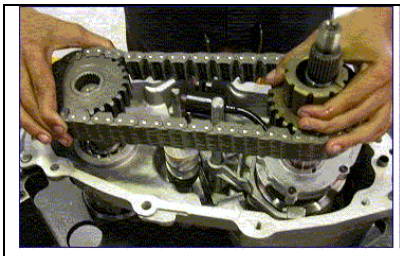
- Align rotor slot of the pump and slot of the pump body in line.
- Slide the pump assembly on the output shaft over pump pin.
- Slip hose clamp over free end of hose coupling with strainer and push onto hose barb on pump and tighten.
- Install the output shaft splines into the reduction hub and engage the output shaft end with input shaft bearing.
- Couple strainer with case and insert the magnet into the transfer case slot.

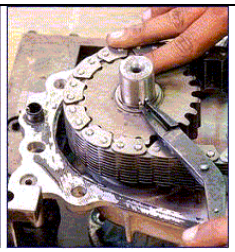


Assembly – Chain Drive

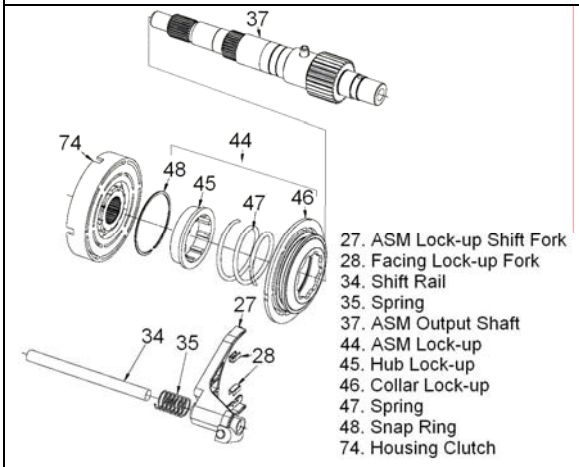
- Position the drive sprocket to the rear output shaft end and driven sprocket to the front output shaft end.
- Install the drive chain onto the sprockets.
- Holding each sprocket with drive chain tight and parallel with transfer case, install the drive chain assembly to the output shafts.

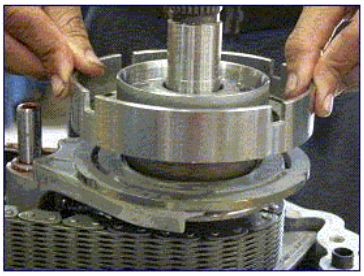
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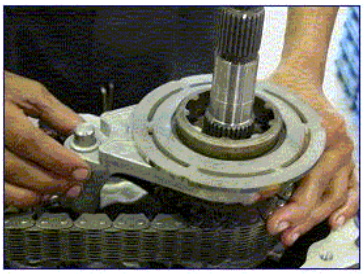




- Rotate the driven sprocket slightly to engage splines on the front output shaft.
- Install the spacer to the front output shaft and insert snap ring into the groove over spacer.



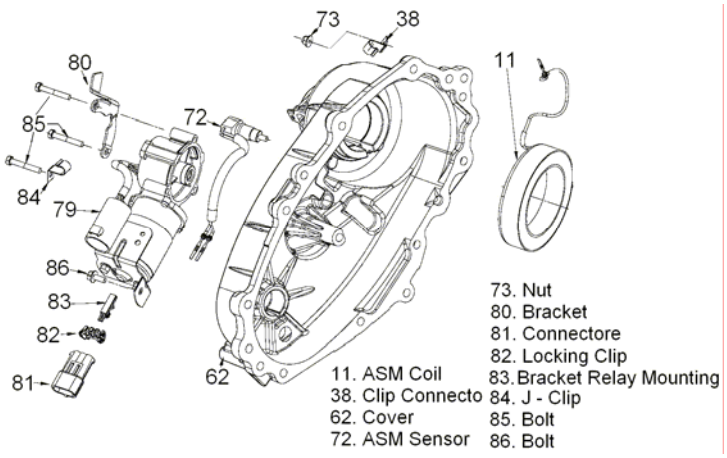




Assembly – Lock-up Shift Part

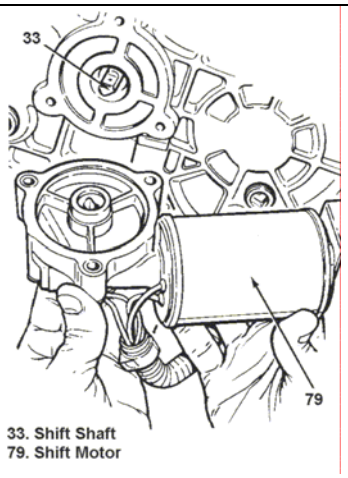
- Install the lockup hub and return spring to the lock up collar and insert the snap ring.
- Install two new facings to the fork.
- Engage the lockup fork in groove in 2WD-4WD lock up assembly and slide this group down over drive sprocket and rail shaft.
- Install clutch housing on out put shaft.
  Apply 1.6 mm bead of sealant on the mounting face of the case.

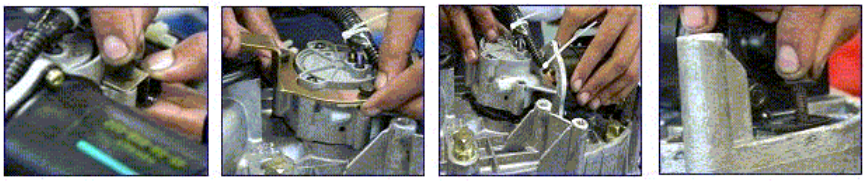
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Assembly – Assembly Cover

- Position the cover with the open end facing up on the table.
- Position the end of needle bearing with the identification mark up and press into the cover (If removed).
- Press the ball bearing in to cover and install snap ring.
- Install the clutch coil assembly inside the cover, put wire bracket and tighten three nuts.
- Install speed sensor assembly to the cover.



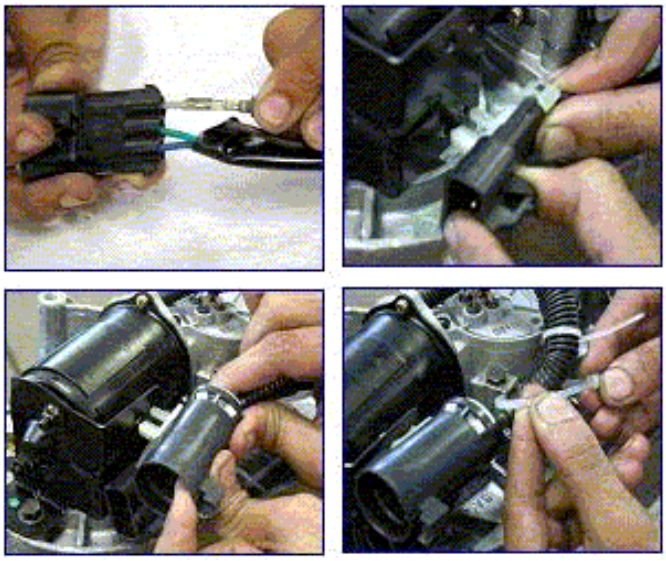


Assembly – Assembly Cover

- Align the cover holes with the transfer case dowel pins
- Align the cover bearings with output shafts
- Align shift shaft with cover boss.

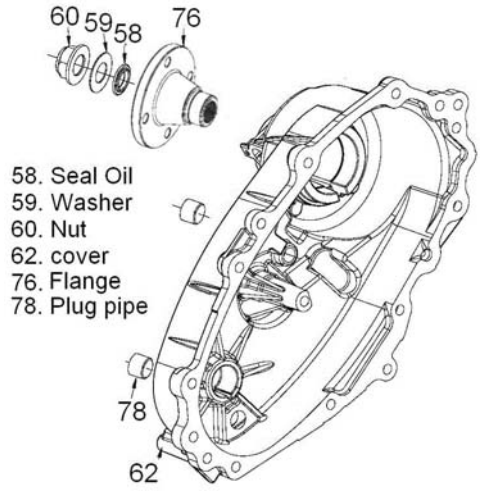
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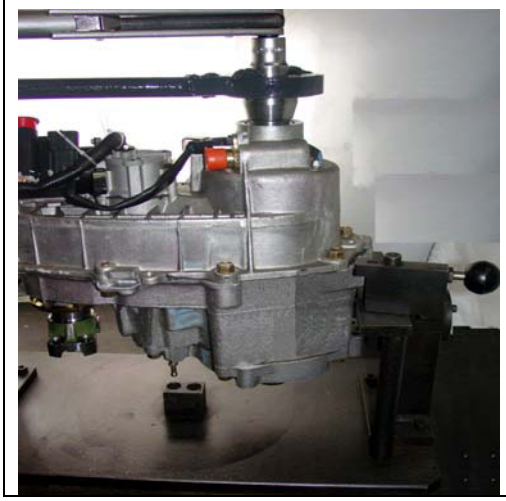
- Align the cover blind hole with rail shaft and make sure that return spring is not cocked.
- Tighten nine bolts positioning identification tag.
- Align the motor with shift shaft and position the motor assembly on to the cover.
- Install the motor to the shift shaft and contact cover. Rotate the motor clockwise direction to check correct engagement.
- Install the bracket to the motor assembly and tighten three bolts.
- Tighten motor bracket bolt.
- Install to oil plug to the cover.



- Pass clutch coil wire through sensor wiring sleeve, connect clutch coil terminal with the connector.
- Install motor connector and sensor connector to the motor bracket.
- Insert wiring in the respective Clip and crimp it properly.
- Install the Speedo gear over output shaft splines in the cover assembly.
- Press the new oil seal into the cover assembly.

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Assembly – Rear Output Flange
Position the circular flange on the upper output shaft in transfer case and install the flange, seal, washer and nut.
Holding the flange, tighten the nut up to specified torque.

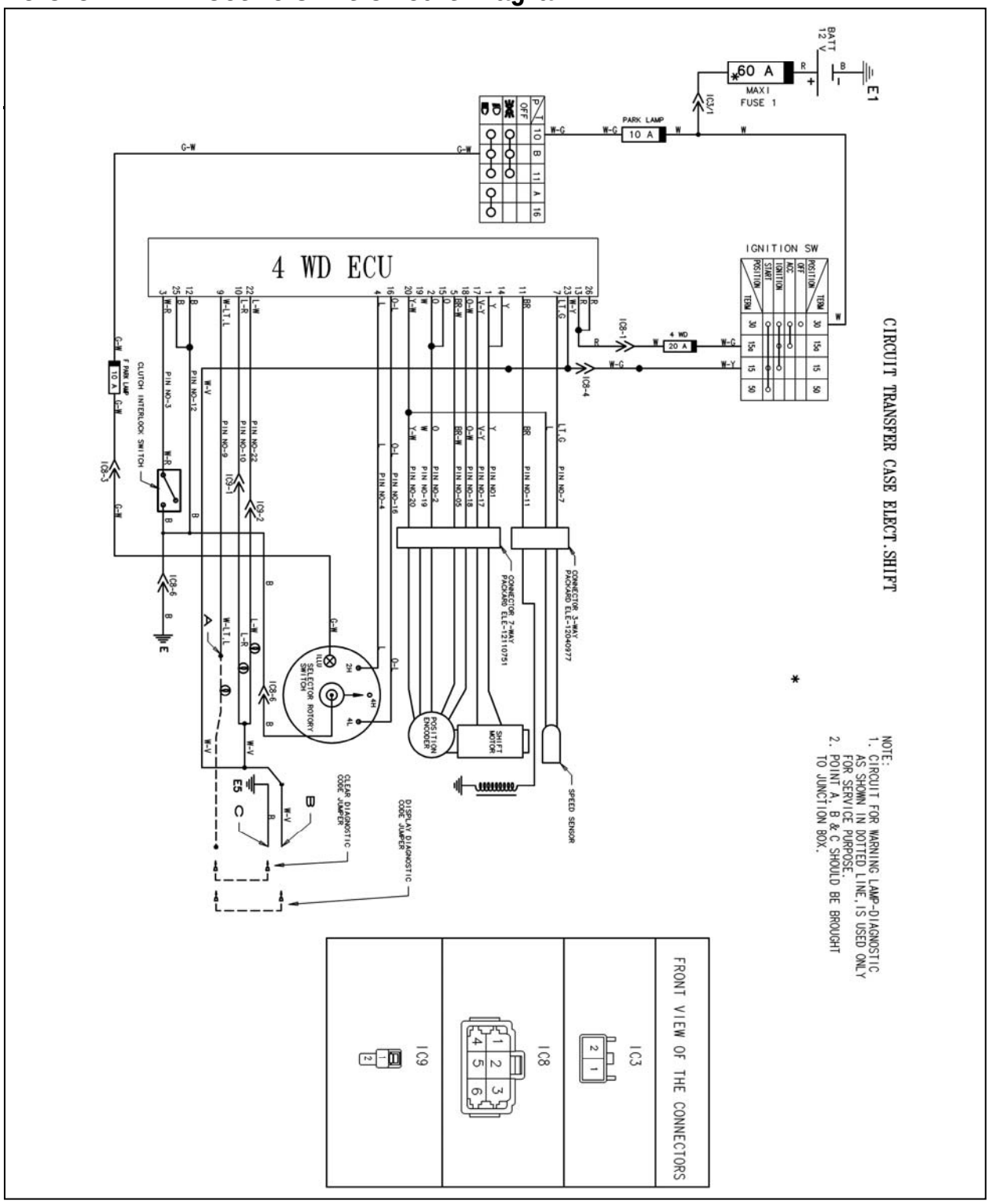
Electronic Control Unit and Self Diagnosis –

- **Electronic Control Unit**

Electronic Control Unit (ECU) is located under the co-driver's seat or under dashboard. Driver operates a selector switch to shift the vehicle from two-wheel drive to four-wheel drive (and vice versa). Shifting is possible during driving (only in 2H to 4H mode).
Interconnections between ECU and other system blocks are as shown in the circuit diagram for Bolero –

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Bolero 4 WD Electric Shift Circuit Diagram –



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Note : In case of malfunctioning in shifting, the 4WD HIGH and 4WD LOW indicator lights will flash, simultaneously.

Self diagnosis of ECU :

ECU detects transfer case system malfunctions and indicates malfunctioning part(s) through flashing indictor lights. The operator will be alerted of fault condition by continuous illumination of both 4WD HI and 4WD LO lights on dashboard when ignition is On.

A service connector is provided to indicate the fault codes in binary. Connect one end to the pin hole number 9 in ECU connector, and other end to the ignition switch. The flashing of indicator light will show the defective code (as illustrated in the table). Identify the malfunctioning part and replace it.

L1	L2	L3	Binary code	Decimal equivalent	Fault with
Off	Off	On	001	1	ECU Module
Off	On	Off	010	2	Shift Motor
Off	On	On	011	3	Synchronizer Clutch
On	Off	Off	100	4	Speed Sensor
On	On	Off	110	6	Selector switch
On	On	On	111	7	Motor Position Switch

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Note –

Before replacing the malfunctioning parts with defective codes, check the wires and connectors for proper condition.

Use only 12v 3-watt bulb for diagnostic purpose.

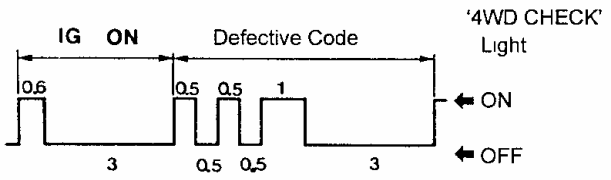
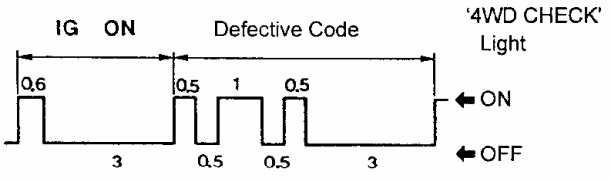
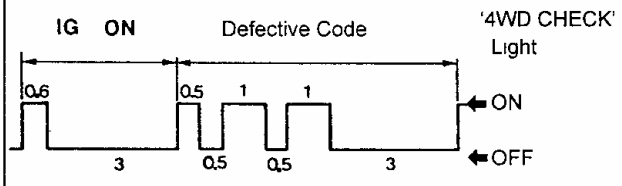
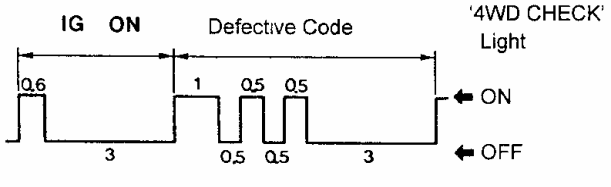
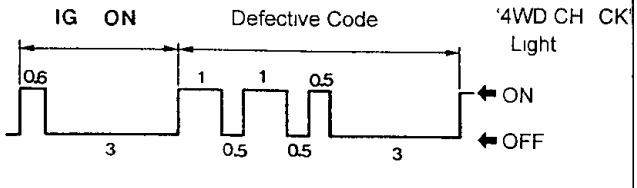
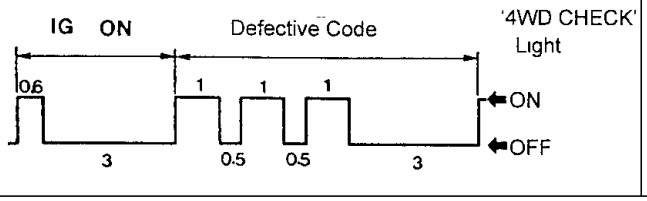
If only one part is malfunctioning, the indicator light will display defective code three times continuously. If more than two parts are malfunctioning, the first malfunctioning part will be displayed three times and then the other malfunctioning parts will be displayed.
After repair, clear the fault stored in the memory. Ground the service connector and keep ignition 'On' for five seconds continuously to erase defective code.

Self diagnosis of ECU –

Connect a service connector as described earlier. Turn the ignition switch On. 4WD CHECK indicator will turn On for 0.6 seconds and turn Off for 3 seconds. Then it will display a defective code 3 times continuously.

The chart for the defect codes is enclosed -----

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No.	Defective Code	Malfunctioning Part
1		E C U
2		Shift Motor
3		Synchronizer Clutch
4		Speed Sensor
6		Selector Switch
7		Motor Position Sensor

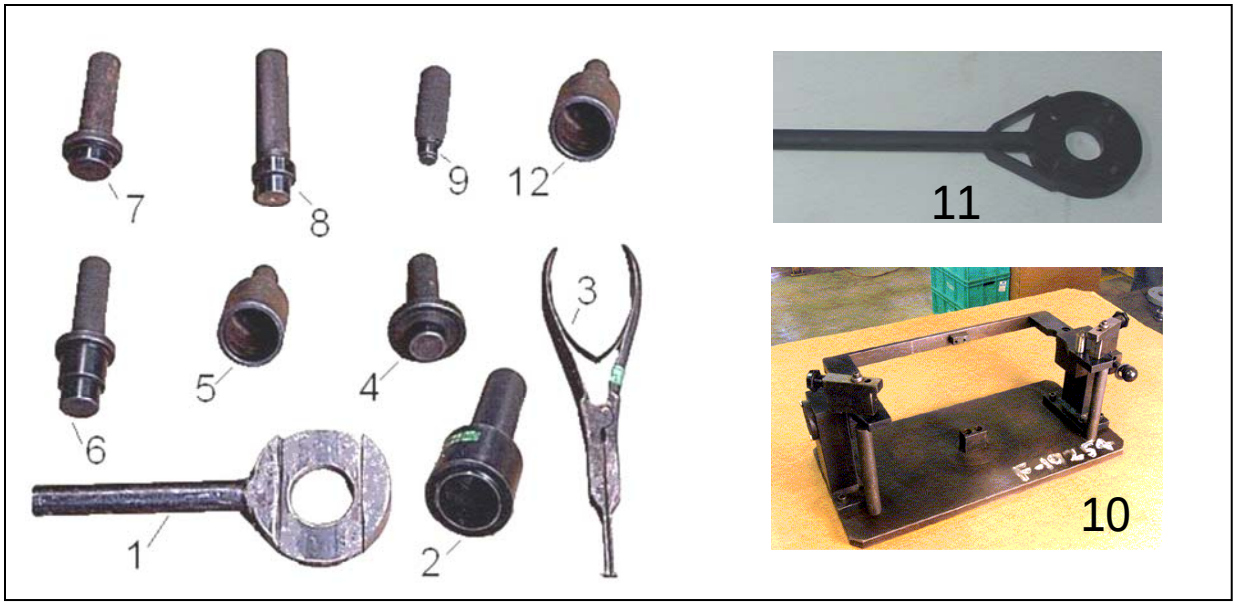
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Tightening Torques –

Bolt location	Torque Values
Level & Drain Plug	35 ± 7 Nm (26 ± 5 lbf-ft)
Flange Nut	365 ± 15 Nm (269 ± 11 lbf-ft)
Front Yoke Nut	225 ± 25 Nm (166 ± 18 lbf-ft)
Case Bolts	35 ± 7 Nm (26 ± 5 lbf-ft)
Motor bolts, and coil nuts	9.5 ± 1.5 Nm (7 ± 1 lbf-ft)
Speedo body bolt	9.5 ± 1.5 Nm (7 ± 1 lbf-ft)
Breather Barb	14 ± 5 Nm (10 ± 4 lbf-ft)

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Special Tools –



Description	Borg Warner Part No.
Yoke Holder - **1**	T-10001
Seal Driver - **2**	T-10003
Snap ring plier Adapter - **3**	T-10007
Snap ring plier - **4**	T-10006
Drift ball bearing - **5**	T-10053
Drift ball bearing Input shaft - **6**	T-10056
Drift NRB fitting Input shaft - **7**	T-10054
Drift Bush fitting Input shaft - **8**	T-10055
Drift NRB fitting Cover- **9**	T-10057
Repair Fixture - **10**	T-10037
Flange Holder - **11**	T-10012
Dust Deflector Press Tool - **12**	T-10188

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Specifications - Transfer Case 4555 (Electrical Shift)

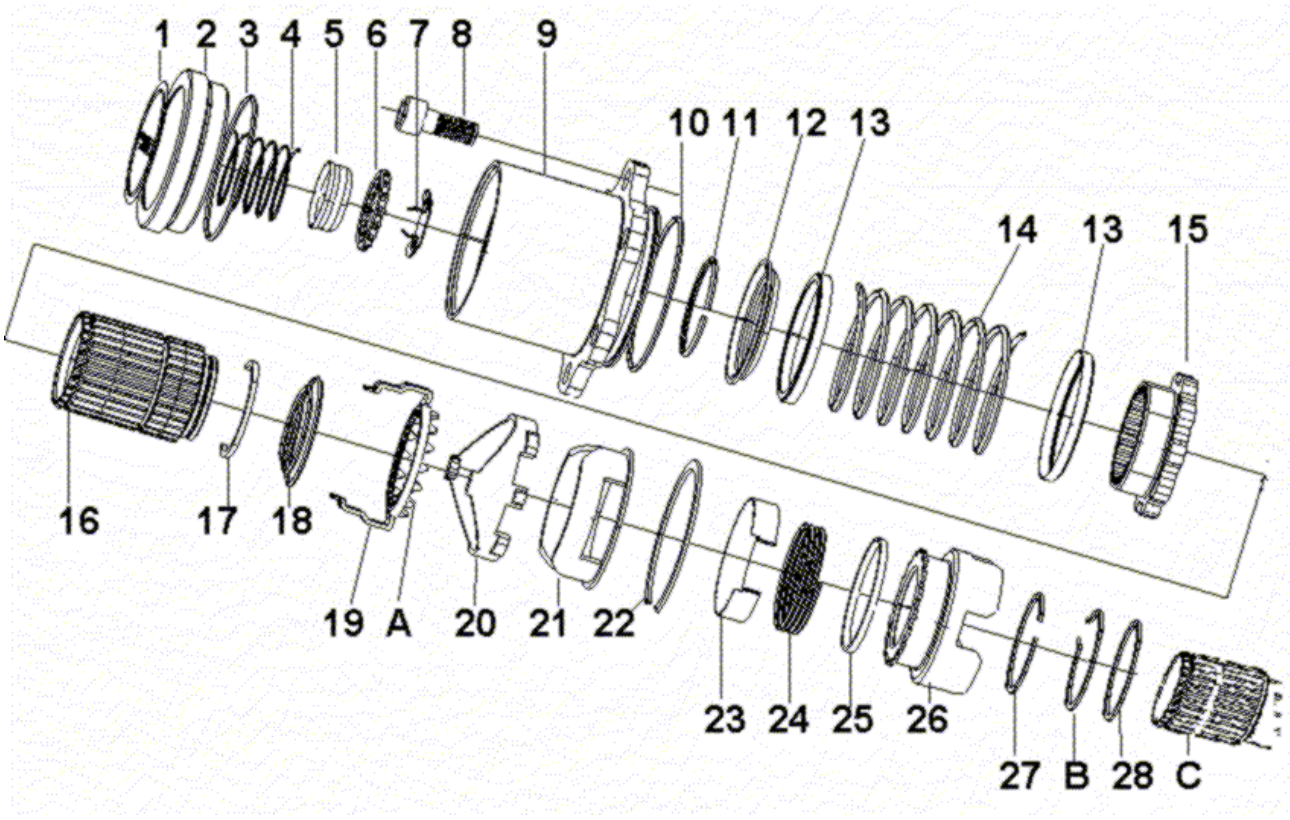
Configuration	Part time, Single Offset
Rear Output Configuration	Circular flange
Front Output Configuration	Fixed Yoke
Input Configuration	Female Splines
Offset hand	Right hand
Lubrication System	Force lubrication by Gerotor pump
Lubricating Fluid Type	Castrol ATF - TQ, IOC- Servo Transfluid A Chemoleium -A HPCL ATF - A
Housing Material	Aluminum
Dry Weight in Kgs.	29.5 Kgs. Approx.
Fluid Capacity in liter	1.2 Approx.
Shift Pattern	2H – 4H – 4L
Shift Control	Selector Switch
4WDH Shift –on the Fly	Yes

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Automatic Locking Hub –

When 4-wheel drive is selected, the automatic hub locks the axle shaft to the wheel hub. This occurs when the vehicle is driven in either forward or reverse direction. The hub unlocks when 2-wheel drive is selected, and the vehicle is driven in the opposite direction for a few feet.

Construction –



The 4 Tanged washers are held in place on the Wheel Spindle. The cut-outs on the drag sleeve (26) fit over the tangs on the washer, preventing the drag sleeve from rotating. The brake band (24) fits over the serrated portion of the drag sleeve. The tangs of the brake band are fitted through the window in the steel inner cage (21). The plastic outer cage (20) fits over the inner cage. Each tang of the brake band fits through each cutout in the outer cage. The cam follower (19) is attached to the clutch gear (15). The follower profile on the cam follower (A) ride against the cam faces or ramps of the steel inner cage. The clutch gear slides on the splines

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on the out side the hub sleeve (16). The axle shaft(C) is splined to the inside of the hub sleeve. The large teeth on the outside of the clutch gear can engage the teeth inside the outer clutch housing (9).The outer clutch housing is bolted to the wheel hub. An End Cap (2) fits over the hub lock assembly. The end cap contains a bearing assembly (6) that supports the other end of the hub sleeve. The End Cap is fitted with an Aluminium Decorative Plate(1) for better aesthetics.

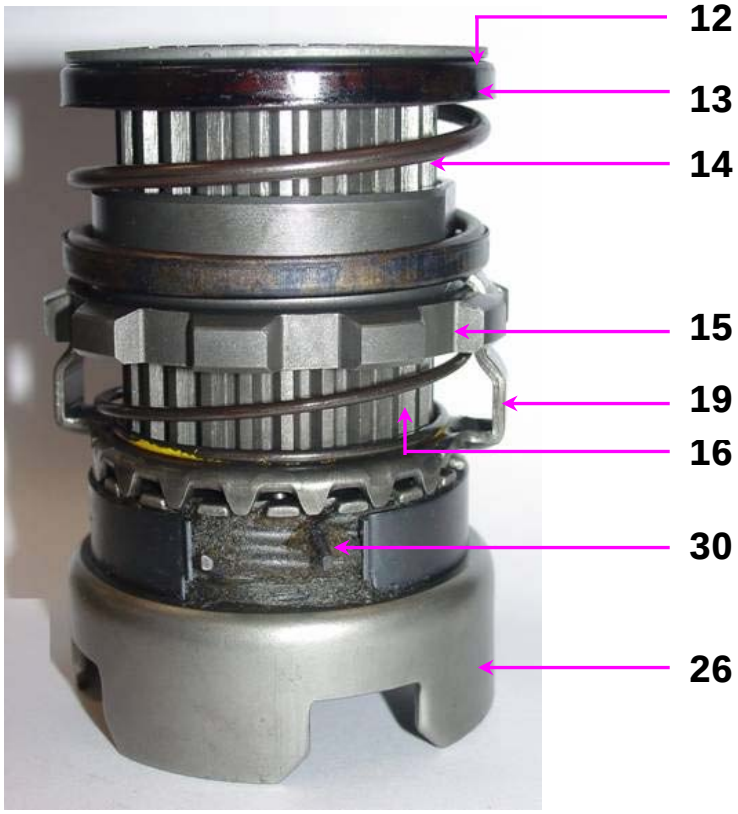
Briefly, this is what happens when the hub locks -
The clutch gear (15) and cam follower (19) rotate up the cam face of the inner cage (21). This causes the clutch gear to move outward on the hub sleeve (16). The out side teeth of the clutch gear engage the inside teeth of the outer clutch housing (9), locking the wheel hub to the axle shaft.
When the hub un-locks,

The clutch gear and cam follower rotate in the opposite direction, back down the cam face of the inner cage. Spring pressure forces the clutch gear inward, unlocking the wheel hub from the axle shaft.

Operation –

Now, let's see how the hub operates in detail. When 4-wheel drive is engaged (and vehicle starts to move), the axle shaft starts to turn the hub sleeve (16), clutch gear (15) and cam follower (19). The steel inner cage (21) and plastic outer cage (20) also start to turn. (Remember, the drag sleeve (26) is fixed to the wheel spindle and doesn't rotate) When the inner cage window hits the first brake band tang (30) the band tightens up on the drag sleeve. This stops the inner cage. The cam follower (19) is forced up the ramp of the inner cage (21).

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As the cam follower moves up the ramp of the inner cage, it is moved outward along the hub sleeve (16), pushing the clutch gear (15) into engagement with the outer clutch housing. The cam follower (19) also pushes against the lugs of the outer cage (20). The outer cage tang contacts the second brake band tang (30). This unlocks the brake band and allows it to turn freely on the drag sleeve serration's.

When 2-wheel drive is selected to disengage the hubs, and the vehicle is driven in the opposite direction for a few feet, the rotating front wheel turns the outer clutch housing, clutch gear (15) and cam follower (19) in

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the opposite direction. The cam follower moves down the ramp of the inner cage (20). The return spring (14) pushes the clutch gear (15) along the hub sleeve (16) and out of engagement with the outer clutch housing.

Trouble shooting –

Symptoms	Causes	Remedial Action
Oil Leakage Make sure that a suspected oil leak is actually coming from the hub. Oil leaks can originate in the axle shaft (oil seal).	A cracked or porous or improper fitment of protective end cap. Damaged or missing "O" rings. Incorrectly installed or damaged sealing ring of the End Cap and outer clutch housing.	Replace the end cap. Fit a new 'O' ring. Fit properly
Does not engage or Disengage. Before disassembly of a locking hub, be sure the problem is caused by the hub and not another component in the drive train.	Transfer case not engaging or disengaging front axle shaft. Viscosity of front differential lubricant too high (i.e. due to cold weather). Front differential pre-load too high. Seized front axle shaft bearing.	Rectify Check & fill proper lubricant. Rectify Rectify / Replace

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Noisy Operation –

A broken or missing 4 tanged washer can cause problems in 2 or 4 - wheel drive.
A broken or missing washer will allow the drag sleeve to rotate with the brake band . If the hub are not engaged , the brake band is unable to lock on the drag sleeve and initiate the locking action of the clutches. If the hubs are engaged, the brake band can not be released to allow the clutch gear to disengage.
A broken or missing brake band cannot lock the inner cage to engage the hub or be unlocked by the outer sleeve to allow the clutch gear to disengage.
If both brake band tangs are touching the centre post of the outer sleeve, there cannot be proper locking or unlocking action of the brake band through the movement of the inner cage and outer cage. The centre post of the outer cage and the window of the inner cage move relative to each other when the hub is locking or unlocking. If the cages are not rotating freely over each other, the hub may fail to engage or disengage.
A sticking clutch gear can cause the hub to bind in either the engage or the disengage position. A broken return spring will cause the hub to remain in the engaged position.
In each case, the defective component should be replaced with the correct part or assembly. Always check the most recent parts list for the correct part numbers and available assemblies for the type of the hub you are servicing.

<u>Lubrication</u> –

The automatic hub lock should be lubricated at every 40000 Kms.

- Remove drag sleeve assembly and keep aside, DO NOT lubricate drag sleeve assembly as it is permanently lubricated with **Darmex** grease.

- Check the brake band and drag sleeve serration for presence of appropriate quantity of grease and wear, in case of insufficient grease, replace the drag sleeve.

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- DO NOT remove the brake band as this could change the spring tension and affect hub operation.

- All components except drag sleeve assembly and outer bearing race assembly are lubricated by dipping them in automatic transmission fluid. Allow excess fluid to drip off before assembling the hub.

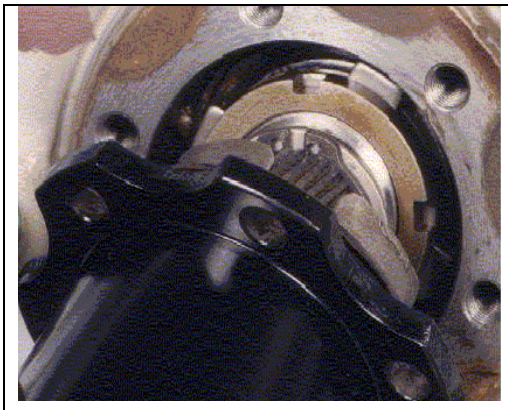
- Lubricate the outer bearing race with light wheel bearing grease. DO NOT use axle grease.

Removal & Installation of Automatic Locking Hub –

Removal –

	Loosen the end cap with the help of pin spanner
	Remove 6 nos. bolts

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	Pull out ALH from the wheel hub.

Installation of Automatic Locking Hub –

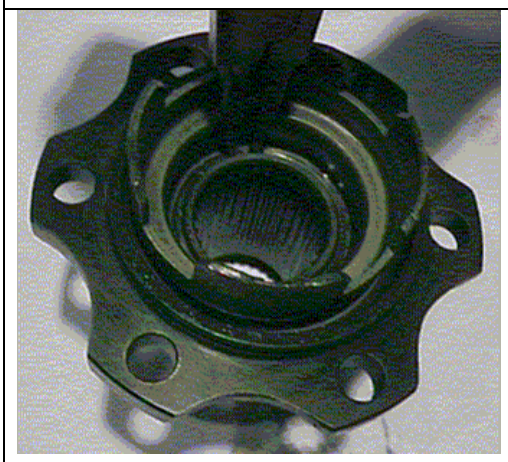
1. Make sure that the snap ring and spacer is installed on the axle shaft.
2. Make sure that the slots on the Drag Sleeve are engaging with the 4-tanged washer. Install the Hub Lock in the wheel hub.
3. Rotate the Hub Lock to match the threaded holes of the wheel hub. Put 6 nos. bolts face to face.
4. Tighten 6 nos. bolts with the help of special Allen key to 5.5 to 6.5 kg-m torque using Torque Wrench.
5. Tight the end cap with the help of pin spanner.

Disassembly of Automatic Locking Hub –



Remove the end cap and bearing race spring. Remove the bearing inner race and retainer.

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	Invert assembly vertically so the drag sleeve comes up.
	Remove the snap ring with suitable plier. Exercise caution while removing the snap ring.
	Remove the drag sleeve with brake band. To lift out the drag sleeve, rotate it slightly to release the brake band tangs from the sleeves and tilt it up on the side opposite the tangs.
Note the position of the components for correct assembly.	
	The clip doesn't need to be removed for the normal servicing. However, if it's damaged, remove it using thumbnail force only to avoid stretching or distorting it. **Do not remove the brake band for normal servicing.**
	Remove the large snap ring from the outer clutch housing.

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	Remove the steel inner cage by pressing it over the tang of the outer cage (in the window). Lift the inner cage straight out, don't tilt it.
	Remove the plastic outer cage by prying one lug out of the large groove in the outer clutch housing. Hold the lug and go on to the next one. It's easiest to start with the lugs opposite the one that fits into the window of the steel inner cage.
	Slide the cam & follower assembly out of the outer clutch housing.

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Cleaning –

- Using a cleaning solvent, clean the all the parts except DRAGE SLEEVE since it is permanently lubricated with **Darmex** grease.

- After cleaning dry the parts with low pressure (20 psi maximum) compressed air.

- Lubricate the bearings race with light wheel bearing grease and cam & follower assembly with ATF oil. Protect lubricated parts from dust.

Inspection –

- Visually check all the parts for damage.

- Examine the protective end cap for cracks, O - ring.

- Brake band for damage or distortion.

- Also, inspect the teeth on the cam follower, clutch gear and outer clutch housing for wear or damage.



When diagnosing a “ratcheting” hub, remember that the noisy hub is “NOT” always the defective one. It depends on whether the hubs have just been disengaged. Let’s examine why.
If only one hub disengages after 2-wheel drive is selected, the faulty hub transmits the wheel rotation to the axle shaft. The mechanical situation is like a conventional axle raised off the ground. The axle shaft drives the differential pinions through the side gear. The ring gear and cage are not turning, so the other side gear and axle shaft are driven in the opposite direction to the first one. The axle shaft tries to engage the hub against the direction of the wheel rotation, causing the noise from the hub. In this case, the faulty hub is not making the noise. The non-noisy hub should be checked. If 4-wheel drive is selected and only one hub engages, there may not be any noise from the hub, depending on the malfunction. The only

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symptom might be a loss of drive at that hub. If the hub is “ratcheting” in 4-wheel drive, it should be inspected.

Assembly –

Following assemblies are to be replaced as sub-assemblies only-- **(if replacement is needed)**



Assembly Cam & Follower



Assembly Drag Sleeve

	Install the cam & follower assembly into the outer clutch housing from the inside.

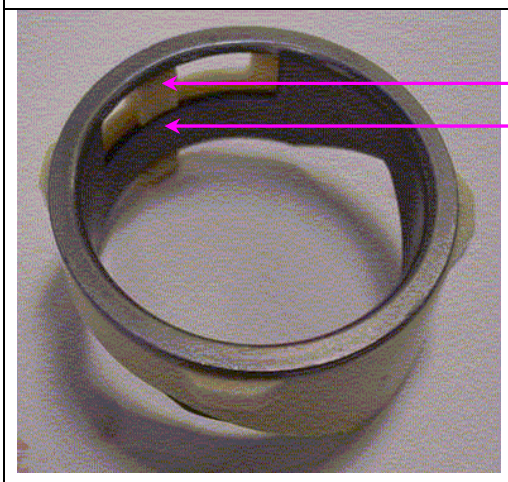
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Install the plastic outer cage into the large groove in the outer clutch housing. The cage may be easier to install if the tangs on the each side of the cutout are installed first.



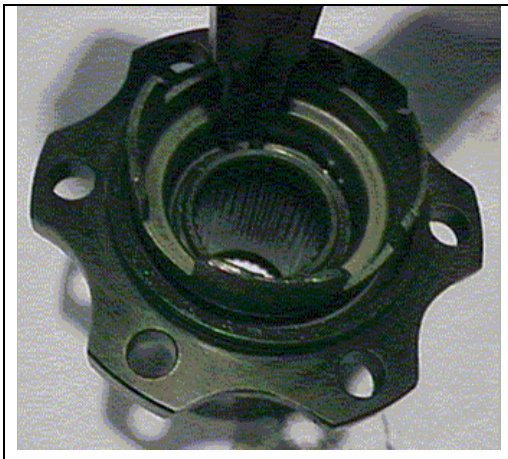
Install the steel inner cage inside the plastic outer cage. (For clarity, the cages on the right are shown outside the hub.) The window (A) must engage the tang (B) of the outer cage for correct positioning.

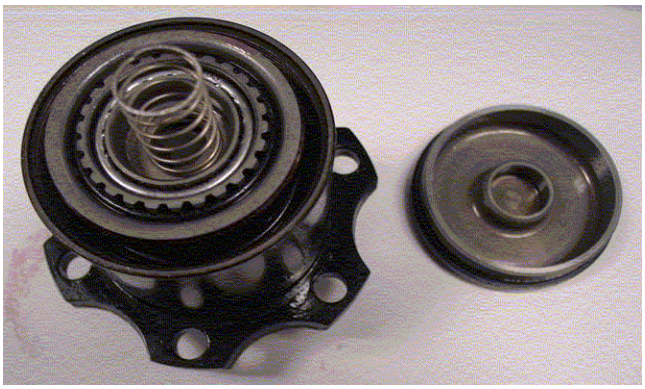
Install the large snap ring in the top groove of the outer clutch housing.



Install the drag sleeve assembly in the inner cage, so that the tangs of the brake band are located on each side of the outer cage tang (C)and in the window of the inner cage. Tilt the drag sleeve slightly to engage the tangs, but be careful not to cock the hub sleeve.

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	Install the snap ring to the hub sleeve.



Install the outer bearing assembly, with the retainer and bearing facing the interior of the hub and the cap facing out.

Install the assembly end cap with the bearing race spring.

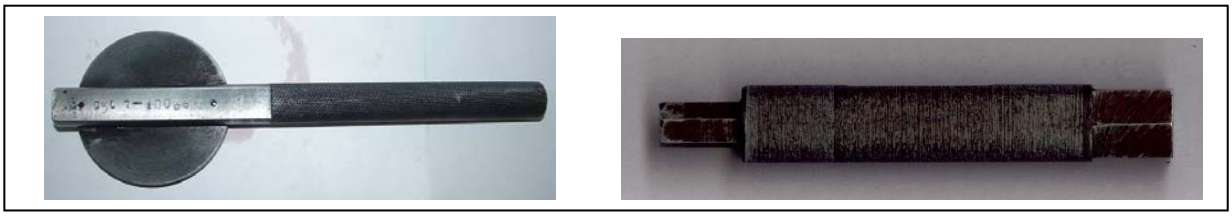
	Ensure that the ALH is in 'Unlock ' mode while installing on the wheel hub.

Tightening Torques –

Description	Torque Value
Allen Bolts (6 Nos.)	59 ± 5 Nm (43 ± 4 lbf-ft)

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Special Tools –



Description	Borg Warner Part No.
Pin Spanner - **1**	T 10068
Special Allen for M10 Bolts - **2**	T 10099

Specifications –

Input Configuration	Female Splines
Output Configuration	Bolted Flange (M10 X 25MM, 6Nos.Bolts)
Location	74 mm dia and 'O' Ring for water resistance
Working Principle	Automatic Locking
Projected Length over from the face of the wheel hub	74.0 mm (Nominal)
Lubricant : **Assembly Drag Sleeve -** **Assembly Cam & Follower-** **Assembly Bearing Race -**	 Darmex grease ATF Castrol -TQ or Dexron II Light wheel bearing grease
Locking & Unlocking in degrees	90^0 Deg. (Clockwise & Counter Clockwise)
Gross Weight	1.75 Kgs. Approx.
Appearance	Black Powder Coated with Aluminium Decorative Plate

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Propeller shaft

Content

Propeller Shaft SUV

Propeller Shaft SC/DC

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Propeller Shaft SUV

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Description -

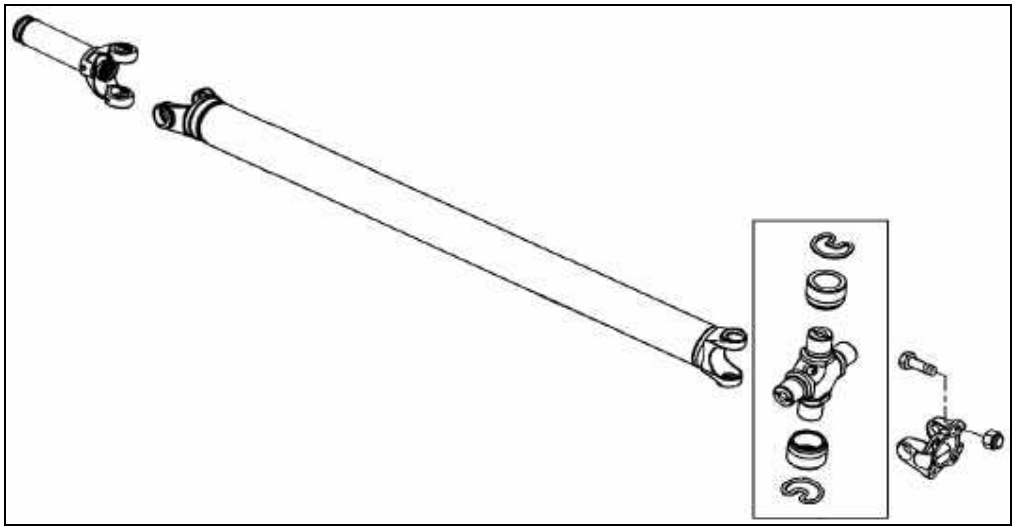
The function of the propeller shaft is to transmit power from one point to another. The shaft is designed to transmit torque from transmission / transfer case to the axle.

The propeller shaft has to operate through constantly changing length while transmitting torque. The axle rides suspended by spring in floating motion. The propeller shaft must be able to change the transmission angle when going through the various road surfaces. This is done through Universal joints which permit the propeller shaft top operates at different angles. The slip joint or the yokes allow the contraction or expansion of the propeller shaft thus allowing the length to change.

The Propeller shaft used on Scorpio VLX is single type with one companion flange & the yoke with slip joint enters in the transmission.

The sealing at the transmission end is achieved using an oil seal. When the propeller shaft is removed from the transmission end some amount of transmission oil is expected to come out. This is normal.

The view of the propeller shaft is shown below -



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Trouble shooting -

Tyres that are out of round or wheels that are out of balance cause a low frequency vibration.
Brake drums that are unbalanced cause a harsh low frequency vibration.
Driveline vibrations can also result from loose or damaged engine mountings.

Propeller shaft vibrations will keep on increasing as the vehicle speed increase. The propeller shaft does not cause a vibration that is present only in a narrow speed range.

Drive condition	Possible cause	Correction
Propeller shaft	1. Undercoating or other foreign on the shaft. 2. Worn out yoke/slip joint. 3. Excessive run out. 4. Incorrect drive line angularity. 5. Worn UJ bearings. 6. Propeller shaft damaged or bent. 7. Excessive run out or unbalanced condition. 8. Excessive pinion shaft run out.	✓Clean exterior of shaft & wash with solvent. ✓Replace the joint/yoke. ✓Check run out- replace shaft. ✓Correct angularity. ✓Replace the UJ. ✓Replace the propeller shaft. ✓Re-index the propeller shaft by 180°, test and correct as required. ✓Re-index the propeller shaft by 180°, test and correct as required
Universal Joint Noise	UJ worn out	✓Replace the UJ

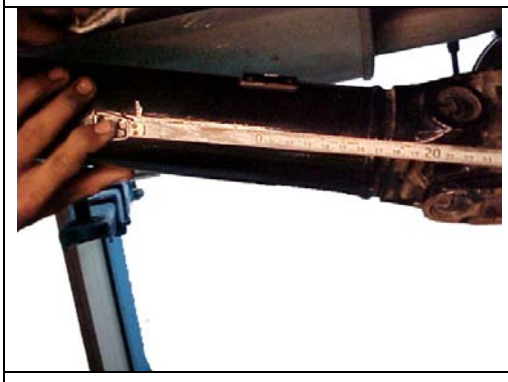
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In Car Repairs -

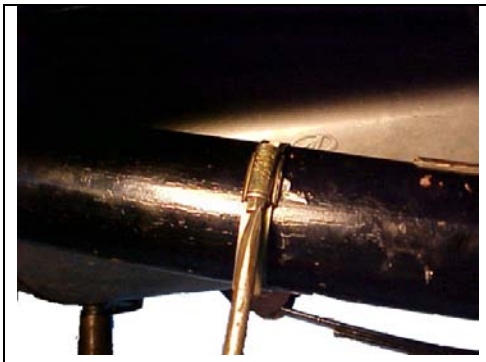
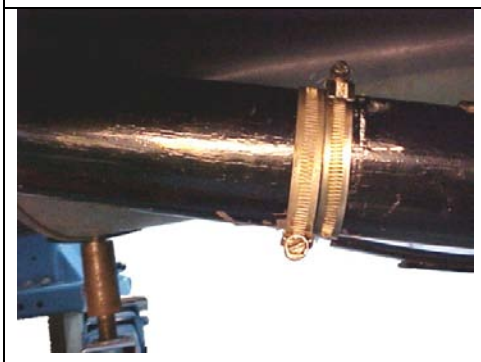
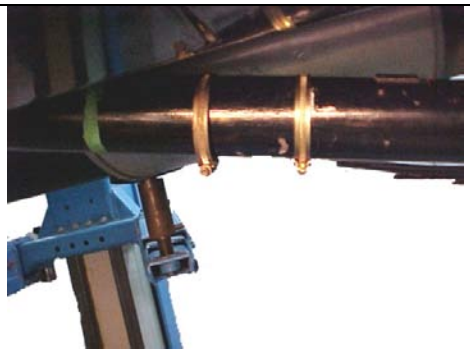
Unbalance -

If the propeller shaft unbalance is suspected then it can be verified by the following procedure.

Removing & rendering the propeller shaft by 180° may eliminate some vibrations.

	Clean all the foreign material from propeller shaft and the universal joint.
	Inspect the propeller shaft for missing balance weight, broken welds and bent areas. If the propeller shaft is bent then it must be replaced.
	Ensure that the propeller shaft is not worn, are properly installed and are correctly aligned with the propeller shaft
	Check the companion flange mounting bolts.
	Raise the vehicle.
	Remove the wheel & tyres.
	Install the wheel nuts to lock the brake drum.
	Mark & number the shaft 6 inches from pinion end at four positions 90° apart.
Run and accelerate the engine until vibration occurs. Note the intensity & the speed at which the vibration occurs.	

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	Install a screw clamp at position “1”
Start the engine and recheck for vibrations. If there is little or no change in vibrations then move the clamp or of the other 3 positions.	
If there is no difference in vibration at the other position then the vibration is not due to the propeller shaft imbalance.	
	If the vibration decreases, install a second clamp and repeat the test.
	If the clamps cause an additional imbalance, separate the clamp (¼ inch above & below the mark.). Repeat the vibration test.
	Increase the distance between the clamps until the vibration is at the lowest level.
	At this position bend the slack end of the clamp so that it does not loosen.
	Install the wheel & tyres. Lower the

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	vehicle.
If the amount of the vibration remains unacceptable then repeat the exercise at the Gearbox end.	

Run out

	Remove dirt, rust, paint & undercoating from the propeller shaft surface.
	The dial indicator must be installed perpendicular to the shaft surface.
	Measure the run out at the center and at the ends - away from the weld.
Replace the propeller shaft if the run out is beyond the specified limit.	

Care of the system -



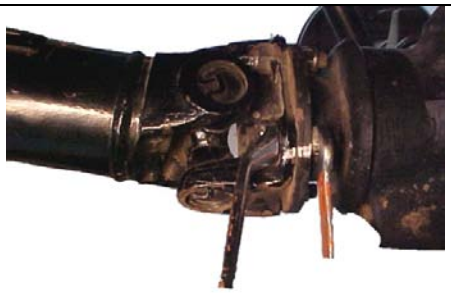
Before undercoating a vehicle with any underbody protection; the propeller shaft and the UJ's should be covered. This will prevent the undercoating from causing an unbalanced condition and vibration.

Use the exact replacement hardware for attaching the propeller shafts. The specified torques must always be applied when tightening the mounting bolts.

Repairs --

	Lift the vehicle

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	Put aligning marks on the flange, UJ and propeller shaft before removal. Do not use a punch to mark impression.
	Remove the mounting bolts at the pinion end
	It is important to protect the machined, external surface of the yoke from damage after propeller shaft removal. Any damage in the machined surface will lead to damage of the seal and cause a leak.
	Remove the cir clips holding the UJ in place.
	Applying the socket wrench on the outside of the propeller shaft flange, force out one end of UJ using a vice as shown. (One end 32 mm socket to receive other end 21-mm socket to push.)

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	While assembling- insert both ends then hold & press fit them with special tool.

Tightening Torque -

Location	Torque Nm (lb-ft)
Companion Flange nuts at Axle end	60.5 ±5.5 Nm (45 ± 4 lb-ft)

Propeller Shaft SC/DC

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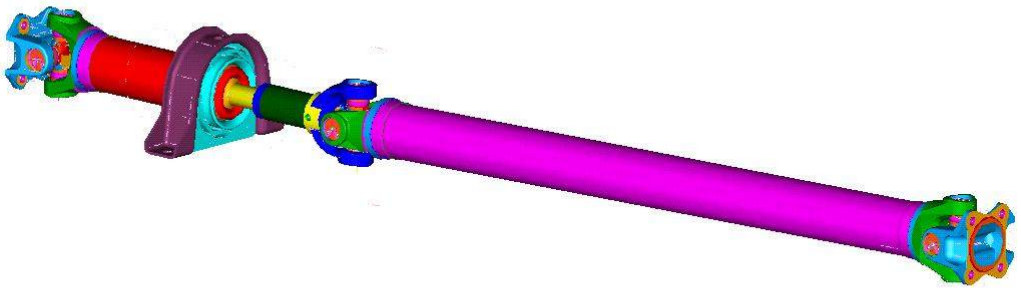
Description

The function of the propeller shaft is to transmit power from one point to another. The shaft is designed to transmit torque from transmission / transfer case to the axle.

The propeller shaft has to operate through constantly changing length while transmitting torque. The axle rides suspended by spring in floating motion. The propeller shaft must be able to change the transmission angle when going through the various road surfaces. This is done through Universal joints which permit the propeller shaft top operates at different angles. The slip joint or the yokes allow the cotntratction or expansion of the propeller shaft thus allowing the length to change.

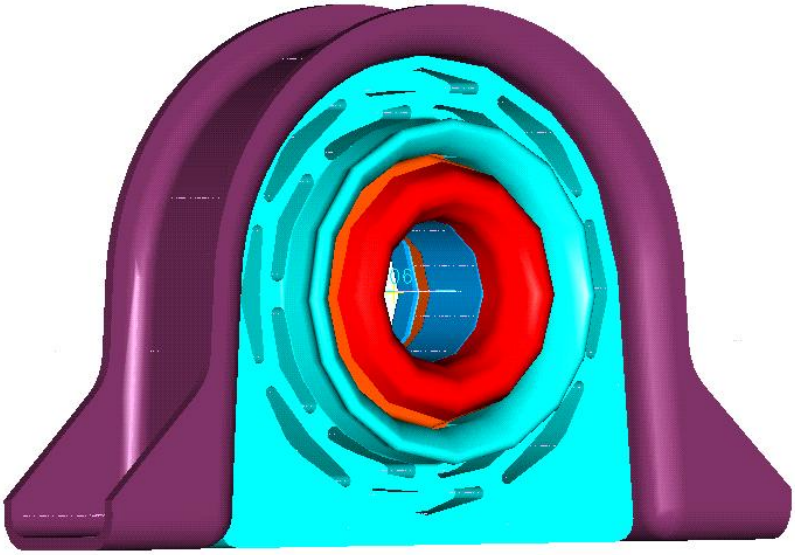
The propeller shaft is built with the yoke lugs in line with each other, which is called phasing. This design produces the smoothest running condition. An out of phase shaft can cause a vibration.

The propeller shaft is 2 piece with a centre bearing construction.
The view of the split propeller shaft is shown below.



The details of the centre bearing are shown below.

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While assembling the split propeller shaft –

1. Locate the centre bearing assembly- keep the bolts loose in the slot of the chassis.
2. Locate & tighten the propeller shaft flange at the gearbox end.
3. Tighten the centre bearings mounting bracket bolts.
4. Fit the rear propeller shaft.

This procedure is important; in order to avoid straining the centre bearing Failure to do so will result in transmission noise and premature failure of the centre bearing

Trouble shooting –

Tyres that are out of round or wheels that are out of balance cause a low frequency vibration.
Brake drums that are unbalanced cause a harsh low frequency vibration.
Driveline vibrations can also result from loose or damaged engine mountings.

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Propeller shaft vibrations will keep on increasing as the vehicle speed increase. The propeller shaft does not cause a vibration that is present only in a narrow speed range.

Drive condition	Possible cause	Correction
Propeller shaft	1. Undercoating or other foreign on the shaft.	Clean exterior of shaft & wash with solvent.
	2. Loose companion flange mounting bolts.	Tighten the mounting bolts.
	3. Worn out yoke/slip joint.	Replace the joint/yoke.
	4. Excessive runout.	Check runout- replace shaft.
	5. Incorrect drive line angularity.	Correct angularity.
	6. Worn UJ bearings.	Replace the UJ.
	7. Propeller shaft damaged or bent.	Replace the propeller shaft.
	8. Broken rear springs.	Replace the rear springs.
	9. Excessive runout or unbalanced condition.	Reindex the propeller shaft by 180°, test and correct as required.
	10. Excessive pinion shaft runout.	Reindex the propeller shaft by 180°, test and correct as required
Universal Joint Noise	UJ worn out	Replace the UJ

In car repairs –

Unbalance

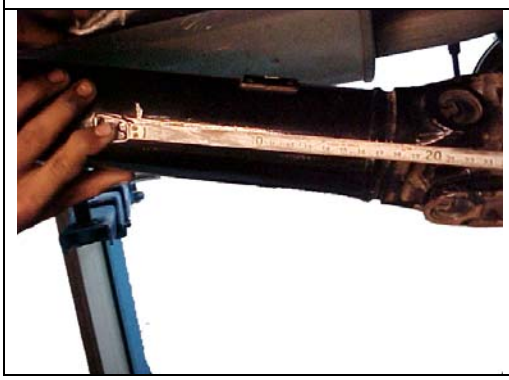
Runout

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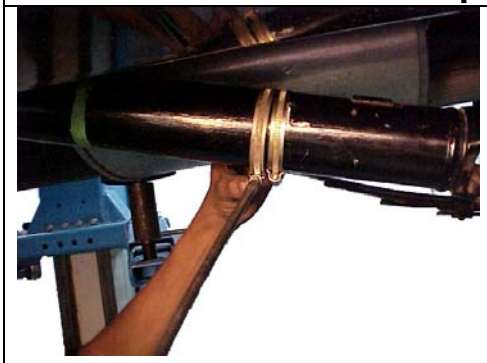
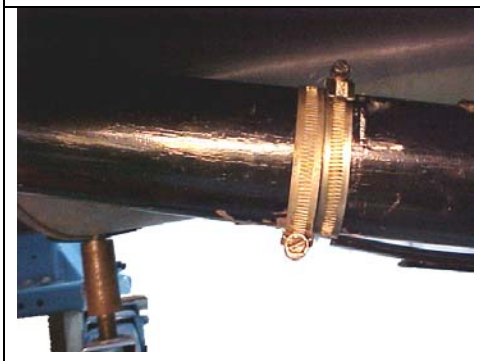
Unbalance –

If the propellers shaft unbalance is suspected then it can be verified by the following procedure.

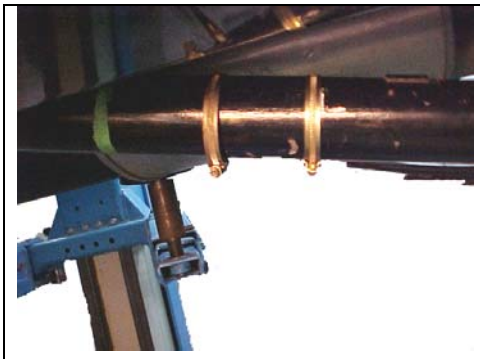
Removing & rendering the propeller shaft by 180° may eliminate some vibrations.

	Clean all the foreign material from propeller shaft and the universal joint.
	Inspect the propeller shaft for missing balance weight, broken welds and bent areas. If the propeller shaft is bent then it must be replaced.
	Ensure that the propeller shaft is not worn, are properly installed and are correctly aligned with the propeller shaft
	Check the companion flange mounting bolts.
	Raise the vehicle.
	Remove the wheel & tyres.
	Install the wheel nuts to lock the brake drum.
	Mark & number the shaft 6 inches from pinion end at four positions 90° apart.

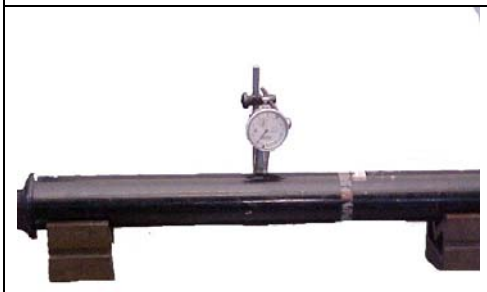
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	Run and accelerate the engine until vibration occurs. Note the intensity & the speed at which the vibration occurs.
	Install a screw clamp at position “1”
	Start the engine and recheck for vibrations. If there is little or no change in vibrations then move the clamp or of the other 3 positions.
If there is no difference in vibration at the other position then the vibration is not due to the propeller shaft imbalance.	
	If the vibration decreases, install a second clamp and repeat the test.
	If the clamps cause an additional imbalance, separate the clamp (¼ inch above & below the mark.). Repeat the vibration test.

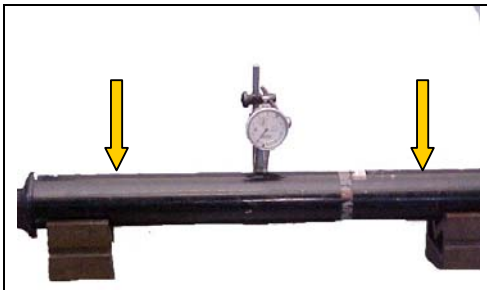
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	Increase the distance between the clamps until the vibration is at the lowest level.
	At this position bend the slack end of the clamp so that it does not loosen.
	Install the wheel & tyres. Lower the vehicle.
If the amount of the vibration remains unacceptable then repeat the exercise at the Gearbox end.	

Runout

	Remove dirt, rust, paint & undercoating from the propeller shaft surface.
	The dial indicator must be installed perpendicular to the shaft surface.

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	Measure the runout at the center and at the ends – away from the weld.
Replace the propeller shaft if the runout is beyond the specified limit.	

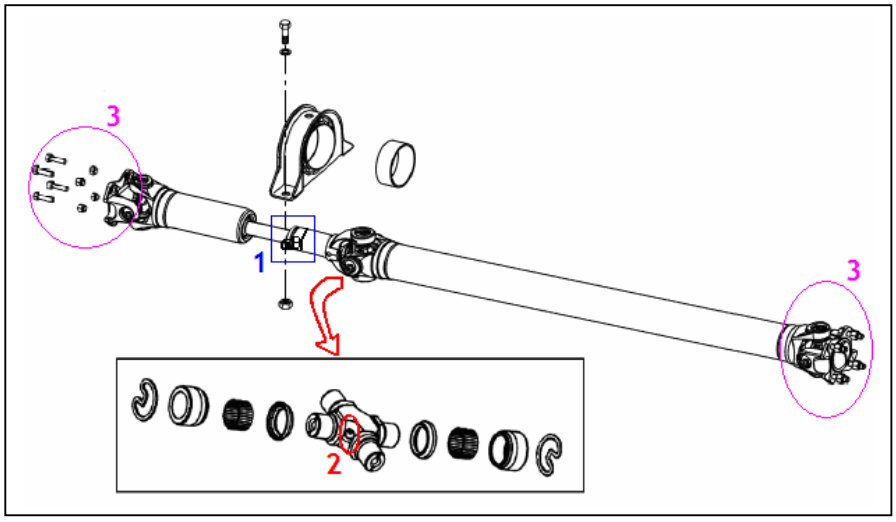
Care of the system --

Caution:
Before undercoating a vehicle with any underbody protection. The propeller shaft and the UJ's should be covered. This will prevent the undercoating from causing an unbalanced condition and vibration.

Use the exact replacement hardware for attaching the propeller shafts. The specified torque's must always be applied when tightening the mounting bolts.

- ✓ The UJ to be greased at every service.
- ✓ The slip joint should be lubricated every 10,000 Kms.

The procedure of greasing is as follows –

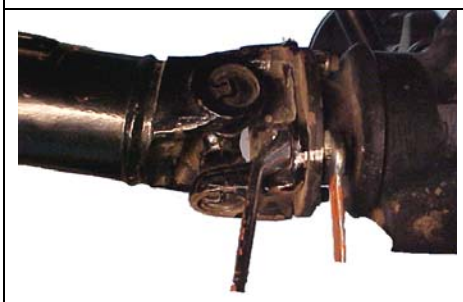


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1. Inspect the Sliding yoke for Grease & play; fill the grease through the grease nipple with pressurized gun.

2. Inspect the Universal Joint for Grease & play; fill the grease through the grease nipple with pressurized gun.

Repairs --

	Lift the vehicle
	Put aligning marks on the flange, UJ and propeller shaft before removal. Do not use a punch to mark impression.
	Remove the mounting bolts at the pinion end
	Remove the mounting bolts at the gearbox end.
	It is important to protect the machined, external surface of the yoke from damage after propeller

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	shaft removal. Any damage in the machined surface will lead to damage of the seal and cause a leak.
	Remove the circlips holding the UJ in place.
	Applying the socket wrench on the outside of the propeller shaft flange, force out one end of UJ using a vice as shown. (One end 32 mm socket to receive other end 21-mm socket to push.)
	While assembling- insert both ends then hold & press fit them with special tool.

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Specification & Wear Limits –

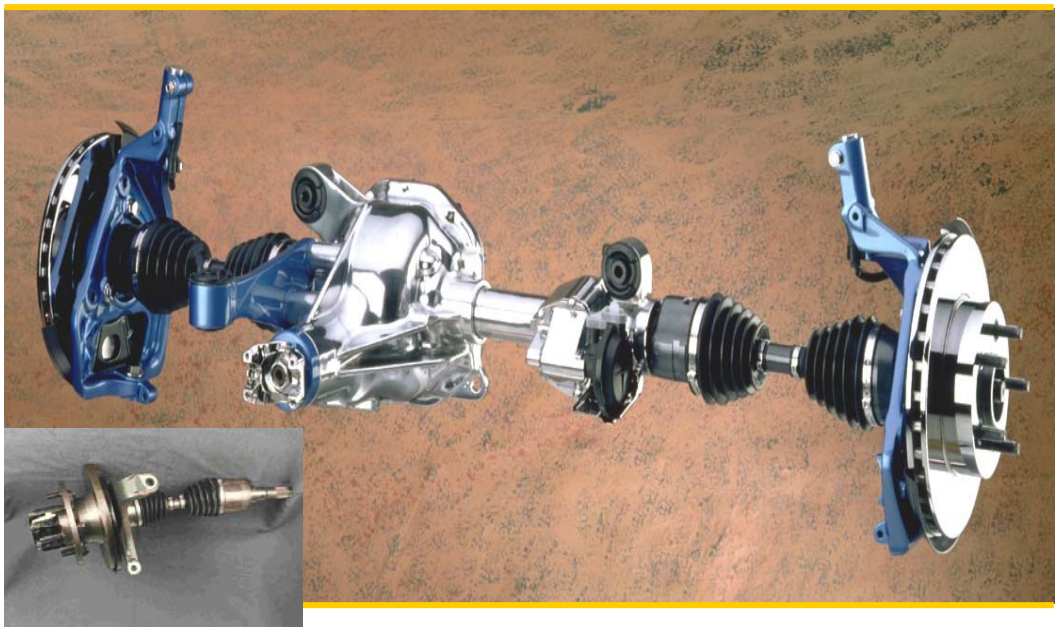
Description	2WD	4WD
Length (Joint to Joint) x O.D x thickness in mm		
Rear	1023.5x70x2	727.5x70x2
Front (Diesel)		479.6x 44.45x3.25
Rear (GB -c/brg)-Split propeller	132.8x 63.5x2.1	
Rear (centre brg to axle) Split propeller	761.4x63.5x2.1	
Runout Diesel	0.5 mm TIR at centre	

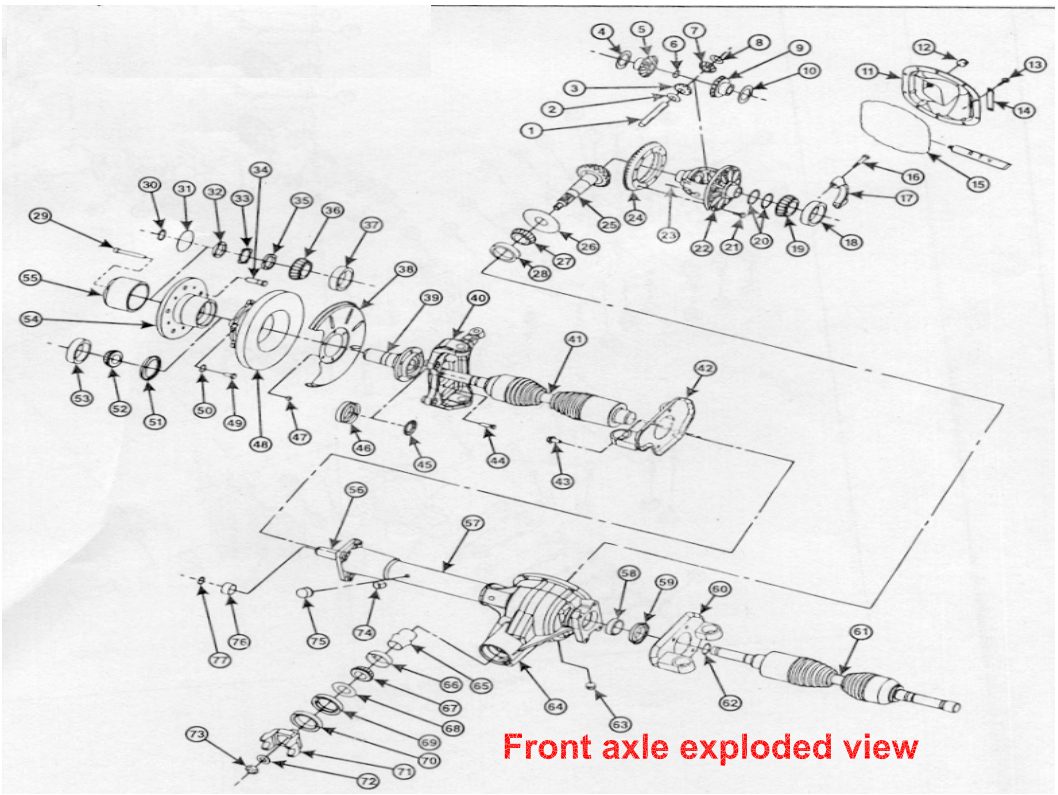
Tightening Torques –

Location	Torque Nm (lbf-ft)
Flange bolt	60 ± 5 Nm (44 ± 4 lbf-ft)
Center bearing mounting bracket	87 ± 15 Nm (65 ± 12 lbf-ft)
Companion Flange nuts at Transmission & Axle end	60.5 ±5.5 Nm (45 ± 4 lbf-ft)

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IFS Live axle





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Main Features of Spicer Axles

1. Use of RTV on the coverface to eliminate the oil leakage complaints.

2. Use of one size collapsible spacer to maintain the preload on the pinion bearings.

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Rear Axle Specifications

Oil Quantity - 1.2 Lit.

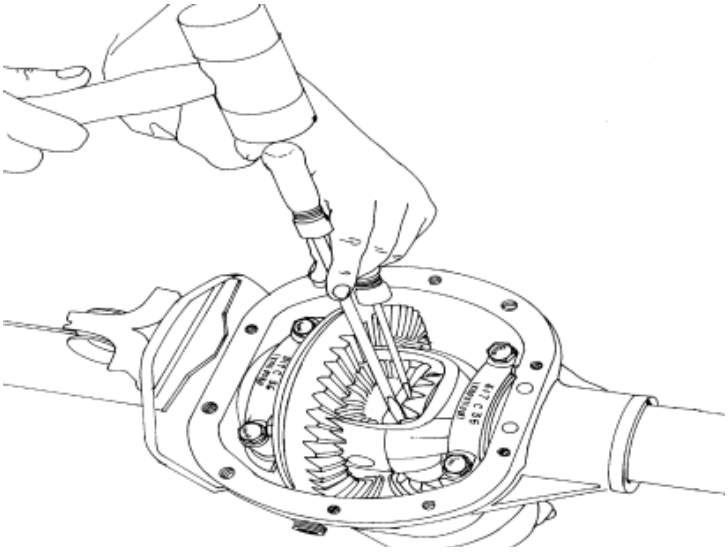
Recommended oil -GL5
- 85 W 140

Oil changing frequency - 40,000 Kms.

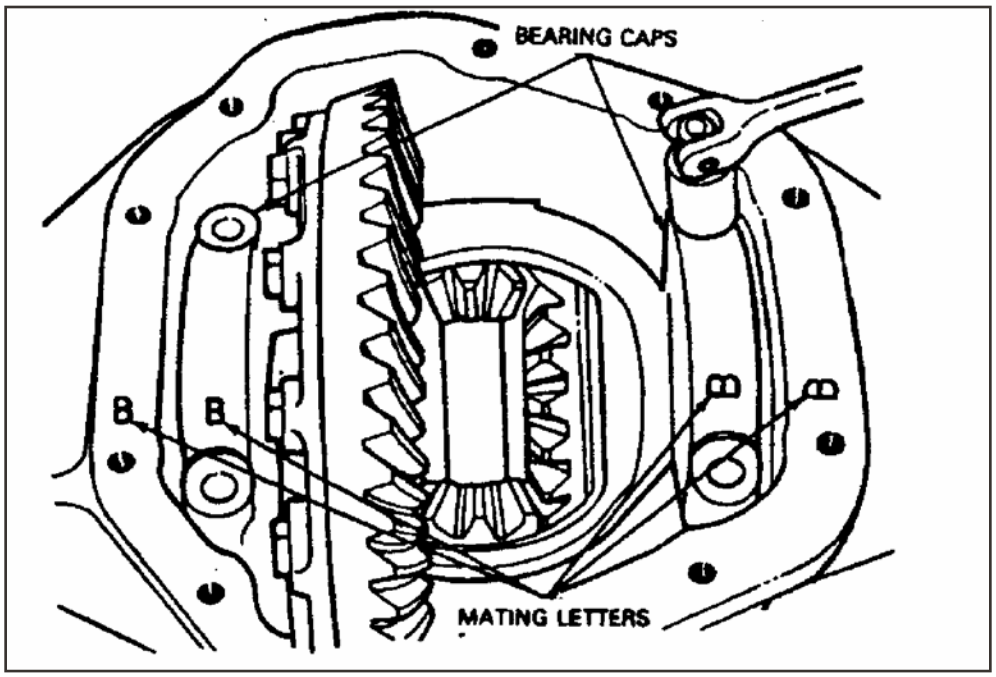
Backlash - 0.005" - 0.008" (0.125 to 0.20 mm)

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Front Axle Disassembly

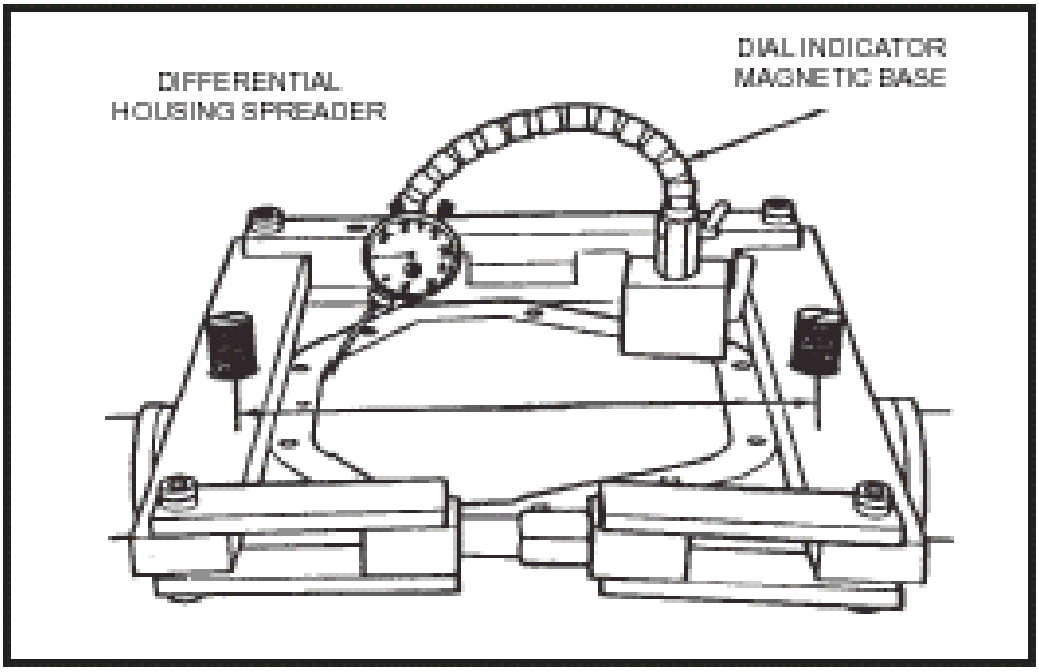


Removing of Lock Clip

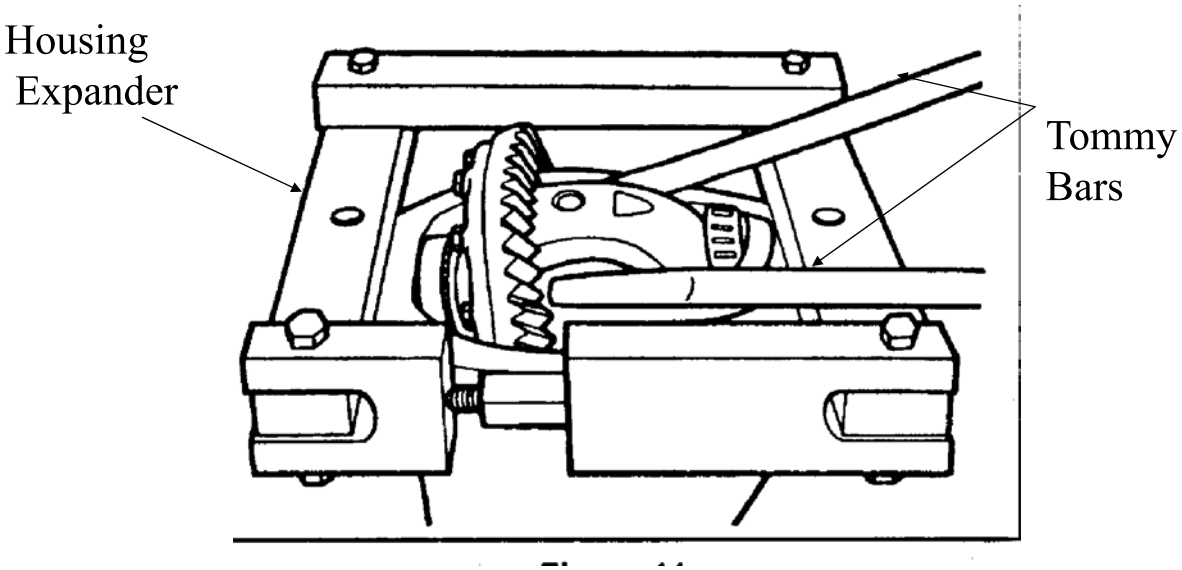


Diff brg cap removal

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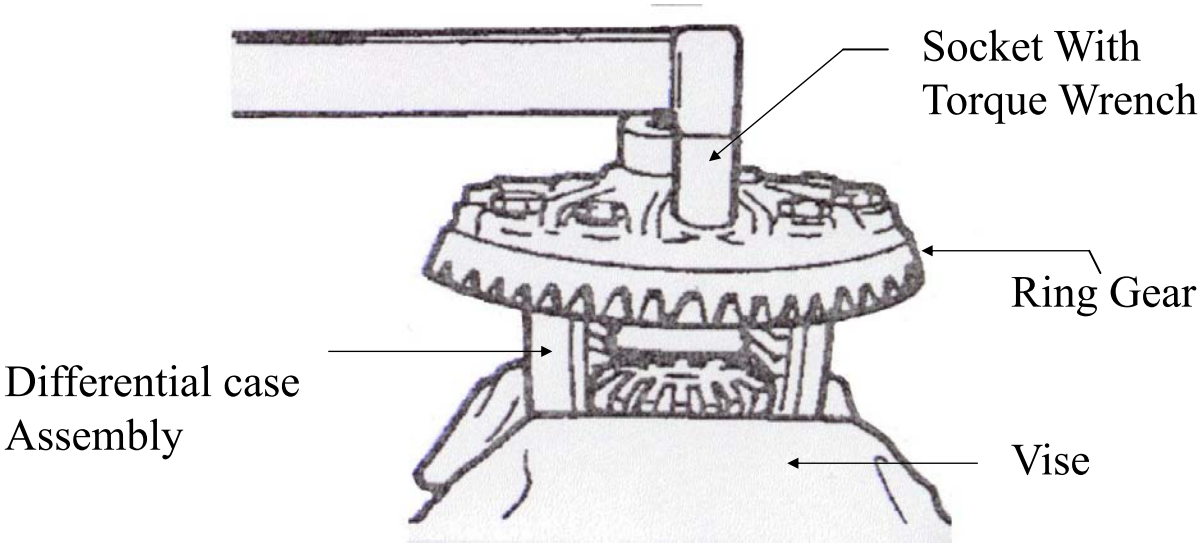


Checking of carrier spreading Expansion Limit 0.58mm max

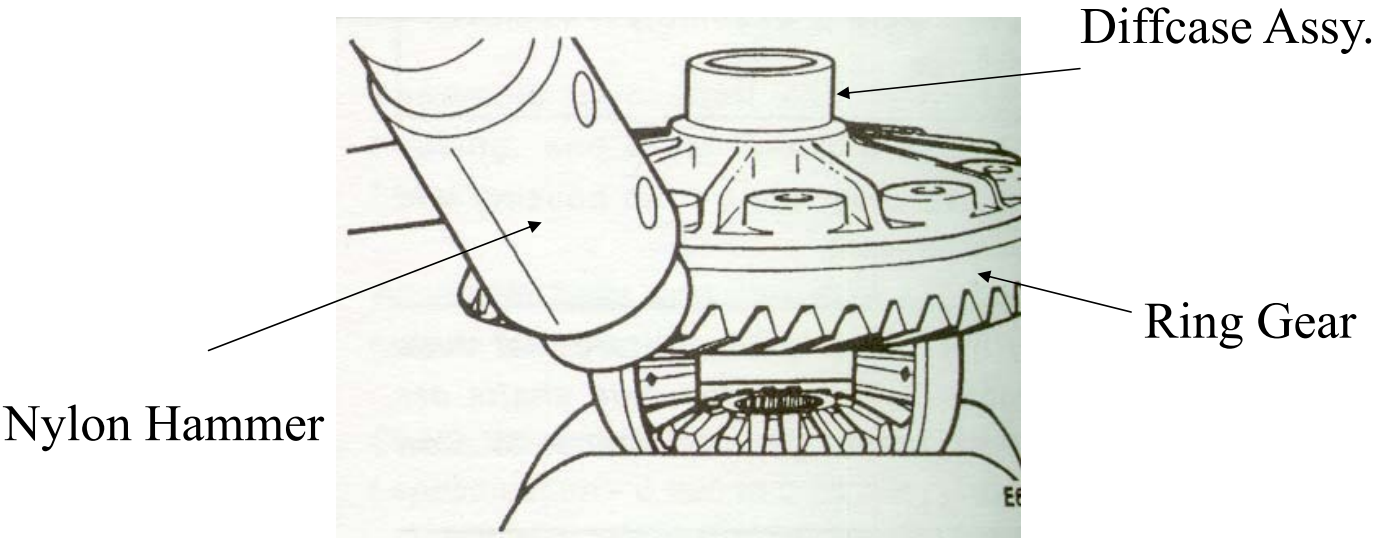


Diff case removal from the centre assembly

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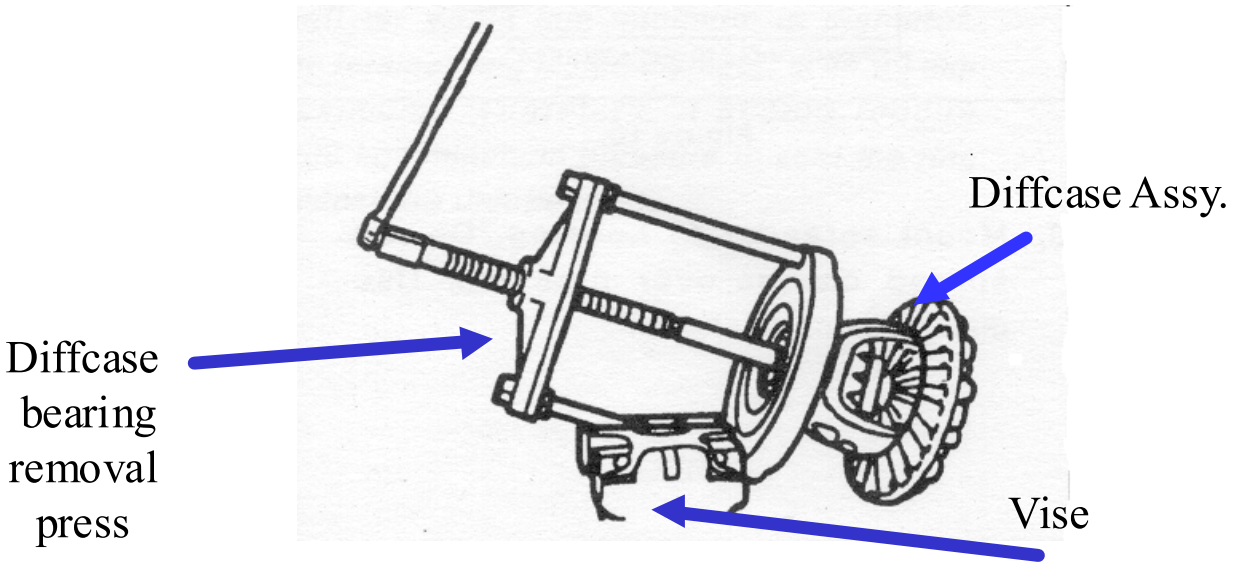


Ring Gear Bolt Tightening & Loosening

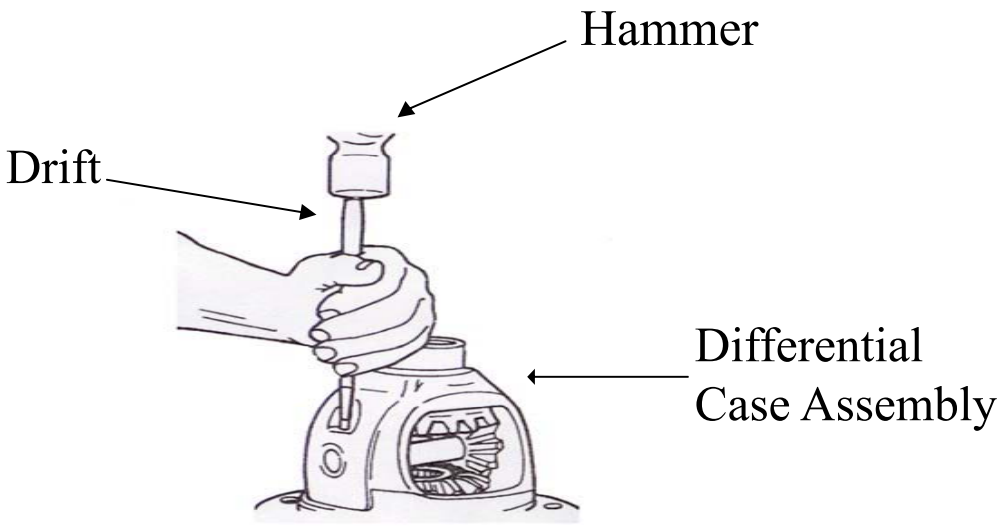


Ring gear removal from the diff assembly

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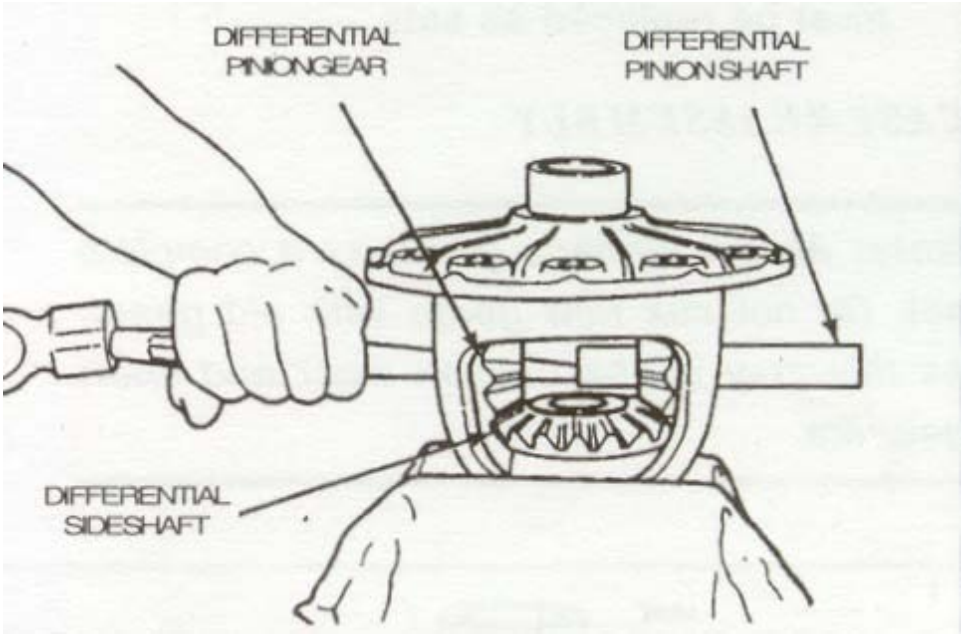


Diffcase bearing removal

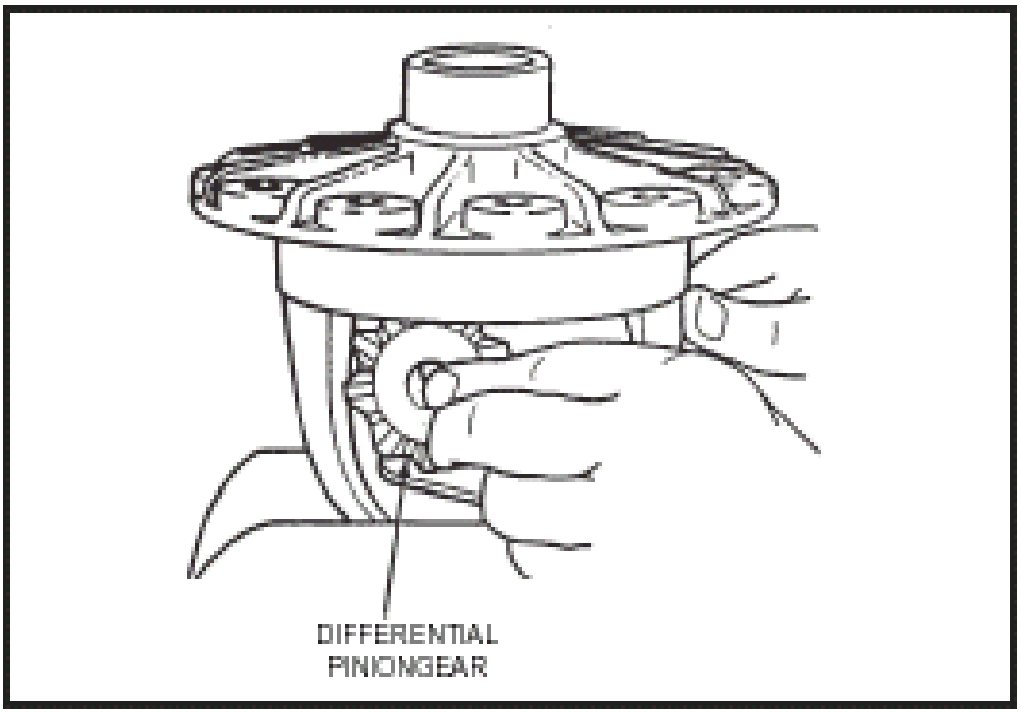


Removal Of Differential Lock Pin

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Diffcase shaft removal



Diffcase gears Removal

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1



2

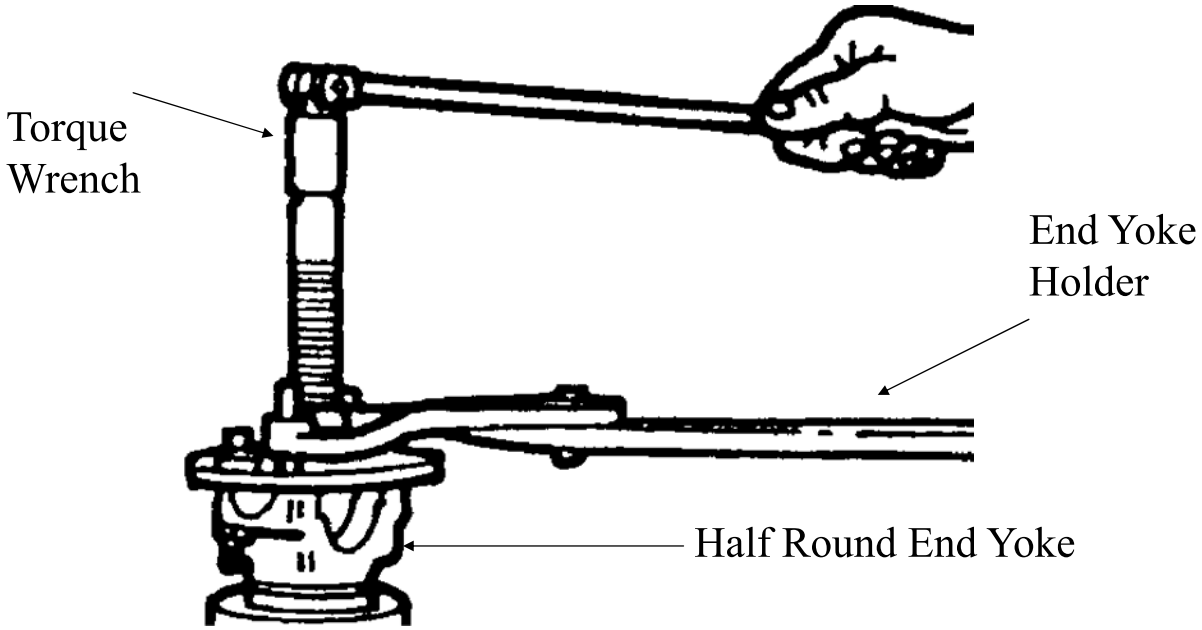


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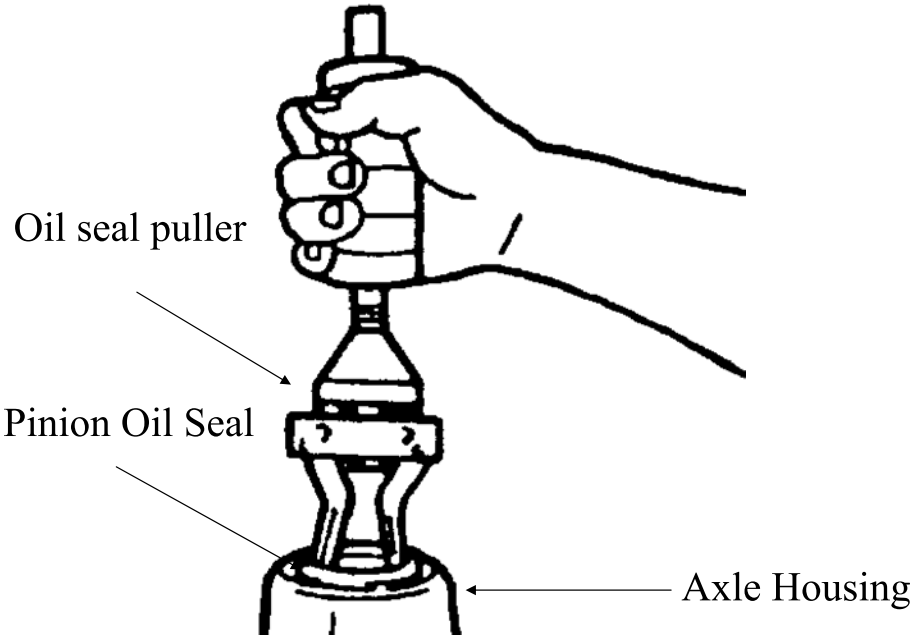


DIFFERENTIAL ASSEMBLY

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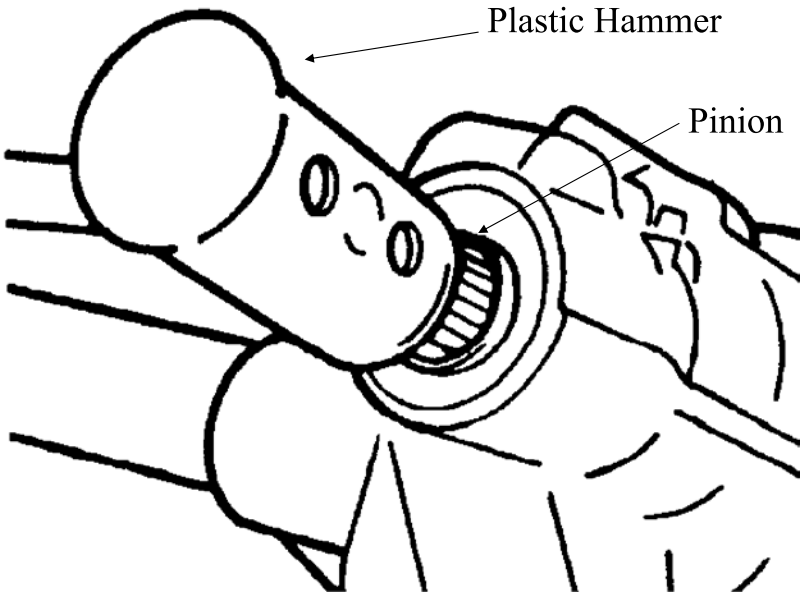


Pinion nut removal

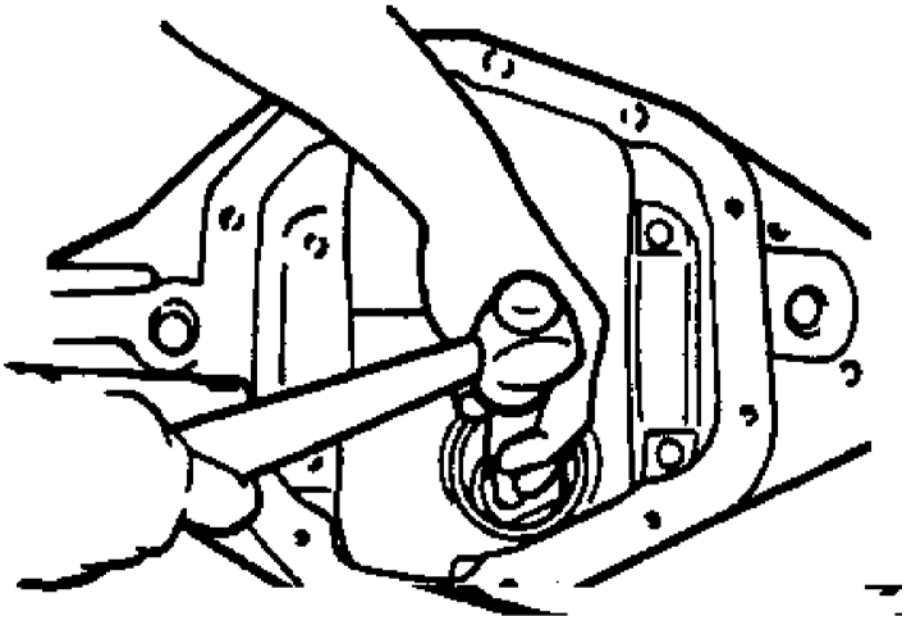


Pinion oil seal removal

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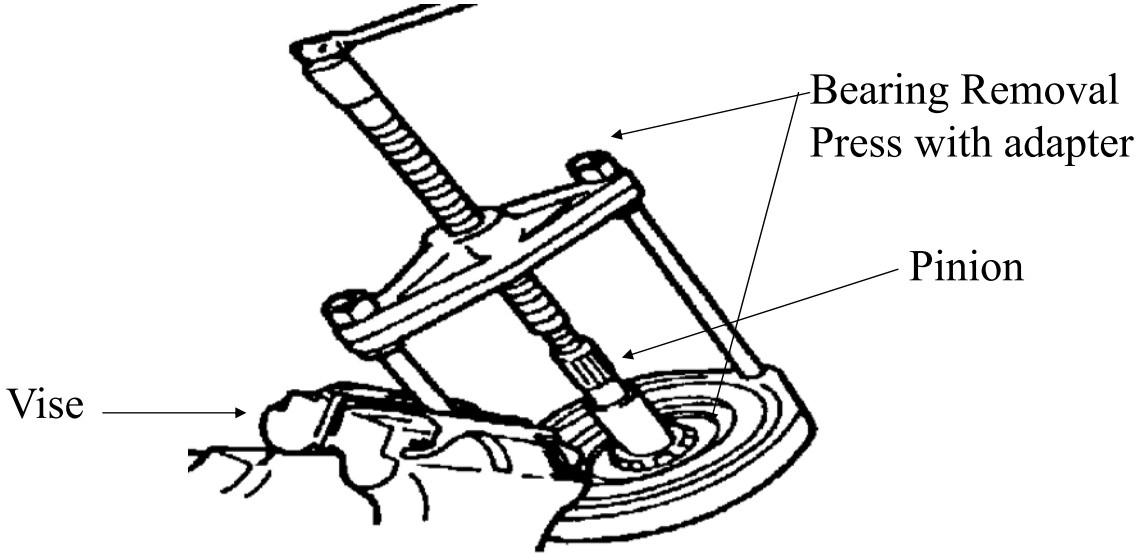


Pinion removal from the housing

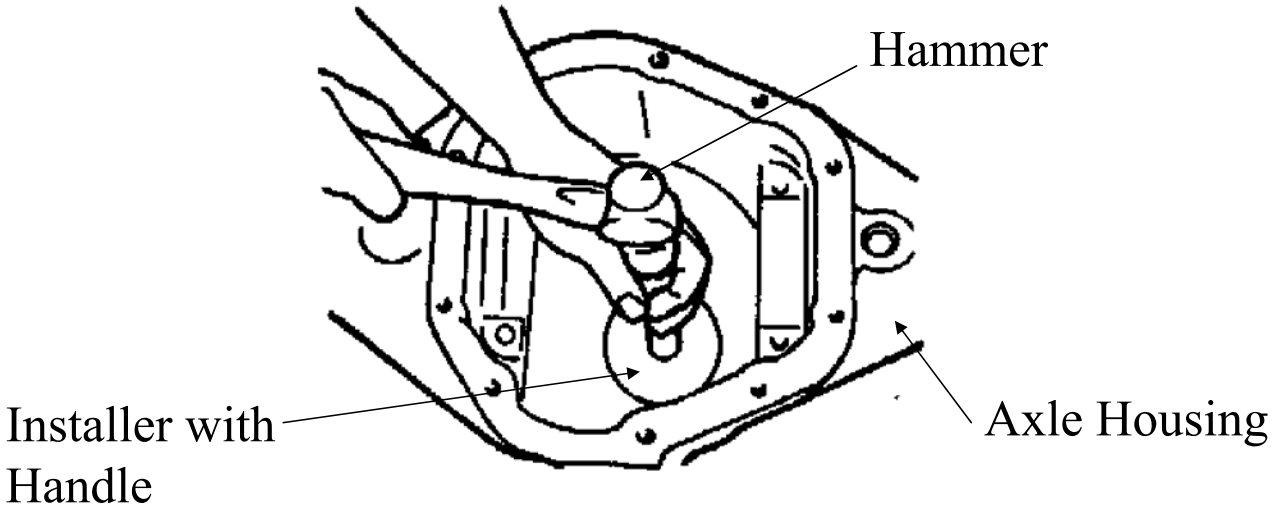


Pinion bearing cup removal

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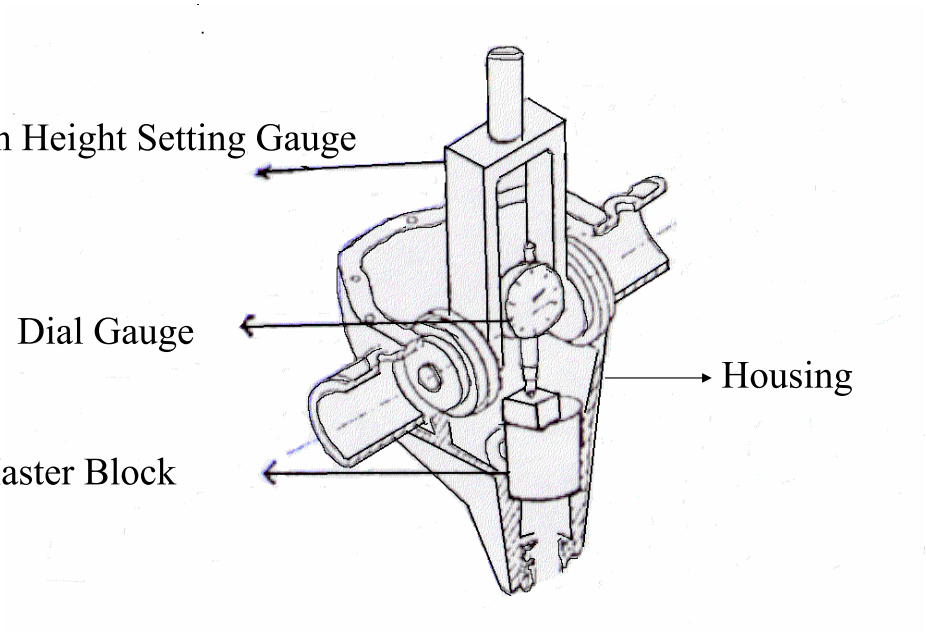


Pinion bearing removal

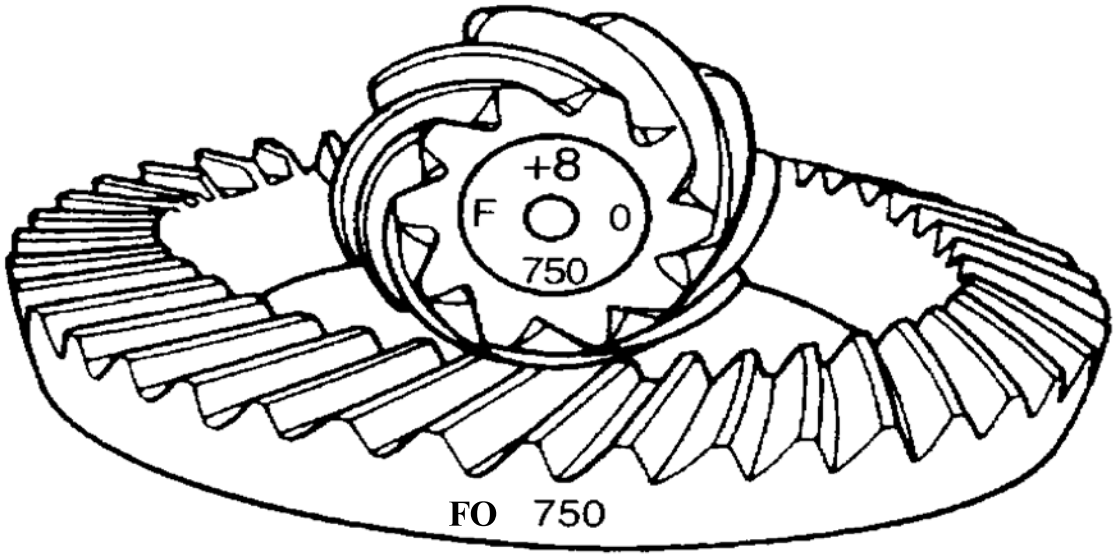


Installation of Pinion inner brg cup

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Pinion Height Shim Selction

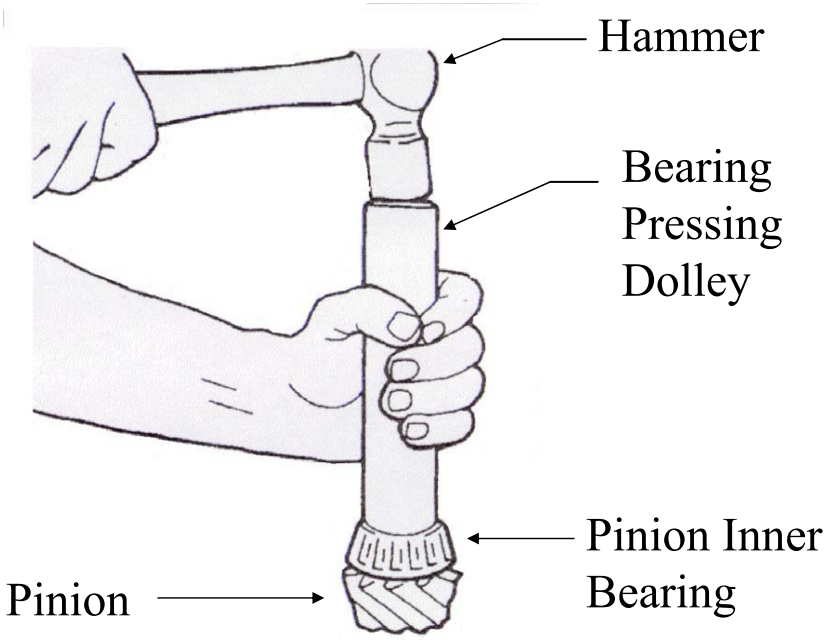


Ring Gear And Pinion Markings

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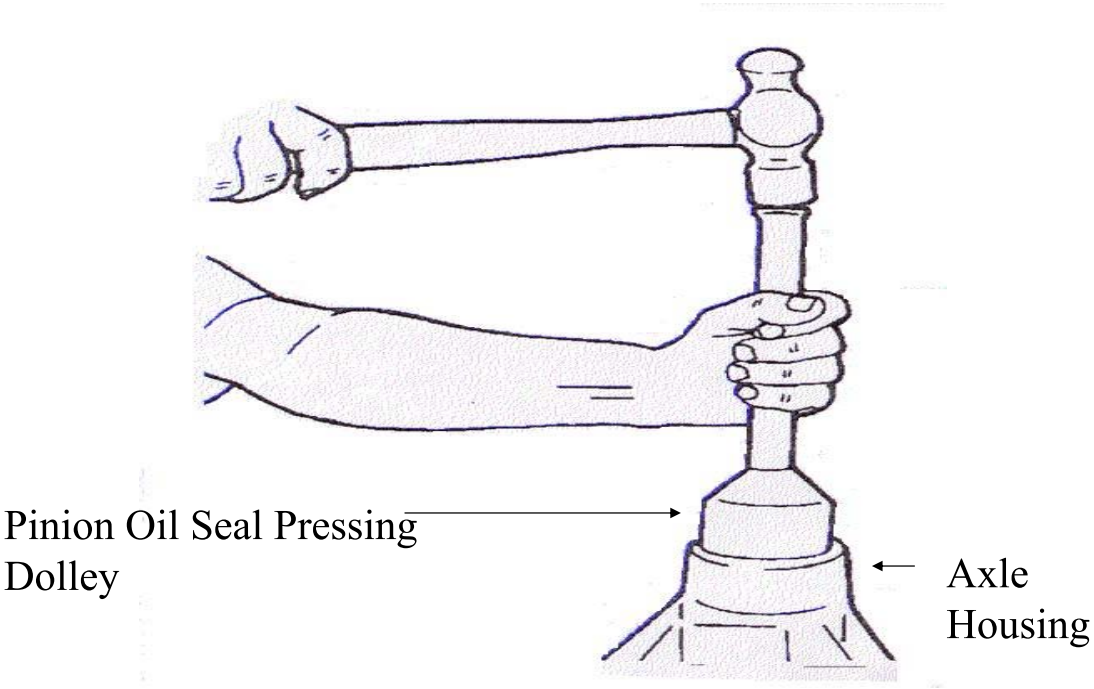
IN CASE OF PINION REPLACEMENT THE FOLLOWING CHARTS GUIDE SHIM SELECTION

Old Pinion Marking	New Pinon Marking (English)								
	-4	-3	-2	-1	0	+1	+2	+3	+4
+4	+0.008	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0
+3	+0.007	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001
+2	+0.006	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002
+1	+0.005	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003
0	+0.004	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004
-1	+0.003	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005
-2	+0.002	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006
-3	+0.001	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007
-4	0	-0.001	-0.002	-0.003	-0.004	-0.005	-0.006	-0.007	-0.008

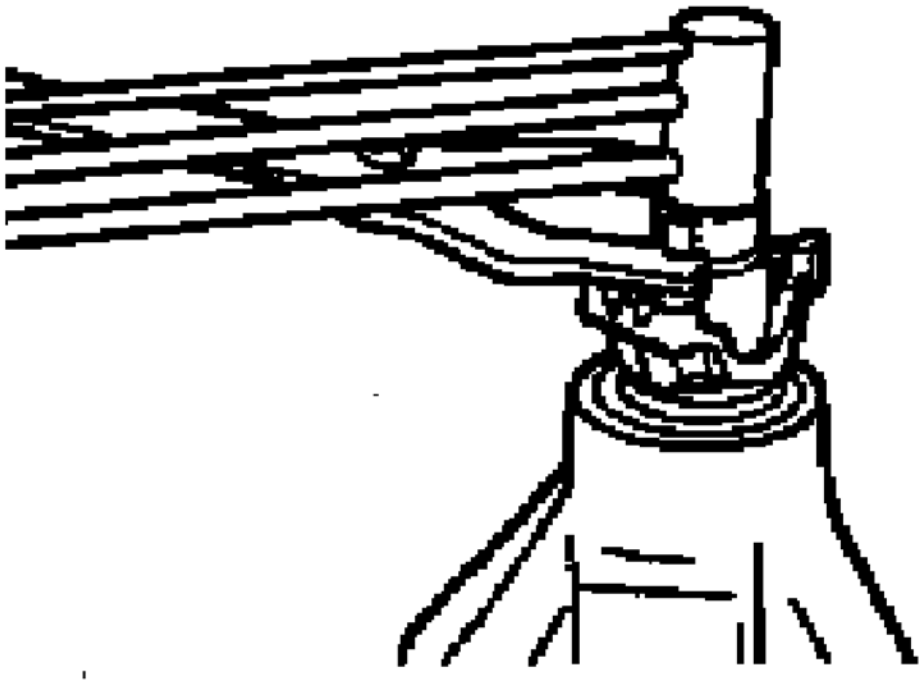


Pressing Of Pinion Inner Bearing

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Pinion Oil seal Pressing

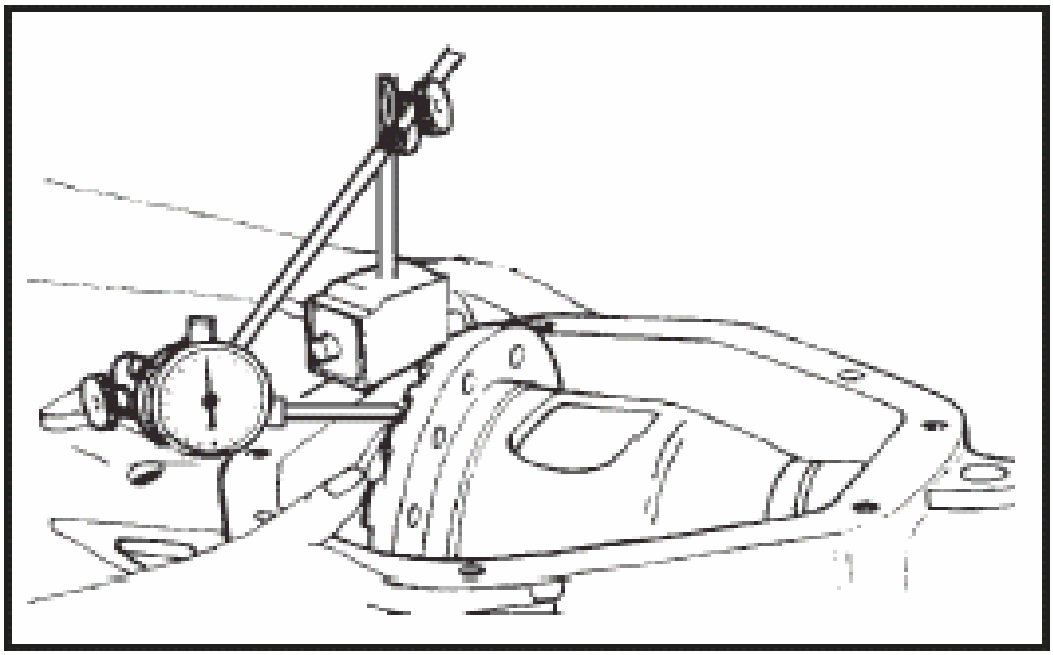


Pinion nut tightening

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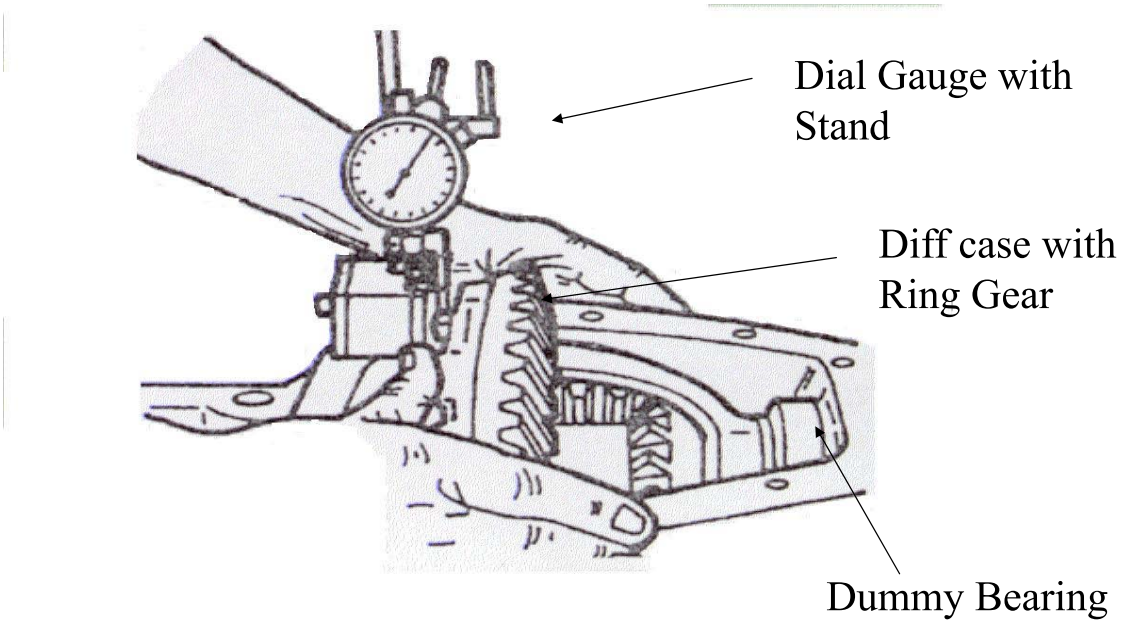


Diffcase With Dummy Bearings

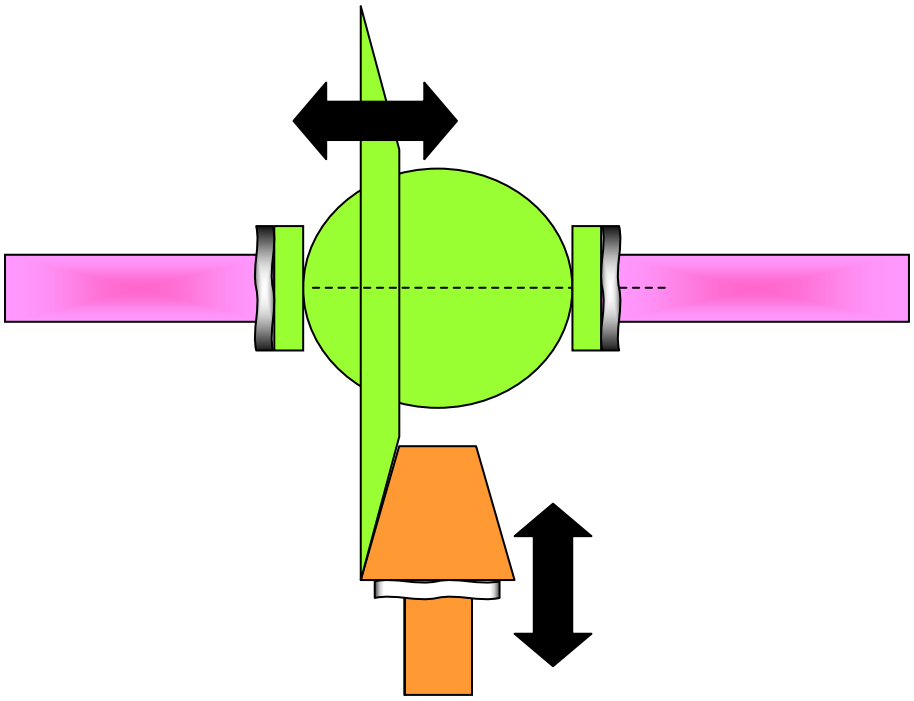


Total Play Without Crown wheel & Pinion.

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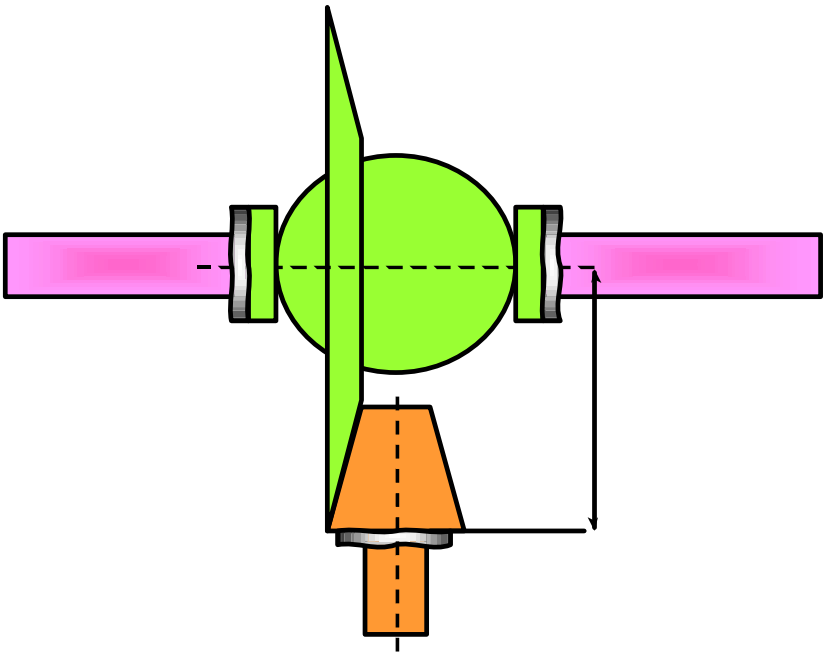


Left Hand Play With Crown wheel & Pinion.

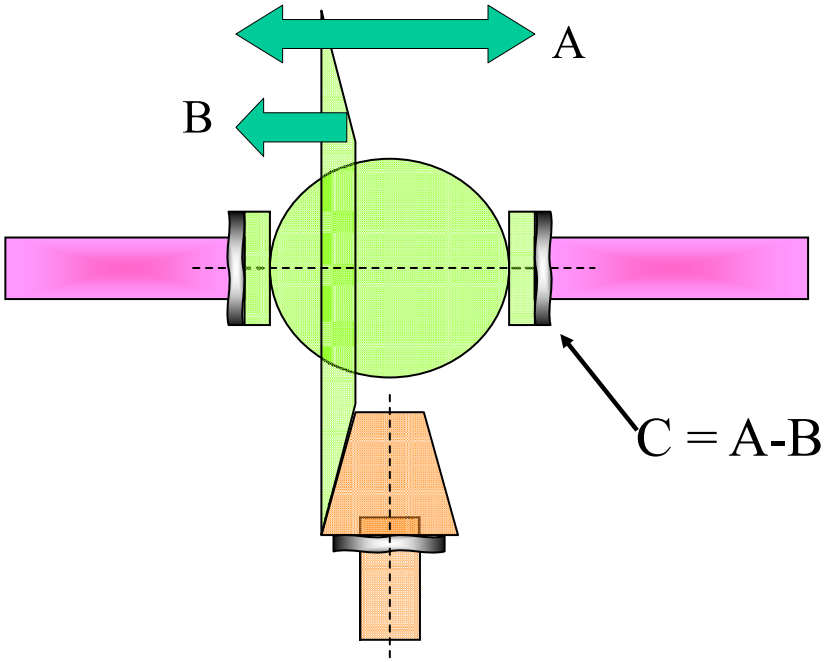


Play Adjustment

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Pinion Height



Worksheet for calculation of backlash

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WORKSHEET FOR CALCULATING RING GEAR BACKLASH AND DIFFERENTIAL BEARING PRELOAD SHIMS

Total play observed (Without crown wheel) = A
Left hand play (With crown wheel) = B
Right hand play = (A - B) = C

This is just an exmple for understanding the calculation with values rounded off to nearest decimal

Case 1.

Suppose A = 0.070" (1.75 mm)
B = 0.040" (1.01 mm)
C = 0.070" - 0.040" = 0.030" (0.74)

Blacklash Calculations -

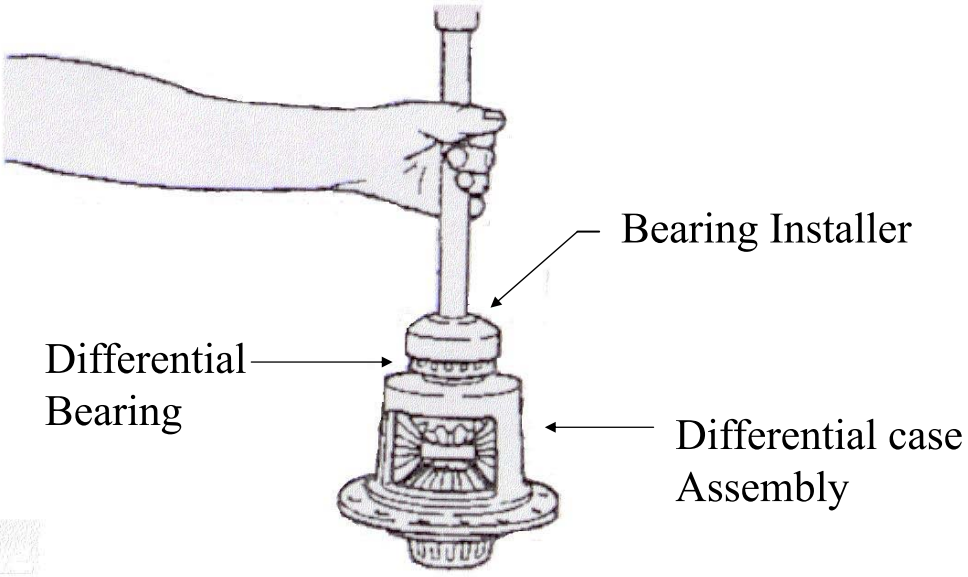
	LH Side	RH Side
	A	B	C
	0.070" (1.75 mm)	0.040" (1.0160 mm)	0.030" (0.762mm)
Preload	+ 0.003" (0.0762mm)	+ 0.003" (0.0762mm)
Blacklash	- 0.006" (0.1524mm)	+ 0.006" (0.1524mm)
Shim Size	**0.037" (0.9398mm)**	**0.039" (0.9906 mm)**

Case 2.

Suppose A = 0.085" (2.159 mm)
B = 0.055" (1.397 mm)
C = 0.085" - 0.055" = 0.030" (0.762mm)

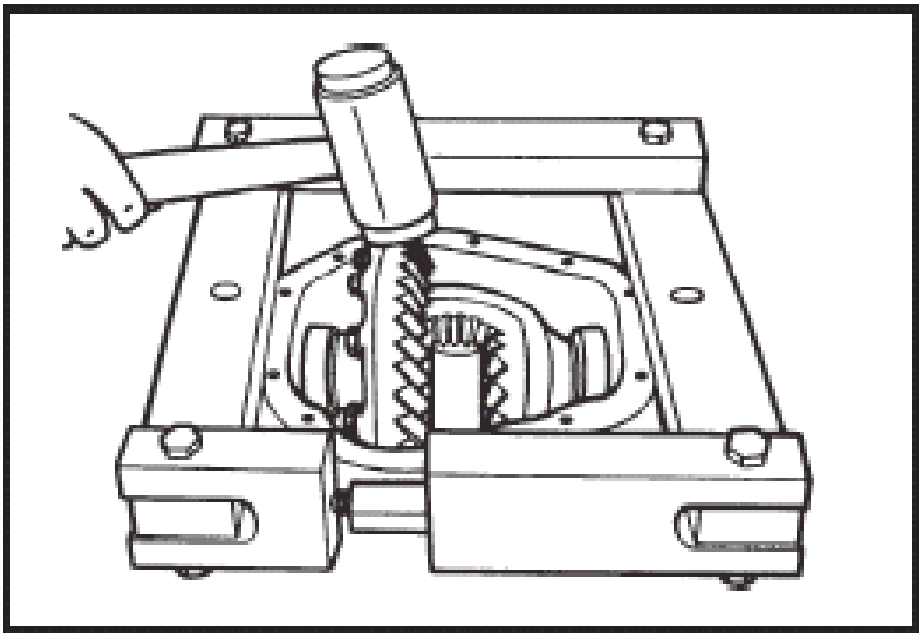
Blacklash Calculations -

	LH Side	RH Side
	A	B	C
	0.085" (2.159 mm)	0.055" (1.397 mm)	0.030" (0.762 mm)
Preload	+ 0.003" (0.0762mm)	+ 0.003" (0.0762mm)
Blacklash	- 0.006" (0.1524mm)	+ 0.006" (0.1524mm)
Shim Size	**0.052" (1.3208mm)**	**0.039" (0.9906mm)**

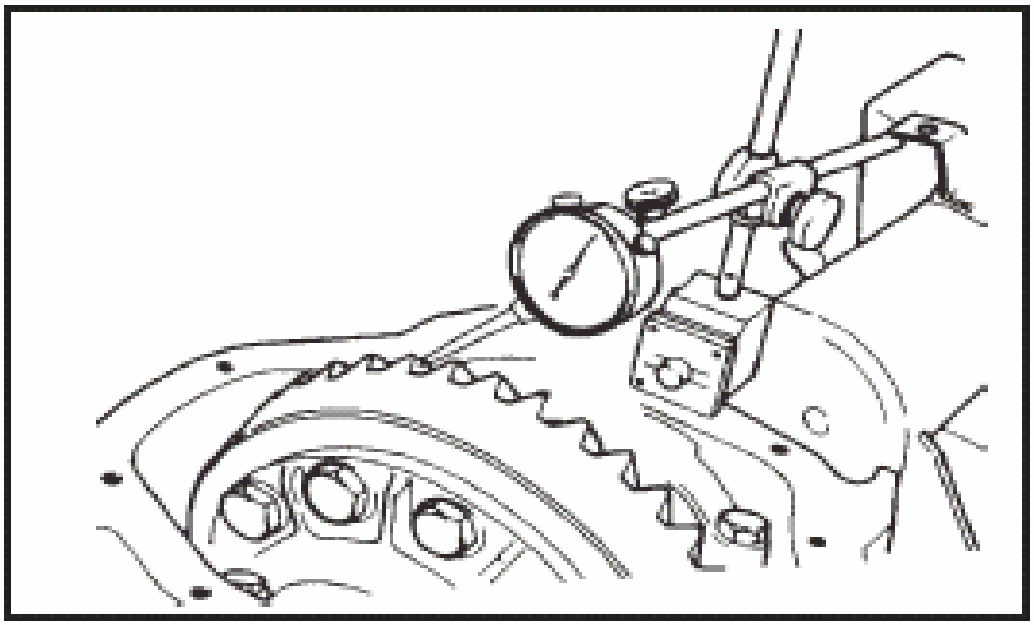


Installation of Differential Bearing

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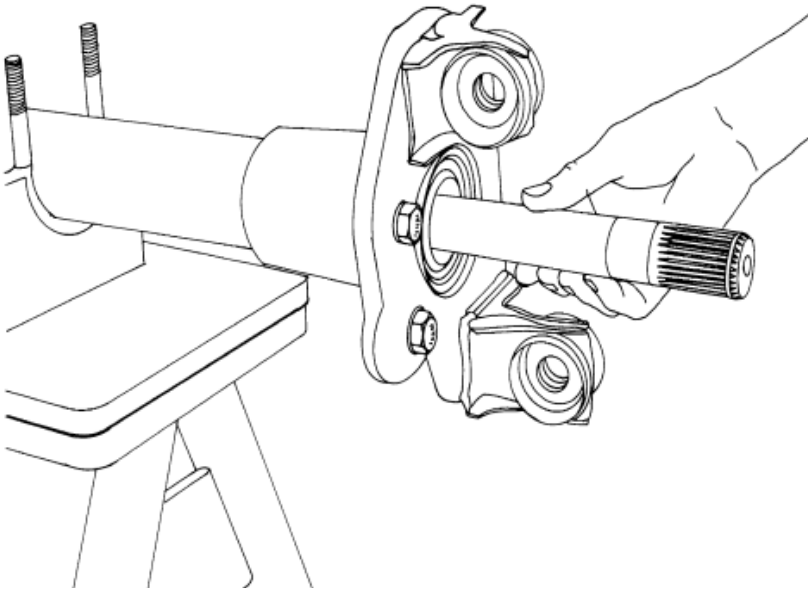


Diffcase And Carrier Assembly

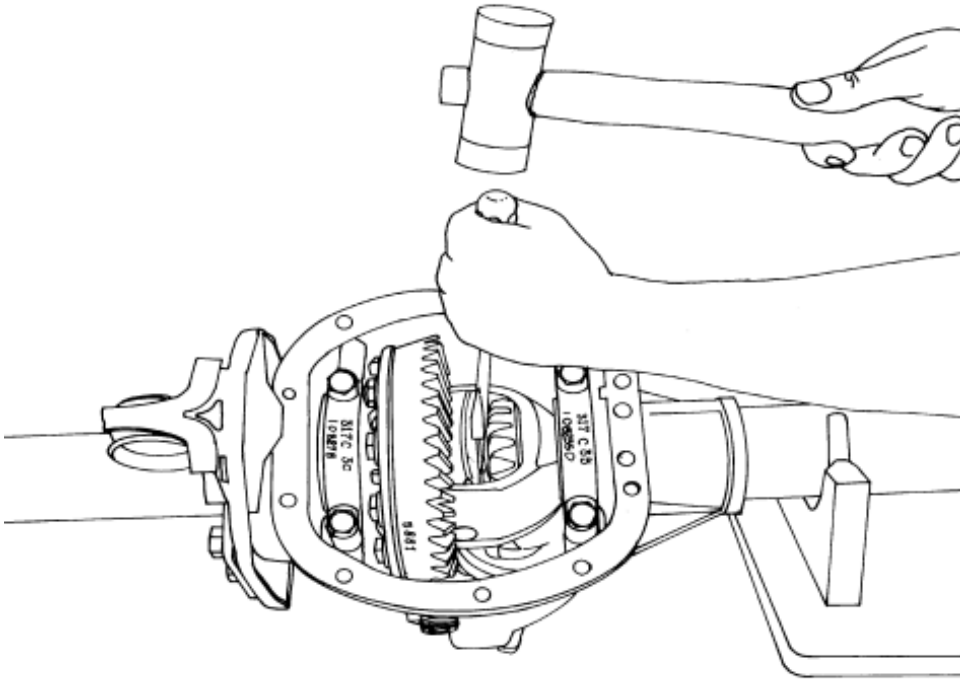


Ring Gear pinion Backlash Checking

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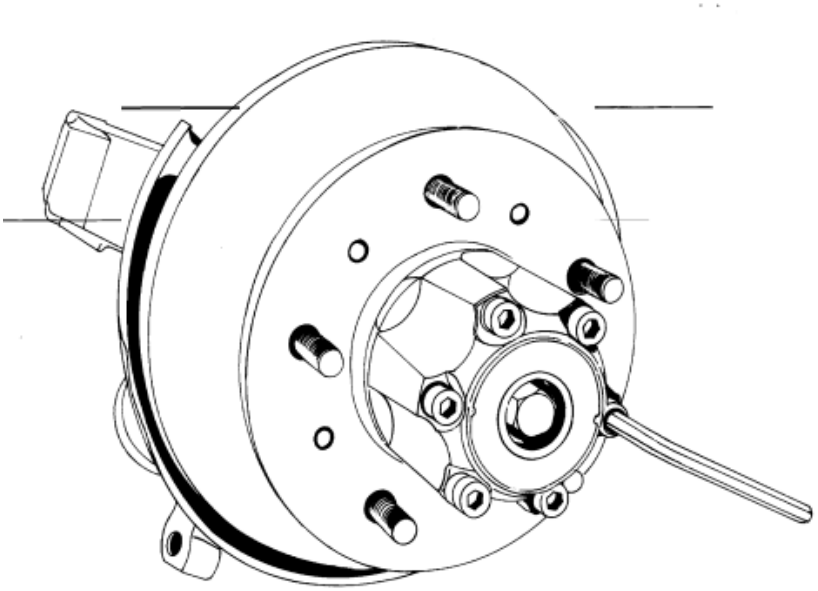


Shaft Removal & Insertion

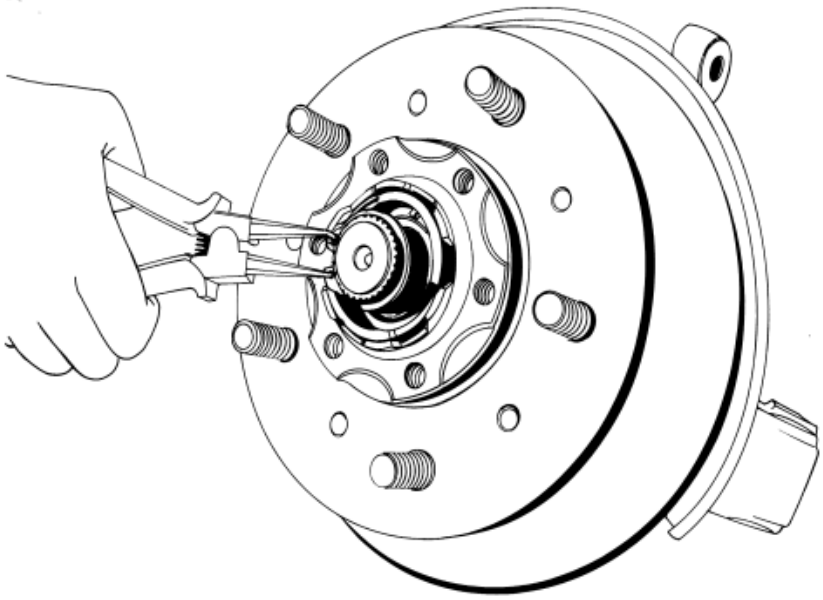


Lock clip Assembly

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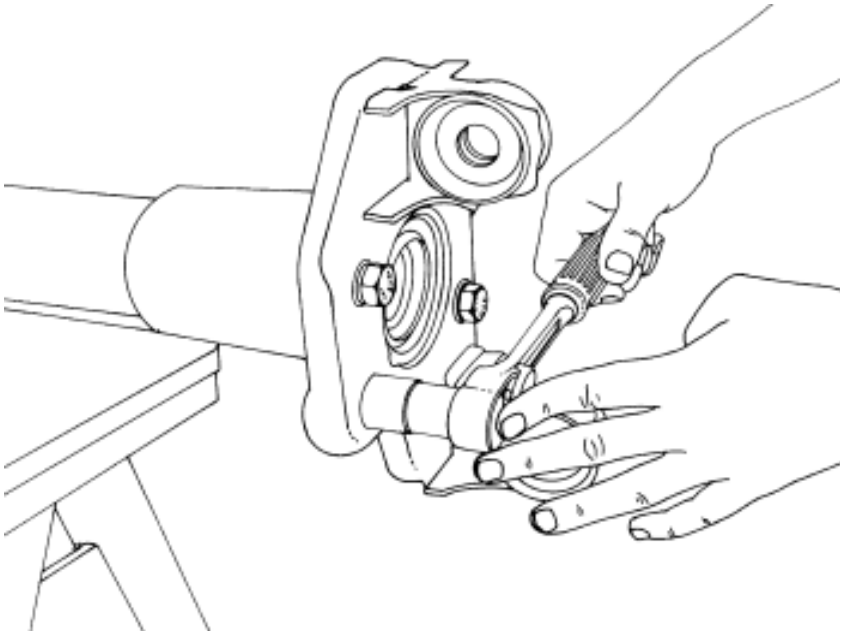


Brake Disc bolt loosening & Tightening

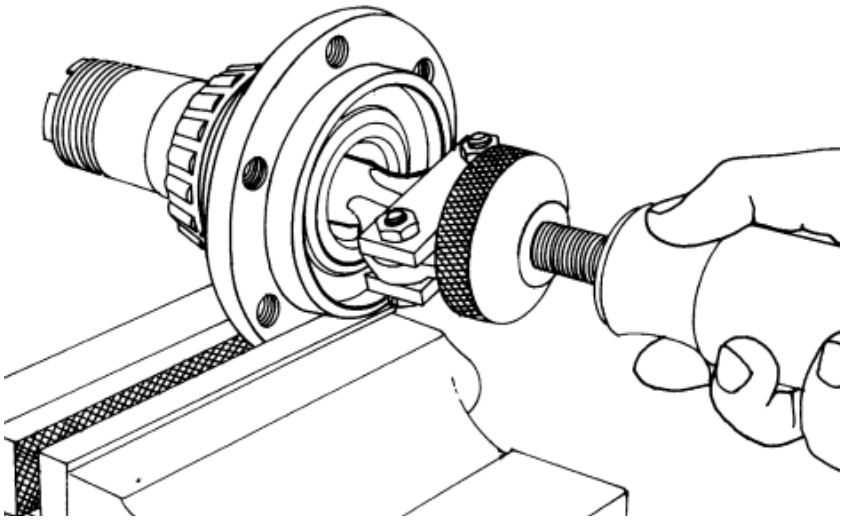


Removal of outer Lock clip

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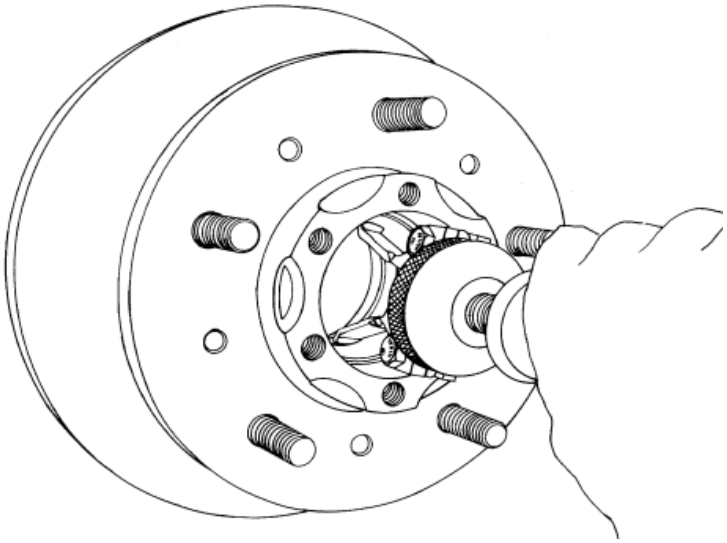


Bracket Nut Loosening

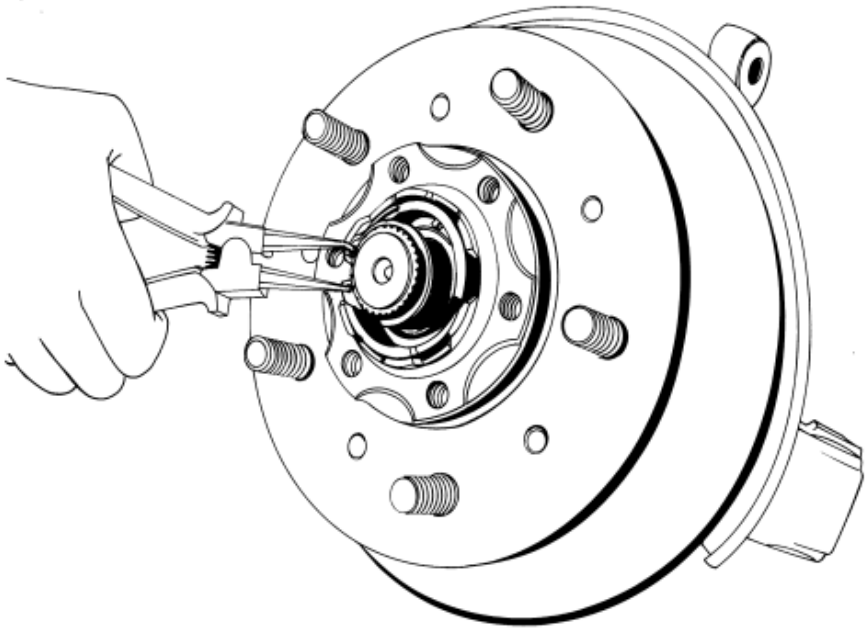


Oil seal Removal

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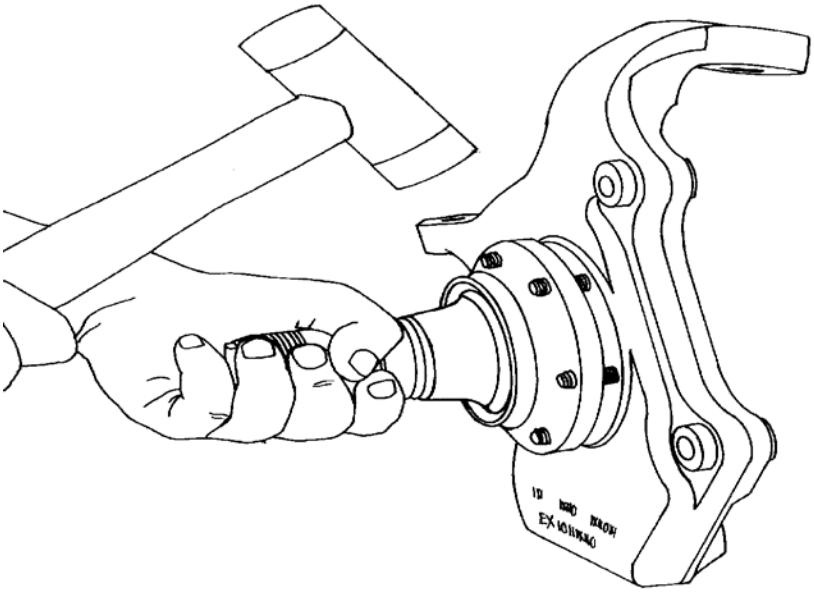


Hub Oilseal Removal

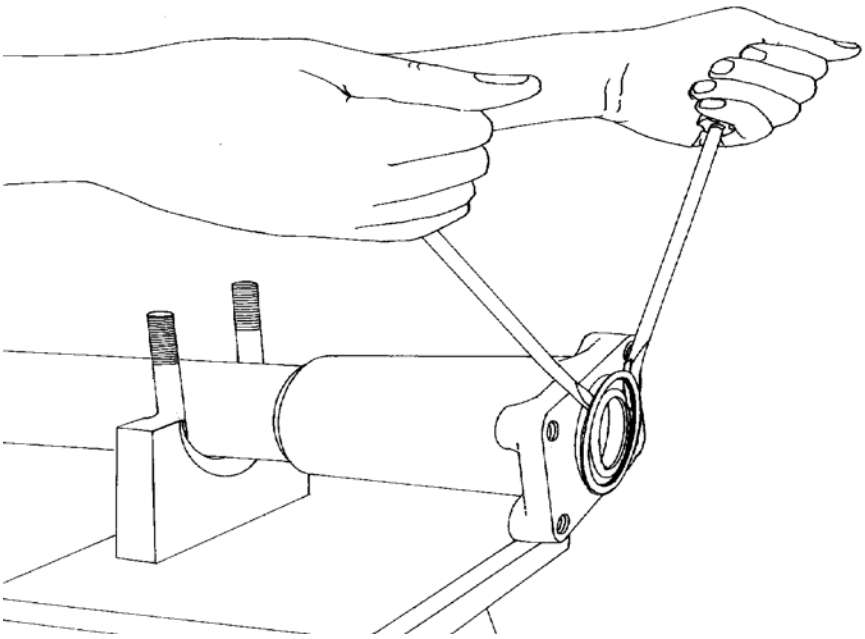


Removal of outer Lock clip

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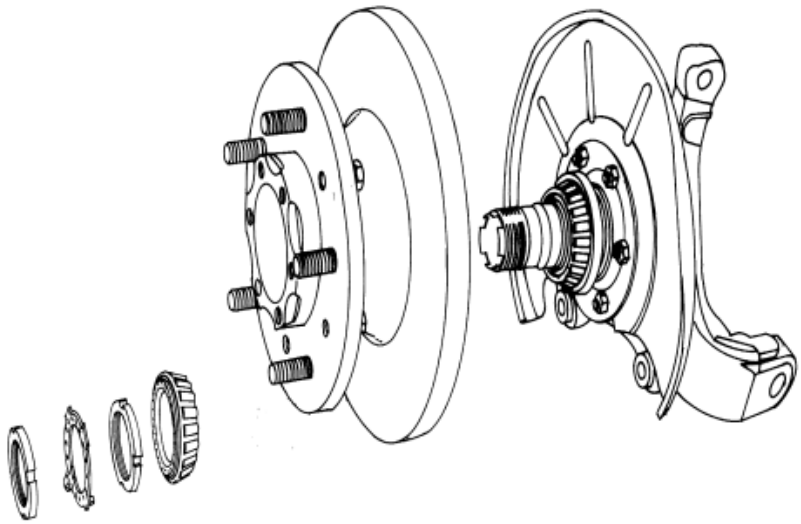


Removal of Knuckle

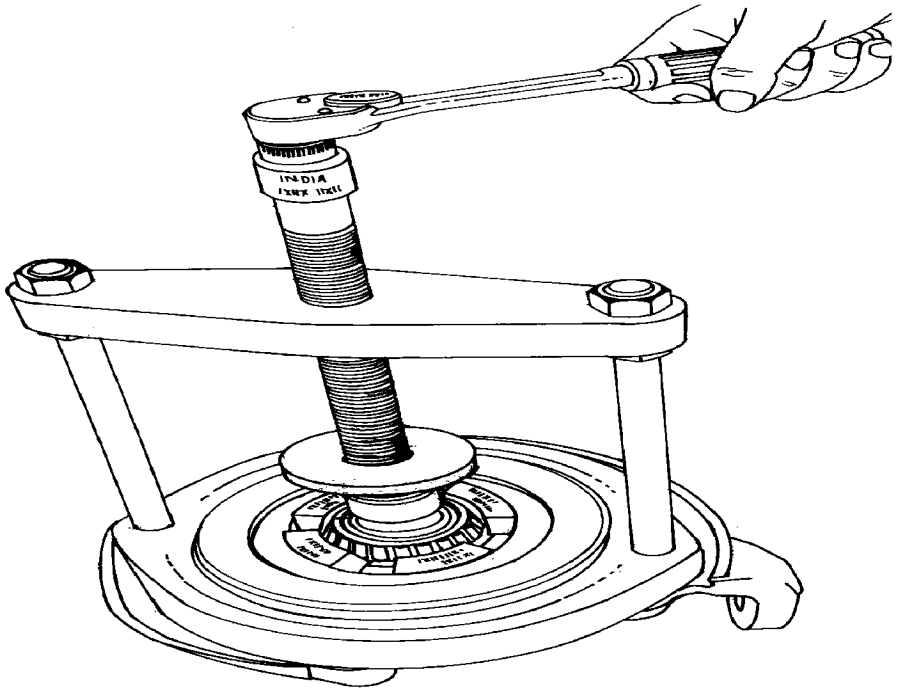


Removal of In-bored oil seal

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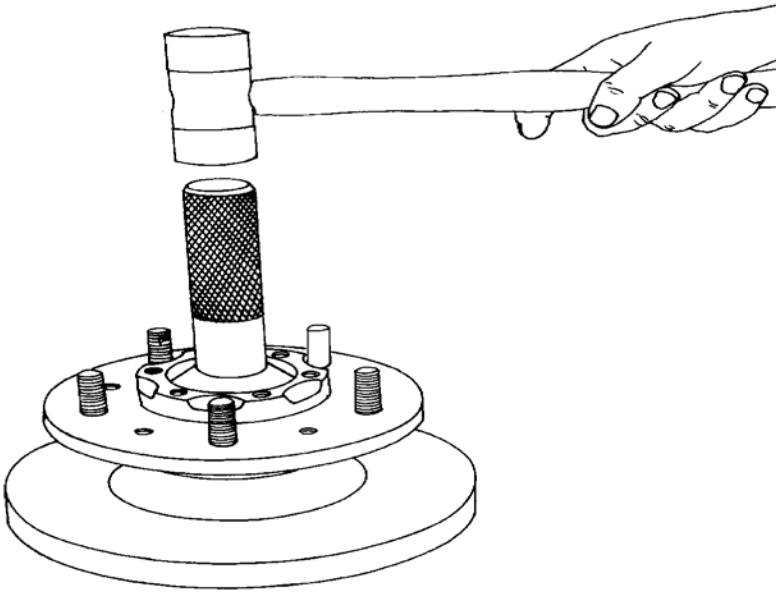


Brake-Disc & Knuckle Assembly

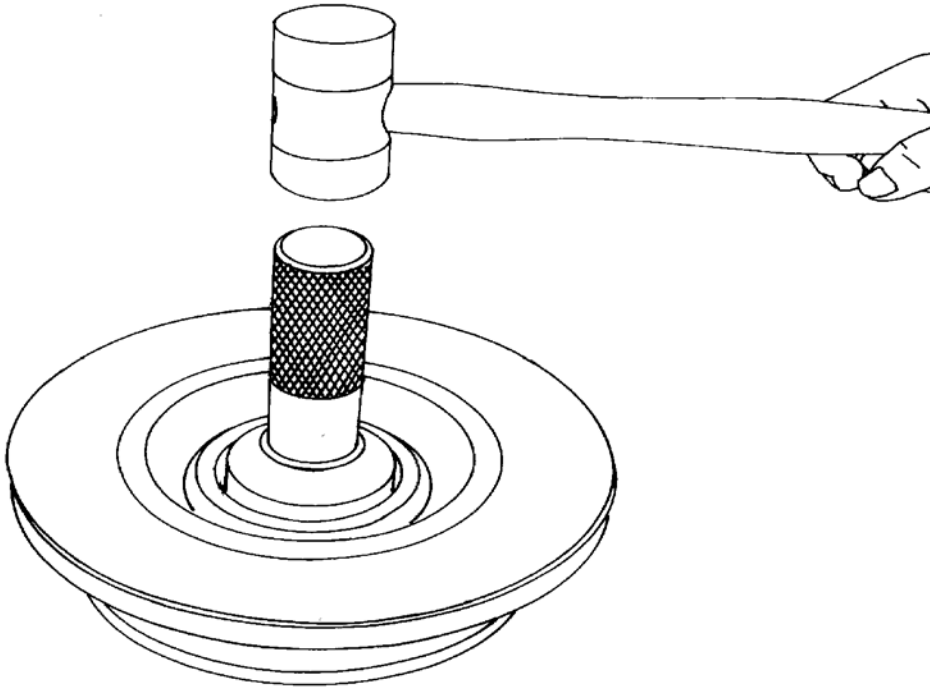


Spindle bearing removal

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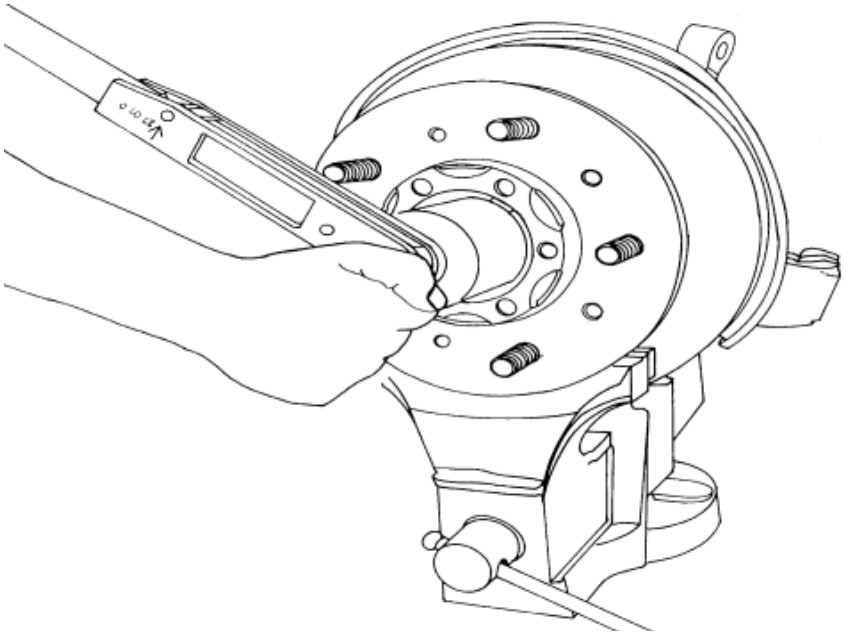


Spindle Bearing Pressing

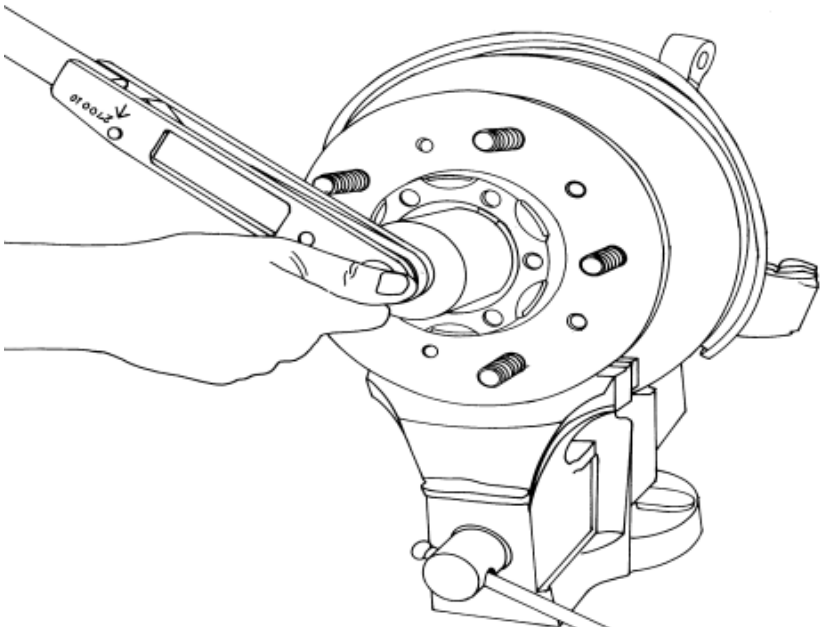


Spindle oil seal Pressing

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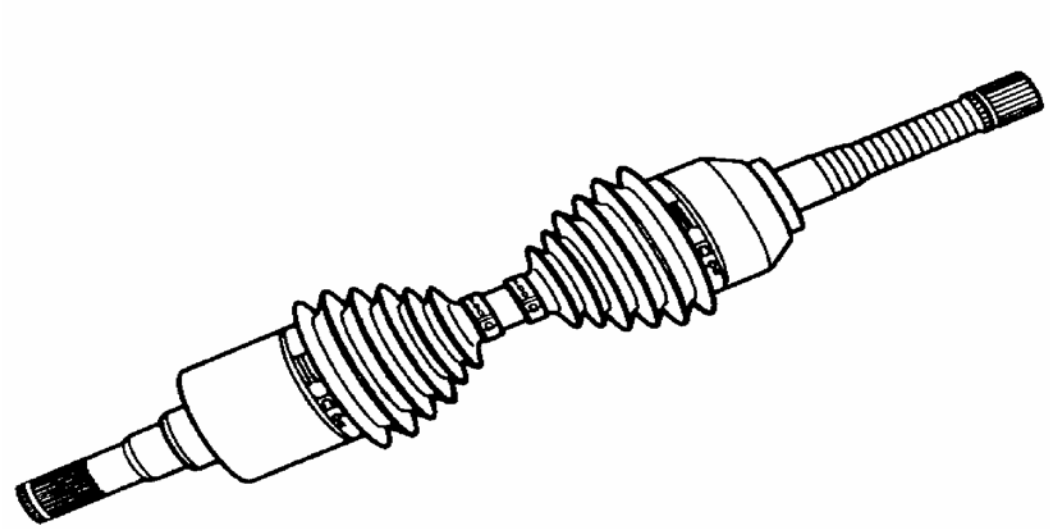


Spindle Nut Torquing

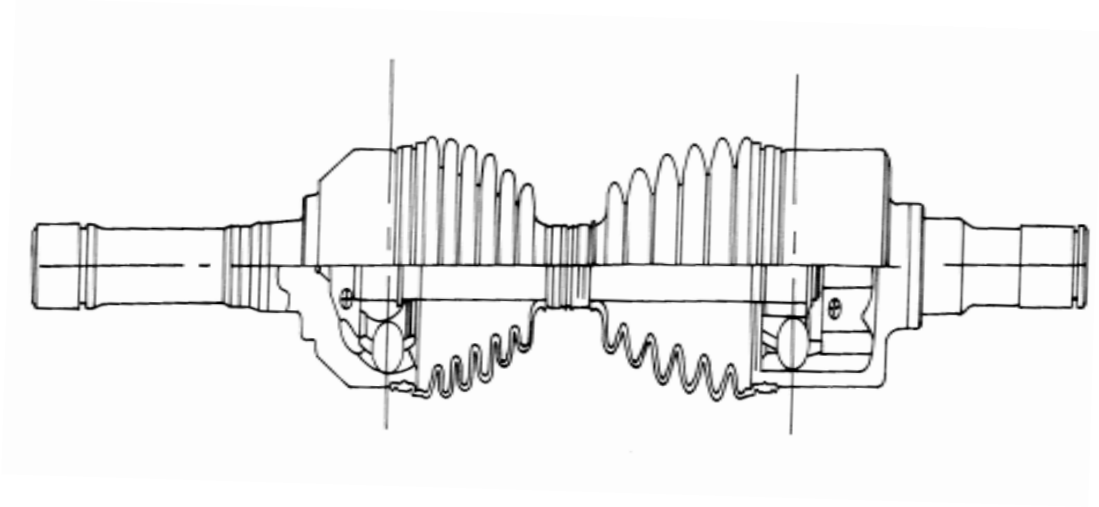


90 Degree Reverse Torquing

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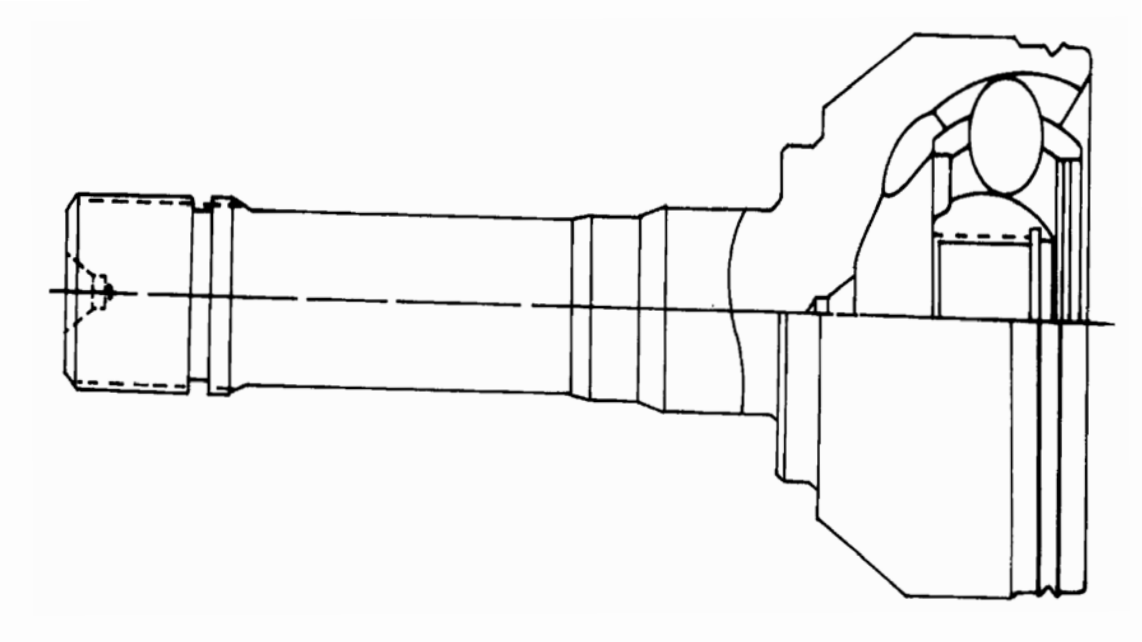


C.V. Joint Assembly

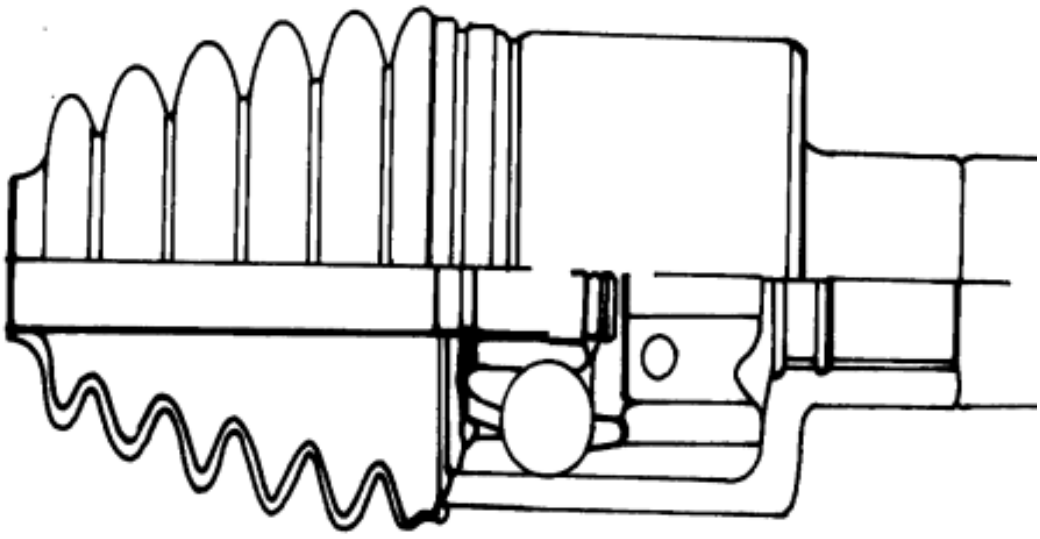


C.V. Joint Assembly

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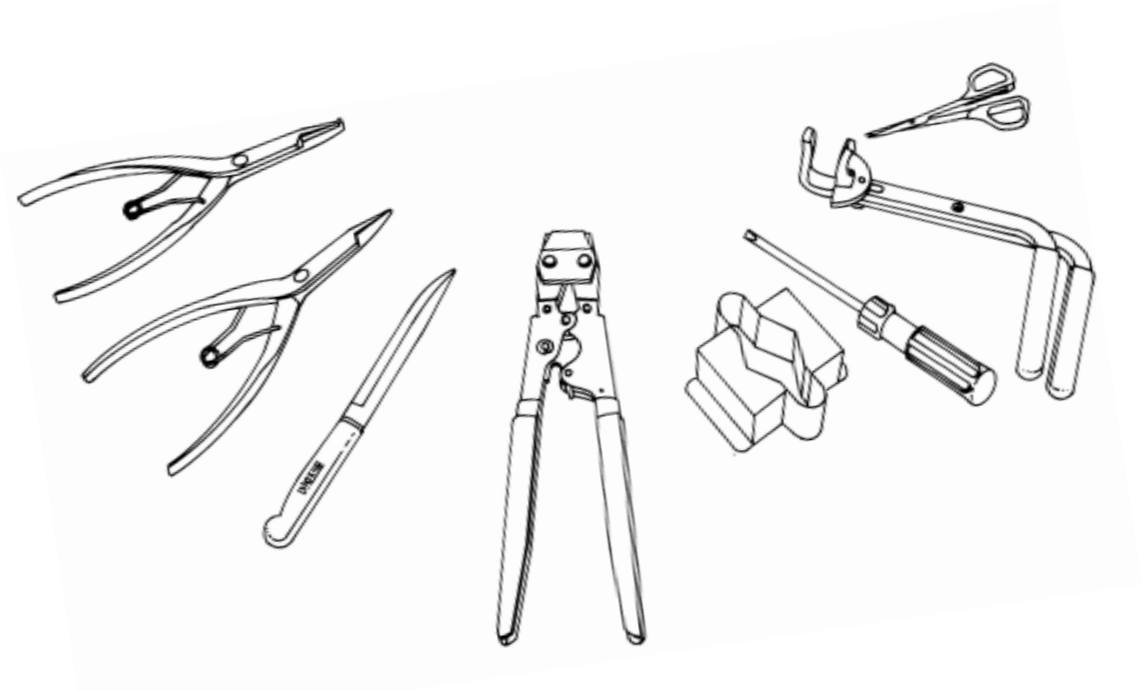


DOJ (Double Offset Joint) Assembly

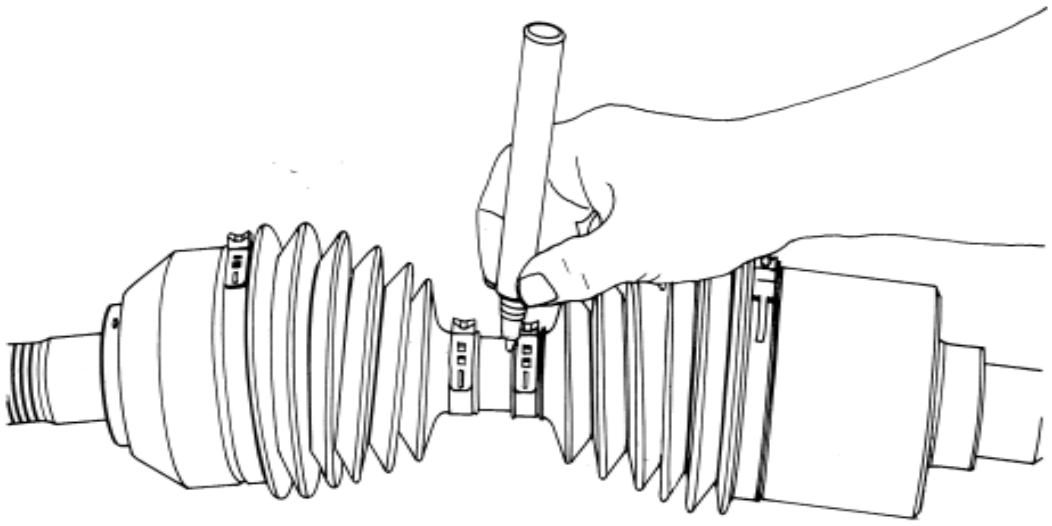


Rzeppa Assembly

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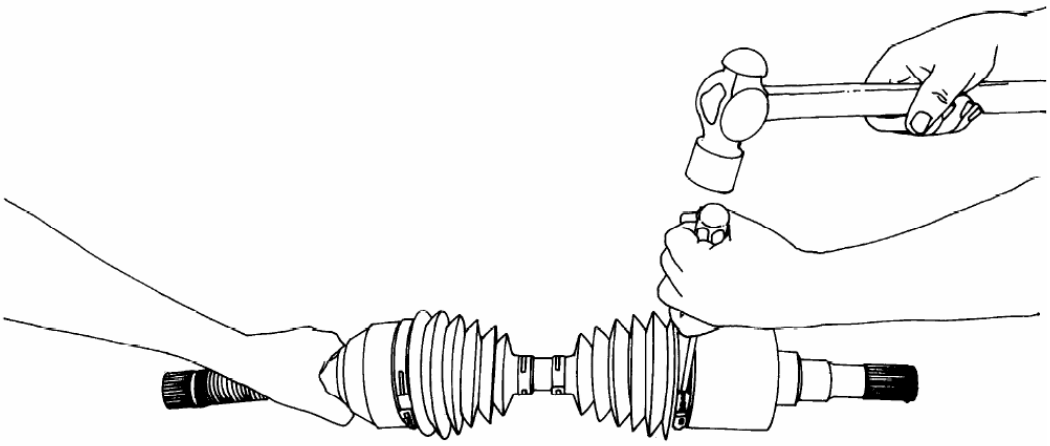


Special Tools FOR C.V. Joint Assembly / Dis-assembly

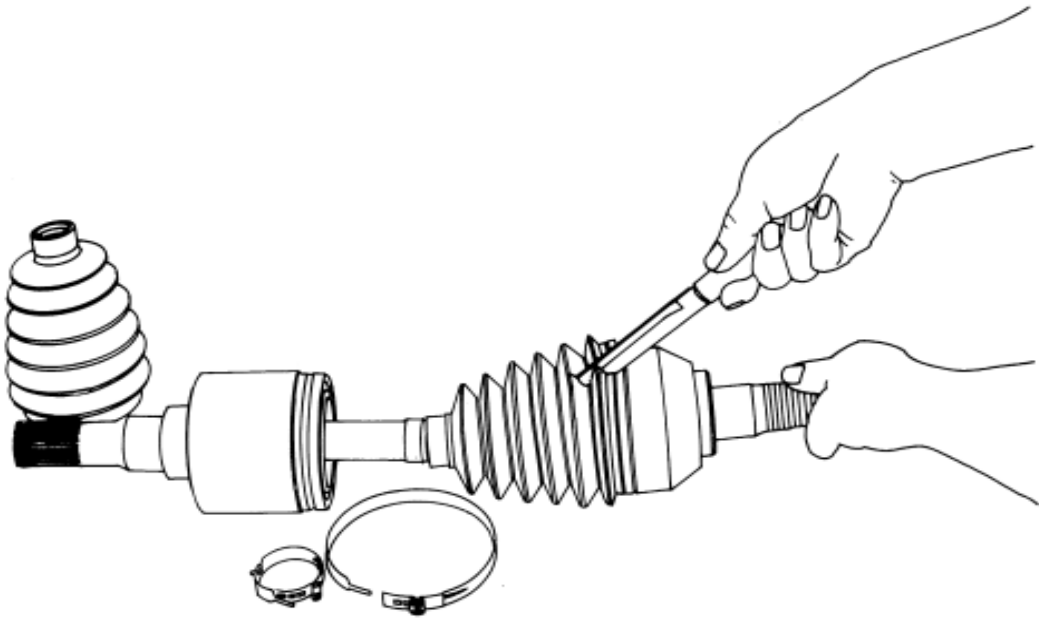


Mark before removing the rubber boot by marker

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Removal of Boot Clamp.



Removing of Rubber Boot

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Specifications

Wrench tightening torque Specifications

	Socket	Kg-cm	N-m
Cover screws ----------	1/2”	3.8-4.5	38-45
Fill plug ----------	1/2”	2.0-3.5	20-35
Diffcase Brg capscrews--	3/4”	4.5-6.8	47-68
Ring Gear screw---------	11/16”	9.5/12.2	95-122
Pinion nut ----------	11/8”	21.7-35.0	217-350
Drain plug ----------	3/8”	2.0-3.5	20-35
Pinion brg preload -----	-----	2.26-4.52	23-46
Breather Adapter-------		3.0 - 4.0	30-40

Specifications

Wrench tightening torque Specifications

	Kg-cm	N-m
Brake shield mounting Bolts-----	3.4 - 4.7	35-47
Hub Assly & Brake disc Assly--	5.8-7.8	58-78
Brake disc Run-out----------	0.10mm Max	
Spindle Nut Torque----------	6.8	68
Spindle lock Nut Torque-------	20.3-30.5	203-305
Total End play(After C.V insertion)	0.10mm Max	

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Rear Axle

Contents

Description
Trouble shooting
Car of the axle
In Vehicle Adjustment & Repair
Rear axle Overhaul
Specification
Tightening Torques
Special Tools
Lubricants

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Description

The rear axle is of the hypoid, semi-floating type using shim adjustment to obtain bearing pre-loads. The differential case with Crown wheel and the drive pinion are mounted in opposed taper roller bearing in one-piece rear axle carrier.

The rear axle pinion receives its power from the engine through the Transmission and driveshaft. The drive pinion rotates the differential case through the engagement with the crown wheel, which is bolted, to the differential case flange. Inside the differential cages are four differential pinions mounted on the differential pinion shaft which is splined to the housing. These gears are engaged with the side gears, to which the axle shafts are splined. Therefore as the differential housing turns, it rotates the axle shaft and the rear wheel. When it is necessary for one wheel to rotate faster than the other is, the faster turning gear causes the pinion to roll on slower turning gear to allow differential action between the two axle shafts.

The axle shafts are held in the housing by the bearings and the retainers at the housing outer end. Axle shaft endplay is pre set and not adjustable. The hub bearings are prepackaged for life.

All operations other than the removal of the axle shafts and the replacement of the wheel bearing oil seal should be carried out with the axle removed from the vehicle.

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Trouble Shooting –

Certain rear axle and driveline trouble symptoms are also common to the engine, transmission, tyres and other parts of the Vehicle. For this reason be sure that the cause of the trouble is in the rear axle before adjusting, repairing or replacing any of the axle parts.

Rear Axle Noise Diagnosis –

Basic characteristics in a rear axle are more difficult to diagnose and repair than mechanical failures. Slight axle noise heard only at certain speed or under particular conditions must be considered normal. Axle noise tends to peak or be more pronounced at particular speeds and the noise is in now way a sign of the trouble in the vehicle.

Where noise is present in objectionable form (Loud and/ or at all speeds) the first effort should be to isolate the noise.

Isolation of noise in any one unit requires care and experience and an attempt to eliminate a slight noise may baffle even the most experienced mechanic/ technician.

Axle noise fall into two basic categories: gear noise and/ or bearing noise.

Axle Noise
Gear Noise
Bearing Noise
Others

Gear Noise –

The most important characteristic of the gear noise is that it is usually sensitive to accelerator position. E.g. noise audible under drive condition will often disappear under coast condition (i.e. driving in neutral with the clutch released and engine running) at the same vehicle speed and vice versa.

Axle gear noise whine will always occur at the same road speed and throttle setting i.e. drive or coast (i.e. driving in neutral with the clutch released and engine running). Gear whine is usually a fairly high pitched pure tone as opposed to a low-pitched rumble caused by a spalled bearing.

Some noises, which can be confused with axle gear whine, are: -

…. Whine from an engine component; this will always occur at the same engine speed irrespective of which transmission gear is used

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…. Whine from an indirect Transmission gear (e.g. 5th gear on some vehicles produces a whine comparable with axle whine) however this will disappear when the direct transmission ratio is selected.

…. Whine from tyres or wind noise from a rack or aerial. These noise generally occur over a very broad speed range and do not change with driving mode i.e. drive or coast (i.e. driving in neutral with the clutch released and engine running)

Remember

Before diagnosing the whine as axle gear noise, ensure that the whine:

(a) Occurs in direct transmission ratio (4th gear)

(b) Changes with throttle/ accelerator variations (drive and coast) (i.e. driving in neutral with the clutch released and engine running)

(c) Always occur at the same road speed and not engine speed,

(d) Occurs over a limited vehicle speed. (This can vary over a wide band should the axle be in extremely bad condition.)

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Bearing Noise –

Bearing noise is inclined to be less throttle sensitive than gear noise and frequently occurs over a wide speed range. Bad cases of faulty bearings can, in fact be detected from walking speed, building up in pitch as speed increases and is not directly affected by changing from drive to coast (i.e. driving in neutral with the clutch released and engine running) and visa versa

(a) Rear wheel bearing noise tends to be low pitched grumble, which can normally be detected and confirmed when driving on a smooth road at constant speed, with the noise most audible while swerving sharply from left to right. If the noise increases or decreases as the car are swerved, it is probable that a wheel bearing is faulty. Driving close to a wall or a curb at a suitable speed can carry out a further check for wheel bearing noise.

(b) Differential bearing noise is usually similar to in pitch to wheel bearing noise but is not affected by the swerve check referred to previously.

(c) Pinion bearing noise is normally at a higher pitch than wheel or differential bearings and is often slightly sensitive to throttle position, although not to the same extent as gear noise.

Other:

1. A further condition, which can exist, is due to a worn bearing that allows the gear set to move out of its correct mesh cause gear noise. This condition is usually throttle sensitive, with the noise frequently disappearing on a “drive” condition.

   Any amount of or endplay in either the pinion bearings or differential carrier bearings are detrimental to the gears and bearings and will cause axle noise.

2. A high spot sometimes occur on either the ring gear or the drive pinion; this shows up as a ticking or light knocking noise over a restricted range of throttle position. The frequency of the noise will indicate whether the high spot is on the pinion (drive shaft frequency) or on the ring gear. The severity of the noise indicates the size of the defect. A light “tick“ is seldom detrimental and usually occurs in new axle and will normally disappear once the axle has been run in.

3. Louder noise usually indicates a more serious defect and a knock occurring in an axle which was previously free from this type of noise must always be investigated.

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Care of the system –

The lubricant level should be checked every 10000 KMs with the vehicle unladen and in a level ground. The lubricant level should be at the lower edge of the filler plug. Use lubricant meeting oils specification of GL 5 and viscosity of SAE 90 .The brand names have been specified in the lubricant section.

First oil change is at 5000 Km
Then at 30,000 Kms
After that every 30,000 Km

Note: Unless otherwise specified the assembly procedure / guidelines is the reverse of the disassembly procedure

IN VEHCILE ADJUSTEMENT & REPAIR –

The works in axle that can be done without removing from the vehicle are:

Replacement of Pinion seal

	Remove the propeller shaft from the companion flange

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	Using the MST 216, Lock the companion flange.
	Unlock the pinion nut
	Remove the companion flange along with the dust cover
	Using screwdriver take out the old oil seal- take care not to damage the seating / contact areas/
	Fit the new seal using the dolly. Apply oil on lip and ensure that seating are has been wiped clean and free of burrs

The backlash adjustment should not be done on the vehicle. This is due to the fact that the spreader usage in vehicle is difficult if the vehicle isn't being attended in a pit. Further after adjustment it may be necessary to adjust pinion height. (Any change in backlash indicates wear- hence though shim adjustment may compensate for gear teeth wear. It will not compensate the pinion wear and pinion bearing wear and loss of preload)

However it is suggested that the tooth contact be checked on the vehicle



before taking decision to open/ overhaul. It is recommended that after draining the oil and opening the rear cover. Put paint marks in four different places. Then push the vehicle forward and backwards at least 15 feet. This will give a much better tooth contact under load. (It should be remembered that with load the tooth contact moves away from toe to heel). The tooth contact without load is given in the specification sheet.)

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Rear axle Overhaul –

Comprises of the following major steps

1. Removal & Refitment of the axle from the vehicle.
2. Removal of the Refitment of the hub and the brake carrier and oil seal.
3. Removal of the differential assembly.
4. Pinion height adjustment and preloading of pinion bearings
5. Assembly of the crown wheel.

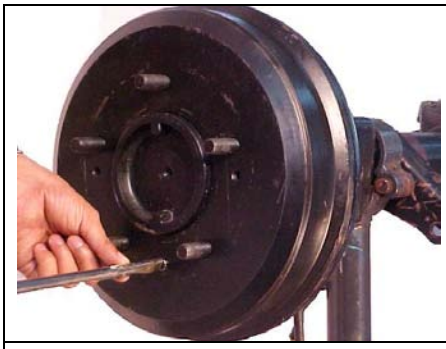
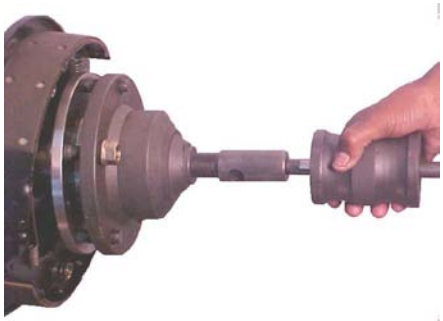
1) Removal and Refitment of the axle assembly from the vehicle

	Support the body on stand and remove the tyres.
	Remove the shock absorber.
	Remove the brake pipe T clamp from axle
	Remove the LSPV spring from axle end
	Loosen suspension links. Axle to be supported & should not fall
Remove the axle from the vehicle	

2) Removal & Refitment of the rear axle shaft & hub

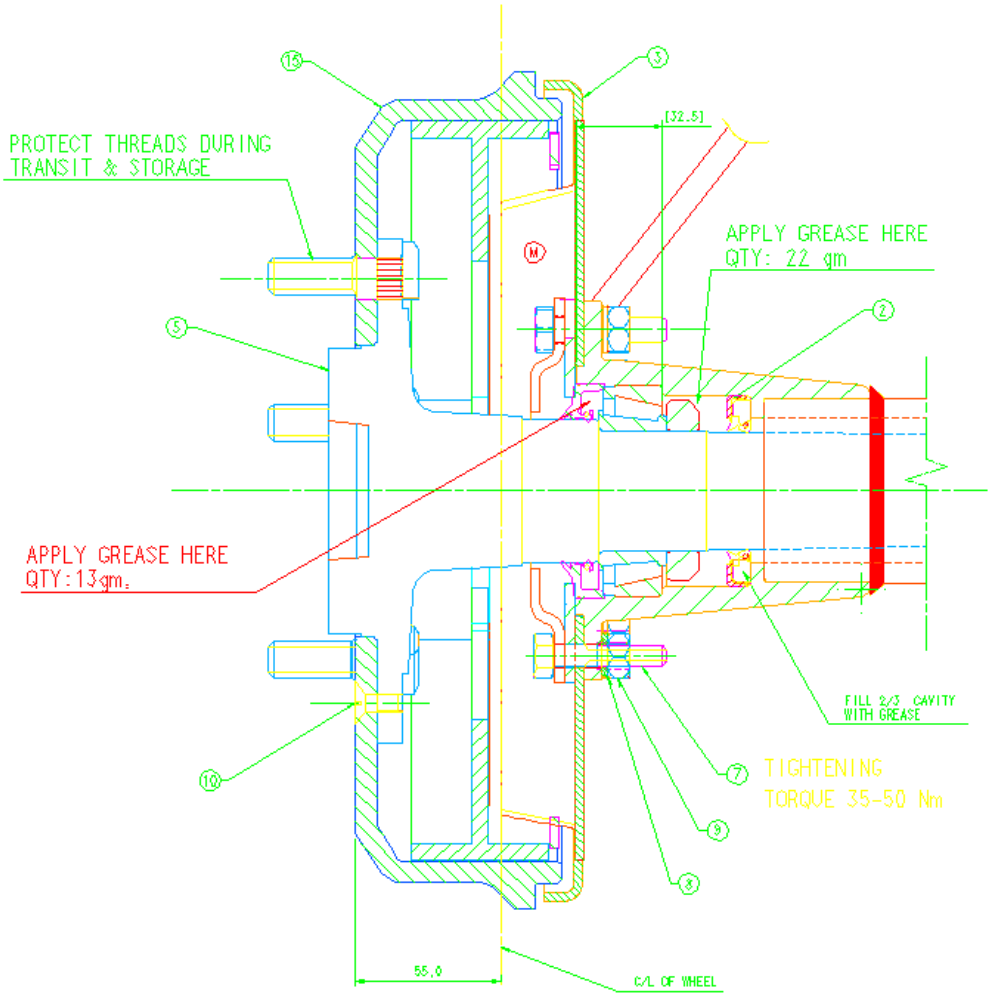
	Remove the brake drum after loosening the two screws

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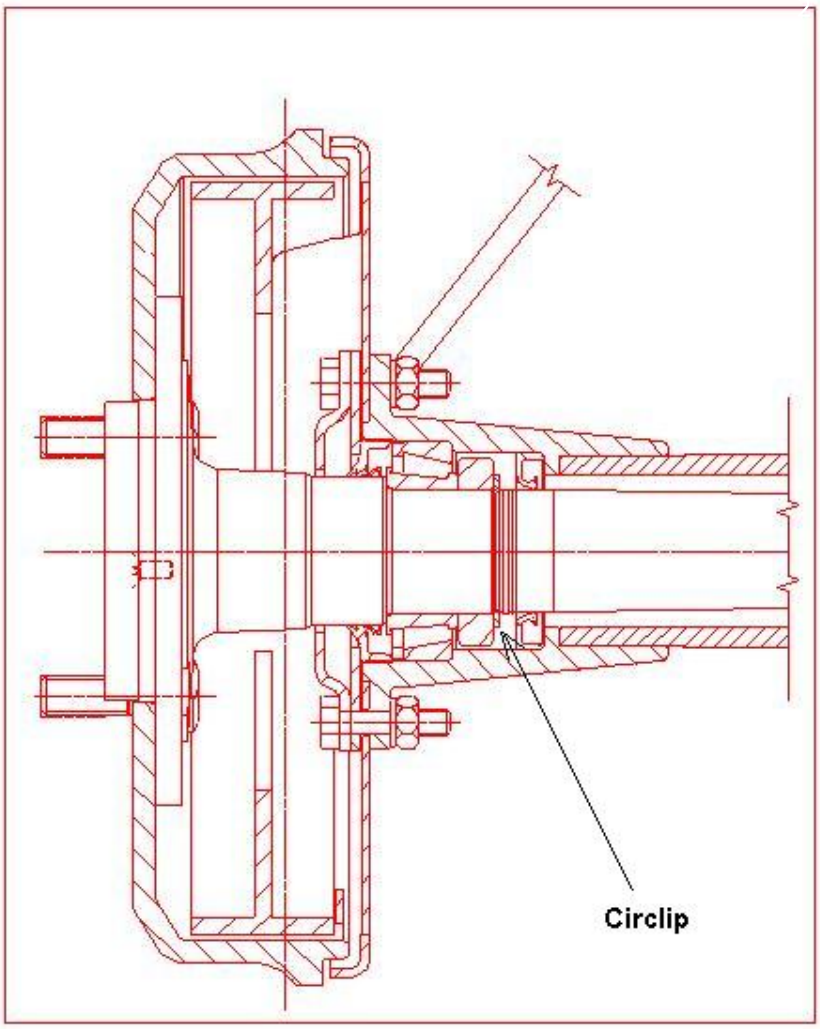
	
	Remove the parking brake locking
	Loosen the 6 screws holding the retainer.
	Using the MST576 and the sliding hammer MST 577. Pull out the hub integral with the axle shaft, prepackaged bearing, retainer ,oil seal and carrier
	For removal of the bearing the locking collar has to be cut using a drill. It should be cut up to the end and then using the chisel it should be snapped open

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	Remove bearing using the hydraulic press and the MST.
	While assembly use the MST 578 to support the bearing & tube MST 579 for pressing



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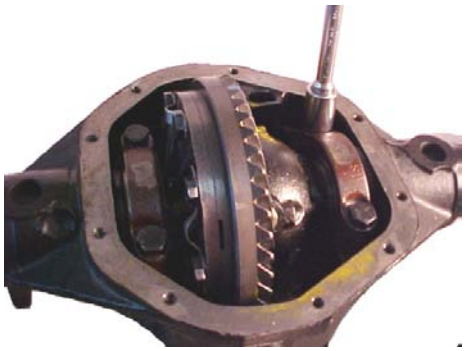
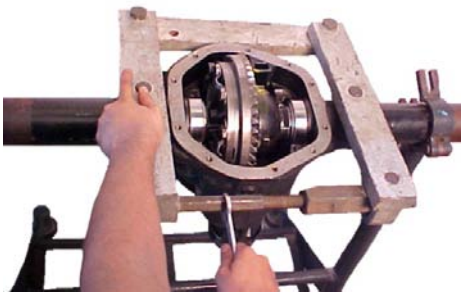


The assembly section is shown in the sketch attached. Please note the bearing direction the circlip

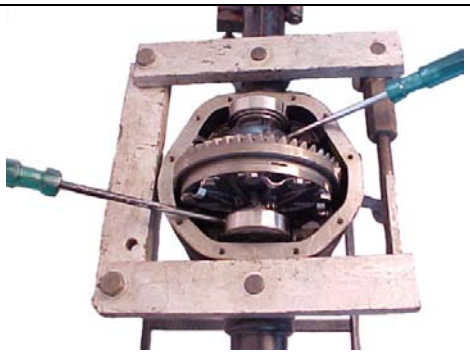
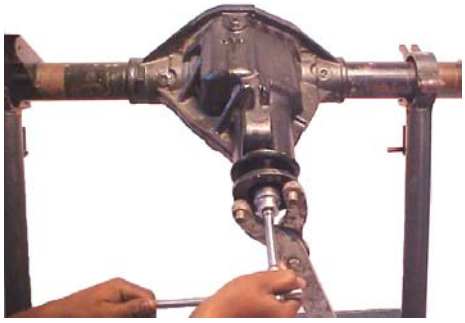
⚠	**DO NOT ATTEMPT TO FIT THE LOCKING COLLAR BY HEATING.** **THE COLLAR IS HARDENED AND TEMPERED.HEATING & PRESSING MAY CAUSE IT TO LOOSEN IN SERVICE CAUSING MAJOR FAILURE**
	While reassemble use the hole in axle shaft flange to tighten the retainer bolts. Please ensure that the hydraulic press is capable of at least 10 tons load and it has an adequate stroke.

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3) Removal of the Centre assembly

	**After draining the oil - remove the differential cover set screws.**
	Remove the differential side bearing bolts
	Remove the side bearing caps,
	Using MST 205, expand the differential.

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	Pull out the crown along with the bearings
	Using MST 216, lock the companion flange.
	Unlock the pinion nut.
	Remove the companion flange along with the dust cover
	Tap the pinion along with bearings,

4) Assembly of the Centre assembly

Using the special tool

Without the special tool

Preloading of the crown wheel and backlash adjustment.

The pinion preload setting and tooth contact setting can be done by using:

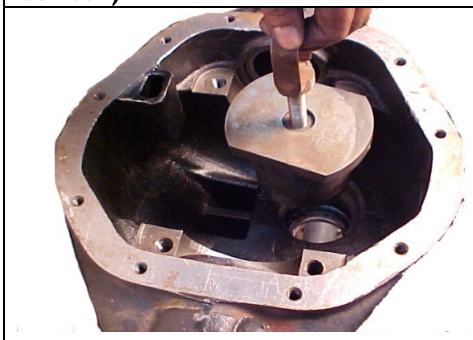
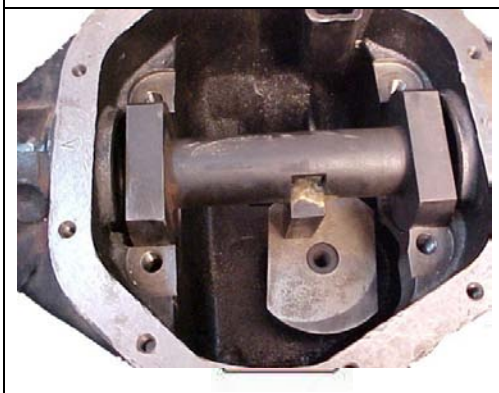
a) Special Tool**. The special tool and gauges are strongly recommended in either of the scenario**

- **new axle housing is used or**
- **the bearing seating surface has worn out.**

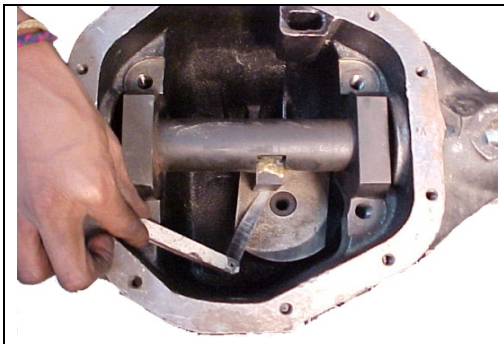
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b) Without the use of special tools. **This can be done only if the crown wheel & pinion is being replaced in the existing housing and the crown wheel bearing seating and the pinion inner bearing seating area is not worn.**

4 a) Assembly Using the Special Tools

	If the pinion bearings are having pitting, flaking or spilling of the raceway then they have to be replaced. Remove the outer race using the MST (For Fitting use MST 200)
To measure the Z value (distance of pinion apex from the carrier center)	
	Place the setting gauge (MST 581) in the carrier (the pinions inner bearing outer race & shim should be removed) Please note that the lifting handle should be removed after placing it in position
	Place the setting gauge 2 – MST 582 (in the crown wheel bore)

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	Measure the gap between the setting gauge 1 and 2 using a feeler gauge.
	Ensure that the gauge 582's face is parallel to the differential case. (Use a level gauge)
	For example if the thickness measured X is 12 thou
	The value etched in pinion is Y Then the shim value is X-Y In this example it will become 12-5= 7 thou
	Place the 7thou shim below the bearing seating area.
	After that cross check the gap between the gauge and the new pinion. It should be the same as the Z mark punched. In this case 5 thou (tolerance ± 1 thou)
	In case the Z value is negative then the gap has to be checked between the bore & MST 582.

This will ensure that the tooth contact of the Crown wheel and pinion is accurate

<u>However this shim also affects the distance between the two pinion bearings and thus will affect the pinion bearing preload</u>.

	Suppose 10 thou of shims were the thickness originally present

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	(at the height adjusting end and the new value is 12 thou.)
	Hence to maintain the pinion bearing preload equal amount of shims at the outer bearing end will have to be adjusted Since the shim thickness at the inner bearing has increased by 2 thou hence add 2 thou of shims from the other end.
	If the pinion preload is not as per the specifications after assembly then add or remove shims from the outer bearing end.
	Please note that if the shims are removed or added at the outer end for adjusting the preload then do not add or remove shims at the height adjusting end- that will disturb the contact.
	Before inserting the companion flange at the end apply **Loctite 638** in the splines so that the loosening can be avoided.

4 b) **Only if the crown wheel & pinion are being replaced – no wear on seating surfaces is present**

	If the pinion bearings are having pitting, flaking or spilling of the raceway then they have to be replaced. Remove the outer race using the MST (For Fitting use MST 200)

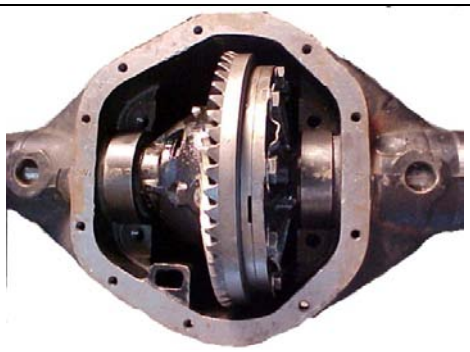
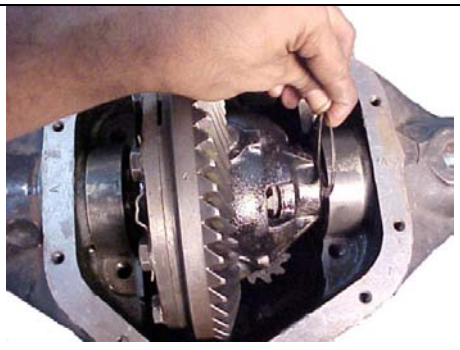
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	If the crown wheels bearings are having pitting, flaking or spilling of the raceway then they have to be replaced. For removal of the bearing use MST 202 (For fitting the crown wheels side bearing use the MST
	Note the Z value etched on top of the old pinion (O) and the Z value etched on the top of the new pinion (N)
	The correct shim thickness = O-N (Old-New) If the value is + then shims have to be added and if - then shims have to be removed. These shims are between the pinion inner bearing outer race & the housing.
	This will ensure that the tooth contact of the Crown wheel and pinion is accurate
	However this shim also affects the distance between the two pinion bearings and thus will affect the pinion bearing preload.
	Suppose 2 thou of shims are adjusted. E.g. + 2 added
	Then to maintain the pinion bearing preload equal amount of shims at the outer bearing end will have to be adjusted Since the shim thickness at the inner bearing has increased by 2 thou hence add 2 thou of shims at the other bearing
	If the pinion preload is not as per the specifications after assembly then add or remove shims from the outer bearing end.
	Please note that if the shims are

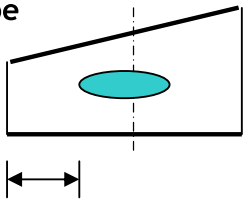
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	removed or added at the outer end for adjusting the preload then do not add or remove shims at the height adjusting end- that will disturb the contact.

Adjustments of the crown preload & tooth backlash

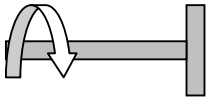
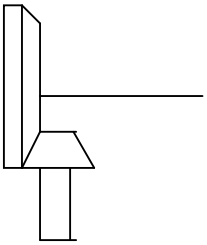
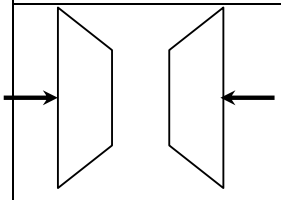
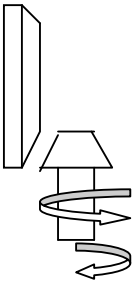
	Install the crown, in the carrier. Instead of using the bearings use MST 583, - one on each side. The advantage of using the MST instead of bearings while setting is that as the outer race does not keep getting tilted hence we get accurate reading further the bearings do not get damaged when they are removed after checking the values of shims required.
	Push the crown assembly towards the pinion so that the backlash is zero.
	In this position find the shim pack which has to be inserted on right (Back of crown) side. And also on the teeth side.
	Move shims from teeth side to back of the crown side so that the backlash is achieved.
	Add an additional 0.075mm (0.003")- of shim on the both the side so that the crown teeth get preloaded.
	Take out the assembly; keep the selected shim packs correctly.
	Remove the MST 583.
	Insert the bearing assembly along with the selected shim pack.

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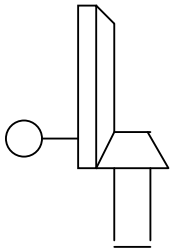
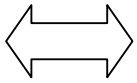
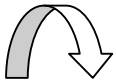
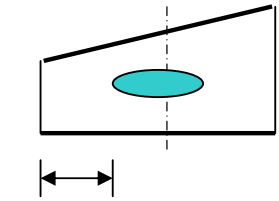
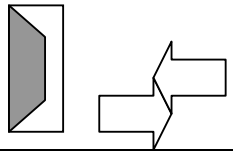
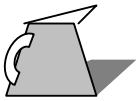
	Use MST 205 to spread the carrier.
	While using the spreader ensures that the expansion is not more than 0.5 mm. If more it can cause permanent deformation of the carrier.
	While assembling the caps ensures that the markings match. Torque- 9.6 to 12.5 M-kg (70 to 90 Lb-ft)
	Check the backlash, if less or more then the shims should be moved from one side to the other. Note: Approximately 5 thou shim is equal to 3 thou of backlash.
	Check the backlash. 0.13 to 0.25 mm (0.005”-0.010”)
	Check the run out in four places it should be less than 0.15 mm (0.006”)
Toe **Heel**  6 mm	After the backlash has been achieved, check the tooth contact on both the drive and the reverse side. Note since the crown wheel is without load hence the contact should not be exactly at center but as shown in the sketch.

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Specifications -

Figure	Description	Value	
	Semi floating single reduction without diff. lock		
	No of teeth on crown N1		
		43	
	No of teeth on pinion N2	10	
	Axle reduction ratio N1/N2	4.3	
	Pinion Pre load	23 to 45 Kg-cm	
	Preloading of differential bearings	0.075 mm (0.003”	
	Crown-pinion backlash Maximum variation of backlash in a crown	(0.005 to 0.008” (0.003”)	

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	Run out of the ring gear / crown wheel	0.15 mm (0.006")
	Hub end play	Max 0.3 mm (0.0012")
	Hub rotational torque	Not applicable
Toe Heel 	Check for correct tooth contact on both the forward and reverse direction	Check on both the driving & reverse flank. This contact is for checking without load.
	Clearance between and side(sun) gears and diff case	0.20 mm (0.008")
	Rotational torque of differential case with sun & pinion gears	5 Kg cm
	Inner race interference Outer race clearance	0.125 mm (0.005 to 0.007")
	Oil grade/ Viscosity/ Quantity	GL 5/ SAE 90/ 1.65 liters

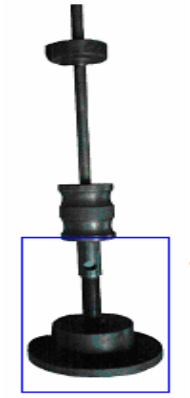
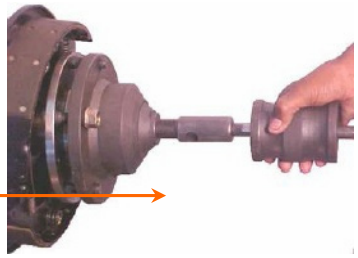
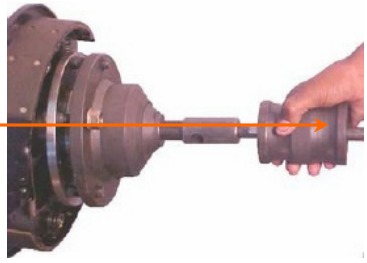
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Tightening Torques -

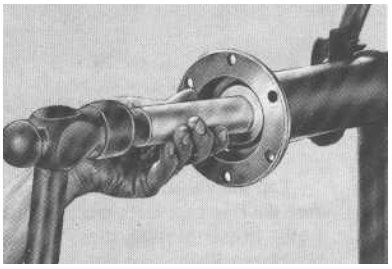
Location	Torque in Nm (lb-ft)
Brake carrier mounting bolts	33.8 to 47.45 (25 to 35 lb-ft)
Pinion nut	217 to 244 (160 to 180 lb-ft)
Crown mounting nuts	54 to 68 (40 to 50 lb-ft)
Differential side bearing bolts	95 to 122 (70 to 90 lb-ft)
Differential disc cover bolts	16 to 20(12 to 15 lb-ft)

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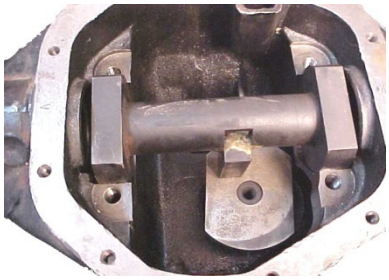
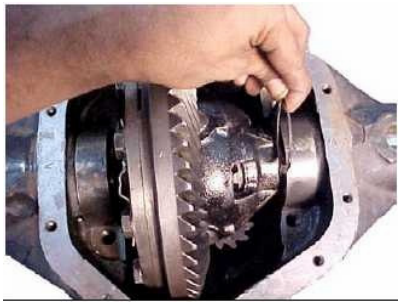
Special Tools -

Description / Part No. / Sketch	Usage View
Puller rear axle shaft MST 576 	
Sliding Hammer MST 577 	
Ring Rear axle collar support. MST 578 	

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Description / Part No. / Sketch	Usage View
Tube-Rear axle collar pressing MST 579 	
Installer Inner Oil seal Rear axle tube MST 580 	
Rear axle Pinion Height setting Gauge (1) MST 581 	

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Description / Part No. / Sketch	Usage View
Rear axle Pinion Height setting Gauge (2) MST 582 	
Differential side bearing setting gage MST 583 	

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Recommended Lubricants –

Specification: GL 5; SAE 90
Maximil DO- EXL

Brands

Maximile : Recommended	Maximile DO
Other options	
IOC	SERVOGEAR HP 90
HP	HP GEAR OIL XP 90
BPCL -	BHARAT SPIROL HD 90
BHARAT SHELL -	SPIRAX HD 90
CHEMOLEUMS -	CHEMOLEUMS TURBO GL5 SAE 90
GULF	MP GO 90
CALTEX	THUBAN GL5-90
VEEDOL	VEEDOL MULTI GEAR 90 HD
CASTROL -	CASTROL HYPOY B 90

Sealant –

Differential cover sealant : Loctite 587 / Gasket

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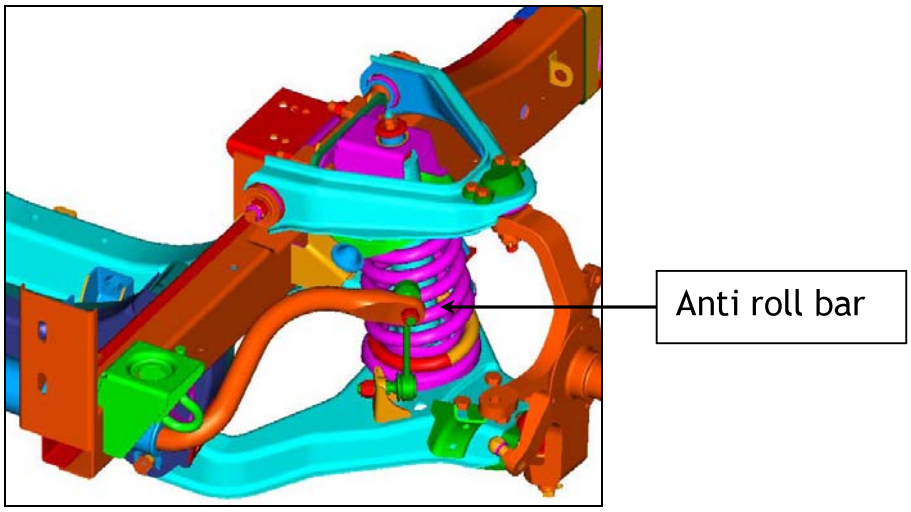
Front Suspension

Contents

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Trouble shooting
Car of the system
In Car repairs
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Working principle, Dismantling & Assembly of the Front Suspension 2WD
Specification & Wear Data
Lubricants
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The front suspension is independent while rear is multilink type. The front suspension in the 2WD vehicle is wishbone type with helical spring and telescopically acting hydraulic dampener. In the 4WD vehicles, the suspension is torsion bar type with hydraulic dampener.



The front also employs anti roll bar with ball joints on the connecting links as shown in the sketch to transfer the loads to the outer wheel during turns.

Trouble Shooting

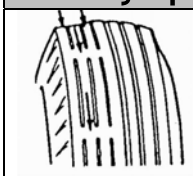
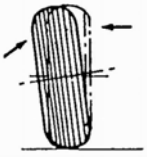
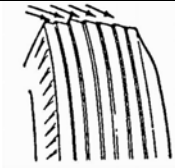
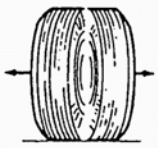
A squeak noise from the shock absorber can be produced if movement between the rubber bushing and metal occurs. Tightening the attaching parts can usually stop this noise. If the squeak noise persist then inspect for worn or damaged bushings and attaching components. Repair as necessary if any thing found amiss.

Squeak also happen due to relative movement from suspension arm's bush inner sleeve (serration end) and chassis bracket. This situation happens, if torque is not as per specs. Torque tightening the LCA & UCA bolts normally resolves the issue.

The shock absorber bushings do not require any kind of lubrication. Do not lubricate the bushings to reduce bushing noise. Grease or mineral oil base lubricants will deteriorate the bushing.

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The shock absorbers are not refillable or adjustable. If a malfunction occurs, the shock absorber must be replaced. To test a shock absorber hold it upright in fully extended position for 10 minutes. Then force the piston in and out of the cylinder four or five times. The action throughout each stroke should be smooth and even.

Symptom	Causes	Remedial action
 **One Edge Wear**	 Excessive camber	✓ Check and adjust: ✓ Hub end play ✓ Camber to be checked and adjusted.
 **Feathered Edge Wear**	 Incorrect Toe In	✓ Check & correct Toe In ✓ Check the chassis bend ✓ If tyre rotation not carried out as per schedule. Do the tyre rotation.
Excessive Vehicle rolling	1. Body Mounts loose. 2. Suspension mounting loose. 3. Broken or deteriorated stabilizer	✓ Tighten the body mounts. ✓ Tighten the suspension mounts. ✓ If broken stabilizer bar- replace

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	4. Worn stabilizer bush 5. Malfunctioning shock absorber 6. Stabiliser link bolt loose	✓ Replace the bushes & tighten to the specified torque, ✓ Replace the shock absorber. ✓ Tighten the link bolts
Vehicle inclined	Broken or deteriorated coil spring	✓ Replace the coil spring
Noise	1. Parts worn or loose 2. Broken coil spring 3. Malfunctioning shock absorber	✓ Tighten the parts or replace ✓ Replace the coil spring ✓ Replace the shock absorber



Caution: Do not lubricate the suspension bushes/joints.

Care of the system

- ✓ The first wheel alignment should be carried out at 5000 kms then at 10,000 Kms. Subsequently every 10,000 kilometres.
- ✓ Torque tighten the LCA & UCA bolts to the required torque. (Upper arm 110-130 Nm , LCA front 150-180 Nm; LCA rear 110-130 Nm)
- ✓ First at 5000 Kms then subsequently every 10,000 Kms.
- ✓ Check the shock absorber for leaks every 10,000 Kms.
- ✓ Check the rubber bushes for the mounting of the shock absorber, stabilizer bar and links every 20,000 Kms or once in a year

In Car repairs

a) ***Wheel*** alignment
b) Wheel hub ***greasing***

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a) Wheel alignment

The sequence of the wheel alignment, which should be followed, is:
Carry out the runout compensation when using the computerized equipment

1. ***Steering Wheel Centralize- cross check & adjust***.
2. Castor checking & adjustment (***Computerized*** / ***Manual***)
3. Camber checking & adjustment(***Computerized*** / ***Manual***)
4. Toe in checking & adjustment. (***Computerized*** / ***Manual***)
5. ***Wheel Turning Angle***, checking and adjustment. (Computerized / Manual)
6. ***Check*** the centralization of the Steering wheel as the final operation

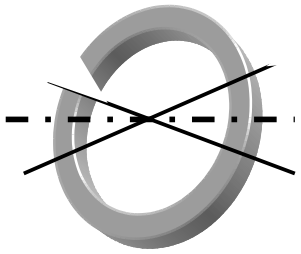
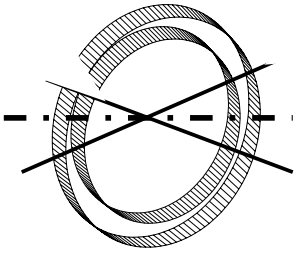
Caution: In order to obtain the correct values and avoid complaints. Please note that that the following parameters have to be adhered to without fail:

- **The tyre pressures in all the four wheels are as per the specifications.**
- **Vehicle should be unladen and parked on level surface**
- **Ensure that the wheel hub play is correct.**
- **Check that the chassis and the under body are not coated with mud. If in doubt get the vehicle cleaned before doing the checking.**
- **Check the ride height variation as per the specification.**
- **Replace the parts of suspension if found badly damaged**
- **Before starting the measurement, ensure that the parking brakes are applied and the rear wheels are blocked**
- **Before doing the wheel alignment - ensure that the linkages i.e. the ball joint are not worn or loose. Check the free play in the steering.**
- **All the tyres and the wheel disc should be of the same type.**

Caution: This procedure for centralizing the Steering wheel is valid only if the misalignment of the spokes is less than 10 degrees. In other words this procedure is only for fine-tuning the steering wheel position not for glaring error. If it is more 10 degrees then remove the steering wheel and initially realign to less than 10 degrees.

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Steering Wheel Centralization

	To check for the centralization of the steering wheel. Drive the vehicle on a level road surface; note the angular position (misalignment of the steering wheel spokes.
	Raise the vehicle. Keep the wheels in Straight Ahead Position.
	Mark the position of the track rods and the track rod ends.
	Slacken the track rod end lock nuts and also remove the gaiter outer retaining clips.
	Rotate both track rods in the same direction approximately 30 degrees for every 1-degree of steering misalignment error.
Clock wise error  Anti clock wise error	If the steering wheel has an anti clockwise angular error then both track rods must be rotated clockwise- when viewed from the left – hand side of the vehicle.
Clock wise error  Anti clock wise error	If the steering wheel has an clockwise angular error then both track rods must be rotated anticlockwise- when

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	viewed from the left – hand side of the vehicle

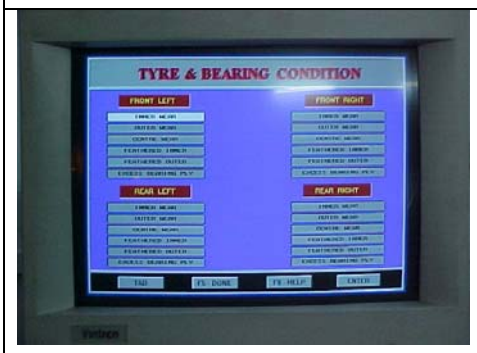
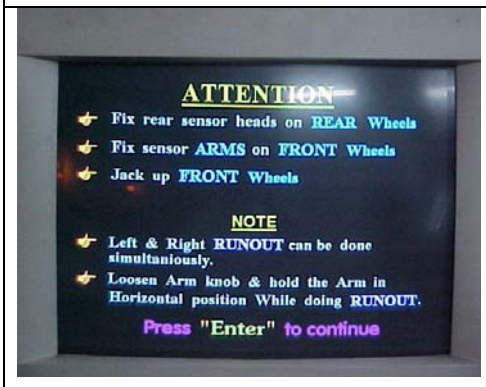
With the computerized wheel alignment gauges the checking procedure may vary slightly. However the sequence of checking and the adjustment procedure remains the same. The most common error made while doing the wheel alignment using the computerized equipment is that the wheel run out compensation procedure is not carried. That is one of the reasons of poor repeatability

The computerized wheel alignment machines, which have been approved by M&M, are of Precision or Manatec make. It is mandatory that the wheel alignment machine be calibrated at regular interval specified by the individual Manufacturer.

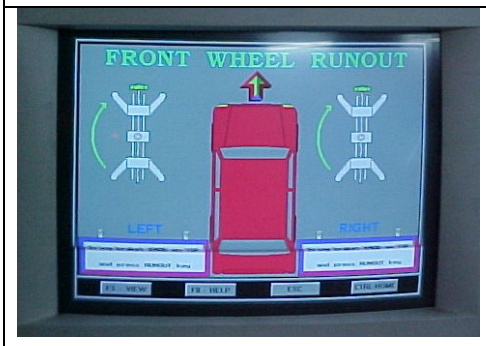
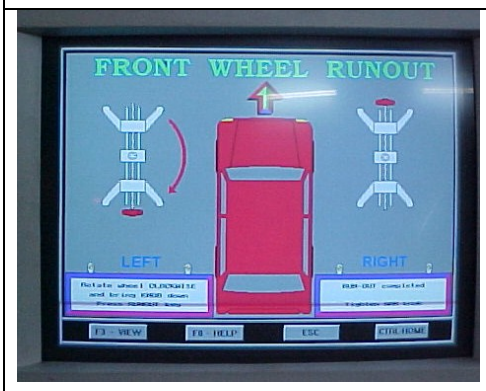
Wheel alignment using computerised gauge (Photos are with Manatec)

	Start the computerised alignment machine. Move the cursor to the alignment name and press enter.
	Enter the details of the details as displayed on the screen, the vehicle code can be selected from the list by pressing the F3 button on the key board. For moving to the other details press “enter” or “tab”. Press “F5” when all the details are

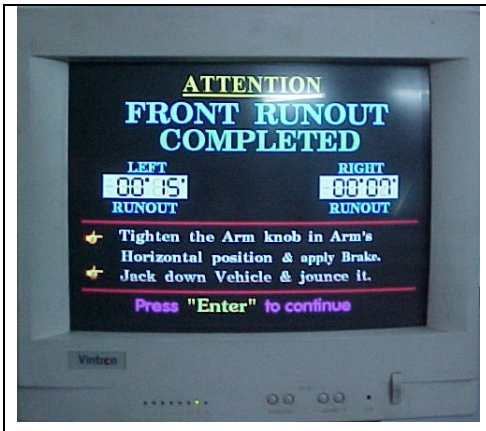
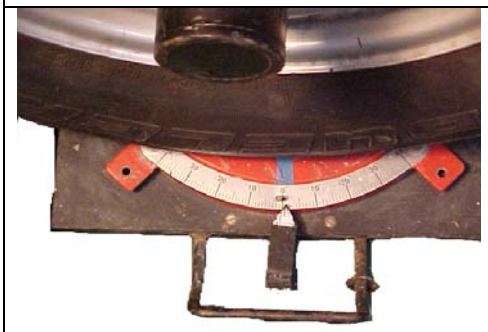
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	entered.
	State the tyre and the bearing condition. The condition can be selected by moving the up or down arrow keys. For selecting particular condition press enter. For going to the next tyre condition press “tab” key. When the conditions are selected press “F5” key
	From the alignment menu select two wheel Alignment, since our vehicle have fixed alignment at the rear.
	Fix the sensors on the rear as well as front wheels. Caution: While fitting the sensors ensure that the clamps are properly tightened. The right sensors are in place, sensors are marked with right and left side.

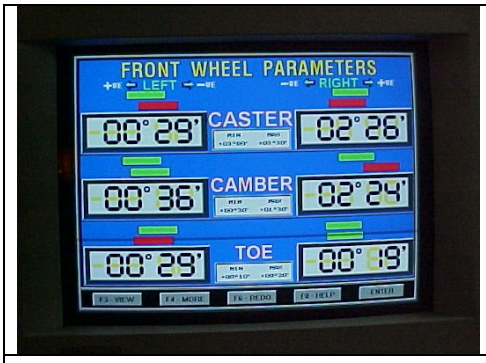
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	Ensure that the bubble in the spirit level of the rear sensor is set in the center of the marking made on it. Jack up the front wheels. Loosen the knob on the sensor.
	For the runout press the runout key on the sensor as shown in the figure.
 	Move the tyre in the direction as shown on the screen by holding the sensor, after completing half rotation press the run out key on the sensor complete the remaining rotation. **Caution :** Move the tyre slowly and smoothly.

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	The front wheel run out will be displayed, press “enter” key to continue.
	Remove the lock-pins of the turning table
	For achieving the straight ahead position move the steering wheel slowly to the directions as displayed on the screen first to the right and the to the left. Hold for some time at the end, for the computer to acquire data. Hold for some time at the centre position. Fix the steering lock at that position. Press “enter” key to continue.
	Press “enter” key to continue. The values of Castor, camber, and toe will appear.

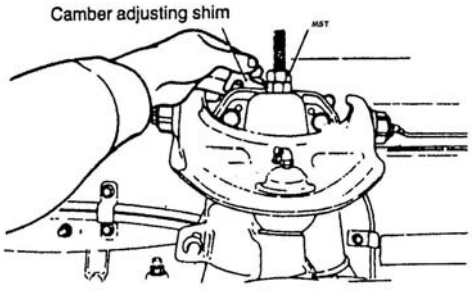
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	The castor & the camber are adjusted by addition or removal of The Toe is changing the track rod end distance. When done press “enter” key.
	The sequence of adjustment which have to be carried is Castor Camber Toe in adjustment
For adjusting the Castor	
	The values should be within 2.75 °±1.00 (2°45’± 1.0°)
	The difference between the two wheels should be within ±45'
	The adjusting shims are available in 1.6, 0.4-mm thickness. ***Addition of shims in front between the fulcrum lever and the chassis bracket will reduce the castor.*** ***Addition of shims in rear between the fulcrum lever and the chassis bracket will increase the castor*** ***0.4 mm = 9’(0.15°)*** ***1.6 mm = 37’(0.62°)***
	Loosen the lower arm mounting bolts ,and the upper arm side nuts so that the lower arm movement is free
	Remove the front apron cover.

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	Compress the spring by moving the lower arm, using a jack
	Loosen the fulcrum mounting bolts
	Add or remove shims as required
	Tighten the fulcrum mounting bolts to 12.0 to 14.0 Mkg (87 lb. ft- 101 lb. ft). Also refer to the Torque chart.
	After that decompress the spring.
	Tighten the lower arm mounting bolts. And the upper arm side nuts. As per the Torque chart **Before tightening shake the vehicle by compressing the front and rear of the vehicle alternatively by hand.**
For adjusting the Camber	
	The value for any given wheel should be 0°14' ± 0°30' and the maximum difference between the two wheels should be ± 30'
	The shims are available in thickness of 3.2, 1.6, 0.8 mm. ***Addition of shim between the fulcrum and the chassis bracket will decrease the camber.*** ***0.8mm =0.15*** °(9') ***1.6 mm = 0.32*** °(19') ***3.2 mm = 0.62***°(37') To increase the camber - remove the shims

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	Loosen the lower arm mounting bolts, and the upper arm side nuts. so that the lower arm movement is free
	Take out the apron cover behind the wheel by carefully removing the plastic fasteners
	Compress the spring by moving the lower arm, using a jack.
	Loosen the fulcrum mounting bolts
	Add or remove shims as required
	Tighten the fulcrum mounting bolts to 12.0 to 14.0 Mkg (87 lb. ft- 101 lb. ft). Refer to the torque chart
	After that decompress the spring.
	Tighten the lower arm mounting bolts. And the upper arm side nuts. **Before tightening shake the vehicle by compressing the front and rear of the vehicle alternatively by hand.**
	Cross-confirm the camber value.
For adjusting the Toe In	
	Adjust by moving the tie rod. The tie rods should be adjusted equally on both sides. The

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	variation between left and right side of the tie rods should be maximum one turn. (If it is more than the centralization of the steering wheel will also be affected.)
Adjusting the Wheel tuning angle	
	Bring the Wheels in Straight Ahead Position (SAP). At this position confirm that the turntables Zero are also showing Zero
	Turn the steering wheel to Right Hand Side so that the wheel turns through 36±0.5° **(Please refer the specifications)**
	Check the condition of the stopper bolt of LH side It should touch the bracket on the lower arm assy.
	If it is not touching or the wheel is not able to turn through 36±0.5° then loosen the lock nut adjust the bolt and then lock the bolt with locknut.
	Turn the steering now towards the Left-hand side and then adjust the stopper on the right hand side.

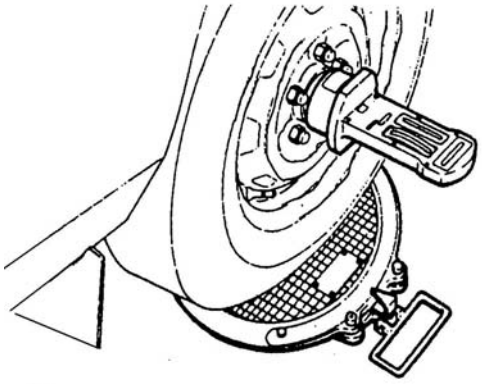
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	For print out press “F10” key to save press “ctrl” and the “home” key together.
	Take print out of the final sheet as displayed in the figure in which all details will be available.
	To exit press ctrl and home.
	The data will be stored in the computer and can be retrieved as and when required.

Even if the manual gauge is used please ensure that it is having high accuracy and also repeatability.

Castor checking (With the bubble type gauge)

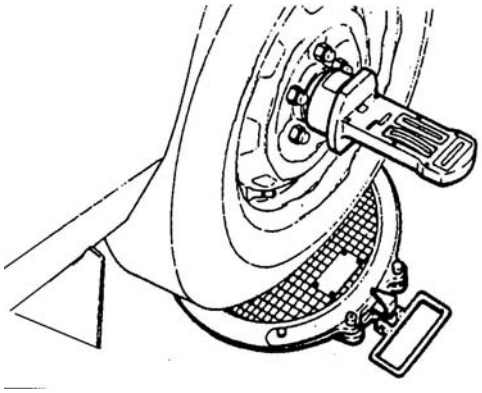
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	Confirm that the bubble is set at Zero and also that the turntable is also set to zero.
	Remove the turn tables locking pin
	Rotate the steering so that the wheel turns inwards by 20 degrees.
	Set the castor scale to zero
	Turn the steering wheel in opposite direction so that it turns outwards by 20 degrees
	The value in the castor scale gives the castor value.
	The values should be within 2.75 ° ±1.00 (2°45'± 1.0°)
	Repeat on the other side
	The difference between the two wheels should be within ±45'
	The adjusting shims are available in 1.6, 0.4-mm thickness. ***Addition of shims in front between the fulcrum lever and the chassis bracket will reduce the castor*** ***Addition of shims in rear between the fulcrum lever and the chassis bracket will increase the castor***

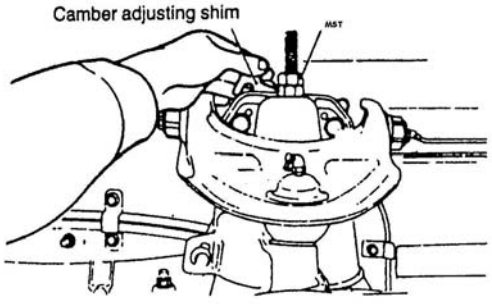
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	0.4 mm = 9'(0.15°) ***1.6 mm = 37'(0.62°)***
	Loosen the lower arm mounting bolts ,and the upper arm side nuts so that the lower arm movement is free
	Remove the front apron cover.
	Compress the spring by moving the lower arm, using a jack
	Loosen the fulcrum mounting bolts.
	Add or remove shims as required.
	Tighten the fulcrum mounting bolts to 12.0 to 14.0 Mkg (87 lb. ft- 101 lb. ft). Also refer to the Torque chart.
	After that decompress the spring.
	Tighten the lower arm mounting bolts. And the upper arm side nuts. As per the Torque chart **Before tightening shake the vehicle by compressing the front and rear of the vehicle alternatively by hand.**
	Cross-confirm the castor value.

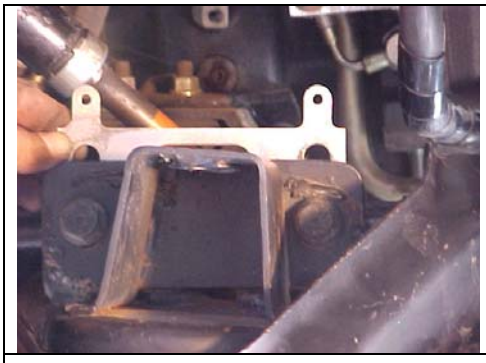
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	Keep the front wheel in straight-ahead condition. (SAP) Clean the hub assembly for any dirt or mud. Remove the front wheel hubcap.
	Install the magnetic base of the gauge in such a way that the centre pin of the gauge aligns with stub axle centre drill and gauge is sitting squarely on the hub. By turning the gauge bring the spirit level to read " ZERO ". The value in the camber scale at this point is the Camber reading. Note the reading
	Repeat the same procedure on the other wheel.
	The value for any given wheel should be 0°14' ± 0°30' and the maximum difference between the two wheels should be ± 30'.
	The shims are available in thickness of 3.2, 1.6, 0.8 mm ***Addition of shim between the fulcrum and the chassis bracket will decrease the camber.*** ***0.8mm =0.15*** °(9')

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	1.6 mm = 0.32 °(19') ***3.2 mm = 0.62***°(37') ***To increase the camber - remove the shims***
	Loosen the lower arm mounting bolts and the upper arm side nuts. so that the lower arm movement is free
	Take out the apron cover behind the wheel by carefully removing the plastic fasteners
	Compress the spring by moving the lower arm, using a jack
	Loosen the fulcrum mounting bolts
	Add or remove shims as required

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	Tighten the fulcrum mounting bolts to 12.0 to 14.0 Mkg (87 lb. ft- 101 lb. ft). Refer to the torque chart
	After that decompress the spring.
	Tighten the lower arm mounting bolts. And the upper arm side nuts. **Before tightening shake the vehicle by compressing the front and rear of the vehicle alternatively by hand.**
	Cross-confirm the camber value.
	Replace the apron and the hub cover.

Caution: Ensure that while the hubcap is being fitted back the Anabond RTV sealant 673 has been applied. The sealant should be applied in the mounting face as well as the inner dia.

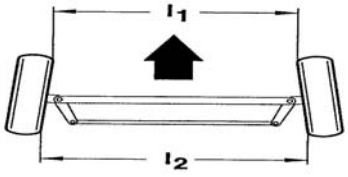
Do not fill grease in cavity.

Failure to do so will result in premature wheel bearing failure and tyre wear.

Toe in checking. (With manual gauge)

	Mark the center of the tyre treads. Do it for both the tyres
	Adjust the height of the pointer so that it touches the marked

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	line in line with the centre of the axle spindle/ hubcap.
	Place the gauge in front of the vehicle so that the pins touch the centre of either the treads/ or the inner edge of the wheel disc at the flat-machined area.
	Note the value in the scale
	Take the gauge to the back of the wheel and take measurement at 180 degrees backward
	Note the value in the scale
	The difference in the value gives the toe in.
	The total difference should be between 1 to 3 mm. (0.15° to 0.45°).
	Adjust by moving the tie rod. The tie rods should be adjusted equally on both sides. with only max. The variation between left and right side of the tie rods should be maximum one turn. (If it is more than the centralization of the steering wheel will also be affected.)

Wheel Turning Angle (With manual gauge)

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	Bring the Wheels in Straight Ahead Position (SAP). At this position confirm that the turntables Zero are also showing Zero
	Turn the steering wheel to Right Hand Side so that the wheel turns through -(Please refer the specifications
	Check the condition of the stopper bolt of LH side It should touch the bracket on the lower arm assy.
	If it is not touching or the wheel is not able to turn through 36±0.5° then loosen the lock nut adjust the bolt and then lock the bolt with locknut.
	Turn the steering now towards the Left-hand side and then adjust the stopper on the right hand side.

Check the Steering Wheel Centralization

One of the most common complaints / perceptions is that after the Wheel Alignment the Steering wheel is not centralized. Though strictly speaking it does not constitute wheel alignment but if the steering wheel is centralized then a lot of customer dissatisfaction will be avoided.

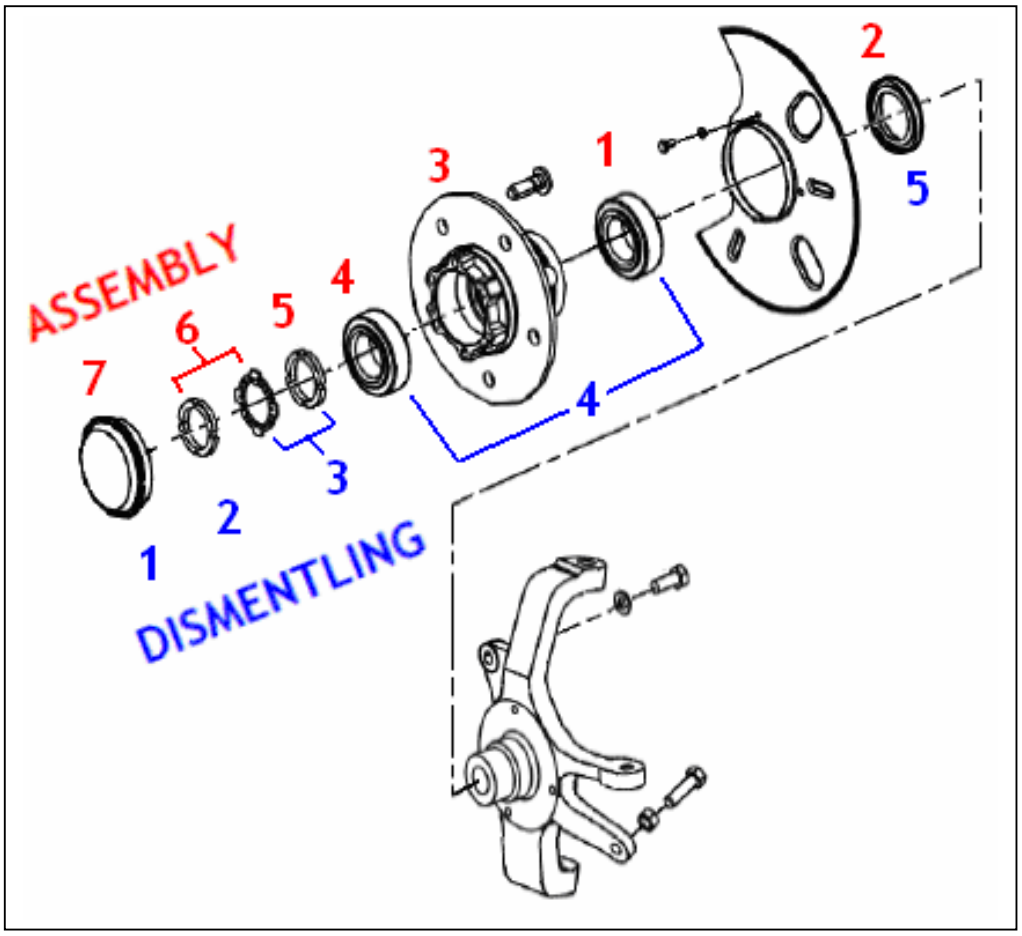
Caution: This procedure for centralizing the Steering wheel is valid only if the misalignment of the spokes is less than 10 degrees. In other words this procedure is only for fine-tuning the steering wheel position not for glaring error. If it is more 10 degrees then remove the steering wheel and initially realign to less than 10 degrees.

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Adjust the Steering wheel centralization

	Cross check the Wheel Toe In after this operation, before releasing the vehicle.

b) Wheel hub greasing -



Dismantling -

- Jack up the vehicle & remove the wheel.
- Remove the caliper assembly without disconnecting the brake hose.
  Caution: Ensure that the brake hoses are not stretched/ damaged. Put the caliper without straining the brake hose.

1. Remove the hub cover using a screwdriver.

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2. Using the MST 571, remove the outer locknut.
3. Take out the lock washer and the inner nut.
4. Pull out the hub along with the bearings.
5. Remove the Oil Seal.

Inspection –

- Inspect the rollers and the inner races of the bearings for Scoring, pitting/ brinelling or spalling.
- If any damage is noticed – inspect the outer races also.
- To remove & refit the outer races, use MST.
- If the outer race / cup is found to be loose in the housing then it is advisable to replace the hub. Trying to recondition the hub bore is not recommended.
- If the bearing seating area or the oil seal seating area in the spindle is worn then replace the spindle.

Assembly -

- Apply the ***MAXIMILE LCG3*** grease on the bearings.

1. Locate the inner bearing cone in the hub.
2. Press the new oil seal using the MST 574.
   Note: The lip of the oil seal should be coated with grease. Also fill grease in the cavity where the oil seal spring is present.
3. Press the hub assembly on the spindle & fill the grease.
4. Locate the inner cone of the outer bearing.
5. Tighten the inner nut. and back off by 90 degrees .The hub play should be within 0.010 to 0.030 mm.
   Ensure that the hub assembly is being rotated while the inner nut is being tightened. This is essential to ensure that the roller centralize themselves and also so that they abut properly.
6. Put the locking washer & tighten the outer nut.
7. Apply Anabond RTV 673 sealant & Press the hub cover using the MST 575.

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Working principle, Dismantling, Assembly of the Front Suspension 4WD

The front Wheel suspension in the 4 WD vehicles is wishbone type with torsion bar springs and telescopically acting hydraulic dampener. Both the lower and upper arm employs two point mounting.

The torsion bar is connected to the Lower control Arms rear end through a Torque control Arm. The rear end of the torsion bar is connected to a ride control arm. A ride control height-adjusting nut links the control arm to chassis.

An anti roll bar is used to transfer the loads to the outer wheel during turns. The telescopic shock absorbers are used to dampen the wheel oscillations and ensure proper wheel contact irrespective of the road condition.

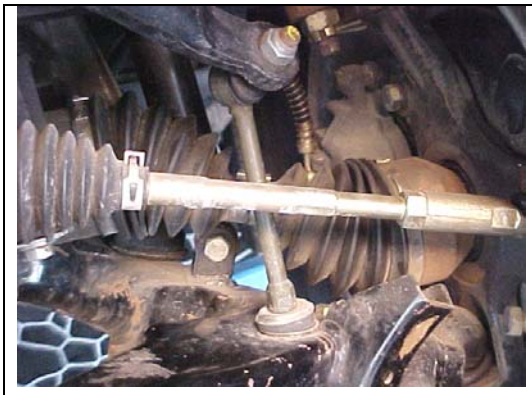
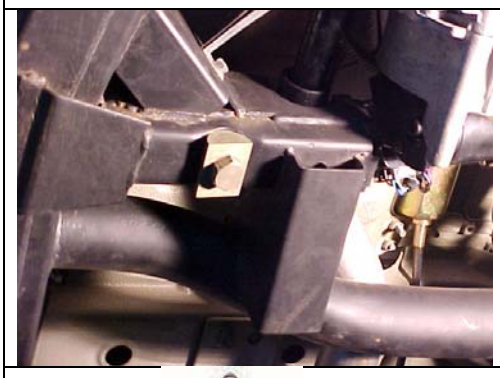
Caution:

The Torsion bars are pre-twisted. LH marking identifies the Left Hand side and RH marking identifies the Right Hand torsion bar. The arrow should be facing front.

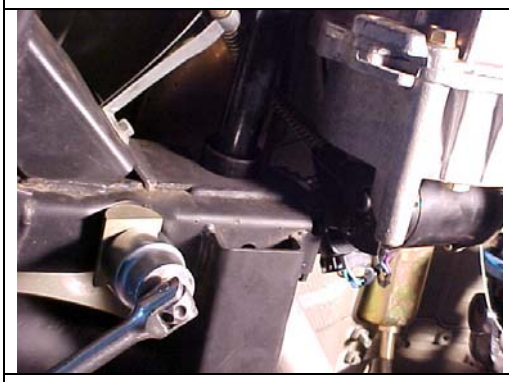
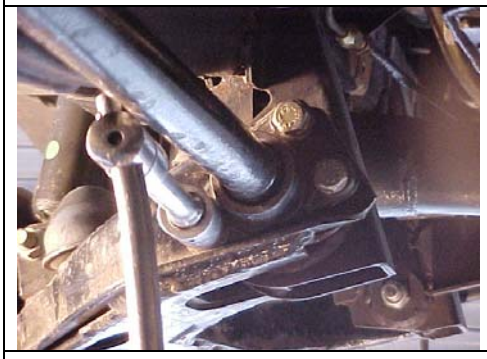
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While jacking up the vehicle (for doing ride height adjustment) ensure that the jack or the two post lift points are not touching the torsion bar.

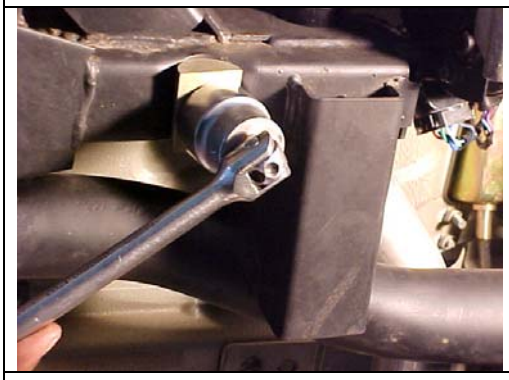
The dismantling sequence is reverse of the assembly procedure explained below –

	Jack the wheels, ensure that the anti roll bar link has been disconnected.
	Insert Lower Control Arm on frame
	Insert The torsion bar rear end in Height Control Arm serration
	Put the height control arm assembly on chassis bracket.
	It is advisable to keep all the bolts of the LCA & UCA loose

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	while doing assembly, as it will ease the assembly operations. Also if the bolts are tightened in this position then the bushes will get preloaded. Further while trying to adjust the ride height the effort required to turn the ride height bolt will be high and cause damage to the face.
	Insert the bolt of height control Arm and flush the thread end to Height control nut. Give a slight twist to the torsion bar by hand so that the rocker maintains a horizontal position/ touching the bottom of the bracket.
	Holding the torsion bar by hand and insert/slide in the Torsion bar into the Lower Control arm's Torque Arm.
	Tighten the Torque Arms 3 bolts (2 bolts onto the weld nuts and 1 free bolt +flanged nut)
	It is essential to tighten the torque arms bolts first. In case it is not done so and the ride height is adjusted. Then the adjustment will not be achieved, and also the twist of the torsion bar by tightening

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	will not result in proportionate lift/height of the LCA. Also the 3 bolts will not seat properly on the torque arm and may damage the threads of the 3 bolts. In other words the torque arm bolts ensure that the torsion bar becomes integral to the LCA through the Torque arm
	Tighten the height control bolts by 24 to 26 Turns
	Lower the Jack so that the wheels are touching the ground.
	Gently shake the Vehicle 5/6 times .
	Tighten the Lower control Arms and the Upper Control Arm's both the front and rear bolts to the specified Torque.
	Measure the ride height. (Lower control Arms front bolt head centre to ground.)
	**Note: Ensure that the measurement is done on level ground with specified tyre pressure on all four wheels. (Front 2.0 bar and Rear 2.2 bar).**
	If variation is more than +/-7.0 mm then tighten or reduce the

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	height by turning the height adjusting nut.
	It is suggested that for turning the nut it is advisable to jack the vehicle.
	Take the measurement again after a ride.
	If the ride height varies from the specifications then readjust after loosening the UCA & LCA bolts and jacking both the wheels only 1 turn of the bolt affects the ride height by 6 to 7 mm. Hence if the ride height is less by say 3 mm then turn the ride height bolt by half a turn

The assembly procedure for fitting the bushes onto the LCA & UCA is the same as mentioned below in the 2WD. There is no change in setting the Wheel alignment procedure also.

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Working principle, Dismantling & Assembly of the Front Suspension 2WD

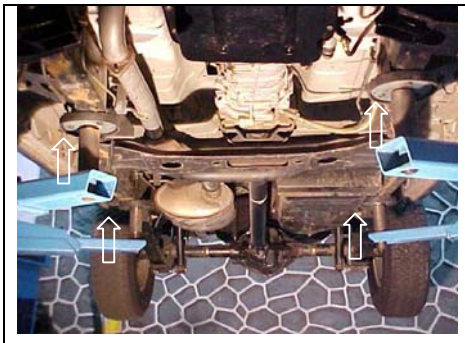
The front Wheel suspension in the 2 WD vehicles is wishbone type with helical spring and telescopically acting hydraulic dampener. Both the lower and upper arm employ two point mounting.
An anti roll bar is used to transfer the loads to the outer wheel during turns. The telescopic shock absorbers are used to dampen the wheel oscillations and ensure proper wheel contact irrespective of the road condition.

Points to be ensured while fitting any new bushes in the suspension -

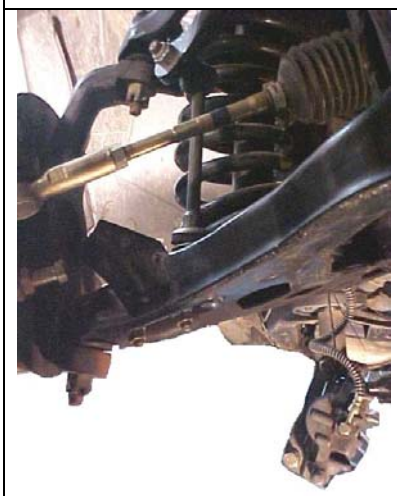
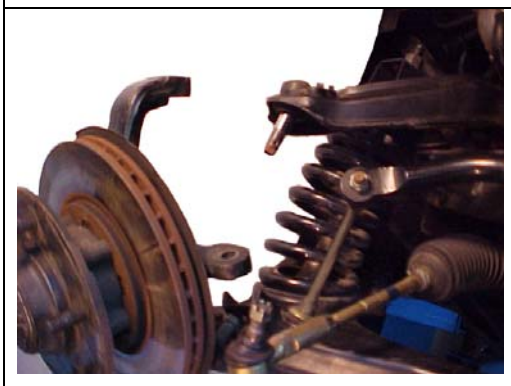
The bolts should be fully tightened only when the wheels are in ground. When the bolts are tightened with any particular wheel jacked up then it causes preloading of the rubber bush in the normal operating zone and thus reducing its life.



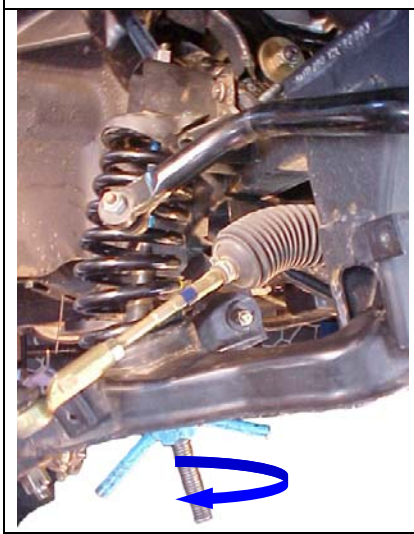
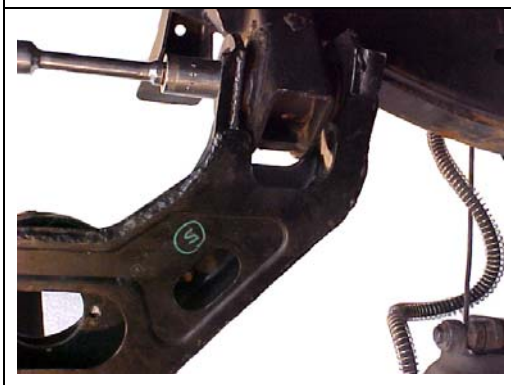
Caution: Do not lubricate the suspension b ints.
For fitting & removing bush use soap solution only.

	Jack the vehicle- locate the jack Behind the lower arm just below the first outrigger
	Remove the tyre .

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	Remove the calliper assembly without disconnecting the brake tube. Caution: Ensure that the brake tubes are not stretched/ damaged. Put the calliper without straining the brake tube.
	Remove the Shock Absorber.
	In case only the Upper arm bushes have to be replaced- remove the arm.

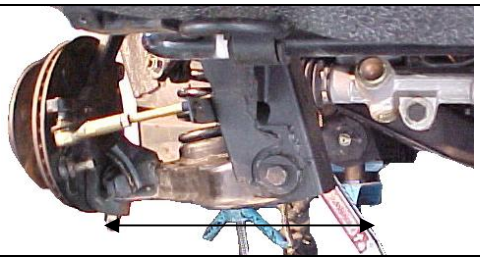
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	Loosen the special tools so that the spring is slowly decompressed.
	Remove the coil spring and the tool gradually
	Remove the lower Ball joint using the Special tool after removing the split pin and the castle nut.
	Remove the pin fulcrum bolt on chassis & remove the upper arm.
	Remove the Lower control arms front and rear nut and remove the LCA.

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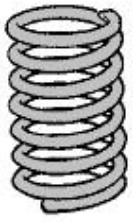
	**Note** While assembling back ensure that 1. The smaller dia of the coil spring is on top i.e. the taper of the spring is upwards. 2. Both the spring should have same spring rating (1 dot or 2 dot) 3. The rubber pad at the top has to be replaced if found cracked or ruptured.
	For removing the upper and lower arm bushes use the Special tool MST 564 & 565 **Note:** **While fitting new bushes use soap solution so that the bush can pressed easily.**  **Caution: Use of any lubricant will result in degradation of the rubber bush and lower life. Pressing without soap solution will damage the bush**

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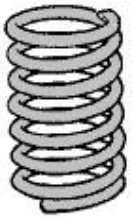
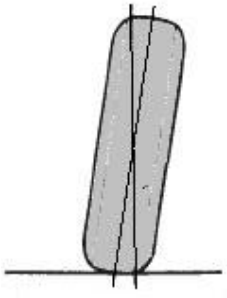
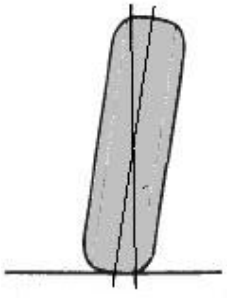
	During refitting use the dolly.
	**Caution:** In the lower arm while pressing the rib in the arm has to match groove in the tool
	Fit the shim in between the chassis and the Upper Control Arm. Tighten fully the fulcrum bolts. Note: Do not fully tighten the nuts in the end of fulcrum pin at the bush end.
	While aligning the lower arm ensure that both the pivot are inserted at the same time. If it is inserted one at a time then inserting may damage the bushes besides making the assembly difficult.
	While tightening the lower arm bolts either the wheels should be on ground or roughly the lower arm should be parallel to the ground & cross member

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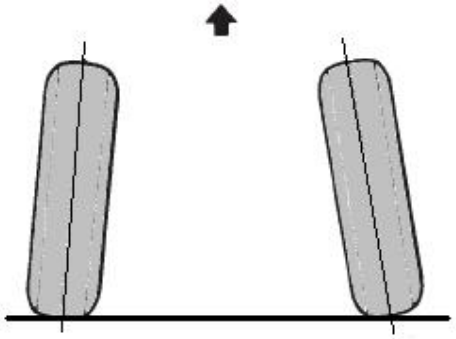
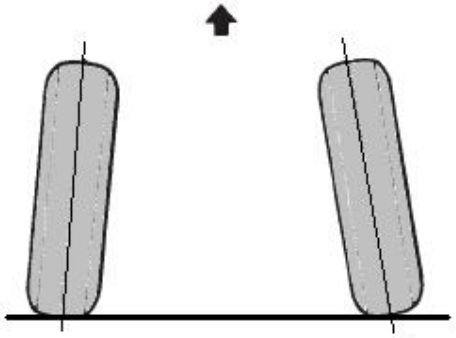
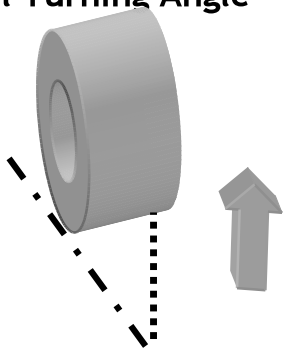
Specifications -

Description	Specification
Type	Independent, double wish bone with telescopic shock absorbers
Front Shock absorbers- 2WD 	Maximum length: 335±3. Minimum length: 222+3. Shock Absorber Stand out – 23 mm
Front Shock absorbers- 4WD 	Maximum length: 378±3. Minimum length: 244+3. Shock Absorber Stand out – 23 mm
Coil Spring 	Approx. Free ht: 309mm Solid ht. : 152.6. Total coils: 8.34 Approx.

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Description	Specification
Coil spring Load Identification 	1 yellow Dot 2 yellow Dots
Camber 	0.23 °±0.5 (0°14' ± 0°30')
Difference between LH & RH Camber 	±0.5° (±30')
Castor	2.75 °± 1.0 (2°45'± 1.0°)
Difference between LH & RH castor	±0.75 ° (± 45')

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Description	Specification
Total Toe in 	1 to 3 mm.
Total Toe in (in degrees) 	0.15 to 0.45 ° (9' to 27')
Shock absorber stand out	23 mm
Individual Toe in	0 to 20 minute
King pin Inclination	10.75° ± 1° (10°45'± 1°)
Wheel Turning Angle 	36° - 2WD 4WD 35°-Inner Wheel angle 32°-Outer Wheel angle
Ride height Variation Between LH & RH. (Up to LCA front pivot bolt)	15 mm

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Lubricants -

No lubricants / grease to be used in the suspension bushes. Only soap solution to be used during assembly

Anabond RTV 673 is used for the hubcap.

Tightening Torques -

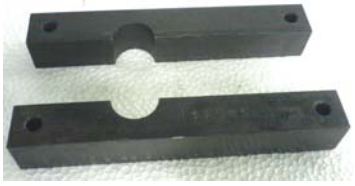
Location	Torque Nm (lbf-ft)
Upper Arm side bushes	120 ± 10 Nm (88 ± 8 lbf-ft)
Upper Arm Ball joint mounting nut	26 ± 3 Nm (19 ± 2 lbf-ft)
Upper Arm pin fulcrum mounting nut	130 ± 10Nm (96 ± 8 Lbft)
Lower Control Arm Front Mounting	165 ± 15 Nm (122 ± 11 Lbft)
Lower control Arm Rear mounting	120 ± 10 Nm (88 ± 8 Lbft)
Torque Arm M12x1.25 with spring washer & weld nut	70 ±10 Nm (51± 8 Lbft)
Torque Arm M10x1.25	50 ±10 Nm (37 ± 7 Lbft)
LCA ball joint mounting nut	70 ±10 Nm (52 ± 8 Lbft)
LCA bump stop mounting	50 ±10 Nm (37 ± 7 Lbft)
Stabilizer bar on Frame	37.5 ±7.5 Nm (28 ± 6 Lbft)
Stabilizer bar + Link	45 ± 5 Nm (52 ± 8 Lbft)
Link on Lower Arm	19 ±3 Nm (14 ± 2 Lbft)
Shock absorber Top- on frame	19 ±3 Nm (14 ± 2 Lbft)
Shock absorber Bottom on LCA	19 ±3 Nm (14 ± 2 Lbft)
Shock absorber Bottom on LCA (4WD)	70 ±10 Nm (52 ± 8 Lbft)
Steering stopper on knuckle	57 ± 7.5 Nm (46 ± 9 Lbft)
Castle Nut UCA	140 ± 20 Nm (103 ± 15 Lbft)
Castle Nut LCA	140 ± 20 Nm (103 ± 15 Lbft)
Frame- Rebound stopper	50 ± 10Nm (37 ± 7Lbft)

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List of the MST's -

Description / Part No. / Sketch	Usage View
MST-561 **Upper Arm Ball Joint Puller** 	
MST-562 **Lower Arm Ball Joint Puller** 	
MST-563 **Fulcrum Mounting Bolt Spanner** 	

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Description / Part No. / Sketch	Usage View
MST-564 **Fixture Upper/ Lower Arm Bush** 	
MST-565 **Extractor/Installer Arm Suspension Bush** 	
MST-571 **Special Socket for hub nut** 	

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Description / Part No. / Sketch	Usage View
MST-572 **Installer Front Wheel Bearing Cone-Outer** 	
MST-573 **Installer Front Wheel Bearing Cone-Inner** 	
MST-574 **Installer Front wheel Hub oil seal** 	
MST-575 **Installer Front Hub Grease Cup** 	

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Rear Suspension

Rear Suspension - SUV

Rear Suspension - SC/DC

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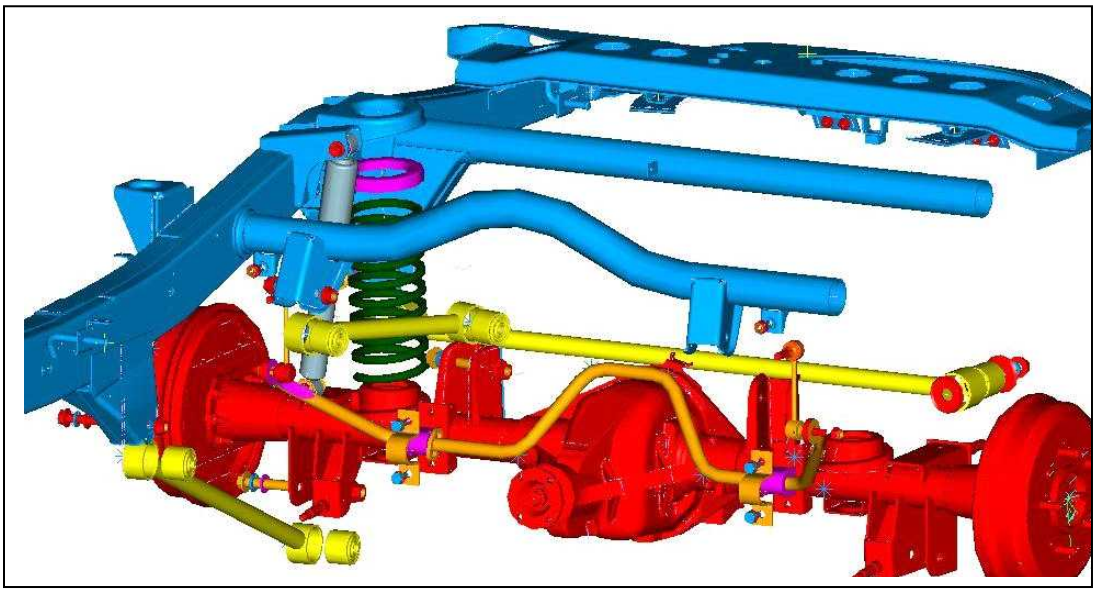
Multilink Rear Suspension - SUV

Contents

Description
Trouble Shooting
Shock Absorbers
Coil Spring Replacement
Bush Replacement
Specifications
Tightening Torques

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Description



The rear suspension is with coil spring and five links. This type of rear suspension provides more comfort & better handling characteristics of the vehicle.

The suspension encompasses Upper Links, lower links, Pan hard Rod. Coil springs & Shock Absorbers.The upper & lower links are tubular with rubber bushes press fitted on both ends. The lower links are taking the loads due to acceleration & braking. The upper links mainly are used to guide and to some extent share the lateral loads. One end of the links is connected to the chassis while the other end is at axle.

The Pan hard rod is connected between the axle & the chassis .It takes all the transverse loads experienced during cornering controlling the axle movement in lateral direction.
The anti roll bars are used to transfer the loads to the outer wheel during turns.
The coil springs absorb the road shocks due to terrain & different load conditions. The shock absorbers dampen the oscillations of the vehicle. The rubber bumper fitted on the chassis reduces the impact loads into the body.

The bonded rubber silent blocks / bushings are press fitted & does not require lubrication with oil. (Also should never be lubricated). While jacking up the vehicle the jack should always be put below the axle only. Under any circumstances the vehicle should not be jacked up putting the jack below any of the link including Pan hard rod.



While lifting the vehicle, if the resting pads are pressing against any of lower links, then there is a strong possibility that lower links may get bent.

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Trouble Shooting –

Problem	Possible causes	Correction
Vehicle tending to be lower on one side & poor ride.	Permanent distortion or breakage of coil spring	✓Replace.
Poor ride (excessive pitching or roll)	Stabilizer link rod loose	✓Tighten. If required add washer between nut & link.
	Unsmooth operation of shock absorber	✓Replace.
	Installation of wrong shock absorber	✓Replace with proper parts.
	Installation of wrong coil spring	✓Replace with proper parts
Bouncy ride	Breakage of coil spring	✓Replace.
	Over inflation pressure of tyre	✓Adjust.
	Unsuitable installation (maximum and/or minimum length) of shock absorber	✓Adjust or replace the coil springs with new ones.
	Deformation or damage of bushing	✓Replace with proper parts.
	Oil leakage of shock absorber	✓Replace
Bouncy ride/ pitching/ roll.	Fault in operation of shock absorber	✓Replace.
	Damage or deformation of shock absorber mount	✓Replace.
	Deformation or damage of shock absorber	✓Replace.
	Anti roll bar link loose	✓Retighten.
Noise	Wear or damage of shock absorber component parts	✓Replace
	Loosening of suspension link installing bolt	✓Retighten to the specified torque.
	Deformation or loss of bushing	✓Replace.

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	Unsuitability of maximum and/or minimum length of shock absorber Breakage of coil spring Wear or damage of ball joint. Deformation of stabilizer clamp. Link nut loose	✓Replace with proper parts. ✓Replace ✓Replace ✓Retighten to the specified torque ✓Retighten to the specified torque

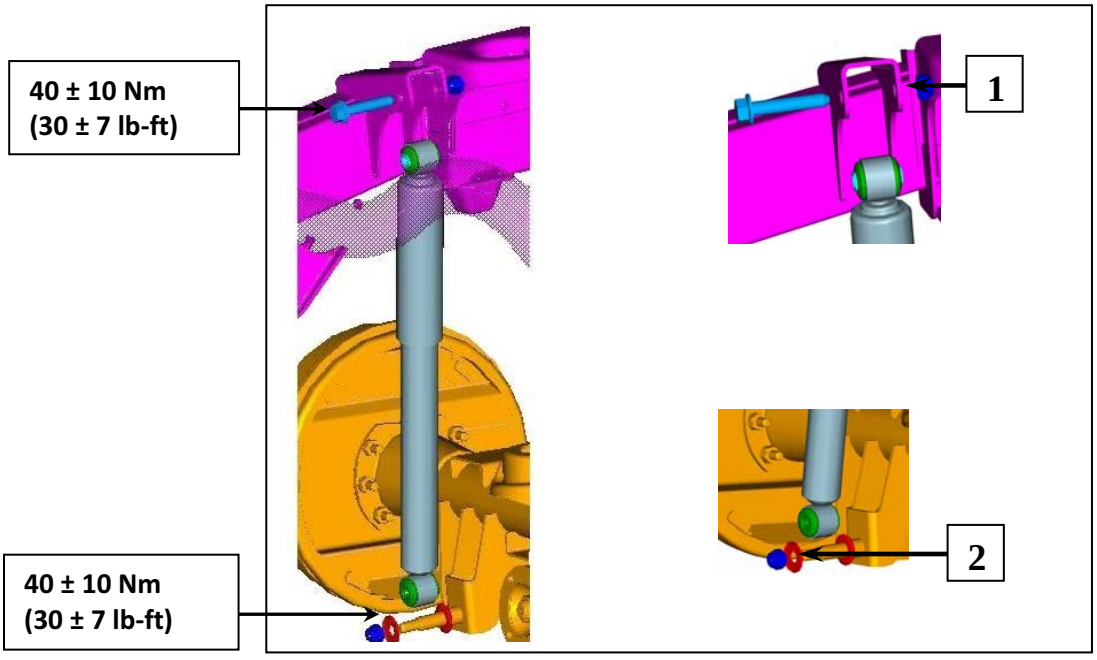
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In Car Repairs -

Note: Unless otherwise specified the assembly procedures/ guidelines are the reverse of the disassembly procedure.

1. Shock Absorber

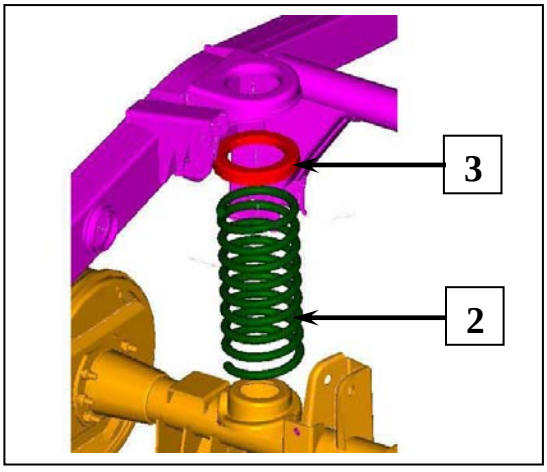
2. Coil spring
Shock Absorber -



1. Remove the upper attaching nut, washer & bolt.
2. Remove the lower attaching nuts, washer from the axle.
3. Remove the shock absorber. (Check Point A)

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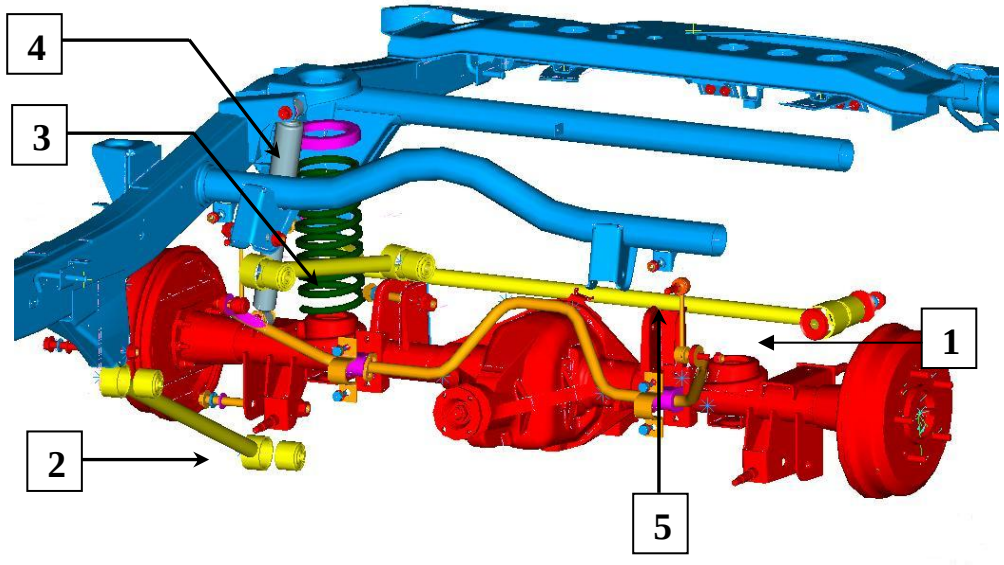
Coil Spring -



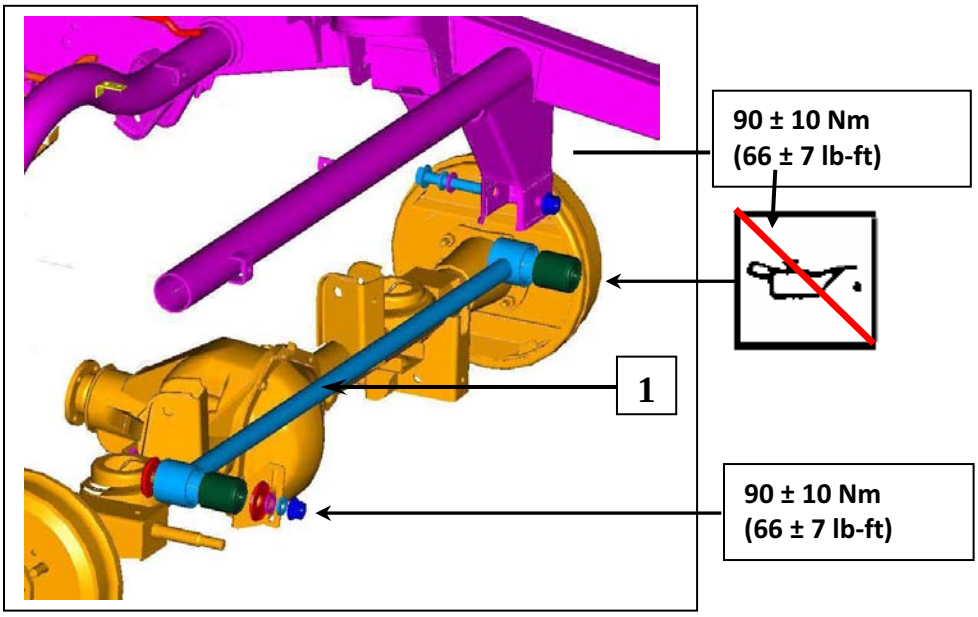
1. Remove the stabilizer bar.
2. Remove the coil springs. (Check Point B)
3. Separate the rubber spring seat.

Suspension Overhaul / Bush Replacement –

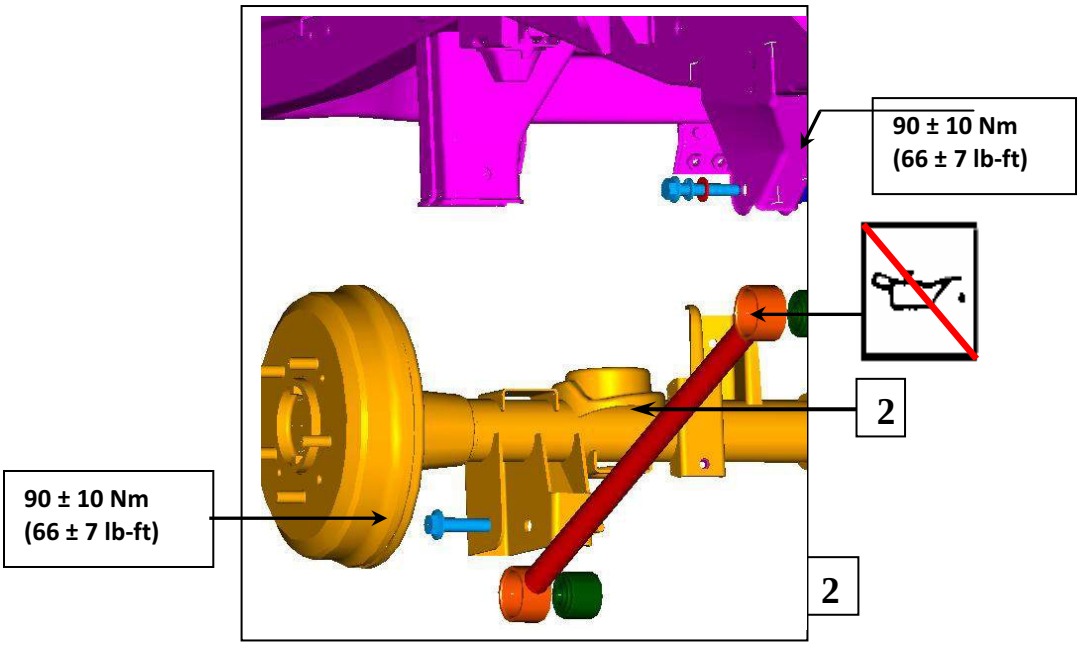
Note: For disassembling the suspension, the vehicle should be placed on the level ground/ four post lift. A two post lift can be used for convenience only for loosening the fasteners if a four post lift is not available.



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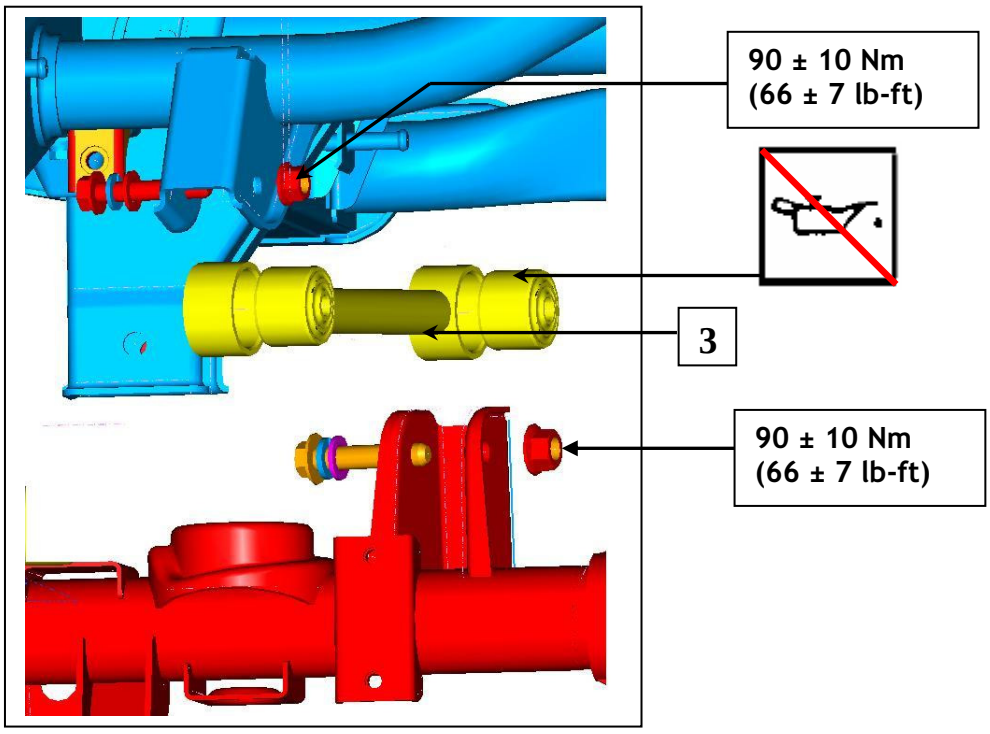


1. Loosen & remove Pan hard Rod by removing nuts, bolts & washers.



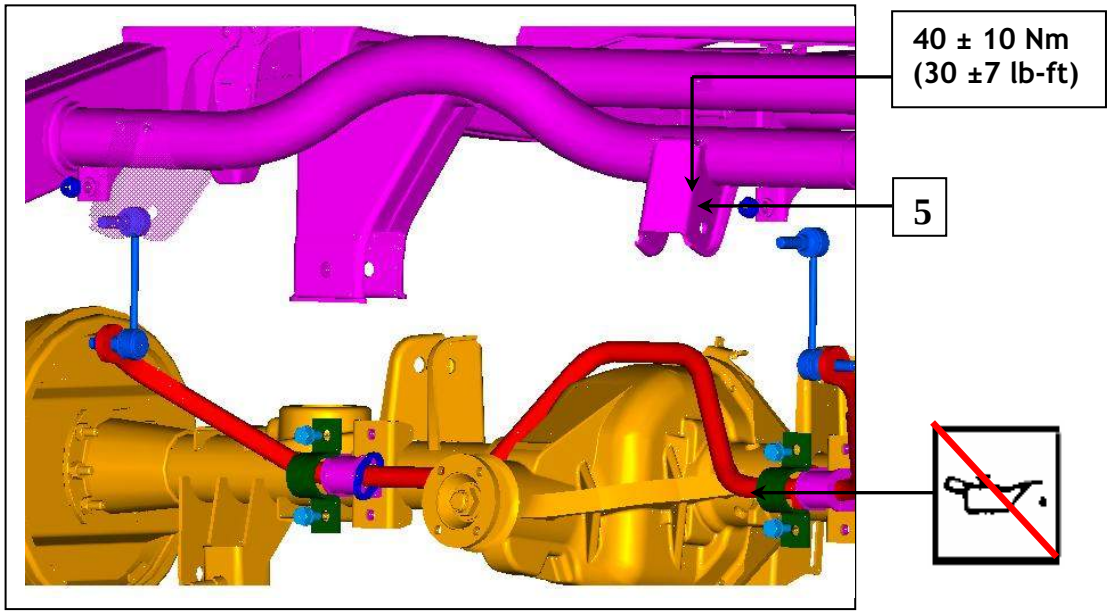
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2. Loosen & remove Lower link assembly.



3. Loosen & remove Upper link assembly.

4. Loosen & remove shock absorber.



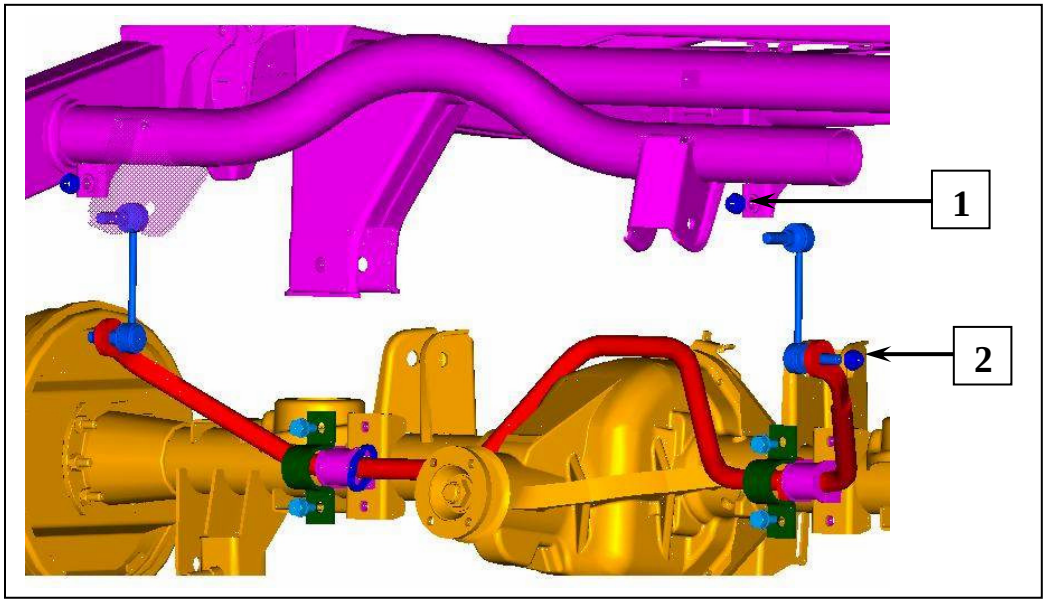
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5. Loosen & remove Stabilizer link nuts.

6. To remove & refit the link bushes. Use the MST in the mechanical press. (Refer Check point C)

Ensure that the bushes are lubricated with soap solution only. Under no circumstance use any mineral oil or grease; as they degrade the bushes.

Stabilizer Bar Link Replacement –

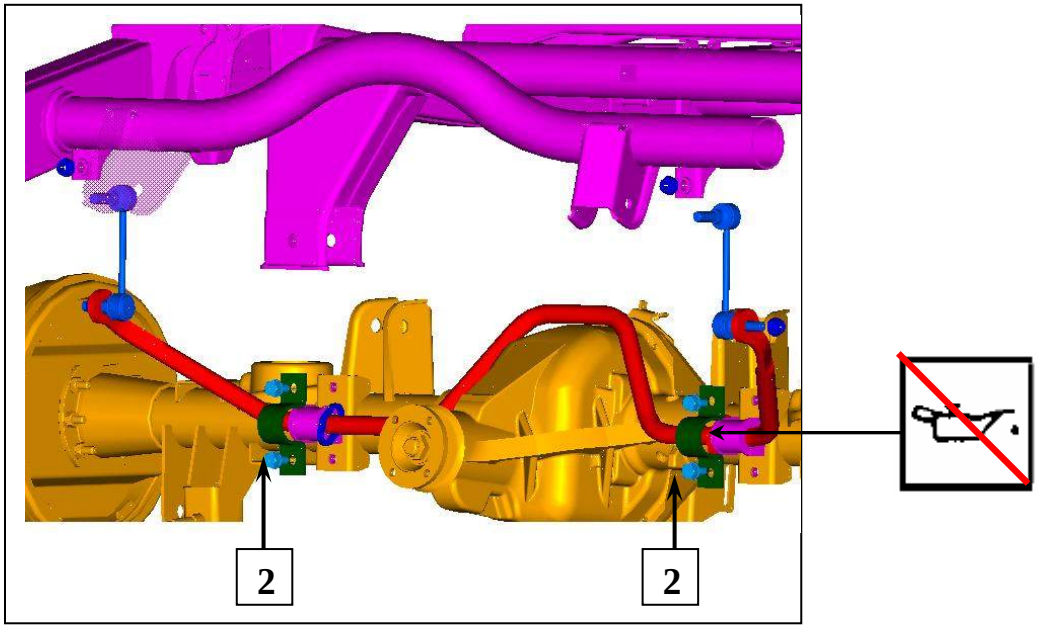


1. Loosen & remove the stabilizer link upper nut.

2. Loosen & remove the stabilizer bar link lower nut & remove the stabilizer bar link assembly. (Check Point D)

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Stabilizer Bar Bush Replacement –



Note: The vehicle should be parked on ground/ four post lift such that all four wheels will be resting on the level surface.

1) Loosen & Remove stab link nuts & the stabilizer bar mounting bolts.

2) Remove the stabilizer bar from the vehicle.

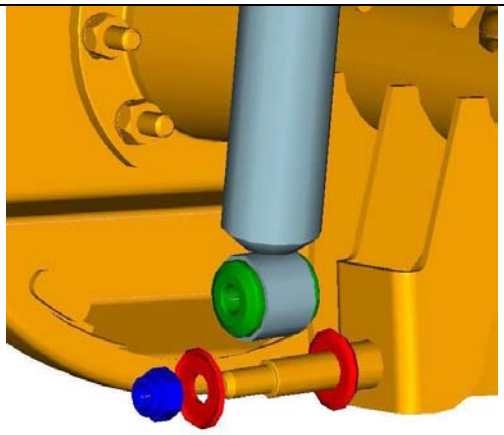
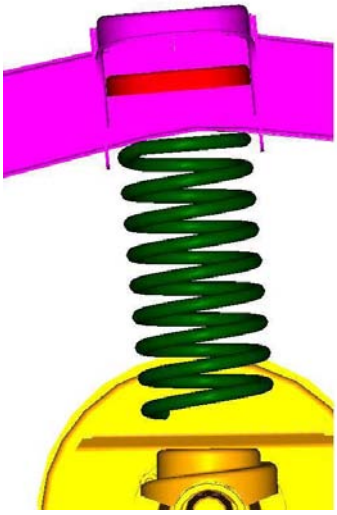
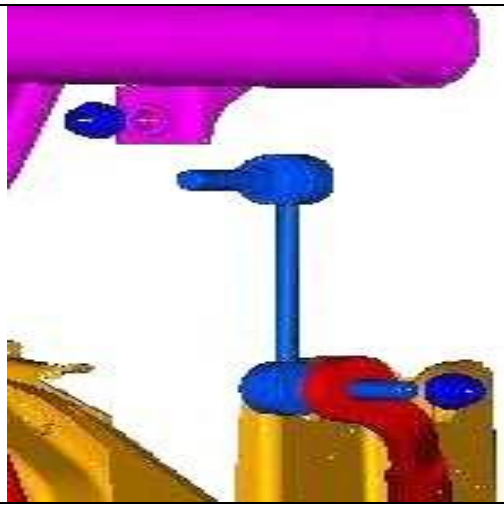
3) Change the old bushes with new one.

Note: While assembling ensure that the bushes are liberally lubricated with soap water.

Never use any mineral based oil / grease for the lubrication of any of the suspension bush including the link bushes / stabilizer bar / shock absorber bushes.

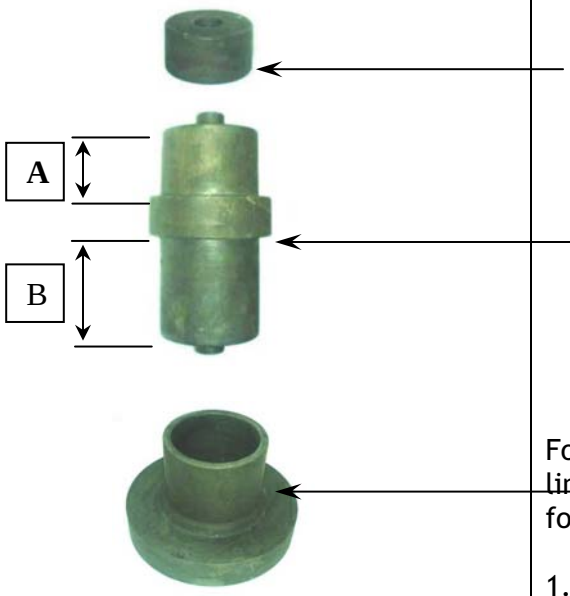
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Check Points -

	**A)** The proper orientation of the cup washers at the bottom end of the shock absorbers should be ensured.
	**B)** While fitting the coil spring back ; The correct orientation should be ensured. If the coil spring is held vertically; the flat end coil should be facing upwards (Towards the Chassis) & curved towards the axle.
	**C)** Ensure the fitment of proper stab link assembly & proper orientation on both sides.

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D)



Protecting sleeve

Special tool for removing Bush

Support Block.

For removing the bush from the link following sequence should be followed – (Refer Photograph)

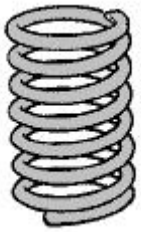
1. Place link on the support block as shown.
2. Insert the spigot in the centre hole of the bush.
3. Place the protecting sleeve on MST --- such that the spigot will not get damaged because of the mechanical press screw.
4. Tighten the mechanical press screw & remove the bush.



Note :
Use the side A of the tool while pressing the lower or upper link bushes.
The side B has to be used while removing & installing the transverse link/ Pan hard rod (The width of the bushes are different)

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Specifications -

Description	Specification
Type	Multi link with stabilizer Bar & telescopic shock absorbers
Rear Shock absorbers 	Maximum length - 503 ± 3.0 mm Minimum length - 314 ± 3.0 mm Stroke - 189 mm Dampening Force - Expansion - 148 ± 21 mm Contraction - 71 ± 13 mm
Coil spring Load Identification 	1 yellow Dot / Line 2 yellow Dots/Line
Tyre Pressure in all for wheels	**32 PSI / 2.2 Bar**

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Tightening Torques –

Description	Value
Pan hard rod – Chassis end & Axle end	90 ± 10 Nm (66 ± 7 lb-ft)
Upper Link – Chassis end & Axle end	90 ± 10 Nm (66 ± 7 lb-ft)
Lower Link – Chassis end & Axle end	90 ± 10 Nm (66 ± 7 lb-ft)
Stabilizer link Nut	40 ± 10 Nm (30 ± 7 lb-ft)
Stabilizer Bar Mounting Bolts	40 ± 10 Nm (30 ± 7 lb-ft)
Shock Absorber Nut – Upper & lower	40 ± 10 Nm (30 ± 7 lb-ft)

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Rear Suspension - SC/DC

Contents

Description

Trouble Shooting

Shock Absorbers

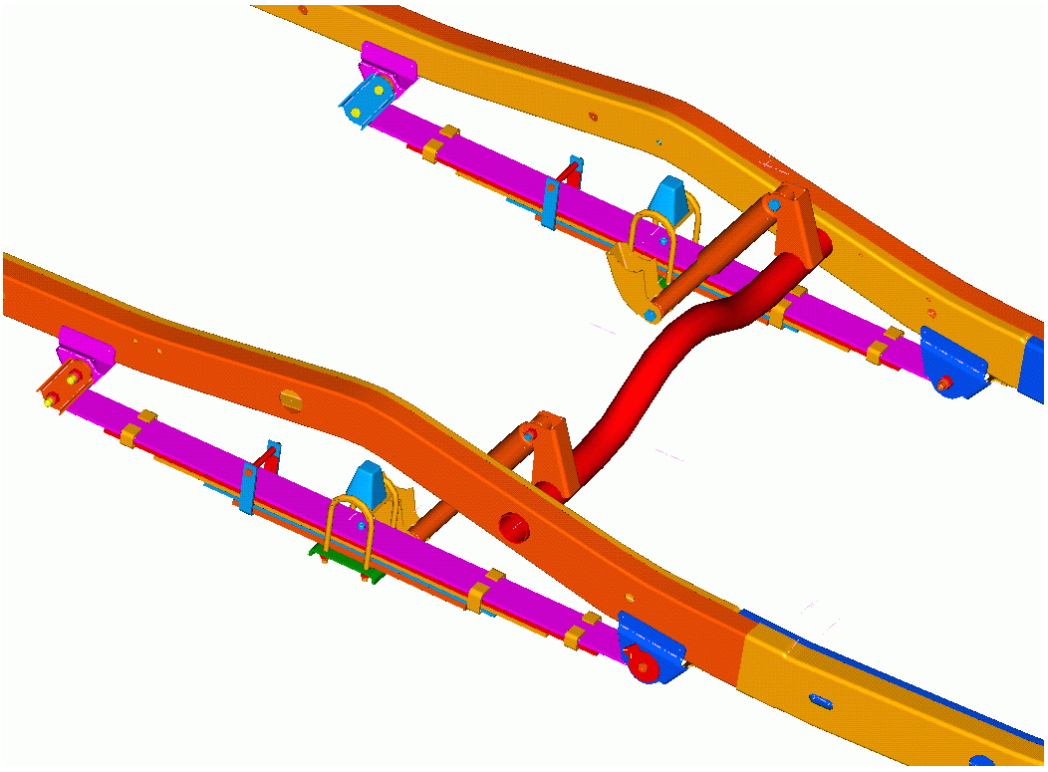
Spring Leaves

Tightening Torques

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Description

The rear suspension is a progressively rated multi leaf spring with double acting shock absorber. The front end of the springs is mounted at the pivot end through rubber bushings. The bushings isolate the road noise and road harshness as the springs move. The rear end of the spring is connected to the springs through shackle



Again the spring and shackles use the rubber bushes to isolate the noise and road harshness. The shackles allow the variation of the spring length when the vehicle moves over the different terrain causing the wheel to move up and down.

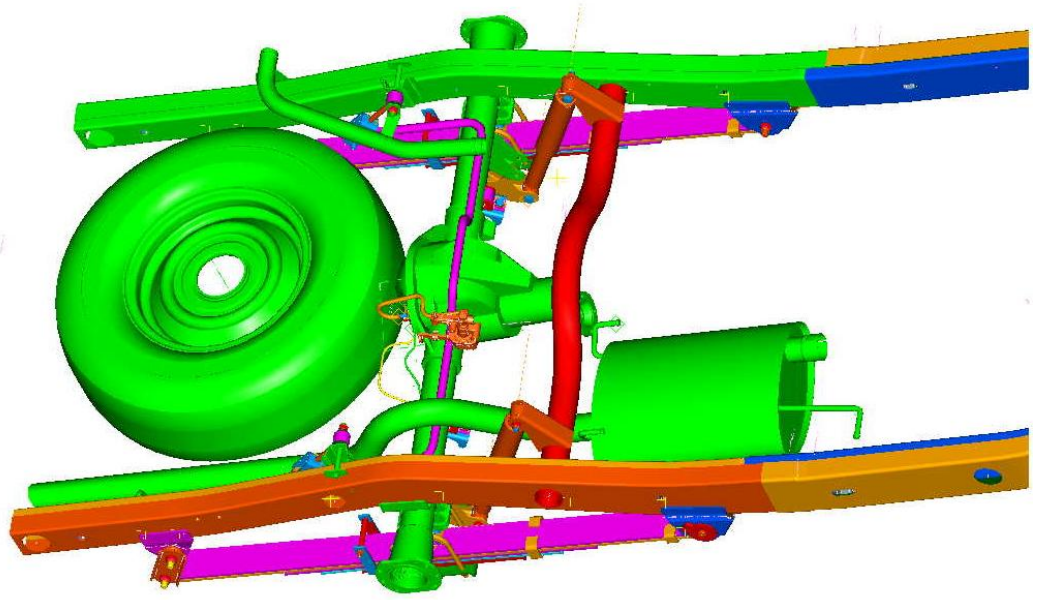
The travel of the spring is controlled by bumper, which is mounted on the axle. The springs are connected to the axle with U-bolts and spring plate. All suspension components that use rubber bushings should be tightened with the vehicle at normal height. If the springs were not at normal ride height condition the ride quality would be affected and also the life of rubber will also be affected. Rubber bushings must never be lubricated.

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The ride control is achieved by the use of double acting shock absorbers and leaf springs. The shock absorbers dampen the jolt and the rebound as the vehicle travels over the various road conditions. The top end of the shock absorber is connected to the chassis while the bottom end is connected to axle.

The anti roll bars are used to transfer the loads to the outer wheel during turns. They have been introduced effective Serial number 32A98547.

A sketch of the antiroll bars in rear with spring, shock absorber & axle is shown below.



Trouble Shooting

A squeak noise from the shock absorber can be produced if movement between the rubber bushing and metal occurs. Tightening the attaching parts can usually stop this noise. If the squeak noise persist then inspect for worn or damaged bushings and attaching components. Repair as necessary if any thing found amiss.

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The shock absorber bushings do not require any kind of lubrication. Do not lubricate the bushings to reduce bushing noise. Grease or mineral oil base lubricants will deteriorate the bushing.

The shock absorbers are not refillable or adjustable. If a malfunction occurs, the shock absorber must be replaced. To test a shock absorber hold it upright in fully extended position for 10 minutes. Then force the piston in and out of the cylinder four or five times. Also check for any hydraulic oil leakage. The action throughout each stroke should be smooth and even.

Symptom	Causes	Remedial action
Suspension Noise	1. Check if mud is between the leaf springs. 2. Check tip insert if broken/ worn out. 3. Check bushes. 4. Check shock absorber bush- worn out/ loose. 5. Check leaf breakage.	✓ Clean with pressurized water. ✓ Replace the tip between the leaves. ✓ Replace the bushes. ✓ Tighten the shock absorber mounting bolt or replace the bushes. ✓ Replace the spring assembly.
Vehicle ride Jumpy/ Jerky	1. Improper tyre pressure. 2. Shock absorber bushes worn out. 3. Spring leaf bushes worn out. 4. Shock absorbers leaking/ weak. 5. Leaf spring sagging / broken.	✓ Keep tyre pressure as recommended. ✓ Replace the shock absorber. ✓ Replace the bushes. ✓ Check the shock absorber and replace if required. ✓ Check the bump clearance as per the specified procedure. Replace springs.

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Shock Absorber –

Remove the upper attaching nut and washer.
Remove the lower attaching nuts, washer and bolts from the axle.
Remove the shock absorber.

While fitting ensure that they are tightened to a torque of 45 to 55 Nm (33 to 40 Lb ft)

Leaf Spring

Bush Replacement

Leaf replacement

Bush replacement

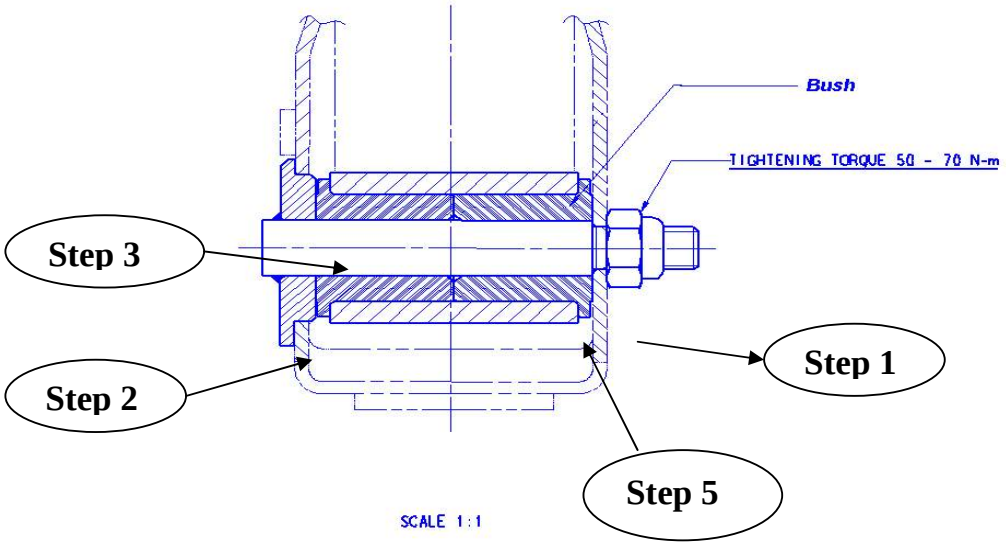
Pivot end bush replacement.

Shackle end bush replacement.

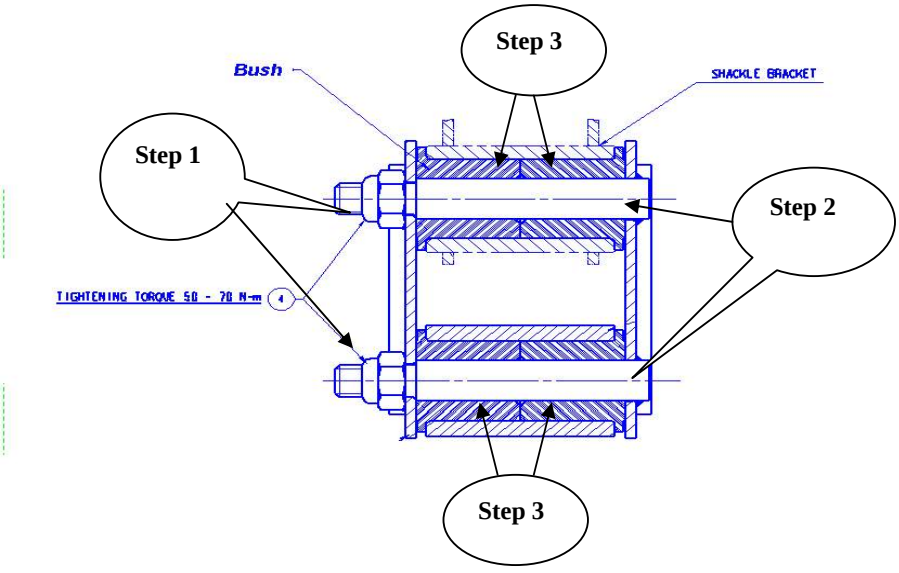
Pivot end bush replacement.

Support the vehicle in chassis
1. Loosen the shackle mounting bolts.
2. Remove the pivot mounting bolts by rotating and pulling.
3. Pull out inner bush by pulling it out
4. Lower the axle and bring the spring out of pivot.
5. Remove the bush by pulling it out.

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1. Loosen the shackle mounting bolts.
2. Remove the shackle / pivot mounting bolts.
3. Pull out the one bush at a time. Each eye is having two collared bushes. They can be pulled out



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While assembling ensure that:

- ☞ **The rubber bushes are liberally coated with soap water.**
- ☞ **The hole in the center of the pivot and the hanger bracket are clean and not blocked by mud. (The hole is provided so that while assembling the air should not get trapped between the two bushes- preventing proper assembly.)**
- ☞ **The eyes in spring and pivot/ shackle are properly aligned before the bushes are inserted.**

After the bushes are inserted, remove the support from the chassis & axle (if used) and then tighten the pivot and shackle bolts to 50 to 70 Nm (37 to 52 Lb ft).

Leaf Replacement –

The leaf springs need to be replaced only if the springs are broken or are sagging.

To check for the spring sagging it is recommended that bump clearance in unladen conditions is measured.

The bump clearance has to measured after ensuring that

- ☞ **The vehicle is in level ground.**
- ☞ **It is unladen.**
- ☞ **The tyre pressure is as per the recommendations and also no variation between left and right tyres.**
- ☞ **The bump stop is not in deteriorated or damaged condition.**

The bump clearance is 85± 10 mm and the variation between Left and right is allowed to be 7 mm

Recambering of the spring is not recommended. (Please note that the spring is of progressive type – any recambering will result in the ride becoming linear as well as stiff.

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Tightening Torques –

Description	Torque
Bolt - Leaf spring pivot	60 ± 10 Nm (45 ± 7 Lb ft)
Shackle at chassis	60 ± 10 Nm (45 ± 7 Lb ft)
Shackle at Spring	60 ± 10 Nm (45 ± 7 Lb ft)
U Bolt	90 ± 10 Nm (67 ± 7 Lb ft)
Shock absorber top	50 ± 5 Nm (37 ± 3 Lb ft)
Shock absorber bottom	50 ± 5 Nm (37 ± 3 Lb ft)

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HVAC

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Description -

The Heater, Ventilation and Air conditioning combines air conditioning, heating and ventilating functions.

The system comprises of:

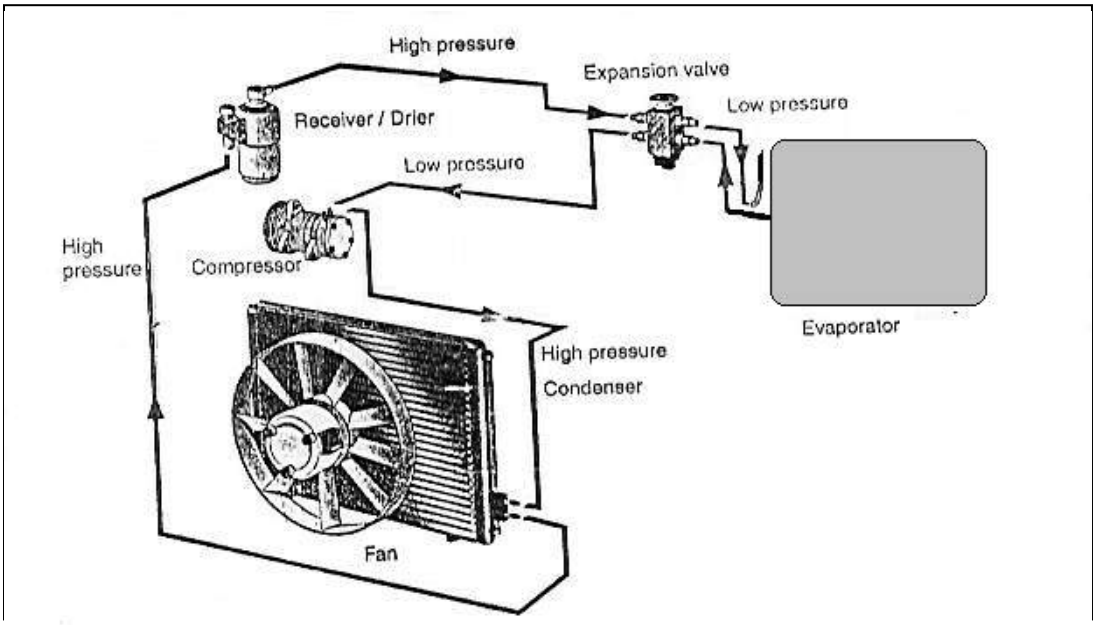
- ✓ Blower & Air Inlet system
- ✓ Heater core, and Air distribution assembly.
- ✓ Air Conditioning system.

Heater system

The heater system is controlled water flow system. A water valve controls the quantity of water entering the heater core.

Air conditioning System

The system uses non-CFC refrigerant R134A.



The refrigerant at low pressure and temperature enters the compressor where it is compressed and its pressure and temperature increase. The refrigerant after leaving compressor enters condenser and here it is condensed into high-pressure liquid and is collected in receiver drier. From the receiver drier it passes through expansion valve where it is throttled down to a low temperature and pressure. After finding its way through expansion valve it finally passes into evaporator coil where it extracts heat

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from surrounding. The refrigerant, which was in low-pressure liquid state, converts to low-pressure vapour. The low-pressure vapour then again enters the compressor.
The incoming air (in fresh mode or recycle mode) passes through a particle filter & then gets cooled and dehumidified by the evaporator. The evaporator is in operation all the times unless the AC switch is kept in off condition. To maintain minimum evaporator temperature a fixed thermostat-setting switch controls the compressor clutch. This switch which is called Anti freeze switch has a probe so that it touches the coldest part of the evaporator is used to avoid formation of ice. (If ice formation is allowed then the ice formed prevents exchange of heat thus reducing the cooling and forcing the compressor to work continuously/ longer period leading to low cooling as well as system failure.)

The evaporator always cools the incoming air (recirculated or fresh) to an amount set by the fixed thermostat value. The cooled air later goes through the heater coil. Thus the final air temperature is dependent on the amount of hot water passing through the heater.

For example when the control panel thermostat is set to the coldest value then no quantity of hot water goes through the heater and the final outcome is only the cold air. As the control panel's knob is moved towards the hotter the mixing start i.e. the quantity of hot water going through the heater starts increasing proportionately.

It should be borne in mind that when the engine is cold the temperature of incoming water is low, hence to get a desired temperature the knob will have to be set any given position. However as the engine warms up the water coming to the heater also gets warmer, thus the final out coming air temperature will raise. As a result after the engine warms up the knob in the panel will have to be readjusted to get the same out coming air temperature.

Trinary Pressure switch: It is mounted on Receiver drier.

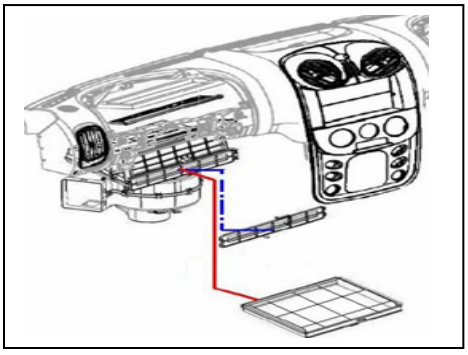
High-Low Pressure operation:. If the system pressure becomes low then it switches off the compressor. Thus in the case of refrigerant loss due to any system leak the compressor failure is avoided. Once the pressure increases above 32 bar then the compressor is shut off to avoid any system failure. If the system pressure falls due to any leaks then the compressor is switched off.
Medium pressure operation: When the pressure in the system goes above 17 bars then it switches on the condenser fan. As the pressure reduces below 14 bar the condenser fan is switched off.

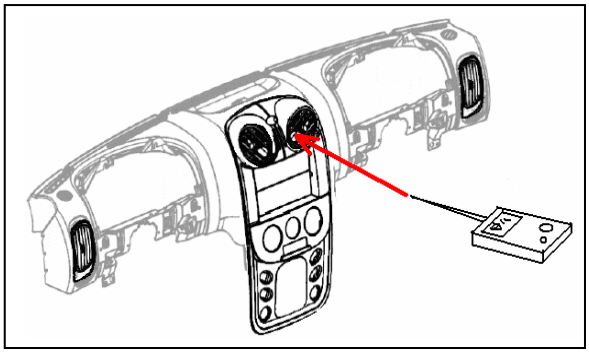
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Trouble Shooting -

AC Performance Test --

This test has to be done in shade and at an ambient temperature of 30 to 40 degrees maximum. If the ambient temperature is more than that, then please take the vehicle to the coolest area available in shade and then carry out the test.





A. Start the engine, switch on the AC and keep the Engine RPM at 1500.

B. Set the Blower to 3rd speed, the ventilation mode to be set to chest and recirculation mode. The temperature control should be set to the coolest.

1. These tests have to be performed at ambient temperature ranging from 30^0 - 40^0 C.
2. Vehicle must be in shed with bonnet closed and engine speed should be set at 1500 RPM with AC on.
3. Blower to be set in 3rd speed, ventilation to be set recirculation mode and temperature control to be set to the maximum cool.
4. In 10 minutes close door test the average grill temperature should be less than 12^0 C. *(Open Door Test - in 10 minutes open door test the drop in average grill temperature with respect to ambient temperature should be 15^0 C).*

Note: In normal conditions:

The low side pressure should be 1.5 to 2.5 bars.

At the High pressure side the pressure should be 15 to 17 bars.

This is with reference to the ambient temperature of 30 to 35° C.
If the ambient temperature is different from the range, refer to the chart for getting the range of suction and discharge pressures.

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Symptom	Causes	Remedial action
Low pressure side pressure high **Ps>2.5to 2.9** **And** **High pressure side pressure gauge high.** **Pd>19.5 to 25 bar** **Discharge air warm**	Evaporator flooding due to Block valve stuck open. 1. Dirt in Block valve. 2. Moisture in the refrigerant circuit	✓ Remove refrigerant ✓ Evacuate/dehydrate ✓ Change expansion valve ✓ Change filter/drier. ✓ Charge correct amount of oil & refrigerant. ✓ Check performance.
Low side –High **High Side- High** **Ps>2.5-3.0 bar** **Pd> 19.5-25 bar** **Suction side piping is hot to touch.**	Non condensable (excessive air) 1. Large amount of air caused by insufficient evacuation after repair or servicing of system 2. Leak in system allowing air and moisture to enter.	✓ Remove refrigerant ✓ Evacuate/dehydrate ✓ Change filter/drier. ✓ Charge correct amount of oil & refrigerant. ✓ Check performance
Low side –High **High Side- High** **Ps>2.5-3.0 bar** **Pd> 19.5-25 bar** **Frosting on suction side piping**	1. Expansion valve stuck open.	✓ Change the expansion valve.
Low side –High **High Side- High** **Ps>2.5-3.0 bar** **Pd> 19.5-25 bar** **Discharge air- Warm** **High side tubes-Very hot** **Compressor clutch- Could continuously cycle on the high pressure switch**	1. Excessive refrigerant 2. Poor condenser cooling 3. Engine or condenser fan not working 4. Fan direction reverse. 5. Condenser fan clogged with debris/ sand. 6. Radiator overheating.	✓ Check refrigerant condition ✓ Check & repair condenser fan. ✓ Check condenser. ✓ Check pressure cap, clearance between fan and radiator. ✓ Check coolant and any other radiator

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Pressure does not come to normal when condenser cooled by water		problem.
Low side- Low or vacuum **High side- High** **Ps> 1.5 bar to vacuum** **Pd> 19 to 22 bar** **Discharge air- slightly cool**	1. Expansion valve- Stuck closed and or insufficient refrigerant flow to suction side of the compressor. 2. Foreign material or moisture entry causing rust formation.	✓ Remove refrigerant ✓ Evacuate/dehydrate ✓ Change filter/drier. ✓ Charge correct amount of oil & refrigerant. ✓ Check performance.
Low side _ low or vacuum **High side- High** **Ps> 1.5 bar to vacuum** **Pd> 5 to 7 bar** **Discharge air-slightly cool** **High side tubes- Cool and showing signs of sweating or moisture build up at the position after the point of restriction.** **Temperature difference found on both the sides of the clogged component.**	Clogging on high side: 1. Clogging between compressor outlet and evaporator inlet (High side) 2. Very little or no refrigerant flow to suction (low) side of the compressor	✓ Remove refrigerant. ✓ Clean & flush system. ✓ Change filter drier. ✓ Charge correct amount of oil & refrigerant. ✓ Check performance
Low side Gauge- Normal to Vacuum (Gradual reduction) **High side- Normal** **Ps> 1.5 to vacuum** **Pd> 14 to 16 bar** **Discharge air becomes warmer as low side cycles to vacuum.**	1. Excessive moisture in system 2. Moisture can freeze within the expansion valve and cause blockage through rust formation.	✓ Remove refrigerant ✓ Evacuate/dehydrate ✓ Change expansion valve. ✓ Change filter/drier. ✓ Charge correct amount of oil and refrigerant. ✓ Check performance.
Low side- High **High side- Low** **Ps> 4 to 6 bar** **Pd> 7 to 10 bar**	1. Compressor malfunction. 2. Compressor faulty, internal blockage in	✓ Replace compressor. ✓ Remove refrigerant ✓ Evacuate/Dehydrat

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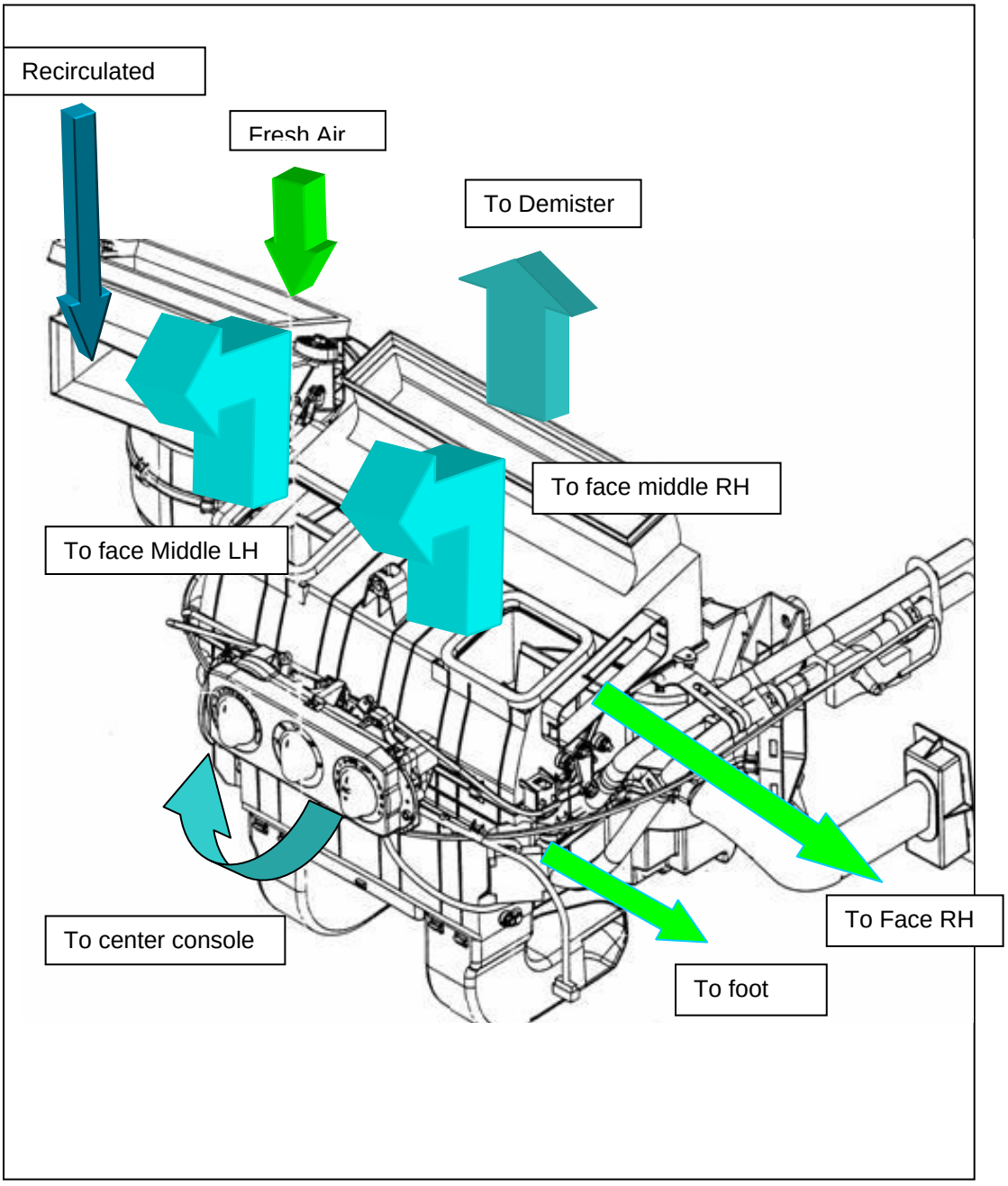
Compressor –Noisy. **Discharge air- Warm** **Discharge hose- Cool.**	suction Hose after low side filing port.	e. ✓ Change filter drier. ✓ Charge correct amount of oil & refrigerant ✓ Check performance.
Abnormal noise	1. Belt slippage/damage. 2. Idler pulley misalignments 3. Compressor clutch pulley faulty. 4. Loose compressor mounting bolts 5. Loose A/C plumbing touching firewall/ front panel/ fenders. 6. Compressor internal damage.	✓ Correct belt tension/ replace belt. ✓ Replace bearing in the pulley. ✓ Check the compressor mounting ✓ Check for loose parts and correct. Fit rubber packing where clearances low. ✓ Replace compressor.
High /Low pressure equalize soon after compressor stops. **Compressor is not hot to touch.**	1. Faulty compressor discharge or inlet valve. 2. Faulty compressor seal.	✓ Replace compressor.
Compressor pressure drops rapidly after switching off and does not stabilize to saturation pressure as per ambient temperature.	1. Non condensable in system	✓ Recover refrigerant/ check for leaks and repair
Line to condenser is excessively hot.	Restricted flow of refrigerant in system	✓ Remove restriction Evacuate ✓ Replace receiver drier. ✓ Charge through the charging unit.
Insufficient/ no air flow	1. Blower rotation direction wrong. 2. Sealing disconnected. Insulation piece blocking air passage. 3. Mode cable not adjusted properly. 4. Voltage insufficient <	✓ Correct the blower fitment. ✓ Renew sealing. Remove blockage. ✓ Adjust cable. ✓ Recharge battery. Check the charging system.

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	12 Volts 5. Improper earthing. 6. Open circuit, wiring harness. 7. Fuse blown 8. Filter clogged	✓ Correct earthing. ✓ Correct wiring. ✓ Replace fuse. ✓ Clean filter element by tapping. ✓ Replace filter element if airflow is still insufficient after cleaning. ✓ Replace filter element after 15,000 km OR one year.
Compressor clutch engagement not satisfactory	1. Open circuit/ Fuse blown. 2. Weak battery. 3. Faulty clutch relay. 4. No refrigerant. 5. Shorted clutch coil. 6. Oil/ dirt on clutch plate.	✓ Replace fuse. ✓ Charge battery. ✓ Change relay. ✓ Check for leaks, charge refrigerant & oil & check. ✓ Replace coil. ✓ Change clutch plates
Check condenser/ radiator Fan- direction of rotation	1. Condenser fan pusher type Radiator fan puller.	If fan not operating: • Loose connection • Loose wiring harness. Motor burnout.

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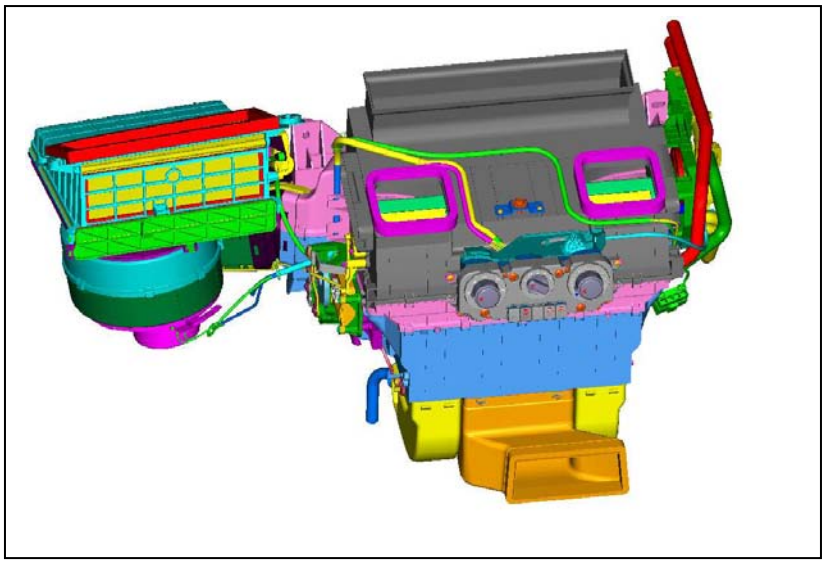
Air circulation in the climate box -



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	Knob Position				
Flaps↓	Face	Face-foot	Foot	Foot-defrost	Defrost
Face LH	Open	Open			
Face RH	Open	Open			
Face Middle RH	Open	Open			
Face Middle LH	Open	Open			
Center Console	Open	Open	Open	Open	
Foot LH		Open	Open	Open	
Foot RH		Open	Open	Open	
Defrost				Open	Open

The Airflow can be either fresh air or recirculation mode.
The air box with the electrically controlled flaps & recirculation mode is slightly different. Sketch given below –



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Care of the system -

The system should be flushed and charged every 50,000 or 1 year of operation. The quantity of the gas which has to be filled is 830 ± 20 grams.

The refrigerant used is R134A.

Do not use / mix R12 & R134 A. the oils used for compressor is unique for R134. DO NOT MIX. IT WILL CAUSE DAMAGE TO 'O' RINGS as well as the R/D.

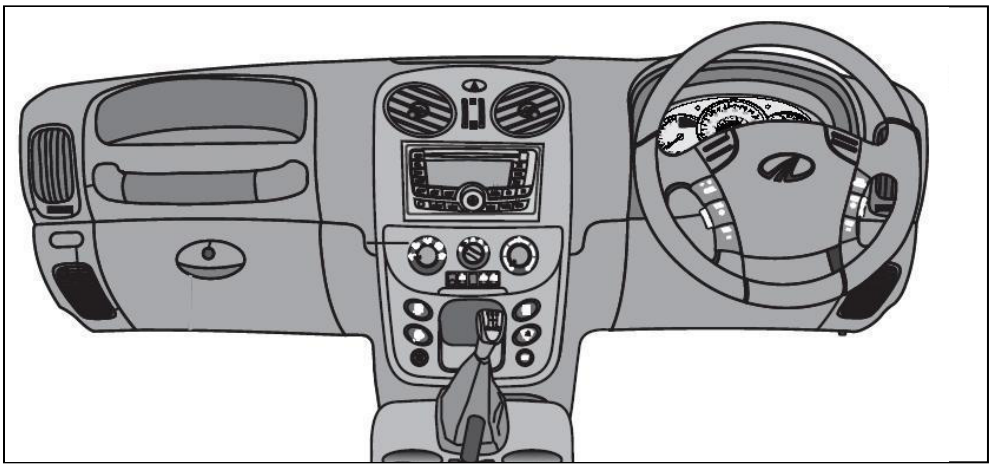
Though R134A is non-CFC, it is recommended that it should not be discharged to atmosphere.

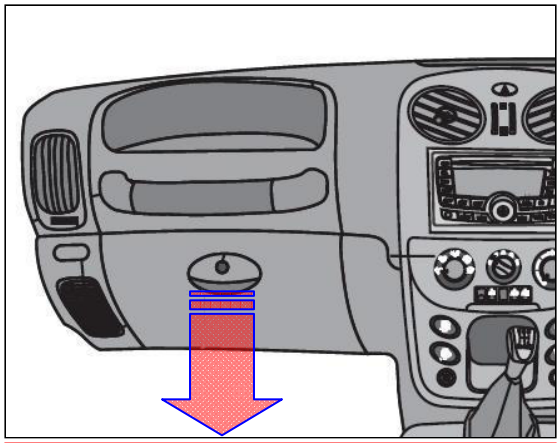
We recommend the use of **ROBINAIR** equipment for evacuation, charging of the system.

The particle filter should be cleaned at every 5000 KMs. Also it is recommended that the vehicle should not be driven with AC or Blower on without the particle filter as it will seriously damage the AC system components.

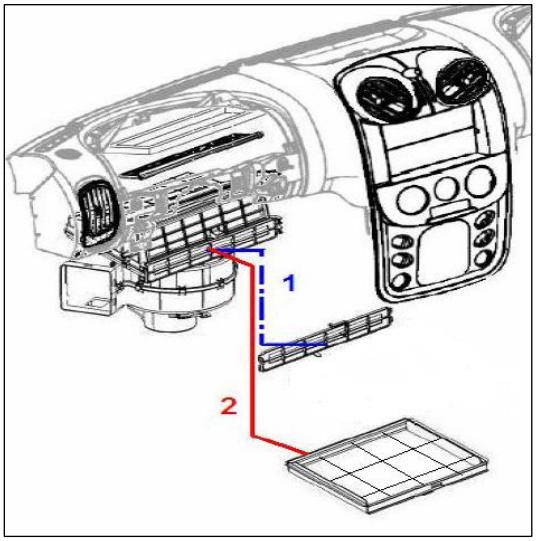
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The procedure for cleaning the particle filter is as follows –





GLOW BOX REMOVAL



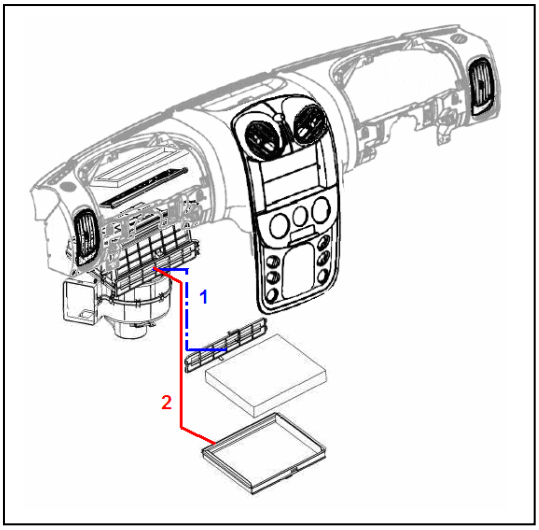
HVAC PARTICAL FILTER - CLEAN

Refer above illustrations -

1. Open and remove the Glove Box.
2. Remove the HVAC Filter Cover [1] by opening the snap clips on both sides.
3. Take out HVAC Filter Element [2]
4. Clean the Filter Element with air blow (If compressed air is used, ensure the pressure is low).
5. Fit the cleaned HVAC Filter & Cover; lock the snap clips on both sides.

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The procedure for the replacement of particle filter is as follows -



Remove the Glove Box.

1. Remove the HVAC Filter Cover by opening the snap clips on both sides.
2. Take out HVAC Filter Element.
3. Put the new Filter Element.
4. Fit the HVAC Filter Cover & lock the snap clips on both sides.

It is recommended that the evaporator fins be cleaned of dirt/ fungus every 40,000 Kilometre or once in 9 months for normal operation. If the vehicle is not clocking long mileage then also it should be cleaned every 9 months (normal areas) and 4 months in dusty conditions.

This will ensure that the heat transfer is effective hence better cooling and also increase the airflow. The recommended cleaning agent is mentioned in the recommended lubricant section.

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In Car repairs -



- ✓ Extreme care has to be taken to prevent any liquid refrigerant in coming in contact with skin. Always wear safety goggles.
- ✓ Do not allow liquid refrigerant to touch bright metal. Refrigerant will tarnish bright metal and chrome surface. Refrigerant in combination with moisture is very corrosive and can damage to all metal surfaces.
- ✓ When charging, always keep the tank in upright position. If the tank is on its side or upside down, liquid refrigerant will enter and affect the compressor.
- ✓ Always double check that the gas being used is a R134A.The refrigerant cylinder is color-coded to avoid confusion. R134A is Blue.
- ✓ The compressor oil for R134A gas is different from R12A compressor oil. Do not mix. If the R12A compatible compressor oil is used then it will damage the O rings as well as the receiver Drier.
- ✓ The Robinair equipment AC 350 should be used with R134A gas only.
- ✓ Never discharge a system or do brazing/welding operation when the engine is ON.
- ✓ PAG oil is highly hygroscope. Open containers only when ready to use. Cap containers immediately after use.
- ✓ Use only the specified oil for the AC system
- ✓ Do not allow PAG oil to contact bare skin.
- ✓ Do not allow PAG oil to contact paint work- wash immediately

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The charging procedure comprises of the following distinct steps -

Discharging the system.

Evacuation of the system and checking for low vacuum leak

Purging - if required.

Preliminary charging & High Pressure leak test.

Charging the system.

Evaporator cleaning

Performance test.

Discharging the system --
The following procedure is recommended for evacuation.

1. Connect the hose of Recovery unit to the vehicle circuit
   Red hose to the high pressure charging port
   Blue hose the low pressure charging port

2. Open the quick coupler valves on the hose after they are connected to the system

3. Check the manifold gauges the units control pane. They should register above zero. If it is indicating zero then either the hose is not connected properly/or/quick coupler valves are not opened or the system is empty.

4. Make sure that the drain valve at the bottom is closed.

5. Open both the manifold valves on the control panel

6. Open the Gas (vapor valve and liquid valve on the tank).

7. Switch on the power

8. Choose Recover option from the panel

9. To assure that the complete recovery of the refrigerant. Wait for 5 minutes and watch the manifold gauges for a rise above zero.
10. If a rise occurs, press HOLD/CONT. repeat until the system pressure hold for at least 2 minutes

11. The system displays the weight of the refrigerant recovered.

12. Confirm that the oil catch bottle is empty. Then slowly open the drain valve and allow the oil to be drained into the bottle. When all the oil has been recovered,

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close the valve immediately. New clean oil must be added to system before recharging with the refrigerant

13. The automatic recovery unit will operate until the air conditioning system has been emptied of refrigerant down to atmospheric pressure. The cylinder can now be closed.

Evacuation of the system –

The evacuation and leak test ensues that the system does not leak under low-pressure conditions.

Ensure that the hoses are connected to the charging ports and valves on the hoses. Tank & manifold are open.

Choose vacuuming program (Shift/Reset option) from the control panel.

Set up the vacuuming time in minutes. Approximately 15 minutes of vacuuming time is recommended.

The unit displays the complete message after the vacuuming is over.

Check the moisture indicator. If it is green, it means that the system is ready for recharging. If it is not green then manual recycling has to be done for one hour. In case the moisture indicator still does not turn green, the reason could be saturated receiver drier. It should be replaced.

The charging station is equipped with recycling facility. During evacuation the refrigerant is automatically recycled to assure recharging with the cleanest possible refrigerant. Recycling begins automatically after 5 second of the vacuum pump starting. Non condensable gases (mostly air) are automatically vented from the tank.

The system must hold the vacuum of –100 Kpa for a minimum of 15 minutes. If vacuum is held then the system has no ands and should be evacuated for further 15 minutes

This completes the evacuation process.

Purging – if required --

Where the system has been ruptured, contaminated, or a compressor has to be removed, reinstalled or replaced, the system should be checked for contamination, and if so then the entire system must be flushed.

The system can be flushed with Nitrogen.

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Preliminary charging & High Pressure leak test --

This ensures that the system does not leak under high pressure conditions.

Confirm that the hoses are connected to the charging ports and valves on the hose, Tank & manifold are open

Enter the refrigerant quantity by weight and press ENTER. (At least 200 grams of charge are required to do the high-pressure leakage test)

Press CHG to start charging. The unit displays the completed message after the charging is completed.

Use the electronic leak detector to probe the leakages. Leakage checking to be done at the following points –

- Expansion valve joints
- All pipe joints.
- Suction & discharge ports.
- Both the charging ports

Note: Inspect for leaks by slowly moving the probe of the detector around all the hose connections and points of possible leakage's. The R134A is heavier than air; hence, any leakage will be more apparent at the bottom of fitting.

Charging the system –

If no leaks are found then do an additional charging of 650±20 grams. The total system requirement is 830 ± 20 grams.

However in case of leakage, the system should be discharged.
After that repeat, the steps from evacuation onwards till the above steps. Then proceed.

In case the system was checked for High pressure leaks by using Nitrogen, Evacuation should done first and then system should be directly charge with 850±20 grams.

Close both the manifold valves and then start the vehicle.

Start the vehicle's AC system and set it to maximum cooling. Check the pressure gauges and temperatures in the vehicle.

Turn off the engine.

Disconnect the high side hose and start the vehicle. Open both the manifold valves to pull the refrigerant from both the hoses into the system.

At the lowest operating pressure close the low side valve and switch off the vehicle. Disconnect the low side hose and remove adapters if used.
Close the high side manifold valve. Both the valves should now be in closed position.

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- ✓ Do not start the engine when the valve on the manifold and tank are open.
- ✓ Ensure that the valves are closed before starting the engine.
- ✓ Never run the compressor without the refrigerant in the system as the lubricant relies on the refrigerant flow

Accurate system refrigerant charge can only be determined by charging the correct amount of R134a.

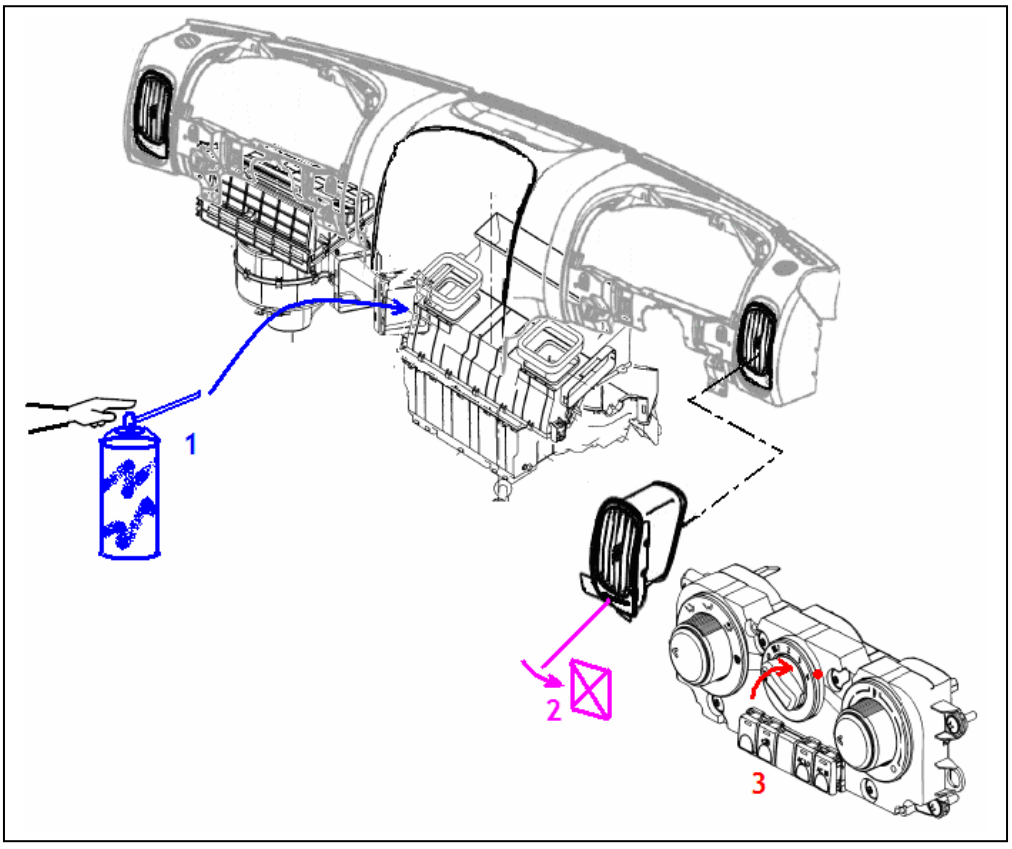
If in doubt as to gas charge, e.g.
Suction pressure low
Or
Discharge pressure low
Or
Air outlet temperature at the face high.

Then: Evacuate the system and Charge with the 830±20 grams of R134 A

Carry out cooling system pressure test and suction (low side) pressure reading comparison.

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Evaporator Cleaning Procedure -



Remove the Glove Box, remove Blower Connection & remove Blower Assembly.

1. Insert "Coil Rinse Nozzle" inside the Climate Box Assembly at the blower neck.
   - Spray "Coil Rinse" at least 2 times.
   - After Spraying, the Liquid becomes Foam & enters in the Evaporator coil.
   - Assemble the removed Blower Assembly again.
   - Wait for 10 minutes.
2. Close all the Vents / louvers.

3. Start AC with Blower on 1st speed, Run the Engine at 1500 RPM for 5 minutes.
   - Put AC Off & put Blower on 4th Speed for 5 minutes, Close all the Vents.
   - All the Evaporator Containments & Water (Liquid) will drain out through the Drain Hose & Evaporator becomes clean.

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Special Instructions for Vehicle Users to avoid Wet Smell on the Evaporator:

Put OFF the AC & put Blower on 4th speed 5 minutes before stopping the Vehicle, this will keep Evaporator DRY & NO WET SMELL will come from Evaporator.

Performance test –

Pressure gauge readings together with the face air outlet temperatures are the only method of checking and diagnosing the cooling system.

Checking system oil charge —

The compressor is charged at the factory with 150 cc of FD46XG(PAG) refrigerant oil, which circulates within the entire AC system. Only this type of oil, which is pale yellow in color, must be used when adding or changing oil. This oil is not compatible with any other PAG oil. It is not necessary to regularly check the oil level in the system. It should be remembered that the oil gets circulated within the whole system. Therefore, whenever an AC system component is replaced a quantity of new refrigerant oil must be added to the system, where a major loss of system oil has occurred. The loss normally takes place when:
Hose failure or leak is present.

Refrigerant system component is damaged due to collision.
If oil is suspected to be in the system

The procedure to be followed is -

Recover refrigerant from the system by evacuation.
Drain out the refrigerant oil.
Flush the remaining oil using R134a refrigerant.
Add 150 cc of new refrigerant oil to the compressor.
Install the compressor after replacing the Suction and discharge “O” rings.
Note: Ensure that the ‘O” rings are not twisted and that both the seals and ‘O’ rings are clean and then oil.
Follow the steps of **charging procedure**.

Compressor Replacement –

1. Discharge the refrigerant

2. Remove the suction and discharge pipes from the compressor, ensuring no foreign items get clogged to the ports. (In order to have better accessibility it is suggested that the following parts be removed first- right wheel, right aprons; oil cooler)

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3. Loosen the tensioner pulley.

4. Remove the fan belt

5. Loosen the compressor mounting bolts.

6. Remove the compressor.

7. Drain and measure the refrigerant oil from the original compressor by removing the drain plug.

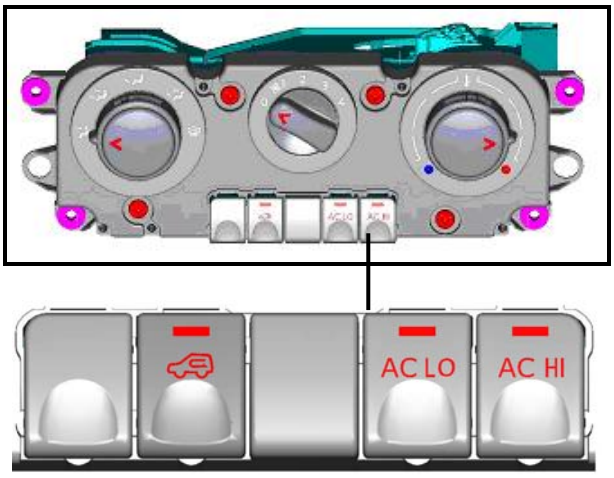
8. For example, the oil quantity drained from the original compressor is 80 cc.
   The replacement compressor comes with 150 cc of compressor oil.
   The implication is that out of the total 150 cc of the original compressor. 70 cc of oil is in the system. Hence if the replacement compressor is fitted as it is, it will cause this 70 cc extra to get into the whole system and affect the performance.

9. Hence it should always be –
   Oil to be drained from new compressor =Total oil capacity of compressor- Drained oil
   The refitting procedure is the reverse of assembly procedure.

10. Follow the steps of **charging procedure.**

Control Panel --

The control panel has 3 knobs- the right knob is for degree of cooling to heating- depending on the knob setting. For maximum cooling set the knob on blue color dot and for maximum heating set the knob on red color dot.



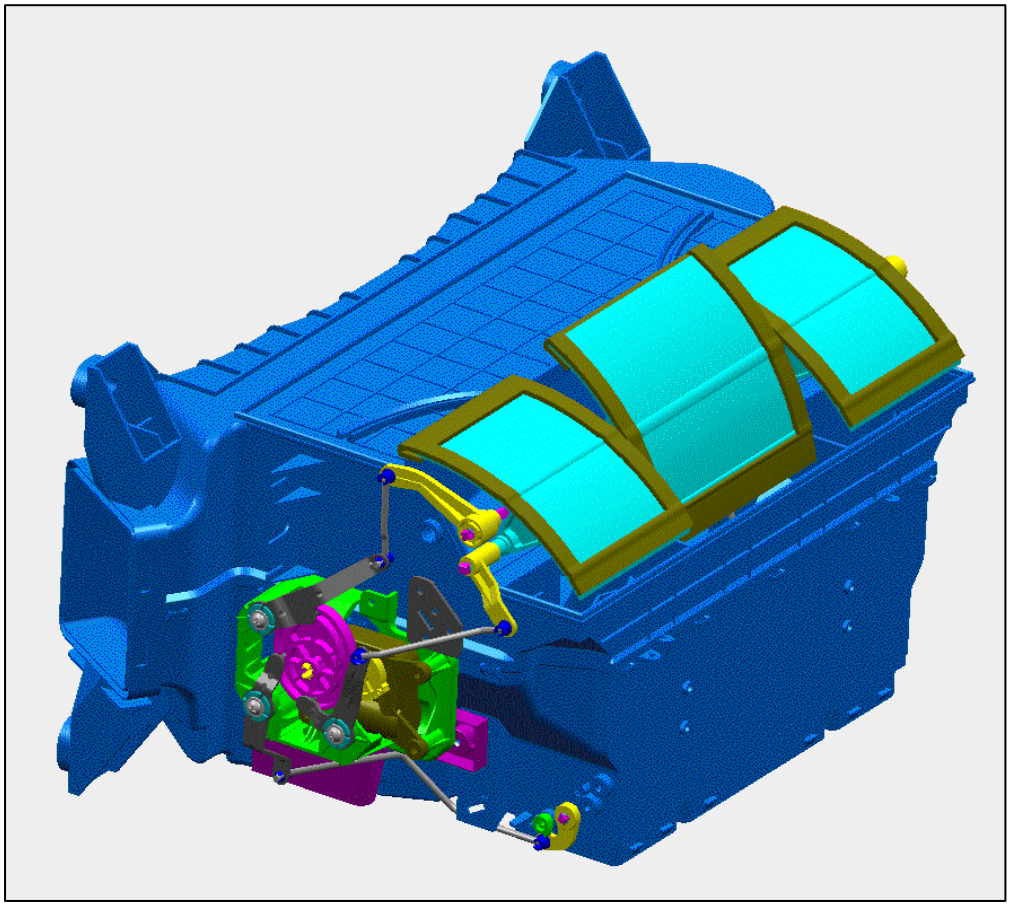
The left knob sets the flap position to direct the airflow to face only or face & feet or feet only or feet & defrosting or only defrosting.

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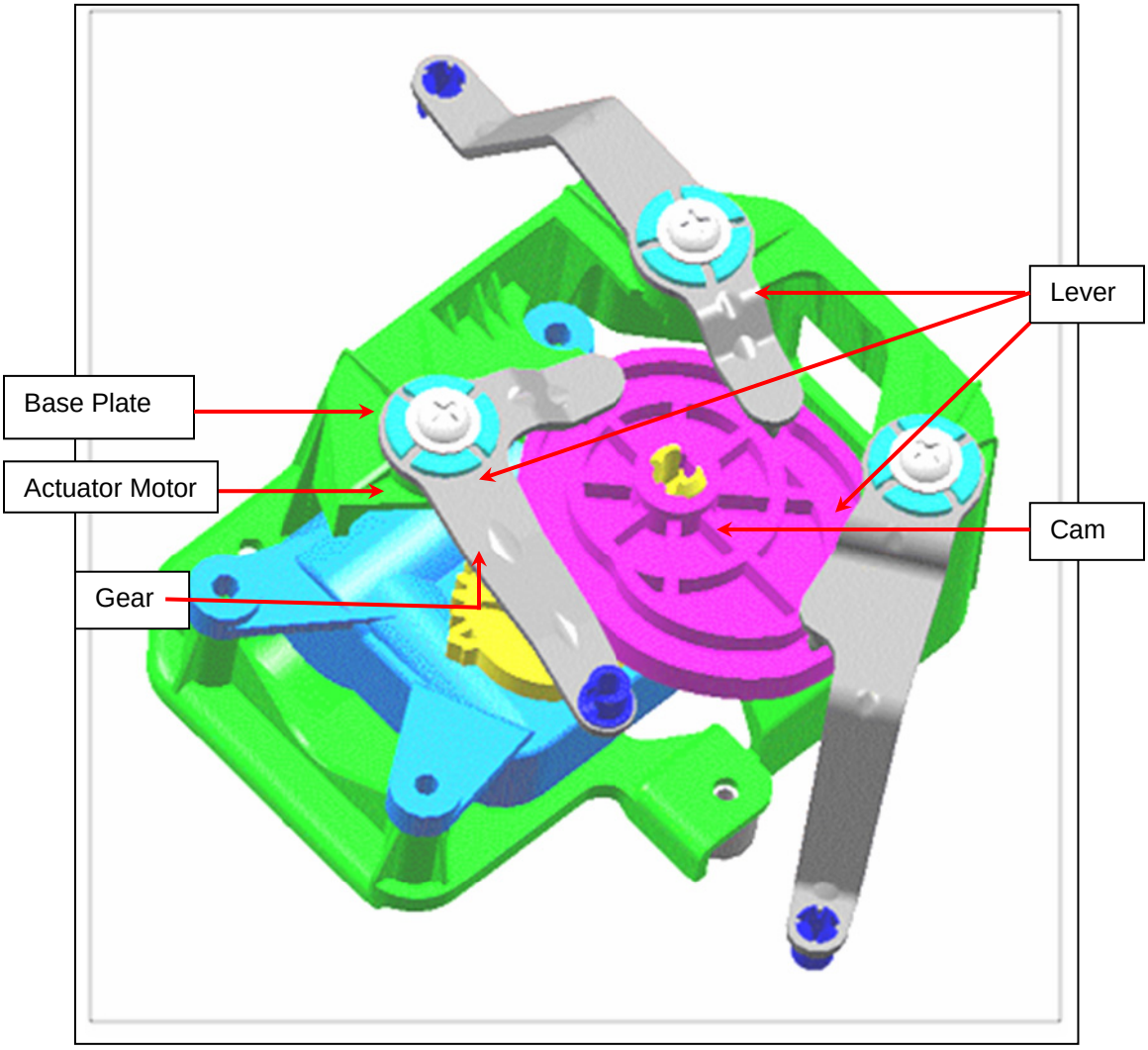
The middle knob controls the blower speed. The bottom row indicates AC low , AC high & fresh air / recirculation mode.

The control panel is PCB based & has only one cable for water valve opening operation.

View of the Base plate assembly with actuators (Electrical Operation of Flaps & circulation modes –



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Setting of the Control Panel Cable --

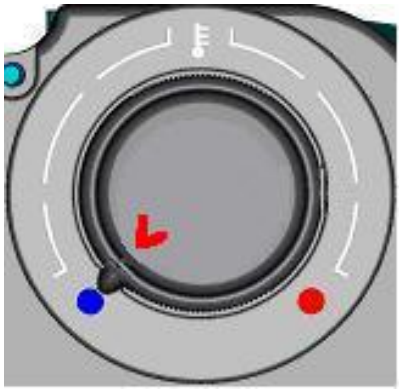
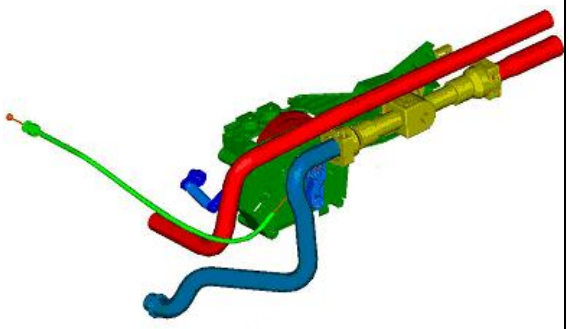
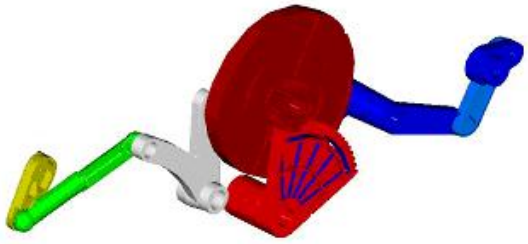
The procedure, which is, outlined below are the setting procedure for assembly. However, please note that the removal of the cables should also be done in the same positions.

Caution: Failure to follow the procedure may cause breakages.

Note: The procedure for setting of the links with Electric actuation is given after the manual control panels

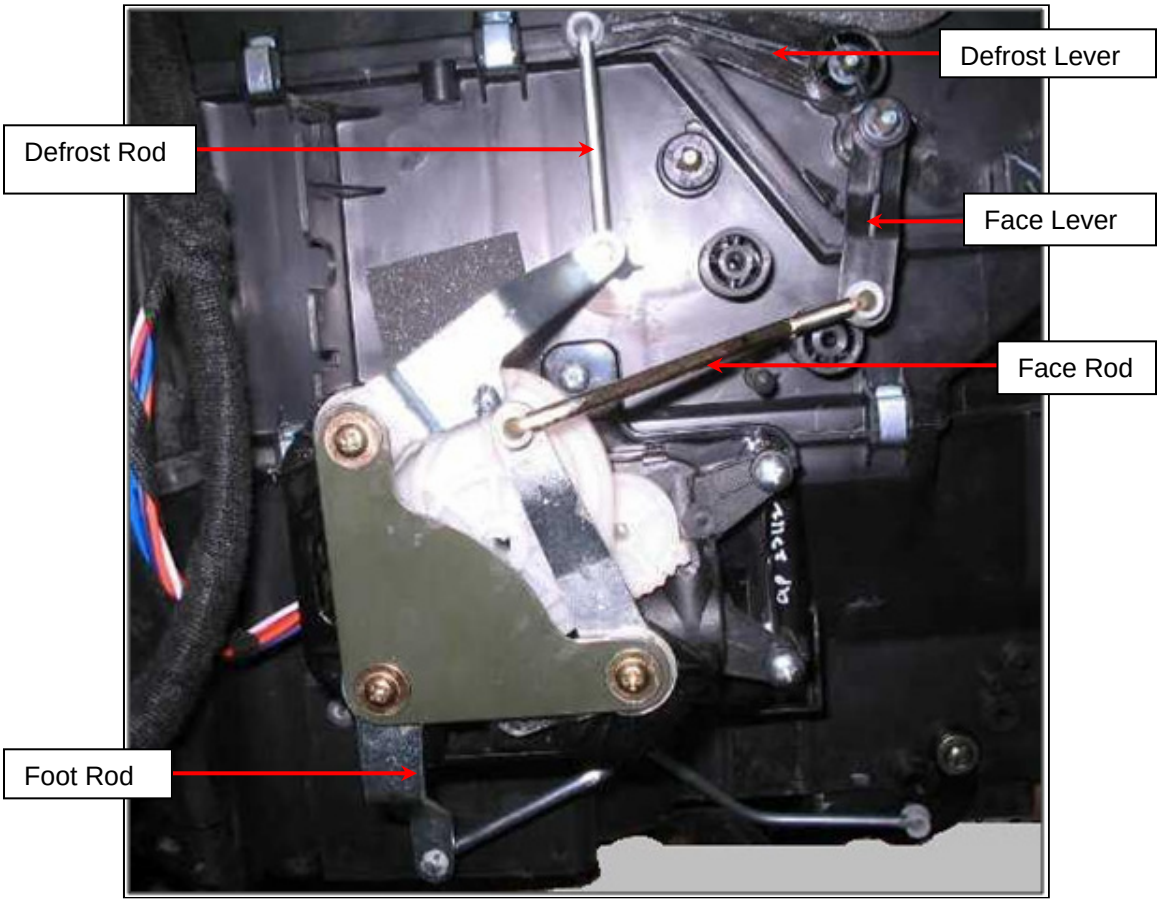
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Water valve setting Procedure -

Hold the control panel in front of the housing.	
	**Keep the cooling & heating knob at the highest cooling point position.**
	
 Water lever at closed position,	**Clamp the cable of the control panel water valve to closed position of water lever in the housing side.**

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View of the Climate control box with Electric Actuation Showing the linkages for different actuation -



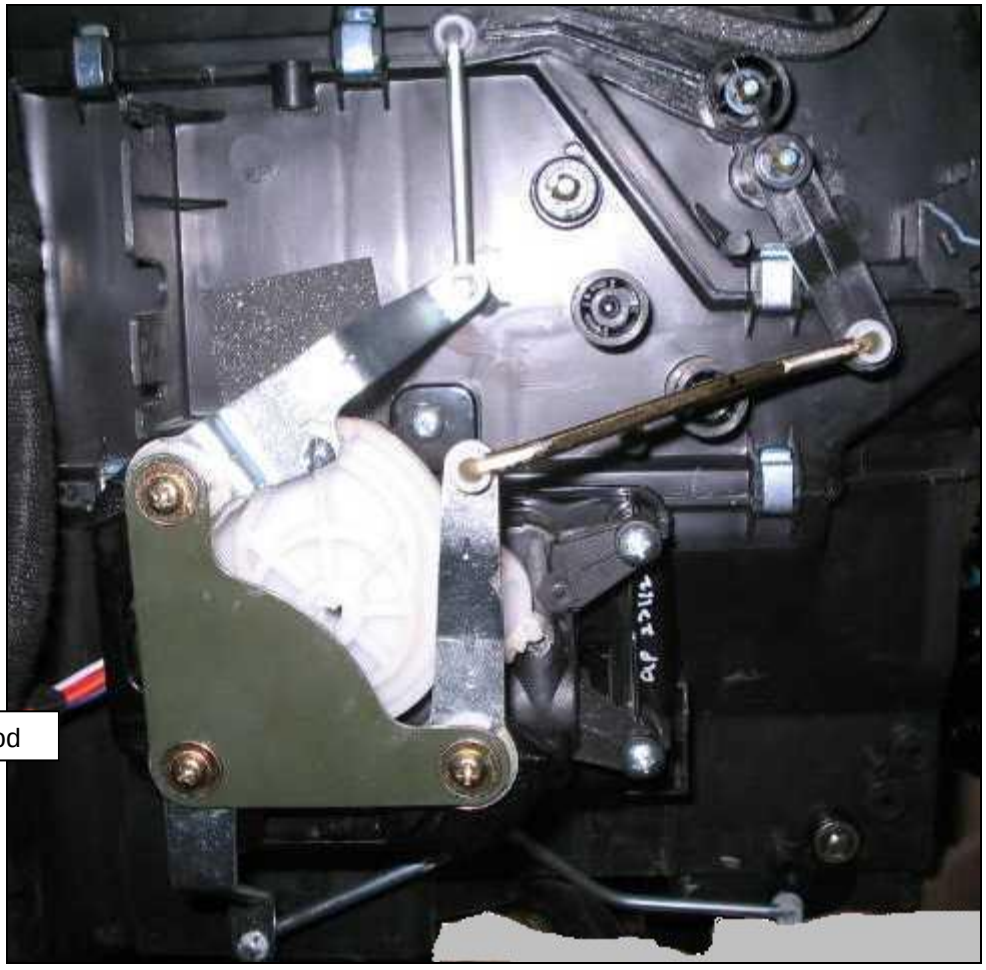
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Fitting the rod by snapping it on the Hook -



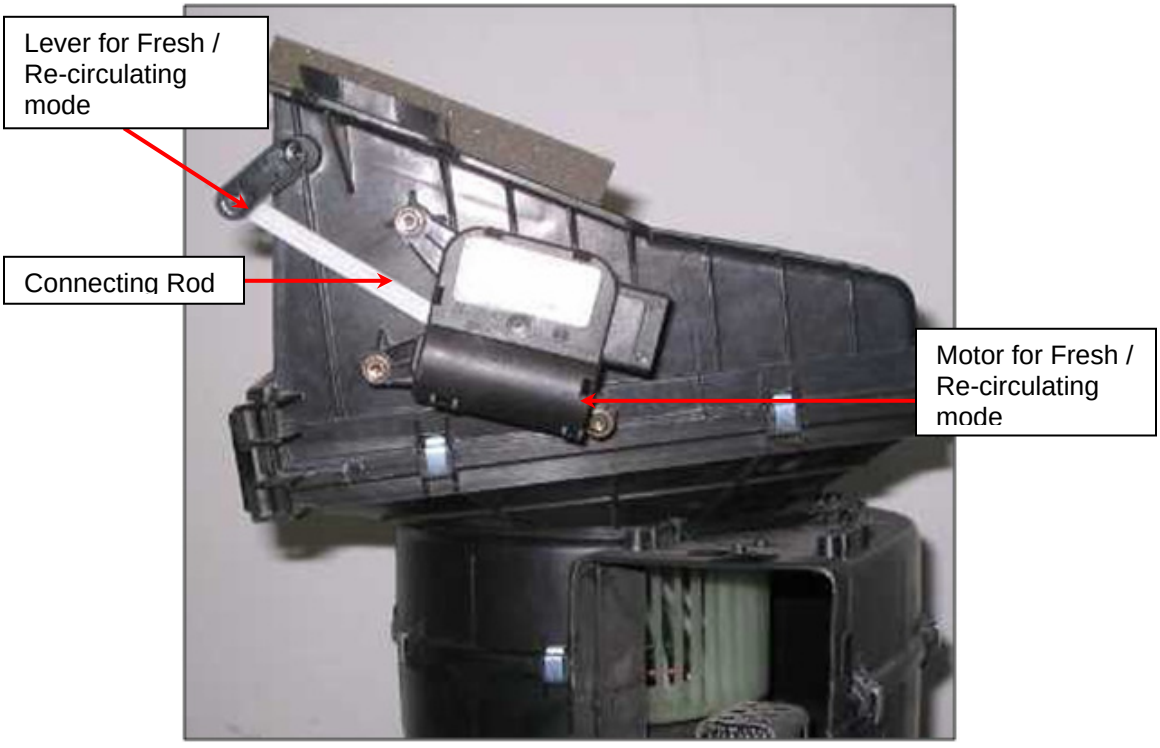
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Photo showing the levers in the face mode –



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Fitting the Fresh /re circulating flap (with the flap in the fresh air mode)



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Replacing the Antifreeze switch –

The function of the anti freeze switch is to protect the refrigerant system from damage. It switches off the compressor when the condenser water dries ices up on the evaporator fins. Otherwise, the evaporator becomes extra cool, resulting in the air passage between the fins getting blocked. Suction pipe becomes extra cool and sometimes iced up, the refrigerant remains liquid even after the expansion valve due to insufficient heat transfer across the evaporator surface and eventually the compressor will get damaged due to liquid refrigerant inflow.

Replacement procedure:

Remove the wiring harness from the connector.
Pull out the probe carefully.
While fitting back, ensure that the washer & the O ring is present.

Recommended Lubricants –

Refrigerant: R134A
Compressor oil: FD46XG. PAG stands for (Poly Alkaline Glycol oil)

Oil quantity to be filled while replacing components –

- Condenser/evaporator: In addition to the drained quantity- 20 cc
- Receiver Drier: Add 20 cc of new oil
- If any one pipe is replaced then 10cc. (If 2 pipes replaced then it should be 20 cc.)

Evaporator cleaning Agent --

"Coil Rinse" Packaged by Chemguard Laboratories; Kuala Lumpar.

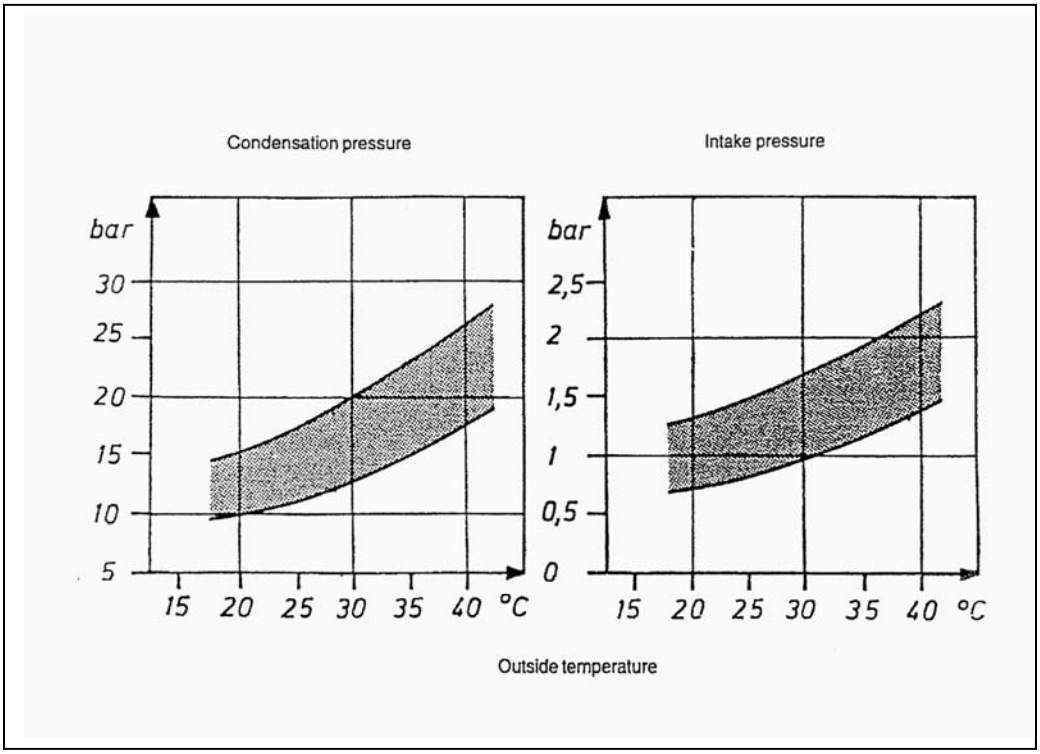
In India Marketed by Astro Trading Company
Contact person Mr. Rakesh Bhai; Mobile no 9820141308

Specifications –

Blower Motor: 3700±300; 12 V; 300 W
Condenser Motor: 2500± 200; 12V; 200 W
Expansion Valve- 2T

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Chart showing the Effect of ambient temperature on Low Pressure side pressure & High side pressure with R134 A



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Brakes

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Rear principle, Assembly & dismantling of the Rear Brake
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Working principle of the brake booster
Parking Brake Description, Setting
Specification & Wear Data
Tightening Torques
List of the MSTs
Recommended Lubricants
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Description

The brake system is vacuum assisted 'H'split type. The front brakes are twin pot calipers with ventilated rotor. The rear brakes are drum types with self-adjusting mechanism. The parking brakes are actuated in the rear through cable. Both the front disc pads and the rear brake liners are non-asbestos.

The system is equipped with ABS which ensures optimum braking distance without allowing the wheels to lock.

Trouble Shooting -

Preliminary checks involve inspecting fluid level, parking brake action, wheel and tyre conditions. Checking for obvious or external leaks or component damage and pedal response. A road test will confirm or deny the existence of the problem.

While road testing if the complaint involved low brake pedal, make several low speed stops and note if pedal comes back to normal height. Check the pedal response with gear in neutral and engine running. The pedal should remain firm under steady pressure. During road test make normal and firm brake stops in speeds of 40 to 60 Km/h. Note faulty brake operation such as pull, grab, drag, noise, low pedal, hard pedal, fade, pedal pulsation, etc.

Diagnosis -

Pedal falls away

A brake pedal that falls away under steady foot pressure is generally the result of system leak. The leak point could be at a brake line, fitting hose, wheel cylinder or Master Cylinder Internal leakages caused by worn or damaged piston, seals may also be the problem cause.
If leakage is severe fluid will be evident at or around the leaking component.

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Low pedal

If a low pedal is experienced, pump the pedal several times. If the pedal comes back up, worn lining and worn rotors or drums are the most likely cause. However, if the pedal remains low and / or the warning light illuminates then the problem is in the master cylinder, wheel cylinder, or calipers.
A decrease in master cylinder fluid may only be the result of normal lining wear. Fluid level will decrease in proportion to the lining wear. It is a result of the outward movement of caliper and wheel cylinder pistons to compensate for normal wear. Top up reservoir fluid and check brake operation to verify the complaint.

Spongy pedal

A spongy pedal is most often caused by air in the system. However thin drums or substandard brake lining and hoses will also cause a condition similar to spongy pedal. The proper course of action is bleed the system or replace thin drums and suspect quality brake lining and hoses. In case the system has not been maintained as per recommendations and the brake hoses have not been replaced then due to swelling of the hoses during braking – it also causes spongy braking. In such a condition it is advisable to replace the hoses and replace all the seals and change the brake fluid.

Hard pedal or High pedal effort

A hard pedal or high pedal effort may be due to lining that is water soaked, contaminated, glazed or badly worn. Defective vacuum assistance will also cause hard operation. The vacuum booster or check valve (NRV) could also be faulty. Test the booster function. As detailed below —

1. Start engine & check booster hose connections as well as the EGR valve connections. Correct any vacuum leak before proceeding further.
2. Stop the engine and put in neutral.

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3. Pump the brake pedal until all the vacuum in the reservoir is exhausted (normally after 6 to 8 pedal applications the brake pedal will become hard)
4. Press and hold brake pedal under light foot pressure

a) If the pedal hold firm then proceed to step 5.
b) If the pedal does not hold firm then and falls away then the master cylinder is defective.

5. Start the engine and note pedal action.

a) If the pedal falls away slightly under light pedal action and then hold firm then proceed to step 6
b) If no pedal action is discernable then vacuum pump or vacuum check valve is defective.

6. Rebuild the vacuum reserve as follows. Release brake pedal. Increase engine speed to 1500 rpm and then bring it to idle and shut off engine.
7. Wait for about 90 seconds and try brake action again. Booster should provide two or more vacuum assisted pedal applications. If vacuum assist is not performed then perform check for the check valve and booster.

Find the enclosed flow chart for reference –

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TROUBLE SHOOTING OF VACUUM BOOSTER ASSEMBLY
BASIC TEST

ENGINE OFF. Depress & release brake pedal several times to remove vacuum from Booster Assembly. After this the pedal application will feel hard to press.

Depress the brake pedal & hold with light pressure of @ 10kgs. & start the ENGINE

If the booster is functioning satisfactory, the pedal will fall slightly & then hold. Here less pressure will be needed to hold the pedal dawn.

.

IF THE BOOSTER IS NOT OPERATING
Disconnect the vacuum hose from the NRV . Then with ENGINE RUNNING , check vacuum supply with a vacuum gauge. There should be at least 600 mm of Hg vacuum for Diesel & 500 mm of Hg for petrol vehicle.

If the BOOSTER is OPERATING pl. turn over & do the VACUUM LEAK TEST.

If VACUUM SUPPLY IS BELOW 600 mm of Hg for diesel & 500 mm of Hg for petrol veh. replace or repair vacuum hose & vacuum source.

If VACUUM SUPPLY IS 600 mm of Hg for or more for diesel or 500 mm of Hg or more for petrol vehicle, then the booster is faulty & should be replaced.

When adequate vacuum supply is obtained, repeat basic test.

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VACUUM LEAK TEST

Run engine to medium speed. Release accelerator & turn Engine OFF. This builds up vacuum.

Wait for 90 sec.& apply brakes. Two or more applications should be vacuum assisted.

IF APPLICATIONS ARE NOT VACUUM ASSISTED disconnect vacuum hose from vacuum source or NRV whichever is easier. If disconnected from NRV , attach short length of hose to valve.

IF APPLICATIONS ARE VACUUM ASSISTED there is no vacuum leak.
DO THE HYDRAULIC LEAK TEST.

Blow into hose attached to NRV. If air passes through , valve is defective.

IF NRV or CHECK VALVE IS DEFECTIVE install new NRV & repeat VACUUM LEAK TEST.

IF NRV OR CHECK VALVE IS OK , vacuum booster is leaking & should be replaced.

HYDRAULIC LEAK TEST

Depress & release brake pedal several times . Then hold pedal depressed with medium pressure.

IF PEDAL FALLS AWAY hydraulic system is leaking. Check for external leakage at wheel cylinders, calipers , brake pipes , hoses & joints.
If there is no external leak, there may be an internal leak (master cylinder seals) . Repair or replace parts needed to correct leak.

IF PEDAL DOES NOT FALL AWAY hydraulic system is not leaking.

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CHECK VALVE OR NRV -- NON RETURN VALVE (MOUNTED ON VACUUM BOOSTER FT. FACE

Brake drag

Brake drag occurs when the lining is in constant contact with the rotor or drum. Drag can occur at one wheel, all wheels, front only or rear only. It is caused by incomplete shoe release. Drag can be minor or severe enough to overheat the lining, rotor and drum.

Brake drag has a direct effect on fuel economy. Undetected minor drag can be misdiagnosed as an engine complaint. In case of severe drag it can also cause clutch slip.

Minor drag will usually cause slight surface charring of the lining. It can also generate hard spots in the rotor or the brake drum from the overheating/ cooling process. In most cases the rotors, drums, wheels, and tyres are quite warm to touch after the vehicle is stopped.

Severe drag can char the brake lining all the way through. It can also cause distort and score rotors and drums to the point of replacement. The wheels, tyre and brake components will be extremely hot. In severe cases the lining may generate smoke as it chars from overheating.

Some common causes of brake drag are:

- Loose or damaged wheel bearing
- Seized or sticky caliper or wheel cylinder piston.
- Loose caliper-mounting bracket.
- Loose mounting bolts of the rotor.
- Distorted brake drum or shoes.
- Rear brake shoes binding on worn/ damaged support plates
- Misassembled components
- Incomplete release of parking brake
- No free play
- Clogged master cylinder return port
- Broken master cylinder return spring

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If the brake drag occurs at all the wheels, the problem may be related to a blocked master cylinder compensation port or faulty vacuum booster (binds does not release).
An improperly mounted brake light switch can also be a cause of drag. An improper mounting may prevent the brake pedal to return completely. This will cause the master cylinder feed port port to be blocked. The brakes would be partially applied causing the drag.

Brake Fade

Brake fade is a product of overheating caused by brake drag. However overheating and subsequent brake fade can also be caused by riding the brake pedal, making repeated high deceleration stops in a short time span, Constant braking on steep roads also cause brake fade. If the brake lining is contaminated with oil or glazed then also the brake fading will take place.

Pedal Pulsation

Pedal pulsation is caused by components those are loose or beyond tolerance limits.
Disc brake rotors with excessive lateral runout or disc thickness variation, or out of round drums are the primary cause of pulsation. Other causes are loose wheel bearings or calipers and worn, damaged tyre

Pull

A front pull condition would be the result of:

- Contaminated lining in one caliper.
- Seized caliper piston
- Binding caliper.
- Loose caliper.
- Loose or corroded slide pin.
- Improper brake shoes
- Inadequate contact of pad.

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- Damaged rotor
- Incorrect wheel bearing adjustment (at one wheel)
- Incorrect tyre inflation(High variations between two wheel)
- Shoe return spring weak or broken

A worn, damaged wheel bearing or suspension components are further cause. A damaged front tyre (bruised, ply separation) can also cause pull.

A common and frequently misdiagnosed pull condition is where the direction of pull changes after a few stops. The cause is a combination of brake drag followed by brake fade at the dragging brake unit.

As the dragging brake overheats, efficiency is so reduced as the fade occurs. If the opposite braking unit is still functioning then its braking effect is magnified. These causes pull to switch direction in favor of the brake unit that is functioning normally.

While diagnosing a pull in change in pull condition, remember that pull will return to the original direction if the dragging brake unit is allowed to cool down (and is not seriously damaged)

Rear Brake Grab

Contaminated lining, bent, or binding shoes and support plate usually causes rear grab (or pull). This is particularly true when one wheel is involved.

Brakes Do not Hold After Driving Through Deep Water Puddle

This condition is generally caused by water soaked lining. If the lining is only wet it can be dried by driving with the brakes lightly applied for 2 to 4 kms. However if the lining is both wet and dirty then it will be necessary to dismantle, clean and reassemble.

Brake Fluid Contamination

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There are two causes of brake fluid contamination. The first involves allowing dirt, debris, or other liquid material to enter cylinder reservoir when the cover is off. The second involves adding to, or filling the cylinder with a non- – recommended fluid.
Brake fluid contaminated with only dirt, or debris usually retains a normal appearance. In some cases the foreign material will remain suspended in the fluid and be visible. The fluid and foreign material can be removed from the reservoir with a suction gun but only if the brakes have not been applied. If the brakes are applied after contamination, system flushing will be required. The master cylinder may have to be disassembled, cleaned and the piston seals replaced. Foreign material lodged in the reservoir compensator/ports can cause brake drag by restricting the fluid return after application.
Brake fluid contaminated by a non recommended fluid will usually be discolored, milky, oily looking or foamy. In some cases it may even appear as if the fluid contains sludge. ***However remember that the brake fluid will darken in time and occasionally are cloudy in appearance. These are normal conditions and should not be mistaken for contamination.***

If some type of oil has been added to the system then the fluid can separate into distinct layers. This can be verified by draining off a sample with a clean suction gun. Then pour the sample into a glass container and observe fluid action. If the fluid separates into distinct layers, it is definitely contaminated.

The only real correction for contamination by non-recommended fluids is to flush the entire hydraulic system and replace all the seals and the brake hose.

Brake Noise -

Squeak/Squeal

Brake squeak or squeal may be due to linings those are wet or contaminated with brake fluid, grease or oil. Glazed linings and rotor/drums with hard spots can also cause squealing. Dirt and foreign material embedded in the system will also cause squeak/squeal. Worn retaining pins can also cause disc pad to squeak/ rattle.

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A very loud squeak or squeal is frequently a sign of severely worn brake lining (or the drum or the rotor). If the lining has worn to the rivets then metal to metal contact takes place. If the condition is allowed to persist then rotors/drums can become so scored that replacement is necessary.

Thump/clunk

Thumping or clunking noise during braking are not caused by the brake components. In many cases such noises are caused by loose or damaged steering, suspension or engine components. However caliper that bind on the slide surface can generate thump or clunk noise. In addition, worn out improperly adjusted, or improperly assembled rear brake shoes can also produce a thumping noise.

Chatter -

Loose or worn components or glazed/burnt lining usually causes brake chatter. Rotors with hard spots can also contribute to chatter. Additional causes of chatter are out of tolerance rotors, brake ling not secured properly to shoes, loose wheel bearings and contaminated brake lining.

Brake lining contamination -

Brake lining contamination is usually a product of leaking calipers or wheel cylinders, driving through deep puddles, or lining that has become covered with grease and gravel during repair.

Wheel & Tyre Problems -

Some conditions attributing to brake components may actually be caused by a wheel or tyre problem

A damage wheel can cause shudder, vibration and pull. A worn or damaged tyre can also cause pull.

Severely worn tyres with very little tread depth can produce a condition similar to grab as the tyre loses and recover traction.

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Flat spotted tyres can cause vibration and wheel tramp and generate wheel shudder during brake operation.

A tyre with internal damage such as bruise or ply separation can cause pull and vibration.

Defective Parking Brake -

Can be caused by excessive brake lever play. Sticky parking cable, grease or oil on shoe, excess shoe clearance (normally caused by malfunction of automatic adjusting mechanism)

Care of the system -

The brake fluid should conform to DOT 3 specifications.

The brake fluid should be replaced once a year or every 40,000 Kms - which ever is earlier. This is because brake fluid is hygroscopic in nature hence it absorbs moisture. The normal braking operation also results in brake fluid getting heated. The process of heating and cooling also results in moisture. The brake fluid boiling point keeps coming down due to the presence of moisture hence if not changed it can cause higher corrosion of the wheel cylinders/ master cylinders/ brake tubes as well as spongy or poor braking.

Caution - Do not mix brake fluid of different brands. Do not use any brake fluid, which is kept in an open container. Always use brake fluid from a sealed container.

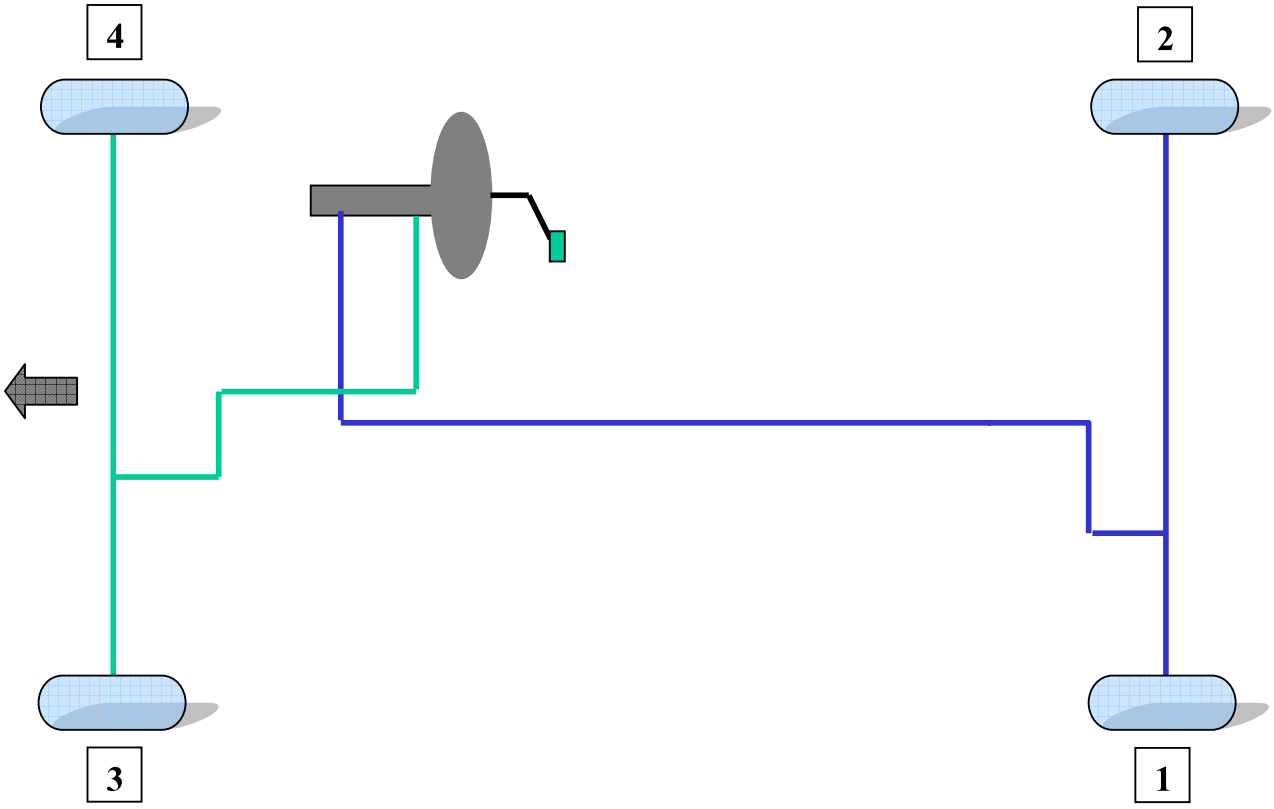
The brake fluid should not be contaminated with any mineral oil. Do not use reuse brake fluid that has just been bled.

The list of the recommended lubricants is enclosed at the end of the ***Manual.***

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In Car repairs -

a) Free Play Adjustment.
b) Brake Bleeding.
c) Front Pad replacement
d) Rear



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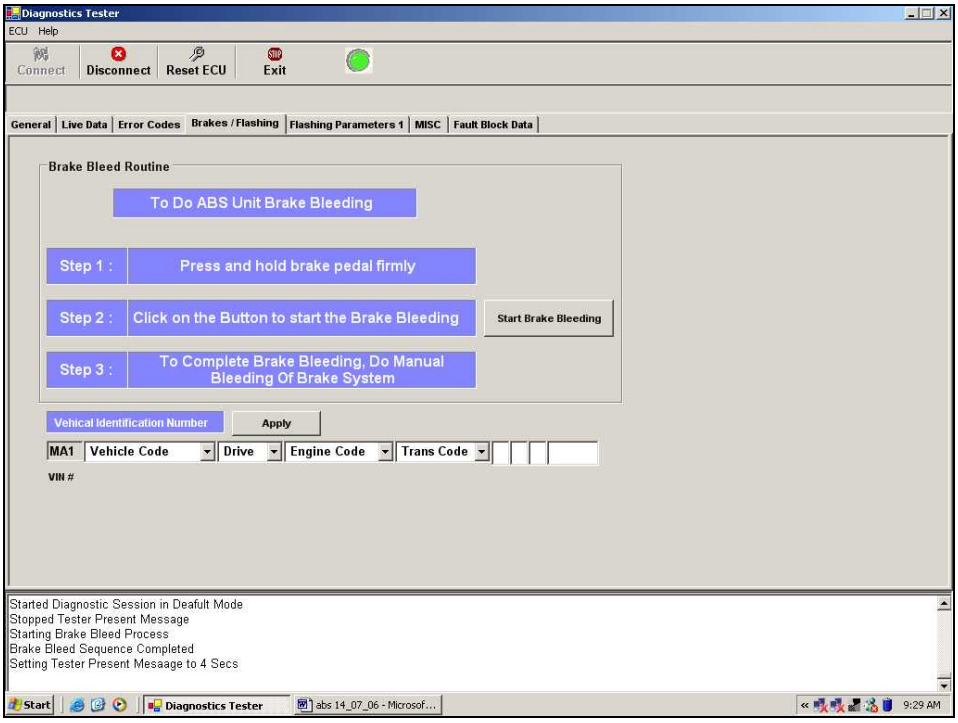
1. Rear left
2. Rear right
3. Front left
4. Front right

The procedure at each of the bleed point is to pump 2 to 3 times; open the bleed screw1/4th turn. Then close the bleed screw. Again pump 2/3 times then open the bleed screw keeping the pedal pressed down. Close the bleed screw and release the pedal. Repeat the operation until no bubbles are coming.

It is also advisable to keep the engine running at idling so that the pedal travel is complete.

2. In the second stage the bleeding of the EHCU assembly needs to be done. The procedure is as below -

1. Connect scan tool to the K-Line Diagnostic Connector.
2. Follow the instructions displayed.



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3. When scan tool displays “BRAKE BLEEDING” disconnect the scan tool and proceed.
4. Perform base brake bleeding a second time.
5. Top up master cylinder fluid level and verify proper brake operation before moving vehicle.

The air trapped in the EHCU assembly will be pushed out into the hydraulic circuit during Step 2. Repeat the manual bleeding as per the sequence explained in Step 1 to ensure no air in the hydraulic circuit.

Caution -
Before opening the reservoir cap- clean the area of all dust and muck.

Before starting the bleeding - ensure that the parking brake is in released condition.

After bleeding each point put back the rubber cap.

Always use the brake fluid from a sealed container.

A pipe should be connected from the bleed screw to a clean container where the pipe other end is fully immersed in brake fluid. Doing the bleeding without the pipe can lead to improper bleeding as the presence of small bubbles can not be seen without the tube.

DO not reuse the bled fluid. (It will have air bubbles entrapped.)

During the bleeding operation ensure that the master cylinder fluid level does not become below lower level. (It can draw air thus defeating the purpose of bleeding)

If the brake fluid has to be reused then it should be poured into a can using clean plastic pipe. The removed fluid should be kept without disturbing for at least 72 hours, so as to allow the air bubbles to get out. Later it is suggested to use chamois leather to strain the brake fluid.

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c) Front Pad replacement

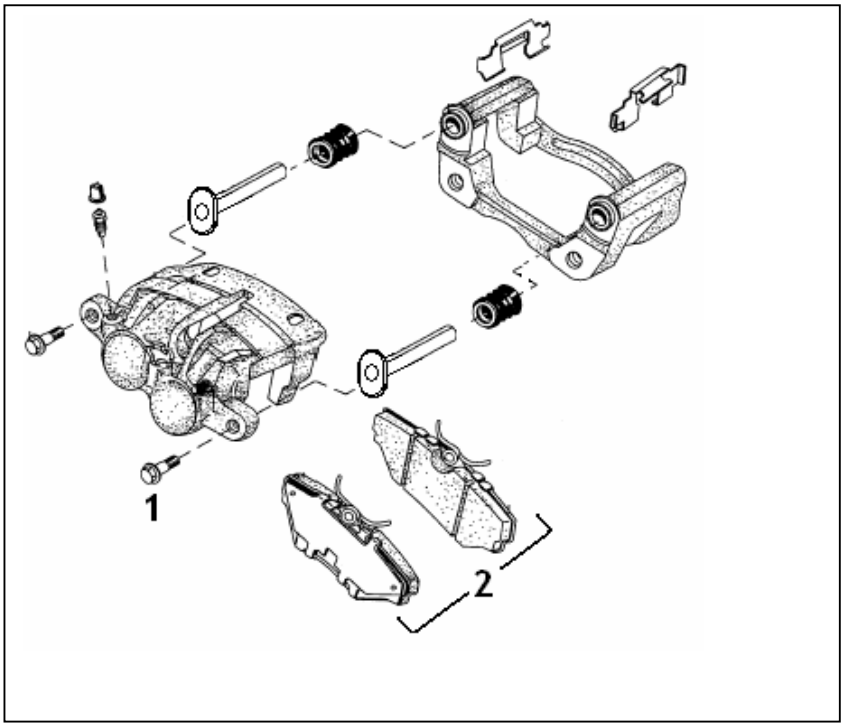
Put the vehicle under hand brake in order to prevent from rolling.

In Car Repairs -

Removal & Refitment of Brake pads --

Note : The Assembly sequence is the reverse of the dismantling sequence. Any special precautions to be taken while disassembling or assembly are indicated & shown later.

Replacement of the brake pads -

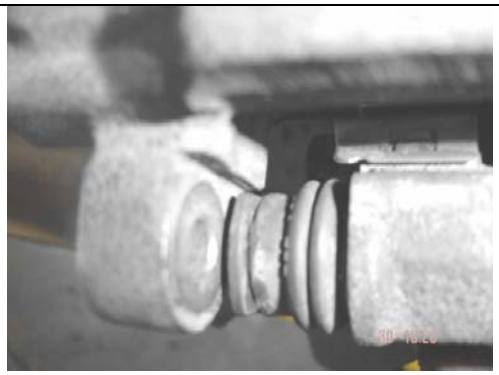


1. Loosen and remove the bolt - Pin of the guide pin & swing up the caliper. (Check Point A)

2. Remove the old pads one by one.

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Check Points –

	**A)** While swinging down the caliper take care and see that the antisqueal shims are not damaged. While fitting the guide pin ensure that the straight portion of the pin matches with the ear of the caliper body. It is recommended to change the antirattle clips at the time of pad change. After tightening the bolt to torque . **Rotate the disc and ensure that the disc is free to rotate.**
	**B)** **Connect a transparent plastic pipe to the bleed screw on the caliper. Dip the other end of the pipe into a container filled with brake fluid.** Ensure the tip of the plastic pipe always remains dipped in the brake fluid. Loosen the bleed screw & push both the pistons one by one into the caliper bore. Ensure the pistons are pushed back fully into the caliper bore.

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Caution :
Because the bleed screw is loosened to push the pistons of the caliper back, it is required to bleed the vehicle to retain the original brake performance of the vehicle.

CAUTION

If the pads are to be reused make sure they are assembled back in the same position as they were when removed i.e., inboard pad on to the piston side and outboard pad to the wheel side. This is possible only when at the time of removal these pads are marked for their positions and kept aside.
Never lubricate the pad seating areas as it may lead to jamming.
After fitting the pads, apply brake pedal 5 to 6 times in static condition in order to make the pads align properly.
The brake pads require nearly 200 Kms of running for bedding in. Hence it is advisable that during the brake testing after fitting the new pads and also during the initial run, severe braking and / or continuous operation be avoided.

Rear Brake liner replacement -

	Remove the wheel. The jacking point for rear axle is below the axle . Care must be taken to avoid any damage to the suspension links.

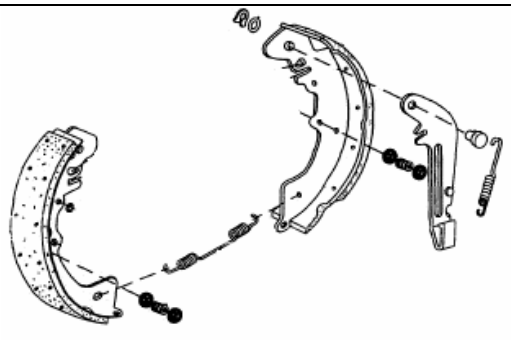
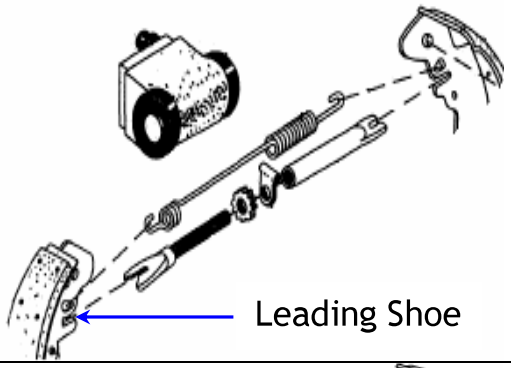
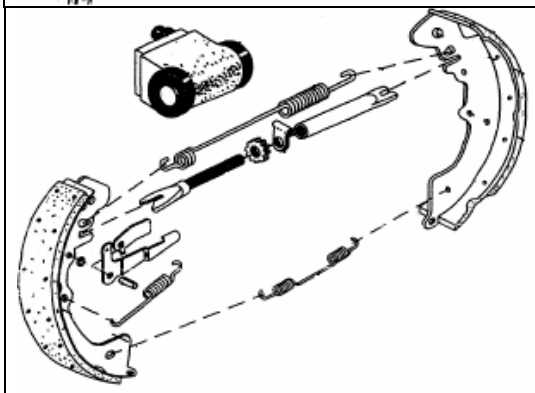
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	Remove the brake drum after removing the drum mounting screw.
	Remove the parking brake cable lock.
	If there is any difficulty in removing the drum ; using a screw driver push the hand brake lever. A click sound will denote that the shoe setting is dropped. Now the drum can be removed using two puller bolts.
	Detach the hand brake cable from the lever on the trailing shoe by moving the lever towards the centre of the brake. & remove the cable end from its location in the end of the lever
	Remove the return spring (near the wheel cylinder) from trailing shoe.
	Reduce the adjuster assembly to its

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	minimum length by lifting the end of the pawl lever and rotating the serrated adjuster nut.
	Remove shoe hold down springs and cup washers from the back plate by compressing the spring.
	Slide both shoes off the wheel cylinder pistons. Care must be taken not to damage the rubber boots on the wheel cylinder. Detach the adjuster assembly and shoe return spring from the shoes.
	While riveting the new liners on to the shoe following care should be taken – - the hole in the shoe rim has not become oblong/oval. - While fitting the rivet the holes in the liner and the shoe rim are in same line. - The rivet head at the back is formed properly & the rivetting should be done inside out. - Inspect the shoe hold down springs, cups & shoe hold down pins for any damage / deformation. Replace if required. - It is advisable to use new shoe return springs. - It is advisable to fit the parking brake cable on the slot in the trailing shoe before assembling it on the back plate. Clean the shoe resting pads on the back plate & both the shoe tips.

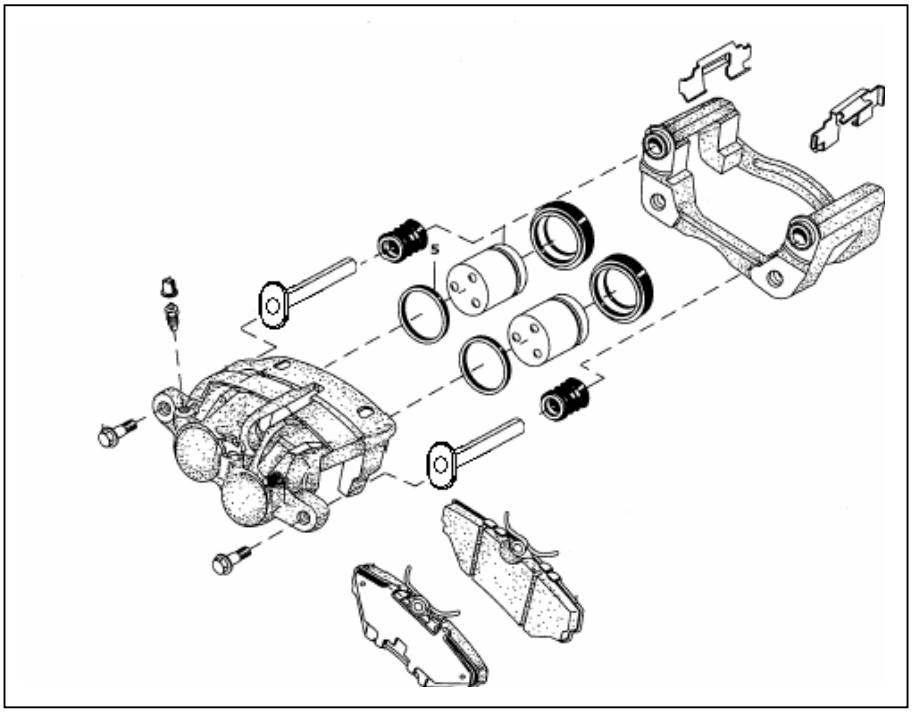
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	Place one shoe on backplate & assemble pin shoe hold down cup. Fit one end of the shoe return spring - lower (abutment spring) in the slot provided on brake shoe. Assemble the other end of the shoe return spring - lower (abutment spring)in the second shoe.
	Hook the shoe return spring (short length coil) to the leading shoe with the adjuster assembly in its minimum length condition,assemble it in between the shoe webs. Attach the other end of the shoe return spring to the opposite end of the trailing shoe.
	Fit the pawl lever to the spring dowel inserting one leg of the pawl between male push rod end & shoe web of the leading shoe & the other end of the pawl leg resting on the adjuster nut. Hook the short end of the spring into the hole in the pawl lever & use plier to attach the opposite end of the spring on to the shoe web.
	Note - Ensure proper resting of auto adjuster inside web & hand brake lever slot.
	Ensure that the the auto adjuster pawl lever edge is properly located on tooth of auto adjuster wheel.
	Connect the Parking brake cable in

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	reverse order of dismantling.
	Centre the shoes relatively by tapping & moving upwards or downwards.
	Before refitting the brake drum check that the drum thickness has not gone below 8.20 mm. **A thin brake drum will flex during braking reducing the braking efficiency and also it will cause improper functioning of the parking brakes.**
	Refit drum & wheels. Apply brakes few times to adjust the brake shoes.

Working principle, Assembly & Dismantling of Twin Pot Caliper Assembly -



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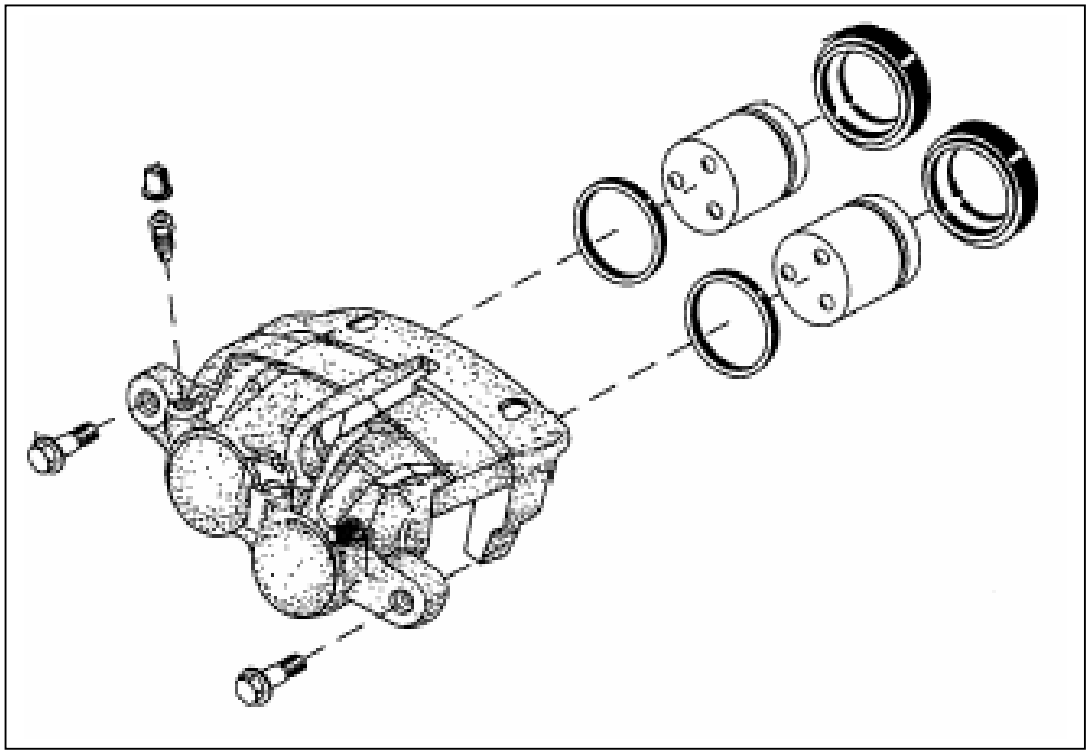
When the brake pedal is pressed then the hydraulic pressure pushes the two pistons to act simultaneously on the brake disc. The combined thrust provided by two pistons is much higher than the single piston caliper.

The sliding rail type carrier on which the twin caliper body slide easily to ensure that equal thrust is applied on both pads. A higher friction pad area improves the durability (life) of the friction material.

Disc brakes by their very nature & design are self adjusting to the wear and hence do not require brake adjustment to compensate the pad wear.

Servicing of Caliper –

- Apply hand brakes. Place wheel chocks on rear wheel
- Jack up the front of the vehicle and remove the front wheels by loosening / removing the wheel nuts.
- Disconnect the hose from the caliper by removing the banjo bolt



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1. Loosen and remove the mounting bolts of the caliper.

2. Remove the caliper assembly after removing the banjo bolt at caliper inlet port.

3. Loosen & remove the sliding pin bolts. Remove the pads. Separate the caliper sub assembly from the carrier sub assembly.
   Clean the caliper & carrier assembly externally with alcohol or fresh brake fluid.

4. Remove the caliper pistons from the bore by blowing dry compressed air through the inlet port of the caliper. Care must be taken to remove both the pistons at a time. Also to avoid the damage to the pistons, place a wooden block in front of the pistons.

4. Remove the boot.

5. Remove the seal- Pistons from the groove by using a blunt edged connector or feeler gauge. Take care during seal removal the bore is not damaged.

6. Remove the bleed screw from the caliper body.

Cleaning & Inspection -

All the removed parts should be cleaned properly using fresh brake fluid or alcohol and kept in a clean tray.

NEVER USE ANY MINERAL OIL BASE FLUIDS LIKE KEROSENE ,DIESEL , PETROL etc,. FOR CLEANING OF REMOVED PARTS.
DO NOT CLEAN THE BORE OF THE CALIPER WITH WATER OR STEAM.

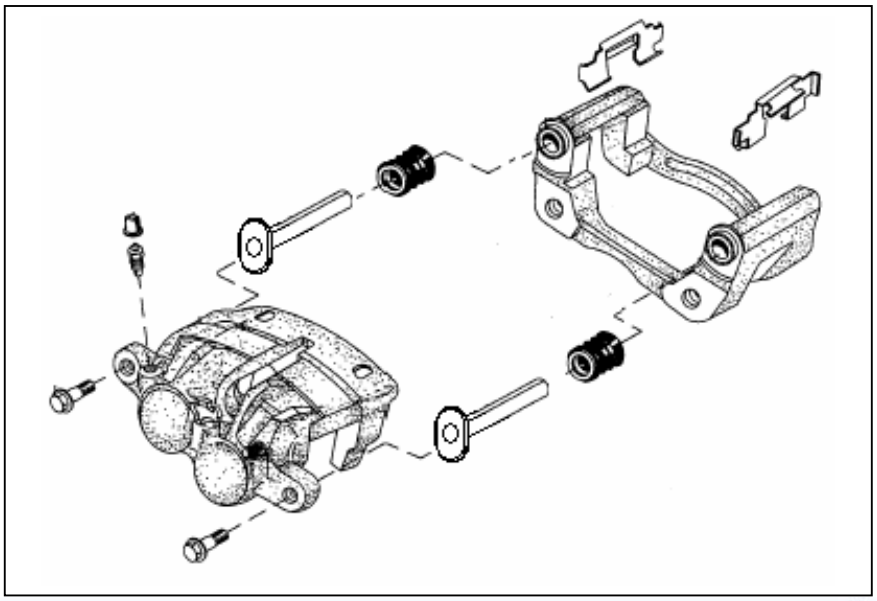
Tips –

	The Piston seals are to be lubricated with fresh brake fluid

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	and assembled in to the seal grooves in the caliper bores. Make sure the seating of this is properly done. Then lubricate the outer surface of the pistons with fresh brake fluid.
	The piston boots are to be lubricated internally with the grease supplied in Caliper Repair Kits before it is assembled on the pistons.
	Fit the boot into the groove in the caliper body. Locking of the rubber boot in the groove to be ensured. Expand the rubber boots & insert the pistons one by one into the caliper bore. The piston should be inserted into the bore in a straight position only. If it gets tilted while pushing, there is a chance that the piston will get jam half way & also can damage the seal.

Servicing / Replacement of Sliding pin -



1. Separate the sliding pins from the carrier assembly .

2. Separate the rubber boots from the sliding pins.

4. Clean the sliding pins & sliding pin bores.

5. Check the sliding pins for bent / damage / rust. If found should be replaced with new ones.

Discard all rubber parts.

Smear the pins and the pin bores with the special grease supplied in Kit.

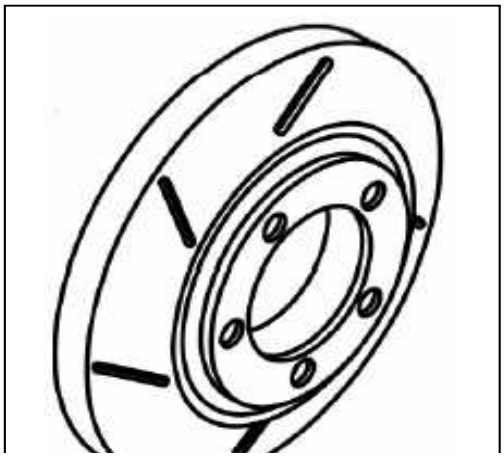
Fit the pin boots on to the pins and assemble it on to the carrier bore.

Ensure proper location of the boot lip on to the carrier. Move the pins in and out 3 to 5 times in order to allow for the trapped air inside the bore to escape.

Repeat the above procedure for the other side caliper assembly.

Inspection of the rotor -

Check the runout of the wheel disc in four places. Excessive lateral runout will cause brake pedal pulsation and rapid unven wear of the brake pads.



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The maximum runout permissible is 0.12 mm

1. **Disc Brake Rotor thickness variations:** Variations in the rotor thickness will cause pedal pulsation, noise and shudder. It should be kept in mind that the disc rotor thickness variation is one of the primary causes for brake pedal pulsation.

The maximum variation permissible is ± 0.012 mm

The rotor thickness should be measured in at least 6 different points around the rotor face. Position the micrometer approximately 15 mm from the outer edge.

Recondition on out of specification rotor -

It is not at all recommended to recondition the brake disc.

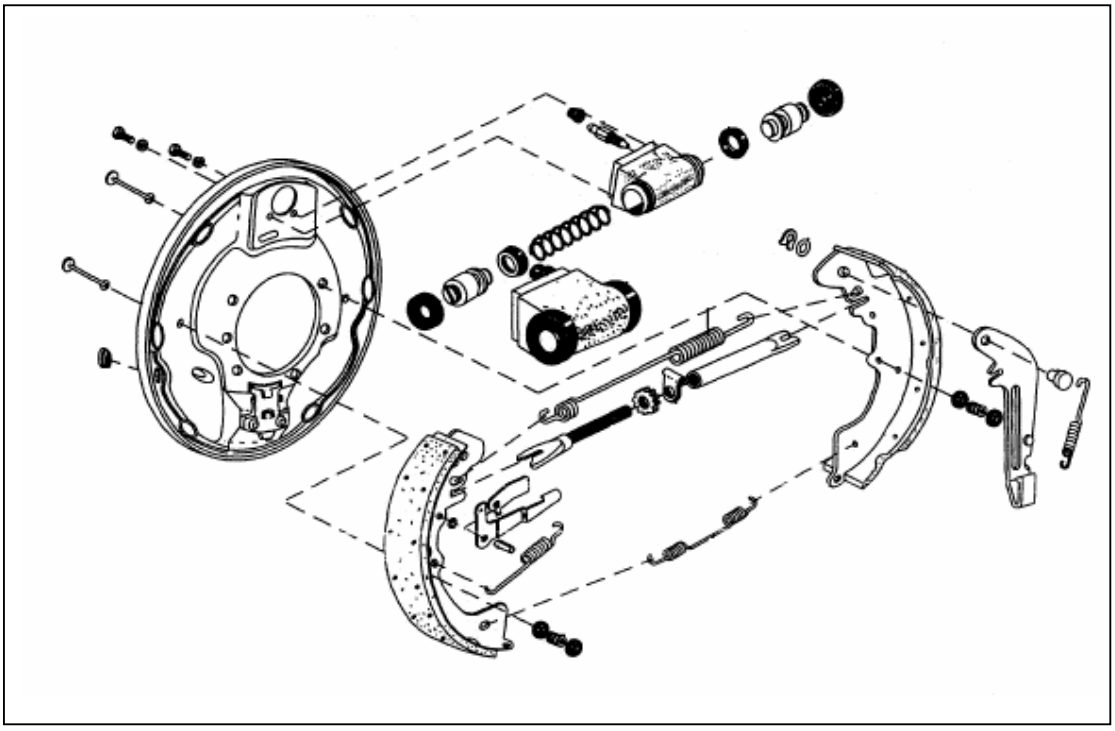
If the rotor requires only minor cleanup of rust, scale or minor scoring then use abrasive disc to clean up the rotor face.

Caution:
Do not go below the minimum specified thickness of 21 mm.

Please ensure that whenever the disc is removed from the hub, then while fitting it back. Use the sealant METALOCK 343 or ANR124 from FEVICOL on the disc mounting bolts thread. Use new spring washers. Failure to do so may cause the mounting bolt to work loose.

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Working principle, Assembly & dismantling of the Rear Brake –



This brake is designed for use on rear wheels and is equally efficient in both forward and reverse direction of movement. A mechanical lever mechanism is incorporated for normal hand brake operation. The feature of this brake is that the brake shoe adjustment takes place automatically when the service brake is applied.

The leading and trailing shoes are connected at one end by a two-piston wheel cylinder and an adjuster assembly. The adjuster assembly consists of a male and female push rod with an adjuster nut operated by a pawl.
Coupled on the trailing shoe is a hand brake lever, which pivots on a pin at the wheel cylinder end of the shoe.

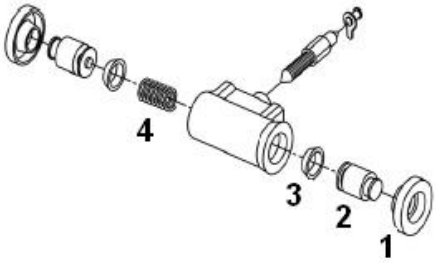
A spring dowel fitted at the leading shoe provides a pivot for the pawl lever , which is retained in position by a spring hooked on to the web. The hand brake cable passes through a hole in the back plate, and the slotted cable end fits in the end of the hand brake lever. When the hand brake is applied, the cable pulls the lever and this movement is transferred via the adjuster assembly to the shoes, which move outwards onto the drum.

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When the foot brake is operated, both the shoes are pushed on to the drum by the wheel cylinder pistons. As the shoe linings wear, the outward movement of the shoes exceeds a predetermined amount and the pawl pivots on the spring dowel to rotate the adjuster nut. This action lengthens the adjuster assembly sufficiently to reduce the clearance between the brake shoes and drum to the desired minimum. The adjustment is repeated, whenever necessary, according to the rate of lining wear.

Dismantling & assembly consist of:

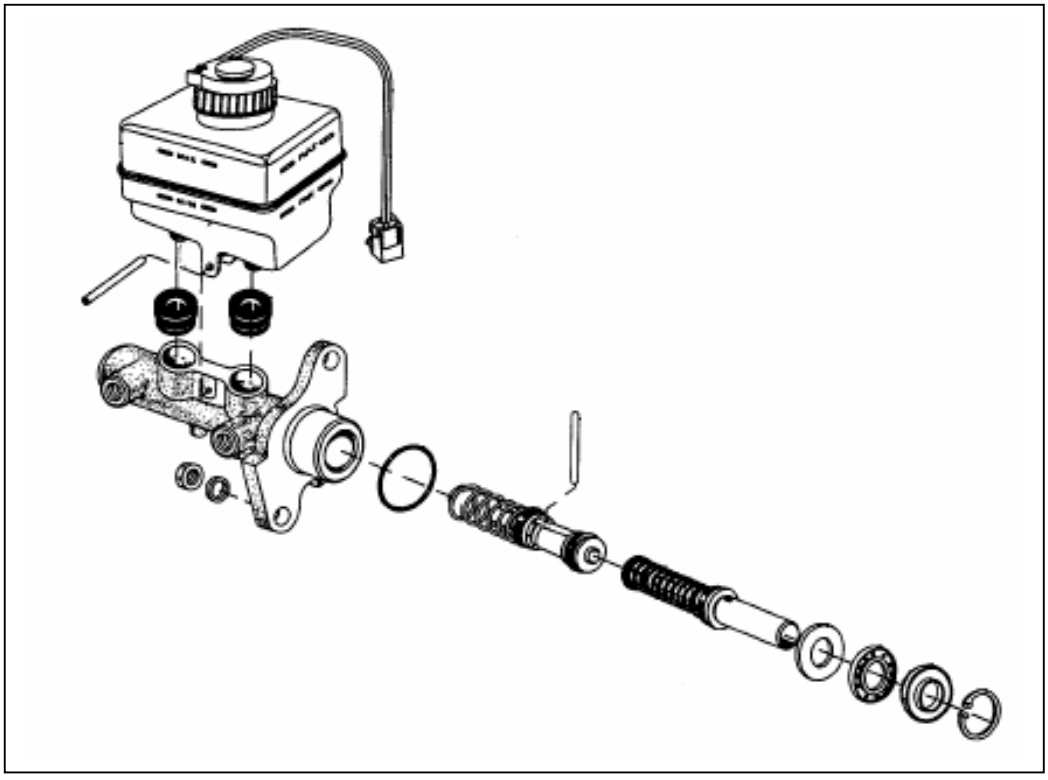
Shoe removal & Wheel cylinder overhaul -

	For removal and refitting the brake liner. Refer to Rear Brake Liner replacement section.
	Disconnect the brake Bundy tubes.
	Remove the rubber boots at the ends of the wheel cylinder. Remove the pistons along with the spring.
	Check the bore of the cylinder for any pitting or scuffing- if so then the wheel cylinder will need to be replaced.
	Check the piston for any deep scoring or scuffing.
	Before assembly clean the wheel cylinder and piston with alcohol or clean brake fluid.

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	Do not attempt to clean with any mineral oil. Any trace of it left will contaminate the brake fluid and reduce the life of the all the rubber components of the hydraulic system.
	It is advisable to fit the parking brake cable on the slot in the trailing shoe before assembling it on the back plate
	Before refitting the brake drum check that the drum thickness has not come below 8.20 mm. **A thin brake drum will flex during braking reducing the braking efficiency and also it will cause improper functioning of the parking brakes.**

Working principle , Assembly & Dismantling of the Master Cylinder



The centre Flow master cylinder, Suitable for ABS system is made of aluminium body with the brake fluid reservoir coupled on to the Master cylinder.

The Tandem Master Cylinder is designed to operate dual line hydraulic systems .It consists of two independent hydraulic chambers working in series and should one chamber or circuit develop a fault, the other remains operative.

In the normal-"Brakes-off" position, the brake fluid can flow unrestricted between the dual line systems and separate chambers in the integral fluid reservoir. Fluid movement to the Independent cylinders is controlled by two valves-(centre valves) ; hence CF/ CF Master cylinder. When the brakes are applied the push rod pushes Master Cylinder primary plunger of the bore.

This master cylinder is divided in to two chambers .The primary train is composite assembly and is resting on stop washer through a connecting pin. Connecting pin is rectangular in section and has a hole at centre. One end of the valve stem passes through this hole. The connecting pin is assembled in to the circular hole on primary plunger.

The poppet valve train consists of poppet valve assembled on the valve stem. This composite assembly is ahead upon by a valve spring. The end of the valve spring is resting on the distance sleeve. The distance sleeve is held rigidly with the plunger by 6 or 8 crimps on the plunger.

A similar arrangement is provided for secondary train also. The secondary plunger has a centre slot into which the stop pin reciprocates. A cover plate is assemble in-between the secondary grommet and connecting pin to prevent falling off of connecting pin from cylinder body. This plate also acts as a baffle and reduces the velocity of fluid jet that will emerge form secondary feed ports on return.

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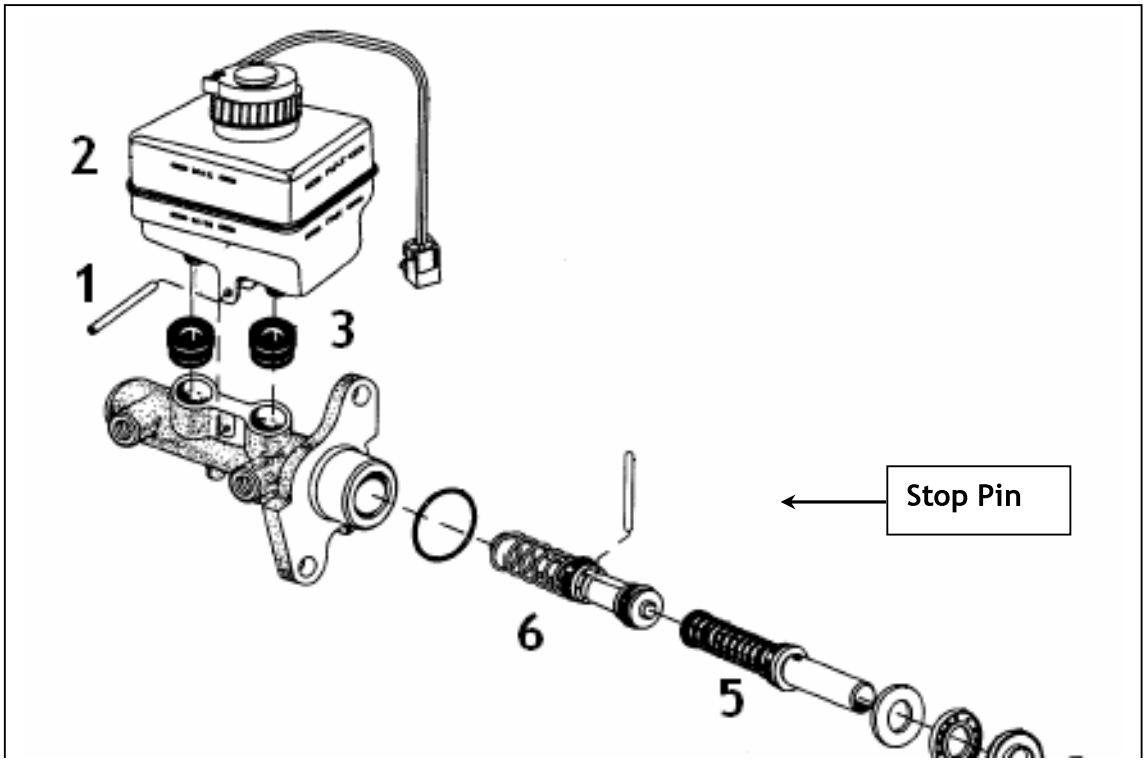
Secondary and primary plunger train moves as a composite assembly. At this juncture the poppet valve (centre valves) of both primary and secondary close the respective sealing faces of the plunger and pressure is developed.

During further stroke of the primary plunger, the primary spring is compressed and pressure is developed. The pressurised fluid is forced though pipelines to the calipers and wheel cylinders.

When the brake is released, the master cylinder plungers move back creating partial vacuum in front of poppet valves (centre valves) deseating by deflecting poppet spring and the port are opened and the brake fluid can again move unrestricted between separate systems and the fluid reservoir.

Servicing of Master Cylinder –

As the TMC is of CV/CV (Center Valve type) design ; the TMC can be serviced using only Major Repair Kit. The assembly procedure is in the reverse order of disassembly.



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1. Remove the Reservoir Fixing Pin by tapping it carefully.
2. Remove the Reservoir Assembly from grommets.
3. Using a blunt edge screw driver; remove the reservoir grommets.
4. Press the Primary Piston in the bore using a hylem rod & remove the circlip.
5. Gently remove the Primary Piston assembly.
6. Hold the TMC in upside down condition & by pressing Secondary Piston gently; remove the stop pin from secondary feed port of TMC assembly. (If any problem is observed while removing the stop pin ; push the Secondary Piston gently using a hylem rod & gently tap the TMC from the Secondary Feed port side on a wooden block.)
7. Remove the Secondary Piston assembly.

Caution -
Use only fresh brake fluid for cleaning.
If contamination is observed in the seals (seals would have swollen and the size would have enlarged compared to the new seals) ensure all rubber parts in the system including rear wheel cylinder seals, front caliper seals and the front and rear rubber hoses must be discarded and the entire system to be flushed with new brake fluid.

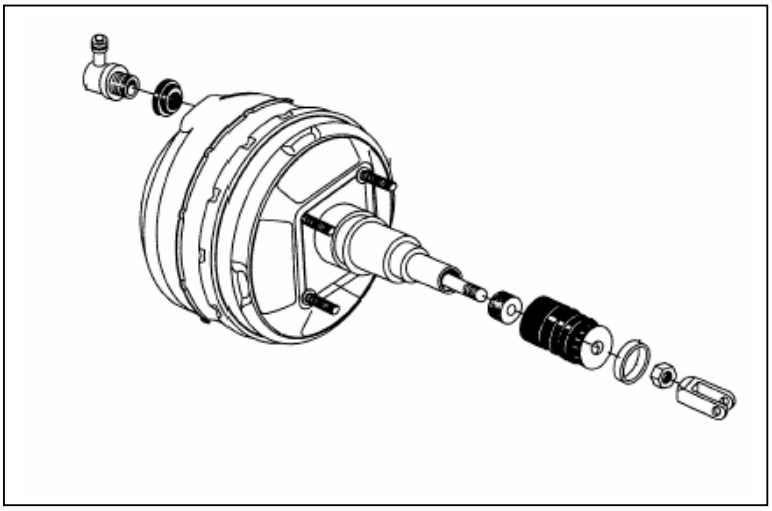
ENSURE THAT THE TMC FLANGE SURFAE IS FREE FROM DIRT,DENT & BURR BEFORE MOUNTING IT ON TO THE BOOSTER.

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NOTE -

1. It is essential that reservoir cap must be removed and cleaned. While assembling the reservoir cap ensure the presence of filter in the reservoir.
2. After fitting TMC on to the vehicle / vacuum booster , the outlet pipes are to be connected and torque tightened.

Working principle of the brake booster -



Note -- The Booster is a non- serviceable Unit & it should never be tampered with.

Ensure booster out put rod is correctly aligned to the primary piston bore during the coupling of TMC to the booster.

The Scorpio vehicle is equipped with a Tandem type vacuum booster to assist driver's effort. This is achieved by using vacuum from the vacuum pump provided on alternator in case of diesel engines & from inlet manifold in case of petrol engines.

A pair of diaphragms is provided between the two shells of the booster & difference of pressure on two sides of diaphragms (one side vacuum

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& other side atmospheric pressure) gives mechanical advantage. This amplifies the driver's pedal effort while braking.

The booster assembly & TMC assembly are coupled with the help of two nuts & washer. The meting dimensions of booster & TMC are factory set. Hence –

Do not alter the height of the output rod of the Vacuum Booster unit at any stage and ensure Booster out put rod is correctly aligned to the primary piston bore during the coupling of TMC to the booster.

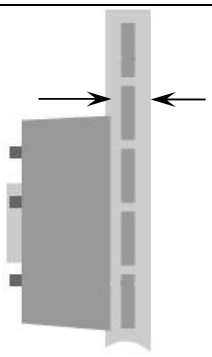
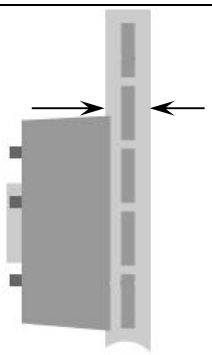
Parking Brake -- Description, Setting -

The parking brake is cable actuated and acts on the rear brakes.
On applying the parking brake the parking cables are pulled and they act on the trailing shoes at the lower end. Since the shoe is pivoted on top it result in actuation of the trailing shoe. Due to the scroll plate the force also gets transmitted to the leading shoe.

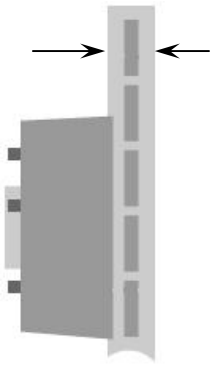
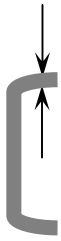
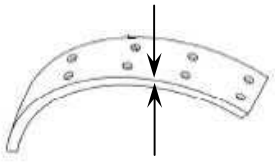
Based on the slackness in the system the parking brake is manually adjusted by readjusting the adjusting stud and lock nut.

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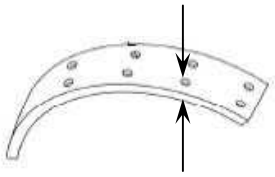
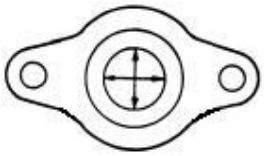
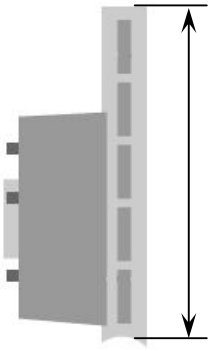
Specifications & Wear data -

Figure	Description	Value
	Disc pad Usable thickness	8.5 max
	Replace disc pad if worn out thickness less than	9 mm
	Disc pad Material	Rane R808 asbestos free
	Rotor thickness	24 mm
	Minimum disc thickness	21 mm
	Runout of rotor face- permissible limit	0.12 mm

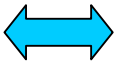
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Figure	Description	Value
	Disc thickness variation allowed	± 0.012 mm
	Rear Drum thickness	8.20 to 8.35 mm
	Minimum thickness of brake drum	8.20 mm
	Maximum taper/ bell mouthing of brake drum	0.05 mm
	Rear brake lining Usable thickness	3.5 mm to 4.3 mm

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Figure	Description	Value
	Replace when lining thickness falls below Minimum Usable thickness of	0.2 mm.
	Brake shoe Lining Material	Sundaram Asbestos free 3691
	Setting length (By setting gauge)	92.5 mm
	Master cylinder I.D	26.99 mm
	Wheel Cylinder I.D Wheel Cylinder I.D	25.4 mm
	Brake disc O.D	298 mm

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Figure	Description	Value
	Rear Drum I.D	282.2 mm
	Boost ratio-tandem booster	7.5
	Booster size Tandem	8 + 9 inch
	Clearance Adjustment- Front Rear	Automatic Automatic
	Free Play of the Brake Pedal	3 mm

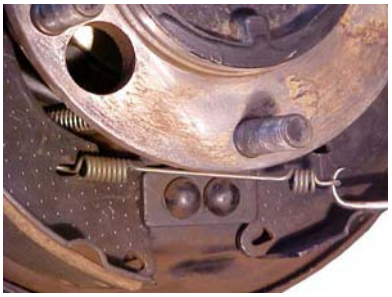
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Tightening Torques -

Description	Torque Value
Front Brake Caliper Mounting Bolts	24 Nm (18 lbf-ft)
Sliding Pin Bolts	27 ± 5 Nm (20 ± 4 lbf-ft)
Banjo Bolt - Caliper	24 Nm (18 lbf-ft)
Brake pipe connectors – Master Cylinder	18 ± 4 Nm (13 ± 3 lbf-ft)
Vacuum Booster – Mounting Nuts	21 ± 7 Nm (15 ± 5 lbf-ft)
Brake Pipe connectors – Wheel Cylinder	21 ± 7 Nm (15 ± 5 lbf-ft)
EHCU Assembly Mounting bolts	57.5 ± 2.5 Nm (42 ± 2 lbf-ft)
EHCU Mounting bolt	11 ± 1 Nm (8 ± 1 lbf-ft)
ECU – CIM Screws	2.8 ± 0.8 Nm (2 ± 0.5 lbf-ft)
EHCU Port - Brake Line Fittings	11 ± 1 Nm (8 ± 1 lbf-ft)
Front - Wheel Speed Sensors Mounting Bolt	20 ± 3 Nm (15 ± 2 lbf-ft)
Rear Differential Speed Sensor Mounting Bolt	20 ± 3 Nm (15 ± 2 lbf-ft)

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Special Tools --

Description/ Part No./ Sketch	Usage View
Tool for removal of Brake shoe hold down spring MST - 570 	
Tool for removal of return spring. MST - 569 	

Recommended Lubricants -

Specification:

Castrol: DOT 3

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TVS Girling: DOT 3

Sealant:
METALOCK 343 or ANR124 from FEVICOL

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1.0 DESCRIPTION

The system provides three channel ABS pressure control to the front and rear brakes. One channel controls the rear wheel brakes and the two remaining channels control the front wheel brakes individually. The main components of the ABS system are

- Speed Sensor Unit (SSU), and the sensor wheels
- Electronic Hydraulic Control Unit (EHCU) consists of
  - Electronic Control Unit (ECU) and
  - Hydraulic Control Unit (HCU).

When the brake is applied, hydraulic fluid is routed from the Master cylinder to the Front & Rear Brakes through the ABS-EHCU. The Primary and Secondary outlet of the Master Cylinder is connected to the EHCU inlet. The EHCU outlet is connected to the Front Left, Front Right and the Rear Brake circuit. The Electronic Control Unit (ECU) monitors the Front Left, Front Right Wheel Speed and Rear Differential speed through the Speed Sensors. If a wheel is about to lock-up, the ECU signals the concerned cartridge (Valve) in the EHCU. The valve modulates the hydraulic brake pressure to the respective wheels to prevent wheel lock-up.

2.0 FUNCTION

2.1. Brake Stop Light Switch

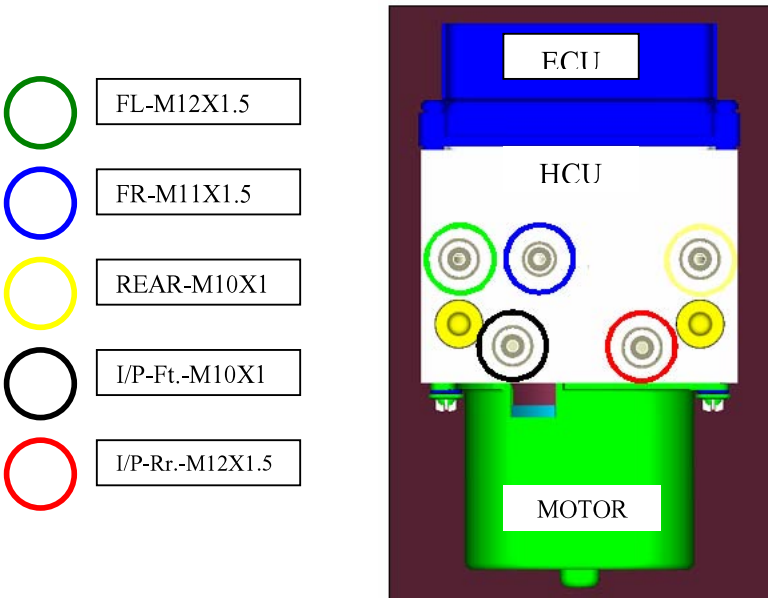
The ECU keeps monitoring the input from the speed sensors continuously. Though the ABS cycle gets initiated when the ECU finds a wheel slip condition, the commencement of ABS activity begins when the ECU receives signal from the Brake Stop Light Switch. In case of Brake Stop Light switch failure, the ECU still functions, if it finds a deceleration situation and wheel slip situation.

2.2. Electronic Hydraulic Control Unit (EHCU)

The Electronic Control Unit (ECU) and the Hydraulic Control Unit (HCU) are integrated together and called as the EHCU. The HCU consists of a valve body, low-pressure accumulators, inlet valves, outlet valves, pump, motor and noise attenuators. The operation of the valves and

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the motor are controlled by the ECU, which receives input from the Speed sensors. The ECU contains the necessary hardware and software to process the input signals and trigger the HCU accordingly.



2.2.1. Isolation

The inlet valve is a Normally Open Valve. Under Normal braking conditions, the fluid from the master cylinder passes through this inlet valve and reaches the outlet. If the information from the wheel speed sensors indicates excessive wheel deceleration (imminent lockup), the first step in the antilock sequence is to isolate the brake pressure being applied by the driver. Thus, with the inlet valves closed, further unnecessary increases in the brake pressure will be prohibited. If required the valve is pulsed for pressure increase in the brakes. When the brake switch opens, the inlet valve is turned off and fluid may return to the master cylinder.

2.2.2. Dump

The outlet valve is a Normally Closed Valve. During an ABS cycle, if the brake pressure has to be reduced to recover the wheel from slipping, the valve is opened for certain duration and accordingly the pressure at the brakes gets reduced. If required, the valve is opened and closed several times, to control the deceleration of the wheel.

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2.2.3. Accumulator

During an ABS cycle, when the outlet valve opens to reduce the pressure at the brakes, the extra fluid from the brakes gets dumped into the Accumulator. This fluid is used to re-apply pressure to the brakes, if required during the ABS cycle. Remaining fluid returns to the reservoir when the brake is OFF. A portion of the fluid also primes the pump. At the end of the antilock stop, when the driver releases the brake pedal, the motor will remain running for a short time to help drain any fluid in the Accumulator.

2.2.4. Pump & Motor

The pump provides the volume needed during the "Re-apply" stage and is operated by a DC Motor. At the end of the antilock stop, when the driver releases the brake pedal, the motor will remain running for a short time to help drain any fluid in the Accumulator.

2.2.5. Noise Attenuator

During an ABS cycle, when the brake pressure is increased, by pulsing the inlet valve and pumping fluid from the Accumulator, an Attenuator (Rubber damper) takes up the pulsations and minimizes the pedal pulsation and Noise.

2.3. Wheel Speed Sensor

The Wheel Speed Sensor works on Hall effect principle. These sensors can be used to find the speed of any rotating member. The sensor reads the tooth on the Toner Ring and produces an output signal proportional to the associated wheel speed.

2.4. Cluster Lamps

The ECU drives the warning lamps in the cluster, whenever there is a malfunction. Under normal conditions, during ignition ON, the lamps will be ON for few seconds and then go OFF. If the lamps continue to glow, then the ABS system needs to be diagnosed to find the fault. Before connecting the Diagnostic connector, check if the Parking brake is ON. If yes, release the parking brake and see if the bulbs are OFF. If not, then continue with ABS system Diagnostics.

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2.5. Diagnostic Connector

The Diagnostic Connector is a standard OBD II connector. Whenever a diagnosis needs to be performed, the Diagnostic Tool has to be plugged into the Diagnostic connector. The diagnostic tool has to be switched ON and then the instructions appearing in the tool has to be followed. Once the communication is established the ECU will send the Trouble code or Fault ID details to the tool.

2.6. Pedal Feel

During an ABS cycle, when the inlet valve is activated and cuts-off the communication between the master cylinder and the brakes, the pedal becomes very hard. This is expected and normal. Also, during the pressure increase sequence, when the inlet valve is pulsed open to allow master cylinder pressure to reach the brakes, the driver may feel slight pedal pulsation, or pedal drop. This is normal and expected

2.7 Dynamic Rear Proportioning. (DRP)

DRP controls rear brake pressure to maximize brake balance efficiency. The activation of DRP is based on wheel slip comparison of the front vs. rear. **The control is modified to take care of the conditions when the wheels are turned and negotiating rough roads.** The rear brake pressure is increased or decreased based on wheel slip (front vs. rear). DRP resumes control after ABS activation.

The advantage of DRP is that it assures the vehicle remains rear skid limited under all loading conditions. It is able to achieve a brake balance that is more efficient than a hydraulic proportioning valve. The Operation of DRP goes unnoticed by the driver in most conditions, as there is not pedal pulsation when the DRP is active.

3.0 OPERATION

3.1. Normal Braking

During normal brake application, pressure is applied through the brake pedal and fluid comes from the master cylinder into the EHCU. The fluid travels through the normally open inlet valve into the brakes.

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The pump does not turn on, and the LPA and attenuators are empty of residual pressure.

Even though the ABS is passive during normal braking, the EHCU constantly monitors wheel sensor inputs for rapid deceleration. If the system were disabled, the driver would always have foundation brakes. The normally open inlet cartridge and normally closed outlet cartridge would remain in these positions to allow fluid pressure to reach the brakes.

3.2. ABS Braking

If the information from the wheel speed sensors indicates excessive wheel deceleration (imminent lockup), the first step in the antilock sequence is to isolate the brake pressure being applied by the driver. Thus, with the inlet valves closed, further unnecessary increases in the brake pressure will be prohibited. Once the pressure is isolated, it must be reduced to get the wheels rolling once again. This is accomplished by dumping a portion of the brake fluid pressure into an Accumulator. A portion of the fluid also primes the pump. The outlet cartridges are operated independently to control the deceleration of the wheel. To obtain optimum braking, the reapply sequence is initiated. The isolation valve is momentarily pulsed open to allow master cylinder and pump pressure to reach the brakes. **The driver may feel slight pedal pulsation, or pedal drop. This is normal and expected.** At the end of the antilock stop, when the driver releases the brake pedal, the motor will remain running for a short time to help drain any fluid in the Accumulator. While the fluid drains back into the system, the Accumulator springs help force the piston back to their original position. When the brake switch opens, the inlet valve is turned off and fluid may return to the master cylinder.

During antilock braking, the solenoid valves contained in the HCU are opened and closed as needed. The valves modulate the brake pressure during an ABS cycle.

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The brake pressure modulation occurs in three stages – Pressure decrease, pressure hold and pressure increase or "Re-apply" stage. During the ABS cycle, the Accumulators in the valve body store extra fluid released to the system. The pump provides the volume needed during the "Re-apply" stage and is operated by the motor

Isolation Mode (Pressure Hold)

Every time the driver applies the brakes, the ECU is signaled to prepare for a possible ABS event. If too much braking force for the given road conditions is generated, the ECU reads the information from the speed sensor(s) as excessive wheel deceleration, and begins the ABS sequence.

The first step is to isolate the brake pressure being applied by the driver. The ECU closes the isolation valve, preventing additional brake fluid pressure from reaching the brake circuit(s). This is achieved by energizing the coil that is directly over the isolation valve causing the plunger to close the orifice, shutting off fluid flow to the locked wheel(s). Although each channel of the system can operate independently, once any front wheel sees excessive deceleration, both front isolation valves are closed.

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Dump Mode (Pressure Release)

Once the pressure is isolated, it must be reduced to allow the wheels to roll again. This is accomplished by dumping a portion of the fluid pressure into a Low Pressure Accumulator (LPA).

With very short pulses of opening and closing the dump valve(s), brake fluid is removed from the channel(s) and dumped into an LPA. This lowers brake pressure at the brake(s) and allows the wheel(s) to begin rolling again. Dump valves of each channel are operated independently.

The ABS system is still in isolation mode during the dump mode. The motor is turned on to allow the pumps to remove brake fluid from the LPA's. A portion of the fluid stored in the LPA's is used to prime these pumps.

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Reapply Mode (Pressure Increase)

The reapply mode is initiated to increase brake pressure. The isolation valve is momentarily opened to allow master cylinder and pump pressure to reach the brakes. This controlled pressure rise continues until excessive wheel deceleration occurs or until the brake pressure equals the master cylinder output pressure. The driver may feel pedal pulsations, which is an operating characteristic of this type of system. The attenuator located in the HCU, acts as a shock absorber to soften this feedback.

As pressure is reapplied to the brakes, the wheels begin to slow down. If the ECU detects excessive wheel deceleration again, the ABS cycle will repeat. This controlled cycle occurs quickly, allowing several ABS cycles to occur every second. It is a much faster and more controlled method of "pumping the brake pedal". The cycles will continue until the driver releases the brake pedal or the ECU determines ABS is no longer necessary.

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Brake Release

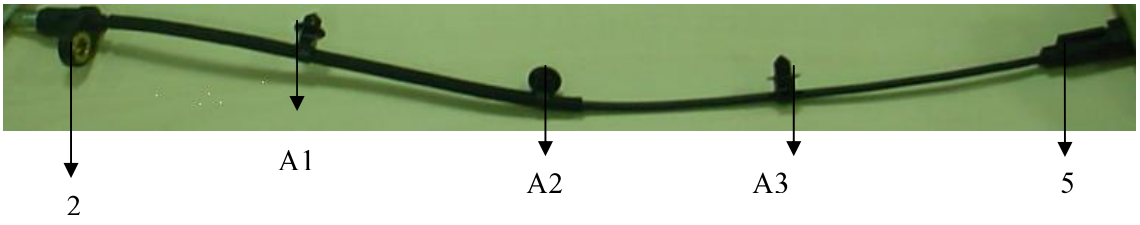
At the end of the ABS event, the motor will remain running for a short period of time to allow the pumps to remove brake fluid from the LPA's. As the fluid returns to the master cylinder, the LPA return spring forces the piston to its normal (home) position

NOTE: The three modes mentioned above, do occur but not necessarily in the order listed every time.

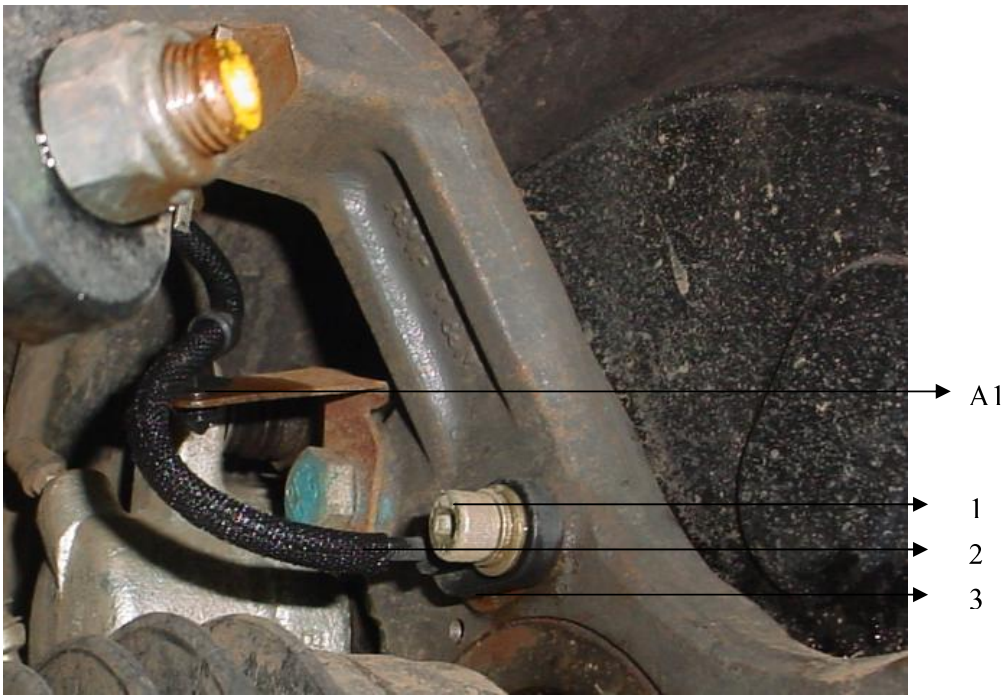
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4.0 INSTALLATION

4.1. Front Wheel Speed Sensor (WSS)



A view of the WSS is shown in the Figure below.



1. Insert the clips into the anchoring points A4 – A1.
2. Install the WSS (2) into the mounting hole in the Knuckle (3).
3. Insert the WSS mounting bolt (1) to the Knuckle (3) and tighten to the required Torque.
4. Reconnect the electrical connector (4).

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Ensure that the air-gap (Between the sensor read face & Toner Ring) is within 0.6 to 2.0 mm. If the gap exceeds this value, the performance of the sensor is affected; hence the performance of ABS will be inhibited. The WSS is not adjustable. If the air-gap is not within these specifications, then either the WSS or other components may be damaged.

Front Sensor:

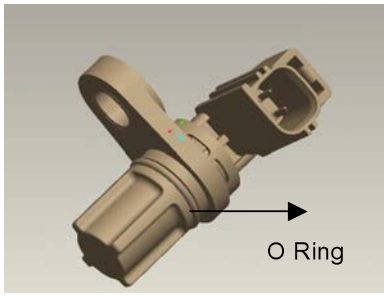
Do's	Don'ts
Install the sensor into the mounting hole in the Knuckle.	Do not push it in with any hard material.
Insert the Sensor mounting bolt & tighten to the required Torque.	Do not leave the sensor loose. It will lead to vibration issues and lead to malfunction of the ABS system.

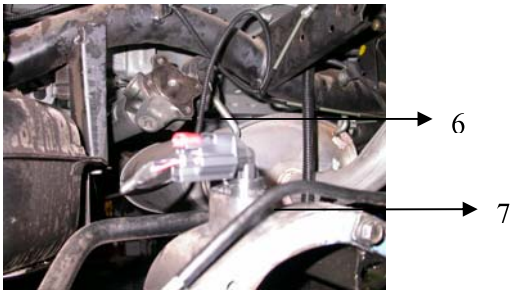
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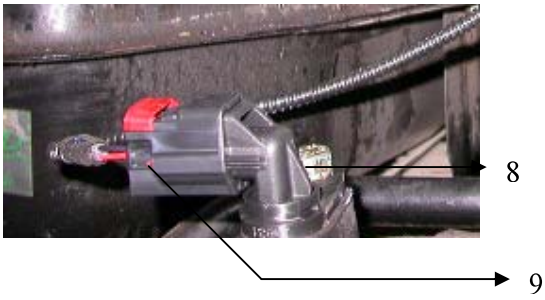
Insert the clips into the anchoring points.	Do not leave the cable loose. If loose, it may foul with other vehicle parts during vehicle running condition or during a turn.
Ensure that the sensor is seated all the way into the mounting surface. This will ensure that the gap between the sensor read face & Toner Ring is within the specifications.	In case the Sensor does not fully get seated, do not hammer it inside the hole. If the gap exceeds the specified value, the performance of the sensor is affected; hence the performance of ABS will be inhibited. The sensor is not adjustable.

4.2. Rear Wheel Speed Sensor (Differential Case)

Please refer Figure below, showing a view of the Rear Differential Speed Sensor.







1. Install O-Ring on sensor (if	Ensure that the air-gap (Between

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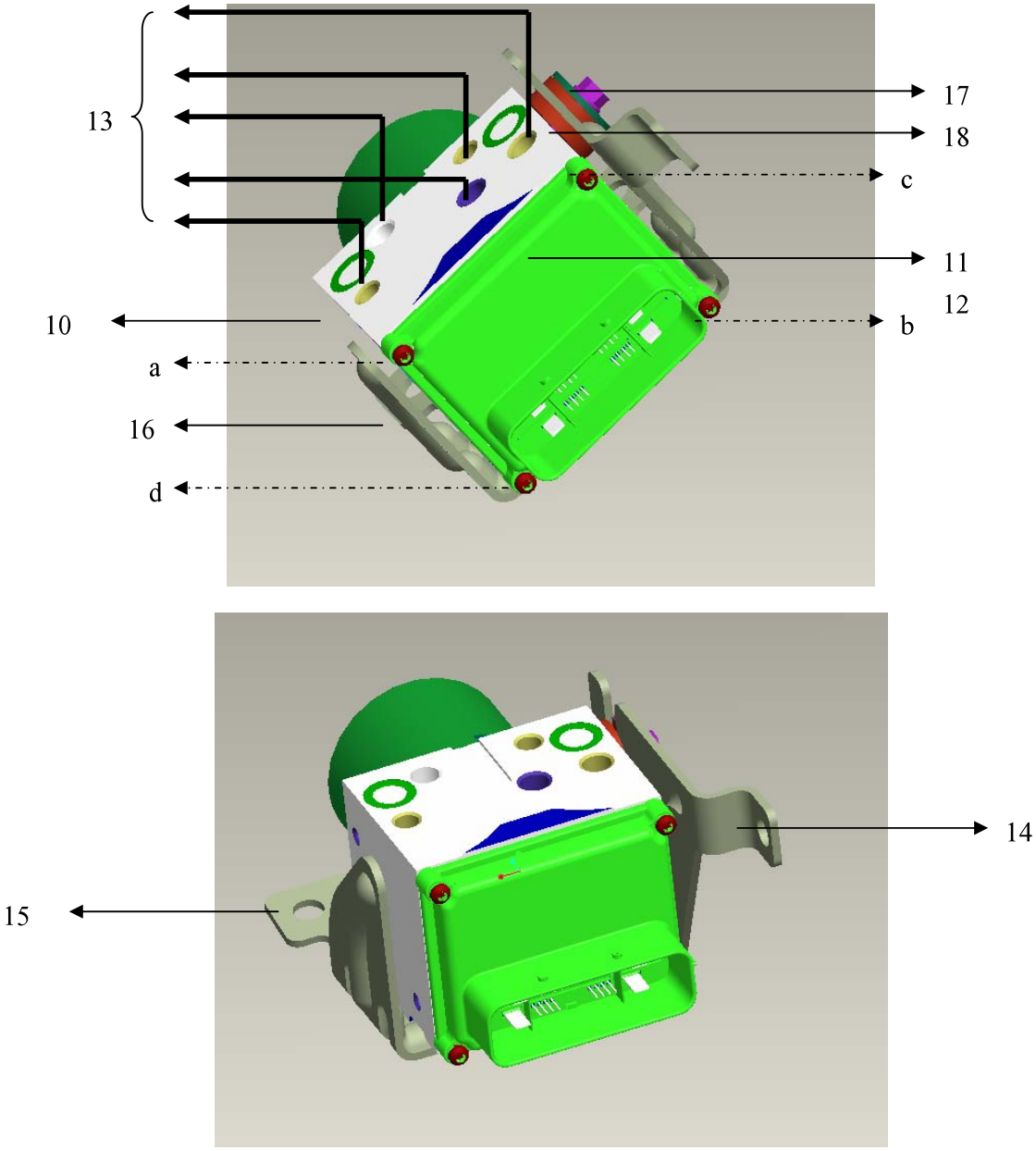
removed). 2. Insert sensor (6) in differential housing (7). 3. Install the Sensor mounting bolt (8) tighten to the required Torque. 4. Connect harness to sensor (9). 5. Lower the vehicle.	the sensor read face & Toner Ring) is within 0.6 to 2.0 mm. If the gap exceeds this value, the performance of the sensor is affected; hence the performance of ABS will be inhibited. The WSS is not adjustable. If the air-gap is not within these specifications, then either the WSS or other components may be damaged.

Rear Sensor:

Do's	Don'ts
Remove the Protective Plug fitted in the Sensor mounting hole in the Differential housing. Clean the surface. Ensure there are no burr or foreign particle in the mounting location. Insert sensor in differential housing.	Do not push it in with any hard material or forcefully with hand or hammer.
Insert the Sensor mounting bolt & tighten to the required Torque.	Do not leave the sensor loose. It will lead to vibration issues and lead to malfunction of the ABS system.
Ensure that the 'O' ring in the sensor has gone in fully and the sensor is seated all the way into the mounting surface. This will ensure that the gap between the sensor read face & Toner Ring is within the specifications.	In case the Sensor does not fully get seated, do not hammer it inside the hole. If the gap exceeds the specified value, the performance of the sensor is affected; hence the performance of ABS will be inhibited. The sensor is not adjustable.

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4.3. Electronic Hydraulic Control Unit (EHCU)



1. If the Grommet (18) has been removed, install it in the Bracket (16).
2. Assemble the EHCU (10) in the Bracket (16).

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3. Insert the EHCU mounting bolt and washer (17) in the Bracket (16) and tighten it to the specified torque.
4. Place the EHCU assembly with the Bracket (16) in the vehicle.
5. Insert the Bracket Mounting bolts (14 & 15) and tighten to the specified torque.
6. Re-connect the electrical harness connector (12) to the ECU (11).
7. Re-connect the brake lines (13) to the EHCU (10) and tighten to the specified torque.
8. Re-connect the battery cable to the battery.
9. Bleed the brake system.

NOTE: If the ECU is being replaced with a new ECU, it must be reprogrammed with the use of a scan tool.

4.4. Installation of ECU

1. Insert the ECU (11) in the HCU (10).
2. Insert the ECU mounting screws (a,b,c & d) and hand tighten in the order a,b,c and d as shown in the Figure.
3. Then tighten to the specified torque in the same order.
4. Re-connect the electrical harness connector (12) to the ECU (11).
5. Re-connect the battery cable to the battery.

Do's and Don'ts

ECU Handling:

Proper electro-static discharge (ESD) handling precautions must be observed, especially near exposed printed circuit board. Reference JEDEC (**J**oint **E**lectron **D**evice **E**ngineering **C**ouncil) standard 625-A. People and equipment should be controlled to guarantee the modules maximum ESD exposure does not exceed 1.5 KV.

Proper handling must be observed in order to keep the cure in place gasket *(CIPG)* and *thermal pads* free of contamination or damage. Non-compliance or damage may result in a compromised seal or loss of module function.

Avoid spilling corrosive brake fluid on wiring.

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General Don'ts:

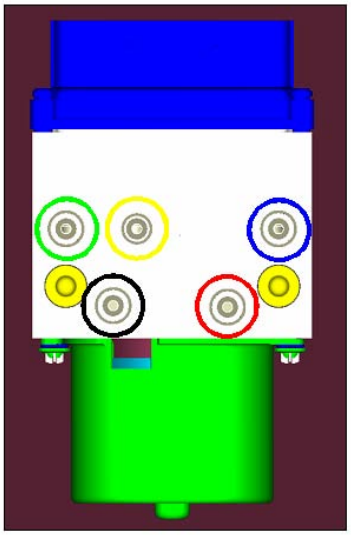
- Do not expose any part of the ABS control system to excessive heat or flame.
- Do not use any ABS component if it has signs of being dropped or damaged.
- Do not repair any ABS component including wire harness and connectors. Replace them, entirely, with new components.

EHCU:

<table>
<tr><th colspan="3">Do's</th><th>Don'ts</th></tr>
<tr><td colspan="3">Ensure that the correct EHCU as per the vehicle configuration is taken for installation.</td><td rowspan="5">If wrong part is used, it will lead to deteriorated / Erratic performance of ABS.</td></tr>
<tr><td>Veh. Config.</td><td>BI P/N</td><td>M&M P/N</td></tr>
<tr><td>M1 2WD</td><td>29061011</td><td></td></tr>
<tr><td>M1 4WD</td><td>29061012</td><td></td></tr>
<tr><td>N1 2WD</td><td>29061016</td><td></td></tr>
<tr><td>N1 4WD</td><td>29061013</td><td></td></tr>
<tr><td colspan="3">Ensure the EHCU assembly is properly fastened – 2 fastening on the wheel arch & one fastening on the sidewall. Apply specified tightening torque.</td><td>If the bracket is not fastened properly, it will lead to vibration issues and lead to deteriorated / Erratic performance of the ABS system.</td></tr>
<tr><td colspan="3">Connect the inlet & outlet brake tubes in the correct ports.
Match the pipe nut colour to the coloured rings in the port identification label.</td><td>Beware of tube-nut wrong threading during brake line installation.

Proper tube routing is essential for performance and safety of the system.</td></tr>
</table>

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Use Plastic clips for brake tube routing.	Do not use metal clip. It will lead to NVH issues.
Tighten the pipe nuts to the specified torque.	Use proper torque when attaching all fasteners and brake lines.

Electrical Connections:

- Wiring routing issues and loose connections are common causes of ABS service calls.
- Ensure proper electrical connections are made at sensors (FL, FR & Rear) and EHCU assembly.
- Ensure that the Diagnostic Connector is secure in its place.

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5.0 TORQUE CHART

Description	Torque (N.m)
EHCU Assembly Mounting bolts	55 – 60
EHCU Mounting bolt	10 – 12
ECU – CIM Screws	2.2 – 3.6
EHCU Port - Brake Line Fittings	10 - 12
Front - Wheel Speed Sensors Mounting Bolt	17 - 23
Rear Differential Speed Sensor Mounting Bolt	17 - 23

6.0 SYSTEM BLEEDING

ABS system bleeding requires conventional bleeding methods plus use of the scan tool. The procedure involves performing a base brake bleeding, followed by use of the scan tool to cycle and bleed the HCU pump and valves. A second base brake bleeding procedure is then required to remove any air remaining in the system.

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1. Perform base brake bleeding.
2. Connect scan tool to the K-Line Diagnostic Connector.
3. Follow the instructions displayed.
4. When scan tool displays “BRAKE BLEEDING” disconnect scan tool and proceed.
5. Perform base brake bleeding a second time.
6. Top off master cylinder fluid level and verify proper brake operation before moving vehicle.

7.0 DIAGNOSTIC & TESTING - ABS

The ABS performs several self-tests every time the ignition switch is turned on and the vehicle is driven. The ECU monitors the system inputs and outputs circuits to verify the system is operating properly. If the ECU senses a malfunction in the system it will set a DTC (Fault Code) into memory and trigger the warning lamp. If the warning lamps in the cluster glow, then Diagnosis should be performed immediately by an authorized service person. The diagnostic tool has to be connected to the Diagnostic Connector C1, found below the steering column & the tool has to be switched ON. Follow the instructions appearing in the tool. Once the communication is established the ECU will send the Trouble code or Fault ID details to the tool. Please refer Appendix-1 for trouble shooting.

	**NOTE: The scan tool is used to diagnose the Antilock Braking System. For test procedures refer to the Diagnostic Manual.**

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8.0 SERVICE

8.1. Serviceable Parts List

None of the child parts in the ABS assembly are serviceable. Following list gives the description of components, which can be replaced.

Sl. No.	Description
1	ABS Assembly
2	EHCU Assembly
3	HCU with Motor
4	ECU with Screws
5	Mounting bracket – EHCU
6	Mounting Accessories
7	WSS – Front
8	Rear differential Speed Sensor

8.2. EHCU Removal

1. Place a heavy rod on the brake pedal, such that it presses the pedal. (This is to keep pressure on the brake system.)
2. Disconnect the battery cable from the battery.

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3. Disconnect the brake lines (13) to the EHCU (10).
4. Disconnect the electrical harness connector (12) from the ECU (11).
5. Remove the Bracket Mounting bolts (14 & 15).
6. Lift the EHCU assembly with the Bracket (16) from the vehicle.
7. Remove the EHCU mounting bolt (17) from the Bracket (16).
8. Remove the EHCU (10) from the vehicle.

8.3. REMOVAL OF ECU

1. Disconnect the battery cable from the battery.
2. Disconnect the electrical harness connector (12) from the ECU (11).
3. Remove the ECU mounting screws (a,b,c & d) from the ECU.
4. Remove the ECU (11) from the EHCU (10).

8.4. WSS Removal

8.4.1. Front Wheel Speed Sensor (WSS-FL & FR)



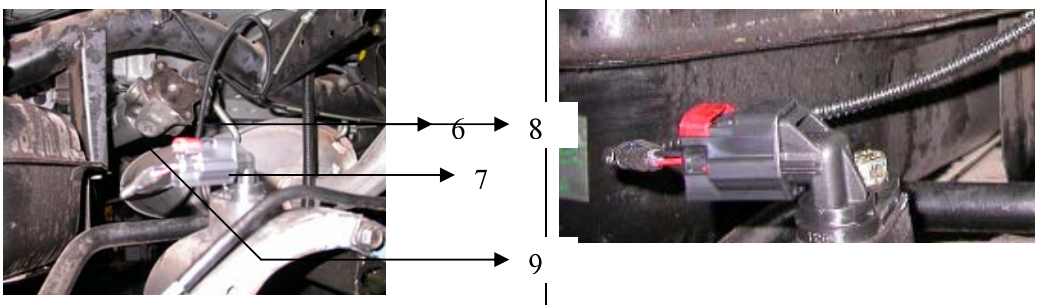
1. Raise and support the vehicle.
2. Disconnect the electrical connector (4).
3. Detach the clips from the anchoring points A4 – A1.
4. Remove the WSS mounting

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	bolt (1) from the Knuckle (3) 5. Remove the WSS (2) from the Knuckle (3).



8.4.2. Rear Differential Speed Sensor



1. Raise vehicle on hoist.
2. Disconnect the electrical connector (9)
3. Remove the Sensor mounting bolt (8) from the Differential Housing (7)
4. Remove the Sensor (6) from the Differential Housing (7).

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ABS Process Do's and Don'ts

Service Bay / Ware-House / Material In-warding:

Rough handling: Modules should not be tossed into vehicles or bounced around prior to assembly.

ABS modules have sensitive components that may be influenced by rough handling.

Mating features such as connector pins and threaded ports can be damaged and become out of tolerance.

Drop Policy: If a module is dropped from more than approximately 12" height, it should be scrapped.

Impact drivers : some Use of screwdrivers that can generate high frequency vibrations can affect certain components in the module.

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9.0 Index of Common Terms Used

DTC : Diagnostic Trouble Codes

ABS Lamp: It is the yellow lamp with the ABS written

Parking Brake Lamp: The parking brake lamp & the FLWI lamp is a combined red lamp. The ABS errors will also be shown through this red lamp.

DRP : Dynamic Rear Proportioning

Note: DRP is equivalent to electronic LSPV. It is active only when the rear wheels are tending to lock.

ABS : Anti Lock Braking System

Note: ABS is active only in the extreme condition when the front wheel lock is taking place. In normal operation the braking does not activate the ABS functionality. Also the brake pedal pulsation when the ABS is active is normal
Note: When the lock takes place normally the rear tend to lock first hence initially the DRP kicks in. Then the second stage if the front is locking then the ABS also becomes active.
Under severe panic braking the front wheels can lock first or all the four wheels will tend to lock. Under this condition the ABS will come into operation immediately.

WSS : Wheel Speed Sensor .

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Front Toner Wheel: Is mounted inside the disc.
Rear Toner Wheel: Is mounted on to differential case assembly & serviced with differential case & not serviced individually.

EOL: End of the Line (Only in the assembly line)

Note : Clear all the DTC codes before giving the vehicle back to the customer. Any unhealed code should be attended and then only the vehicle to be released.

It is recommended that when ever the vehicle reports to the workshop, the DTC codes should be checked.

The status of the code (healed or not present) when it came to the workshop as well as before leaving the workshop, should be printed. (Use the print command in the diagnostic, converts to a PDF file, later the PDF file to be printed. This record should be kept in the vehicle history and can be useful later.)

After clearing all the ABS related errors drive the vehicle and do at least 5 ABS braking application and check if any errors are recorded. Suggestion is that the vehicle speed should not exceed 50 Km/hr when doing the panic braking to check ABS performance.

ISO : Isolation valve

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Steering

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Description

The power steering system is a rack and pinion type hydraulic system. The engine driven hydraulic –pump supplies oil to a control valve situated in housing that supports the pinion shaft. Movement, imparted to the control valve from the shaft in the steering column is via a torsion bar. This sensing bar moves the control valve, which in turn directs the oil to one side or the other side of the ram piston inside the steering rack.

The control valve is a rotary type spool valve controlled by the torsion bar interposed between the steering shaft and pinion of the steering box. The spool valve is a shaft with six flutes and a sleeve, which has six internal axial grooves, encases this. Radial ports in the sleeve and shaft pass the oil from the supply to the lines connected to the ram chamber.

A series of the splines between the shaft and the sleeve limit the twist of the torsion bar to about 7 degrees in each direction; below this angle the torque applied by the driver to the steering box is transmitted by the torsion bar. This fail-safe feature provides a mechanical drive from the steering shaft to the pinion in the event of any power system failure.

The amount of the twist of the torsion bar and the movement of the spool valve is proportional to the effort applied by the driver. Initial power steering assistance is obtained at about 0.5 degrees deflection of the bar and this power rises progressively as the bar moves to about 4 degrees; the point o maximum assistance.

When the wheel is in straight-ahead position, all the ports are open so oil is allowed to flow through the valve and return to the reservoir.

As soon as the wheel is turned, the torsion bar is deflected; this allows the spool valve to rotate relative to the sleeve, cutting off the oil flow both to the reservoir and one side of the ram. At the same time the other side of the ram is subjected to oil pressure, which builds up sufficiently to move the road wheel and return the torsion bar to no – torque position. During this stage the oil displaced from the uncompressed side of the ram is returned to the reservoir.

On occasion when the resistance to road wheel movement is excessive, the oil pressures build up to its maximum. At this pressure a relief valve fitted inside the pump opens and allows the oil to return to pump inlet.

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Trouble Shooting –

The rack and pinion design is a simple design. However it is still susceptible to various problems in particular to leaks. If the bellows are ripped or are unable to keep the contaminant's away then it can cause damage to oil seal and subsequent leaks.

One complaint, which can be present, is that the steering may be stiff and jerky when the unit is cold and as the vehicle is driven/ warmed the power assist gradually comes back. It normally indicates that grooves worn into the bore of the pinion aluminum housing by hard control valve seals.

Wear in the centre housing causes the fluid to leak around the rack piston. Causing either steering wander or lack of straight-ahead stability. Another cause of steering wander and erratic control often accompanied by clumping, thunking noise is the deterioration of rack mounting bushings.

Fluid levels can be hard to locate. Sometimes you will see a low level in the pump reservoir but no evidence of escaping liquid. Squeeze the bellows and you will probably find that they are full of liquid. To confirm if that side of the rack is the culprit, then remove the both the bellows, clean the rack housing and then operate the system to observe the seepage directly.

It should be mentioned that a rusty input shaft U joint or deteriorated flexible textile/rubber coupling could imitate rack problems.



After attending to the repairs it critical that the system be completely flushed completely. Disconnect the return line from the pump and put in a container, then disable the injection (remove the wire from the shut off solenoid) and crank the engine. Add fresh fluid until you get a clear flow from the line. Take care that the reservoir does not run dry during the flushing. Failure to do so will result in premature failure of the repaired unit.)

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The possible causes for the power steering complaints are tabulated below:

Problem	Possible Causes	Corrections
Objectionable Hiss	Noisy relief valve in hydraulic pump. Steering gear noise valve noise is transmitted trough the steering column or open-air passages in the area where the column or controls pass through the floor into the engine compartment.	✓There is some noise in all the power steering system. One of the most common is a hissing sound most evident at stand still parking. Hiss is a high frequency noise that is present in every valve and results from high velocity fluid passing valve orifice edges. There is no relationship between this noise and the steering gear performance. DO not replace the intermediate shaft or the steering gear unless the noise is too objectionable. Check the dashboard seals between the drivers area and under hood to eliminate open space/ gaps
Rattle or chuckle noise in Steering Gear	1. Gear loose on frame. 2. Steering linkage looseness. 3. Pressure hose touching other parts of the vehicle. 4. Loose IBJ or OBJ 5. Improper over centre-clearance. A slight rattle may occur on turns because of increased clearance off the high point. This is normal and clearance must not be reduced below specified limits to eliminate this slight rattle.	✓ Check the gear mounting bolts. Torque the bolts to specifications. ✓ Check the IBJ and OBH for wear. ✓ Adjust the hose position. Do not bend the tubing by hand. ✓ Replace. ✓ Adjust to specification
Excessive wheel Kick Back or Loose Steering	1. Air in the steering. 2. Steering Gear Mounting	✓ Add oil to the pump reservoir and bleed. ✓ Tighten attaching bolts

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	loose. 3. Front wheel Bearings Incorrectly adjusted or worn. 4. Steering Gear improperly adjusted. 5. Damaged or worn steering Gear. 6. Worn or damaged rubber bushing for mounting steering gear	to the specified torque. ✓ Replace loose parts. ✓ Adjust the wheel bearings or replace as required. ✓ Adjust to specifications ✓ Dismantle and assemble the steering gear as specified. ✓ Replace the rubber bushings.
Vehicle leads to one side or the Other (keep in mind the road condition and wind conditions.) Test the vehicle , Going in Both directions , On a Flat road	1. Front end misaligned. 2. Unbalanced steering gear valve. If this is the cause steering effort will vary light in direction of lead and heavy in opposite direction. 3. Steering shaft rubbing with the ID of the shaft tube 4. Steering linkage not level.	✓ Adjust to specifications. ✓ Replace the gear Valve. ✓ Align the column. ✓ Adjust as required.
Momentary Increase in steering Effort When Turning the Wheel Quickly To the Right or Left	1. Low oil level in Reservoir. 2. Pump Belt slipping. 3. High Internal leakage's (Steering Gear or Pump)	✓ Add steering fluid as required. ✓ Tighten or replace belt. ✓ Refer to pump test.
Poor return of Steering	1. Tyres under inflated. 2. Lower coupling flange against the steering gear adjuster 3. Steering wheel rubbing against directional signal housing. 4. Tight or seized steering shaft bushing/bearings.	✓ Inflate to specified pressure. ✓ Loosen the pinch bolt and assemble. ✓ Adjust the steering column.

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	5. Steering joint or linkage binding. 6. Steering column misaligned. 7. Lack of lubrication in the suspension ball. 8. Improper front end alignment. 9. Steering gear adjusted too tight. 10. Kink in return hose.	✓ Replace the bearings. ✓ Re-lubricate/ replace the joints. ✓ Align the steering column. ✓ Re-lubricate/ replace the ball joints. ✓ Check & adjust to specifications. ✓ Adjust the preload. ✓ Replace the hose.
Steering wheel Surges or Jerks when Turning with engine running, especially during Parking.	1. Low oil level in Pump. 2. Loose pump belt. 3. Sticky flow control valve. 4. Insufficient pump pressure	✓ Add fluid as required. ✓ Adjust tension as per specification. ✓ Clean the control valve or replace the pump. ✓ Refer to the power steering System Test.
Hard steering effort in both the directions	1. Low tyre pressures 2. Lack of lubrication is suspension or ball joint. 3. Steering gear to column misalignment. 4. Pump belt slipping. 5. High internal leakage. 6. Sticky flow control valve. 7. Lower coupling flange rubbing against steering gear. 8. Steering gear preload high. 9. Improper front end alignment	✓ Adjust the tyre pressure. ✓ Lubricate & re-lubricate at proper intervals. ✓ Align the steering column. ✓ Tighten or replace belt. ✓ Fill to proper level and inspect for leaks. ✓ Refer to pump Pressure test. ✓ Replace or clean the valve. ✓ Loosen the pinch bolt and assemble correctly. ✓ Adjust the preload in Straight-ahead position. ✓ Check & adjust to specifications.
Foaming Milky Looking Power	Air in the fluid and loss of fluid due to internal pump	✓Check for leak & correct. Bleed the system. Extremely

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Steering Fluid. Low Level and Possible low pressure	leakage causing overflow	cold temperature will cause aeration problems if the oil level is low. If oil level is correct and the pump still foams then check for the air leakage caused by loose joint
Low oil Pressure due to Restriction in the Hose	1. Check for kinks in the hose. 2. Foreign objects stuck in the hose.	✓ Remove the kinks or replace the hoses. ✓ Remove the foreign object or replace the hose.
Chirp Noise in Steering Gear	Pump belt slipping	✓Tighten or replace Belt
Belt squeal (Particularly noticeable at Full wheel Travel & Standstill Parking)	Pump belt slipping	✓Tighten or replace Belt
Growl noise in Steering Pump	1. Scored pressure plate, thrust plate or rotor 2. Extreme Wear of cam ring	✓ Replace Pump. ✓ Replace Pump.
Growl noise in Steering Pump	1. Low oil level 2. Air in the oil. Poor pressure hose connection.	✓ Add the power steering fluid. ✓ Bleed the system.
Rattle or knock noise in steering Pump	1. Pump Vanes sticking in rotor slot 2. Pressure hose touching other parts of the Vehicle.	✓ Replace pump, flush system. ✓ Adjust hose position.
Swish Noise in steering Pump	Faulty flow control valve	✓Replace pump.
Whine Noise In Steering Pump	Pump shaft bearing scored	✓Replace pump.
Low oil Pressure Due to Steering pump	1. Flow control valve stuck or inoperative 2. Pressure plate not flat against the cam ring. 3. Extreme wear of the cam ring. 4. Air in oil. 5. Low oil level	✓ Replace pump. ✓ Replace pump. ✓ Replace pump, flush system. ✓ Locate source of leak & correct. Bleed the system.

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	6. Pump belt slipping 7. Damaged hoses or steering gear	✓ Add power steering fluid as required. ✓ Tighten or replace belt as required ✓ Replace as necessary.

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Care of the system –

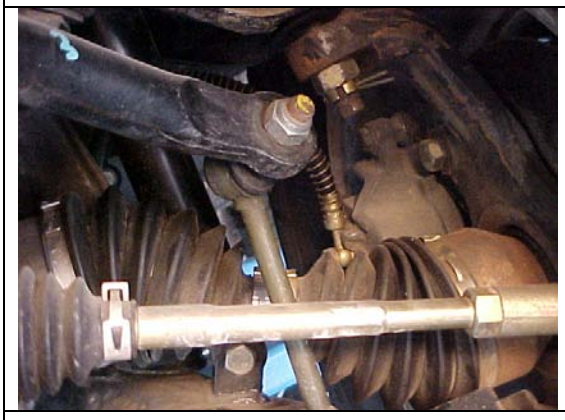
The lubricant level should be checked every 10000 KMs with the vehicle un-laden and in a level ground. The lubricant level should be between the maximum and minimum mark. The fluid level should be checked with the engine in off condition. If the oil level is excess it will tend to come out from the filler cap in use lubricant meeting oils specification of ATF (Automatic Transmission Fluid. The brand names have been specified in the Operators Manual and also in the end of the Section.

In Car repairs –

The following repairs can be carried out without removing the assemblies.

a) Removal and refitment of out board Joints (OBJ)
b) Greasing of the OBJ (In case the rubber gaiter is torn.)
c) Removal & Refitment of the Steering Wheel.
d) Checking for Steering Play.
e) Steering Wheel - Centralize
f) Bleeding the system.

a) Removal and re-fitment of Track rod ends/ Outer Ball Joint

	Loosen the wheel nuts. Lift up the vehicle and remove the front wheels.
	Slacken the track rod end lock nut.
	Remove the castle nut split pin and remove the castle nut.
	Remove the track rod end using the special tool.
	Remove the track rod end. While removing the track rod end, make a note of the number of turns required to remove the end.
	While fitting back the end or fitting a new end turn it back the same number of threads

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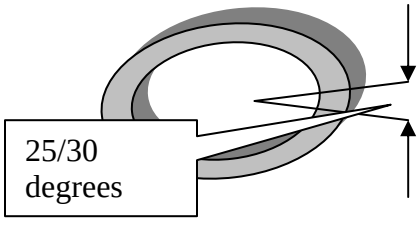
b) Greasing of the track rod end/Outer Ball Joint (Only if the rubber gaiter is torn.)

	After removal of the track rod end
	Remove the circlip
	Fill the joint with about 10 grams of grease
	Fit a new gaiter and put the lock

c) Removal & Refitment of the Steering Wheel

	Remove the horn cover, using the screw driver
	Remove the lock nut, using the 22 mm socket

d) Checking and adjusting the Steering Play

	After driving the vehicle in a straight road, check the wheel spokes for angular play. If more than 25 to 30 degrees then check -Tie-rod end ball joint or steering gear inner ball joint or Lower arm ball joint or universal joint
	Replace the defective part/parts
	**While checking ensure that the engine is in off condition and wheels are in Straight Ahead Position (SAP position)**

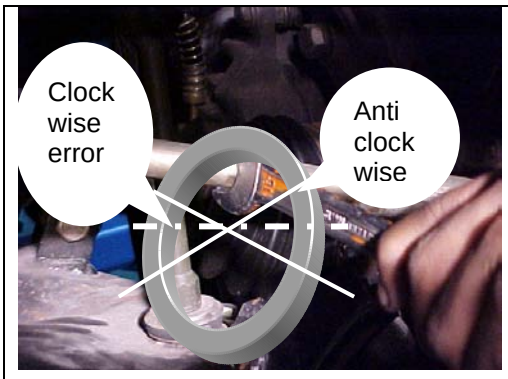
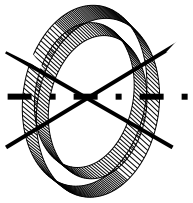
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e) Steering Wheel – Centralization

This procedure for centralizing the Steering wheel is valid only if the misalignment of the spokes is less than 30 degrees. In other words this procedure is only for fine-tuning the steering wheel position not for gross error. If it is more 30 degrees then remove the steering wheel and initially realign to less than 30 degrees.

	To check for the centralization of the steering wheel. Drive the vehicle on a level road surface; note the angular position (misalignment of the steering wheel spokes.
	Lift up the vehicle
	Mark the position of the track rods and the track rod ends
	Slacken the track rod end lock nuts and also remove the gaiter outer retaining clips.

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	Rotate both track rods in the same direction approximately 30 degrees for every 1-degree of steering misalignment error. If the steering wheel has an anticlockwise angular error then both track rods must be rotated clockwise- when viewed from the left – hand side of the vehicle
Clock wise error  Anti clock wise	If the steering wheel has an clockwise angular error then both track rods must be rotated anticlockwise- when viewed from the left – hand side of the vehicle
	Check the front wheel alignment (Toe In) after the steering wheel has been centralized

f) Bleeding the system

Before starting the Bleeding operation, ensure that the Vehicle is in level ground, and the reservoir is filled to the maximum specified.

As with any hydraulic system ensure that the recommended fluids only are used. Ensure that no dirt enters the system while topping up. Before opening the reservoir cap, wipe the area with a cloth.

	**Ensure that the front wheels are jacked up and wheels are lightly touching the ground.** **If this is not done then the steering linkage and components will be under undue stress.** **Even with the wheels partly jacked up, do not hold the steering in fully locked position for more than 10 second. Failure to**

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	do so may damage the pump beyond repairs.
	Start the engine.
	Rotate the steering wheel from lock to lock 3 to 4 times.
	Check if the oil in the reservoir has dropped down drastically- if so check for any leaks.
	Check if any foaming/ frothing is taking place.
	Repeat the rotation from lock to lock till the foaming subsides
	If the foaming is not subsiding after ¾ of the above cycle, check for the tightness of the hoses in particular the reservoir to the steering pump and later the steering gear to reservoir. The loose connection in these pipes will allow air to sucked into the system.
	After completing the bleeding operation, ensure that with the engine running the oil level is between the maximum and minimum mark
	Close the cap

Dismantling & Assembly of the Steering Gear –

We do not suggest overhaul of the steering gear.

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Working principle of the Steering Pump -

The steering pump is non-serviceable. Hence it cannot be repaired.

The pump is a constant flow, vane type incorporating a flow control valve (with an integrated relief valve) and it is gear driven by engine. The power steering pump consists of housing, drive shaft, cartridge assembly & bearing(s) apart from the valve.

As the pump rotates a vacuum is created at the inlet, which causes atmospheric pressure to force the fluid in to pump from the reservoir. As the rotor rotates, the inlet port closes and the fluid is trapped between the vans. Further movement forces the fluid to be pressurized as the profile of the cam ring constantly reduces the available volume. At the minimum point of the profile the chamber opens into the outlet port.

The rotor is having 10 vanes, thus each rotation is equal to 5 pumping action. The discharge rate of the power steering pump increases in proportion to the pump speed increases.. The flow control valve is provided to maintain the optimum flow of the supplied oil for power steering operation, at all engine speeds. The relief pressure will open when the system pressure exceeds the set value. This normally happens when the steering wheel is turned and held in the lock position.

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Specifications -

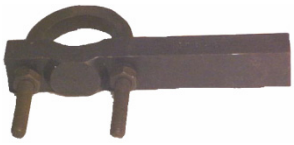
Description	Value
Steering Gear Type	Rack & Pinion, End Take Off, Integral Power Assisted
Steering Gear Make	Sona Koyo
Rack Travel (Steering Gear)	LH - 75 mm & RH - 75 mm, maximum
Overall Steering Ratio	20 : 1
Total Turns Available on Input Shaft of the Steering Gear	3.75
No. Of Steering Wheel Rotations (Lock to Lock)	3.6
Torque required on input shaft to move the Rack (preload)	1.5 Nm
Normal Operating Pressure	85 bar
Steering Wheel Diameter	395 mm / 365 mm
Power Steering Pump	Sliding Vane Type - Positive displacement
Pump Make	Koyo
Pump Make	Delphi
Direction of pump rotation	Clockwise when viewed from shaft end
Pump Flow	8.5 LPM @ 1000 rpm
Pump - Pressure Relief	75 kg/cm2 0r 75 bar
Pump - Drive	Gear driven
Wide Operating Speed - Pump	600 rpm - 6500 rpm
Wide Operating Temp. Pump & Gear	- 40 ° C to + 120 ° C
Flow Control cum Pressure Relief Valve in Pump	In-built System 7.5 +0.5 / - 0 M-pa. 8.5 ± 0.7 lit / min @ 1500 RPM
Oil capacity - System	0.8 lts. Approx.

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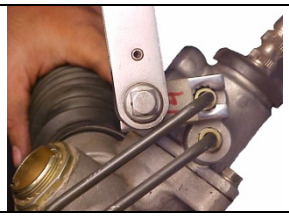
Tightening Torques –

Description	Torque Value Nm (lbf-ft)
Steering Gear Centre Bolt	120 ±10 Nm (88 ± 7 lb-ft)
Steering Gear Mounting Clamp Bolts	85 Nm (63 lb-ft)

List of the MSTs –

Description / Part No. / Sketch	Usage View
MST – 547 **Steering wheel puller** 	
MST – 548 **Steering stand** 	
MST – 549 **Tie rod end remover** 	
MST – 550 **Socket steering pump Nut**	

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MST – 551 **Unit wrench –12 mm** 	

Recommended Lubricants –

The recommended brand names are
DEXTRON TEXMATIC 1278 / 1888 from CALTEX ATF

Capacity is 0.8 lts.

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Airbag

Content

* Airbag RHD
* Airbag LHD

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Airbag RHD

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Necessity

The seat belt is a concrete device for protecting the body of a passenger in a collision. But when the body is subjected to a large impact in the case of a high-speed collision, the seat belt alone cannot protect the body. And especially in the case of a serious front-end collision, the upper body tilts forward even when it is secured with the seat belt, and the head or chest may collide with the steering wheel or the windshield, resulting in injuries.

The SRS Air bag system is a device that reduces head and chest injuries to the driver and passengers by inflating an airbag installed in the steering wheel or the instrument panel when such a collision occurs, supplementing the function of the seat belt.

Thus, the SRS Air bag system supplements the restraining and protective functions of the seat belt. For that reason the name of the system is **S**upplementary **R**estraint **S**ystem **(SRS)**

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FUNCTION & EFFECT

Function of Air Bag

- Absorbs Kinematics energy of occupants
- Protects occupants from injuries in case of accident
- Protects occupants from interior trims
- Protects occupants from broken glass
- Reduces occupants neck load by kinematically restraining spin of neck.

Effect

Decrease in fatality when safety system is used
(Data published by NHTSA, 1999)

When only using Seat Belt: -	45% Decrease
When only using Frontal Air Bag: -	14% Decrease
When using Seat Belt + Frontal Air Bag: -	**50% Decrease**

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SRS Components

The SRS system consists of the following components:

- Driver side Air Bag Module
- Passenger side Air Bag Module
- Air Bag ECU
- Air Bag Warning indicator (On Instrument Cluster)
- Wiring Harness
- Driver Seat belt Pre tensioner
- Passenger Seat belt Pre tensioner

Operation

The crash sensors in the air bag ECU continuously monitor to determine if the frontal impact is severe enough to deploy the air bags. When an impact of sufficient force occurs, the air bag ECU sends an electrical signal to the air bag modules which in turn rapidly ignites the energetic material and inflates the air bag. The inflated airbag deploys out of steering wheel and glove box cover. As the entire deployment of air bag happens in less than a second, in combination with seat belts, it slows down the driver's or passengers forward motion, thus reducing the risk of head or chest injury. The air bags deflate quickly thru the pores in the air bag cushion. Therefore air bag is not a substitute of seat belts. To maximize your protection always wear seat belts. The SRS can function only when the ignition key is 'ON'.

Note: The SRS front air bags are not designed to inflate for side or rear collisions, roll over or if it is involved in low speed frontal collision.

How Airbag Inflators Work

The intended function of an airbag is to provide supplemental restraint to automobile occupants in the event of a collision. This is done by the rapid inflation of a cushion by non-toxic gas that is generated and/or released by an inflator in response to an electrical signal from a collision detecting sensor(s). The inflated cushion helps to absorb the energy of a driver or passenger and prevent body contact with the vehicle structure.

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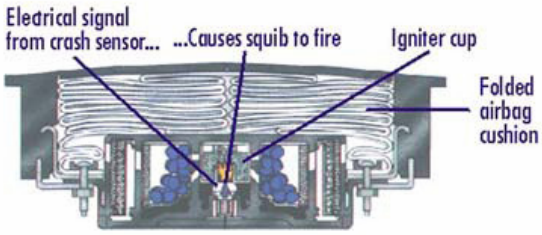


Figure A
Inflator receives an electrical signal to fire.
Time sequence: 0-1 milliseconds.

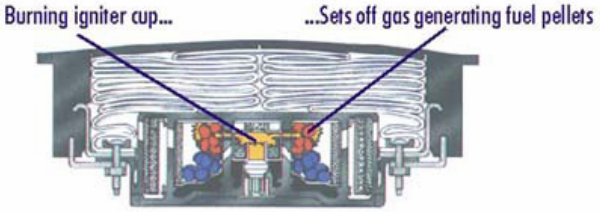


Figure B
Initiator fires; pyrotechnics ignited.
Time sequence: 1-2 milliseconds.

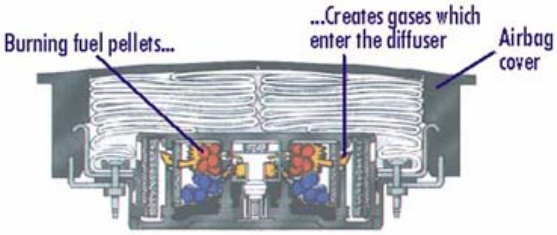


Figure C
Gas generant burns producing inflation gases.
Time sequence: 2-4 milliseconds.

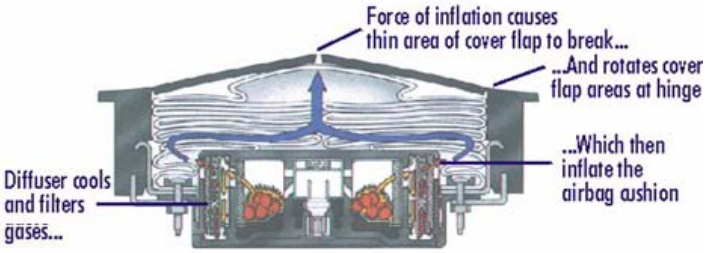


Figure D
Gases begin to inflate the cushion and break open the cover.
Time sequence: 5-10 milliseconds.

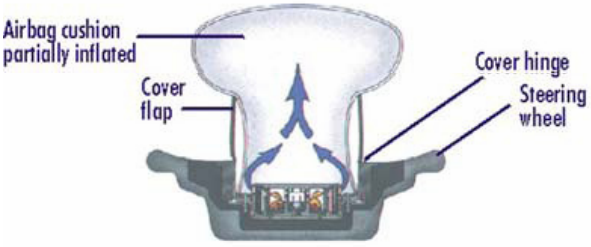


Figure E
Cushion deploys and begins to fill.
Time sequence: 15-25 milliseconds.

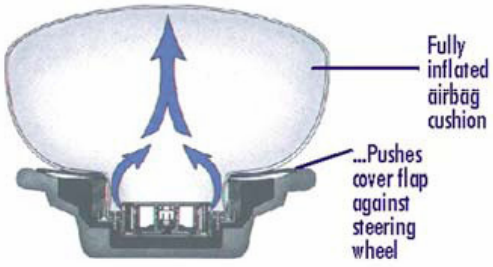


Figure F
Cushion inflated to provide occupant restraint.
Time sequence: 25-50 milliseconds.

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Definitions:

SRS- Supplementary Restraint System

DAB- Driver Airbag assembly

SW- Steering Wheel assembly

PAB- Passenger Airbag Assembly

Lower Cover PAB: Part of the Instrument Panel directly below PAB

RP-Rotary Pretensioner used in the retractor of Scorpio Front Seat Belt Assembly

SB-Seat Belt assembly

Pyrotechnics – any of the above described devices (DAB, PAB or RP)

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General Precautions:

Please read the following precautions carefully before performing the airbag system service. Observe the instructions described in this manual, or the airbags could accidentally deploy and cause damage or injuries.

- Except when performing electrical inspections, always turn the ignition switch OFF and disconnect the negative cable from the battery, and wait at least three minutes before beginning work.

- Use the replacement parts which are manufactured to the same standards as the original parts and quality. Do not install used SRS parts from another vehicle. Use only new parts when making SRS repairs.

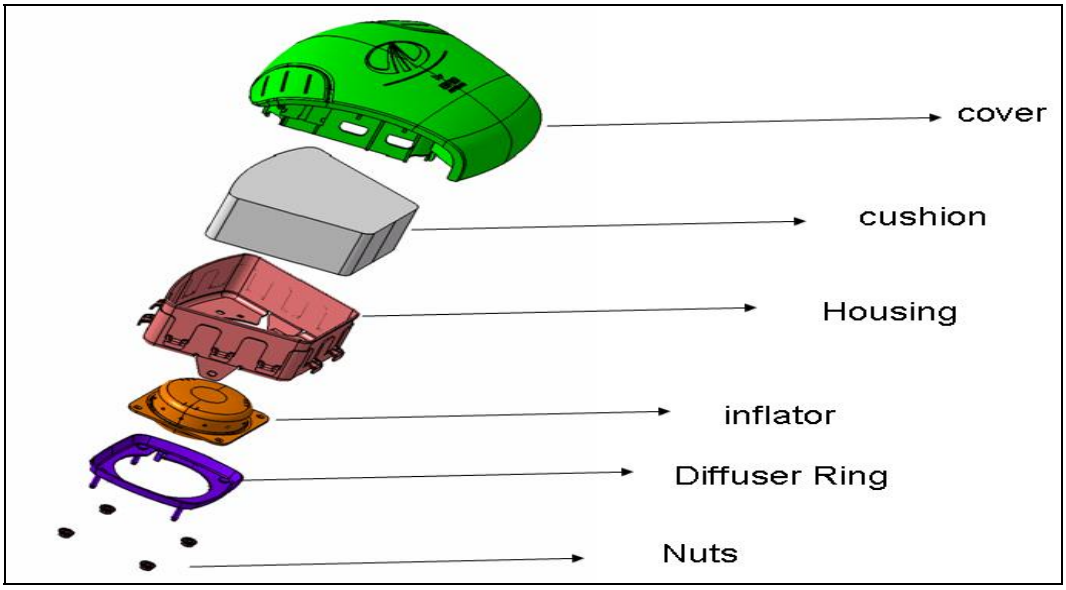
- Carefully inspect any SRS part before you install it. Do not install any part that shows signs of being dropped or improperly handled, such as dents, cracks or deformation.

- Before removing any of the SRS parts (including the disconnection of the connectors), always disconnect the SRS connector.

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Driver Air Bag (DAB)

Exploded view of Driver Air Bag



Description

The Driver Air Bag Module sits centrally as a complete unit in the steering wheel. At high speeds, the danger arises of being thrown against the steering wheel in the event of a crash, even if the driver's seat belt is fastened. The air bag protects the driver against collision with the steering wheel & thus alleviates the consequences of the accident. The deployment of DAB depends upon the severity and direction of the frontal collisions.

Note: The SRS front air bags are not designed to inflate for side or rear collisions, roll over or if it is involved in low speed frontal collision.

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Removing a fired DAB from vehicle

Most of the times, a fired airbag has to be removed from the vehicle after accident or inadvertent deployment - before installation of the new DAB.



Fig shows a fired DAB. Now before installing a new DAB the fired DAB has to be removed from the vehicle.

The following steps are to be followed when removing a fired DAB from vehicle

- Rotate SW until one of the holes on the side of SW is accessible.



- Using the appropriate Allen key tool, unscrew and remove the M6 socked head bolt from the SW.

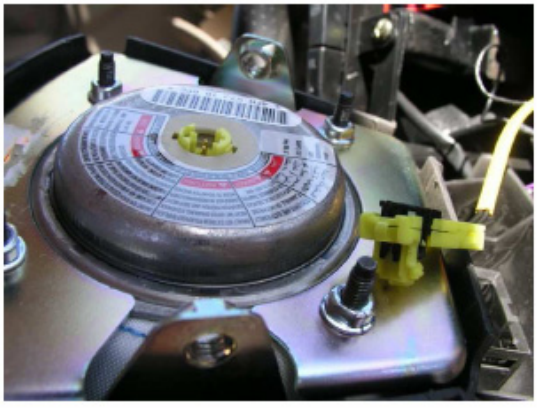
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- Turn the SW by 180 degrees to access the second bolt fixing DAB to the SW.
- Undo and remove the second bolt the same way as described above.
  Note: Two bolts once removed should not be reused as they are precoated with dry adhesive.
- Pull out and remove the DAB from SW.
- Lift up the black tab in DAB connector with a screwdriver. Pull off the connector and remove it from DAB.





- Discard the DAB; recycle metal and plastic components as appropriate.
- Wash hands with soap after completing the disassembly.

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Removing live (non-fired) DAB from vehicle

Note: - It is recommended that the person doing the task wears an antistatic wrist or ankle strap when handling a new airbag.

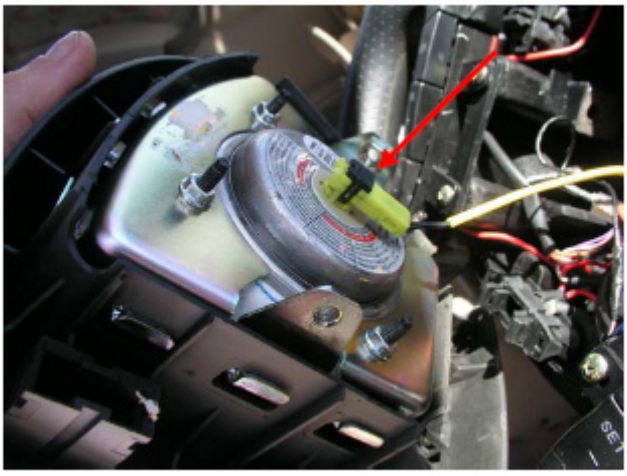
If the DAB in vehicle has not been fired, it has to be ensured that the **vehicle ignition key is in "OFF" position** before and during removing DAB from the vehicle. This is necessary in order to avoid resetting the "Airbag Fault" alarm. Apart from the above, please follow the same procedure of **"Removing a fired DAB from vehicle".**

Assembly Procedure of Driver Air Bag (DAB)

Note: It is recommended that the person doing the task wears an antistatic wrist or ankle strap when handling a new airbag.

The following steps are to be followed while assembling DAB in vehicle.

- Insert the DAB connector to the airbag. Assure the correct connector orientation is maintained, as per the below pictures. After inserting the connector, secure it by pressing the black tab.



Note: In case the DAB connector had been melted during previous airbag deployment, the DAB loom has to be replaced prior to airbag installation.

- Fit the DAB into the SW cavity, and align the 3 rectangular housings in DAB with horn switches in the SW.

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- Press the DAB to fit in the SW. Assure the 3 horn switches had engaged in the respective DAB housings.

- Rotate the SW until there would be access to one of the holes in the side of SW. Assure that holes in DAB and SW align correctly, or otherwise use the screwdriver to align them.

- Locate and insert M6 x 16mm long socket head screw into the hole on the side of SW. Torque to 10 +/- 1.0 Nm.

- Rotate the SW by 180 deg and assemble the second M6 x 16mm socket head screw the same way as described above.

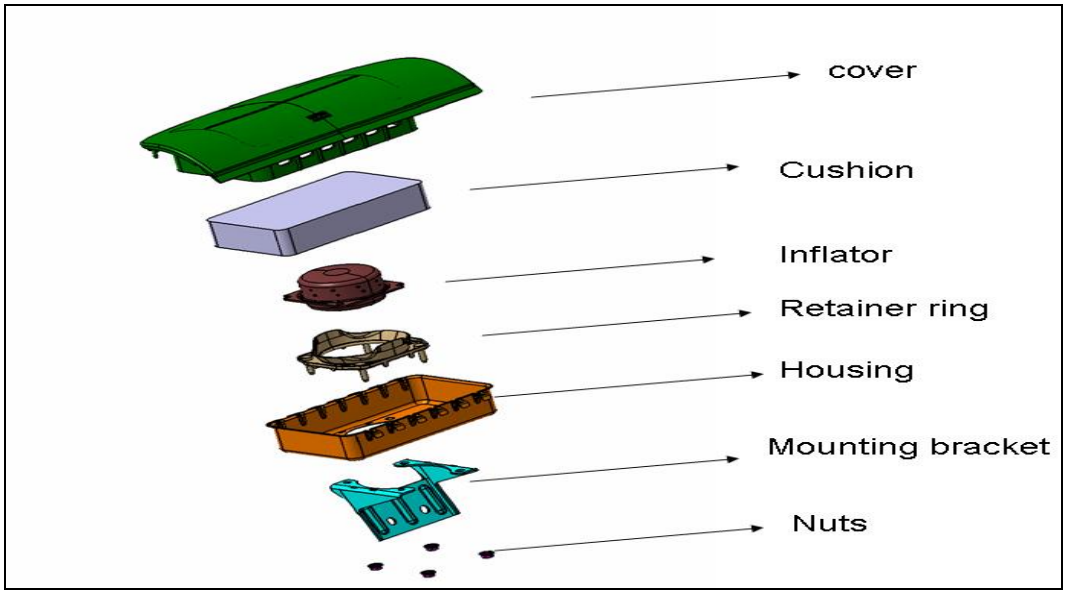
- Switch the ignition “on” and assure the airbag warning lamp in the instrument cluster is off.

- Assure the vehicle horn works correctly.

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Passenger Air Bag (PAB)

Exploded View of Passenger Air Bag



Description

The Passenger Air Bag (PAB) is located above the glove box compartment.
The PAB prevents the Co-driver from serious injuries in case of accident.
The deployment of PAB depends upon the severity and direction of the frontal collisions.

Note: The SRS front air bags are not designed to inflate for side or rear collisions, roll over or if it is involved in low speed frontal collision.

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Removing a Fired PAB from vehicle

Usually the PAB has to be removed from the vehicle after it has been fired upon accident or inadvertent deployment.

The following steps are to be followed when removing a fired PAB from the Vehicle:

- Lift the corners of Lower Cover PAB to undo the attaching clips. Use plastic or wooden tool for this task to avoid part damage. Remove the Lower Cover PAB from the Instrument Panel.

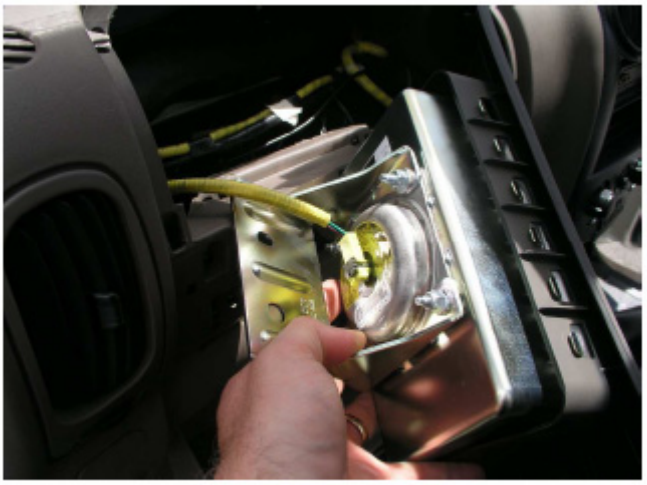



- Using the appropriate spanner, undo and remove the 2 x M8 hexagonal bolts fixing the PAB bracket to the vehicle Cross Car Beam

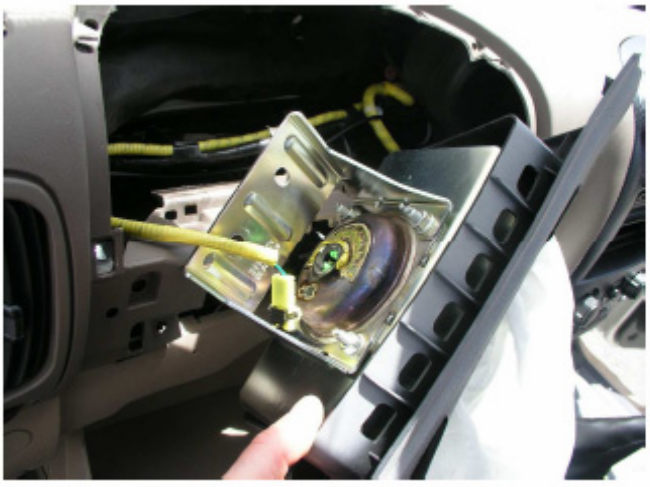


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- Lift the PAB Cover from the Instrument Panel and pull the PAB upwards to remove it from the Instrument Panel.



- Lift the tab from airbag connector and putt connector up to disconnect airbag loom



- Discard the PAB; recycle metal and plastic components, as appropriate.

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- Wash hands with soap after completing the disassembly.

Removing live (non-fired) PAB from vehicle

Note: It is recommended that the person doing the task wears an antistatic wrist or ankle strap when handling a new airbag.

If the PAB in vehicle has not been fired, ensure the **vehicle ignition is OFF** before removing airbag loom connector from the airbag. Ignition has to be also kept OFF all the time during assembly and re-assembly – to avoid resetting the "Airbag Fault" alarm. Apart from the above, please follow the same procedure of **"Removing a fired PAB from vehicle".**

Assembly Procedure of Passenger Air Bag (PAB)

Note: It is recommended that the person doing the task wears an antistatic wrist or ankle strap when handling a new airbag.

The following steps are to be followed when installing PAB in the vehicle:

- Insert the PAB connector to the airbag. Assure the correct connector orientation is maintained, as per the below picture. Lock the connector by pressing black tab.



Note: In case the PAB connector had been melted during previous airbag deployment, replace the whole airbag loom affected.

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- Place the PAB into the cavity in Instrument Panel. Align 3 location studs in the PAB cover with relevant holes in Instrument Panel. Push the PAB Cover down to fit into Instrument Panel.



- Locate and insert two M8 socket head screw into the holes in PAB bracket.
  Torque Specification: 18 +/- 2.0 Nm.





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- Align and press to assemble the Lower Cover PAB to the Instrument Panel.





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Shipping

Shipping of the Pyrotechnic assemblies

Pyrotechnic assemblies are considered Hazardous Materials. Persons shipping Hazardous Materials must be properly trained and must consult current published regulations to ensure conformance to all applicable regulations.

Packaging containing Pyrotechnics must be marked appropriately, displaying the “class” of the Hazardous Materials inside. The following picture is showing branding of the Hazardous Materials Class 9. Scorpio
Airbags and RP SB classify to this class.



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Storage

- General storage must meet state and local regulations.
- Store the SRS unit, the front impact sensor and the side impact sensors in a cool (less than 40 C/104 F) and dry (less than 80% relative humidity, no moisture) area.
- Keep inflators, modules and seat belt assemblies away from flame, water, and any chemicals that may degrade the assembly material.
- Inflators, modules and seat belt assemblies should be stored in the upright position in their original shipping container, if possible, until installation.
- Store damaged inflators, modules and seat belt assemblies in a dry place in limited quantities.
- It is important to store the discharged pyrotechnic inflator units in containers, which prevent precipitation (rain, snow, etc.), from coming in contact with the gas generant residue.
- Store the removed airbag on secure, flat surface away from any high heat source (exceeding 85 C/185 F).
- Never perform electrical inspections to the airbags, such as measuring resistance.
- Do not position yourself in front of the airbag assembly during removal, inspection, or replacement.

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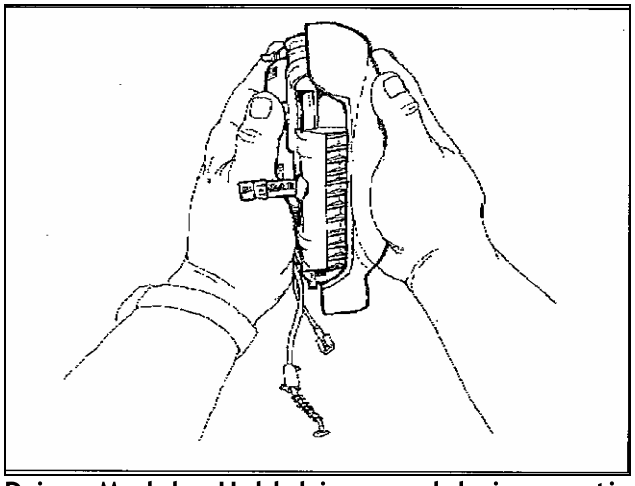
Handling of the Pyrotechnic assemblies

1. Undeployed Pyrotechnics
    a. Do not place any objects on top of Airbag Covers. These objects may become projectiles in case of inadvertent Airbag deployment.
    b. Wear anti static straps (foot or hand) when handling Pyrotechnics.
    c. Do not attempt to dismantle Pyrotechnics or their components.
    d. Do not apply electrical voltage to the Pyrotechnics terminals, especially if external loom is connected to the connector.

2. Deployed Pyrotechnics
    a. Wash hands after handling the deployed pyrotechnics.

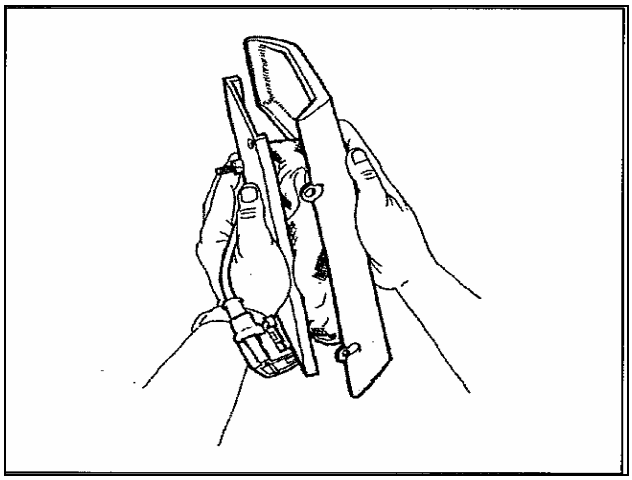
Proper Handling

Below are examples of the safest methods of holding Air bag modules

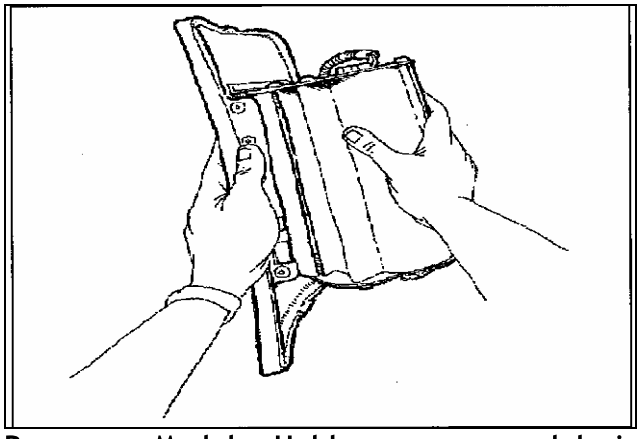


Driver Module—Hold driver module in a vertical position with right hand on cover.

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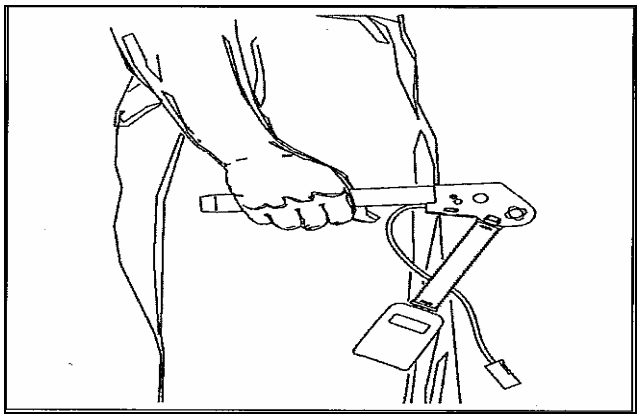


Knee Bolster—Hold knee bolster module in vertical position with right hand on cover.

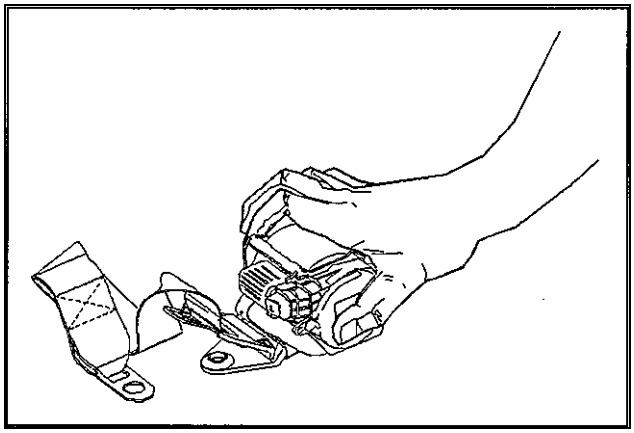


Passenger Module—Hold passenger module in vertical position with lead wires at top and left hand on cover.

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Seat Belt Pretensioner—Hold seat belt pretensioner by the round tube with the round tube end pointed away from the body and the buckle pointing down.



Seat Belt Retractor—Hold seat belt retractor by gripping the end caps or sides of the retractor.

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Dos & Don'ts for Air Bag System

Do's

- Do store modules in an upright position.
- Do keep modules dry.
- Do carry modules with the cover side pointing away from the body.
- Do place modules with their cover side upwards.
- Do carefully inspect modules for damage.
- Do stand to one side when connecting modules.
- Do make sure all test equipment is properly calibrated and maintained.
- Do wash hands after handling deployed air bags.

Don'ts

- Do not store highly flammable material together with modules or gas generators.
- Do not store gas generators at temperatures exceeding 80°C.
- Do not store modules upside down.
- Do not attempt to open gas generator housing.
- Do not expose gas generators to open flame or sources of heat.
- Do not place anything on top of a module cover.
- Do not use damaged modules.
- Do not touch a fired module or gas generator for at least 10 minutes.
- Do not use any electrical probes on the wiring circuit.

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IMPORTANT SAFETY WARNINGS

- As the solid propellant burns, the airbag module may heat up and vent hot gas.



- Always wear gloves and safety glasses during handling of pyrotechnic devices.



- Because of peak noise levels during deployment of pyrotechnics, there is a potential risk to hearing. Always wear ear protection during deployment.

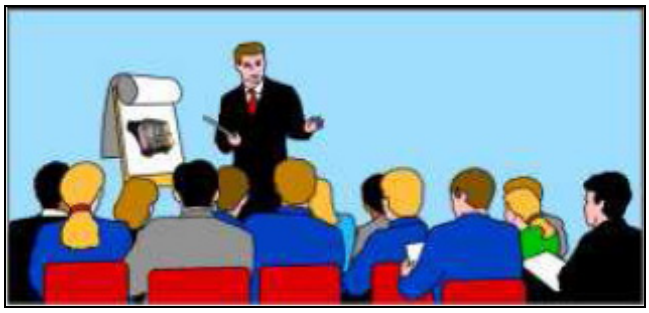


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- Always wash hands after handling deployed pyrotechnic devices.



- Deployment and associated activities shall only be performed by trained personnel.



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Frequently Asked Questions (FAQ)

Q: What are the concerns that need to be reviewed if handling inflators/modules in a processing facility?
Ans: Safe work practices should be reviewed to eliminate the potential hazards that may result in an unplanned deployment. Examples of potential hazards to review are:

- Electrical equipment and wiring that could come into contact with the connector lead wire or initiator pins.
- Possible pinch points that could damage or tear the lead wire
- Materials that buildup large amounts of energy (e.g. plastics) that could be discharged in the form of electrostatic energy
- High heat sources that exceed 1500 C

Q: What would cause an airbag to accidentally discharge?
Ans: The probable causes are as mentioned below:

- Introduction of an electrical energy source
- Heating the metal airbag inflator canister to a temperature greater than 150° C
- Drilling, sawing, puncturing, and shearing in the igniter/squib area.

Q: How much force does it take to puncture an inflator wall?
Ans: The airbag inflator vessel wall thickness and pressure containment specifications are such that the force required to puncture the inflator wall is likely greater than would be experienced under reasonable handling conditions on a production line. Power equipment (e.g., robotics, drills, pisses, metal shears, etc.) may be able to puncture the inflator wall. Care should be taken to prevent unplanned or unsafe acts by power equipment or external penetration of the inflator wall.

Q: What is the cooling time of the inflator if one deploys?
Ans: The airbag module attachment components can be handled within minutes following deployment. When handling inflators, you should allow up to 45 minutes cooling time in order to handle it without the hazard of burning the skin (<40° C).

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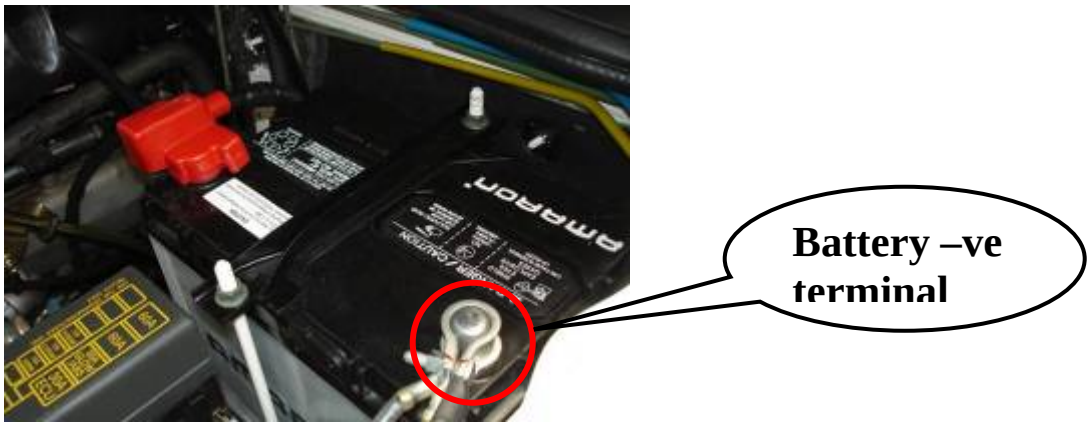
Procedure for checking Clock spring Continuity and replacement

To remove the clock spring for continuity checking follow the below steps:

1.) Crank the engine for making the front wheel in straight direction.
2.) Start rotating the steering wheel to extreme left.
3.) From extreme left, Start rotating the steering wheel to extreme right. This total travel will complete 3.5 rotations of steering wheel.



4.) From extreme right side, start rotating the steering wheel for 1.75 turns to left side.
5.) This 1.75 rotation (which you have done in step 4) confirms that the steering wheel is in center of the vehicle.
6.) Stop the engine.
7.) Disconnect the Battery negative terminal.



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8.) Remove the Horn Pad by removing the screws on either side as shown in photo.





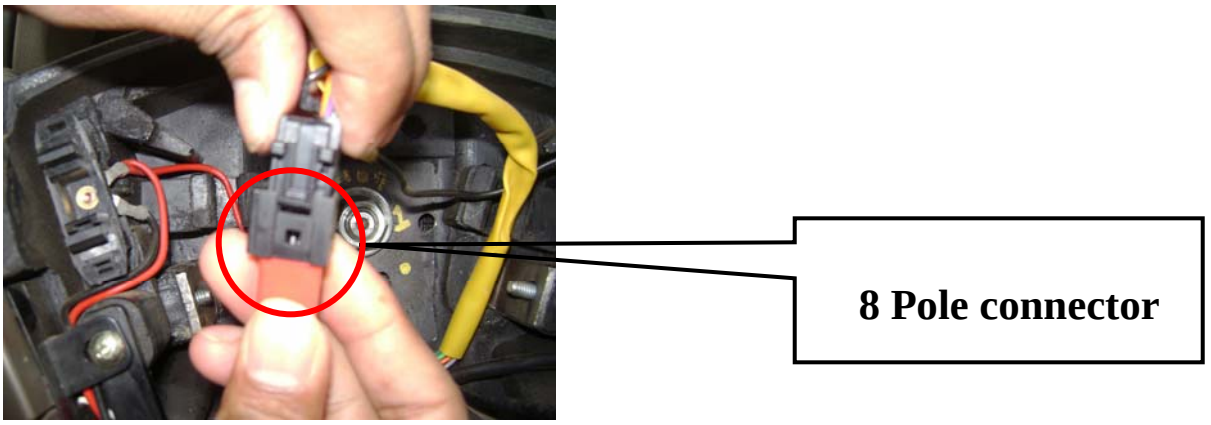


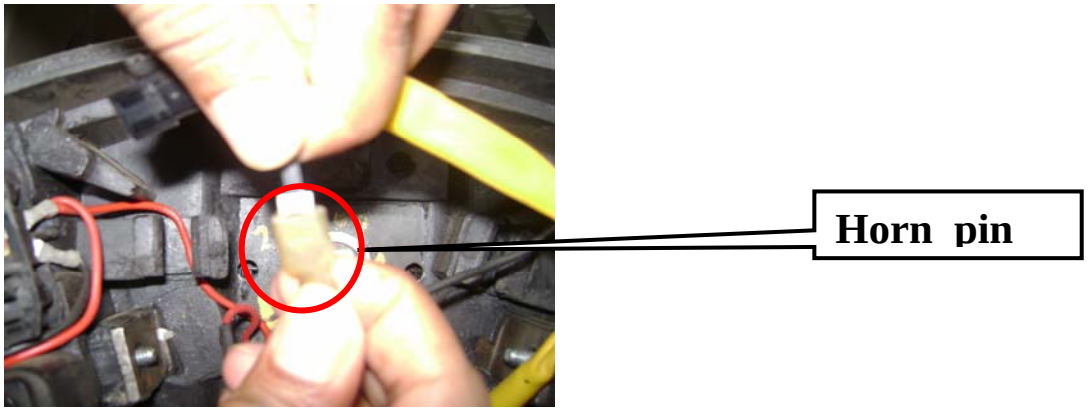
9.) Remove the Squib connector of DAB as shown.



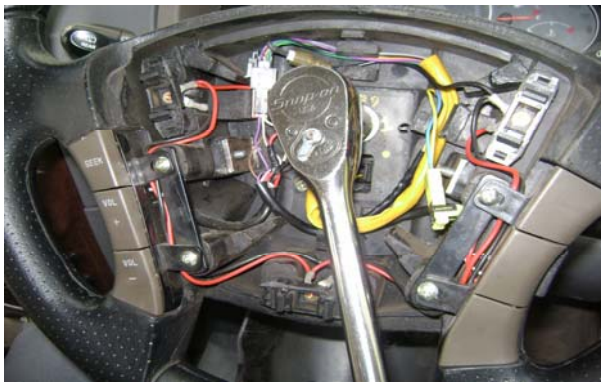
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10.) Unplug the 8 Pole connector (Clock spring Vs steering wheel switches) & Horn terminal.





11.) Loose the steering wheel nut and remove the same from steering rod.



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12.) Remove the steering wheel from steering rod. At most care to be taken while removing the steering wheel that the connector of clock spring should not get entangled in Steering wheel cutout.(Please ref. the attachment)



13.) Remove the connector from steering wheel slot carefully.



13.) Remove the 5 screws that fasten the shroud.

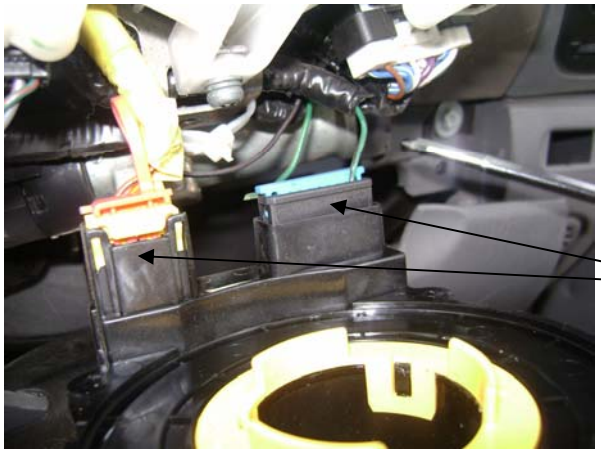


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14.) Remove 4 screws of Clock spring which holes the clock spring on combination switch.



15.) Unplug the wiring harness connectors which goes to Clock spring at bottom side of Clock spring.

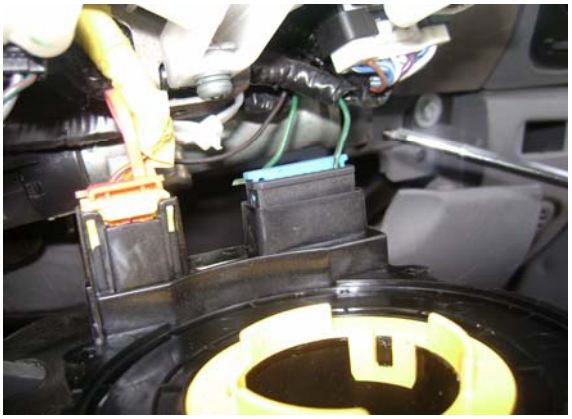


16.) Check the continuity of clock spring as per below mentioned.
17.)If found any discontinuity in any circuit like Cruise, Audio ctrl, Horn & airbag. Replace new clock spring.



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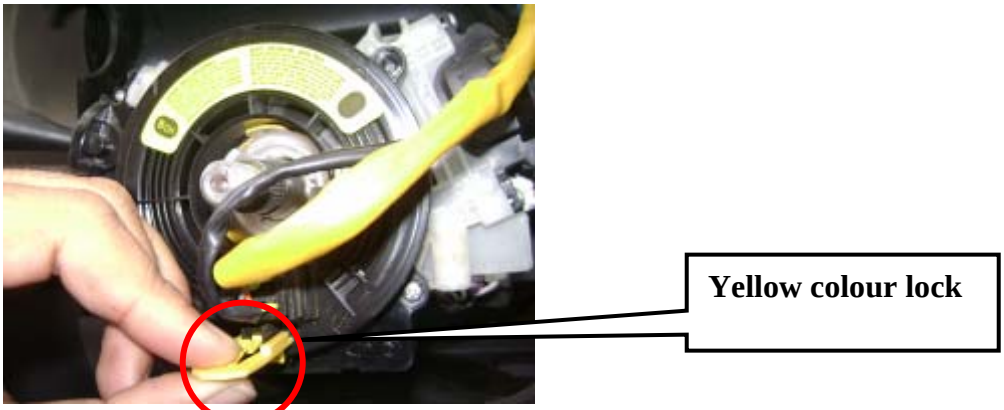
18.) Connect 8 Pole & 4 pole connector of wiring harness to clock spring



19.) Tighten the clock spring with four screws with 4 Nm torque.



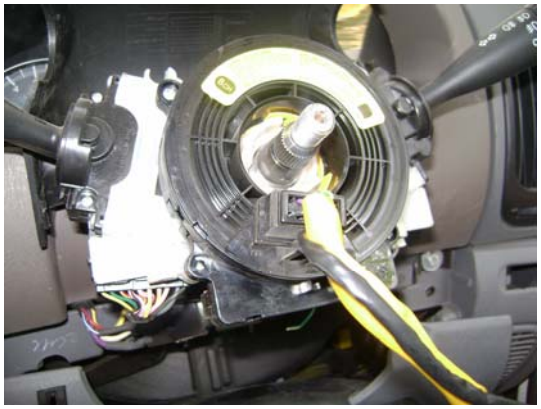
20.) Remove the yellow colour lock. Clock spring has total 5.7 rotations. This Yellow lock defines the center position of Clock spring. I.e. after removing the Lock, clock spring will have 2.5 rotations on right side& 3.2 rotations on left side.



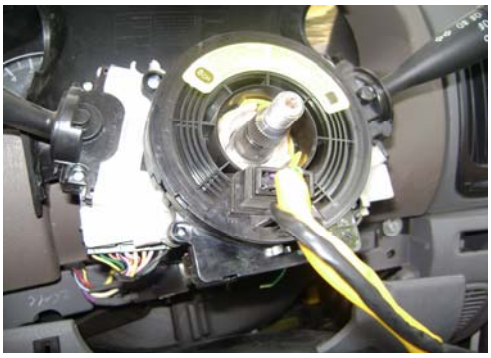
Note: If this lock is already found broken / missing. Then to define center position Of clock spring follow the steps from 21 to 24.

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21.) Hold the clock spring rotor wire in hand as shown below & Start rotating to extreme Left in anticlockwise direction.



22.)From extreme left point start rotating the rotor to extreme right in clockwise direction. Clock spring will complete 5 rotations from extreme left to extreme right.



23.) From extreme right start rotating the rotor for 2.5 rotations in anticlockwise direction.
24.) This point defines the middle position of the clock spring. With this we can ensure that clock spring will have 2.5 rotations on right side & 3.2 rotations on left side.

25.)Fix & press the shroud and fix with the help of 5 screws.

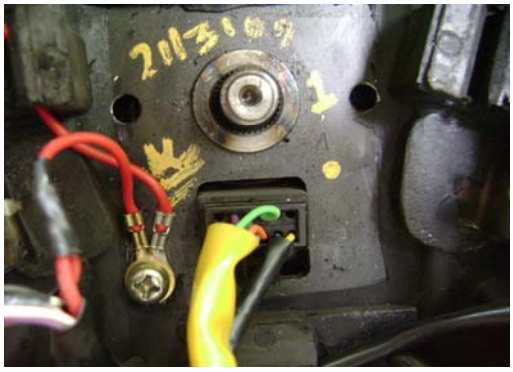


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26.) Place the steering wheel on the steering rod. While placing this steering wheel ensure 8 & 4 pole connector of clock spring to taken out from slot provided on steering wheel along with complete wiring harness.



27.) Locate the steering wheel slot in clock spring grommet.



28.) Tighten the steering wheel nut. Make sure that the steering wheel is in straight ahead Position with front wheels.



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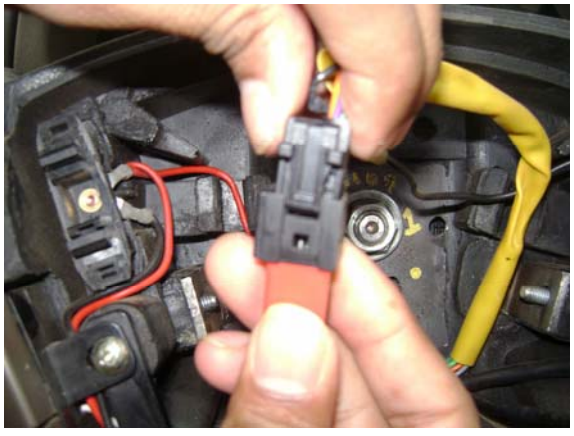
29.) After tighten the nut, route the wire through guidelines as shown.

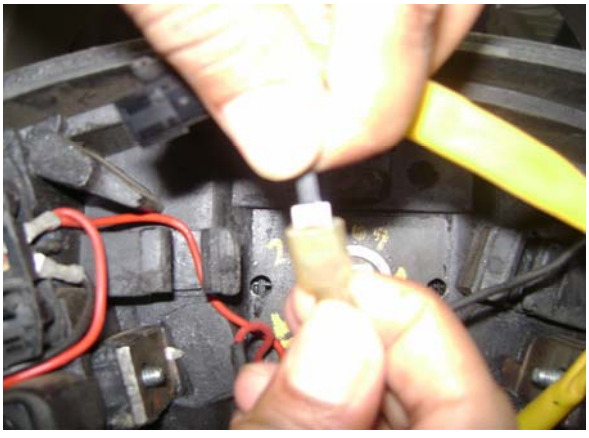






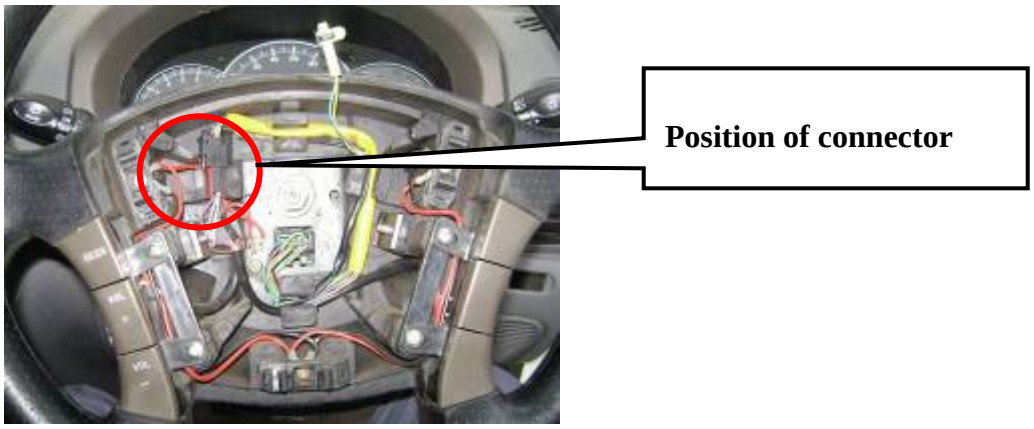
30.) Make the connection of 8 pole connector & horn pin.





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31.) After connection route the connector as shown.



32.) Connect the DAB squib connector to the DAB.



33.) Place the horn pad.



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34.) Tight the DAB screws with LN key.





35.) Re-connect the battery negative terminal to Battery.

36.) Verify that the horn works.

37.) Turn ON the Ignition and check the Audio Control through steering wheel switches Functions.

Note: Whenever the Battery is disconnected driver door power window auto function is Disabled.

35.) Start the engine.

36.) Learn the power window regulator as per procedure mentioned in Smart power window.

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Airbag - LHD

Contents

- Necessity
- Function & Effect
- Supplementary Restraint System(SRS) Components
- Operation
- How Air bag inflators work
- Definition
- General Precautions
- Driver Air Bag (DAB)
- Passenger Air Bag (PAB)
- Shipping
- Storage
- Handling of the Pyrotechnic Assemblies
- Dos & Don’ts
- Important Safety Warnings
- FAQ
- Clock Spring Removal/Refitment

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Necessity

The seat belt is a concrete device for protecting the body of a passenger in a collision. But when the body is subjected to a large impact in the case of a high-speed collision, the seat belt alone cannot protect the body. And especially in the case of a serious front-end collision, the upper body tilts forward even when it is secured with the seat belt, and the head or chest may collide with the steering wheel or the windshield, resulting in injuries.

The SRS Air bag system is a device that reduces head and chest injuries to the driver and passengers by inflating an airbag installed in the steering wheel or the instrument panel when such a collision occurs, supplementing the function of the seat belt.

Thus, the SRS Air bag system supplements the restraining and protective functions of the seat belt. For that reason the name of the system is **S**upplementary **R**estraint **S**ystem **(SRS)**

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FUNCTION & EFFECT

Function of Air Bag

- Absorbs Kinematics energy of occupants
- Protects occupants from injuries in case of accident
- Protects occupants from interior trims
- Protects occupants from broken glass
- Reduces occupants neck load by kinematically restraining spin of neck.

Effect

Decrease in fatality when safety system is used
(Data published by NHTSA, 1999)

When only using Seat Belt: - 45% Decrease
When only using Frontal Air Bag: - 14% Decrease
When using Seat Belt + Frontal Air Bag: - **50% Decrease**

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SRS Components

The SRS system consists of the following components:

- Driver side Air Bag Module
- Passenger side Air Bag Module
- Air Bag ECU
- Air Bag Warning indicator (On Instrument Cluster)
- Wiring Harness
- Driver Seat belt Pre tensioner
- Passenger Seat belt Pre tensioner

Operation

The crash sensors in the air bag ECU continuously monitor to determine if the frontal impact is severe enough to deploy the air bags. When an impact of sufficient force occurs, the air bag ECU sends an electrical signal to the air bag modules which in turn rapidly ignites the energetic material and inflates the air bag. The inflated airbag deploys out of steering wheel and glove box cover. As the entire deployment of air bag happens in less than a second, in combination with seat belts, it slows down the driver's or passengers forward motion, thus reducing the risk of head or chest injury. The air bags deflate quickly thru the pores in the air bag cushion. Therefore air bag is not a substitute of seat belts. To maximize your protection always wear seat belts. The SRS can function only when the ignition key is 'ON'.

Note: The SRS front air bags are not designed to inflate for side or rear collisions, roll over or if it is involved in low speed frontal collision.

How Airbag Inflators Work

The intended function of an airbag is to provide supplemental restraint to automobile occupants in the event of a collision. This is done by the rapid inflation of a cushion by non-toxic gas that is generated and/or released by an inflator in response to an electrical signal from a collision detecting sensor(s). The inflated cushion helps to absorb the energy of a driver or passenger and prevent body contact with the vehicle structure.

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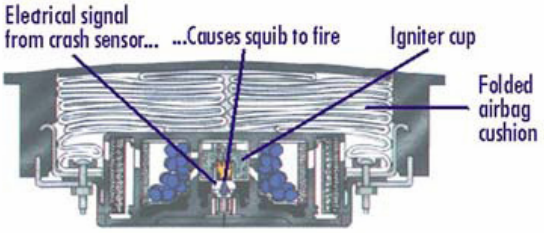


Figure A
Inflator receives an electrical signal to fire.
Time sequence: 0-1 milliseconds.

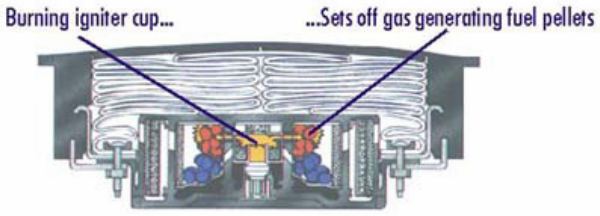


Figure B
Initiator fires; pyrotechnics ignited.
Time sequence: 1-2 milliseconds.

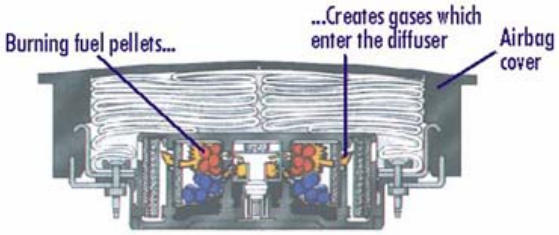


Figure C
Gas generant burns producing inflation gases.
Time sequence: 2-4 milliseconds.

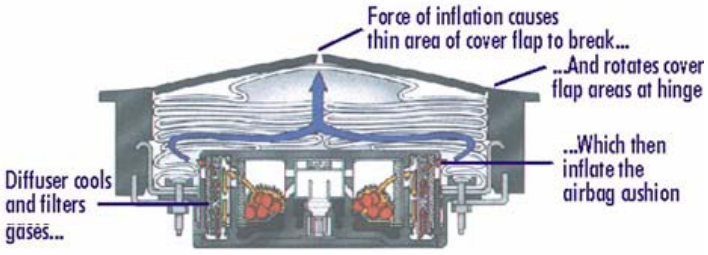


Figure D
Gases begin to inflate the cushion and break open the cover.
Time sequence: 5-10 milliseconds.

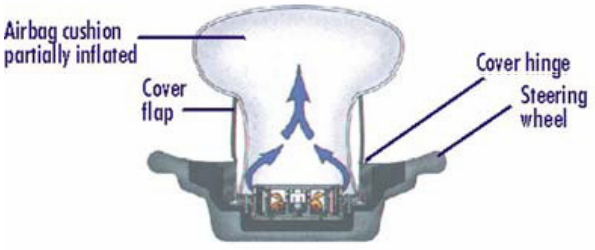


Figure E
Cushion deploys and begins to fill.
Time sequence: 15-25 milliseconds.

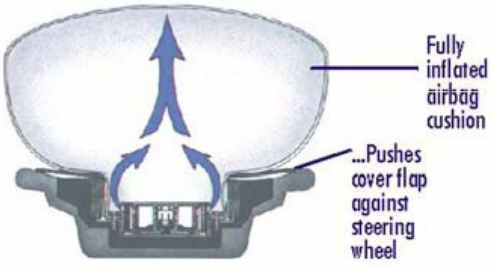


Figure F
Cushion inflated to provide occupant restraint.
Time sequence: 25-50 milliseconds.

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Definitions:

SRS- Supplementary Restraint System

DAB- Driver Airbag assembly

SW- Steering Wheel assembly

PAB- Passenger Airbag Assembly

Lower Cover PAB: Part of the Instrument Panel directly below PAB

RP-Rotary Pretensioner used in the retractor of Scorpio Front Seat Belt Assembly

SB-Seat Belt assembly

Pyrotechnics – any of the above described devices (DAB, PAB or RP)

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General Precautions:

Please read the following precautions carefully before performing the airbag system service. Observe the instructions described in this manual, or the airbags could accidentally deploy and cause damage or injuries.

- Except when performing electrical inspections, always turn the ignition switch OFF and disconnect the negative cable from the battery, and wait at least three minutes before beginning work.

- Use the replacement parts which are manufactured to the same standards as the original parts and quality. Do not install used SRS parts from another vehicle. Use only new parts when making SRS repairs.

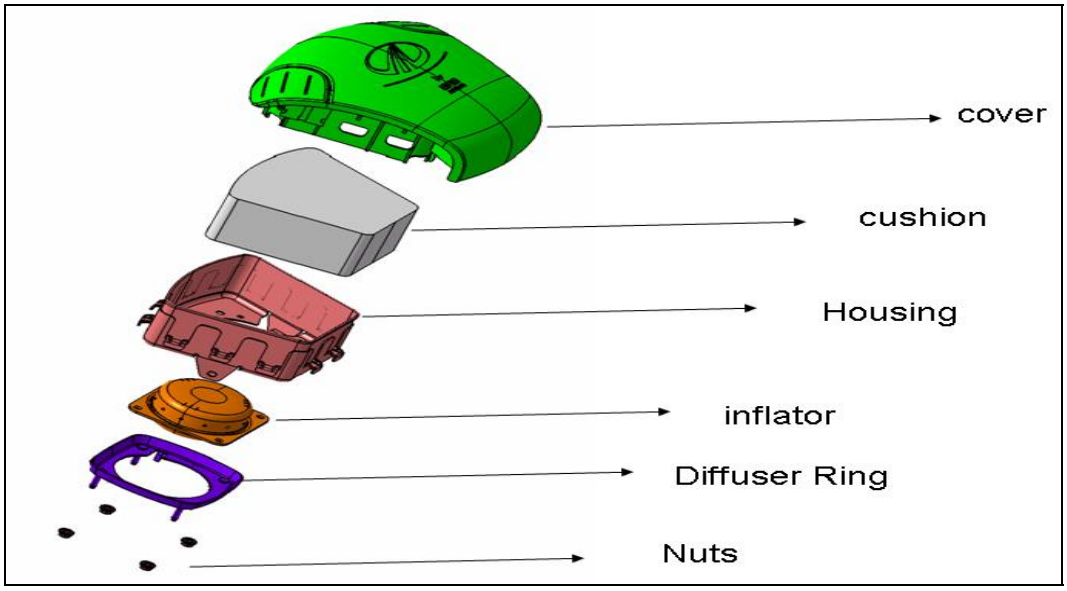
- Carefully inspect any SRS part before you install it. Do not install any part that shows signs of being dropped or improperly handled, such as dents, cracks or deformation.

- Before removing any of the SRS parts (including the disconnection of the connectors), always disconnect the SRS connector.

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Driver Air Bag (DAB)

Exploded view of Driver Air Bag



Description

The Driver Air Bag Module sits centrally as a complete unit in the steering wheel. At high speeds, the danger arises of being thrown against the steering wheel in the event of a crash, even if the driver's seat belt is fastened. The air bag protects the driver against collision with the steering wheel & thus alleviates the consequences of the accident. The deployment of DAB depends upon the severity and direction of the frontal collisions.

Note: The SRS front air bags are not designed to inflate for side or rear collisions, roll over or if it is involved in low speed frontal collision.

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Removing a fired DAB from vehicle

Most of the times, a fired airbag has to be removed from the vehicle after accident or inadvertent deployment - before installation of the new DAB.



Fig shows a fired DAB. Now before installing a new DAB the fired DAB has to be removed from the vehicle.

The following steps are to be followed when removing a fired DAB from vehicle

- Rotate SW until one of the holes on the side of SW is accessible.



- Using the appropriate Allen key tool, unscrew and remove the M6 socked head bolt from the SW.

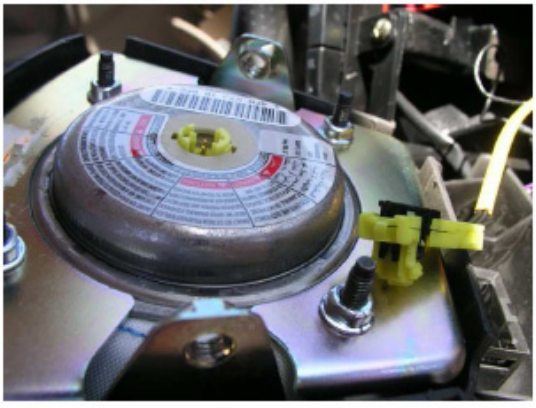
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- Turn the SW by 180 degrees to access the second bolt fixing DAB to the SW.
- Undo and remove the second bolt the same way as described above. **Note:** Two bolts once removed should not be reused as they are precoated with dry adhesive.
- Pull out and remove the DAB from SW.
- Lift up the black tab in DAB connector with a screwdriver. Pull off the connector and remove it from DAB.





- Discard the DAB; recycle metal and plastic components as appropriate.
- Wash hands with soap after completing the disassembly.

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Removing live (non-fired) DAB from vehicle

Note: - It is recommended that the person doing the task wears an antistatic wrist or ankle strap when handling a new airbag.

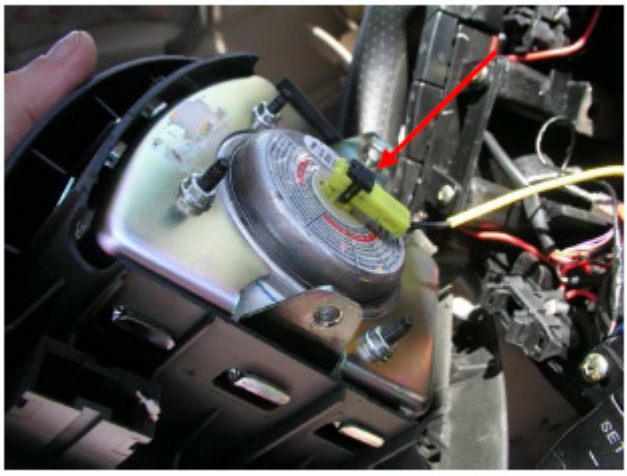
If the DAB in vehicle has not been fired, it has to be ensured that the **vehicle ignition key is in "OFF" position** before and during removing DAB from the vehicle. This is necessary in order to avoid resetting the "Airbag Fault" alarm. Apart from the above, please follow the same procedure of **"Removing a fired DAB from vehicle".**

Assembly Procedure of Driver Air Bag (DAB)

Note: It is recommended that the person doing the task wears an antistatic wrist or ankle strap when handling a new airbag.

The following steps are to be followed while assembling DAB in vehicle.

- Insert the DAB connector to the airbag. Assure the correct connector orientation is maintained, as per the below pictures. After inserting the connector, secure it by pressing the black tab.



Note: In case the DAB connector had been melted during previous airbag deployment, the DAB loom has to be replaced prior to airbag installation.

- Fit the DAB into the SW cavity, and align the 3 rectangular housings in DAB with horn switches in the SW.

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- Press the DAB to fit in the SW. Assure the 3 horn switches had engaged in the respective DAB housings.

- Rotate the SW until there would be access to one of the holes in the side of SW. Assure that holes in DAB and SW align correctly, or otherwise use the screwdriver to align them.

- Locate and insert M6 x 16mm long socket head screw into the hole on the side of SW. Torque to 10 +/- 1.0 Nm.

- Rotate the SW by 180 deg and assemble the second M6 x 16mm socket head screw the same way as described above.

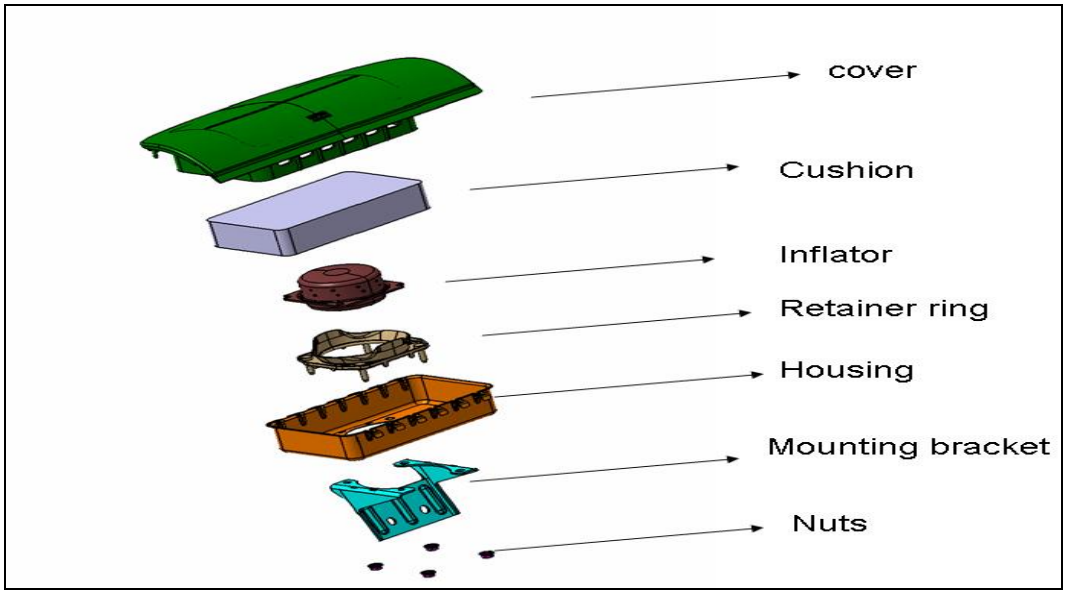
- Switch the ignition “on” and assure the airbag warning lamp in the instrument cluster is off.

- Assure the vehicle horn works correctly.

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Passenger Air Bag (PAB)

Exploded View of Passenger Air Bag



Description

The Passenger Air Bag (PAB) is located above the glove box compartment.
The PAB prevents the Co-driver from serious injuries in case of accident.
The deployment of PAB depends upon the severity and direction of the frontal collisions.

Note: The SRS front air bags are not designed to inflate for side or rear collisions, roll over or if it is involved in low speed frontal collision.

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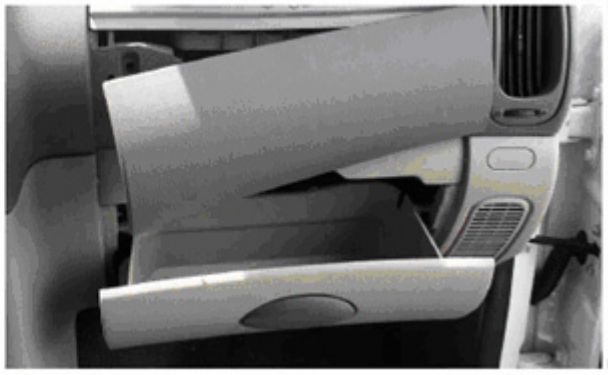
Removing a Fired PAB from vehicle

Usually the PAB has to be removed from the vehicle after it has been fired upon accident or inadvertent deployment.

The following steps are to be followed when removing a fired PAB from the Vehicle:

- Lift the corners of Lower Cover PAB to undo the attaching clips. Use plastic or wooden tool for this task to avoid part damage. Remove the Lower Cover PAB from the Instrument Panel.





- Using the appropriate spanner, undo and remove the 2 x M8 hexagonal bolts fixing the PAB bracket to the vehicle Cross Car Beam

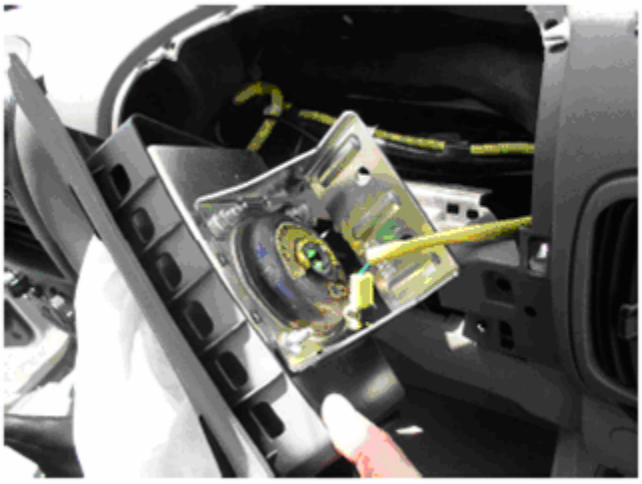


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- Lift the PAB Cover from the Instrument Panel and pull the PAB upwards to remove it from the Instrument Panel.



- Lift the tab from airbag connector and putt connector up to disconnect airbag loom



- Discard the PAB; recycle metal and plastic components, as appropriate.
- Wash hands with soap after completing the disassembly.

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Removing live (non-fired) PAB from vehicle

Note: It is recommended that the person doing the task wears an antistatic wrist or ankle strap when handling a new airbag.

If the PAB in vehicle has not been fired, ensure the **vehicle ignition is OFF** before removing airbag loom connector from the airbag. Ignition has to be also kept OFF all the time during assembly and re-assembly – to avoid resetting the "Airbag Fault" alarm. Apart from the above, please follow the same procedure of **"Removing a fired PAB from vehicle".**

Assembly Procedure of Passenger Air Bag (PAB)

Note: It is recommended that the person doing the task wears an antistatic wrist or ankle strap when handling a new airbag.

The following steps are to be followed when installing PAB in the vehicle:

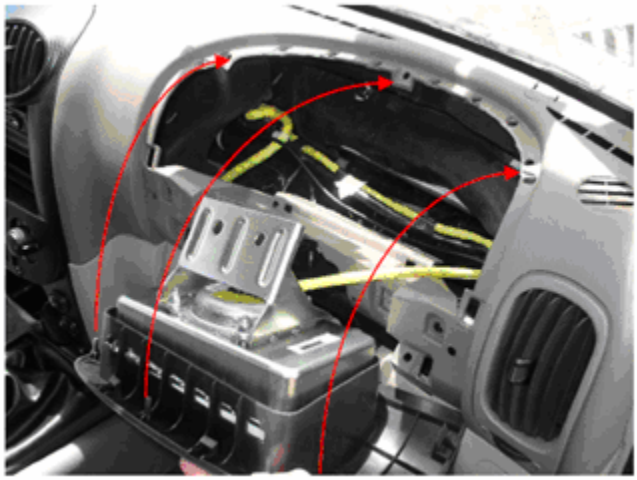
- Insert the PAB connector to the airbag. Assure the correct connector orientation is maintained, as per the below picture. Lock the connector by pressing black tab.



Note: In case the PAB connector had been melted during previous airbag deployment, replace the whole airbag loom affected.

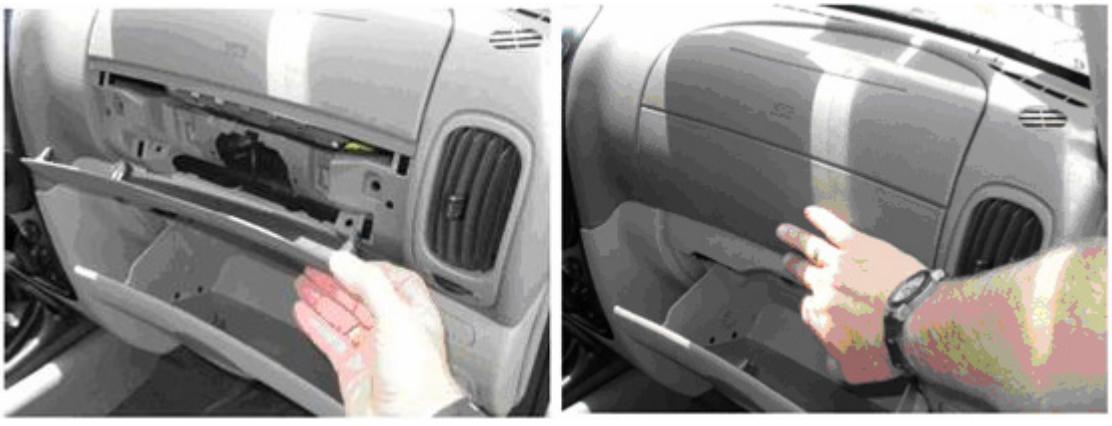
- Place the PAB into the cavity in Instrument Panel. Align 3 location studs in the PAB cover with relevant holes in Instrument Panel. Push the PAB Cover down to fit into Instrument Panel.

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- Locate and insert two M8 socket head screw into the holes in PAB bracket.
  Torque Specification: 18 +/- 2.0 Nm.

- Align and press to assemble the Lower Cover PAB to the Instrument Panel.



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Shipping

Shipping of the Pyrotechnic assemblies

Pyrotechnic assemblies are considered Hazardous Materials. Persons shipping Hazardous Materials must be properly trained and must consult current published regulations to ensure conformance to all applicable regulations.

Packaging containing Pyrotechnics must be marked appropriately, displaying the “class” of the Hazardous Materials inside. The following picture is showing branding of the Hazardous Materials Class 9. Scorpio
Airbags and RP SB classify to this class.



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Storage

- General storage must meet state and local regulations.
- Store the SRS unit, the front impact sensor and the side impact sensors in a cool (less than 40 C/104 F) and dry (less than 80% relative humidity, no moisture) area.
- Keep inflators, modules and seat belt assemblies away from flame, water, and any chemicals that may degrade the assembly material.
- Inflators, modules and seat belt assemblies should be stored in the upright position in their original shipping container, if possible, until installation.
- Store damaged inflators, modules and seat belt assemblies in a dry place in limited quantities.
- It is important to store the discharged pyrotechnic inflator units in containers, which prevent precipitation (rain, snow, etc.), from coming in contact with the gas generant residue.
- Store the removed airbag on secure, flat surface away from any high heat source (exceeding 85 C/185 F).
- Never perform electrical inspections to the airbags, such as measuring resistance.
- Do not position yourself in front of the airbag assembly during removal, inspection, or replacement.

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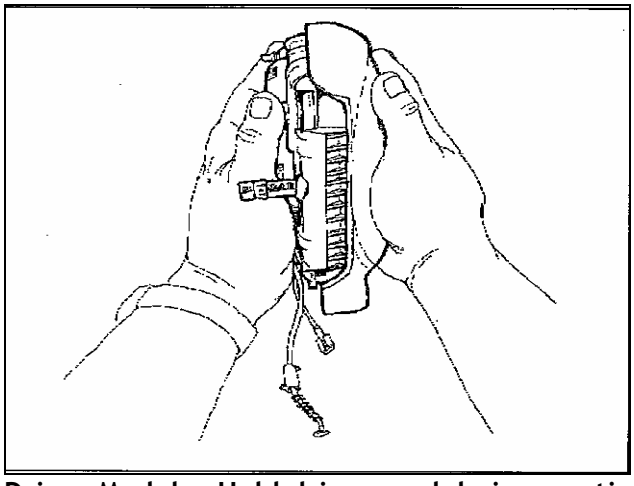
Handling of the Pyrotechnic assemblies

1. Undeployed Pyrotechnics
    a. Do not place any objects on top of Airbag Covers. These objects may become projectiles in case of inadvertent Airbag deployment.
    b. Wear anti static straps (foot or hand) when handling Pyrotechnics.
    c. Do not attempt to dismantle Pyrotechnics or their components.
    d. Do not apply electrical voltage to the Pyrotechnics terminals, especially if external loom is connected to the connector.

2. Deployed Pyrotechnics
    a. Wash hands after handling the deployed pyrotechnics.

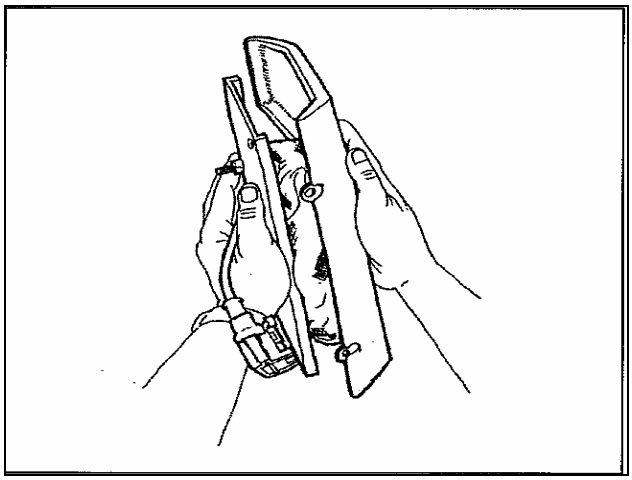
Proper Handling

Below are examples of the safest methods of holding Air bag modules

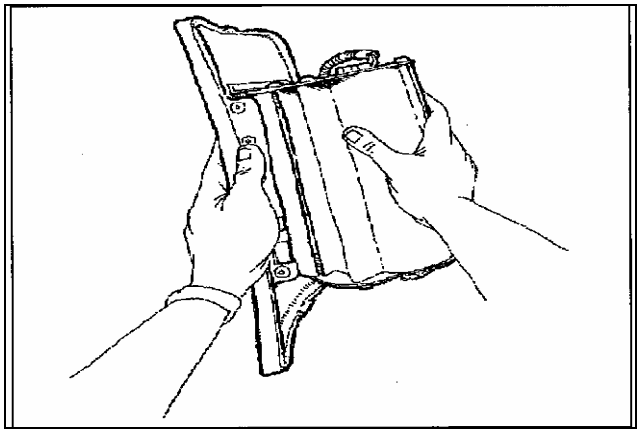


Driver Module—Hold driver module in a vertical position with right hand on cover.

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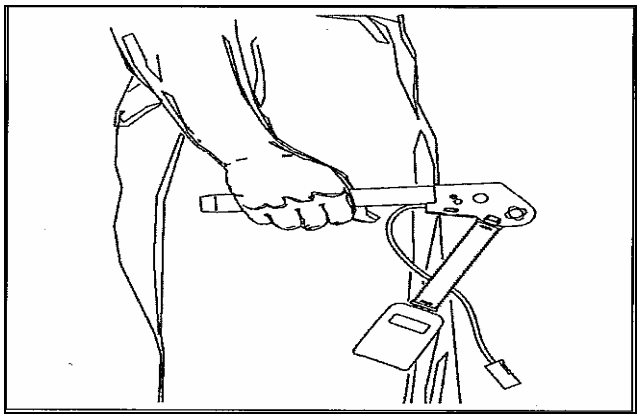


Knee Bolster—Hold knee bolster module in vertical position with right hand on cover.

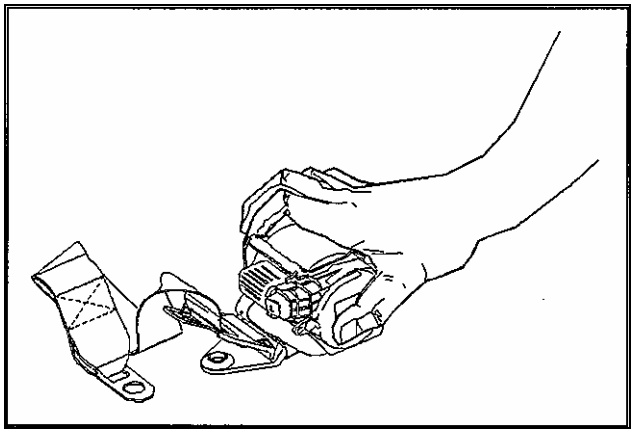


Passenger Module—Hold passenger module in vertical position with lead wires at top and left hand on cover.

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Seat Belt Pretensioner—Hold seat belt pretensioner by the round tube with the round tube end pointed away from the body and the buckle pointing down.



Seat Belt Retractor—Hold seat belt retractor by gripping the end caps or sides of the retractor.

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Dos & Don'ts for Air Bag System

Do's

- Do store modules in an upright position.
- Do keep modules dry.
- Do carry modules with the cover side pointing away from the body.
- Do place modules with their cover side upwards.
- Do carefully inspect modules for damage.
- Do stand to one side when connecting modules.
- Do make sure all test equipment is properly calibrated and maintained.
- Do wash hands after handling deployed air bags.

Don'ts

- Do not store highly flammable material together with modules or gas generators.
- Do not store gas generators at temperatures exceeding 80°C.
- Do not store modules upside down.
- Do not attempt to open gas generator housing.
- Do not expose gas generators to open flame or sources of heat.
- Do not place anything on top of a module cover.
- Do not use damaged modules.
- Do not touch a fired module or gas generator for at least 10 minutes.
- Do not use any electrical probes on the wiring circuit.

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IMPORTANT SAFETY WARNINGS

- As the solid propellant burns, the airbag module may heat up and vent hot gas.



- Always wear gloves and safety glasses during handling of pyrotechnic devices.



- Because of peak noise levels during deployment of pyrotechnics, there is a potential risk to hearing. Always wear ear protection during deployment.

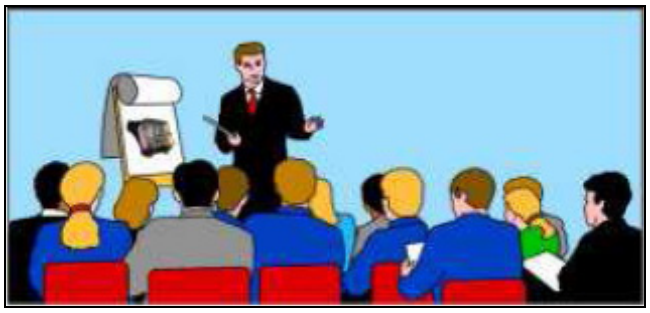


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- Always wash hands after handling deployed pyrotechnic devices.



- Deployment and associated activities shall only be performed by trained personnel.



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Frequently Asked Questions (FAQ)

Q: What are the concerns that need to be reviewed if handling inflators/modules in a processing facility?
Ans: Safe work practices should be reviewed to eliminate the potential hazards that may result in an unplanned deployment. Examples of potential hazards to review are:

- Electrical equipment and wiring that could come into contact with the connector lead wire or initiator pins.
- Possible pinch points that could damage or tear the lead wire
- Materials that buildup large amounts of energy (e.g. plastics) that could be discharged in the form of electrostatic energy
- High heat sources that exceed 1500 C

Q: What would cause an airbag to accidentally discharge?
Ans: The probable causes are as mentioned below:

- Introduction of an electrical energy source
- Heating the metal airbag inflator canister to a temperature greater than 150° C
- Drilling, sawing, puncturing, and shearing in the igniter/squib area.

Q: How much force does it take to puncture an inflator wall?
Ans: The airbag inflator vessel wall thickness and pressure containment specifications are such that the force required to puncture the inflator wall is likely greater than would be experienced under reasonable handling conditions on a production line. Power equipment (e.g., robotics, drills, pisses, metal shears, etc.) may be able to puncture the inflator wall. Care should be taken to prevent unplanned or unsafe acts by power equipment or external penetration of the inflator wall.

Q: What is the cooling time of the inflator if one deploys?
Ans: The airbag module attachment components can be handled within minutes following deployment. When handling inflators, you should allow up to 45 minutes cooling time in order to handle it without the hazard of burning the skin (<40° C).

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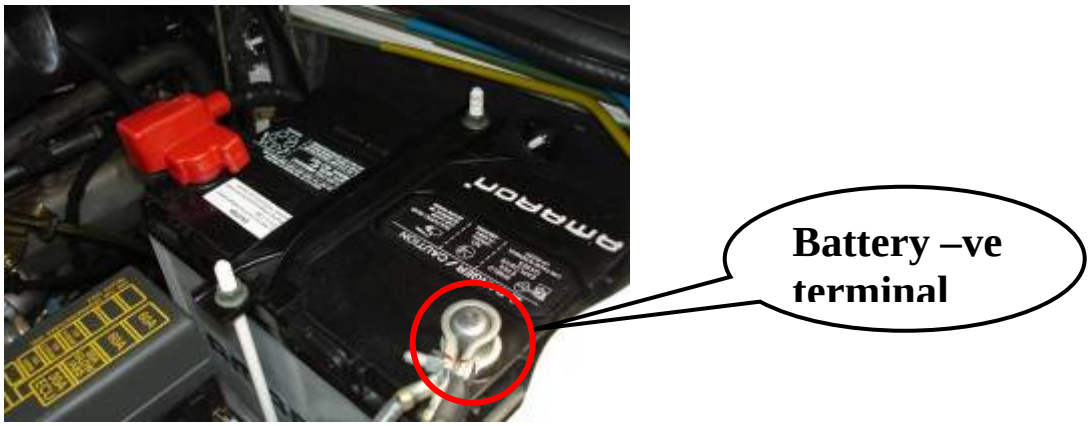
Procedure for checking Clock spring Continuity and replacement

To remove the clock spring for continuity checking follow the below steps:

1.) Crank the engine for making the front wheel in straight direction.
2.) Start rotating the steering wheel to extreme left.
3.) From extreme left, Start rotating the steering wheel to extreme right. This total travel will complete 3.5 rotations of steering wheel.



4.) From extreme right side, start rotating the steering wheel for 1.75 turns to left side.
5.) This 1.75 rotation (which you have done in step 4) confirms that the steering wheel is in center of the vehicle.
6.) Stop the engine.
7.) Disconnect the Battery negative terminal.



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8.) Remove the Horn Pad by removing the screws on either side as shown in photo.





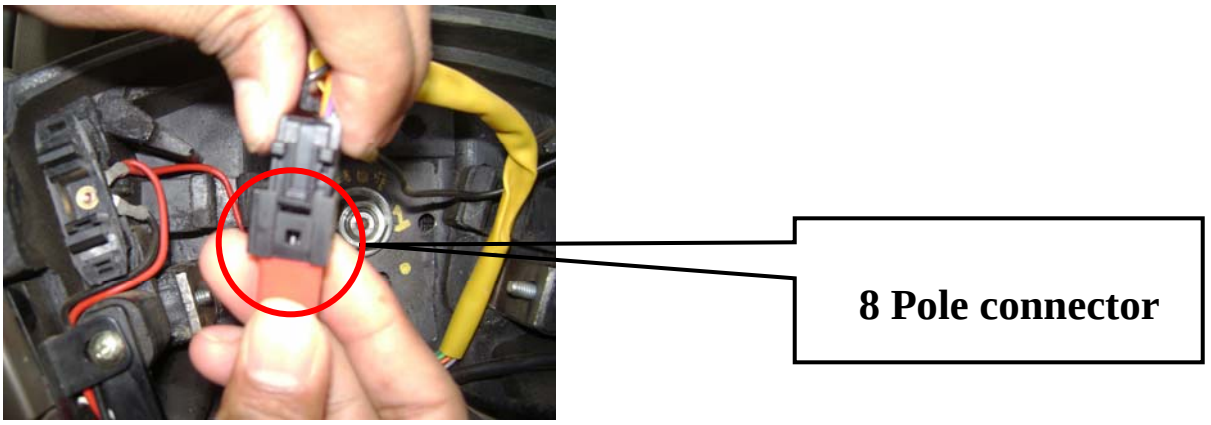


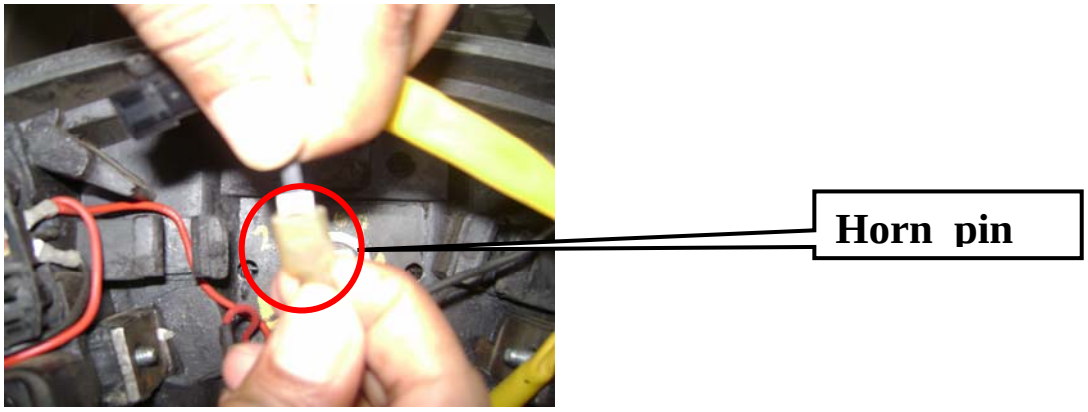
9.) Remove the Squib connector of DAB as shown.



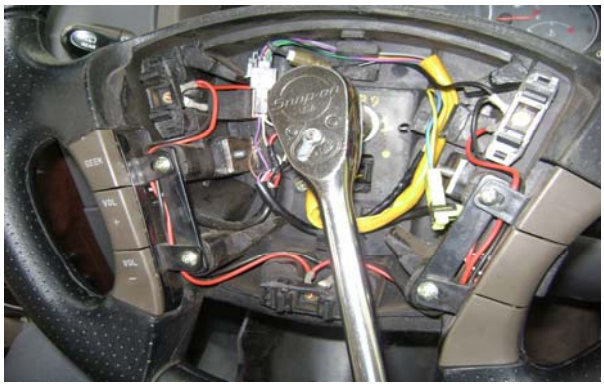
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10.) Unplug the 8 Pole connector (Clock spring Vs steering wheel switches) & Horn terminal.





11.) Loose the steering wheel nut and remove the same from steering rod.



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12.) Remove the steering wheel from steering rod. At most care to be taken while removing the steering wheel that the connector of clock spring should not get entangled in Steering wheel cutout.(Please ref. the attachment)



13.) Remove the connector from steering wheel slot carefully.



13.) Remove the 5 screws that fasten the shroud.

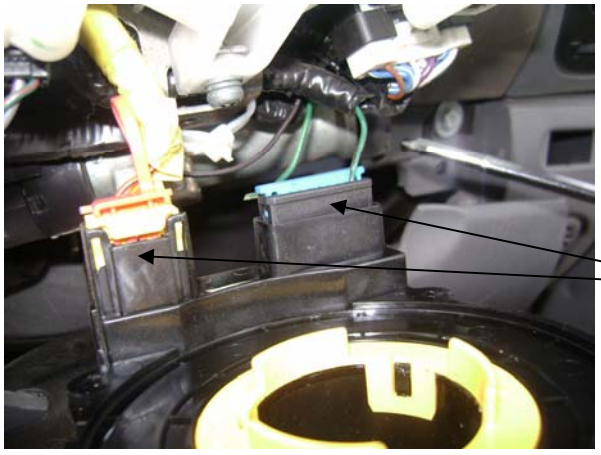


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14.) Remove 4 screws of Clock spring which holes the clock spring on combination switch.



15.) Unplug the wiring harness connectors which goes to Clock spring at bottom side of Clock spring.

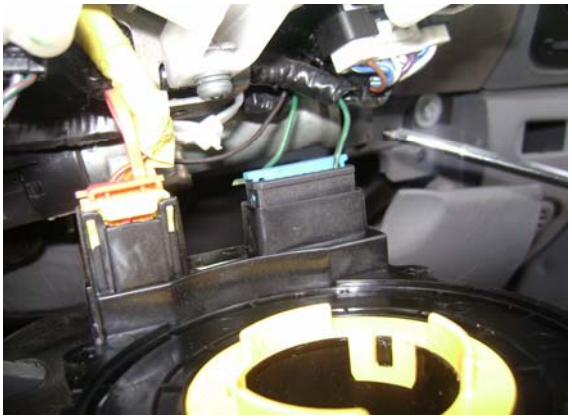


16.) Check the continuity of clock spring as per below mentioned.
17.)If found any discontinuity in any circuit like Cruise, Audio ctrl, Horn & airbag. Replace new clock spring.



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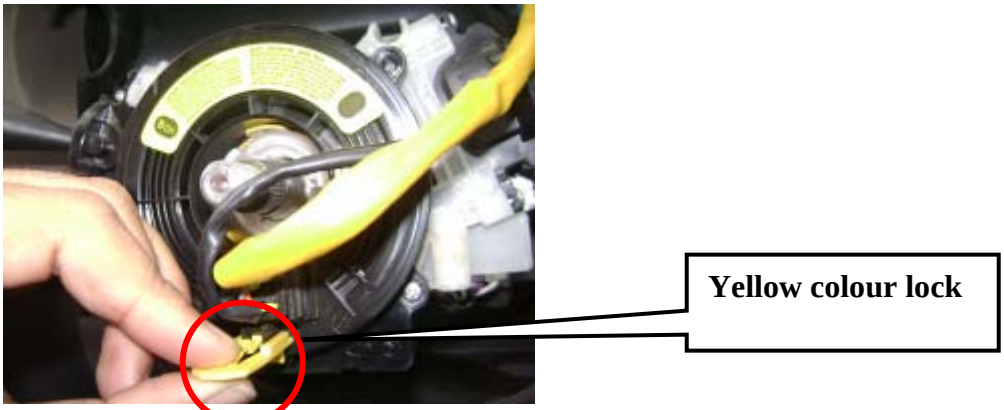
18.) Connect 8 Pole & 4 pole connector of wiring harness to clock spring



19.) Tighten the clock spring with four screws with 4 Nm torque.



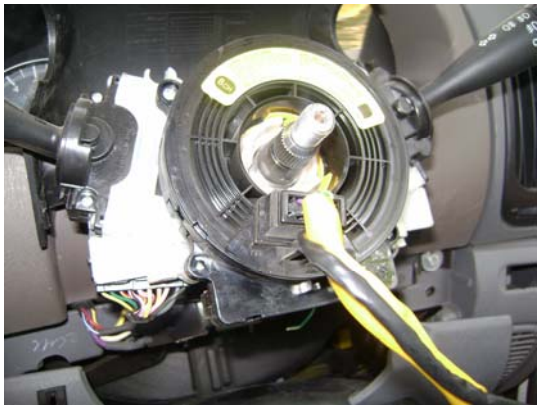
20.) Remove the yellow colour lock. Clock spring has total 5.7 rotations. This Yellow lock defines the center position of Clock spring. I.e. after removing the Lock, clock spring will have 2.5 rotations on right side& 3.2 rotations on left side.



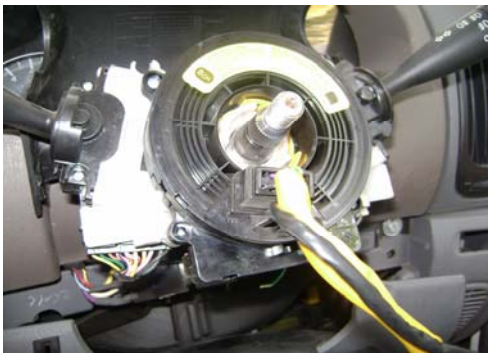
Note: If this lock is already found broken / missing. Then to define center position Of clock spring follow the steps from 21 to 24.

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21.) Hold the clock spring rotor wire in hand as shown below & Start rotating to extreme Left in anticlockwise direction.



22.)From extreme left point start rotating the rotor to extreme right in clockwise direction. Clock spring will complete 5 rotations from extreme left to extreme right.



23.) From extreme right start rotating the rotor for 2.5 rotations in anticlockwise direction.
24.) This point defines the middle position of the clock spring. With this we can ensure that clock spring will have 2.5 rotations on right side & 3.2 rotations on left side.

25.)Fix & press the shroud and fix with the help of 5 screws.

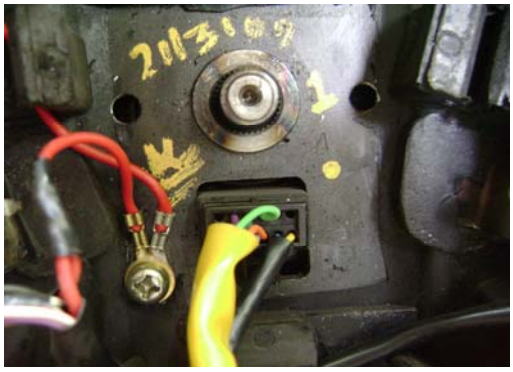


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26.) Place the steering wheel on the steering rod. While placing this steering wheel ensure 8 & 4 pole connector of clock spring to taken out from slot provided on steering wheel along with complete wiring harness.



27.) Locate the steering wheel slot in clock spring grommet.



28.) Tighten the steering wheel nut. Make sure that the steering wheel is in straight ahead Position with front wheels.



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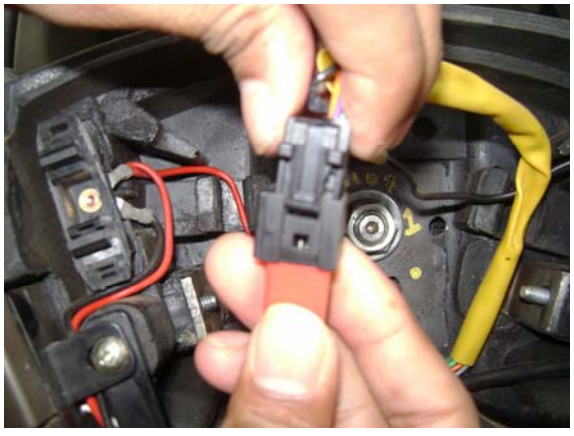
29.) After tighten the nut, route the wire through guidelines as shown.

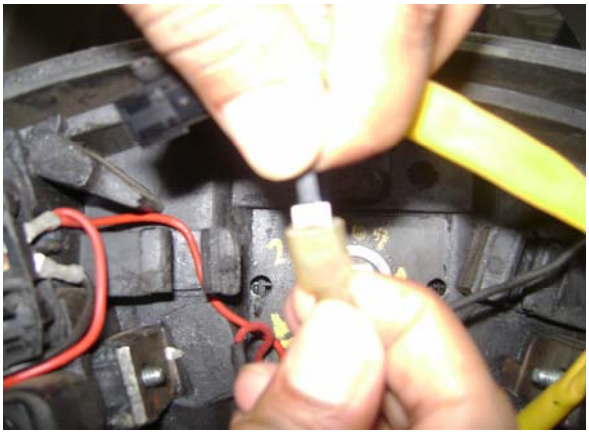






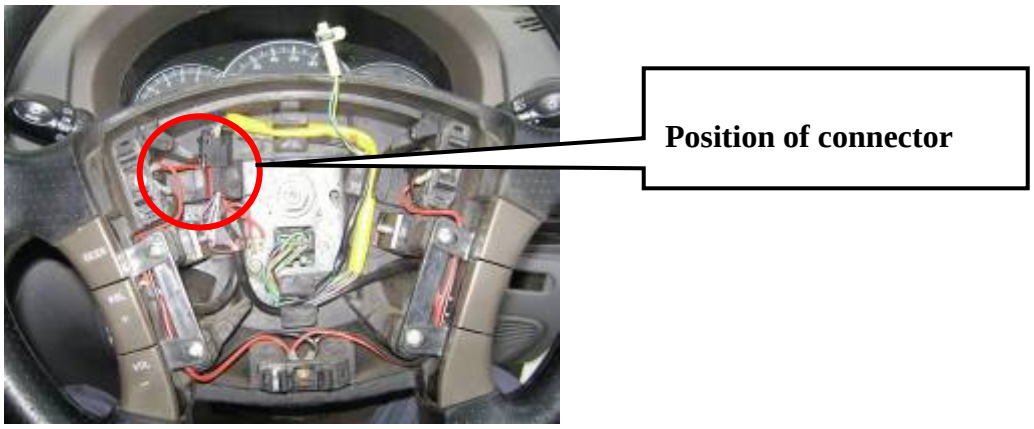
30.) Make the connection of 8 pole connector & horn pin.





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31.) After connection route the connector as shown.



32.) Connect the DAB squib connector to the DAB.



33.) Place the horn pad.



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34.) Tight the DAB screws with LN key.





35.) Re-connect the battery negative terminal to Battery.

36.) Verify that the horn works.

37.) Turn ON the Ignition and check the Audio Control through steering wheel switches Functions.

Note: Whenever the Battery is disconnected driver door power window auto function is Disabled.

35.) Start the engine.

36.) Learn the power window regulator as per procedure mentioned in Smart power window.

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Immobilizer

Contents

Definition

System components involved

Immobilizer System Work Flow.

Learning.

DTC – explanation.

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Description -

Immobilizer is Vehicle safety system against Vehicle Theft. Vehicle should not run of its own power incase of un-authorized usage. Safety against the vehicle theft even if the access into the vehicle is gained. Immobilizer is a major security device to prevent the vehicle being operated by an un authorized person. An electronic immobilizer is part of
the engine control unit (ECU), and prevents the vehicle from being started unless it recognizes signals from a right remote key.

Advantages -

- Enhanced security
- Immobilization through Engine Management system.

Integrated Key with transponder chip

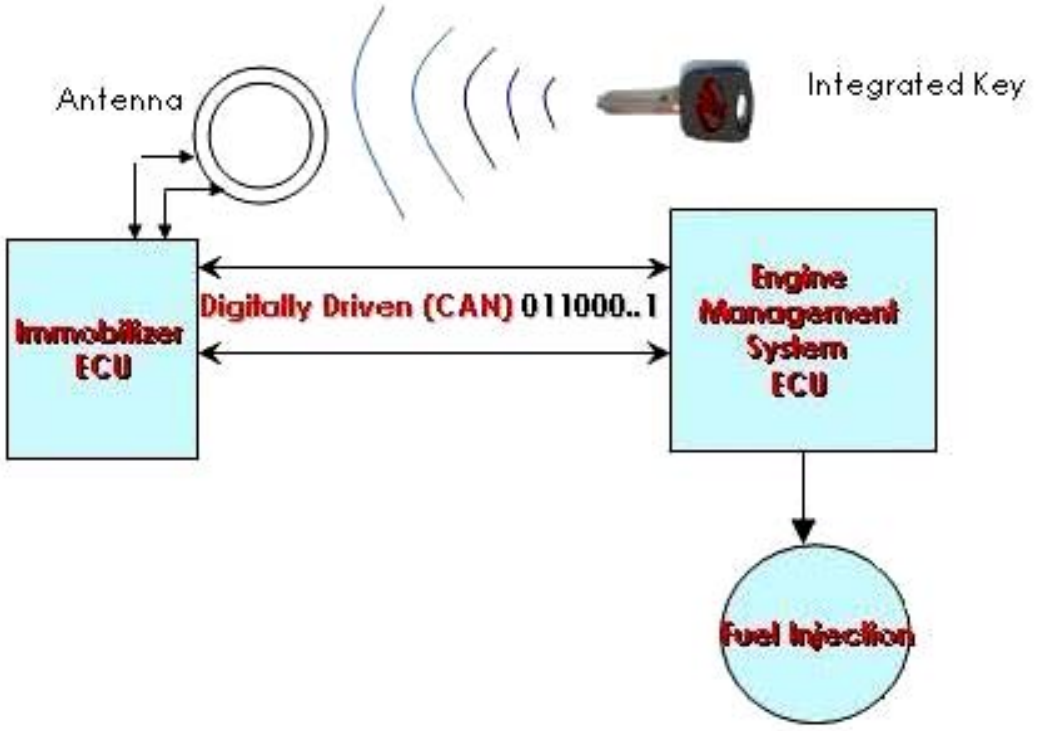


Immobilizer ECU (ICU)



Engine Management ECU (EMS ECU)

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Transponder consists of –

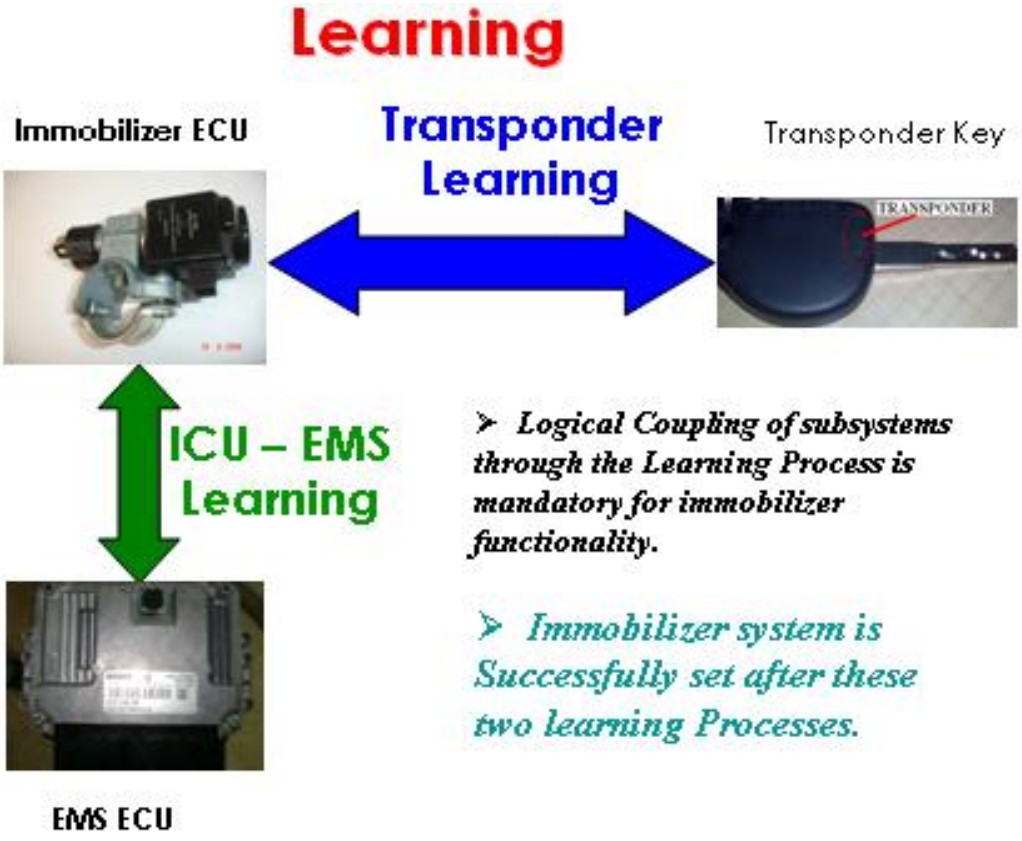
- **Chip without battery.**
- **Glued into the key fob.**
- **Communicates with ICU through RF.**
- **Each Transponder is configured with Mahindra specific codes during the manufacturing.**
- **Only the Mahindra Specific Transponder can be used with Immobilizer.**
- **Identified by unique 32 bit Identifier.**

Immobilizer ECU (ICU) is –

- **Fitted in the IGN lockset.**
- **Securely Communicates with the Transponder and identifies the validity of the transponder through RF.**
- **ICU will communicate only to the Mahindra specific transponders.**
- **Securely communicates to the EMS and conveys the key status information over CAN.**
- **Securely communicates with the ICU and identifies the valid Immobilizer ECU.**
- **Based on the key status it starts/ immobilizes the engine.**

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Immobilizer System Work Flow



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ICU - EMS Learning



- Immobilizer ECU to be learned with EMS and Vice versa.
- Use Learning Tool + Python to perform the learning.
- This learning is to be done in case of Immobilizer ECU OR/AND EMS change
- Change in dataset may influence the Learning again

Transponder - Learning



- Use the Learning Software application + Python to perform the learning
- This learning is required when Immobilizer ECU / Key is changed

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DTC-

Code	Label
90A0	Key is rejected by the Immobilizer ECU
90A1	Invalid Transponder password is found
90A2	No response from EMS ECU
90A3	No EMS ACK after signature mismatch
90A4	Mismatch in checksum 1
90A5	Mismatch in checksum 2
90A6	Mismatch in checksum 3

Serviceable Elements-

	Replacements			Learning to be repeated	
Services	ICU	Keys with lockset	EMS	Transponder learning	ICU - EMS learning
Key change		YES		YES	
ICU Change	YES			YES	YES
EMS Change			YES		YES

Refer to the Diagnostic Manual on Immobilser for further details on the Structure, Learning & Error codes.

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Audio System

Contents

Description

Layout and Location of controls

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Description –

Audio control on steering wheel allows the driver to operate the audio system without any disturbance and movement, while driving the vehicle. **The system has four switches** which are mounted on Steering wheel.

1. SEEK (Scanning the different radio frequency, changing the track in case of CD)
Press the SEEK switch once to go up by 0.05MHz on the radio station frequencies.
Press the seek switch continuously for more than 3 Sec for AUTO Scan of radio Station.
In CD/SD CARD/ USB modes, next track can be played by pressing the switch once.

2. VOLUME + (Volume control)
To increase the volume by one point presses the VOL+ switch.

3. VOLUME - (Volume control)
To reduce the volume by one point press the VOL- switch

4. MODE: To switch between different modes in Audio system. There are five modes available in Audio. When MODE switch is pulled once, next mode is selected in the following sequence provided the required media are connected

- Tuner
- CD/MP3
- SD Card
- USB
- Auxiliary



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General Features-

1. FM/AM/SD/USB /MP3/CD PLAYER/RECEIVER WITH AUX IN
2. 2DIN FIXED PANEL
   - Avoids Audio easy theft
   - Avoids Panel lost or broken problem
3. ROTATAORY VOLUME ENCODER (Endless Type)
   - Contemporary design
   - Easy to operate
   - Rubber Grip which surrounds the Knob provides good feeling
4. Illuminated Ring around Power/Volume knob
   - Better aesthetics
   - Convenience in Night for driver
5. FRONT ILLUMINATED AUX IN
6. 1 REAR PRE-OUT
7. LONG STROKE ILLUMINATED PANEL SWITCH/KNOBS
   - Contemporary design
   - Easy to operate
8. COVERED SD/USB PORT
   - Provides protection from dust & external abuse etc.
9. IN-BUILT steering switch function
10. CD IN SLOT- ILLUMINATED INDICATOR

Audio Section Features-

1. Maximum Output Power: 40WX4
2. BASS, TREBLE, BALANCE, FADER adjustment function
3. Preset DSP/TONE curves
4. Loudness ON/OFF function
5. Audio Mute

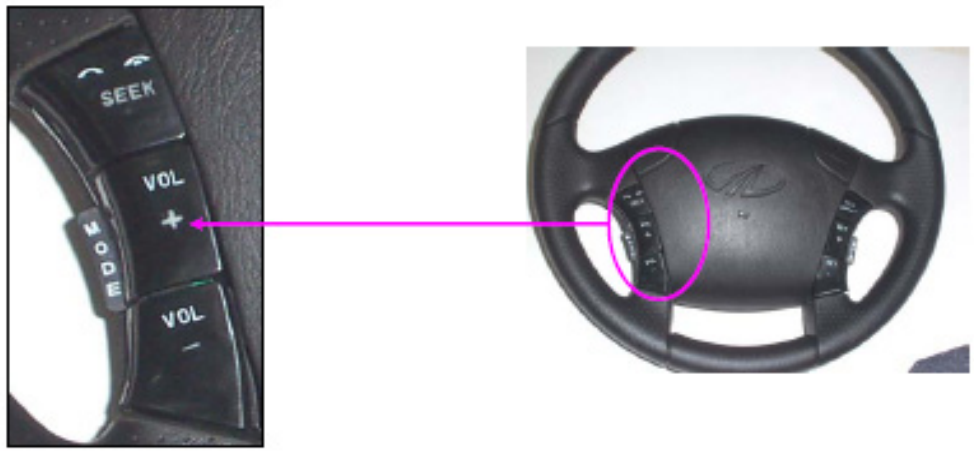
Tuner Section Features-

1. 2 FM(FM1 & FM2), 2AM(MW1 & MW2) Band, 1AUT band
2. 24 preset memories & 6 AUT memories
3. Manual & Auto Seek
4. Radio Preset Scan
5. Local/Distant Selection

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SD/USB/MP3/ CD Player Section-

1. Track/file UP/Down & Forward/Reverse Function
2. Track One Reset (Top Function)
3. Track/File Scan (Intro Function)
4. Track/File Repeat Function
5. Random track/file Play Function
6. Folder Up/Down Function
7. Fast Select for MP3 files
8. Information Function for Track/MP3 file Play back
9. Mute/Pause Function



AUDIO CONTROLS ON STEERING WHEEL

• Do not place the removed faceplate or the faceplate case in areas exposed to direct sunlight, excessive heat or humidity. Also avoid places with too much dust or the possibility of water splashing.
• To prevent deterioration, do not touch the terminals of the unit or faceplate with your fingers.
• To prevent a short circuit when replacing a fuse, first disconnect the wiring harness.
• Do not place any object between the faceplate and the unit.
• Applying spray cleaner directly to the unit or wiping the faceplate with a hard cloth or using a volatile liquid such as thinner may scratch the surface or erase characters.

Note -
1) Press the Power ON/OFF button available on face plate to TURN ON/OFF the Audio system. Turning ON /OFF of Audio system is not available on Steering wheel switches.
2) In case of non functioning of Audio Control through steering wheel switches, Audio can still be operated either through Face plate or Remote.

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Cruise Control

Contents

Introduction

Description

Care of the system

Electrical Circuit Diagram

Diagnosis

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Introduction

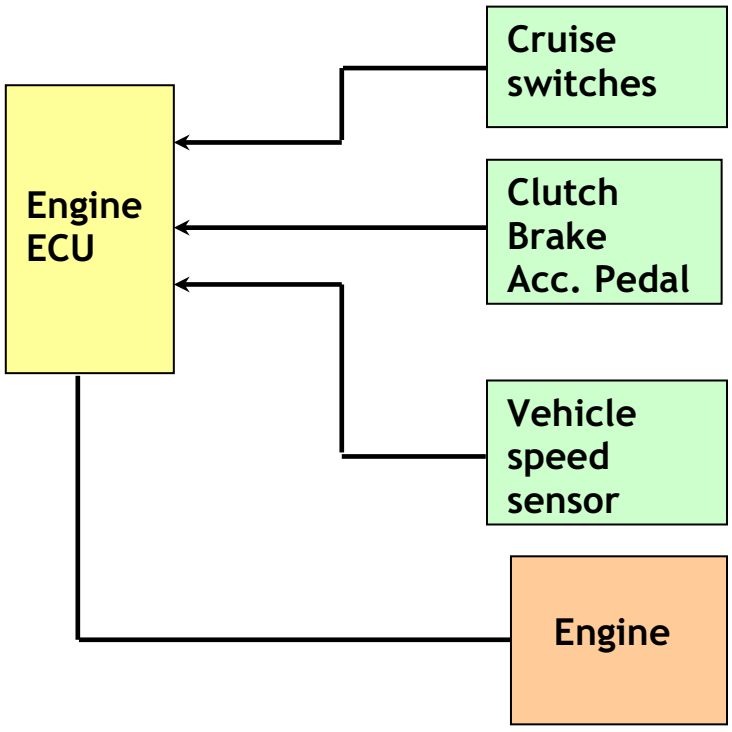
Cruise control known as **speed control** or **Auto cruise** is a system to automatically control the speed of the vehicle. It enables the driver to maintain a constant road speed without using the accelerator pedal. To activate cruise, the vehicle speed must be greater than 40 km/h and engine speed should be greater than 1200 rpm.

Need for the feature -

- Its usefulness for long drives across sparsely populated roads results in better fuel efficiency.
- To maintain the lane speed limit.

Operating Principle -

Cruise Control system works on the closed loop system principal. System controls the fuel injection of Engine depending on the feedback signal of speed of the vehicle, to maintain the SET speed of vehicle.



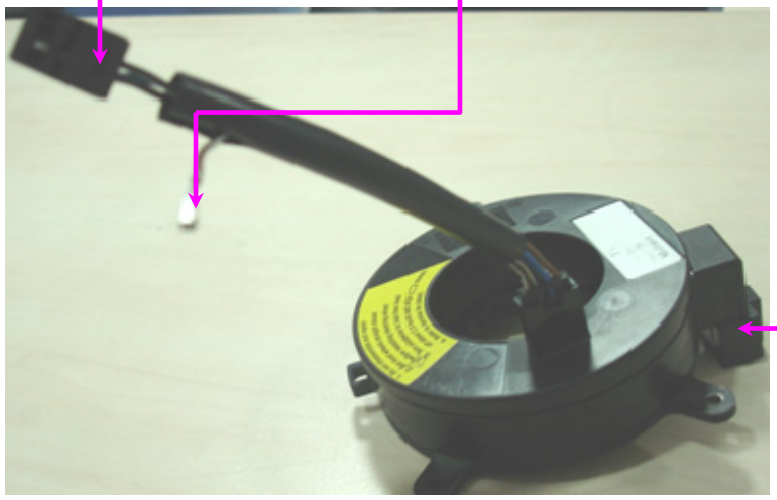
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System Description -

1. Switches on steering wheel.
2. Clock spring (Communication link)
3. Electronic Control unit (ECU)







Clock spring

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The system has four switches -

Press SET+ to go into cruise mode.

1. **SET (+) To increase the set cruising speed -**

   - Press and hold the SET (+) switch.
   - It will increase the speed of the vehicle by 1.5Km/hr, while vehicle is in Cruise mode.
   - While in Cruise mode, if pressed continuously, vehicle speed increases by 1.5Km/hr. e.g. if vehicle is running at the speed of 70 Km/hr in cruise mode ,on pressing set (+) once ,speed will increase by 1.5 km/hr, if press continuously the speed will also increase continuously in steps of 1.5 km/hr.
   - Release the SET (+) switch as soon as the desired cruise speed has been reached.

2. **SET (-)To reduce the set cruising speed –**

   - Press and hold the SET (-) switch.
   - It will decrease the speed of vehicle by 1.5Km/hr, while vehicle is in Cruise mode.
   - While in Cruise mode, if pressed continuously, vehicle speed decreases continuously by 1.5Km/hr. e.g. if speed is 70 km/hr on pressing cruise (-) once, speed will decrease by 1.5 km/hr, if press continuously the speed will also decrease continuously in steps of 1.5 km/hr.
   - Release the SET (-) switch as soon as the desired cruise speed has been reached.
   - Do remember that cruise control system will not operate at vehicle speed below **40 km/hr.**

3. **RESUME/COAST (resume to the last preset speed) -**

By pressing the **RESUME/COAST** switch, the last set cruise speed can be resumed, provided the ignition switch is ON and the vehicle speed is above 40km/hr. e.g. If the user activates the cruise at 90 Km/hr & runs the vehicle. After some time, user deactivates or comes out from Cruise mode. Here if user wishes to have the same cruise speed (i.e.90km/hr), user may press RES/COAST button, which will re-activate the cruise mode and vehicle cruise speed will be maintained at 90km/hr

4. **CRUISE (Press "cruise" button to Disengage the cruise control)**

The purpose of this switch is to deactivate the cruise application by pressing the clutch or brake pedal, or when the cruise switch is pulled up.
The preset cruise speed in system memory will automatically get cancelled when the ignition switch is turned off.

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Clock spring (Communication Link) & Engine ECU

- All the Steering Switches are connected to Engine ECU through Clock spring.
- Clock spring is part of Steering & it acts as a communication link between switches and engine ECU
- Clock spring takes all electrical inputs signals from steering switches & feed to Engine ECU.
- Depending on various electrical signals from Switches, Engine ECU takes the respective action related to the cruise application

Overtaking the vehicle in cruise mode -

Cruise Control will not work in **1st Gear & reverse gear.**

2nd Gear or 3rd gear - ~30 km/hr
4th Gear or 5th gear - ~ 45 km/hr are the preferable speeds in each gear above which the Cruise Control can be comfortably operated.

If the foot is kept on Accelerator Pedal, then the Cruise Control function is overridden & the input is taken from the Accelerator.

If the Accelerator Pedal is released before 20 seconds, then the Cruise Control function will still be active & the system will return to Cruise Control mode. If the Accelerator Pedal is released after 20 seconds, then the system will not return to Cruise Control mode & the driver has to reactivate the Cruise Control if owner wants to return to the Cruise Control mode.

While driving with cruise control, never shift the gear to neutral [or] to other gears, without pressing the clutch pedal. Otherwise engine will over run.



- DO NOT use cruise control on slippery road surfaces (rainy/icy/snow-covered), up-hill / down-hill driving.
- DO NOT use in heavy traffic where a constant speed can not easily be maintained.
- If the SET PLUS button is pressed, the acceleration is felt to be too fast & vehicle goes beyond control , then press brake or clutch immediately for safety and to come out of cruise.

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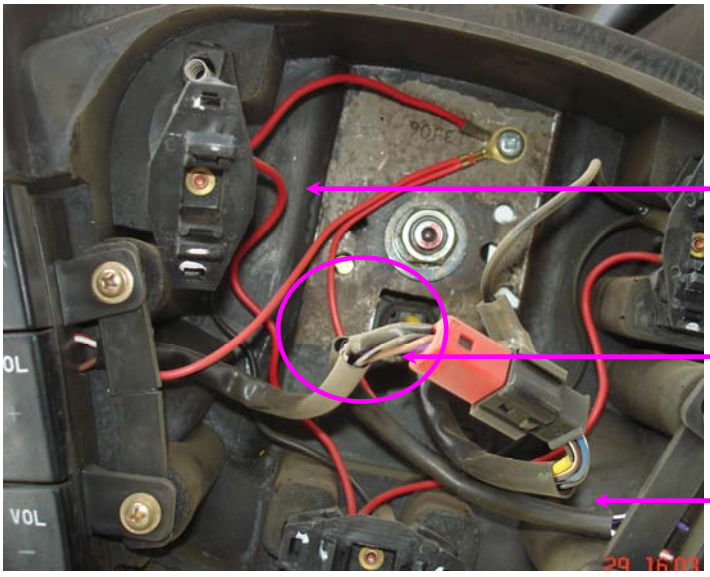
Care of the system-

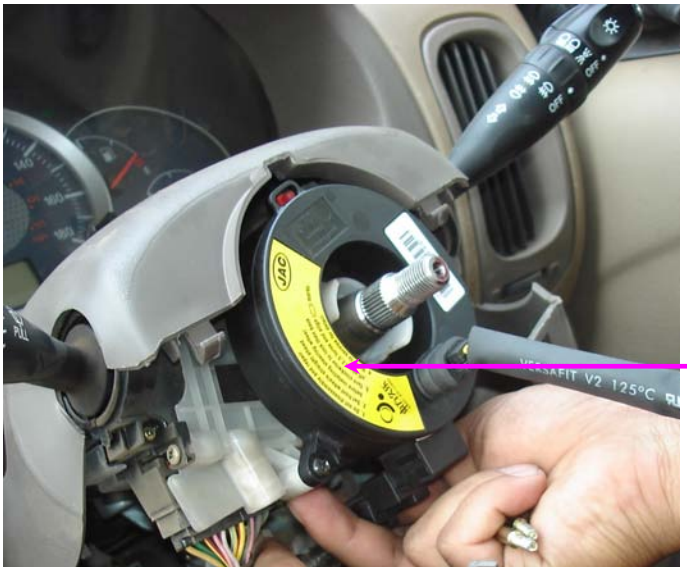
Though the system gives comfort on driving, driver has to be always in alert condition to avoid accident.

ALERT CONDITIONS -

- Unpredictable Obstacles
- Sharp Turns
- Steering control
- Drowsy Feeling

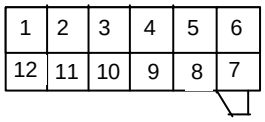
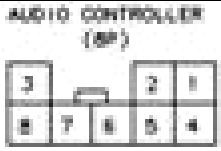
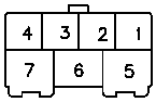
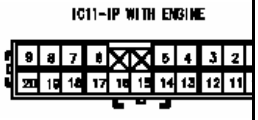
Electrical Layout & Location Of Cruise Units -





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CONNECTOR INFORMATION

Connector (Pole, Colour)	Connecting Wiring Harness	Connector Position	IC No	No. of Pins	M/F	Connector view
(8P, Black)	W/H IP	***Below horn pad***	-	8	F	
(12P, Black)	W/H IP	***Below horn pad***	-	12	F	
(8P, Blue)	W/H IP	***Centre Bazel***	-	8	F	
IC (5+2P, White)	W/H IP-Engine Room	***A-PILLAR RIGHT***	5	5+2	F	
IC (21P,Black)	W/H IP-Engine	***A PILLAR LEFT***	10	21	M	
IC (20P, Grey)	W/H IP-Engine	***A-PILLAR LEFT***	11	20	M	

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S. No.	Symptom	Reason	Cause	Action
1	Cruise mode not working or not getting deactivated.	1.Due to non availability of signal from clutch switch brake switch to ECU	1.Clutch switch faulty 2. Brake switch faulty	**How to check the CLUTCH switch:** • Check the voltage level between battery ground and at K58 (break out box). • Clutch press conditions no voltage i.e. open condition. • Clutch in idle i.e. not pressed it should be 12volt. If above (a) condition satisfy, clutch switch operation is ok or else switch is faulty. **How to check the BRAKE switch:** • Check the voltage level between battery ground and at K17 & K 80. • Brake in press condition voltage should be 12 volt & when brake in idle condition open condition i.e. absence of 12 volt. • If above condition satisfy, brake switch operation is ok or else switch is faulty
2	Cruise mode not working or not getting deactivated.	1. Due to non availability of signal from steering switches	1. loose connection of clock spring connector and wiring harness connector 2. Clock spring damaged 3. Steering Switches faulty	1. pl check the proper connection of wiring harness connector to clock spring connector 2. pl check the clock spring if damaged replaced as per the standard procedure 3. **How to check the working of steering switches:** • pl connect the brake out box at Engine ECU wiring harness. Do not connect the other end of brake out box to the engine ECU. check the resistance value between K35 & • k32 (resistance w.r.t to each switch is given in below table.if particular switch or all switch do not satisfy the condition mentioned in table

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				• Pl. change the steering switch assembly with new one.
3	Cruise is not getting activated	Due to non availability of signal from Vehicle speed sensor	1.loose connection of speed sensor connector 2.Speed sensor faulty	1. Pl check the proper connection of speed sensor connector and vehicle wiring harness connector. **How to confirm the speed sensor faulty:** • Pl run the vehicle to see whether the cluster shows the speed of vehicle if yes vehicle speed sensor is said to be ok. If not change the speed sensor and check with the same procedure. • Once cluster shows the speed of vehicle, service engineer can check the cruise mode as per the procedure.

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TABLE for checking the resistance value w.r.t Steering switches -

S.No.	Switch	Switch condition	Resistance in ohms
1	All in idle condition	Not pressed	4330 +/- 5%
2	SET+	Pressed	810+/- 5%
3	SET-	Pressed	420+/- 5%
4	Cruise off	Pressed	150+/-5%
5	Coast / RES	Pressed	1630+/-5%

TABLE for checking the voltage value w.r.t. Steering switches -

Voltage should be checked across K35 & K32

S.No.	Switch	Switch condition	Voltage in volts
1	All in idle condition	Not pressed	4.2 to 4.5volt
2	SET+	Pressed	2.6 to 3 volt
3	SET-	Pressed	1.8 to 2.2 volt
4	Cruise off	Pressed	.87 to 1.1 volt
5	Coast / RES	Pressed	3.4 to 3.8 volt

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Rain Light Sensor

Contents

Introduction
Description
Operating Principle
Electrical Layout
Fitment Procedure
Circuit Diagram
Diagnosis

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Introduction-

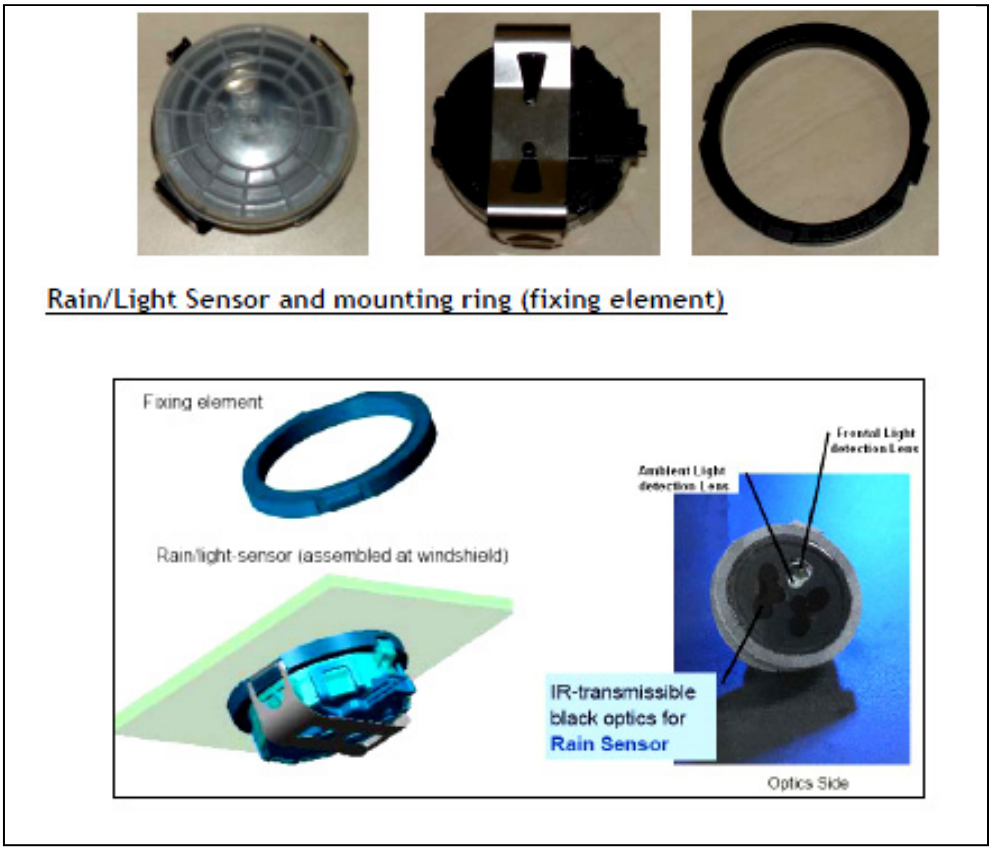
The primary applications of Rain Light Sensor are
1. Automatic Switching ON/OFF the wipers
2. Infinite control of the wiper speed relative to the amount of rain
3. Automatic Switching ON / OFF the headlamps in Low light/tunnel condition RLS provides luxury feature to customer by automatically controlling Wiper & Headlamp system.

Need for the feature
In adverse weather conditions, this rain sensor reduces the strain on the driver by automatically controlling the wiping process, Also light sensor is extremely useful in conditions like tunnel entry and low light condition in a day, thus increasing both driver comfort & safety.

System Description

The system consists of:
• RLS Sensor
• Mounting Ring / Fixing Element
• ECU / Gateway (nothing but a controller) which receives data from Sensor and accordingly activates & deactivates Wiping System & Head-Lamp System (located below Driver Seat)
• “AUTO LIGHT” and “AUTO RAIN” Switches on Centre Bezel

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Operating principle

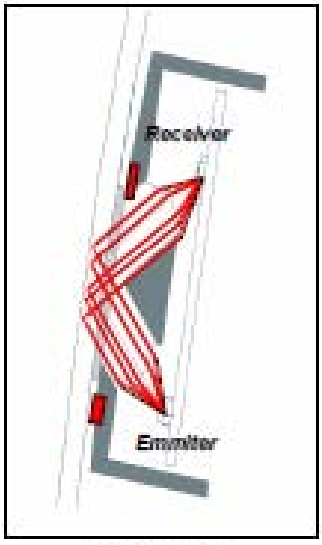
Light Sensing

• The ambient light detection lens picks up the light / luminous intensity in the vicinity of the vehicle.
• The frontal light detection detects the light / luminous intensity directly in front of the vehicle.
• With intelligent software algorithm & considering difference between ambient light detection lens & frontal light detection length accordingly Head-lamps will get On & OFF.

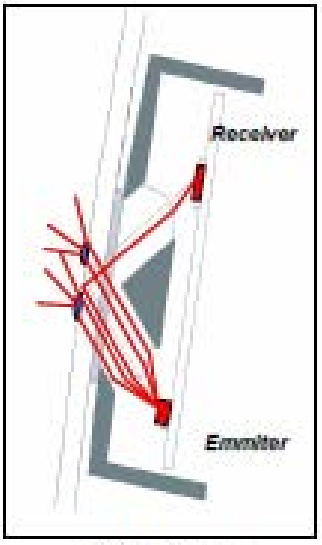
Rain Sensing

• This Rain Light sensor is based on the principle of reflection and refraction.
• This sensor has Emitters & Receivers.
• The sensor transmits infrared beams towards windscreen and light bounces back from surface of the windscreen to the receiver.
• The light bounces back from surface of the windscreen to the receiver.
• If water in any form sticks on the outside surface of the windscreen, it disturbs the Beams and microcontroller interprets the data and determines the wiping speed.

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Dry Windshield Reflection



Wet Windshield Reflection

RLS Operation -

1. Turn ON the Ignition
2. To activate the “AUTO LIGHT” feature, press switch with Auto light symbol
3. The orange **LED** on the switch will be continuously **ON** indicating that AUTO LIGHT feature is activated. To come out of the Auto Light we have to press the switch once again.
4. To activate the “AUTO RAIN” feature, press switch with Auto wiper symbol .

• Once “AUTO RAIN” mode is activated, system will give one WIPE on a Windshield and the orange **LED** on the switch will be continuously **ON** indicating that AUTO RAIN feature is activated.
• This feature will get deactivated either by turning off the ignition or pressing the AUTO RAIN button.
• In case of any damages / scratches to windshield, new sensor needs to be installed/ assembled.
• Old sensor can not be used on the new windshield as it is calibrated for a particular windshield.
• In case of any damage to Sensor, new sensor needs to be installed/ assembled at authorized service stations because sensor is a non-serviceable unit.
• Auto Head-lamps will remain “ON” until enough Light intensity is not available. Once enough light is present, after 5 Sec Head-Lamp will go OFF. This is a designed feature to avoid false Switching ON / OFF of Headlamp.
• Do not put any band/tape outside the sensor on windshield.
• Do not use any chemical to clean inner surface of front windshield to avoid any damage to the sensor.

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Limitations -

• There is a difference between Light intensity sensed by Sensor & by Human eye. It may possible in the evening time Head- Lamp will get on early as sensor senses it as a Low intensity.

This is absolutely a normal behavior. In case customer doesn't require Light, he can switch OFF “AUTO LIGHT” mode anytime.

• After sensing the water on windshield, wiping will start automatically. It might possible that after wiping initiated you cannot see water on windshield but still wipers will keep on

wiping. This is because of the mist present on windshield. Human eye cannot see that but Sensor can sense it & it will keep on wiping. This is absolutely a normal behavior. In case customer doesn't require Wipe, he can switch OFF “AUTO RAIN” mode anytime.

• Sensor cannot detect difference between water & mud, ice, snow, oil etc. In these cases sensor may not behave properly and customer can switch OFF “AUTO RAIN” mode manually.

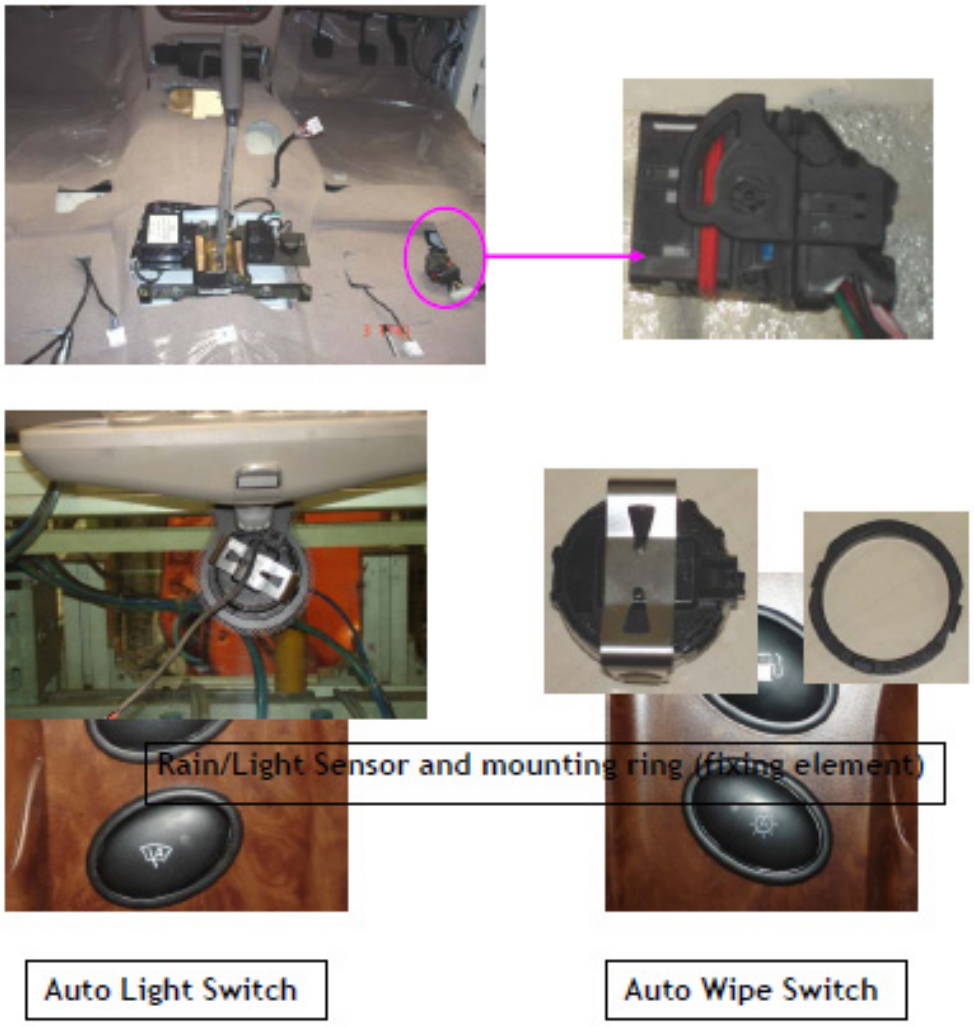
Follow me home lamp -

In order to help the driver / passenger, while getting out of the vehicle during night time, the headlight will light up for maximum 30 seconds. This feature will get activated only when “Auto Light” switch is pressed which is mounted on centre bezel. At low intensity, on turning off the ignition and door opening, this feature will get activated for 30 seconds.

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Electrical Layout & Location of RLS Units -

Auto Light Switch
Rain/Light Sensor and mounting ring (fixing element)



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RLS Sensor Fitment Procedure –





3. Take off the cover from the sensor

4. Position the sensor in the ring
=> No fingerprints on the Sil-gel!
=> Position the coding of the sensor into the recess of the ring
=> Position the sensor sloping at the windshield





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5. Press the sensor at the windshield



6. Snap the spring into the ring
=> Both sides of the spring
=> Important: 2 times a click-sound



7. Sensor mounted at the windshield



8. Plug in the connector to the sensor
=> Important: The connector must be plugged into the sensor **after** mounting the sensor to the windscreen



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RIGHT

The spring shall be pressed in the middle to be sure that the spring snaps perfectly into the fixing ring.





WRONG

If the spring is pressed at the edge, the spring will not snap completely into the fixing ring.





Typical bubbles after sensor mounting. These bubbles will disappear without any intervention. The air diffuses through the sil-gel.



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Diagnosis –

S. No.	Problem	Cause	Solution
1	No automatic Wiping after Rain start	• "AUTO" mode not activated • No Power to Controller	✓Check whether "AUTO" mode for RLS is activated. (Put left lever of Combination Switch in "AUTO" mode as marked on Lever) ✓Make sure all electrical connections (i.e. Controller, Sensor) are connected.
2	No automatic Head-Lamp Switch-ON after entering in Tunnel / Basement	• "AUTO" mode not activated • No Power to Controller	✓Check whether "AUTO" mode for RLS is activated. (Put left lever of Combination Switch in "AUTO" mode as marked on Lever) ✓Make sure all electrical connections (i.e. Controller, Sensor) are connected.
3	No initial Wipe after putting RLS in Auto Mode	• RLS Gateway connector is not connected. • RLS Sensor connector is not connected • Error in Wiper circuit	✓Check whether RLS Gateway is connected to W/H. ✓ Check whether RLS sensor is connected to W/H. ✓Check whether Wiper circuit is ok as per TC4 check list for Wiping System. ✓Check supply pin (Battery B+) for RLS Sensor. ✓Check Ground Pin of RLS Sensor. ✓Check crimping of Wiper in Connectors at Sensor & Gateway End.
4	In "AUTO" mode, Head-Lamps get switch-ON before time. (Roughly 20 Min early at Twilight Condition)	Sensor sensing limitation below 800LUX	✓This is absolutely OK behavior of Sensor. There is a difference between actual Human Eye Light (LUX) Sensing & Sensor Light (LUX) Sensing. ✓ Whenever ambient light intensity drops below 800 LUX, RLS will Switch-ON headlamps in Auto mode. ✓If driver / owner doesn't require Head-Lamp, he can come out of "AUTO" mode by shifting Left lever of Combination Switch.

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5	In "AUTO" mode Headlamps get Switch-ON in Low Beam only.	• As per design specifications	As per the Homologation requirement, ✓ **In "AUTO" mode Headlamps will always get Switch-ON in Low Beam.** ✓ **High Beam option is not available for "AUTO" mode.** ✓ If user / customer want to put Headlamp in High Beam, he can always manually Switch – ON head lamps by usual method and activate the same. **(Note: Once manually headlamps are ON, you are out of "AUTO" mode hence automatic wiping &automatic Head-lamp ON-OFF will not work).**
6	In daytime bright light condition, Headlamps remain "ON" after activating "AUTO" mode	• Manual Switch for Head-Lamp is ON. • RLS Sensor on Windshield is covered with Cloth /cardboard / Sun Film /any kind of shadow.	✓ Please check whether Manual Switch, for Headlamps is OFF at Right Leaver of Combination Switch. ✓ Please check whether RLS sensor is not covered with any Cloth / cardboard / Sun film / shadow
7	In Automatic Wiping condition, wipers doesn't wipe with Rain Intensity Speed.	• Dirty / sticky Windshield in Sensor Area	✓ Please check whether Windshield area above sensor is clean. It should be free form dirt, dust, oil, sticky material etc. ✓ RLS system is designed for Automatic Wiping as per Rain Intensity Speed. But user/ customer requirement will vary from person to person. ✓ At drizzling rain, some customer may not feel to Switch-ON wipers or some may feel that wiping is required. The wiping intensity is fixed for Optimum Speed pattern & it is fixed. The Customer can not change it. If he needs faster /

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			slower wiping, he can switch to Manual Wiping by going in high / Low Wipe mode.
8	In "Auto" mode though there is no water on windshield, wipers keep on wiping.	• High amount of moisture present in the air • Damaged Wiper Blades	✓ RLS Sensor is very sensitive in detecting water. In Rainy Season, after wiping water on windshield though we are not able to see the water on windshield, a thin layer in terms of moisture gets accumulated on Sensor area. This also detected by Sensor as Water and it keeps on Wiping. This kind of behavior is more common in Rainy Season since there is lot of moisture present in atmosphere. If require, in such condition user can manually switch-OFF Wipers by coming out of "AUTO" mode. ✓ Check the wiper blade for wear. ✓ If the wiper blade can not wipe the windshield uniformly and clearly, replace the wiper blade with new one
9	In "Auto" mode though rain intensity is less, wiper keeps on wiping for long duration	Damaged Wiper Blades	✓ Check the wiper blade for wear. If the wiper blade can not wipe the windshield uniformly and clearly, replace the wiper blade with new one.
10	Erratic Sensing for Rain & Light	• Air Gap developed Between Sensor & Windshield • Water / Dust / Dirt accumulated Between Sensor & Windshield	✓ Check whether there is any air gap between RLS Sensor & Windshield. ✓ Check whether any water droplet / dust / dirt is present between RLS Sensor & windshield ✓ For above both conditions, we need to replace complete sensor with New One.
11	RLS is sensing Rain only no Light or vice a versa.	• Error in Wiper circuit • Error in Head-Lamp	✓ Check whether Lighting System / Wiping System is ok as per TC4 checklist.

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		Circuit	
12	Erratic behavior in Snow / Fog / Smog.	• Snow/Fog/ Smog	✓ Snow / Fog / Smog is a form of Water. ✓ Sensor can not exactly differentiate between water & Snow / Fog / Smog. This is a limitation of RLS. In case of erratic sensing in such conditions, please Switch-OFF "AUTO" mode of RLS.

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Reverse Parking Assistance System

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Description –

Reverse Parking Assistance system is an indicating system, which detects the obstacle behind the vehicle above the ground level and alerts the driver with the distance and direction of the obstacle along with the alert sound while reversing the vehicle

Need for the feature -

- To indicate the driver about the obstacle behind the vehicle which cannot be viewed by normal IRVM and Side view mirrors while taking reverse.
- To avoid accidents of the vehicle while taking reverse.
- To avoid hitting the child playing behind the vehicle while reversing the vehicle.

Operating Principle -

It works on ultrasonic principle, In case of any obstacles lying behind the vehicle up to maximum distance defined from the rear bumper i.e. 120 cm, obstacle height should be 30 cm from the ground.

Sensor height (from the centre of the sensor) is above 57.8 cm from ground level in un laden condition and 44.5 cm in fully laden condition, waves get disturbed and are reflected back to sensor and sensor transmits the signal to ECU which converts data into Audio/Visual alarm to driver.
The audible warning begins when reversing vehicle from a distance of about 120 cm. The smaller the distance, longer will be the beep.

- High sensitivity
- - System automatically gets activated when the vehicle is shifted to reverse gear.
- The system generates both audible and visual warning on IRVM when the vehicle comes within 120cm of the obstacle.
- Display with car image in IRVM provides the distance in cm and the direction of the obstacle (left or right side of the vehicle)
- 3 sensors provide the maximum coverage across the width of the vehicle.
- Uses ultrasonic frequency for accuracy

Specifications -

- Operating temperature range: 35-110°C
- 3 detection zones: Less than 50, 50-70, 70-120 cm

Maximum Detection Distance –
1st zone: 120cm – 70cm – Green indication with corresponding distance
2nd zone: 70cm – 50cm - Green & Orange indication with corresponding distance
3rd zone: Less than 50cm – Green, Orange & Red indication with STOP indication.

System Description

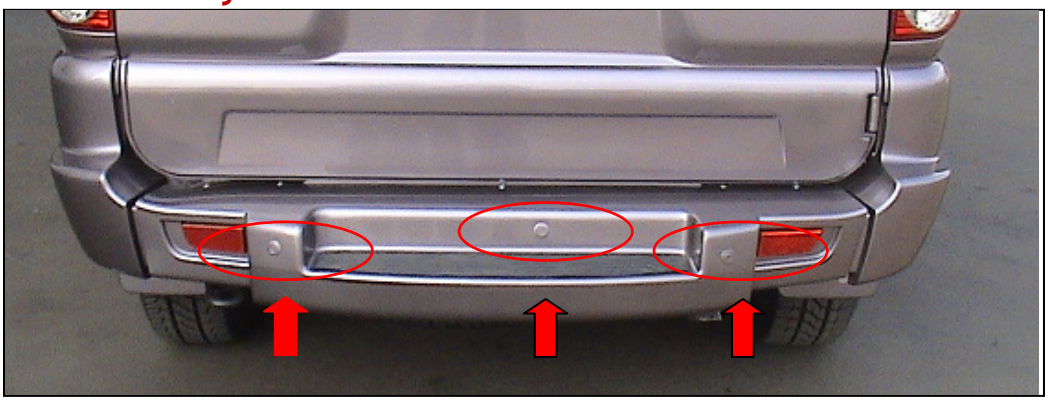
Reverse Parking Assistance system consists of:

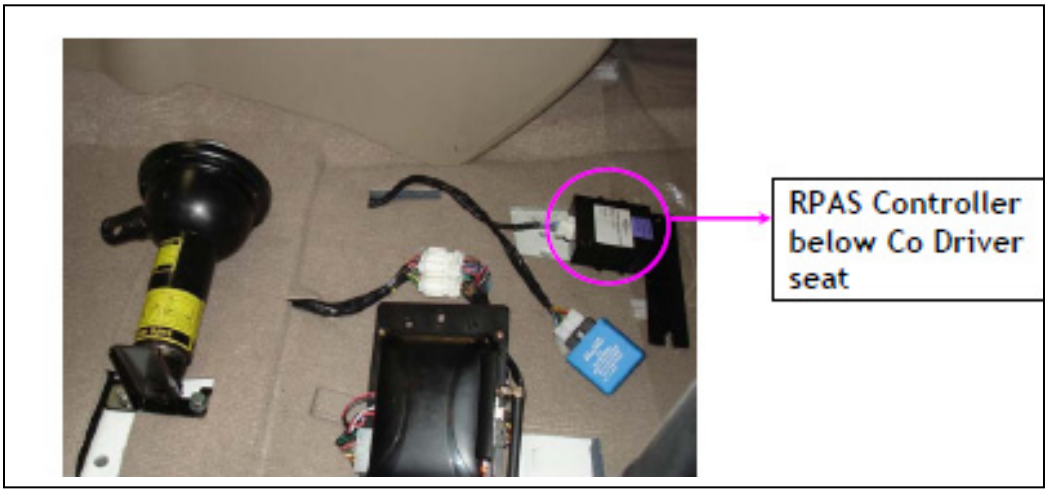
- Electronic Control unit (ECU)
- Sensors (3 numbers fitted at the rear bumper)
- Internal Rear View Mirror (IRVM) with car image and buzzer integrated.

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Electrical Layout & Location of RPAS Unit –

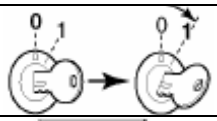




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RPAS Operation -

Step by step approach -

1		Turn ON the ignition
2		Car image will appear on the left side of the IRVM with **green** and **orange** indications blinking 3 times confirming the system healthiness.
3		Shift the gear to Reverse and move the vehicle slowly.
4		-If the obstacle is more than 120 cm from the rear bumper, then the system will not show any indication in the IRVM and it will not give any beep sound also. -No directional indication.
5		If the obstacle comes at 120cm or less from the rear bumper, system will start giving indication with beep sound to the user.
6		- If obstacle distance from the rear bumper is in between 120cm to 70cm - Directional indicator will blink **Green** in the corresponding direction of the obstacle and the distance will be displayed on right side of IRVM with the nearest multiple value of 5 like 75, 80, 85, 90, 95, 100, 105, 110, 105, 120. - Beep sound will come with longer interval between the beeps.
7		Obstacle in between 120cm to 70cm GREEN : Blink ORANGE: OFF RED : OFF
8		- If obstacle distance from the rear bumper is in between 70cm to 50cm, - Directional indicator in the IRVM will blink **Green & Orange** in the corresponding direction of the obstacle and the distance will be displayed on right side of IRVM with the nearest multiple value of 5 like 70, 65, 60, 55, 50. - Beep sound will come with shorter interval between the beeps.
9		Obstacle in between 70cm to 50cm GREEN : Blink ORANGE : Blink RED : OFF

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10		- If obstacle distance from the rear bumper is below 50cm - Directional indicator will be ON with **Green, Orange and Red** in the corresponding direction of the obstacle and the distance indicator will display **STOP** continuous beep sound showing danger beyond this point.
11		Obstacle in less than 50cm GREEN : ON ORANGE : ON RED :ON

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Limitations -

• System cannot sense the wire mesh, handrail or small objects.
• System will give wrong signal on reversing the vehicle on grasslands and bumpy roads.
• System cannot sense the obstacle like cotton or surface which absorbs supersonic easily.
• System may malfunction or may not function properly when the same frequency of the system (40 KHZ) supersonic sound is created by other systems like metal sound, high pressure emission rise or horn sound to sensor.
• The system may malfunction on a plain ground to ramp or vice versa
• System may give wrong signal by sensing the ground when the bumper is tilted more from the normal position.
• System operation is dependent on the reflection angle of the obstacle.
• System may give false alarm during the heavy rain conditions and during the snow conditions and heavy wind conditions.
• System may give wrong signal when the vehicle is in overloaded condition by sensing the ground.
• System will not sense the pot holes or the trenches or drainages which are below the ground level.



• This system is designed to be an aid and should not replace the need to drive carefully. Under no circumstances manufacturer will accept any responsibility or liable for any direct or indirect, incidental or consequential damage, or for any injuries resulting
from installing or use of this system.
• This system is not designed to prevent contact with small or moving objects. It is designed to provide a warning to assist the driver in detecting large stationary objects when moving in reverse at parking speed of approximately less than **5 Km/ Hr**.
• The reverse parking assistance system may have reduced performance or get activated during the inclement weather.
• To help in avoiding personal injury, always use caution when in reverse and when using the Reverse Assistance System.
• Please practice reverse parking using different obstacles to grasp this product performance.
• Clean the sensors make them free from ice for proper working of the system.
• Pressing the sensor on active region may damage the sensor & hamper its sensing range, in turn causing the system to malfunction.

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Diagnosis -

Sr. No.	Problem	Possible causes	Resolution
1	Display of CAR image is not appearing in the IRVM when the switch is in 'ACC' position	A. No power supply to the IRVM	1. Verify the supply and ground wire in the IRVM connector is connected properly. 2. Check for the Fuse to IRVM is not blown out. 3. Check for the short of the power and the ground wire.
		B. IRVM may be faulted	1. Verify with the new IRVM
2	Display of the CAR image appeared and gone OFF immediately	A. Signal from the controller is not going to the mirror	1. Verify the controller connector whether it is connected properly 2. Verify with the new Controller
		B. Controller may be faulted	1. Verify with the new controller 2. Verify with new sensors.
3	Car image in the IRVM is appearing but the 3 blinks of the Green and Orange LED of the distance indicators not coming on both sides	A. Signal from the sensor is not coming to the controller	1. Check whether the controller connector is connected properly. 2. Check whether the sensor connector is connected properly to the wiring harness of the sensor.
		B. Controller may be faulted	1. Verify with the new controller
		C. Sensors may be Faulty.	1. Verify with the new sensors.
4	Car image in the IRVM is appearing but the 3 blinks of the Green and Orange LED of the distance indicators not coming on single side	A. Signal from the Corresponding sensor is not coming to the controller	1. Check whether the corresponding sensor connector is connected properly. 2. Check whether the wires in pin 7 and pin 15 of the controller connector are connected properly. 3. Check whether the controller connector is connected properly.
		B. Corresponding side sensor may be	1. Verify with the new sensor on the corresponding

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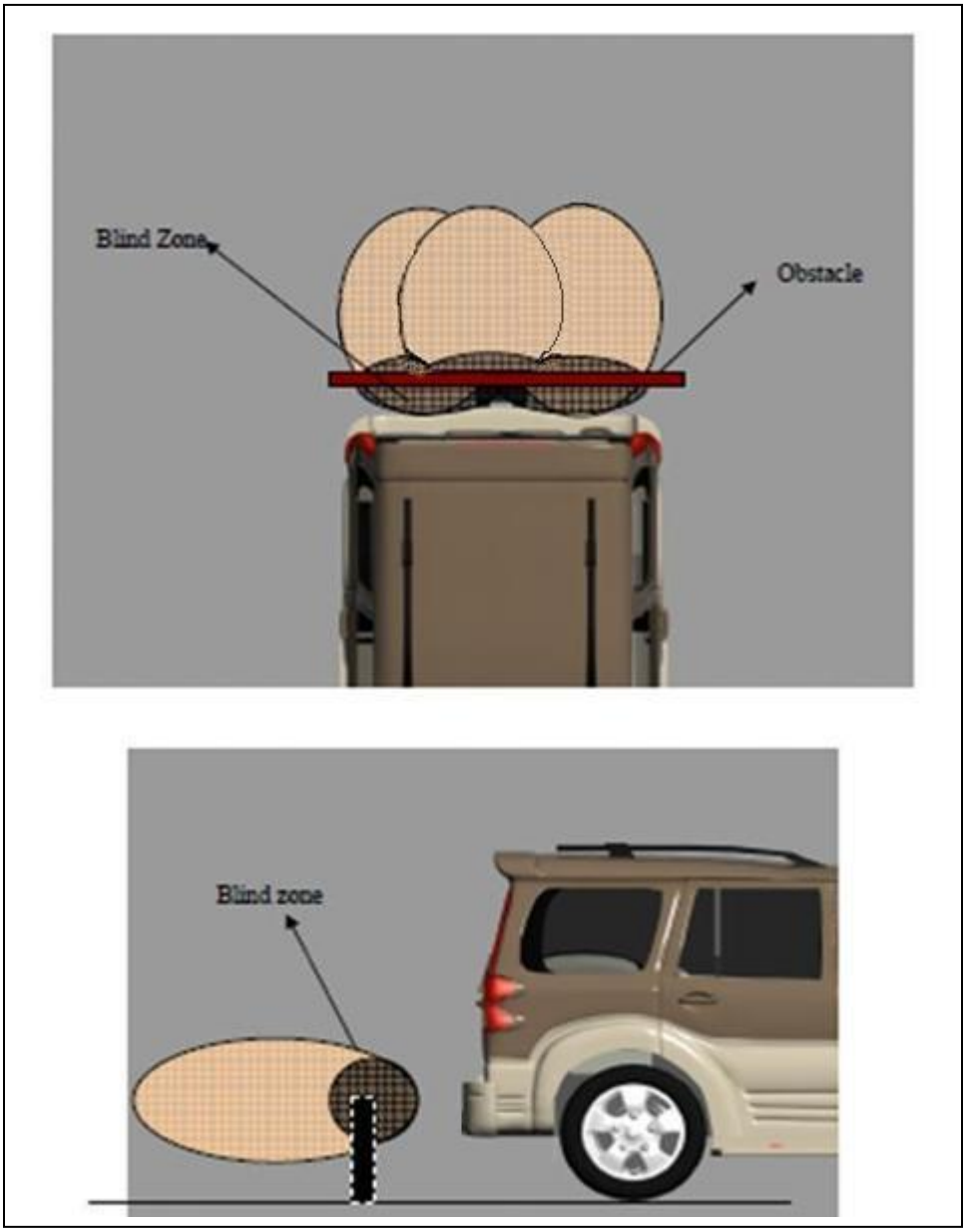
		faulted	side.
5	Car image with 3 blinks of the Green and Orange LED appearing during Ignition ON, but the system is not sensing the obstacle during the Reverse.	A. Signal from the Reverse switch is not coming to the controller (pin 1)	1. Check whether reverse lamp is glowing during Reverse, if not; the problem is in the Reverse switch. 2. Check the voltage at the pin 1 to the ground. If the voltage is not within 12+/-4V, then the problem is in the Reverse switch wiring harness. Change the corresponding wiring harness.
		B. Controller may be faulted	1. Check with the new Controller.
6	False alarm with display and buzzer Sounds sometimes without the obstacle behind the vehicle during reverse.	A. Sensors are blocked with mud, snow or ice	1. Gently clean the sensor for any foreign materials and don't scratch the sensor. Sensor body should be inline with the sensor cover.
		B. Sensors are not installed in proper orientation.	1. Check whether sensor has come out slightly from the bumper. 2. Check sensors are installed such that 'UP' indication mark is on top and the projection in the sensor is fitted correctly in the projection of the bumper. 3. Verify whether sensor is shifted down by more than 10 degree, if so change the angle of the sensor towards upside.
		c. Bumper may be shifted more from its original position	1. Check whether bumper is shifted more from its original position, if so correct it or change the bumper with new one.
7	System is giving Constant false alarm when there is no obstacle behind the vehicle during reverse.	A. Sensor is not installed in proper orientation, which is sensing the Ground or the foot step.	1. Check whether sensor has came out slightly from the bumper. 2. Check sensors are installed such that 'UP' indication mark is on top and the projection in the sensor is fitted correctly in the projection of the

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			bumper. 3. Verify whether sensor is shifted down by more than 10 degree, if so change the angle of the sensor towards upside.
		B. Bumper may be shifted more from its original position	1. Check whether bumper is shifted more from its original position, if so correct it or change the bumper with new one.
		C. Foot step is not in its original position.	1. Verify whether the foot step is damaged or moved much from its original position.
8	Only the buzzer indication is coming, but display of the direction and the distance indication is not displaying in the IRVM.	a. IRVM may be faulted	1. Verify with the new IRVM
9	Only the display indication is available, but no buzzer indication is available	a. IRVM may be faulted	1. Verify with the new IRVM
10	Obstacle is not sensed properly by the sensor	Sensor may be faulty	1. Verify whether sensor body is inside the sensor cover (i.e. if sensor body and sensor cover is not inline), then change the sensor. During fitment of the sensor, sensor body should not be touched.

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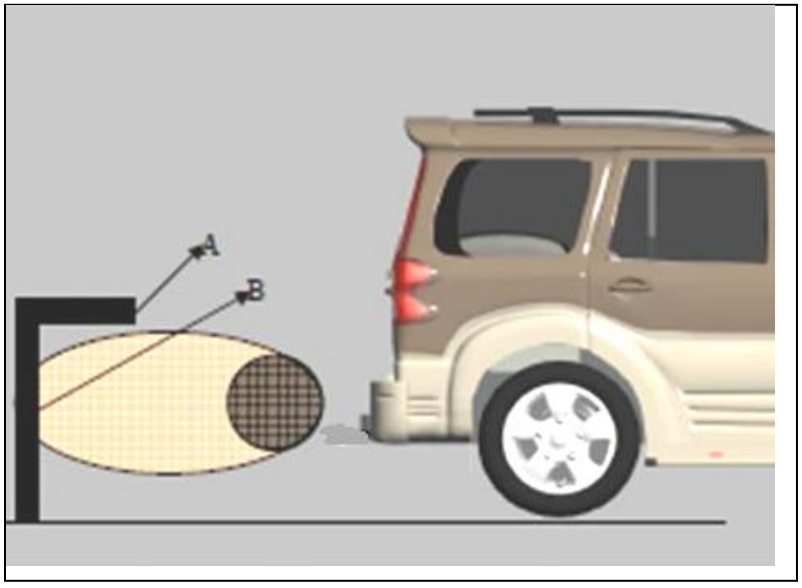
Attention -
Obstacle at the blind zone cannot be sensed by the system.



Please check the condition of the obstacle behind you vehicle before reversing. In some cases, the display may be not as same as the reality due to the sensor installed level, obstacle shape, reflection condition and so on. Some examples are given below.

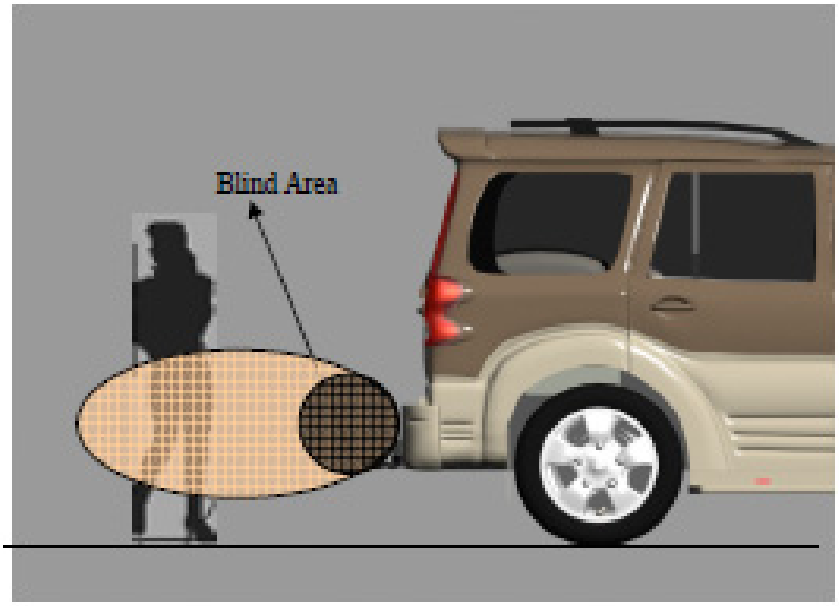
1. Point B will be detected sooner or later, but A may not be detected forever.

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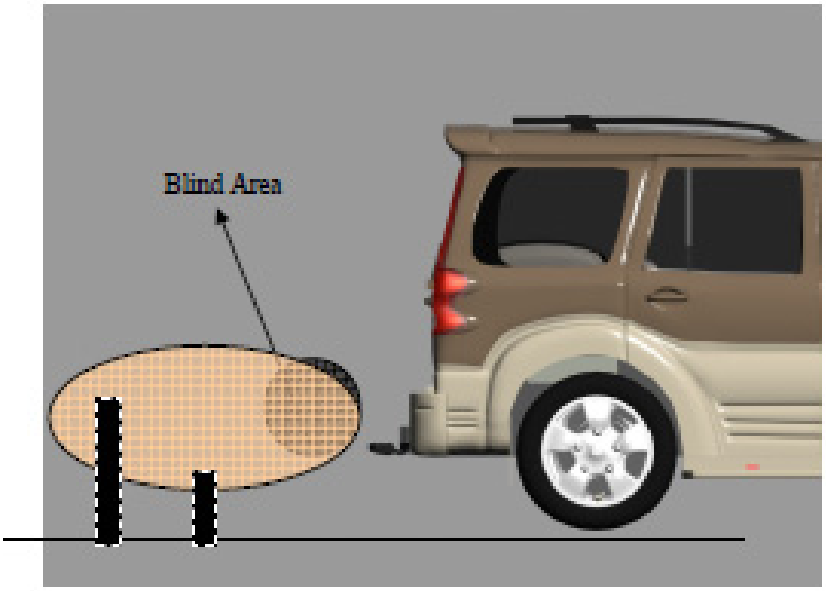


2. Not all the obstacles is detected from 120cm, for instance, a person is detected from 75cm because of the week reflection or absorption of the waves of the clothes.

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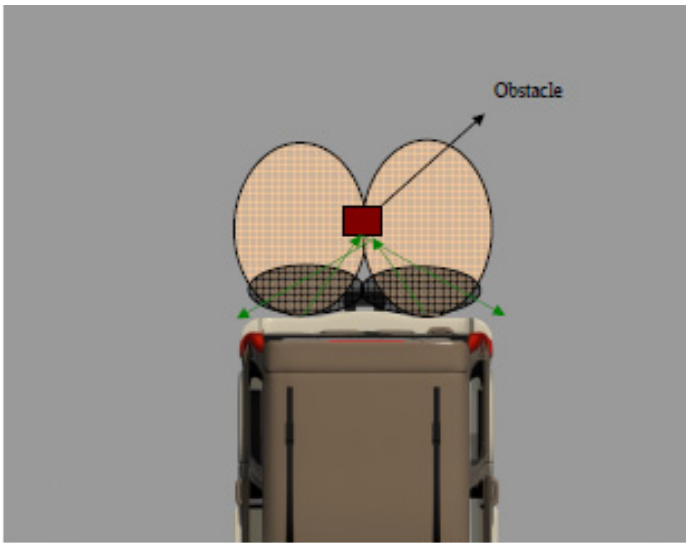


3. The distance indication may move ups and downs due to different sizes of the obstacle at different positions.

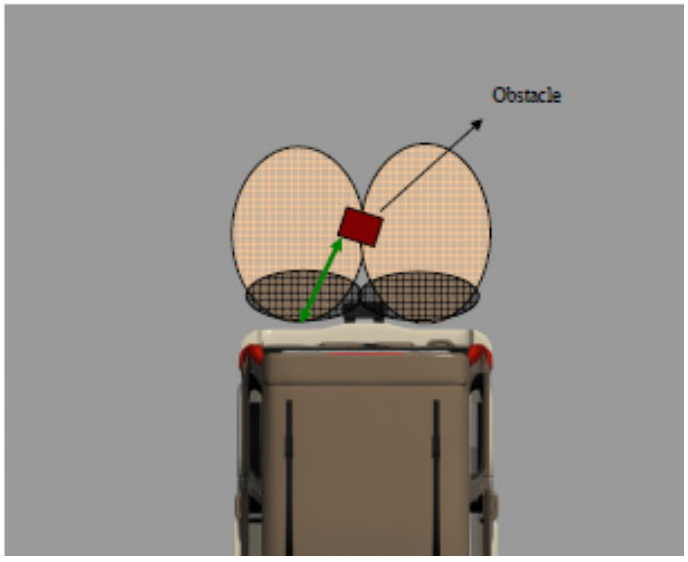


4. Though the obstacle is in the sensing zone the obstacle may not be detected since the ultrasonic waves are not getting reflected back to the sensor because of parallel/plain/flat surface obstacle parallel to bumper.

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5. If the parallel/plain/flat surface obstacle in angular position, the obstacle will be detected.



7. The obstacle of conical shape may not be detected, since the ultrasonic waves get reflected away.

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Smart Power Window

Contents

Description

Operating Principle

Function

Location of Power Window Unit

Diagnosis

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Description –

Smart Power window with anti-pinch automatically stops during express up when obstructions are detected in the path of the closing window.
This feature is provided on both the sides (i.e. Driver & Co Driver)
Customer benefit: Safety and convenience, particularly with feature like one-touch closing.

Operating Principle –

Motor With Hall effect sensor - Power Window assembly with in-built Hall effect sensor in motor gives output pulses for every revolution of motor to the controller which enables the controller to trace the position of the glass and reverse the direction of glass in case any upward movement of glass is obstructed before it reaches to top end position.

Controller - The electronic control unit which is programmed with logic senses and memorizes the end positions along with the frictional resistance of door during the learning process.

Functions

Driver/Co Driver door with anti-pinching -

AUTO UP:
• Turn ON the Ignition.
• Pull the Driver/Co Driver door switch button more than 0.5 Sec. Glass will start moving in upward direction. Remove your hand from switch.
• During this upward travel, any obstacle is detected with the force value ranging between 70 ~ 100 Newton, controller will sense the load and will reverse the direction of glass in down ward direction for almost full stroke length.
• However if the force against the glass is less than the specified value then this function does not operate.

AUTO DOWN:
• Push the Driver/Co Driver door switch button more than 0.5 sec, glass will start move in downward direction. Remove your hand from switch.
• These all functions like Auto Up/ down, Anti-pinch during Auto UP will get deactivated in case of removal of Vehicle Battery Positive or Negative terminal.
• With de-activation of this feature, normal power windows will still function.

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Smart power window learning -
To activate the feature the learning of the power window assembly for one complete cycle is required & is as follows –

1. Move the window glass to extreme bottom most position by continuously pressing the switch.
2. Start moving the glass up by pressing UP switch, hold the switch for two seconds after reaching to top most position, system will understand this position as extreme top position of glass.
3. Start moving the glass down wards by pressing down switch, hold the switch for two seconds after reaching bottom most position, system will understand this position as extreme bottom position of the glass.

With the above action, the system memorizes the end positions and the controller is set for that stroke length.
Now pull and hold the power window switch for 1 sec for express window up. The same procedure is to be repeated for express window down.
During express up, if movement of glass is obstructed by a 70 N force or more, it will start moving in down ward direction for almost full stroke length.

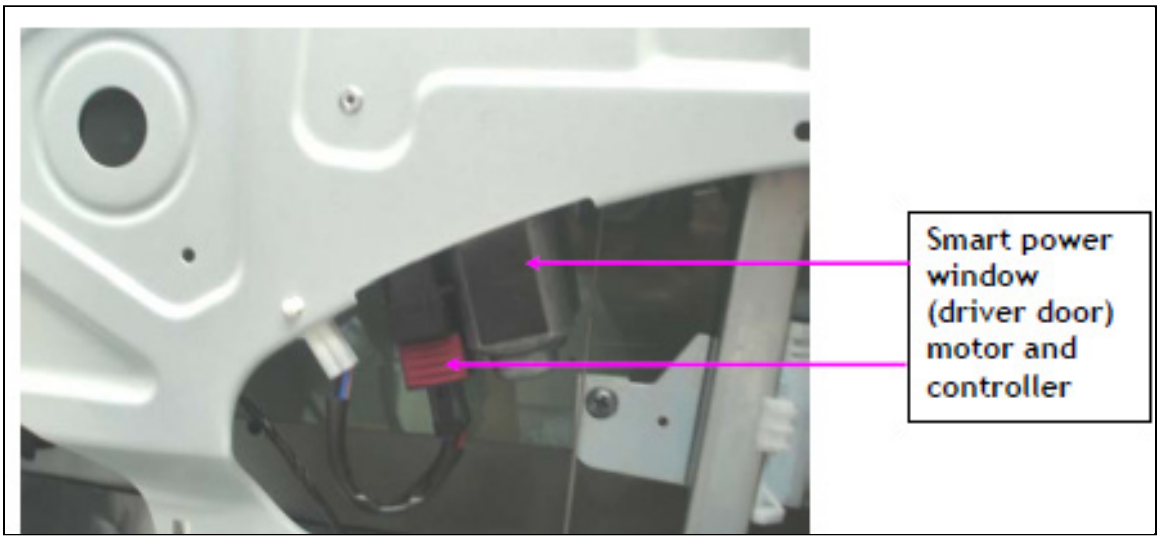


• Make sure that the passenger has his/her hands etc. inside the vehicle before closing the windows.
• Do not leave children unattended inside the vehicle. They could unknowingly activate switches.

Recommendations -
1. In case of vehicle Battery terminal removal (Positive & negative) the express up/express down/ Anti pinch during express up will get de-initialized. To initialize the function we have to learn the system for one complete cycle.
2. In case of hard whether strip condition in express Up mode, glass will treat it as an obstacle and glass will start going down. This needs to be checked at authorized service stations
3. In case of anti pinching 5 times continuously at the same point, controller will loose memory, so power window needs to be re learnt.

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Location of POWER WINDOW Unit -



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Diagnosis –

S. No.	Failure	Symptoms / Effects	Causes	Corrective Action
1	Power Window not operating	No electrical Feature working	No power supply	
		In-operation of all four power windows	Battery discharged / Battery voltage below 9V (Under load)	Replace / Re-Charge battery
		Power Window fuse (40A) blown	High inrush current - Power window jammed	Lubricate glass run
				Check and replace power window
2	Express up not working		Regulator not initialized	Top / Down initialization is required
			5 times continuous anti-pinch (<6 Seconds between each anti-Pinch)	Top / Down initialization is required
			Up / Down signal available for <0.4 Seconds	Up / Down signal required for minimum 0.4 Seconds
3	Anti Pinch working		Regulator not initialized	Top / Down initialization is required
			5 times continuous anti-pinch (<6 Seconds between each anti-Pinch)	Top / Down initialization is required
			Controller failure	Power window system to be replaced
			Hall sensor failure	Power window system to be replaced

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4	Automatic anti-pinch during Express up / Manual up		Obstacle in path of glass movement	Obstacle to be removed
			Glass run very hard	Glass run to be checked. Glass run to be lubricated
				Glass run to be changed.

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Tyre Pressure Monitoring System

Contents

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Description –

TPM system measures the pressure and temperature inside the tyre and transmits it to central receiver unit inside the vehicle through radio frequency. The receiver unit receives this information, identifies data received corresponds to which tyre and gives warning signals if undesirable tyre pressure/ temperature condition occurs.

TPM system provides warning signals to the driver in order to understand the healthiness of the tyre which helps him to maintain the recommend air pressure in such a way to have a good vehicle dynamics and better fuel efficiency.

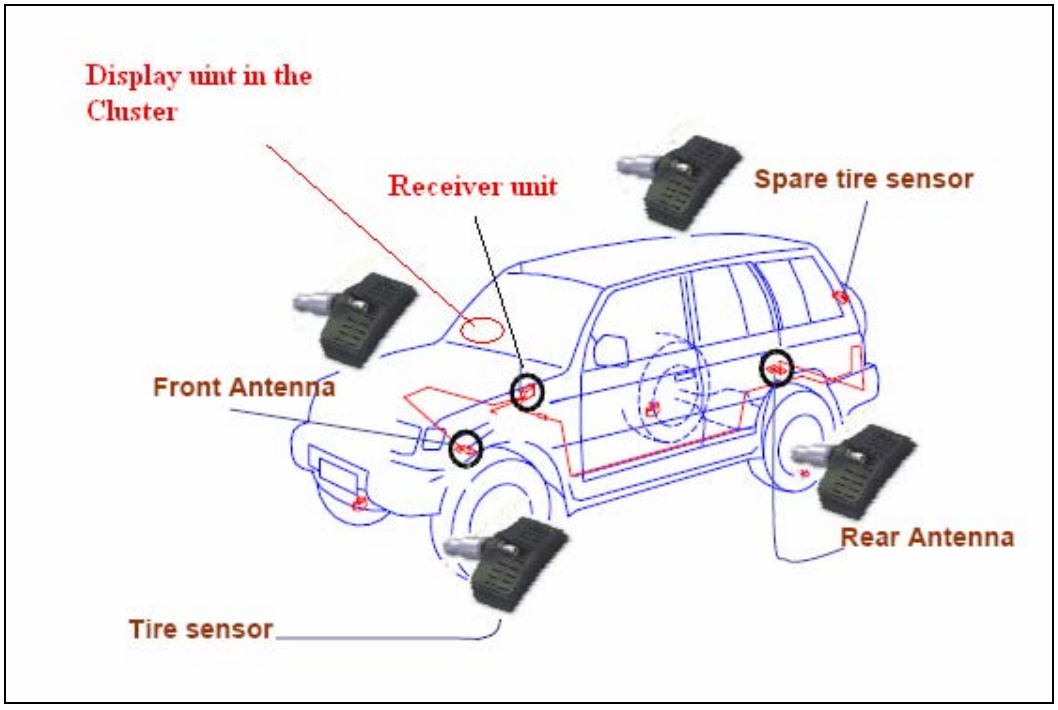
TPMS for a vehicle, comprises of –

1. Pressure sensor mounted on each wheel (FL, FR,RR,RL & Spare wheel)

2. Receiver (ECU) located in the vehicle near park brake.

3. Display unit located in the instrument cluster.

<u>Location of the sensors, Receiver & Display unit in the vehicle</u> –



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Location of the TPMS Display unit in the instrument Cluster -



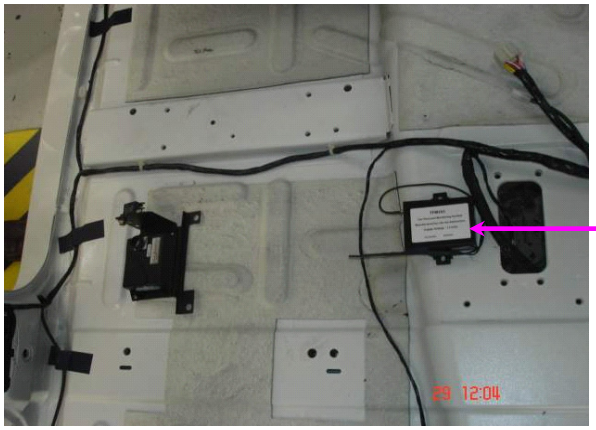
INSTRUMENT CLUSTER



DISPLAY UNIT

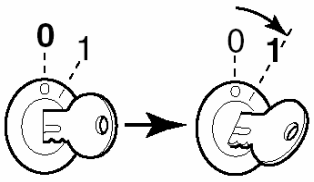
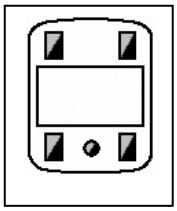
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Electrical Layout & Location of TPMS Units

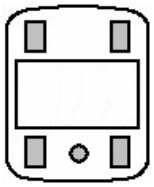
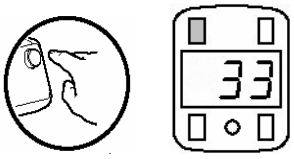
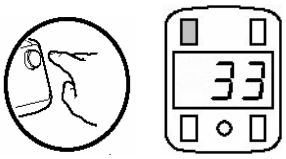
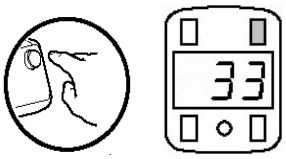
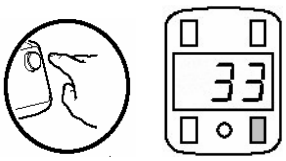
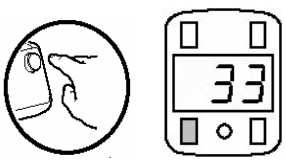
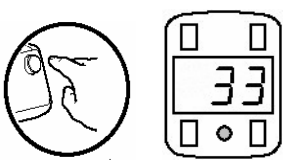
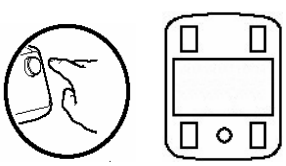


TPMS Controller near Hand Brake

TPMS operation:

1	 Turn on ignition.
2	 The system performs a self check and receives latest updated information (pressure) of all tyre locations.  **Note:** Only applies to permanent battery fed solution **Note:** This procedure takes max. 10 seconds.

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3		**<u>All tyres OK mode</u>** If all conditions are ***OK***, system confirms showing all green LED's. other wise during a self test itself if any one of the tyre pressure is below set value(either warning or alert condition), deflated tyre location LED will blink orange, red respectively.
		Loop Display mode If pressing the mode button at the end of OK mode, the system will display the current pressure of each tyre starting from FL. (Rotation from FL->FR->RR->RL-> Spare) with in 10 seconds
4		Single tyre Display mode During Loop Display mode if Mode button is pressed again, display will show pressure & temp of **Front Left** tyre.
5		When Mode button is pressed again within 1 minute, display will show pressure & temp of **Front Right** tyre.
6		When Mode button is pressed again within 1 minute, display will show pressure & temp of **Rear Right** tyre.
7		When Mode button is pressed again within 1 minute, display will show pressure & temp of **Rear Left** tyre.
8b		With Spare Wheel When Mode button is pressed again within 1 minute, display will show pressure & temp of **Spare wheel**.
9a		When Mode button is pressed again within 1 minute, display will exit from single tyre display mode to OK mode.

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There are three warning modes (3, 4, 5) available in the system.

1. PSI
2. TEMP. °C
3. **TEMP. ALERT**
4. **LEAKAGE ALERT**
5. **PRESSURE ALERT**

PRESSURE ALERT —

Please check pressure -

Condition: If any one of the tyre pressure is 75% of set value (32 psi) or lower.
Response:
-The corresponding tyre LED will blink **orange** (0.2 seconds on, 0.8 seconds off) for one minute and beep in the same frequency for 15 seconds. If driver wants to turn off the beep sound, he has to push the mode button.



-The 3-digit 7-segment LED will show the current pressure of the deflated tyre.

-This complete procedure will be repeated only once. After this it will light up **orange** continuously

-At the same time it will illuminate the **pressure alert LED** near the display.

UNDER PRESSURE ALARM -

Condition - If any one of the tyre pressure is 50% of set value (32 psi) or lower.

Response -
- The LED of the corresponding tyre will blink **red** with doubled frequency (0.1 seconds on, 0.4 seconds off) for 2 minutes and beep at the same frequency for 15 seconds.
- If driver wants to turn off the beep sound, he has to push the mode button.

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- The same sequence will be repeated continuously until the condition is improved (a normal or warning condition has been met).
- The 3-digit 7-segment section will show the current pressure of the tyre.
- At the same time it will illuminate the **pressure alert LED** near the display.
- User has to attend the tyre immediately by stopping the vehicle

TEMPERATURE ALERT -

Condition - If the temperature of the concerned tyre is 100°C or higher. This can happen running the vehicle with deflated tyre

Response -
-The LED of the corresponding tire will blink **red** (0.2 seconds on, 0.8 seconds off) for 2 minutes and beep at the same frequency for 15 seconds.
- If driver wants to turn off the beep sound, he has to push the mode button.
- The 3-digit 7-segment section will show the current temperature of this tire.
- At the same time it will illuminate the **temperature alert LED** near the display.
- User has to immediately attend the tyre by stopping the vehicle

LEAKAGE ALERT -

Condition: If the specific tyre is losing more than 3 PSI within 1 minute.

Response:

-The LED of the corresponding tire will blink **red** (0.2 seconds on, 0.8 seconds off) for 2 minutes and beep at the same frequency for 15 seconds.



- If driver wants to turn off the beep sound, he has to push the mode button.
- The same sequence will be repeated continuously until the condition is improved (a normal or warning condition has been met).
- At the same time it will illuminate the **Leakage alert LED** near the display.
- User has to immediately attend the tyre by stopping the vehicle.

OVER PRESSURE WARNING -

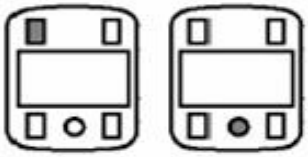
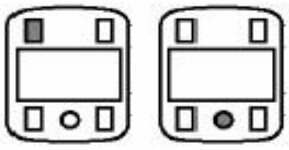
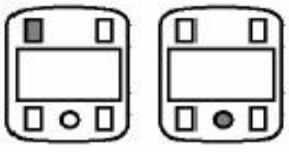
Condition - If the pressure of one (or more) of the tyres is 48 PSI or higher.

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Response -
- The LED of the corresponding tyre will blink **red** (0.2 seconds on, 0.8 seconds off) for 2 minutes and beep at the same frequency for 15 seconds.
- If driver wants to turn off the beep sound he has to push the mode button.
- During this whole period, the 3-digit 7-segment LED will show the current pressure of this tyre.
- Stop the vehicle immediately and check the tyre pressure

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Using Spare Tyre in case of tyre puncture -

1		For example, If the Front Left tyre gets punctured, the concerned tyre location LED along with pressure alert LED will blink red. At the time of blinking if driver wants to replace the punctured tyre, e.g. Front Left with healthy one i.e. spare wheel (with Green LED), Follow Step (2)
2		While pressure alert is active, press and hold Mode button for 5 seconds until confirmation beep tone sounds.
3		(e.g.) Left Front and Spare Wheel locations light up sequentially.
4		Press Mode button to accept the change => Spare Wheel replaces (e.g.) Left Front. A beep tone confirmation acknowledges the change.
5		Now physically swap the tyre actually on the vehicle. Front Left tyre location will become green and Spare wheel location will become red now.
6		After rectifying punctured tyre,if user wants to keep the same location i.e. FL tyre at FL location, once again Press mode button for 3 sec.Again FL and Spare wheel will blink green sequentially and Spare wheel will come to its original position , Folllow Step (4)

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After rectification of the puncture, the swapped spare wheel should be brought back to the original position by following steps No. 4 to 6.
If more than two tyres are to be swapped refer to sequential tyre rotation procedure.

Care to be taken while servicing -

The sensors are lightweight, mounted in the wheel rim. It's important to be careful when using a tyre-mounting machine. The sensor could be damaged in two ways either by:

- Direct contact with the machine or
- By the bead of the tyre as it is forced over the rim.



- In case of tyre damage/ worn out ,the same sensor needs to be checked for the physical damage before installing in the new tyre at recommended service station After installation , the tyres need to be learned with system

- TPMS sensor is more precise than consumer-grade tyre pressure gauges. It may be necessary to explain this if the customer routinely mis-inflates tyres using a gas station gauge.

- If tyres are rotated or a sensor is replaced, the receiver must be reprogrammed, otherwise the system will continue to report the correct pressures, but will assign them to the wrong locations on the vehicle.

- In tyre rotation while deflating the tyre by 3 PSI, take care you are not deflating the same tyre after long confirmation beep.

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TPMS Sensor Replacement Procedure –

Dismantling –

	Start breaking down tyres by deflating them. Use a tyre valve tool to remove the valve core from the stem to completely deflate the tyre. Remove all the air and then remove the locknut. Press the sensor gently towards inside. It will get detached from the rim. Then start removing the tyre bead as follows:
	Break down tyres preferably by using a bead breaker with Nylon Roller.

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 	While using a bead breaker, the valve must be positioned opposite to the bead breaker to avoid bead breaker to avoid possible sensor damage.
	Lift outer tyre bead over the rim using a tyre tool. Note – Valve must be positioned just left of the start position to avoid sensor damage. Do not allow the tyre tool to touch the sensor.
	Lift inner tyre bead over the rim using a tyre tool. Note – Valve must be positioned just left of the start position to avoid sensor damage. Do not allow the tyre tool to touch the sensor.
	Lift the inner tyre bead over the rim & remove the valve stem.

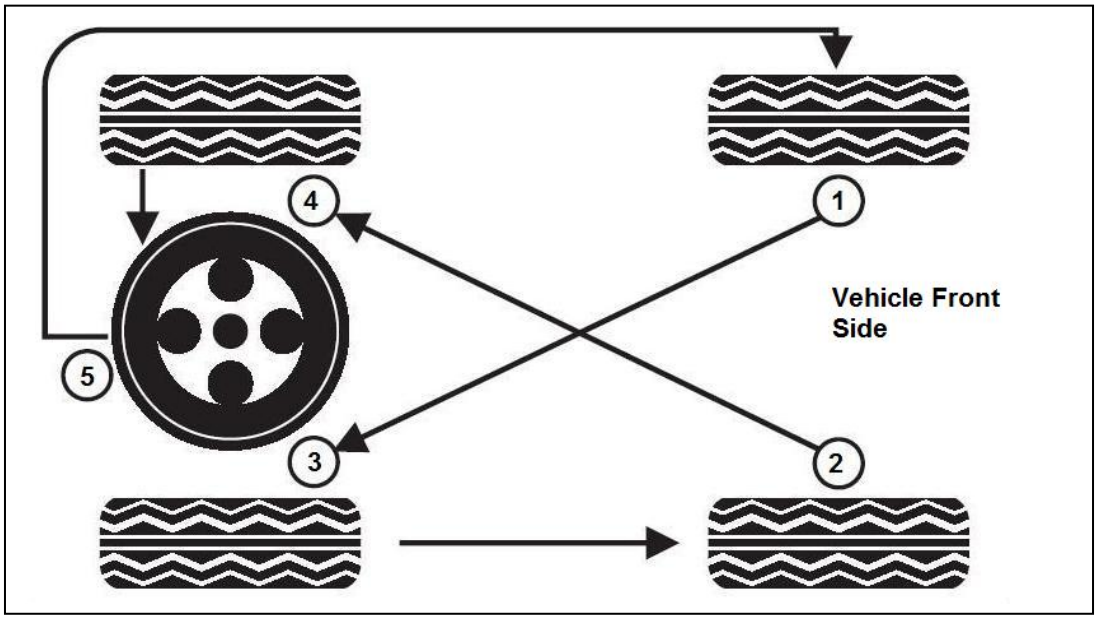
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Assembly –

	Fit & tighten the sensor onto the wheel rim. Note – Tightening Torque – 5 Nm
	Place inner tyre bead over the rim. **Note -** Start off mounting the tyre completely opposite to the valve position.
	Place outer tyre bead over the rim. **Note -** Start off mounting the tyre completely opposite to the valve position.
	Inflate all tyres to recommended pressure, check valve area for leakage & rebalance the wheels prior to installing back on the vehicle. Note – Recommended Tyre Pressure – 32 psi.

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Tyre Rotation procedure -

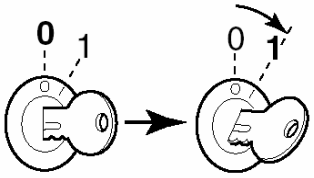
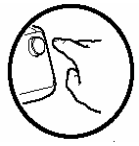
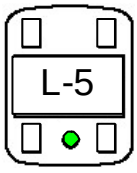
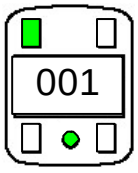
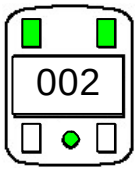
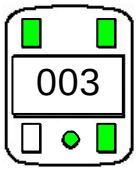


After Tyre Rotation -

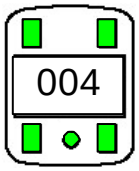
FL **5**	FR **3**
RL **2**	RR **1**
ST **4**	

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Learning the system after Tyre Rotation –

1		Press and hold Mode button on display.
2		Turn on ignition.
3		Release Mode button when display shows L-5. To program spare wheel sensor, Proceed to step 4
4		Deflate spare tyre by 3 PSI. The spare wheel sensor is programmed when a long confirmation beep tone sounds with respective tyre location LED and automatically FL tyre LED will start blinking.
5		After spare tyre programming, the FL tyre will start blinking green with icon indication 001.Deflate FL tyre by 3 PSI. The FL tyre sensor is programmed when a long confirmation beep tone sounds with respective tyre location LED
6		After FL tyre programming, FR tyre will start blinking green with icon indication 002.Deflate FR tyre by 3 PSI. The FR tyre sensor is programmed when a long confirmation beep tone sounds with respective tyre location LED
7		After FR tyre programming, RR tyre will start blinking green with icon indication 003.Deflate RR tyre by 3 PSI. The RR tyre sensor is programmed when a long confirmation beep tone sounds with respective tyre location LED

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8		After RR tyre programming, RL tyre will start blinking green with icon indication 004.Deflate RR tyre by 3 PSI. The RR tyre sensor is programmed when a long confirmation beep tone sounds with respective tyre location LED
9		Wait for 1 minute, system will come back to all tyres ok mode and all LEDs will light green.

Limitations –

- TPMS does not monitor other conditions then tyre pressure & temperature, such as tyre wear.
- TPMS is unable to detect an instant tyre burst or other defect timely and inform the driver in advance
- At a time, only one tyre can be swapped with spare wheel.
- There may be possibility of getting SCH error on crossing environment area prone to heavy power lines and RF signals.

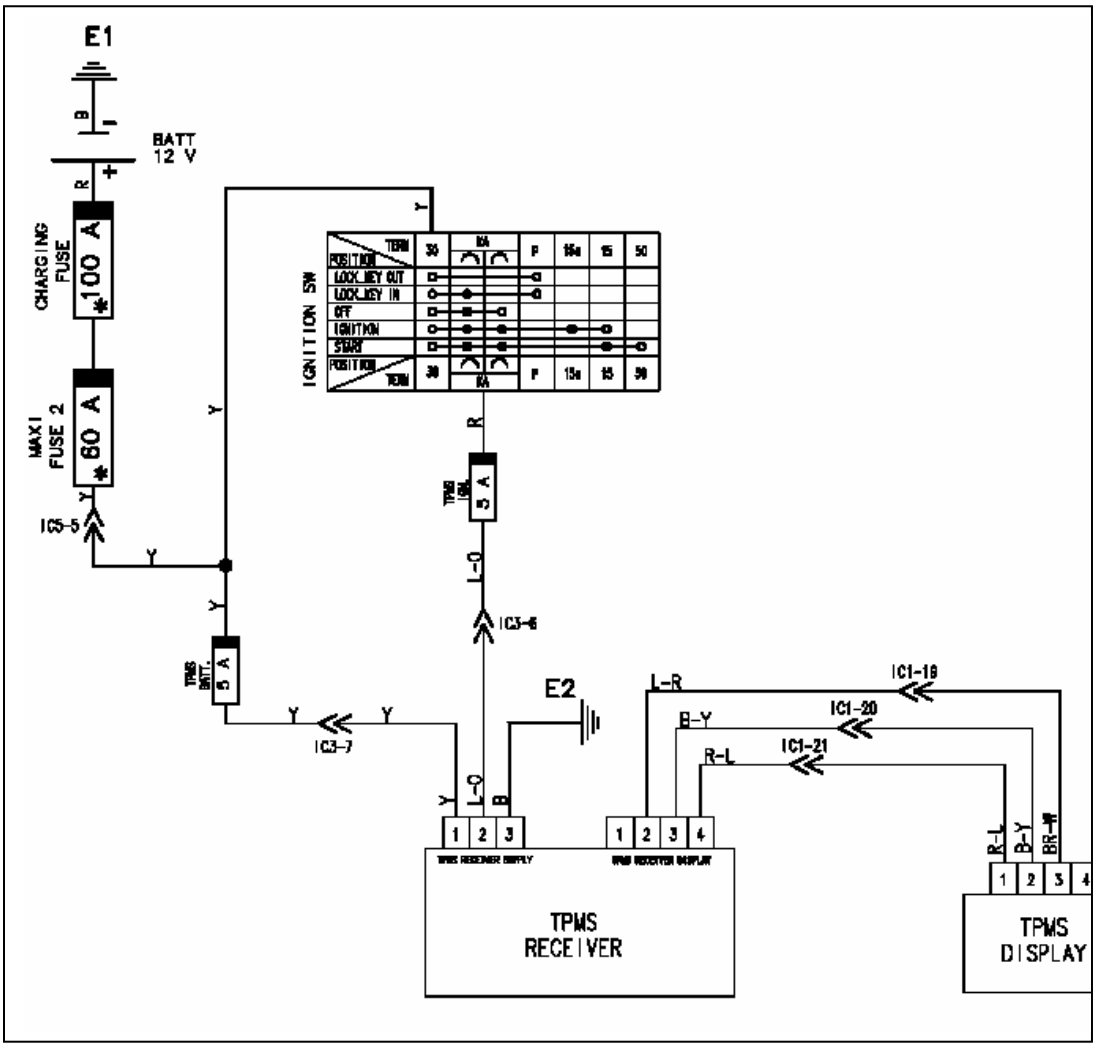
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Important Points:

- It is recommended to fill the pressure to 32 psi at digital gauge station only.
- Every 15 days, owner has to inflate the tyre up to 32 psi and inflation should be done at cold condition/ambient temp.
- Pressure deviation b/w TPMS Display and Gauge will be depending upon the following factors:
- Atmospheric pressure
- Error in pressure filling gauge(not calibrated)
- Air leakage during inflation/deflation
- TPMS measures the absolute pressure of the tyre not relative pressure(gauge pressure)
- Pressure deviation is defined for 0.5 psi (min) and 2 psi (max) by M&M.
- TPMS sensor has inbuilt battery which has got 5 years lifespan, so sensor needs to be replaced after 5 years.
- If vehicle battery/fuse is first disconnected and then connected, it will take 2 minutes to come to All Tyre OK mode in TPMS display.
- While inflating tyre, pressure updating will take 2 minutes on TPMS display.
- It should be noted that if you rotate the tyres or replace the sensor on your vehicle, you MUST re-program the receiver unit inside otherwise it will consider the sensor is on a different wheel location.
- At a time, only one tyre can be swapped with spare wheel and then follow the learning procedure
- If more than one tyre needs to be learned, all the 5 tyres are to be learned as per the learning spare wheel procedure mentioned in the manual.

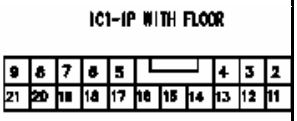
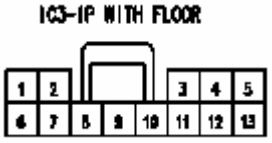
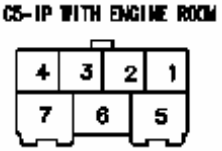
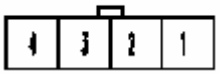
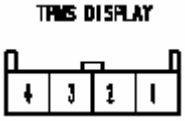
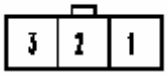
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Electrical Circuit Diagram - TPMS



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Connector Information -

Connector (Pole, Colour)	Connecting Wiring Harness	Connector Position	IC No	PINS	M/F	Connector view
IC(21P, White)	IP- W/H Floor	*A-PILLAR RIGHT*	1	21	F	
IC(13P, Natural)	W/H IP-Floor	*A-PILLAR RIGHT*	3	13	F	
(5+2P , White)	W/H IP-Engine Room	*A-PILLAR RIGHT*	5	5+2	M	
(4P , White)	W/H IP	Beneath centre console	-	4	F	
(4P , Black)	W/H Floor	Beneath centre console	-	4	F	
(3P , White)	W/H Floor	Beneath centre console	-	3	F	

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Diagnosis –

S. No	Symptom	Reason	Cause	Action
1	Display shows SCH error in all the tyre location	1. Due to lose of signal reception between all transmitters and receiver.	1. Antenna connected with ECU might have been removed. 2. Pin in the antenna may be damaged.	Change the antenna.
2	Any one of the tyres alone show SCH error.	Signal interruption between particular senor and receiver	1. Sensor non-available inside the tyre. 2. Sensor life may exceed 5 years life.	1. Check & confirm. 2. After the specified life time of the sensor customer has to replace the sensor
3	Even if customer changes the new tyre with new sensor system shows “SCH” error.	New sensor is not learned with receiver	If the new sensor is fitted with old receiver, the learning needs to be done.	Refer the learning procedure.
4	Display not switching on.	Separate connector for TPMS display not connected. (4 pole connector at the receiver end).	While connecting cluster, may forgot to connect this TPMS connector.	Check the four pole connector behind the cluster.
5	Display not switching ON	Even though all connectors are connected, display not coming ON.	Fuse for the TPMS may be fused out.	Refer to the circuit diagram to locate the fuse, battery connection pin & Ignition pin and check the 12V supply is available in those pins after switch on ignition.

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6	Display not switching ON	Chances of disconnection of signal line form receiver to display in the cluster.	One of the wires may be connected to dummy terminal.	The colour code is given in the back side of the 4 pole connector. But connection may not be done as per the colour code. Please Refer to the circuit diagram.

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Wheels & Tyres

Contents

Description

Trouble Shooting

Care of the system

In Car repairs

Removal & Refitment of the tyre

Specification & Wear Data

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Description

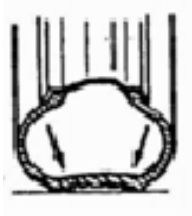
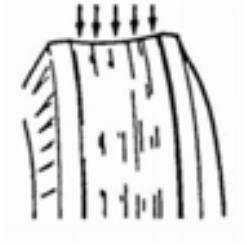
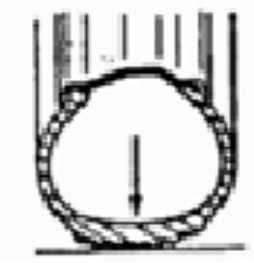
The tyres fitted in Scorpio are radial tubeless tyres and with a suitable wheel disc.

In the tyre P 235/75 R 16 - The 215 is the width of the tyre in mm at the designated air pressure and load. The / 75 is the aspect ratio of the tyre. (Ratio between the height and width here the height is 0.75 times the width

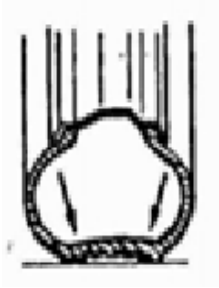
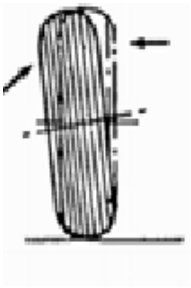
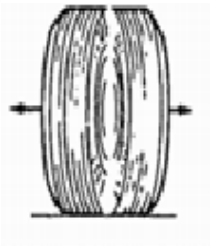
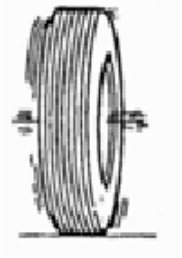
The tyres play a very important and vital role in the vehicle handling and ride characteristic. Hence it is advised that any change not as per the specification have to be done with caution.

The air pressure maintained has a direct influence on the fuel average obtained, braking and also on ride characteristic. Hence it is imperative that the tyre pressure be maintained as per specification. The tyre specified with the specified air pressure gives these tyres a safe speed of 180 Km/hr

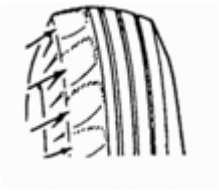
Trouble Shooting –

Symptom	Causes	Remedial action
 **Rapid wear at Shoulder**	 **Under Inflation** Lack of rotation Excessive cornering.	✓ Maintain the correct tyre pressure. ✓ Do the tyre rotation.
 Rapid wear at centre	 Over inflation	✓ Maintain the correct tyre pressure.

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 Cracked Treads	 **Under Inflation**	✓Maintain the correct tyre pressure.
 One Edge Wear	 ***Excessive camber*** Excessive cornering	Check and adjust: ✓ Hub end play ✓ Camber to be checked and adjusted.
 **Feathered Edge Wear**	 **Incorrect Toe In** No tyre rotation.	✓ Check & correct Toe In ✓ Check the chassis bend ✓ If tyre rotation not carried out as per schedule. Do the tyre rotation.
 Bald Spots	 Unbalanced tyre Out of round brake drums in rear.	✓ **Balance the tyres.** ✓ Check the brake drum roundness. ✓ Check jammed wheel cylinder/ calipers. ✓ Check the wheel bearings. ✓ Avoid driving with sudden brake locking.

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	Faulty wheel bearings. Sudden braking.	
 **Wavy / Scalloped wear**	Lack of rotation or Worn or Out of Alignment Suspension	✓ Tyre rotation. ✓ Check & replace the suspension components.
Side Wall crack- radial/ diagonal	**Kerb damage** Stone hit	
Side wall crack circumferential / tyre bulging	**Run Flat** (It is more obvious from inside)	

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Care of the system –

The tyre is one of the most abused components hence maintaining the tyre is of utmost importance.

The recommended tyre pressures are given below:

	235/70 R16	
	Front	**Rear**
Up to 5 persons + 40 Kg load	2.2 bar / 32 psi	2.2 bar / 32 psi
	235/70 R16	
	Front	**Rear**
More than 5 person	2.2 bar / 32 psi	2.2 bar /32 psi

The tyre pressure should be checked once in a fortnight. (Once a week during summers). The tyre pressures should always be checked & corrected in cold condition. The valve should be always covered with the valve cover. An opened valve can have the valve needle stuck in a partial position causing the tyre to bleed during operation..

The tyre pressure specified can cater to continuous high-speed performance. Hence it is not advisable to increase the tyre pressure before going on a high speed run.

The practice of keeping the tyre pressure lower in summer is actually detrimental to the tyre. To understand that let us examine what happens – if lower pressure is kept. Then the sidewall flexing is going to be more hence the heat generation will also be higher which will result in a faster increase in tyre pressure. So the wear rate is going to be higher.
Similarly the practice of bleeding the tyre pressure to reduce the pressure after a long run can cause the sidewall to crack and in a worst scenario sidewall bulging.

Before going on a long drive it is a good practice to remove the stones/pebbles trapped in the treads. The probability of a puncture due to stone trapped and digging through the crown once it gets heated up is reduced.

It should also be kept in mind that a radial tyre with higher pressure is more prone to burst under impact from stone at high speed or kerb impact. Lower air pressure results in higher sidewall flexing and drastically increases the chance of sidewall damage / cut in bad roads.

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Wheel balancing should be done at least every 20,000 KMs. It is compulsory to do a balancing of the wheel after any puncture.

The tyre rotation should be carried out every 10,000 KMs.

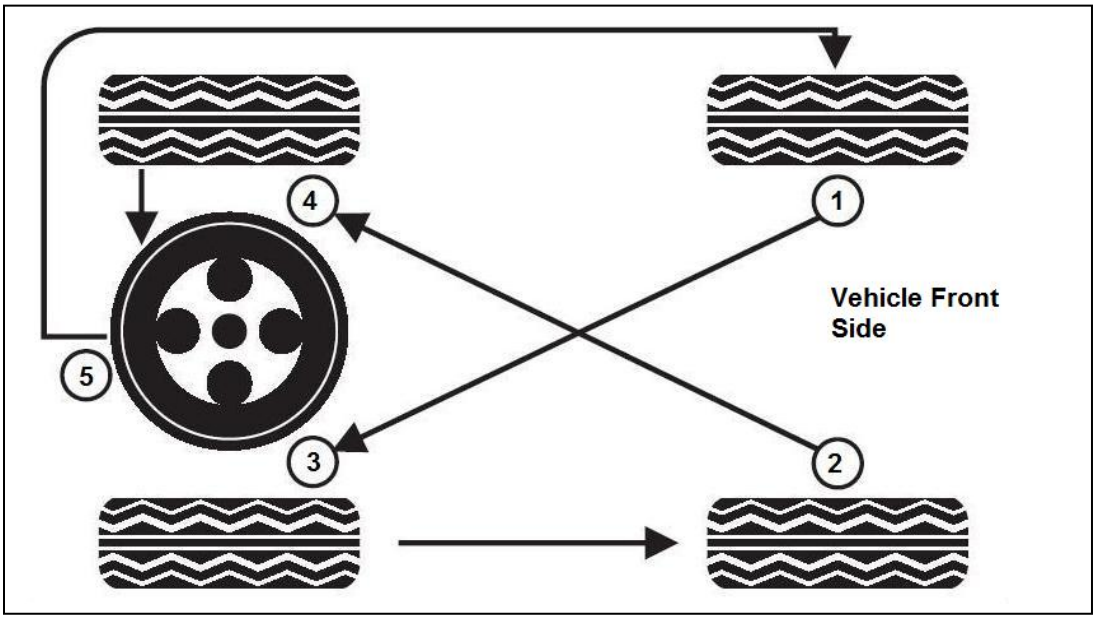
Wheel alignment is recommended. If the wheel disc is having any deformation particularly in the bead seating area then do not wait until the mileage has covered-get it balanced.) In case of abnormal tyre wear refer to the Trouble shooting section and take the corrective action suggested.

The grooves in the tyre are used to pump out the water between the road and the tyre. In case the water is not pumped out the tyre will ride on water. Since the coefficient of friction of water is very low that will result a sliding action. Obviously the amount of water which the tyre can pump out between the ground and the tyre will depend on the depth of the groove which is acting as a channel. The tyre manufacturers recommend that a minimum tread depth of 1.6 mm should be present.

Once the tread depth is less than 1.6 mm it is recommended to replace the tyres. I t is not advisable to retread the tyre.
Any kind of lubricant on the tyre is detrimental as it promotes degradation of rubber and also increases the chance of hardening. Normally this happens when a mechanics rubs the spare oil or grease on to the sidewall of the tyre.

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Tyre Rotation –



1. Check & ensure tyre pressure at **2.2 bars / 32 psi** in all five wheels.

2. Rotate (swap the positions) the wheels as shown in the diagram above

    - Driver side rear goes to Driver side front position.
    - Driver side front wheel goes to Co-Driver side rear position.
    - Co-Driver side rear wheel goes to spare wheel position.
    - Spare wheel goes to Co-Driver side front position.
    - Co-Driver side front wheel goes to Driver side rear position.

In case the vehicle reports for wheel wobbling then the sequence of balancing & rotation should be as follows:
Important: Before going ahead with the procedure; do road tests and at that time:-
Please remember that the road shocks can come to the steering wheel while going over rough or uneven patch.
The important point is that after the road shock is over then it should not continue to vibrate.

Preliminary Stage:

Mark each tyre assembly position with respect to the hub/ axle shaft.
Balance all the tyre and place it back it each wheel in the same position. (Tyre pressure for all wheel-32psi)
Now follow the sequence of Stage A, Stage B, Stage C. Road test after each stage:

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Sequence of operations:

Road Test → **A** → Road test → **B** → Road te

C → Road test

If the stages of A, B, & C are done together then improvement may not be noticed. In worst case scenario the problem may get aggravated.

Before dismounting the wheel Mark the position of the wheel & tyre assembly with respect to the hub (uses any wheel mounting bolt as a reference and applies a paint mark to hub with respect to disc + tyre.

Check the wheel balancing. **(Also refer Note 1)**

If the imbalance amount is less than 40 gm.

If the imbalance is > 40 gm

C After B - If after road test no change in wobbling; then Rotate the assembly by 180 degree in clockwise direction

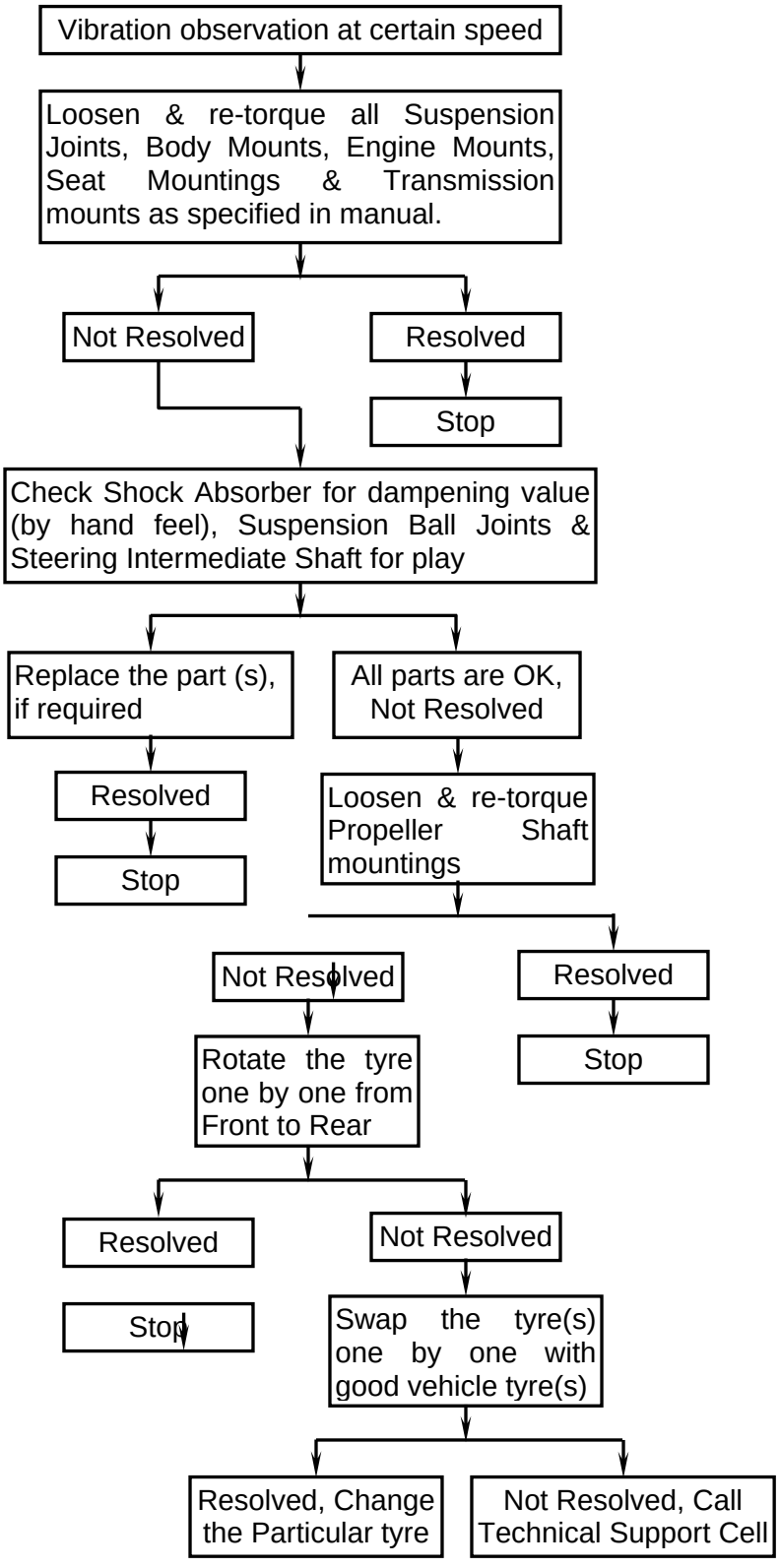
Rotate the wheel assembly & check the imbalance

Imbalance location should not change more than 80 mm in circumference.
The max imbalance can be 40 gms

While mounting the wheel assembly, rotate the wheel assembly by 180 degrees. Now the matching marks will be opposite

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Flow chart to attend Vibration Concern



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In Car Repairs -

The tyres should be removed and then only be attended for puncture or damage.

For removal of the tyre from the vehicle the jacking points are:

For 2WD Front- to be supported on the chassis, behind the lower arm just below the first outrigger.

For 4WD Front -Behind the lower arm just below the first outrigger. While locating the jack or the locating for the 2-post lift please ensure that it does not touch the torsion bar. (It can cause the torsion bar to bend.)

For the rear wheels: below the axle.



Never go under the vehicle when it is jacked up. This jack is meant for only raising the wheel. For any under body work/inspection support the vehicle on vehicle stands.

If the vehicle is run with severely under inflated tyres – the vehicle stability may be affected. A run flat wheel can also damage the wheel disc- besides literally shredding the tyre.

Removal & Refitment of the tyre -

It is recommended that the tyre removal and re-fitment on the wheel disc be done in a tyre specialist shop where the tyre fitting machines are available. The advantage of the machine over the conventional method is that the damage to the beading area is totally avoided.

In absence of the machine; ensure that:

No sharp tools are inserted while removing the tyre.
No sharp tools/ screwdriver is used while fitting the tyre.
While refitting the tyre the use of powder between the tube & the tyre is recommended

It is recommended that the tyre be inflated to a pressure of 40 PSI. This will ensure that the bead is locked in properly and also in centralizing. Then later reduce the pressure to the recommended pressure.

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Removal & Refitment of the spare wheel from the vehicle -

	Remove the covering on the rear and using the wheel spanner lower the spare wheel
	Lower the wheel on to the ground and take off the locating tang from the disc.
	The fitment of the old tyre to the spare wheel carrier is the reverse of the above procedure
	While fitting the tyre on to the axle ensure that - The bolt holes in disc are not oblong. - The threads of the bolt are not having dirt – neither is there dirt/ mud in the nut. (Generally while removing a wheel the nuts are left in the ground collecting dirt/mud. It is a better practice to keep the removed nuts on vehicle.
	While tightening the wheel nut tighten in diagonally opposite order to each other.  **Failure to do so can cause vibration of the steering wheel at high speed.**

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Tightening Torque's -

Description	Torque in Nm (lb-ft)
Wheel Nut (Normal/Alloy wheel)	97.5± 5 Nm
Body Mounts	55 ± 5 Nm

Specification & Wear Data -

Description	Value
Run out of the tyre- radial	1.5 mm
Run out of the tyre- lateral	1.5 mm
Unbalanced allowed- tyre	Max. 1.8 Kg-f
Minimum tread depth	1.6 mm

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HEADLAMP AIMING/ALIGNMENT

Headlamp alignment can be done by two methods.
(1) "USING THE AIMING INSTRUMENT"
(2) "IN THE DARK ROOM"

(1) HEADLAMP ALIGNMENT USING THE AIMING INSTRUMENT:

(Follow instruction of the equipment supplier, if any)

- **Ensure that the:**

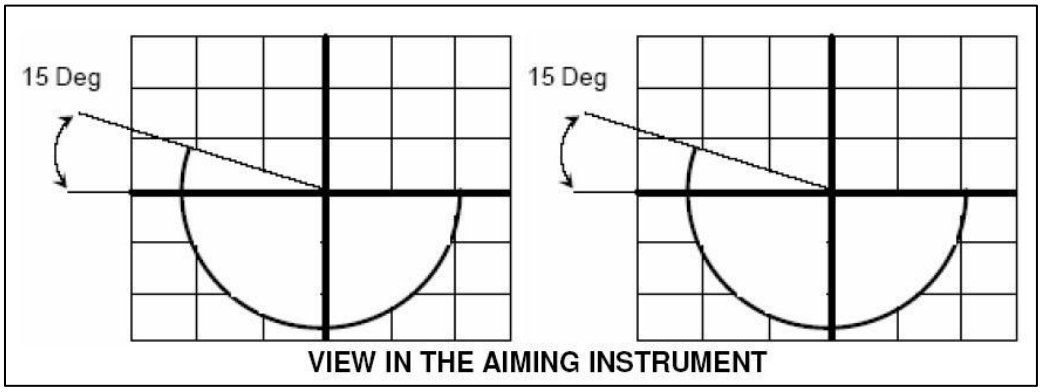
a) Vehicle & headlamp aiming equipment placed on the same **Level surface.**
b) Check and ensure all four tyre pressures as per specification.
c) The headlamp aiming instrument height should be in the centreline of headlamp.



Refer above illustration –

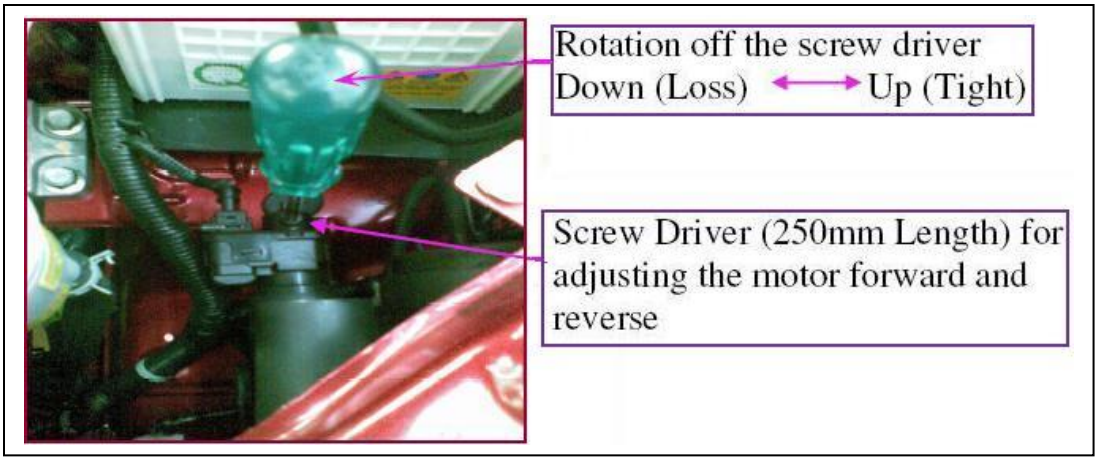
1. Bring the aiming instrument lens in front of headlamp as shown in above diagram.
2. Then switch ON Headlamp **LOW** beam (HLLD system actuates in Park 'ON').
3. Keep the levelling switch in **"0"** position.
4. Observe the demarcation between light & dark zone. This demarcation line should coincide with horizontal line at an angle of **15** Deg. Refer illustrations shown below.
5. If the low beam does not coincide with the lines on the screen, adjust the setting Screws to the set pattern at a required height (i.e. cut-off height marked on aiming instrument), with the help of star head Screwdriver.

Refer illustration below for Demarcation between light & dark zone -



VIEW IN THE AIMING INSTRUMENT

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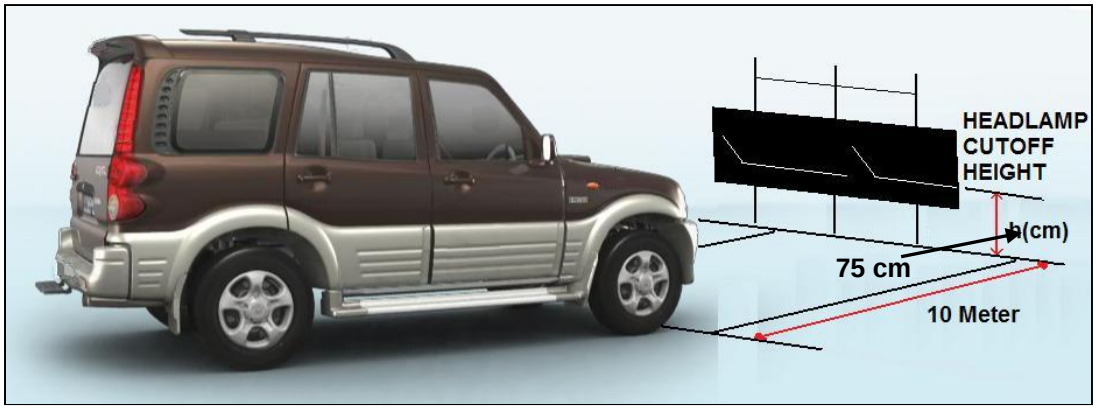
6. For RHD vehicles the oblique line at **15deg** will be oriented towards LH side, and for LHD vehicles the same will be oriented towards RH side.
7. Check the system function by moving the switch position from **0 to 3**, accordingly Cut-off pattern will move **downward** & at 0th position the cut-off will come at original - **1.3%** setting.
8. If the beam pattern is moving with the switch operation that means system is OK.
9. After setting both Headlamp cut-off pattern, check the head lamp reflector, There should not be any **fouling** between Headlamp Reflector & Housing.
10. Head light centre height in Scorpio Vlx is **880mm** from ground level**.**

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(2) HEADLAMP ALIGNMENT IN THE DARK ROOM:

- **Ensure that the:**

a) Vehicle & black screen/ board both are placed on the same **Level surface.**
b) Check and ensure all four tyre pressures as per specification.
c) Headlamp levelling switch position is on zero (0).



Refer above illustration -

1. Keep the vehicle at a distance of **10 meter** from the black screen in the dark room.
2. Mark the **-1.3%** height on the board as shown. i.e. **130mm** below the Headlamp centre height.
3. Set both LH & RH headlamp by setting the cut-off pattern at a height marked on the board/screen.
4. Check the function of system, by operating the switch 0 to 4 and observe the cut-off pattern movement in down word direction accordingly.
5. At zero position of switch the cut-off should come at **-1.3%** heights on screen.

Select the switch position as per following table for M-1 category vehicles -

Switch Position	Vehicle loading condition
0	Driver / Driver with Front passenger.
1	Driver + Front passenger + Rear seat occupied
2	All seats occupied
3	All seats occupied with luggage or Driver with luggage at extreme rear side.

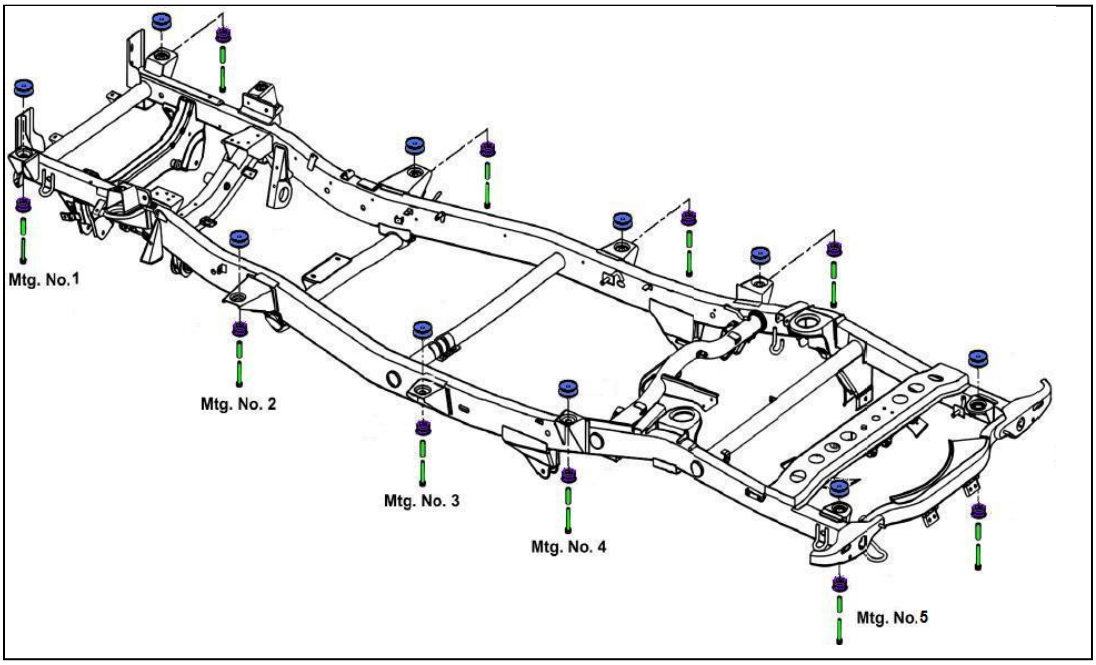
NOTE:

1. Head light centre height in Scorpio Vlx/ Sle/ Lx is **880mm** from ground level.
2. 'h' is the height **130mm** below the HL-centre height i.e. **-1.3%** setting of cut-off pattern. So here **h (cm)** is **75 cm/ 750mm**.
3. Distance of vehicle from black board is **10 meters**.

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BODY MOUNTING BOLTS - TIGHTEN

Nut/ Bolt description	Spanner Size	Quantity Nos.	Torque Value – Nm.
• Body mtg. bolts	17 mm.	10 nos.	65 ± 05 Nm.



NOTE:

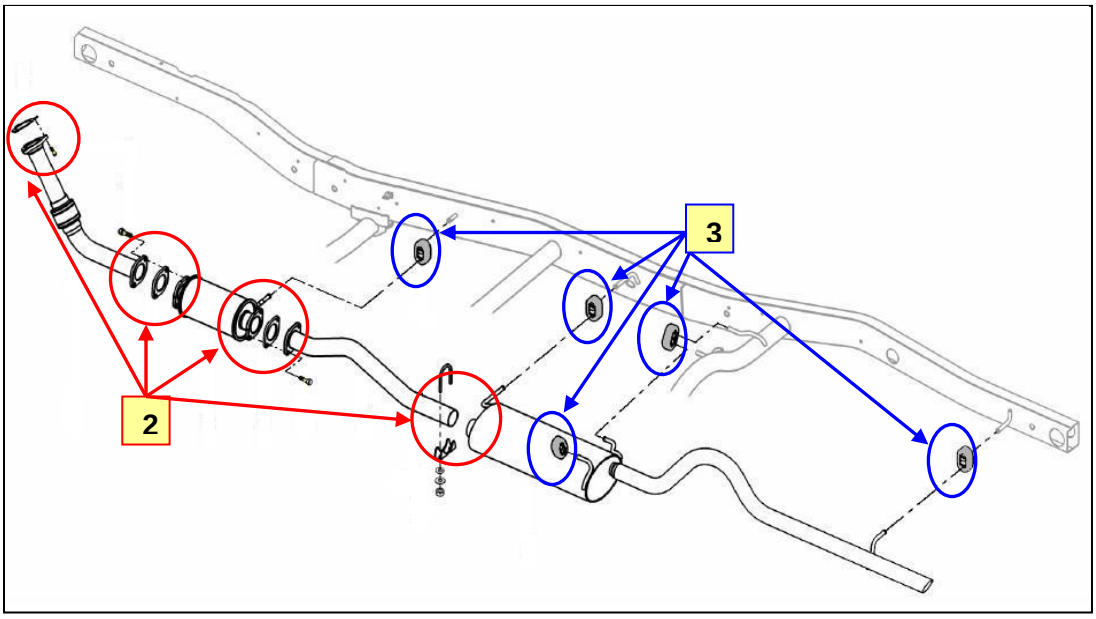
- Body mounts/ triggers on front both are denominated as Mtg. No.1 to 5.
- There are 05 Nos. Body mounts on vehicle left hand side as well as 05 Nos. on vehicle right side.
- Refer above sketch for body mount locations.



- Park the vehicle in inspection pit /2 post lift/ 4 post lift.
- If the activity is done on a 2 post lift, ensure that the LSPV spring is disconnected before lifting the vehicle & re-connect the LSPV spring & ensure that the setting height is correct after job complete.

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EXHAUST SYSTEM



EXHAUST SYSTEM - CHECK

Refer above illustrations A & B.

1. Check all the Exhaust mountings for exhaust pipe fouling and correct fittings.
2. Check all the Exhaust joints for leakage and correct fittings.
3. Check rubber hanger for crack and shift, replace and correct if required.



- Park the vehicle in inspection pit/ 2 post lift / 4 post lift.
- If the activity is done on a 2 post lift, ensure that the LSPV spring is disconnected before lifting the vehicle & re-connect the LSPV spring & ensure that the setting height is correct after job complete.

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Painting / Refinishing.

Contents

Trouble shooting

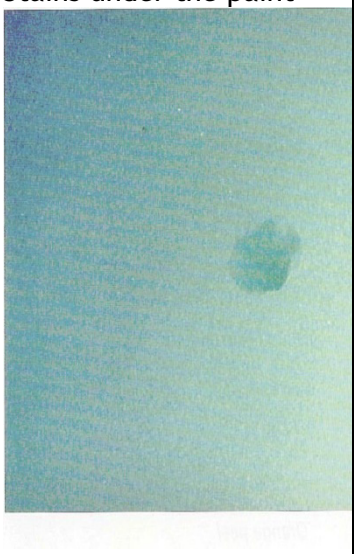
Paint application

Technical Terms

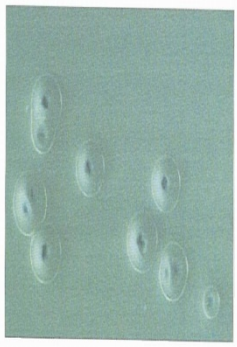
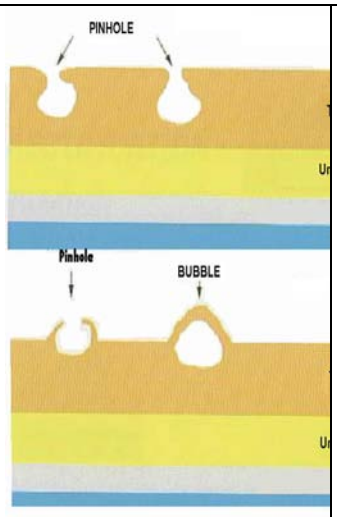
Paint details

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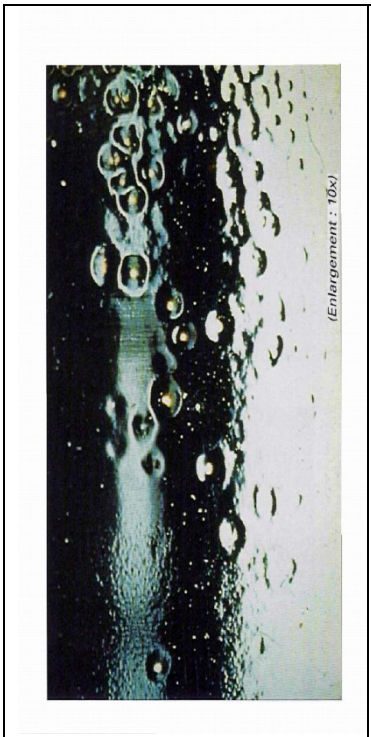
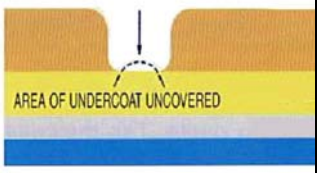
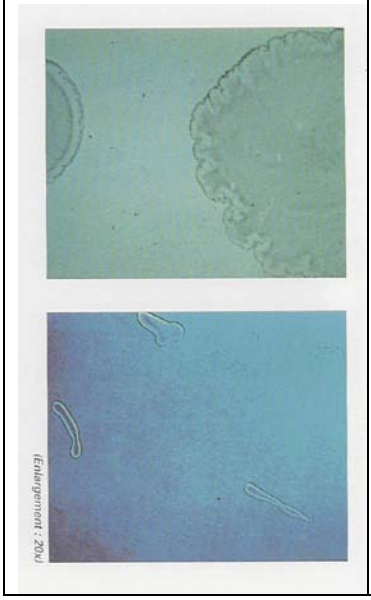
Trouble Shooting

Symptom	Causes	Remedial action
Stains under the paint  Stain appearing in the film under the finishing paint.	Application on to a stained undercoat (Fall out, faulty preparation). Gun cleaning problems.	Preparation. ✓ .Remove the affected coats with abrasive paper ✓ Finish sand **Painting.** ✓ Mask and apply the final coats according to recommended procedure
Micro Blistering/ Pinholing	1. Paint too thick. 2. Flash off time too short. 3. Oven temperature rises too rapid. 4. Viscosity too high, high paint output	**Preparation.** ✓ Remove the affected coats with abrasive paper. ✓ Finish sand. **Painting.** ✓ Mask and apply the final coats according to recommended procedure.

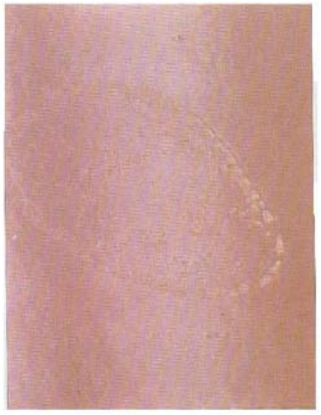
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  **Concentration of very small bubbles of solvent or air included in the paint film. A pierced bubble is called a pinhole.**		
Blistering  Blister or bubbles caused by absorption or presence of water.	1. Absorbed salts incompletely removed, pollution of the undercoat (finger marks under the paint), faulty products.	Preparation. ✓ Remove the affected coats with abrasive paper ✓ Finish sand **Painting.** ✓ Mask and apply the final coats according to recommended procedure.
Craters	1. Contamination of the prepared	✓ Remove the affected coats with abrasive

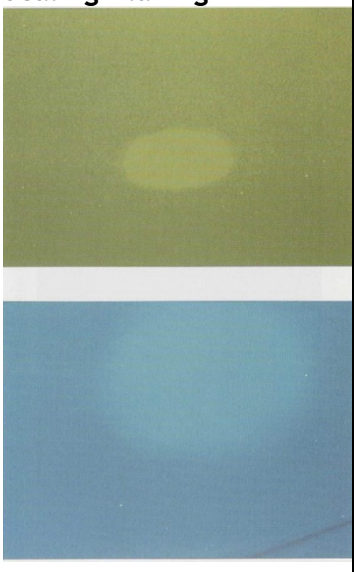
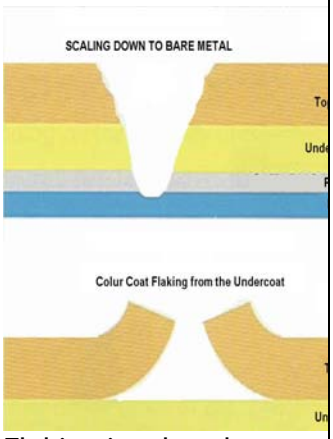
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 **cavities in the finish coat, possibly allowing the previous coat to show.**	surface causing a wetting fault (silicone, grease, wax, soap, atmospheric agents cause which can cause a similar activity) 	paper. ✓ Finish sand. ✓ Mask and apply the final coats according to recommended procedure.
Symptom	**Causes**	**Remedial action**
Stains or Deposits on the Paint 	Stain or residue of product deposited during manufacture, preparation or use of the vehicle e.g. adhesives, fuel, hydraulic fluid, lubricant	For Deposits ✓ Treatment with a body work cleaning product. If the fault persist ***Polishing:*** Elimination of the fault using the polishing paste. The thickness of the paint film removed must not exceed 8 microns. ✓ Return the gloss with a finishing polish. **Sanding + Polishing.** Elimination of the fault using a suitable abrasive paper. The thickness of the film removed must not exceed 8 microns. Next polish

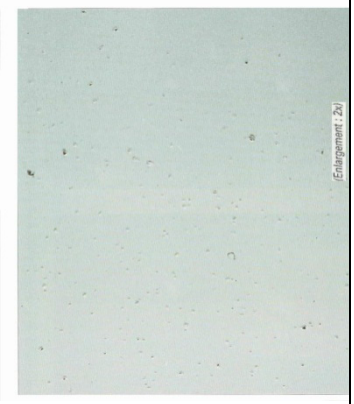
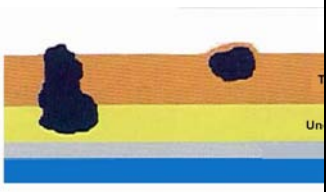
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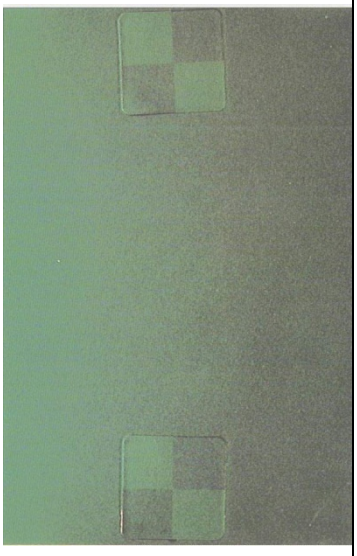
		with a polishing paste and a finishing polish. If the fault is still persisting. **Preparation**. Remove the affected areas with abrasive paper. Finish sand. **Stain:** Preparation Remove the affected coats with abrasive paper Finish sand Paint. Mask and apply the final coats as per recommended procedure.
Atmospheric fall out  	Stains or deposits mainly affecting the horizontal surfaces of the body work. This fall out can cause an attack in depth, which can extend to flaking of the paint if it is not dealt with without delay. Atmospheric fall out can be of industrial origin(foundry, cement works, furnace…), vegetable (tree resin) or animal (bird or insect droppings	Remove the affected coats with abrasive paper. If bare metal is showing - apply an anti corrosion primer. Finish sand Mask and apply the final coats according to recommended procedure.
Runs	Viscosity of the	Depending on the severity of the fault , carry out one

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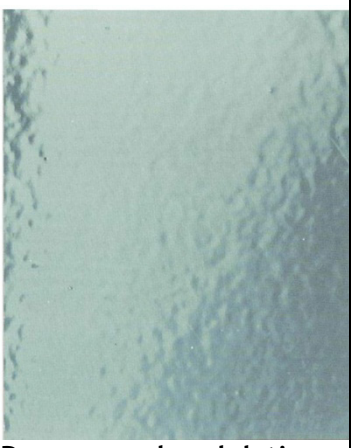
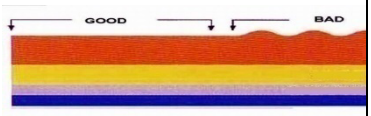
 (Scale 1:1) **Layers of paint or varnish in the shape of a curtain starting , generally , on vertical parts or from a panel joint**	product:- 1. Thickness too great. 2. Paint flow too great. 3. Air pressure too low. 4. Gun too near.	or the other of the following solutions: **Sanding +Polishing.** Elimination of the fault using a suitable abrasive paper. The thickness of the paint film removed must not exceed 8 microns. Next polish with a polishing paste and a finishing polish **Or** Remove the affected coats with abrasive paper. Finish sand Mask and apply the final coats according to recommended procedure.
Symptom	**Causes**	**Remedial action**
Scaling/Flaking  Mechanical destruction of one or more of the coats of the paint film which can extend to bare metal and give rise to corrosion of metal parts.	 Flaking is related to poor adhesion of one coat on the previous coat or to the base and can affect one or several components of the vehicle. It can be caused by either Stone chips, damage. High-pressure washing	Preparation. ✓ Remove the affected coats with abrasive paper. ✓ If bare metal is showing apply an anti corrosion primer. ✓ Finish sand. **Painting.** ✓ Mask and apply the final coats according to recommended procedure.

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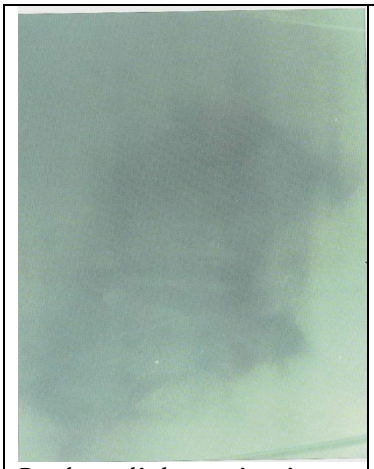
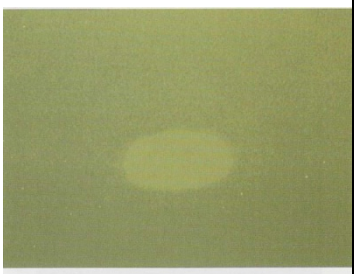
	used inappropriately Preparation or paint procedures not followed correctly.	
Dirt  **Small solid particles embedded in the paint producing a rough paint surface**	**Foreign bodies present in the air or the product during painting.** 	**Preparation.** Depending on the severity of the fault , carry out one or the other of the following solutions: **Sanding +Polishing.** Elimination of the fault using a suitable abrasive paper. The thickness of the paint film removed must not exceed 8 microns. Next polish with a polishing paste and a finishing polish **Or** Remove the affected coats with abrasive paper. Finish sand **Painting.** Mask and apply the final coats according to recommended procedure.

Symptom	Causes	Remedial action
Thin paint / Lack of cover  **Partial or total insufficiency of color or**	1. **Paint flow insufficient.** 2. **Unsuitable gun nozzle.** 3. Gun too far away.	**Preparation.** Flat with fine paper to obtain adhesion to the underneath coat **Painting.** Mask and apply the final coats according to recommended procedure

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varnish. It can cause differences in color and relief of the paint surface or a lack of gloss		
Orange Peel  **Pronounced undulations of the paint film giving a granular appearance resembling orange peel**	Application parameters, solvent balance, paint viscosity, surface condition of the previous coat, paint film thickness. 	**Preparation.** Remove the affected coats with abrasive paper. . If bare metal is showing apply an anti corrosion primer .Finish sand **Painting.** Mask and apply the final coats according to recommended procedure.
Insufficient gloss **Poor reflection of light or image which can appear Matt**	Insufficient thickens, sinking, excessive baking, under baking of the preceding coat, faulty products	Polishing. Elimination of the fault using polishing paste. The thickness of the paint film removed must not exceed 8 microns. Return the gloss with a finishing polish. If the fault still persist. **Preparation.** Flat with fine paper to obtain adhesion to the underneath coat then paint **Painting.** Mask and apply the final coats according to recommended procedure
Marbling	1. Temperature of the application too low	**Preparation.**

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 **Dark or light stains in the shape of irregularly distributed veins giving a non uniform color to the panel**	2. Faulty dilution 3. Poor spraying technique 4. Faulty gun adjustment	Flat with fine paper to obtain adhesion to the underneath coat. **Painting.** Mask and apply the final coats according to recommended procedure
Color difference. **Difference in color visible between two panel**		**Preparation.** Flat with fine paper to obtain adhesion to the underneath coat **Painting.** Mask and apply the final coats according to recommended procedure
Sanding/Polishing marks   **Sanding marks: scratches visible through the paint film.**	Sanding/ polishing procedure poorly executed	**Preparation.** Flat with fine paper to obtain adhesion to the underneath coat **Painting.** Mask and apply the final coats according to recommended procedure

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Polishing marks: lighter paint halo		
Deterioration  **Superficial deterioration of the paint finish**	**The micro scratches can be caused by an over aggressive roller brush car wash (badly maintained, incorrectly adjusted, etc)** In this case they are circular or lengthwise and cover the whole of the body. In other case they will be multi directional (a dirty or abrasive sponge, rubbing by an object etc.)	**Preparation.** ***Polishing***. Elimination of the fault with cutting paste. **The thickness of paint removed should not exceed 8 microns.** Restore the gloss with finish paste. If the fault persist Fine rubbing down + polishing. Rub down with suitable abrasive paper and then polish. ***Scratches*** **Preparation**. Remove the affected coats with abrasive paper. Finish with fine paper **Painting.** Mask and apply the final coats according to recommended procedure

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Paint application

Surface preparation

Proper surface preparation is the key to top quality body panel refinishing. Even if it is sometimes long, sanding with the adequate abrasives of suitable material and properly trained personnel will ensure a quality result. The importance of selecting the right grit is a must. If unsuitable grit is used then will cause damage impossible to hide. For example a 40 grit causes very deep scratched – do not ever use this grit.

Always clean the panel surface with a wax and grease removal solution and then wipe the surface with a lint free rag before applying primer or paint. Cleaning will also remove any residual silicone from the painted surface.

Body putty that is procured from any major supplier is recommended. If synthetic body filler is to be used then it should be a quality product.

Primer

The type of primer to be used is dependent on the condition of the panel surface. Bare metal should be primed with epoxy – base. A sealant is recommended when applying a second color coat over an existing color coat. With certain colors sealants are also important in preventing bleed through.

Base/ Color coat

Base color coat paint finishes must be applied in a clean envoirement. Top loader guns are recommended for applying the base / color cat paint.

Base / color coat paint should be reduced/ thinned and applied to the manufacturers suggestion. Please refer to the manufacturer suggestion.

Basecoat/ Clearcoat

Basecoat/ Clearcoat application is a two stage process. The Basecoat is applied over the final primer coat. The Clearcoat is then applied over the Basecoat. The Clearcoat provides the paint finish with a high gloss and increased durability

The work areas should be well ventilated for application of Basecoat and Clearcoat paint. More particularly when applying the Clearcoat paint.

Buffing & polishing

Minor paint defects in Basecoat/ Clearcoat can frequently be removed by light sanding, buffing & polishing. Wet sand the defect with 600 grit soaked in mineral spirits.

Buff the surface area with fine grade buffing compound. Finish the repair with quality polishing compound to blend and restore the gloss.

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Technical Terms

Single Coat

A single coat spray pattern is applied from left to right. After that the returning right to left spray pattern is applied so that it overlaps the lower one half of the initial spray pattern

Double Coat
A double coat spray pattern is applied from left to right. Then the returning spray of right to left is applied.

Drying
Drying and hardening of the film involves 3 stage of evaporation.
1st stage- Dust free stage.
2nd stage- tack free stage.
3rd stage-hard dry stage.

It is recommended that to obtain a high quality of gloss the painting operation and drying be done in a paint booth where the heating can be achieved.

Degrease/ De wax

Degreasing or dewaxing involves cleaning a panel surface either with 3M All-purpose cleaner or any other equivalent. This removes the surface grease or wax

Flash Time
is the time required for the solvent to evaporate from the applied primer / paint coat.

Mist Coat

A mist coat is frequently used as the final color coat. Mist coats are overthinned paint that is sprayed wet.

Surface Primer Coat

A surface primer must be applied over the repaired metal substrate. The body parts taken from the Spare parts have the OE treatment of CED priming.
The primer provides a bond between the metal and the colurs base coat. Various type of primers for use in exposed parts are available. Surface primers are available in either sandabale or non sandabale form.

Spot putty can be applied on top of the primer to cover up small imperfections which will not get covered / concealed by the standard primer

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Reducer/ Thinners

Is mixture of volatile liquids and are used to reduce the surface primers and color coat paints. Use only the type that is specified.

Paint Details
For paint details refer Technical Service Bulletin (TSB)

The Reference Number for TSB is M&M/IO/PAINT/1/10/08

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