FREIGHTLINER® LLC
A DaimlerChrysler Company

STERLING 360

Student Guide

SDF-915
3/06

Training Manual Use

This training manual is intended for use while attending a Freightliner, LLC Service Training Program. Continuous improvements in our products and service procedures may make some of the information in this manual obsolete or invalid.

Current Manufacturer's Publications

Always refer to current, approved, Manufacturer's Publications when servicing Freightliner, LLC trucks. Training materials are for reference only.

Environmental Concerns

When discarding materials, please attempt to recover and recycle them. To preserve our environment, follow appropriate environmental rules and regulations for recovery and disposal of materials.

FREIGHTLINER LLC
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COURSE CONTENT

- Module 1: Overview
- Module 2: Manuals
- Module 3: Familiarization
- Module 4: Maintenance
- Module 5: Engine
- Module 6: Transmission
- Module 7: Diagnostics

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INTRODUCTION

- Welcome
- Safety Precautions
- Course Objectives

Welcome

Who, What, Where & When

1. Welcome
2. Instructor name
3. Course Title
4. Course length
5. Time
6. Breaks
7. Rest rooms
8. Smoking
9. Meals
10. Transportation
11. Telephone #'s
12. Enrollment & Course Catalog

Personal Introductions

13. Instructor Introduction - (personal & professional)
    a. Technical background
    b. Teaching background
14. Introduction - Student
    (personal & professional)
    a. How long have you worked at current dealership/location?
    b. How long have you been a technician?
    c. What is your specialty or area of interest?

This is what I expect to get from this course.

Course Evaluation

We need your help to keep this course focused on your needs. Your instructor will give you our Course Evaluation form. When the course is over, please complete the form and return it to your instructor before you leave.

The Business Class M2 course contains material that is covered in other Freightliner LLC training material. Please consider attending these classes, and go to The Learning Center at *www.AccessFreightliner.com* to continue your technical training.

Related and recommended classroom courses:

Service & Maintenance (1001, 2 days)

HVAC (1053, 4 days)

Electrical Problem Solving (1151, 4 days)

Electronic Systems, (1401, 2 days)

Modules and/or Self-Paced courses available on-line at The Learning Center on *www.AccessFreightliner.com*:

Introduction to the DMM (SDW001-1)

Seven Steps to Circuit Mapping (Elec_sevensteps)

ServiceLink Web Based Training (FSW290)

Safety Precautions

Some of our course activities require you to turn on vehicle ignition. Remember that safety precautions must always be performed before you turn trucks on in the shop.

When working on or around trucks, observe the following precautions:

- To start a vehicle, the technician must be properly seated in the driver's seat. Vehicles are not started from the floor.
- In some cases the whole class will be working on a single vehicle.
  If you are in the cab, **do not:**
  - Start the engine
  - Honk the horn
  - Turn on the windshield wipers
  - Release the parking brakes
  - Depress the clutch pedal (manual linkage)
  - Operate anything that may cause harm to another student
- Observe normal shop safety procedures and be alert to prevent accidents

Shop Rules:

1. If you take it apart, you put it back together properly. Leave the trucks in "as good as" or better shape than you found them.
2. If you get a tool out, you put it back where you found it. Don't leave it out for the next group.
3. If anything breaks or you find something broken, let the instructor know.
4. Once you find a "bug," ask your instructor whether you should remove it or leave it.
5. Work safely. If you don't have the proper equipment, ask for it.

Goal

This course will provide technicians with a foundation for improved customer service by means of reducing labor expenses and "shop comeback" repairs.

Course Objectives

Module 1 - Sterling 360 Overview

A. The student will be able to describe basic product specifications.

B. The student will be able to find service information in the Workshop Manual.

C. The student will be able to find component locations on the vehicle.

D. The student will be able to safely operate the cab tilt function.

E. The student will be able to find service intervals in ServiceLit.

F. The student will be able to perform basic dash dis-assembly/re-assembly.

G. The student will be able to explain basic engine specifications and construction.

H. The student will be able to locate engine related components.

I. The student will be able to perform a valve adjustment.

J. The student will be able to explain basic automatic transmission specifications and construction.

K. The student will be able to locate automatic transmission related components.

L. The student will be able to perform an automatic transmission Dealer Adjust procedure.

M. The student will be able to find and perform diagnostic routines from the Workshop Manual.

N. The student will be to perform diagnostics using the MUT/VCI.

O. The student will be able to initiate and read diagnostic flash codes.

MODULE 1

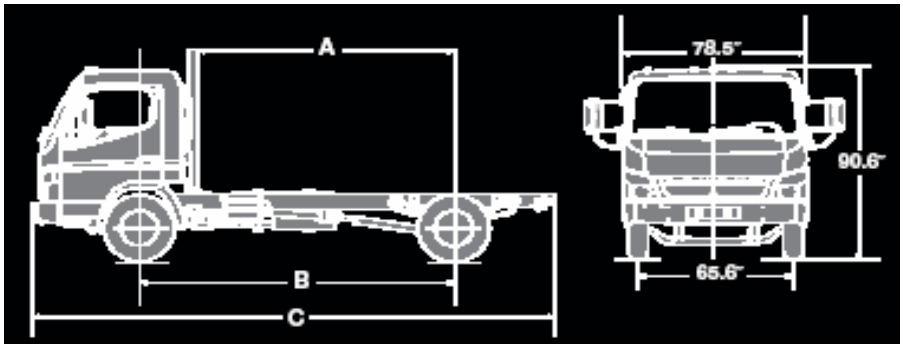
OVERVIEW

- Important Features
- Component Identification and Location

Use space provided for your notes and questions.

Be sure to enter new and different features.

Notes:



LCOE 40

- Class 4 – GVW 14,050 lb
- WB 114 – 152 in

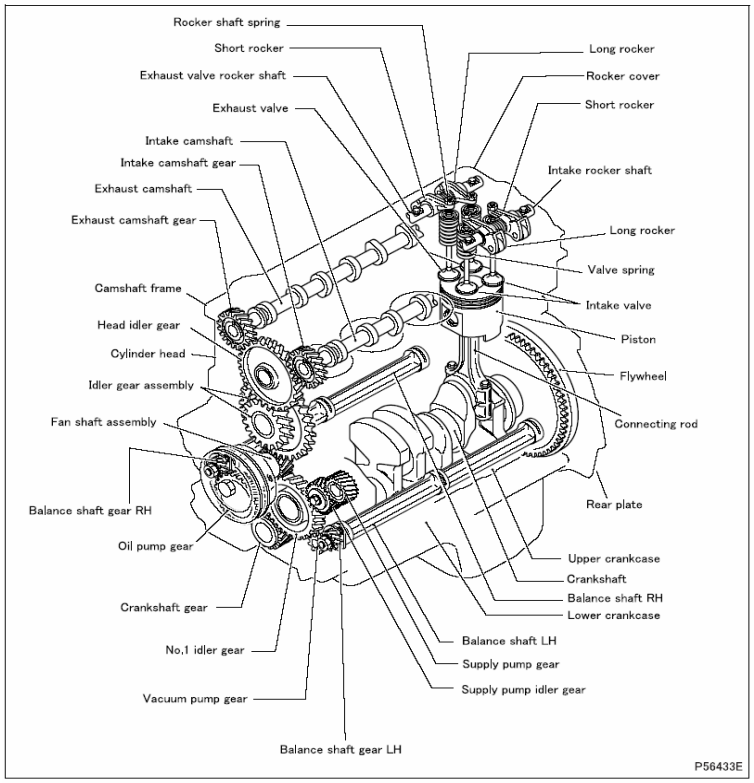
LCOE 45

- Class 4 – GVW 14,500 lb
- WB 114 – 164 in

LCOE 50

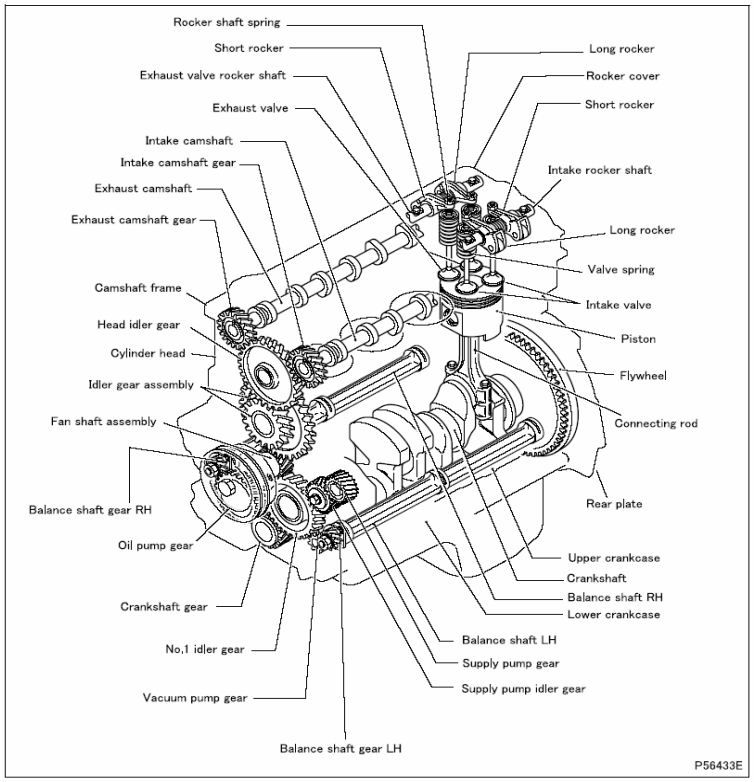
- Class 5 – GVW 17,995 lb
- WB 114 – 176 in

Notes:



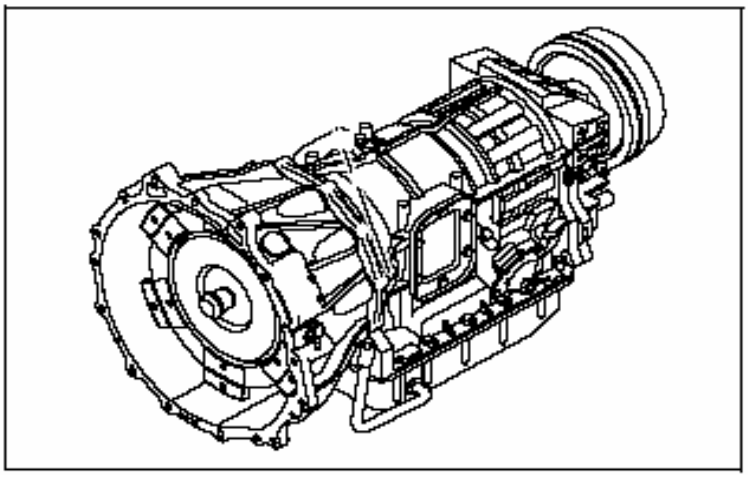
Item	Specifications	
Engine Model		4M50T8
Type	4-cylinder, in-line, 4-cycle diesel engine	
Combustion Chamber	Direct injection type	
Valve Mechanism	Double overhead camshaft (DOHC)	
Maximum Output HP/rpm		175 / 2700
Maximum Torque ft.lb/rpm		391 / 1600
Bore X Stroke mm (in)	114 × 120 (4.49 × 4.72)	
Total Displacement L (cu in)	4.899 (299)	
Compression Ratio	17.5:1	

Notes:



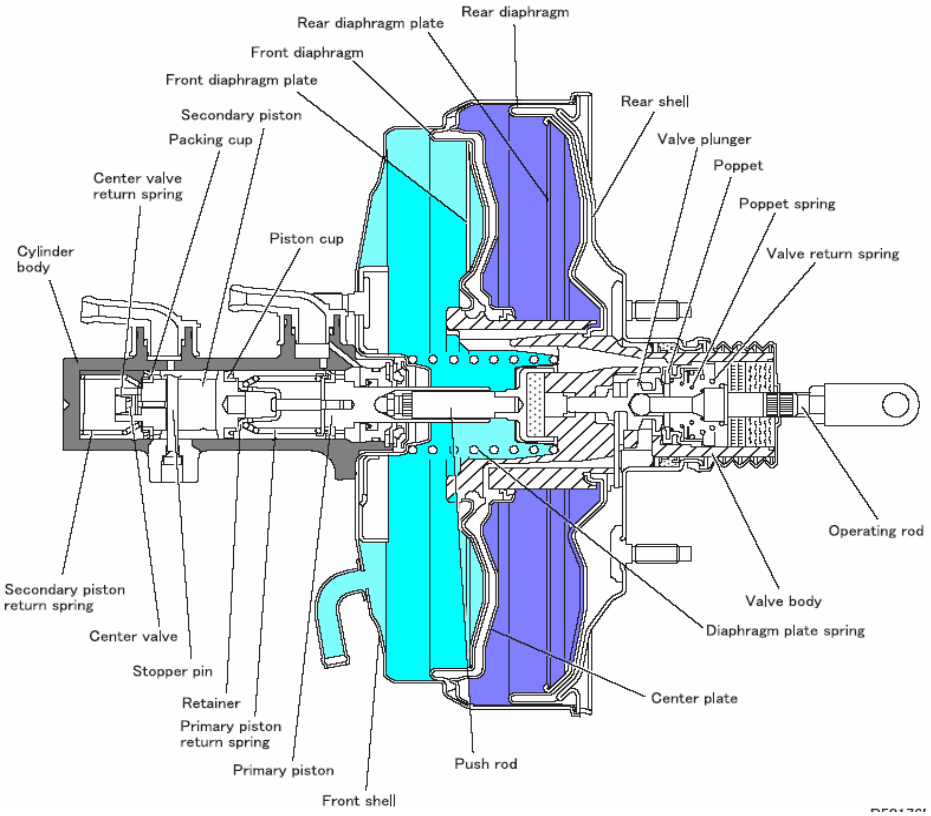
- Bosch Common Rail Fuel System
- Electronic Injectors
- EGR
- Intake Throttle Valve
- Balance Shafts
- Glow Plugs for Cold Starts
- Turbocharged/After-cooled
- Water cooled turbo

Notes:



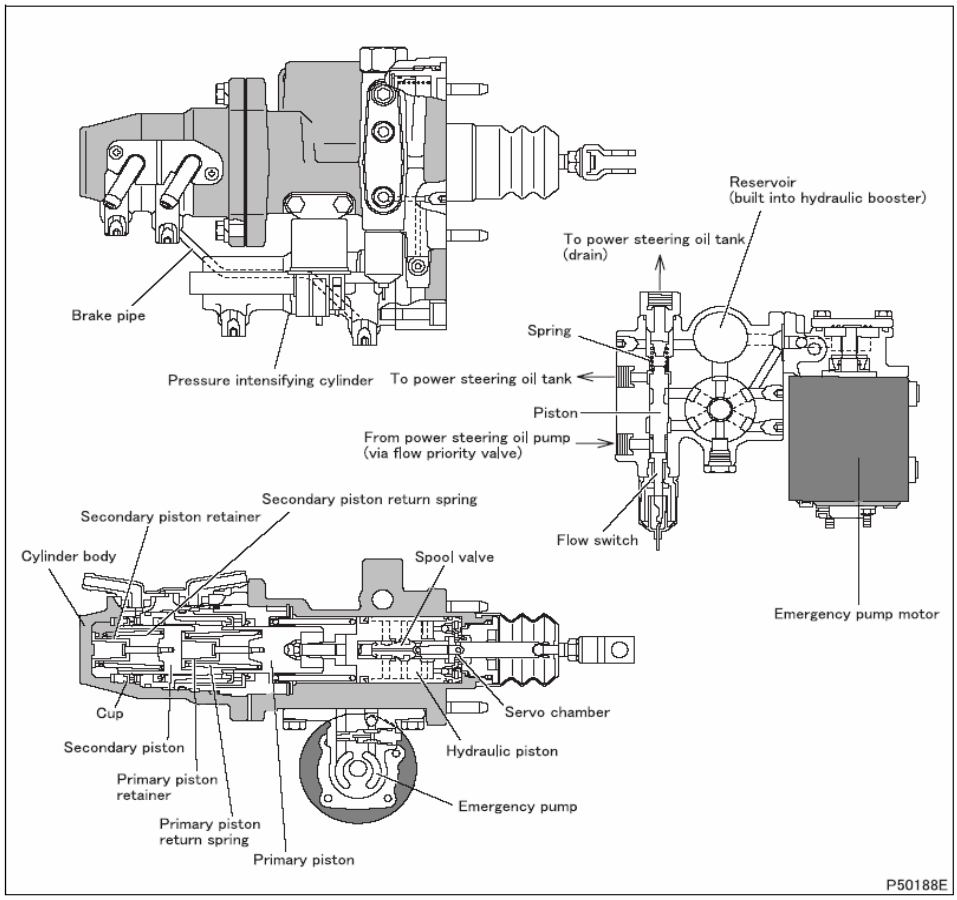
Item	Specifications	
Manufacturer	Aisin	
Transmission Model	M036A6	
Torque converter	3-element (with lockup clutch)	
	Stall Ratio 1.60	
Transmission	Planetary type; 6 forward gears, 1 reverse gear	
Gear ratios	1st	3.742
	2nd	2.003
	3rd	1.343
	4th	1
	5th	0.773
	6th	0.634
Automatic Transmission Fluid	Type Mobil ATF3309	

Notes:

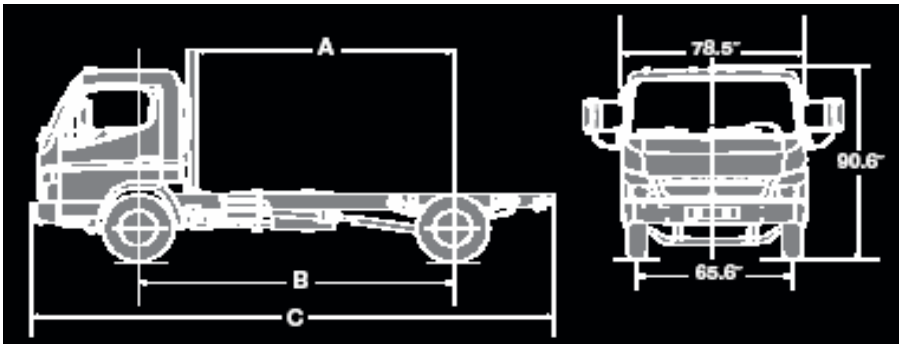


- All Models have Hydraulic Disc Brakes
- LCOE 40, LCOE 45
  - Vacuum Booster
  - Engine driven vacuum pump for booster and exhaust brake

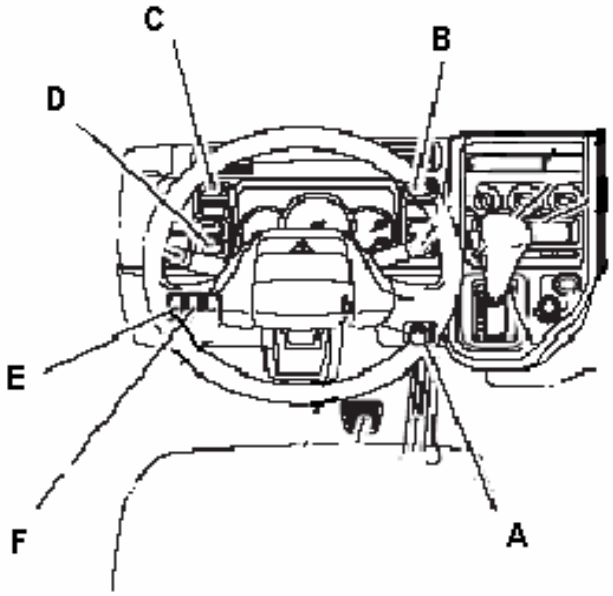
Notes:



- Hydraulic Disc Brakes
- LCOE 50
  - Hydraulic Booster
  - Uses Power Steering Pump
  - Backup Electric Motor
- Retains vacuum pump to operate exhaust brake



- Power Steering
- LCOE 40/45
  - ♦ 215/85R16
- LCOE 50
  - ♦ 215/75R17.5
- Automatic Exhaust Brake
- Two 799 CCA Batteries
- 100 amp Alternator



A. Idle Control

B. Warm Up Switch

C. Low Oil Level

D. Door Lock Switch

E. Panel Light

F. Dome Lamp (body)

MODULE 2

MANUALS

Use space provided for your notes and questions.

Be sure to enter new and different features.

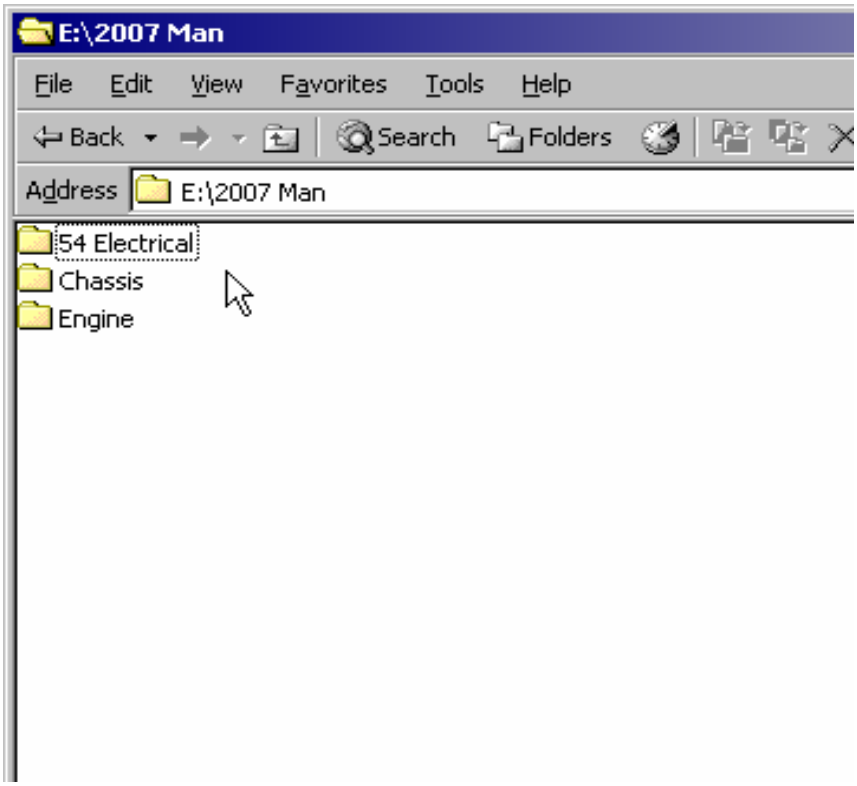
Notes:

FE

SERVICE MANUAL
2007 Model

- Manuals will be available in ServicePro mid-2006
- Preliminary 2007 manual on CD
- Must have Acrobat Reader

Notes:



- Place CD in drive and open
- Open CD from My Computer icon
  - Some computers may automatically open the CD
- Open the 2007 Man folder
- Three main files
  - 54 Electrical
  - Chassis
  - Engine

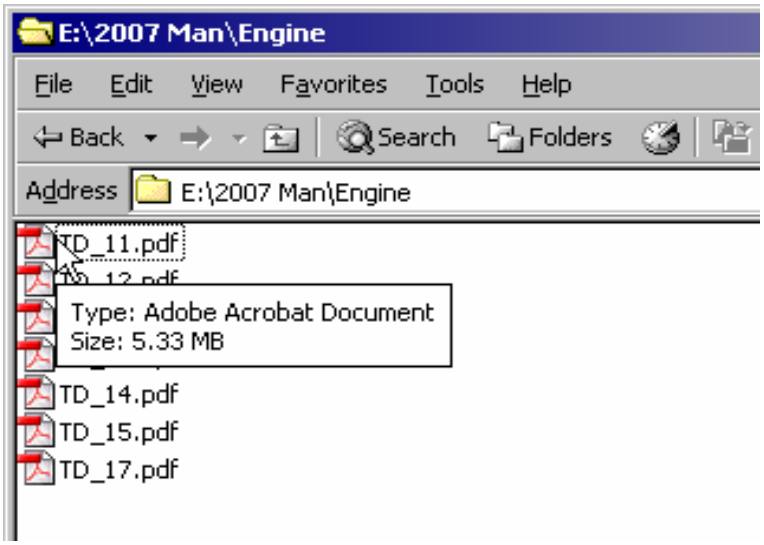
Notes:

GROUP INDEX

- 54 Electrical has most electrical systems with the exception of
  - Engine
  - Transmission
  - ABS
- Engine has groups 11 - 17
- Chassis has remaining groups

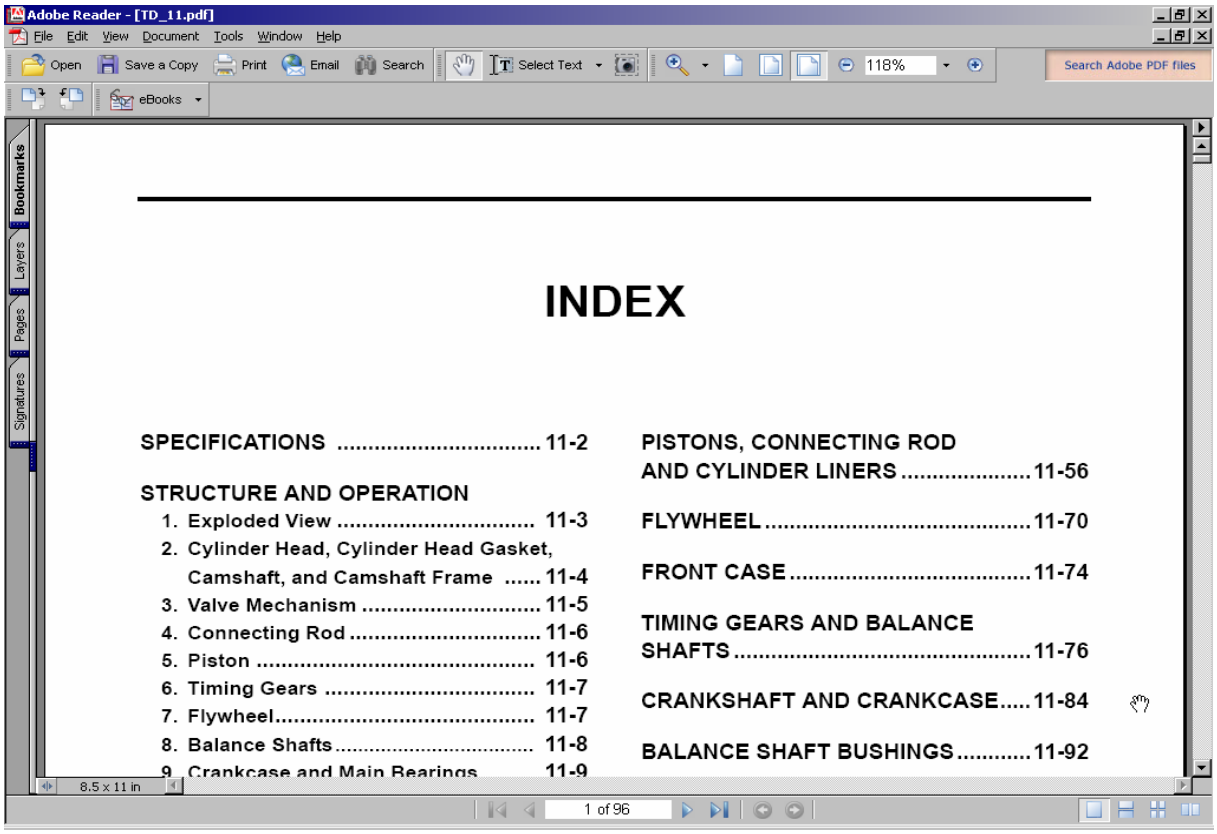
Note: Sterling 360 Group numbers are unique to the 360

Notes:



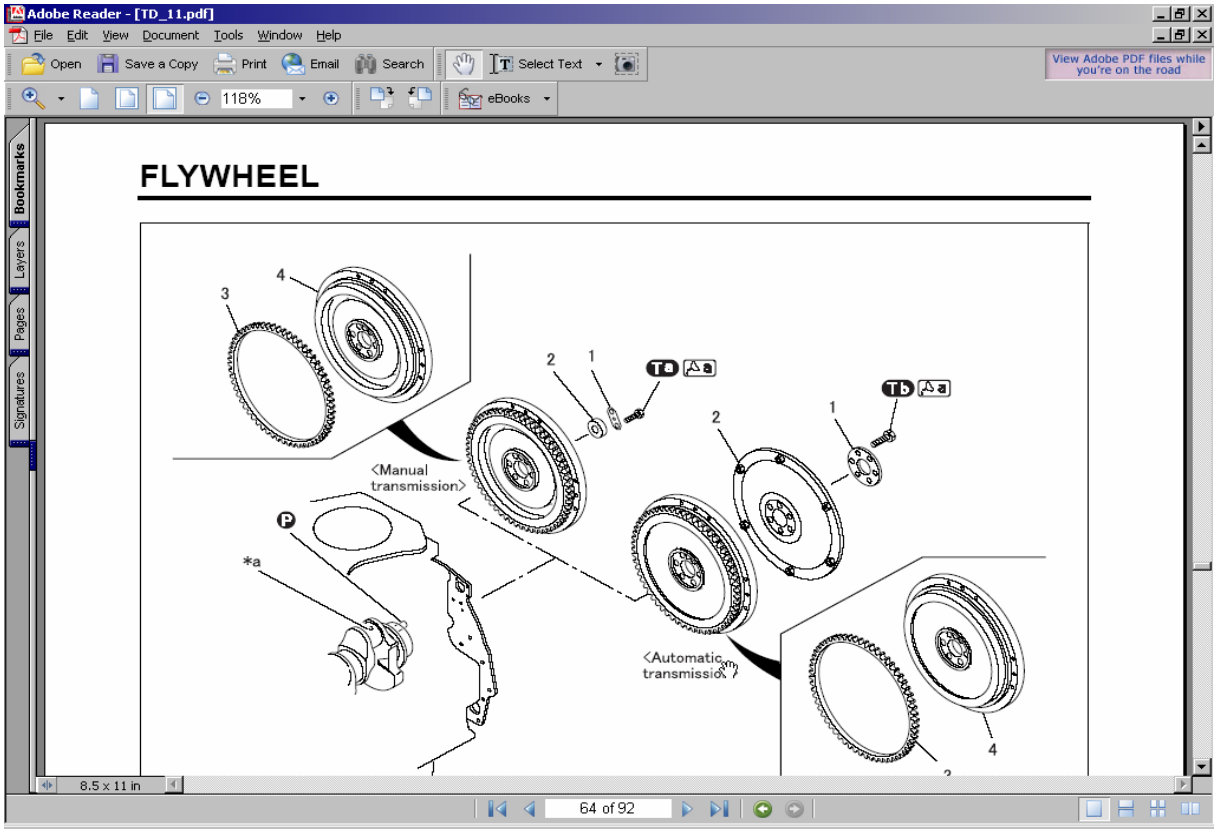
- Open the Engine folder
- Engine related file are listed by group number
- Open file by double clicking

Notes:



- Group Index will open
- Use right scroll bar to find pages
- Page number shows up at bottom of screen
- Flywheel is 11-64

Notes:



- Page 11-64

Notes:

GROUP INDEX

Now it’s your turn

Complete Exercise 1 - Sterling 360 Manuals

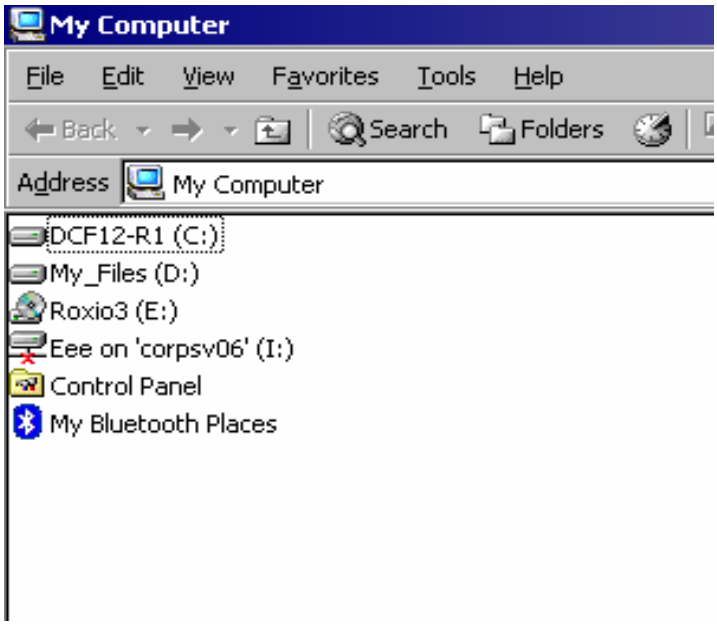
Exercise 2.1 Sterling 360 Manuals

Sterling 360 Manuals will be available in ServicePro by mid-year. In this class you are being supplied with a preliminary version of the Workshop manual on CD. This Worksheet will help you navigate the CD to find important information.

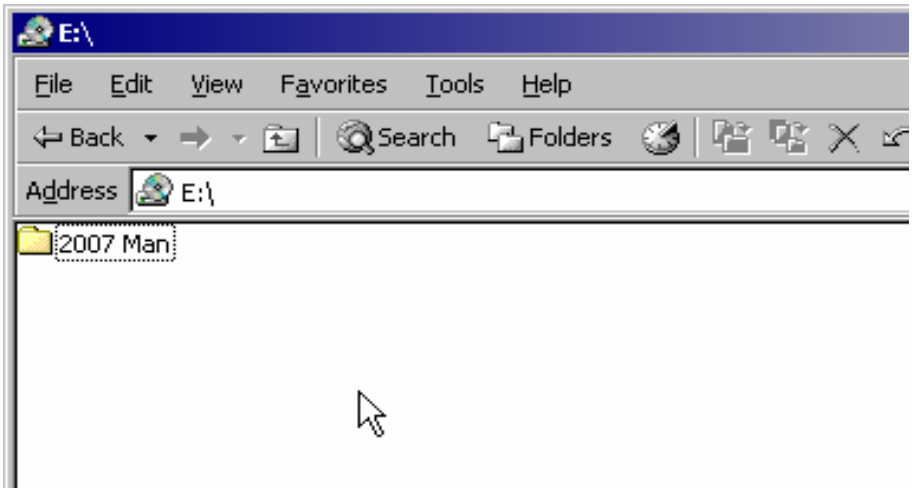
Insert CD into CD drive. If your computer is set to auto-start a CD you will go directly to the third screen below: if not the next two screens tell you how to open the CD.

Go to the My Computer icon on your desktop and double click

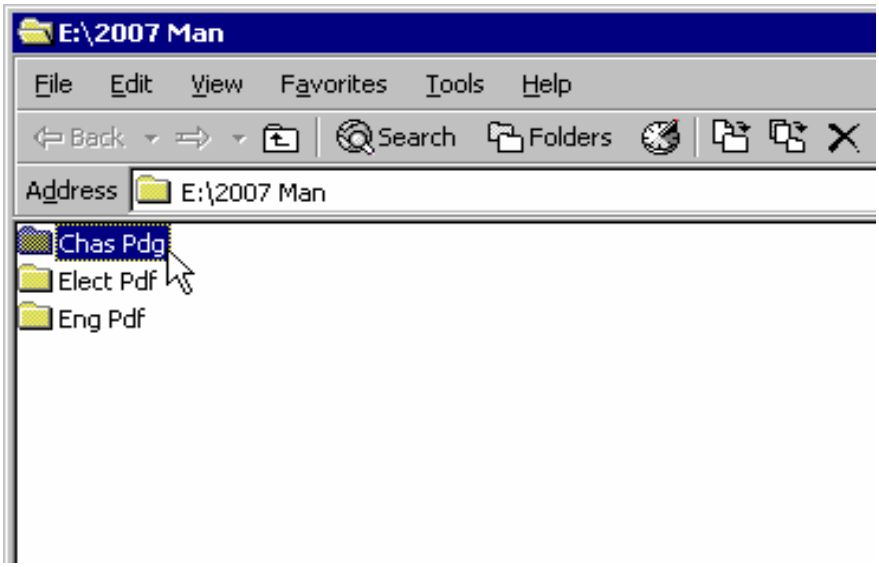
From the list select the CD drive and double click (in the illustration it's drive E)



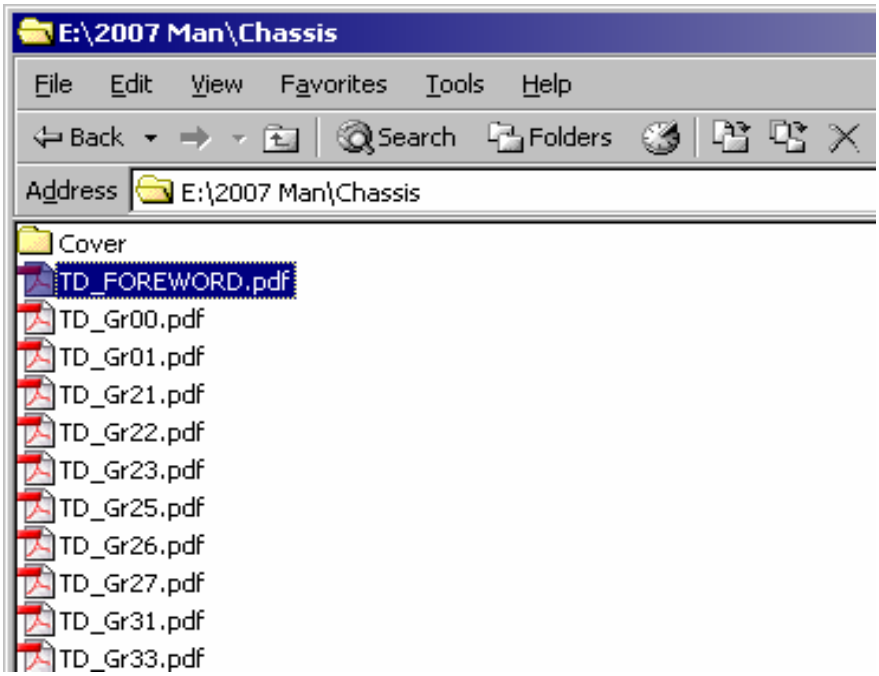
This will show a list of the files on the CD.



Open the 2007 Man folder by double clicking on it

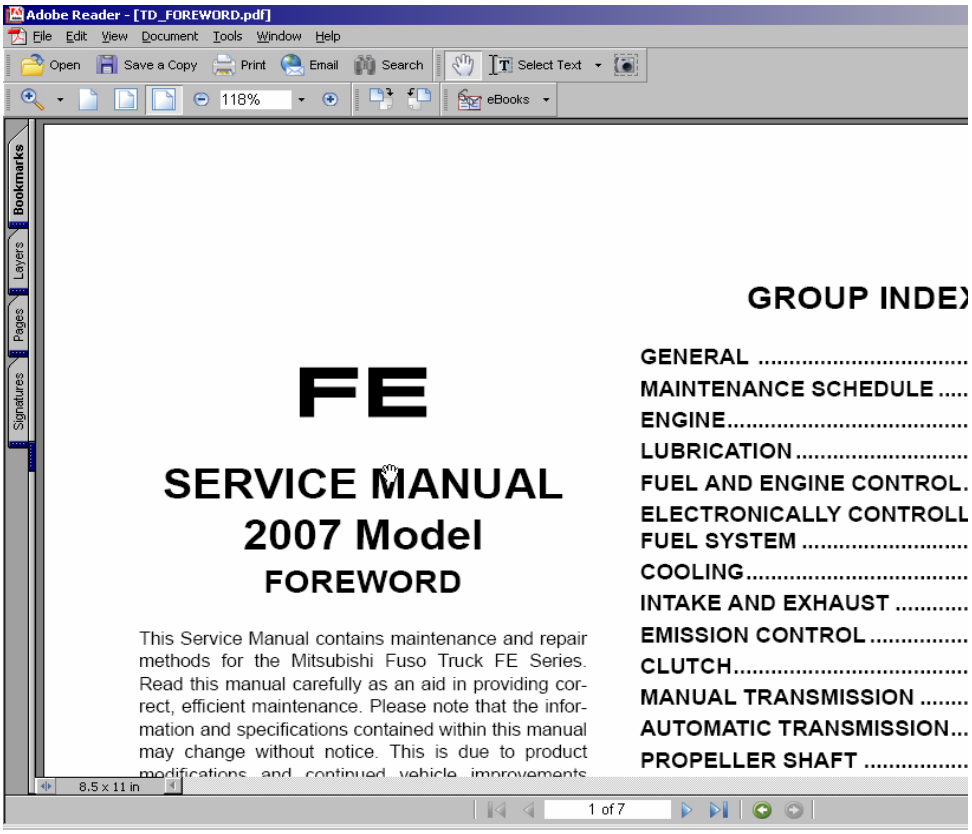


Select the Chassis file and double click on it

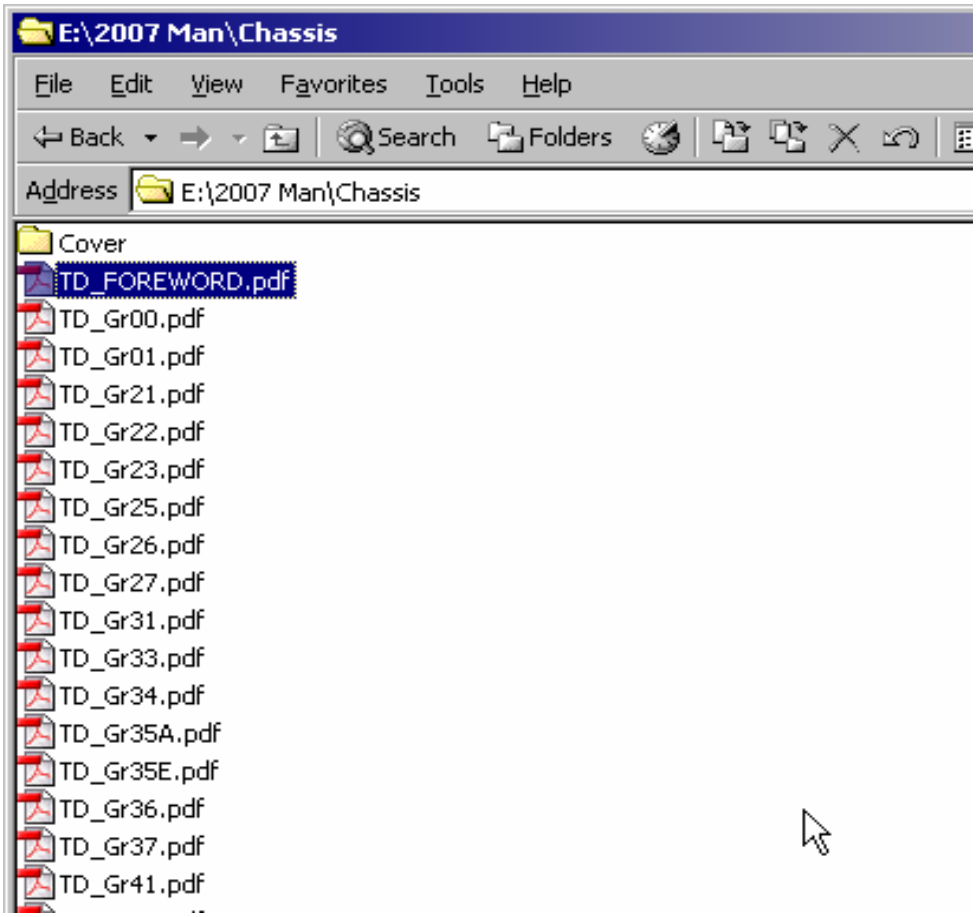


Select the TD_FOREWARD file and double click on it.

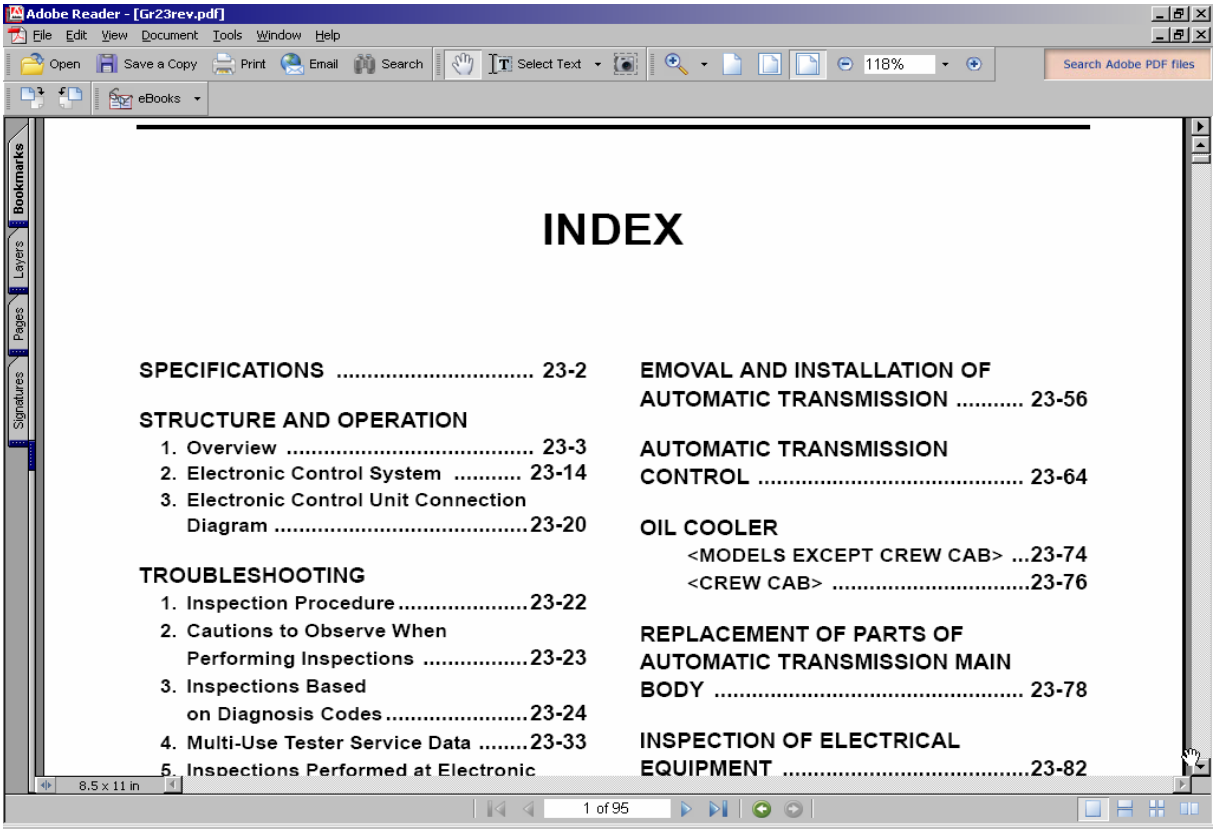
This page has the Sterling 360 group numbers on it. You may want to print this page for future reference. There is a copy at the end of this exercise.



Close this file by clicking on the X in the upper right hand corner. That should bring you back to this screen.



Open the group 23 file.

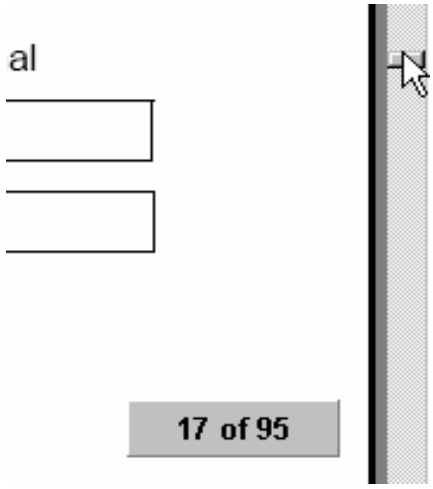


Scroll down and find Installed Location of Parts.

1. What page number is this on? _____

Go to this page by using the scroll bar, page numbers are shown at the bottom center of the screen.

Note: If you grab the scroll bar placement indicator and move it, the page numbers show in a small drop down screen as you are moving the indicator.



If this feature doesn't work, ask your instructor to turn it on for you.

Once you get to the Installed Parts Location page, use the location identifiers (A01, B05, etc.) to answer the following questions:

	Item	Location
2.	Transmission ECU	_____
3.	Multiuse Tester Connector	_____
4.	Multiuse Tester Connector	_____
5.	ATF Thermo Switch	_____
6.	Output Speed Sensor	_____

Now see if you can find the list of diagnostic fault codes.

7. What is the code for lock-up clutch problem?

   Fault code _____ Flash code _____

Close this section of the manual and find the Brakes section. You will have to go back to the CD file list. You can use the Group Index at the end of this exercise to find the proper file.

8. What group number is Brakes? _____

Open the Brakes file and use it to answer the following questions:

9. Referencing the Specifications; what company manufactures the brake boosters?

   _____

10. How long should it take the brake booster vacuum pump to reach 23.6 in Hg at 3000 RPM?

    _____

11. What is the wear limit thickness for a disc brake pad?

    _____

One more change, close the Brakes file and find and open the Elect folder (Group 54). In group 54 there is a general index that covers the whole section. This is another one you may want to print out for reference. It is included at the end of this exercise.

Open the *GR_54_HOW_TO.pdf* file. This is a short section take the time to read through it. This will help you answering the following questions.

Pay particular attention to the diagram of the connector shown at 1.5 on page 3. All electrical connectors follow this numbering convention and not the numbers printed on the connector. We will discuss this more when we get to Diagnostics.

12. Find the schematic for the Fuel Gauge Circuit, what circuit feeds power to the fuel gauge?

    Circuit _____ Color _____

13. What circuit connects the fuel gauge to the sending unit?

    Circuit _____ Color _____

Note the lettered bold numbers on the schematic such as C02, J04, U31 and T05. Also note the #258 above the T05 number. Now open the file for Electrical Equipment Installation Positions.

14. What do the lettered bold numbers from the schematic represent?

    _____

Find Inspection of Electrical Equipment on the index open the file and go to the page with #258.

15. What is the specified resistance for the sending unit at ½ reading?

    _____

GROUP INDEX

INDEX

54-05 INDICATOR AND WARNING LAMP CIRCUIT

54-06 CAB SIDE ELECTRICAL CIRCUIT

54-07 CHASSIS SIDE ELECTRICAL CIRCUIT

54-08 ENGINE AND TRANSMISSION SIDE ELECTRICAL CIRCUIT

54-09 OTHER CIRCUIT

54-10 PARTS INSTALLATION POSITIONS

Cab side

Engine and transmission

Chassis side

54-11 INSPECTION OF PARTS

54-12 STARTER AND ALTERNATOR

54-13 ON-VEHICLE INSPECTION AND ADJUSTMENT

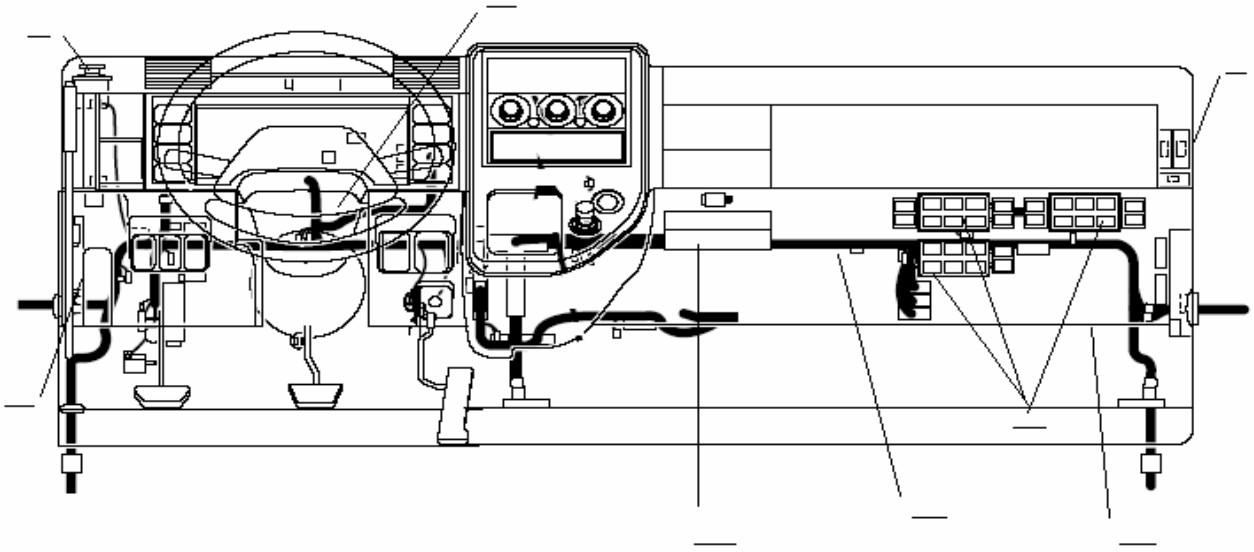
54-14 CONNECTOR CONFIGURATION CHART

MODULE 3

FAMILIARIZATION

Exercise 3.1 Interior Components

This exercise will familiarize you with the vehicle. There are three sections to this worksheet, Interior, Exterior and Under Cab. Take turns and find as many components as you can. When everyone has done the first two sections, lift the cab and complete the final section. You may refer to the Workshop Manual if needed. After 45 minutes we will return to the classroom and discuss your answers.



Go to the truck and find the components listed below. Mark component locations on the picture above.

A. Fuse Panel

B. Brake Fluid Reservoir

C. Washer Fluid Reservoir

D. Relay Panels

E. Master Cylinder & Booster

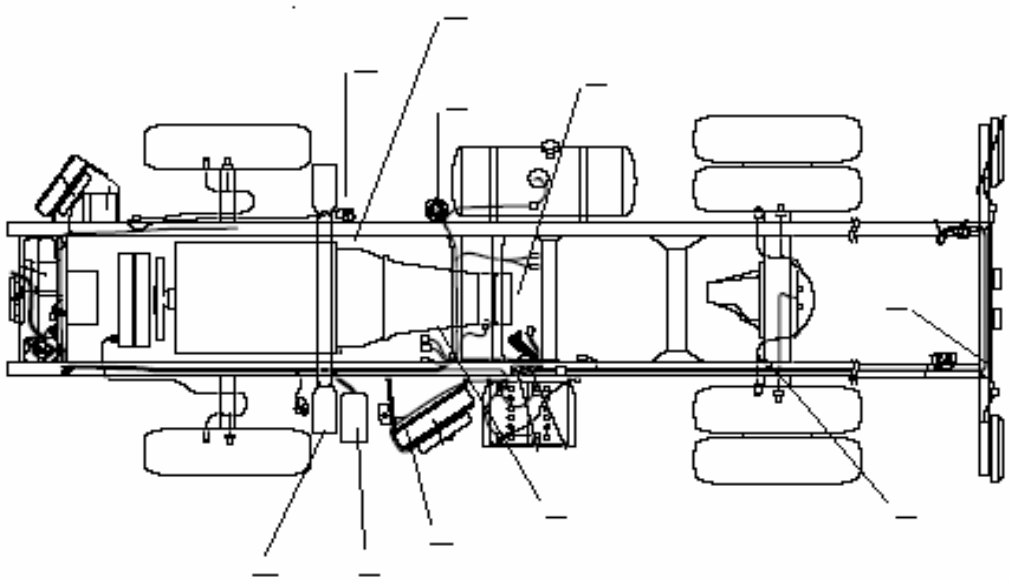
F. Engine ECU

G. Transmission ECU

H. Blower Motor

Exercise 3.2 - Exterior Components (Cab Down)

Draw an arrow to the location of each component. Put the component number by the arrow.

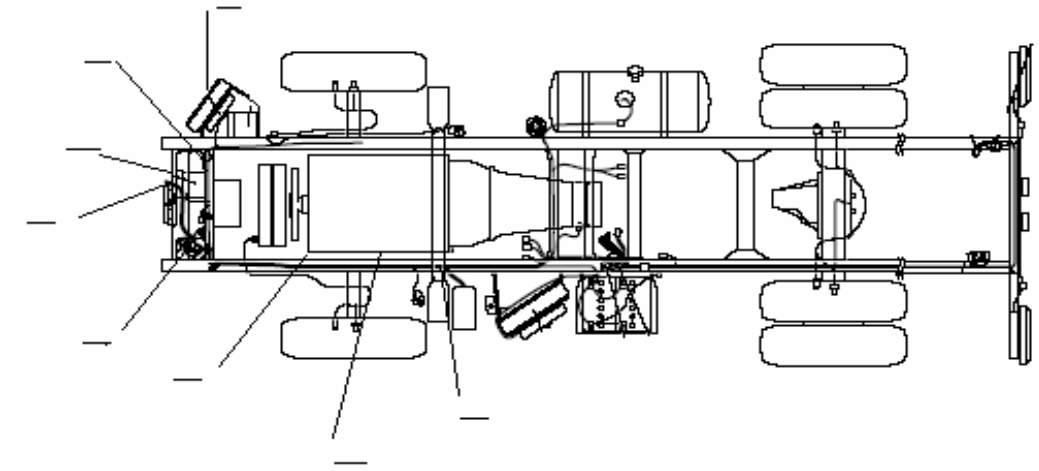


A. High current fuse box
B. Transmission cooler
C. Fuel water separator
D. Neutral safety switch
E. Air cleaner
F. Exhaust brake
G. Coolant Tank
H. Parking brake
I. Rear axle ABS connectors
J. Body builder connections

Exercise 3.3 - Under Cab

After all students have the other sections of this worksheet are complete, tilt the cab and continue. Each student should tilt the cab. Have your instructor demonstrate the correct procedure including the secondary safety latch.

Draw an arrow to the location of each component. Put the component number by the arrow.



A. ABS Controller

B. AC Condenser

C. AC pressure switch

D. AC Service Ports

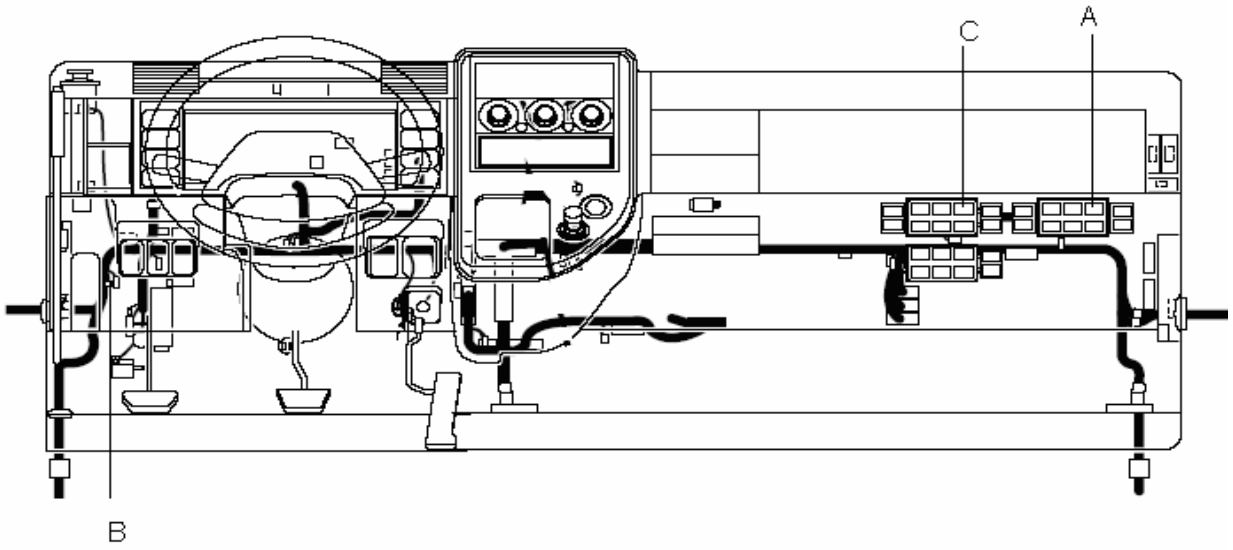
E. Power Steering reservoir

F. Body Builder connections

G. Chassis/Cab/Engine harness junction box

H. Engine oil dip stick

Exercise 3.4 - Behind the Dash Panels



Find and check off the following items behind the dash panels. Some of these were noted in previous exercises, but now you have clear access.

Note: The marked components are for questions on the next page.

A. Relay panels_____

B. Automatic Transmission ECU_____

C. Throttle Position Sensor_____

D. Blower Motor_____

E. HVAC Filter_____

F. Engine ECU_____

G. Washer Motor_____

H. Joint Connectors_____

You will have to use the Workshop Manual to answer the following questions.
Be sure and locate each component mentioned.

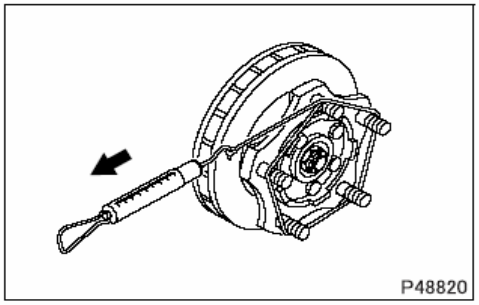
1. What does the relay in position A above control? _____
2. What is the resistor at position B above for? _____
3. What does the relay at position C above for? _____

MODULE 4

MAINTENANCE

Item	Time of inspection and maintenance									Working procedures	Reference Gr
			Inspection interval								
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Every 10,000 km/ 6,000 miles	Every 20,000 km/ 12,000 miles	Every 30,000 km/ 18,000 miles	Every 40,000 km/ 24,000 miles	Every 50,000 km/ 30,000 miles	Every 90,000 km/ 54,000 miles	Every 250,000 km/ 150,000 miles		
ENGINE											
Fuel, oil, or coolant leaks from engine	×									Check engine for fuel, oil and coolant leaks.	Gr11, 12, 13A, 14
(E)(N) Engine conditions	×									Check the engine for smooth starting and quiet running.	Gr11, 13, 15, 17, 54
Manifold bolts and nuts torque							×			Check inlet exhaust manifold bolts and nuts for looseness.	Gr15
(E) Check and adjust valve clearance		×					×			Check valve clearance with thickness gauge.	Gr11
(E) Oil filter replacement			Every 10,000 km/6,000 miles or 12 months							Replace oil filters.	Gr12
(E) Fuel filter replacement			Every 20,000 km/12,000 miles or 12 months							Replace fuel filter.	Gr13A
(E) Fuel line			Every 20,000 km/12,000 miles or 12 months							Inspect the fuel tank, cap and lines for damage causing leakage.	Gr13A
(E)(N) Belts tension and damage	×		Every 10,000 km/6,000 miles or 12 months							Inspect belts for crack, wear and tension.	Gr14
(E) Cooling system				×						Check radiator and pressure cap for sealing performance and mounting condition. Inspect hoses for looseness, deterioration, damage causing leakage. Remove dust and foreign matter deposit from radiator and intercooler front.	Gr14
Coolant level and leaks from cooling system	×									Check coolant level and if level is low, check for coolant leaks.	Gr14
Coolant replacement			Every 24 months							Replace coolant.	Gr14
(E) Turbocharger rotor play									×	Check turbocharger rotor play.	Gr15
Air cleaner element			Every 5,000 km/3,000 miles							Clean air cleaner element by blowing clean compressed air.	Gr15
(E)(N) Air cleaner element replacement						×				Replace air cleaner element.	Gr15
(E)(N) Exhaust system				×						Inspect the exhaust system for damage, corrosion and loose connection causing leakage.	Gr15
POWER TRAIN											
Clutch pedal and clutch disc wear	×		×							Check the pedal for free play. Check clutch disc wear.	Gr21

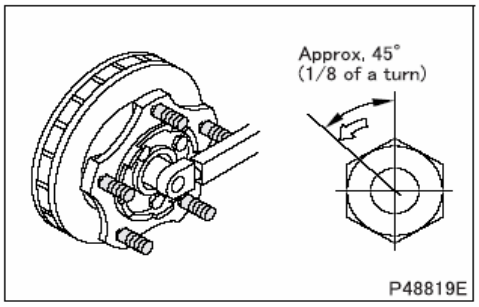
Item	Time of inspection and maintenance									Working procedures	Reference Gr
			Inspection interval								
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Every 10,000 km/ 6,000 miles	Every 20,000 km/ 12,000 miles	Every 30,000 km/ 18,000 miles	Every 40,000 km/ 24,000 miles	Every 50,000 km/ 30,000 miles	Every 90,000 km/ 54,000 miles	Every 250,000 km/ 150,000 miles		
Propeller shaft flange torque and universal joint looseness			×							Check flange yoke bolts for looseness and universal joint for play.	Gr25
Propeller shaft center bearing							×			Check center bearing if trace of grease flowing out is evident. Check center bearing for wear, damage and play.	Gr25
FRONT AND REAR AXLE											
Wheel hub bearing					×					Check wheel hub bearing for play.	Gr26, 27
Wheel hub bearing hub seals replacement					×					When wheel hub bearing grease is replaced, also replace the wheel hub bearing hub seals.	Gr26, 27
Wheel and tire	×		×							Check disc wheel for corrosion, deformation and cracks. Measure inflation pressure with tire gauge. Check tire tread and side wall for cracks and damage. Measure tire tread groove depth to make sure it is deep enough. Check tire tread for uneven wear, stepped wear and other abnormal wear. Rotate tires if there is a difference in the amount of wear on each tire.	See later section.
Retightening wheel nuts		×	×							Check wheel nuts for looseness. Check at the first 50 to 100 km/30 to 60 miles after changing a wheel.	See later section.
SUSPENSION SYSTEM											
Suspension springs	×									Check for broken springs and tilt of vehicle body toward either side.	Gr33, 34
Retightening U-bolts		×		×						Check U-bolt nuts for looseness. Check at the first 1,000 km/600 miles after removing and retightening U-bolt nuts.	Gr33, 34
BRAKING SYSTEM											
Service brake pedal	×									Check brake pedal play and stroke.	Gr35A
Brake performance	×									Depress the brake pedal and check that the brakes work effectively and evenly on all wheels.	Gr35A
Disc brake pad and disc			×							Check disc brake pad and disc for damage and wear.	Gr35A



■ **Inspection: Starting torque of wheel hub bearing**

[Inspection]

- After installing the lock nut, perform the following inspection.
- Measure the tangential force at the hub bolt position using a spring balancer.
- If the tangential force is within the specified value, the starting torque conforms to the standard value. If the measured value deviates from the specified value, adjust.



[Adjustment]

- Tighten the lock nut to the specified torque (primary tightening) while turning the wheel hub and rotor, and then loosen it completely.
- Smooth operation of the outer bearing and inner bearing by turning the wheel hub and rotor several times, and then tighten the lock nut to the specified torque (secondary tightening).
- Return the lock nut by approximately 45 degrees (1/8 of a turn) and secure it with a split pin. If pin holes do not align, align them in the course of loosening. Make sure that there is no play in the axial direction.
- Perform measurement again after adjustment. If any fault is found, replace the outer and inner bearings.

Item	Time of inspection and maintenance									Working procedures	Reference Gr
			Inspection interval								
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Every 10,000 km/ 6,000 miles	Every 20,000 km/ 12,000 miles	Every 30,000 km/ 18,000 miles	Every 40,000 km/ 24,000 miles	Every 50,000 km/ 30,000 miles	Every 90,000 km/ 54,000 miles	Every 250,000 km/ 150,000 miles		
Brake lining			×							Check lining for wear through inspection hole.	Gr35A
Brake drum					×					Disassemble and check drum for wear, crack and damage.	
Parking brake lever stroke	×									Check parking brake lever stroke.	Gr36
Looseness, play and damage of brake system parts			×							Inspect brake lines and hoses looseness, play and damage. Inspect wheel cylinder and brake master cylinder for looseness, play and damage.	Gr35A
STEERING SYSTEM											
Steering wheel play	×									Turn steering wheel right and left to measure play at steering wheel rim. Measure while engine is running.	Gr37
Steering wheel operation	×									Check that the steering wheel does not vibrate or pull to one side and that it is not unduly heavy. Also make sure that the steering wheel returns to its neutral position smoothly.	Gr37
Steering system			×							Check steering system for looseness, steering wheel play and operating condition. Inspect for oil leaks, booster and oil pump function.	Gr37
CAB											
Defroster	×									Make sure that warm air blows properly onto the windshield.	Gr55
Rearview mirrors	×									Seated in the driver's seat, adjust the angles for clear views of the sides and rear. Make sure the mirrors are clean.	Gr51
License plate and reflector condition	×									Check the license plate and reflectors for loose installation, damage, and dirt.	–
Door locks	×									Push down the lock knob and verify that the door does not open even when the inner handle is operated.	Gr43
Seat belts	×									Confirm that the seat belt buckles function correctly when fastening and unfastening.	Gr52
ELECTRICAL SYSTEM											
Horn operation	×									Press the horn button to check that the horn is working properly.	Gr54

Item	Time of inspection and maintenance									Working procedures	Reference Gr
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Inspection interval								
			Every 10,000 km/ 6,000 miles	Every 20,000 km/ 12,000 miles	Every 30,000 km/ 18,000 miles	Every 40,000 km/ 24,000 miles	Every 50,000 km/ 30,000 miles	Every 90,000 km/ 54,000 miles	Every 250,000 km/ 150,000 miles		
Windshield washer fluid level	×									Confirm that the windshield washer fluid level is above the bottom of the inspection window.	–
Windshield wiper and washer operation	×									Check the washer for proper fluid spray direction and the wipers for normal action.	Gr51, 54
Lighting system	×									Make sure that each lamp lights up or flashes properly. Check lamp lenses for dirt and damage.	Gr54
Gauge, warning/indicator lamp operation	×									Check that gauges, warning lamps and indicators are working properly.	Gr54

Items	Time of inspection and maintenance							Lubricant specifications	Reference Gr
	Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Inspection interval: Every 10,000 km/ 6,000 miles	Every 20,000 km/ 12,000 miles	Every 30,000 km/ 18,000 miles	Every 40,000 km/ 24,000 miles	Every 50,000 km/ 30,000 miles		
Ⓔ Engine oil contamination and oil level	×							Engine oil API classification, CD, CD/SF, CE, CE/SF or CF-4 or JASO classification DH-1 Over 30°C {86°F} SAE 40 40 to –5°C {104 to 23°F} SAE 30 15 to –15°C {59 to 5°F} SAE 20W-20 Over –15°C {5°F} SAE 15W-40 Below 0°C {32°F} SAE 10W-30	Gr12
Ⓔ Engine oil replacement		×	×						
Manual transmission oil level			×					Engine oil Vehicle operated continuously at high speed API classification CC SAE 30 or SAE 40 Gear oil API classification GL-3 SAE 80 (General) GL-3 SAE 90 (Warm region) GL-4 SAE 90 (Tropical region)	Gr22
Manual transmission oil replacement		×	Every 60,000 km/36,000 miles						
Automatic transmission fluid level			×					Mobil ATF3309 manufactured by Exxon Mobil	Gr23
Automatic transmission fluid replacement						×			
Transfer gear oil level <FG Model only>			×					Gear oil API classification GL-3 SAE 80 (General) GL-3 SAE 90 (Warm region) GL-4 SAE 90 (Tropical region)	Gr24
Transfer gear oil replacement <FG Model only>		×			×				
Rear axle housing gear oil level			×					Gear oil API classification GL-5 Below 40°C {104°F} SAE 90 Over 40°C {104°F} SAE 140 Use SAE 140 when operating vehicle at high load, such as continuous ascent on slopes and when the outside temperature is 10°C {50°F} or more <Limited slip defferential only> Limited slip differential oil API classification GL-5 SAE 90	Gr27
Rear axle housing gear oil replacement		×			×				
Front axle housing gear oil level <FG Model only>			×					Gear oil API classification GL-5 Below 40°C {104°F} SAE 90 Over 40°C {104°F} SAE 140 Use SAE 140 when operating vehicle at high load, such as continuous ascent on slopes and when the outside temperature is 10°C {50°F} or more	Gr26B
Front axle housing gear oil replacement <FG Model only>		×			×				
Hub bearing grease replacement					×			Wheel bearing grease [NLGI No. 2 (Li soap)]	Gr26, 27
Front axle birfield joint grease replacement <FG Model only>					×			Wheel bearing grease [NLGI No. 2 (Li soap)]	Gr26B
Front axle kingpin bearing grease replacement <FG Model only>					×			Wheel bearing grease [NLGI No. 2 (Li soap)]	Gr26B
Front axle steering knuckle grease replacement <FG Model only>					×			Wheel bearing grease [NLGI No. 2 (Li soap)]	Gr26B
Brake reservoir tank fluid level	×							Brake fluid <SAE J1703f or FMVSS No. 116 DOT3>	Gr35A
Brake fluid replacement							×		

Items		Time of inspection and maintenance							Lubricant specifications	Reference Gr
		Pre-operational checks	New vehicle at 4,000 km/ 2,500 miles	Inspection interval: Every 10,000 km/ 6,000 miles	Every 20,000 km/ 12,000 miles	Every 30,000 km/ 18,000 miles	Every 40,000 km/ 24,000 miles	Every 50,000 km/ 30,000 miles		
Power steering fluid level				×					Automatic transmission fluid <DEXRON, DEXRON II or DEXRON III type>	Gr37
Power steering fluid replacement								×		
Lubrication of propeller shaft	Center bearing							×	Bearing grease [NLGI No. 3 (Li soap)]	Gr25
	Universal joint, slip joint			×					Wheel bearing grease [NLGI No. 2 (Li soap)]	See later section.
	Double Cardan joint <FG Model only>			×						
Lubrication of rear suspension spring pin				×					Chassis grease [NLGI No. 1 (Li soap)]	See later section.
Lubrication of kingpins				×					Wheel bearing grease [NLGI No. 2 (Li soap)]	See later section.
Lubrication of door hinge				×					Chassis grease [NLGI No. 1 (Li soap)]	Gr43
Lubrication of anchor hook <except crew cab>				×					Chassis grease [NLGI No. 1 (Li soap)]	Gr42

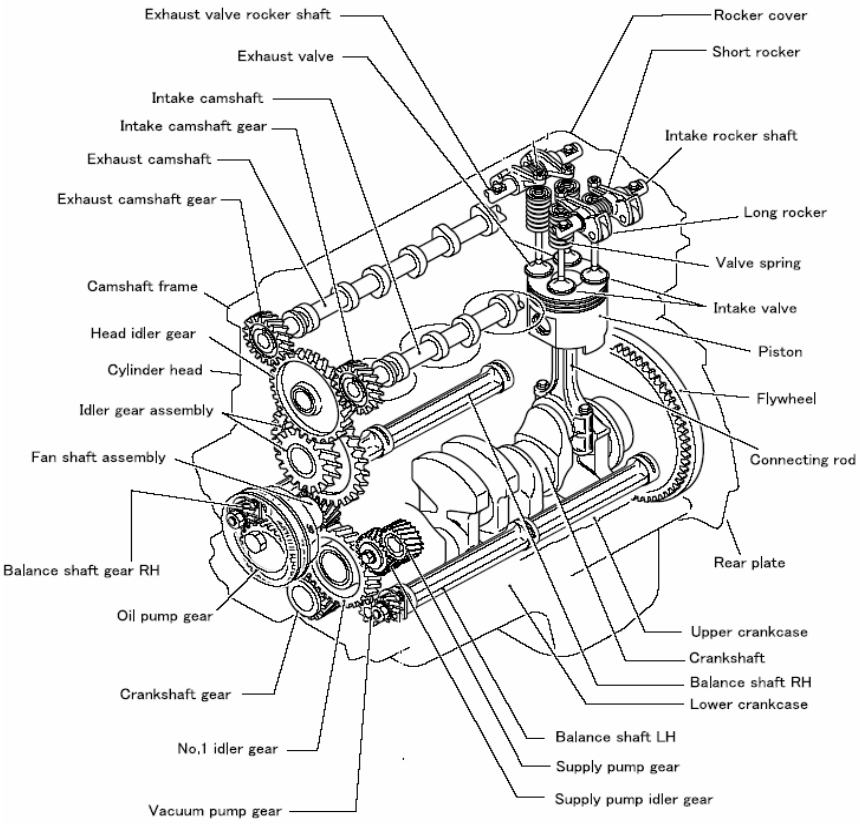
Exercise 4.1 - Wheel Bearing Adjustment

You will be checking the rear wheel bearing adjustment on the truck. You will have to find the specifications.

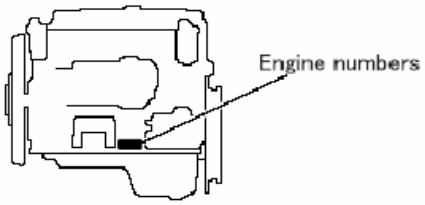
1. In what section do you find rear axle wheel bearing adjustment? _____
2. What are the torques in ft-lb for the adjustment procedure?
   a. Primary tightening _____
   b. Secondary tightening _____
3. How far do you back off the adjustment nut after the secondary tightening? _____
4. What is the tangential force in pounds used to check the bearing adjustment? _____
5. What did you measure when you checked the adjustment? _____

MODULE 5

ENGINE

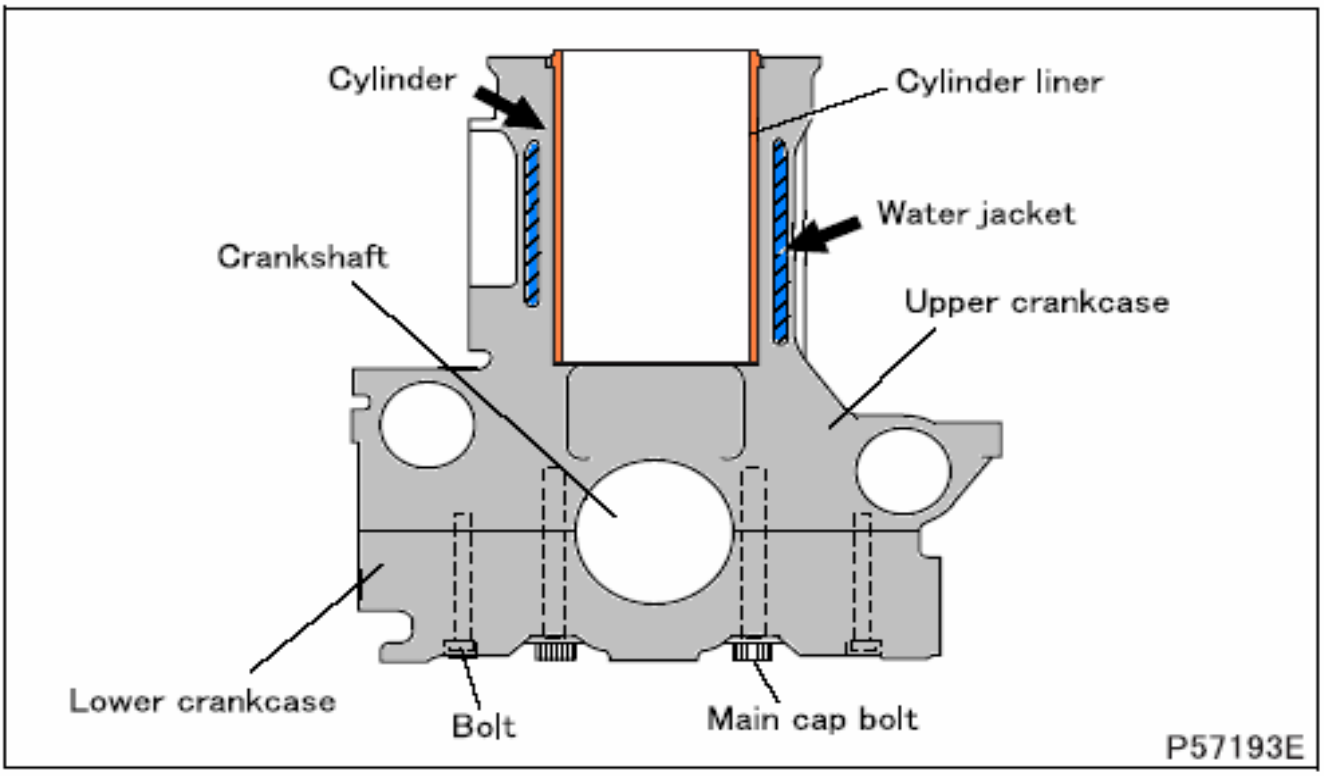


- 4 cyl diesel
- Dual Overhead Cam
- Twin Balance Shafts
- Belt drive pulley not on crankshaft
- Threebond used as sealant in specific areas

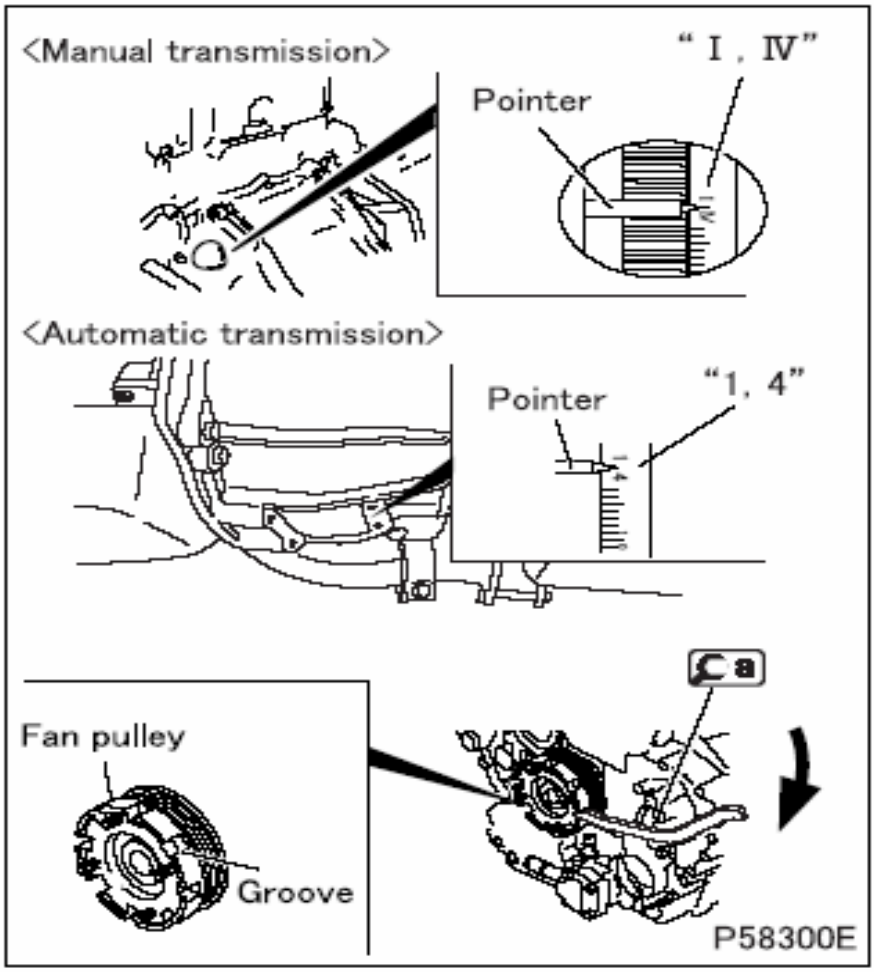


Engine						
4M50-T	4	M	5	0	T	Turbocharged Order of development within same series Order of development among different series Diesel engine No. of cylinders (4)

- Engine Model code
- Location of numbers
- Model code also found on valve cover

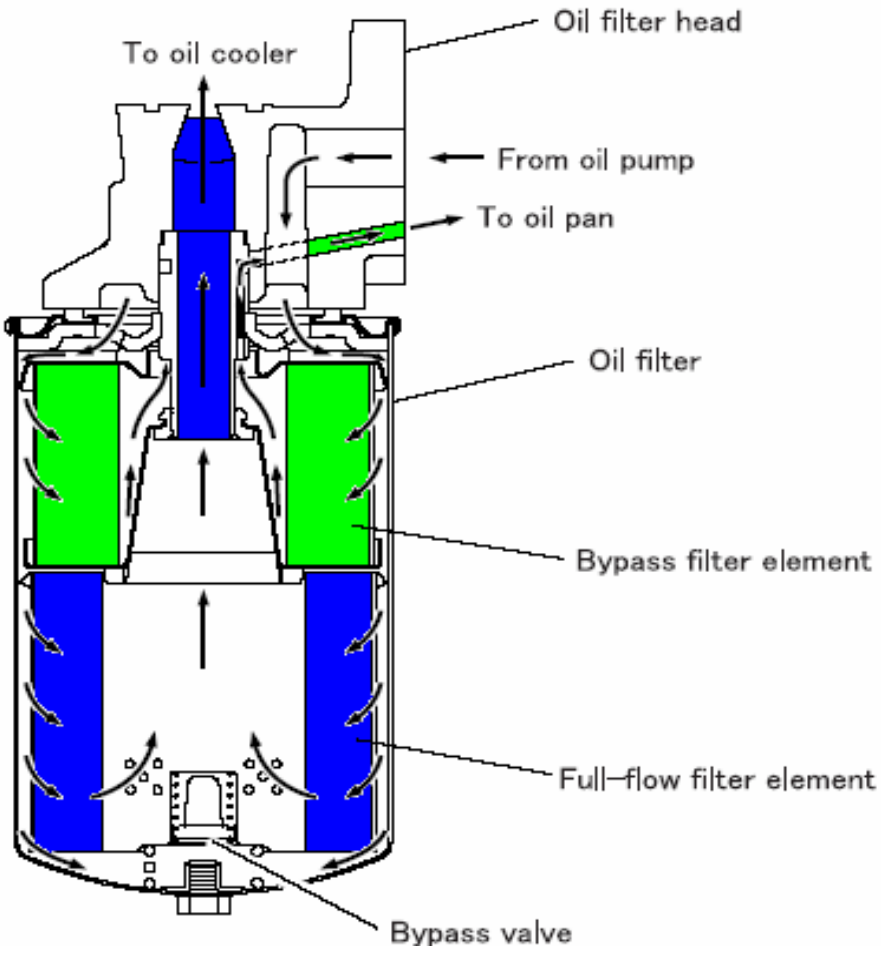


- 2 piece crankcase
- Dry liners – push fit

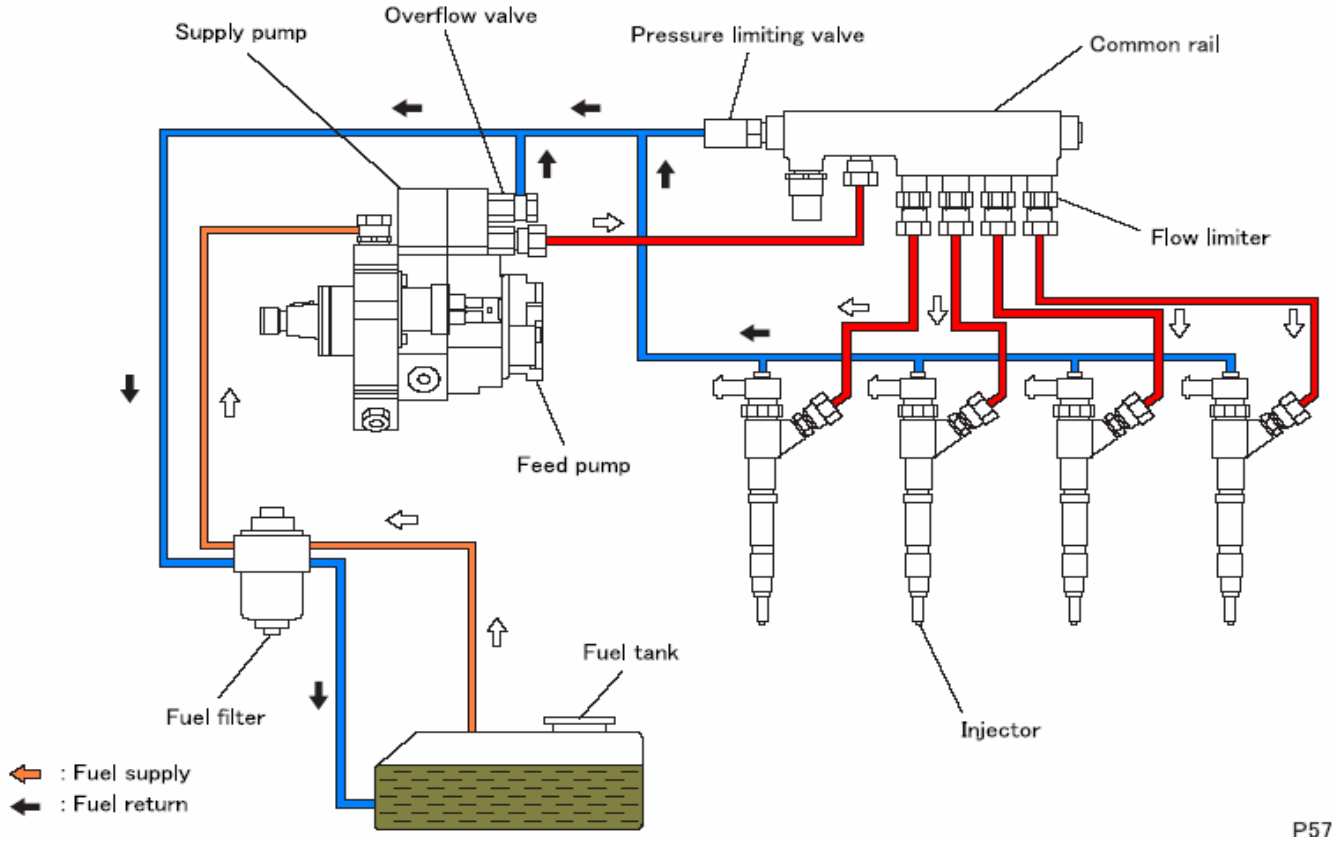


- TDC mark, viewed from lower inspection cover (AT)

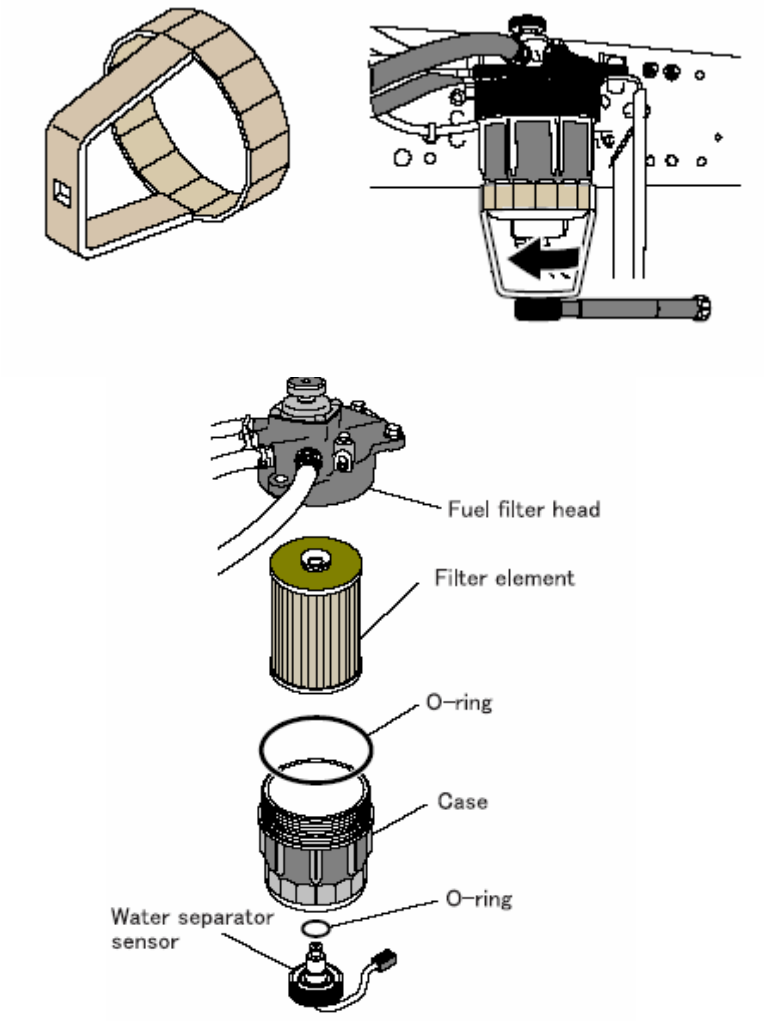
- Special tool used in fan pulley to bar engine



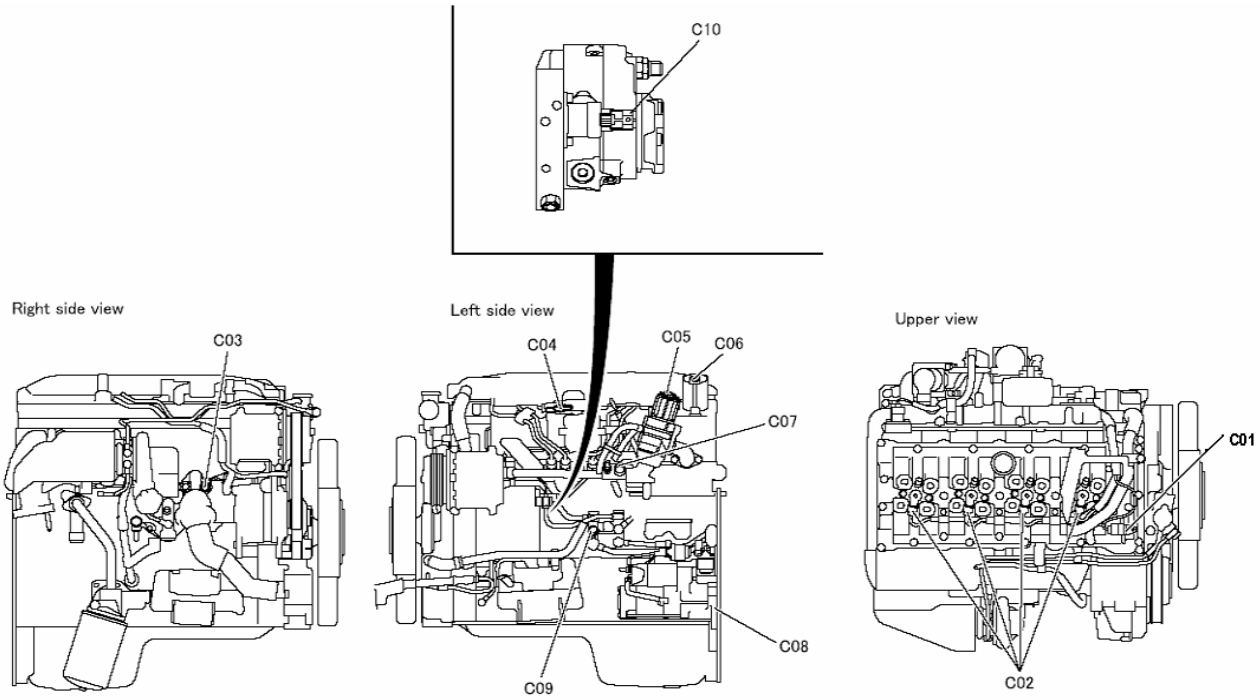
- Spin-On
- Has drain plug
- Combination Oil Filter
- Full Flow
- By-Pass
- Must use proper filter



- Bosch Fuel System
- Common Rail
- Solenoid on injector
- Gear supply pump
- 3 cyl rotary high pressure pump
- Up to 23K psi at injector

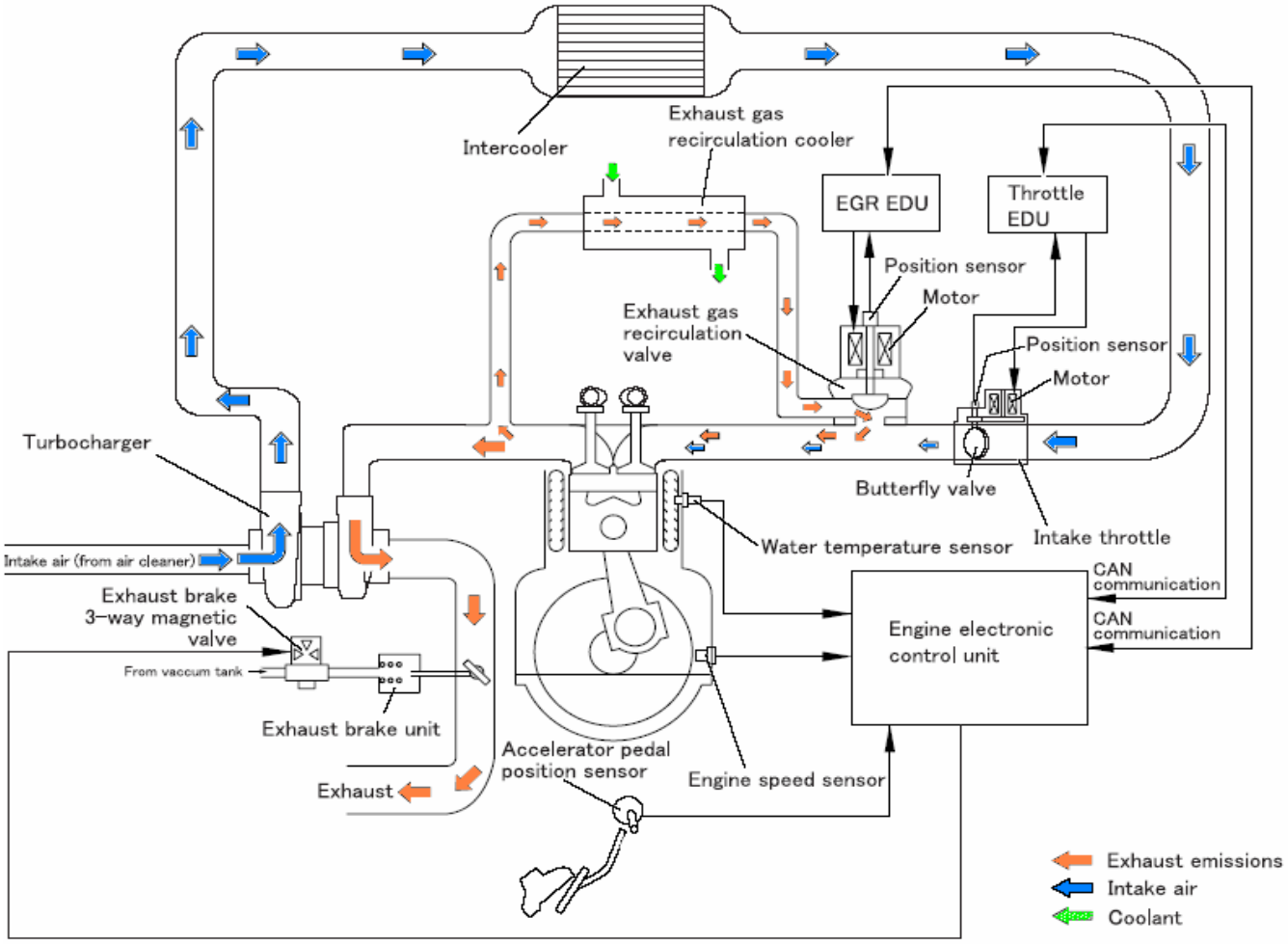


- Special tool required for fuel/water filter
- Part of Dealer Special tools
- Has 2 air bleeds and hand pump



C01 Cylinder recognition sensor
C02 Injector
C03 Water temperature sensor
(Connects to engine ECU)
C04 Throttle actuator
(Building into motor, position sensor)
C05 EGR valve
(Building into motor, position sensor)
C06 Boost pressure sensor
C07 Common rail pressure sensor
C08 Starter
C09 Fuel temperature sensor
C10 MPROP (Injection quantity adjustment valve)

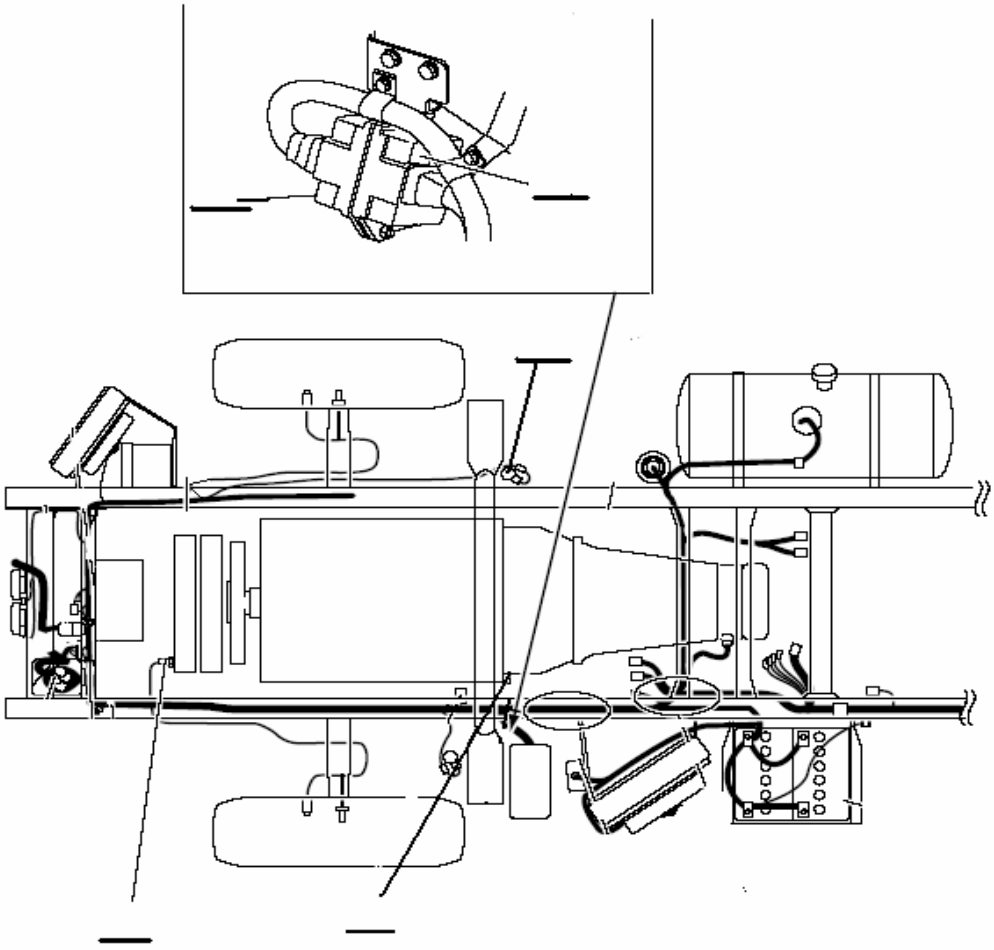
ECU : Electronic control unit



- EGR
- Throttle Valve
- Ex Brake on when warm up switch is on

Exercise 5.1 - Engine Sensors

Go to the truck and identify as many sensors as you can. You can use the manual to find the ones you can't identify.



Mark the appropriate letters on the lines above to identify engine components.

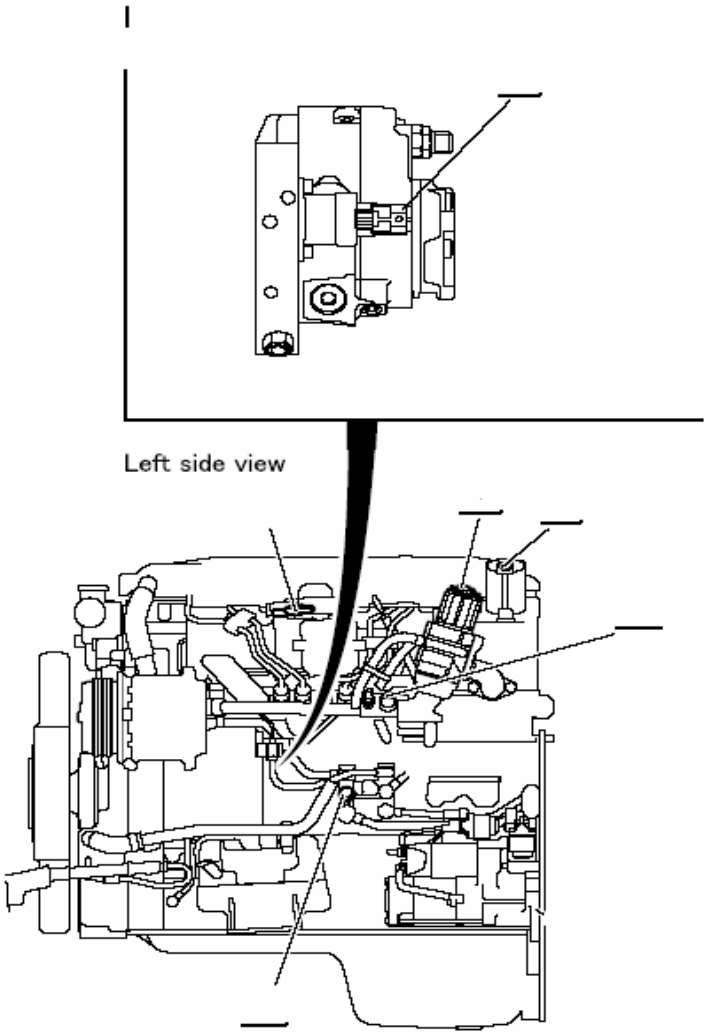
A. Boost Air Temperature Sensor

B. Throttle EDU

C. EGR EDU

D. Ex Brake 3 way magnetic valve

E. Engine Speed Sensor



F. Throttle Valve Actuator & Sensor

G. Fuel Temperature Sensor

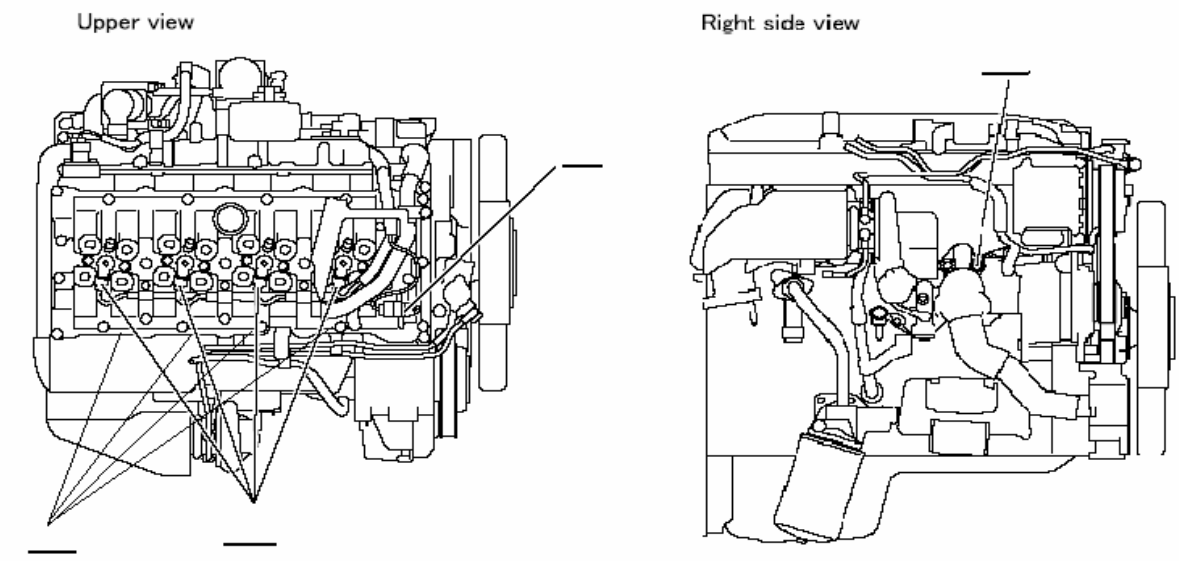
H. EGR Valve & Sensor

I. Common Rail Pressure Sensor

J. MPROP (Injection Quantity Valve)

K. Boost Pressure Sensor

Exercise 5.1 - (cont.)



L. Water Temperature Sensor

M. Injectors

N. Cylinder Recognition Sensor

O. Glow plugs

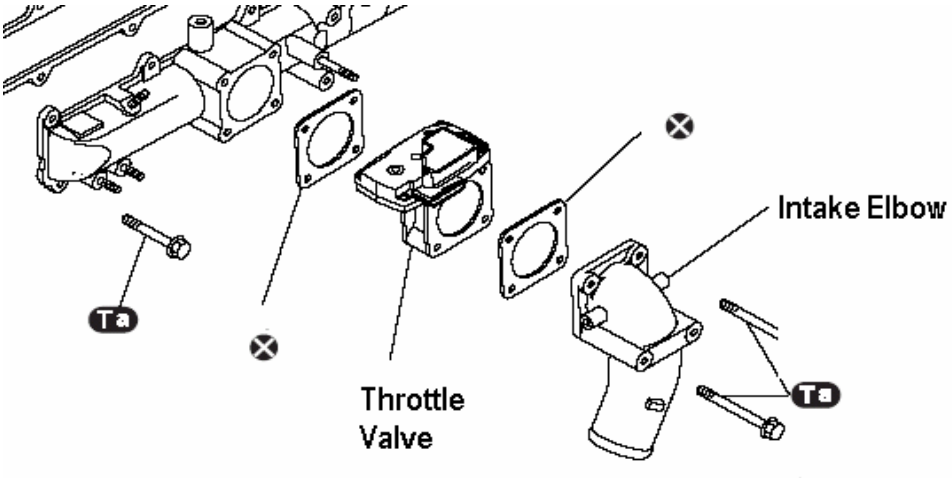
Exercise 5.2 - Valve Adjustment (2500 mile service)

Your instructor will help guide you through the steps required to perform a valve adjustment. This will be a full group exercise.

1. Remove the wiring and stand off clips from the throttle valve and EGR valve.

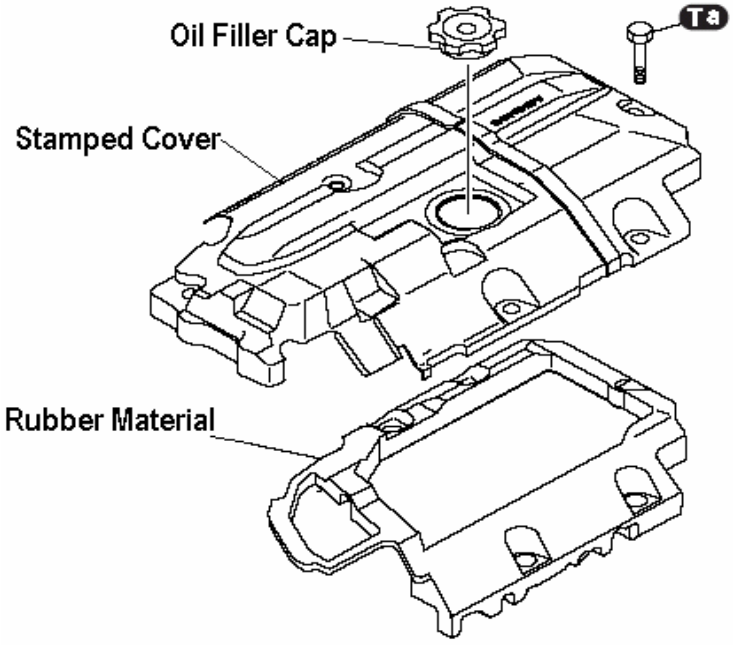
Note: All connectors have a release lever, the stand off clips also have an easy release clip.

2. Remove the intake elbow and throttle valve (4 bolts). You can leave the intake hose connected with the elbow attached. This will greatly improve access to the fuel rail.



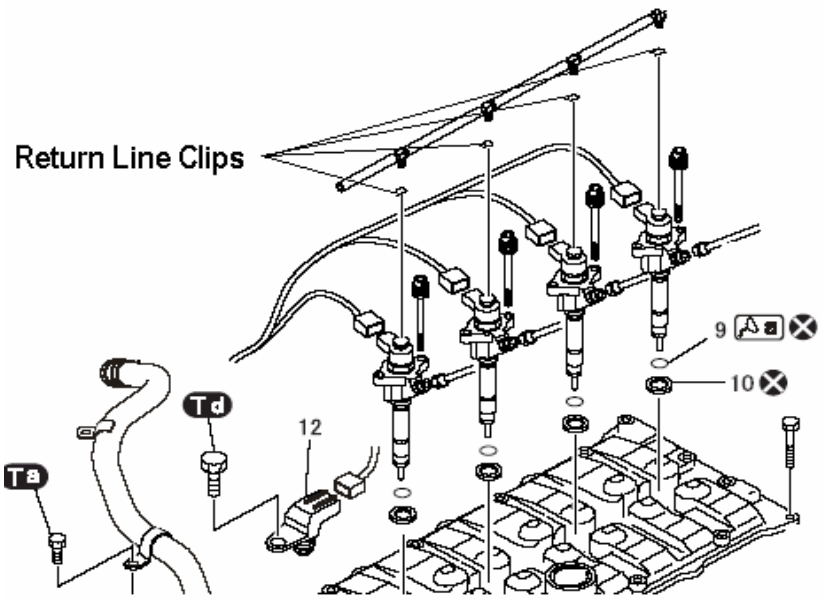
Note: The black circles with and X indicate that a gasket is not to be reused.

3. Remove the oil filler cap and top stamped cover. Once these are removed you can also remove the rubber material under the cover.



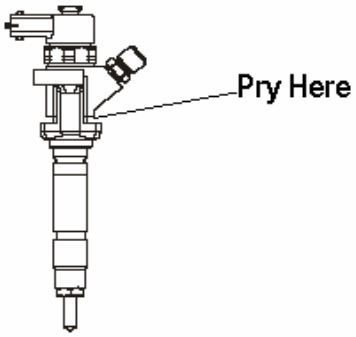
4. Using compressed air, blow any debris from around the injectors. Be sure to have proper eye protection.

5. Disconnect the fuel return lines and injector wire harness. Take care not to lose the fuel return line clips.

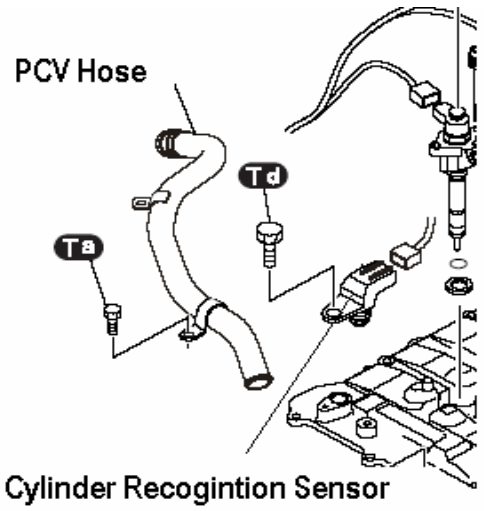


6. Remove the 2 fuel return line clamp bolts. One is on the valve cover and the other is just below the intake manifold. This will give you enough freedom to remove the valve cover without damaging the hard portion of this line. Be very careful not to bend the line.
7. Remove the fuel lines from the injector and fuel rail. You can use an offset, 17 mm, 3/8 drive, fuel line wrench that is part of the MB 9000/400 fuel system tools. It is marked HAZET 4550-1.
8. Remove the injector hold down bolts. Before removing the injectors, check again to see that there is no accumulation of debris that will fall into the cylinder when the injector is removed. You may have to use compressed air to blow out the area around the injector again.

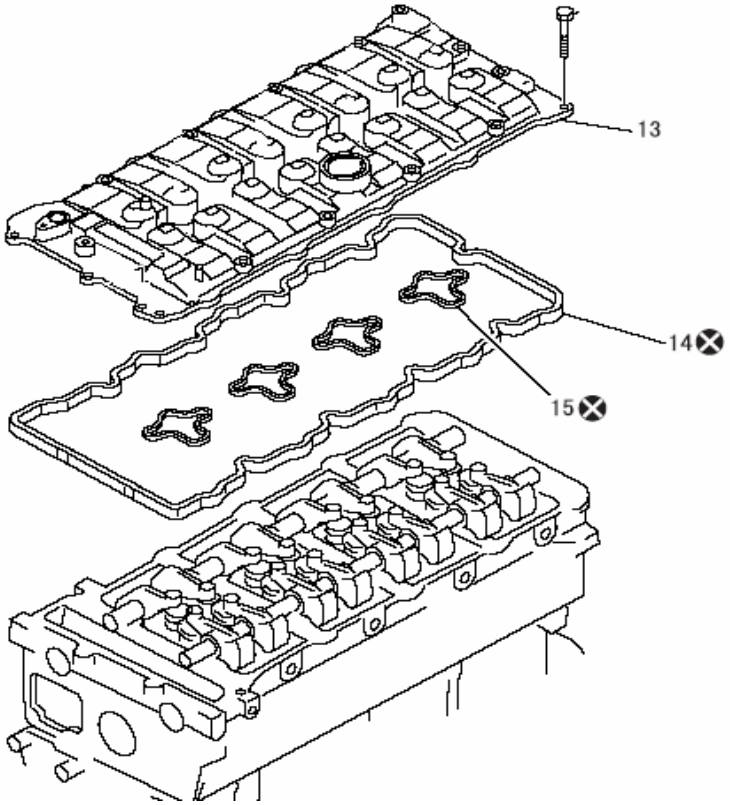
Note: You will have to use a pry bar to remove the injector. You can pry on the flat below the fuel inlet fitting. It is just above the hold down clamp.



9. Disconnect the PCV tube and move it out of the way. Also remove the cylinder recognition sensor.

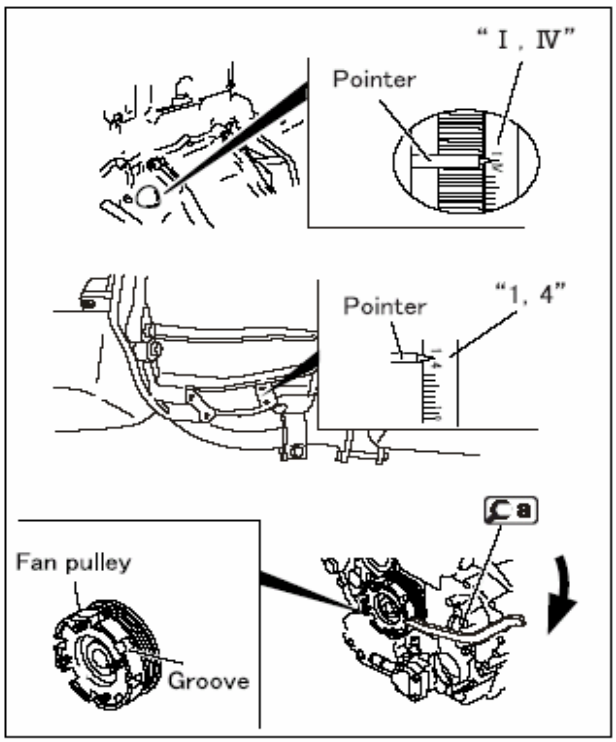


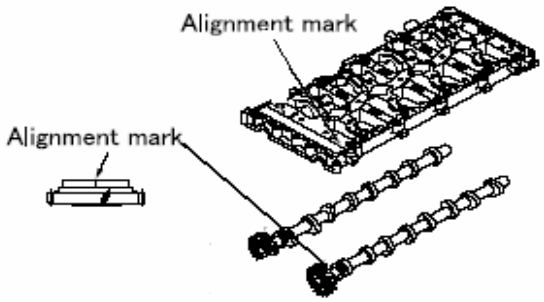
10. You can now remove the rocker cover.



Note: Gaskets number 15, there are also 2 "O" rings between the valve cover and head that are not shown on the diagram.

11. Now you have to bring number one cylinder up on TDC compression stroke by baring the engine over using the slotted fan pulley.





It is easiest to use the plug in the converter housing at the left rear of the cylinder head to find TDC. You can verify that number one cylinder is at TDC compression by observing the marks on the left camshaft drive gear.

12. Look up the specifications for valve clearance:

    a. Intake valves _____

    b. Exhaust valves _____

13. Adjust the valves indicated in the chart below:

Cylinder No.	1		2		3		4	
Valve	IN	EX	IN	EX	IN	EX	IN	EX
No. 1 cylinder piston at TDC on compression stroke	O	O	O	–	–	O	–	–
No. 4 cylinder piston at TDC on compression stroke	–	–	–	O	O	–	O	O

Note: Because of the articulate foot on the rocker, it is easier to loosen the adjusting screw and set the valve lash than to check it.

14. Rotate the engine and adjust the remaining valves.
15. Re-assemble the engine.
16. Before re-assembling the engine look up the following torques

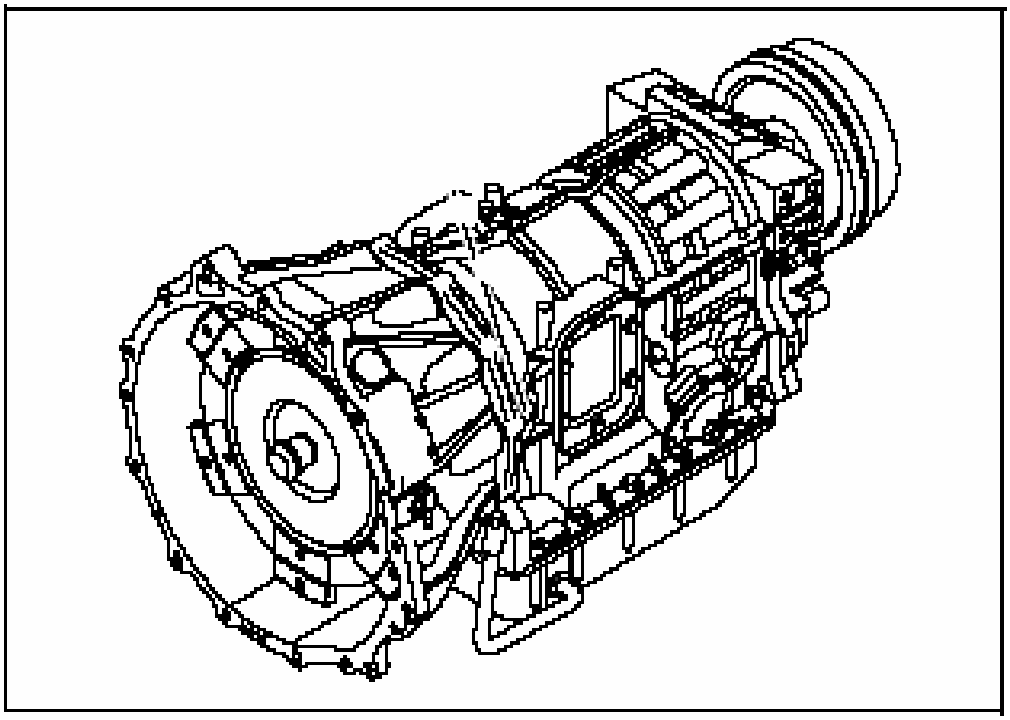
	Torque	**60**
Valve adjuster lock nut		
Rocker cover bolt		
Injector line		
Injector hold down		
Sensor retaining bolt		

Use 60% of the recommended torque on the above bolts. On hold-downs, use the same torque at the sensor retaining bolt.

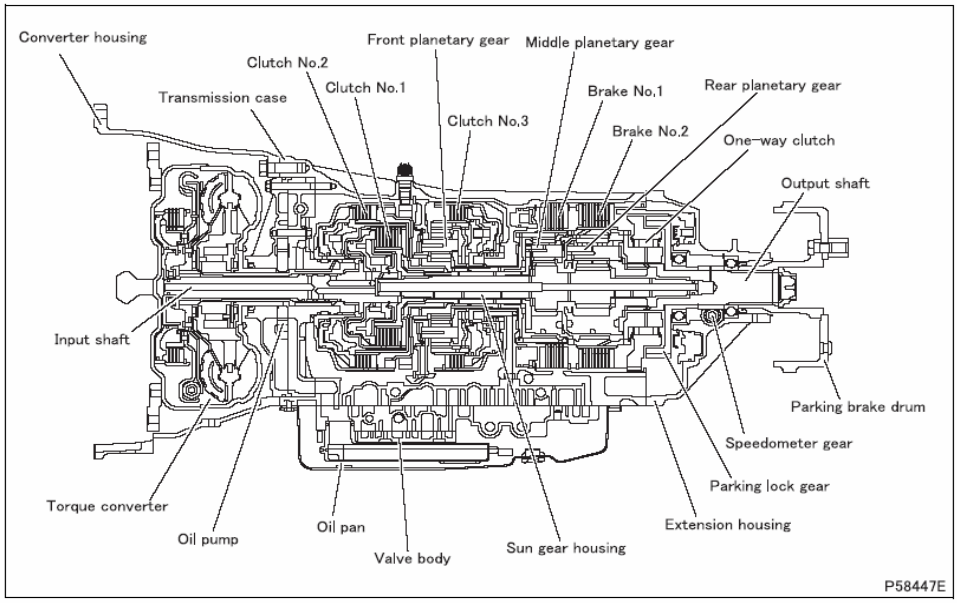
17. Re-assemble the engine using the 60% torque values.

MODULE 6

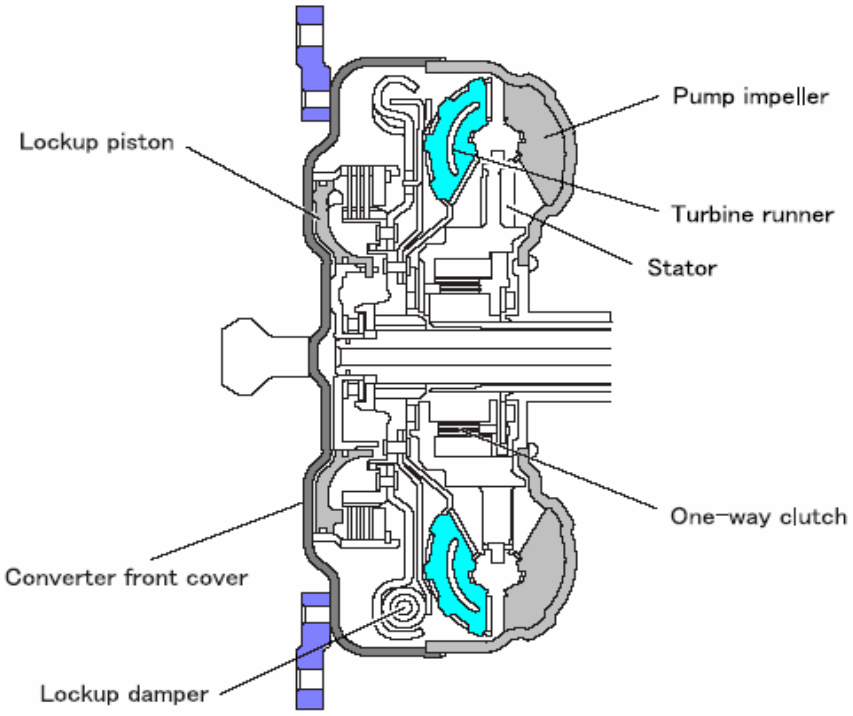
TRANSMISSION

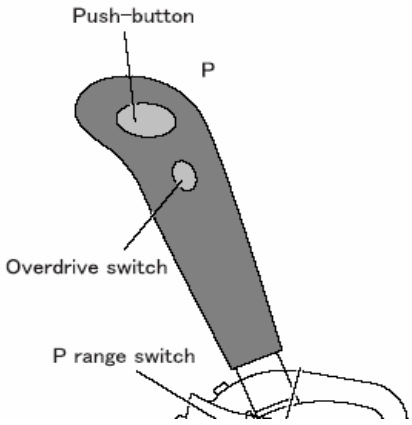


Item	Specifications	
Manufacturer	Aisin	
Transmission Model	M036A6	
Torque converter	3-element (with lockup clutch)	
	Stall Ratio 1.60	
Transmission	Planetary type; 6 forward gears, 1 reverse gear	
Gear ratios	1st	3.742
	2nd	2.003
	3rd	1.343
	4th	1
	5th	0.773
	6th	0.634
Automatic Transmission Fluid	Type Mobil ATF3309	

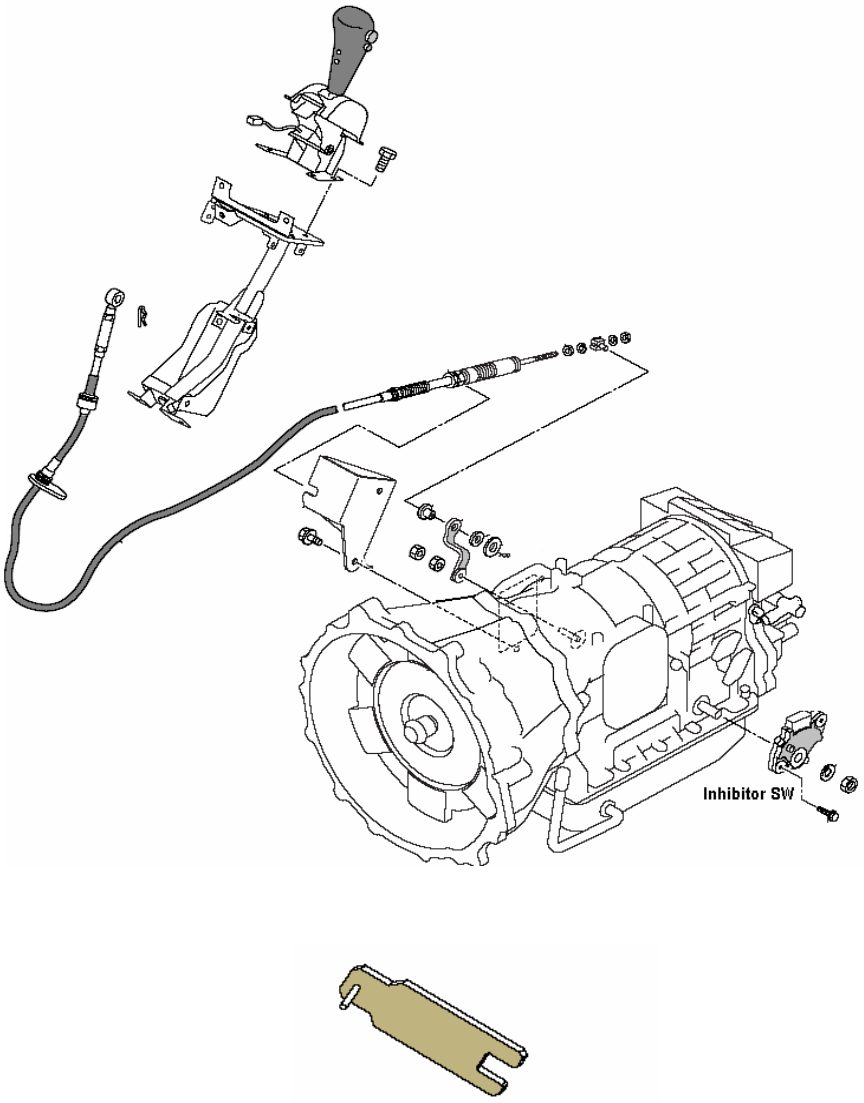


- Uses 5 friction clutches & 1 one-way clutch for gear selection
- Electronic controls
- Shares signals with Engine on CAN buss

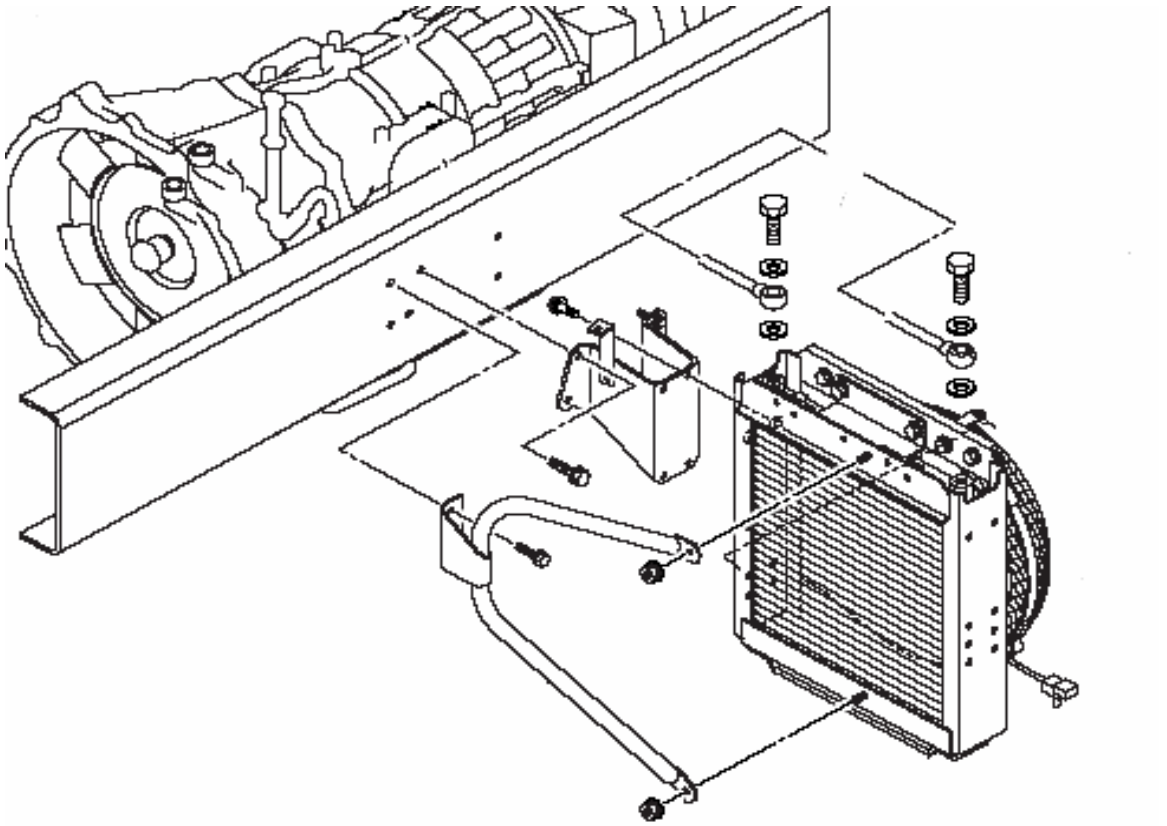




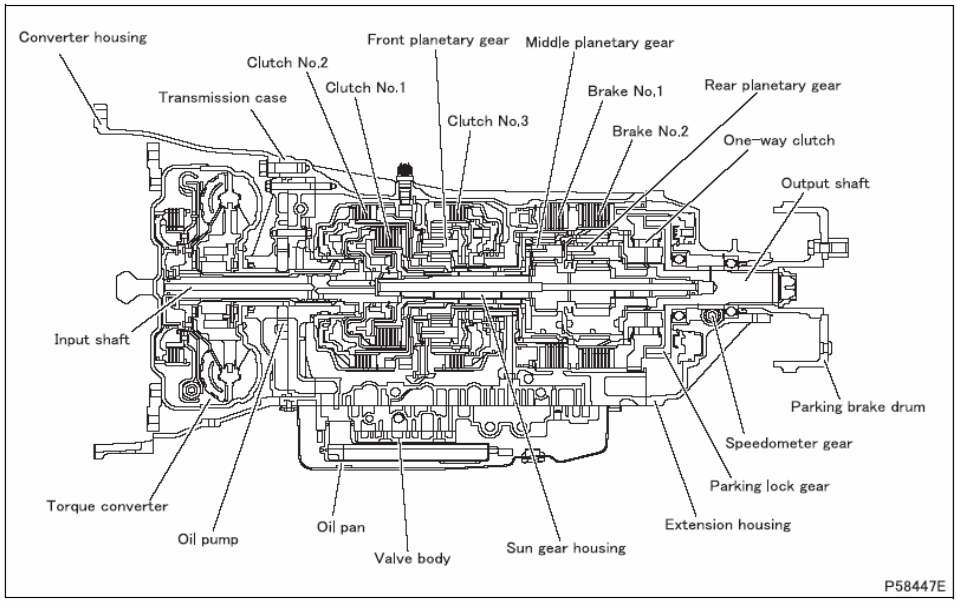
- Lock-Up can occur 2 – 6 gears
- ECU decides lock-up clutch operation
  - Engine speed
  - Throttle position
  - TC temp sensor
- OD switch locks out 5th & 6th gears



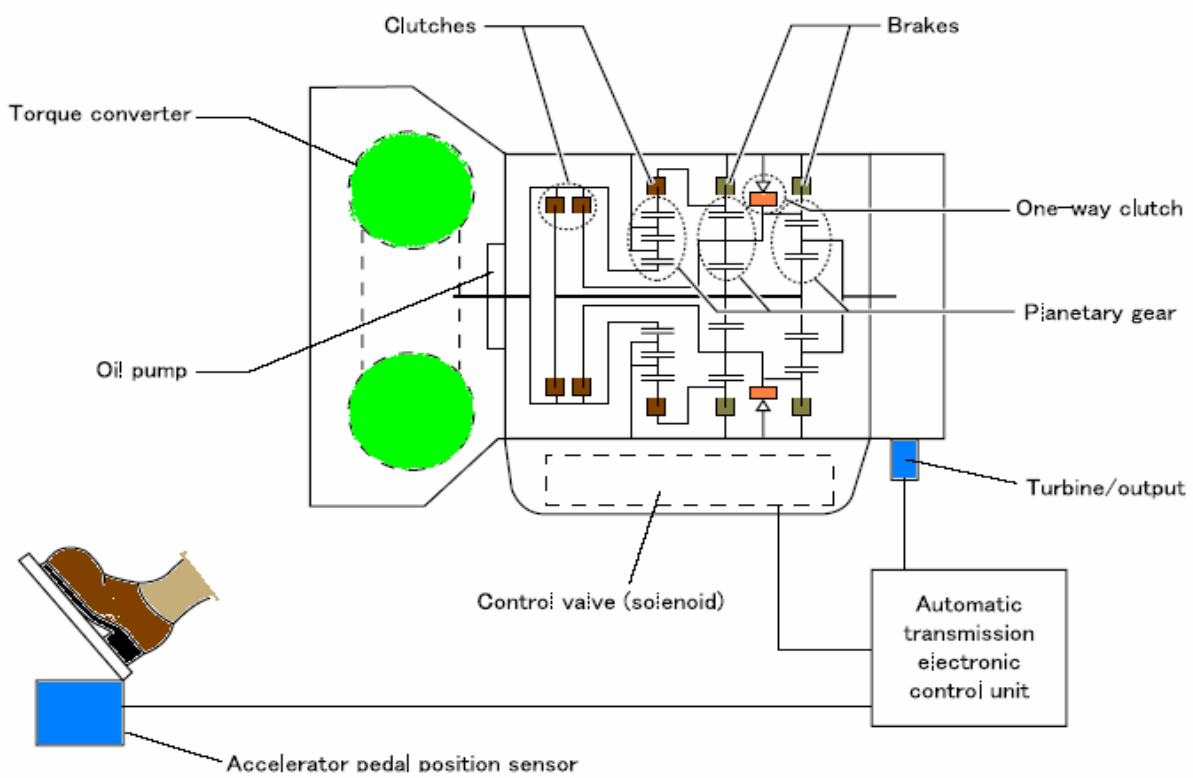
- Cable operated selector lever
- Special tool for inhibitor switch adjustment



- Frame mounted oil cooler
- Electric fan
- Controlled by thermostatic switch (not ECU)



- No internal parts are available for this transmission
- Repairs are limited to external seals and sensors

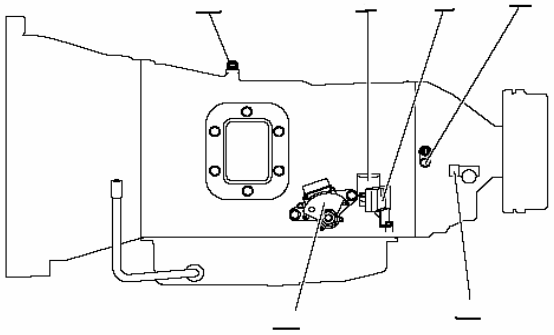


- Dealer Adjust
  - Learning procedure for Trans ECU
- Must be performed
  - When transmission is replaced
  - When trans ECU is replaced
- Procedure listed in 23-53 of Workshop manual

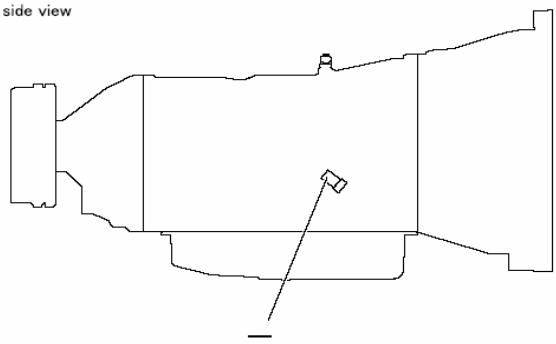
Exercise 6.1 - Transmission Sensors

Go to the truck and identify as many sensors as you can. You can use the manual to find the ones you can't identify.

Left side view



Right side view



Mark the appropriate letters on the lines above to identify engine components.

A. Inhibitor Switch

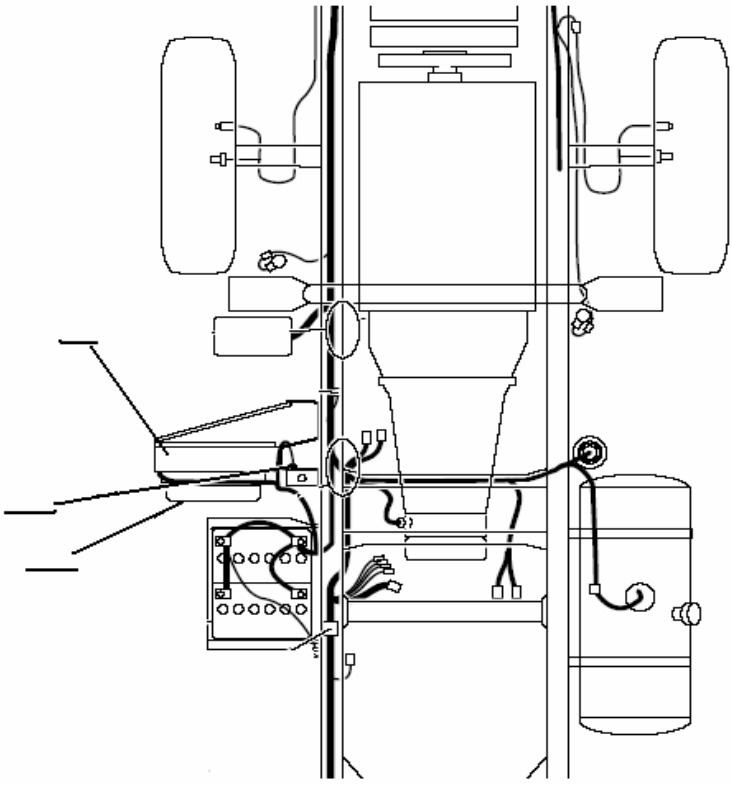
B. Oil Temperature Sensor

C. Output Speed Sensor

D. Vehicle Speed Sensor

E. Turbine Speed Sensor

F. A/T Solenoid Connectors (2)



G. ATF Cooler

H. ATF Cooler Fan

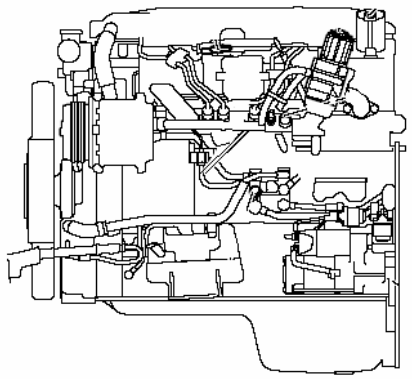
I. ATF Thermo Switch

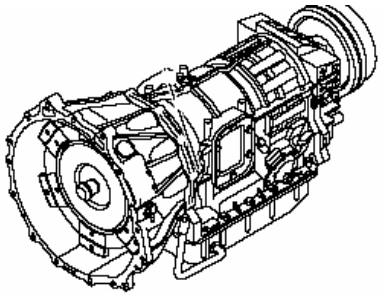
Exercise 6.2 -

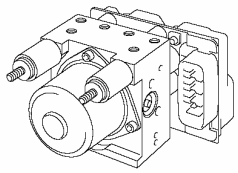
Automatic Transmission Dealer Adjust			
Read through this procedure completely before attempting to perform			
	Engine & trans must be at operating temperature		
	Park brake set, wheels chocked		
	Move selector from **N** to **D** and **D** to **R** at least 3 times		
FAIL	If the ATF Temp Warning lamp come on solid, the procedure has failed.		
	Replace AT Diag fuse, turn truck off and start all over.		
	PROCEDURE		**RESULT**
Step 1	**Enter Adjust Mode**		
	Engine at idle		
	Remove AT Diag fuse		*ATF Diagnostic lamp will begin flashing and will*
			continue throughout test
	Move Selector from **D** to **3**, 3 times in 10 sec		*ATF Temp Warning light begins to flash*
	Move Selector to **D**, **OD** switch from **ON** to **OFF**		*ATF Temp Warning light flashing*
Step 2	**Within 30 sec**		
	RPM to 1200 RPM and hold, left foot hard on brake		*Trans applies and releases clutches*
	Hold RPM until ATF Temp Warning light goes out		*ATF Temp Warning light goes out*
Step 3	Back to idle		
	Move Selector to **R**, **OD** switch from **ON** to **OFF**		*ATF Temp Warning lamp begins to flash*
Step 4	**Within 30 sec**		
	RPM to 1200 RPM and hold, left foot hard on brake		*Trans applies and releases clutches*
	Hold RPM until ATF Temp Warning light goes out		*ATF Temp Warning light goes out*
Step 5	Back to idle		*ATF Temp Warning lamp flashes slowly*
	Shift to **Park**, turn engine off, replace AT Diag fuse		
FAIL	If at any time during the procedure the ATF Temp Warning		
	lamp comes on solid, the procedure has failed.		
	Replace AT Diag fuse, turn truck off and start all over.		

MODULE 7

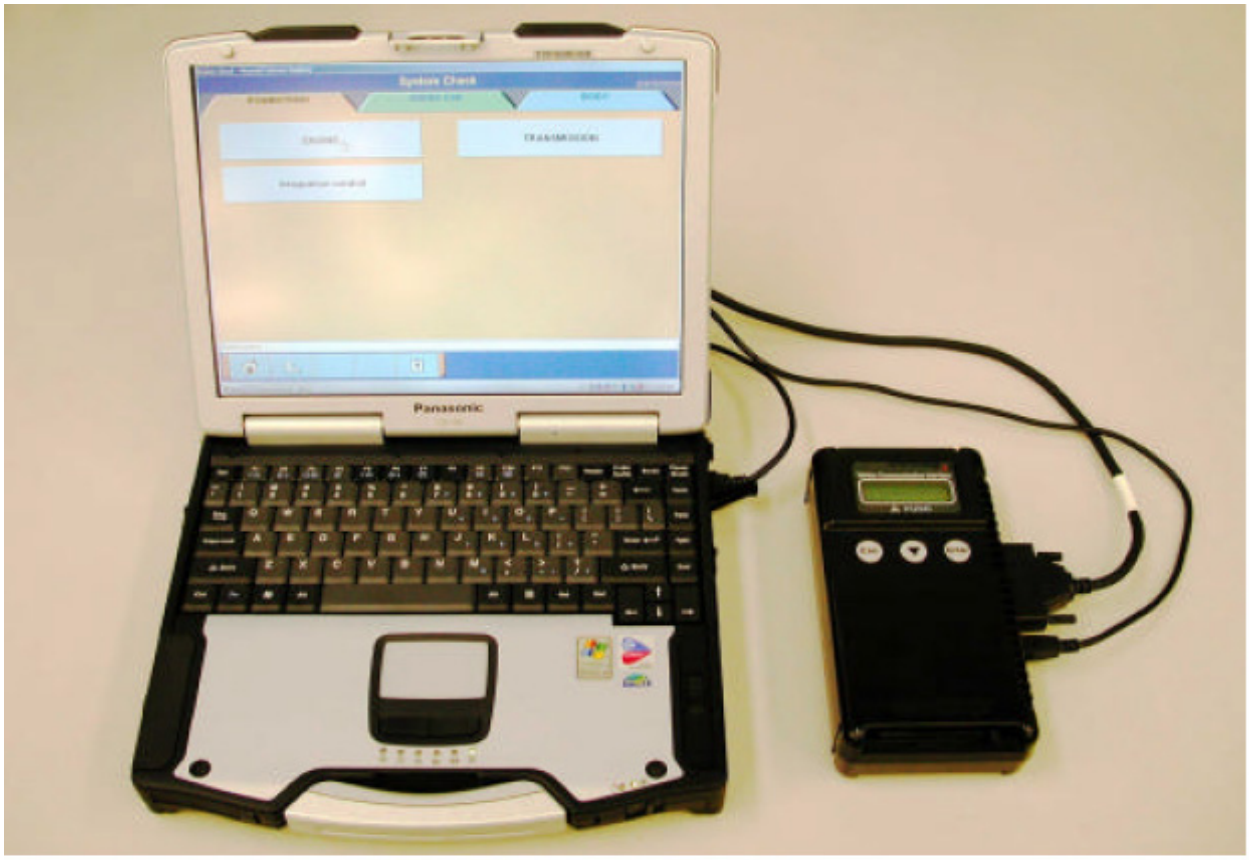
DIAGNOSTICS



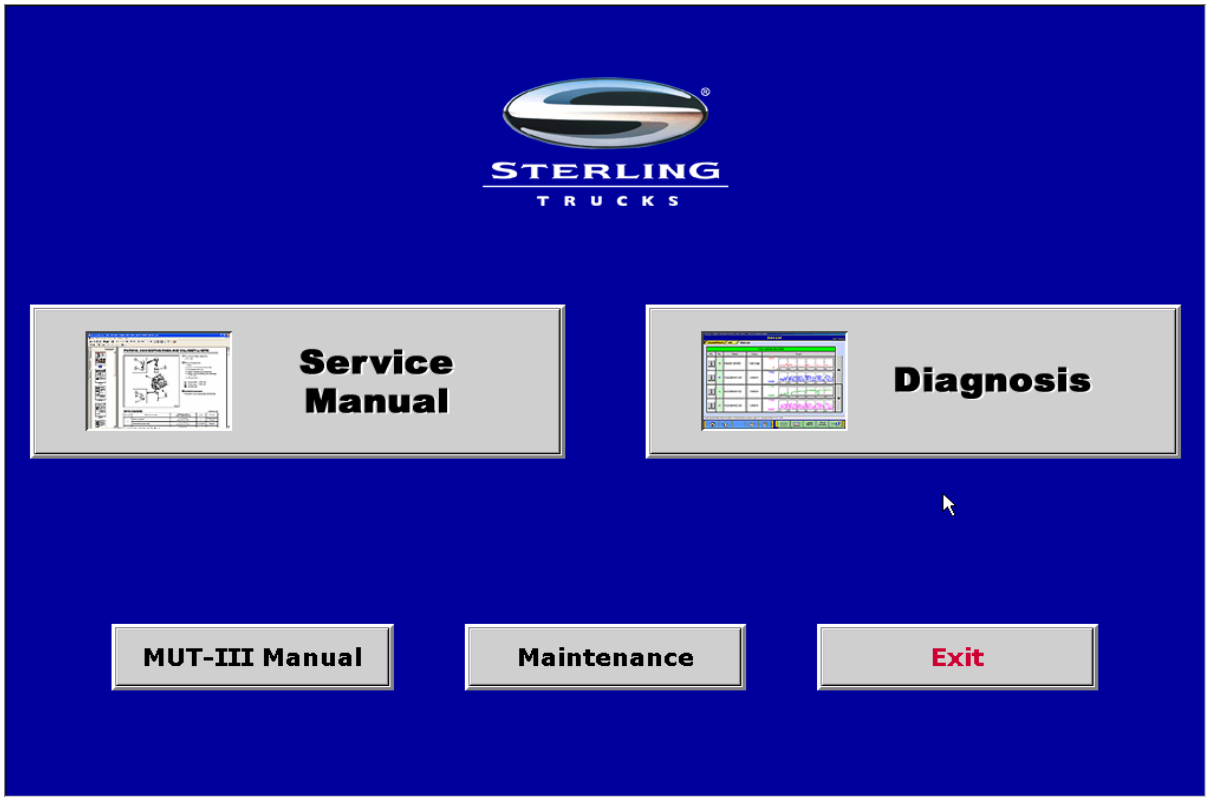




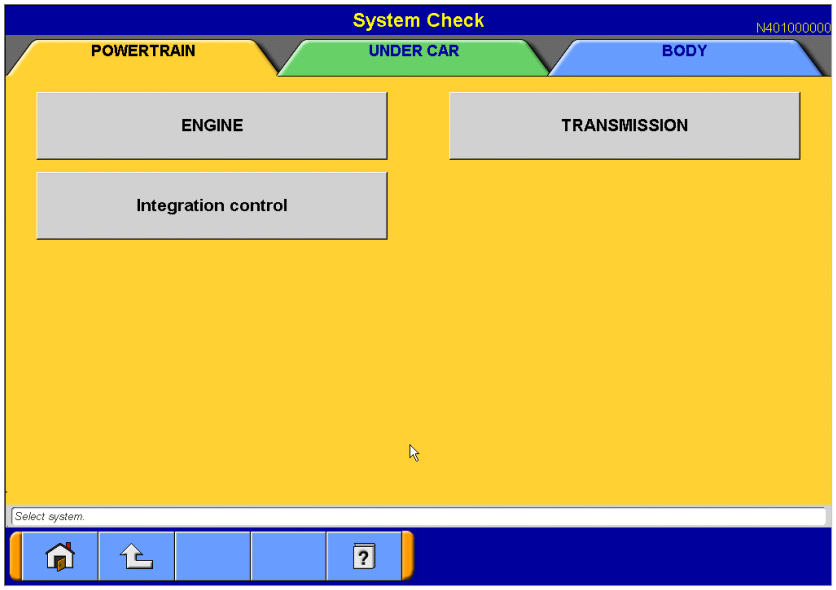
- Vehicle has 3 electronic systems
  - Engine
  - Transmission
  - ABS
- ECU's generate diagnostic codes
- Read by MUT (Multi Use Tester) or flash codes

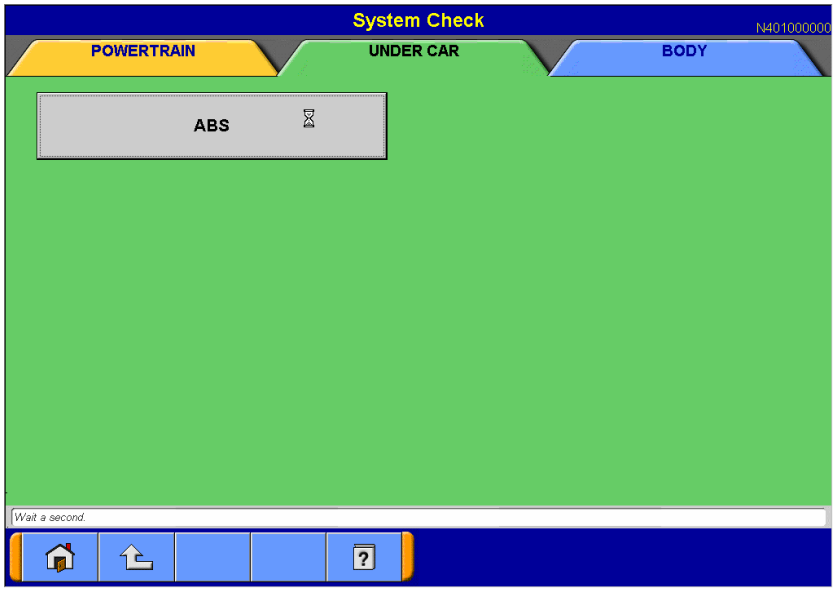


- MUT – Multi Use Tester
  - Software diagnostic program
  - Requires a PC
- VCI – Vehicle Communication Interface
  - Connects PC to vehicle
  - Can stand alone as a recorder device
  - Contains voltmeter functions



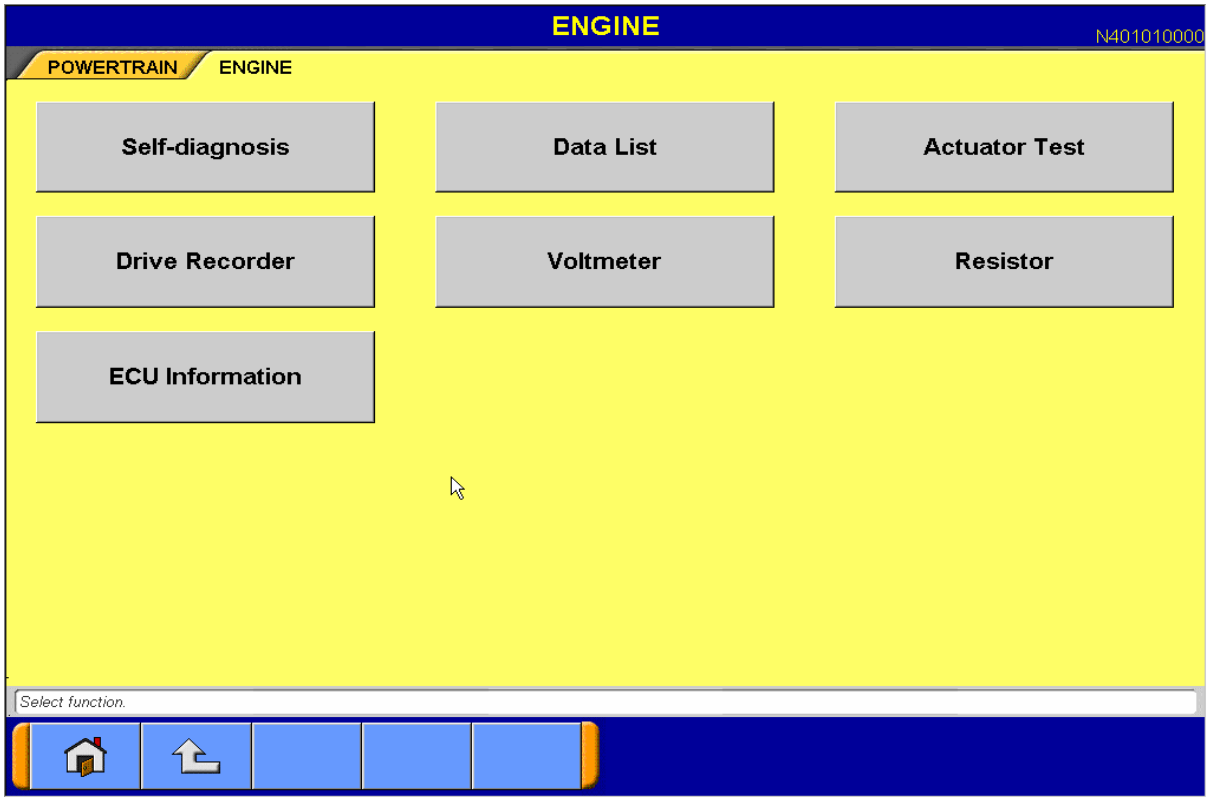
- Initial Screen
- Service Manual button is not operable
- MUT-III Manual in software



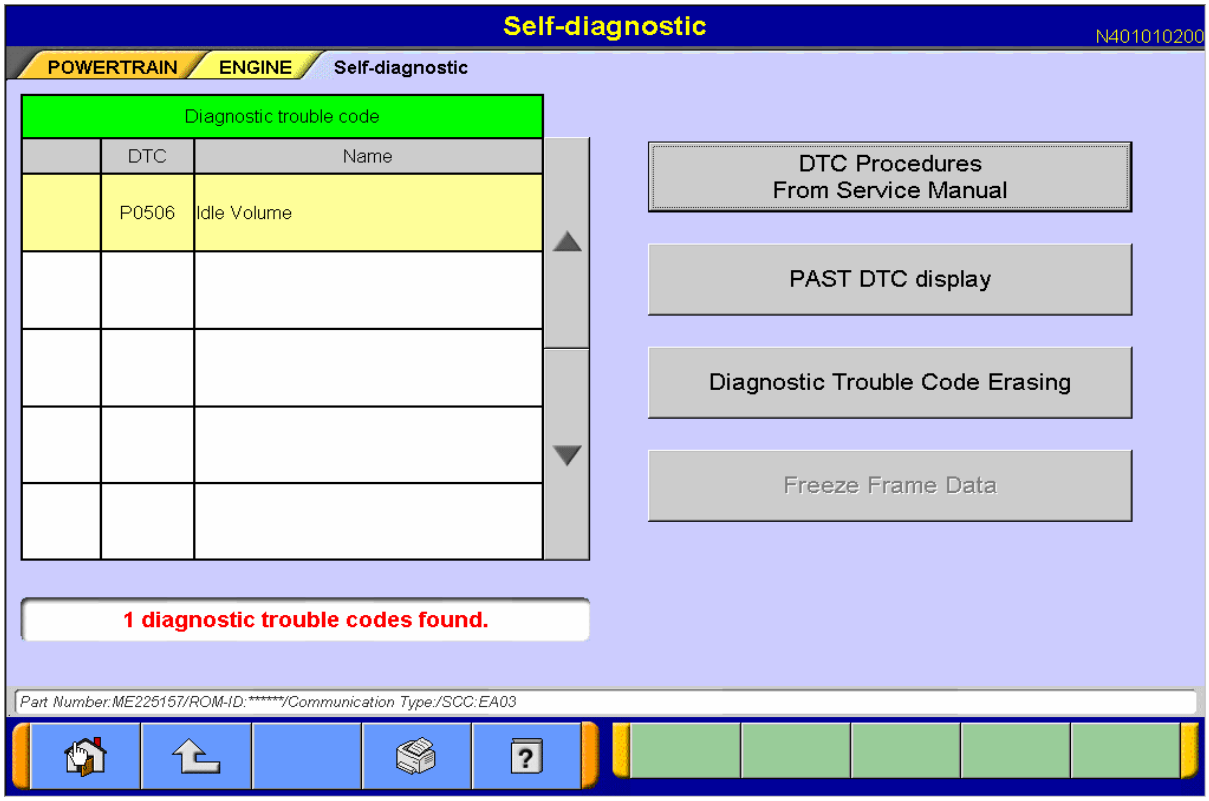


Three tabs

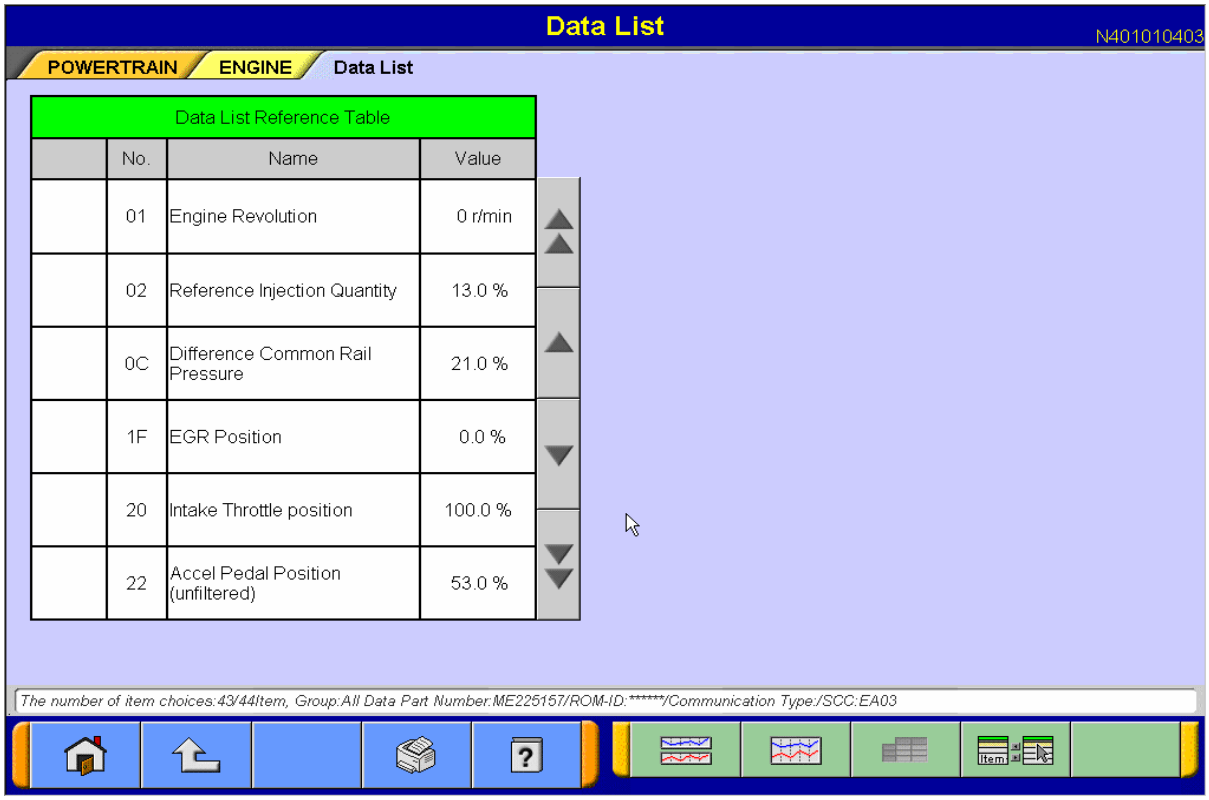
- Powertrain
  - Engine
  - Transmission
- Under Car
  - ABS
- Body
  - Not used at this time



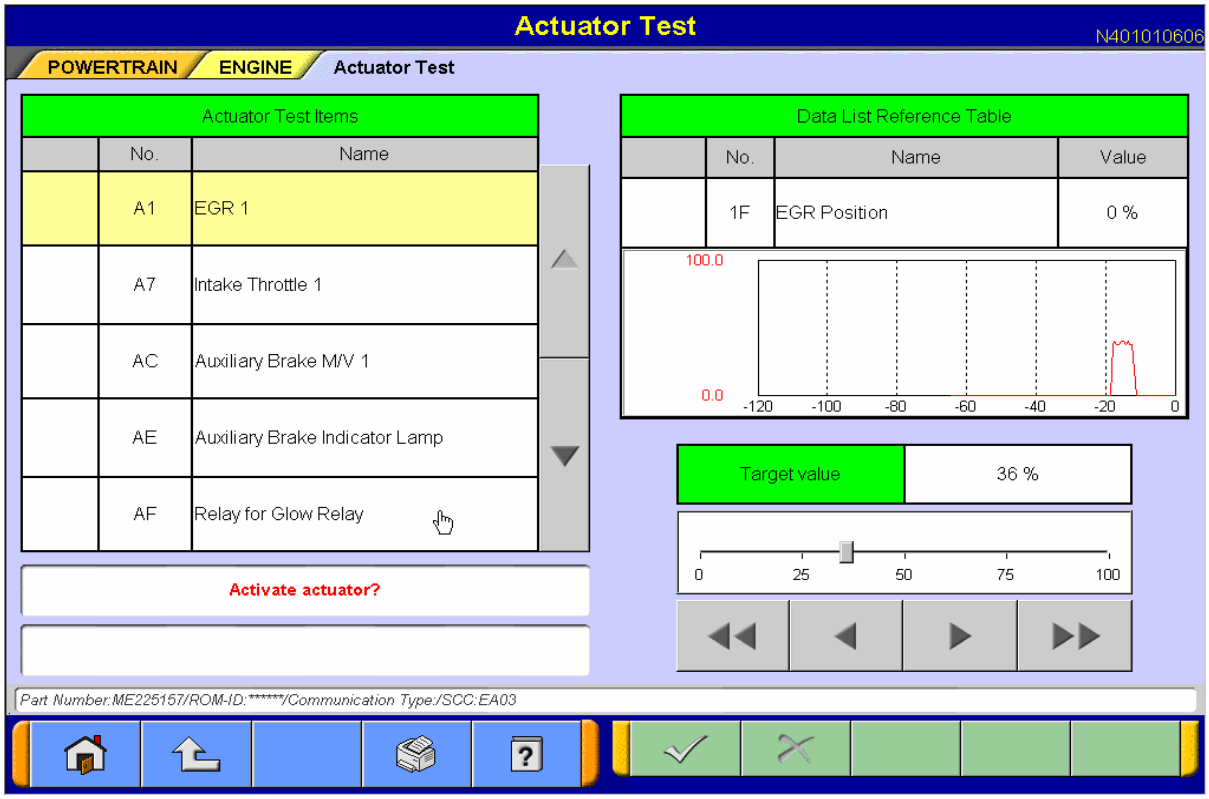
- Self-Diagnosis
  - Fault codes
- Data List
  - Sensor information
- Actuator Tests
  - Can turn on outputs
- Drive Recorder
  - Can use VCI as a recording device with or without MUT
- Voltmeter – Resistor
  - Volt/Ohmmeter function of VCI
- ECU Information



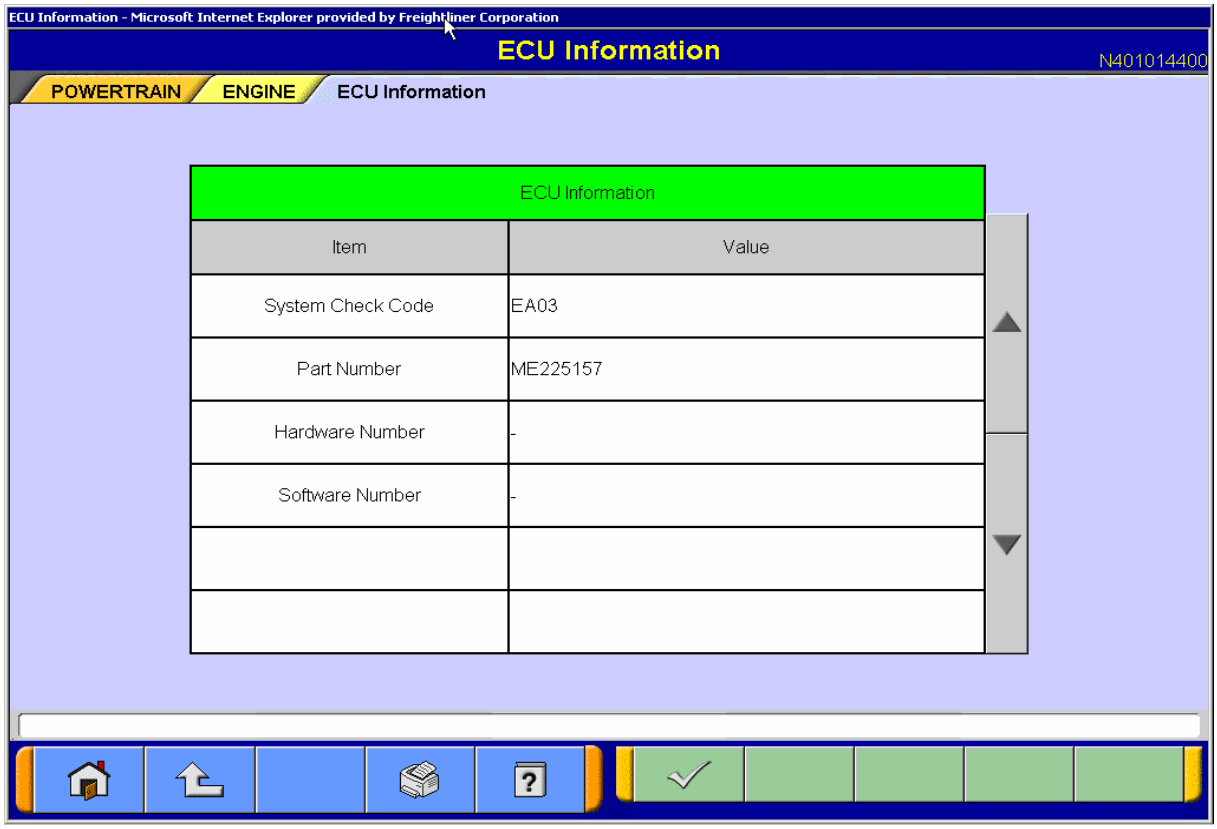
- Reads Fault codes
  - Current
  - Past
- Has diagnostic procedures
- Erase codes



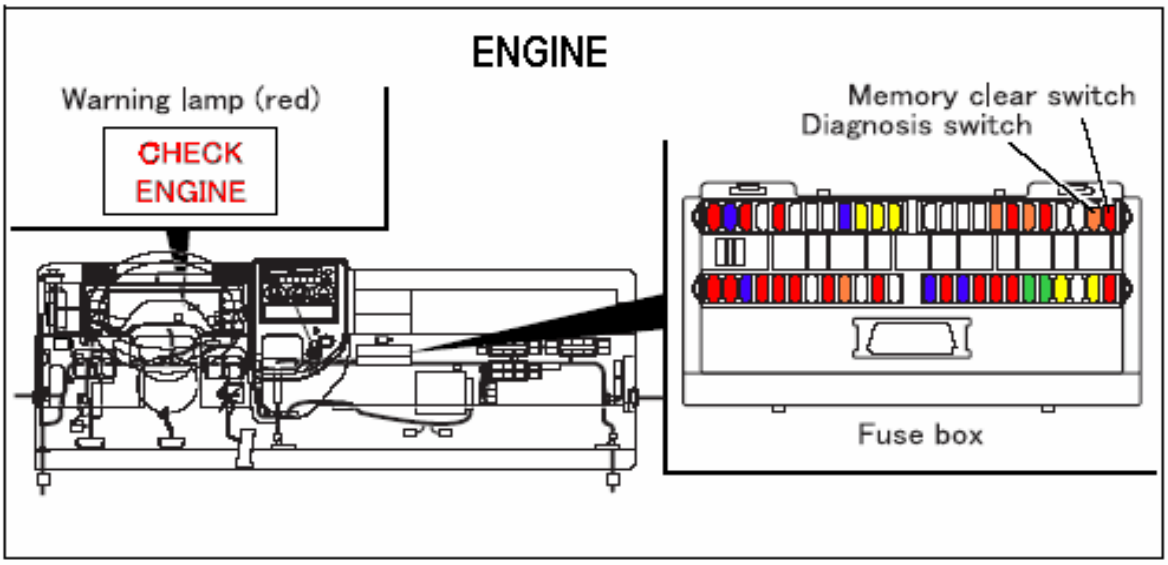
- Data List
  - Reads sensor inputs
  - Can display as a graph



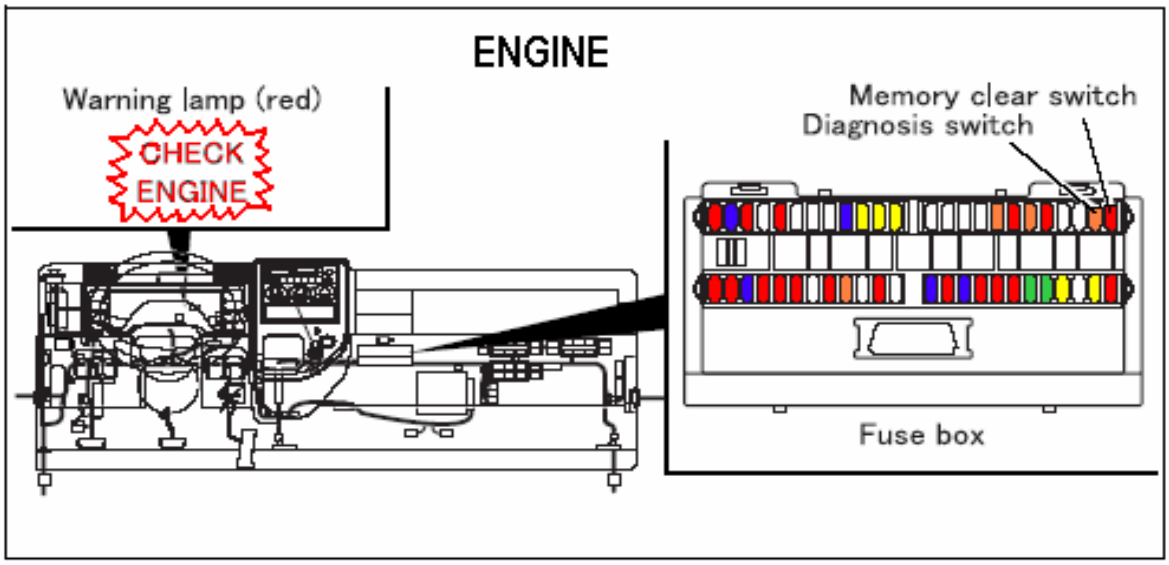
- Actuator Test
  - Controls outputs
  - Can display as a graph



- ECU Information
  - Varies by ECU



- Flash Codes
- Device fuses act as diagnostic switches
- Present Codes
  - 5 amp fuse
  - Orange
- Past Codes
  - 10 amp fuse
  - Red



- 2 digit flash codes
- Long Flash
  - First digit
- Short Flash
  - Second digit
- 01 – No faults

Exercise 7.1 - Diagnostics

A truck comes in with the transmission warning lamp lit. You determine that is has a P0715 fault. Using the Workshop manual answer the following questions:

1. Which part of the transmission electronics has a problem?

   _____

2. What is the number of the electrical equipment inspection for this fault code?

   _____

Find the electrical equipment inspection procedure, remove the device in question and test it per the procedure. If you need any special pieces to perform the test, your instructor will provide them.

3. What are the test specs?

   Hi _____

   Lo _____

4. Did your device pass? Yes _____ No _____

5. If the device passed and the code was still active, what would you do next?

   _____

Exercise 7.2 - Diagnostics

Connect the MUT III to the truck. Jack up the rear axle so that both rear wheels are off the ground.

Open up the MUT III program and find the ABS. In the ABS portion, open the Data List. Find the wheel speeds in the data list, now spin one rear tire by hand while one person observes the screen.

1. Record the wheel speeds:

   RR Speed _____

   RL Speed _____

Disconnect the second highest connector on the group of connectors on the left rear frame rail by the left rear tire. Spin the tires again:

2. Record the wheel speeds:

   RR Speed _____

   RL Speed _____

3. What did that connector affect?

   _____

Go to the ABS main screen and select Self-Diagnosis.

4. Is there an active diagnostic code? Yes _____ No _____
5. If yes, what is the code? _____
6. What connector does the procedure send you to?

   _____

7. What is the specification for this test?

   _____

8. Plug the sensor connector back in and test from the ABS connector at the ABS ECU. Were you able to read the specified resistance?

   Yes _____ No _____ Measured value _____

Exercise 7.3 - Diagnostics

Disconnect the EGR valve sensor. Use the fuses to flash the proper diagnostic codes. Start with Group 13E to answer the questions below.

1. What flash code did you pull up? _____
2. What fault code is that? _____
3. Are you able to find a diagnostic procedure for the fault code in group 13E?

   Yes _____ No _____
4. What group number do you have to go to? _____
5. What is the electrical equipment inspection procedure number? _____
6. What tests can you perform? _____

When you get a chance connect the MUT III to the vehicle and access the Engine main screen and click on the Self-Diagnosis button.

As long as the EGR is still disconnected you should see the same fault as you found above. Click on the DTC Procedures From Service Manual button. Follow this through at least 5 or 6 screen giving appropriate answers.

7. Is the MUT III procedure the same as in the Service Manual?

   Yes _____ No _____
8. Does it appear to be more or less detailed? More _____ Less _____
9. Which do you think would be the preferred method of troubleshooting?

   MUT III _____ Service Manual _____