00 GENERAL INFORMATION

What's in this section:

00 GENERAL INFORMATION
Walkaround

Introduction

- The new MX-5 Miata strives to continue with the long-held tradition of “oneness between car and driver.” Mazda engineers kept this goal in mind when creating every aspect of the MX-5 Miata.

Engine

- The MX-5 Miata is equipped with the 2.0 liter, 4 cylinder LF engine. This engine boasts 170 HP at 6700 RPM (6AT: 166 HP at 6700 RPM) and 140 lb/ft torque at 5000 RPM.

- The MX-5 Miata uses 5W-20 oil and has an oil and oil filter capacity of 4.5 quarts.

Suspension

- The MX-5 Miata is equipped with Tire Pressure Monitoring System (TPMS). TPMS is an optional features for vehicles equipped with either the Sport or Grand Touring models. Vehicles equipped with TPMS are also equipped with run-flat tires. Like the RX-8, the MX-5 Miata does not come with a spare tire, but rather a tire-repair kit.

For 16-inch wheels

- Front camber is between -0°41′ and 0°21′ based on vehicle height. Front caster is set between 6°27′ and 5°31′, depending on vehicle height. Front toe is set at 2 mm ± 4. (0.08 in ± 0.15). All three are adjustable.

- Rear camber is set between -1°33′ and -0°45′, depending on height. Rear toe is set at 3 mm ± 4 (0.12 in ± 0.15). Both are adjustable.

For 17-inch wheels

- Rear camber is between -0°51′ and 0°15′ based on vehicle height. Front caster is set between 6°34′ and 5°39′, depending on vehicle height. Front toe is set at 2 mm ± 4. (0.08 in ± 0.15). All three are adjustable.

- Rear camber is set between -1°42′ and -0°49′, depending on height. Rear toe is set at 3 mm ± 4 (0.12 in ± 0.15). Both are adjustable.

Front suspension

- A newly developed in-wheel-type double-wishbone suspension takes full advantage of the low hood line enabled by the optimized engine layout. The front upper arm and the front lower arm have been lengthened and attached to the highly rigid front crossmember to allow for linear alignment changes during jounce and rebound of the front wheels. Due to this, roadholding and handling performance have been improved.

Walkaround

Brakes

- The MX-5 Miata is equipped with 11.4 inch ventilated front discs and 11 inch solid rear discs. An Anti-lock Brake System is optional with the MX-5 trim level and standard on vehicles equipped with the Touring and Sport and Grand Touring packages.

- Like the RX-8, Dynamic Stability Control is an option on MX-5 Miatas equipped

Transmission

- The MX-5 Miata is equipped with three different transmissions: a 5-speed MT (M15M-D), a 6-speed MT (P66M-D) and a 6-speed AT (SJ6A-EL)

- Both 6-speed transmissions are all-new. The 6-speed AT uses a unique method for checking fluid. We will discuss this in further detail during the course.
  The 6-speed AT offers steering-wheel mounted paddle shifters.

Steering

- The MX-5 Miata uses a standard hydraulic power assist-steering, not EHPAS.

Walkaround

Body and Accessories

- The all-new Z-folding top is simple to use.
  To open the top, simply lower the windows, release the single center-mounted latch, and fold the top into the rear compartment and push down gently, to latch the top.
  To close, press this button to release the top, pull-up and secure it with the central latch.

- Like the RX-8, Xenon, HID Lights are an available option.

- The MX-5 Miata has optional all-new advanced keyless system. This system allows the driver to perform many common functions (unlocking door, starting the vehicle, etc) without using a traditional key or fob.

- The MX-5 Miata uses a high speed Controller Area Network (CAN). The following modules are on the high speed network: PCM, TCM, DSC HU/CM (with DSC), ABS HU/CM (with ABS), Keyless Control Module, Steering Angle Sensor (with DSC), Instrument Cluster.

01 ENGINE

Objectives

After completing this section, you will be able to:

- Explain the operation of the pressure-based evaporative emission system.
- Explain the operation of the wide-range air/fuel ratio sensor.
- Perform pressure-based evaporative emission system diagnosis using WDS and the Mazda approved evaporative system tester.
- Perform a wide-range air/fuel ratio sensor evaluation using WDS.

What's in this section:

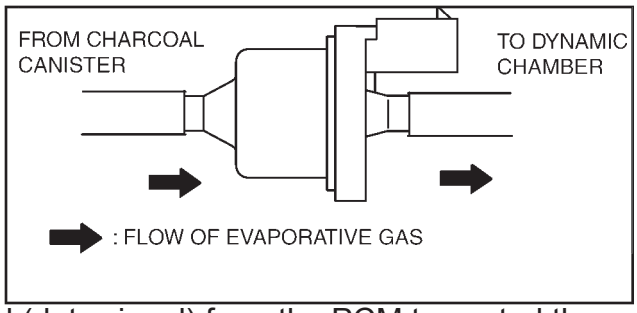
Activity	Title	Location
4	Pressure-based Evaporative System Diagnosis	Shop
5	Front Wide-range Oxygen Sensor Evaluation	Shop

Purge Solenoid Valve Function

- The purge solenoid valve adjusts the amount of evaporative gas to be introduced to the intake air system.

Purge Solenoid Valve Construction/Function

- The purge solenoid valve is installed on the evaporative hose.



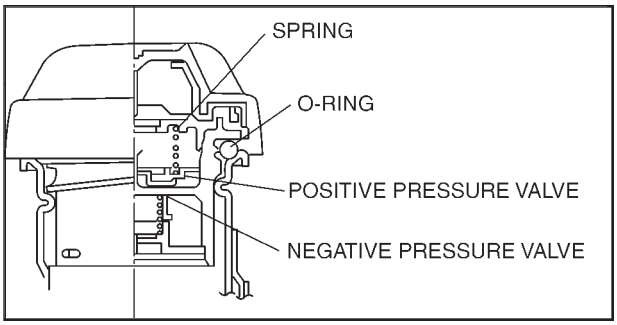
- It consists of a electromagnet, spring and plunger.
- It opens and closes the passage in the solenoid valve according to the purge solenoid valve control signal (duty signal) from the PCM to control the amount of evaporative gas to be introduced to the dynamic chamber according to engine operation conditions.
- The signal the PCM sends energizes and magnetizes the electromagnet, pulling the plunger. The passage between the ports opens when the plunger is pulled, and evaporative gas is introduced to the intake air system according to intake manifold vacuum.

Fuel-filler Cap Function

- If the evaporative gas passage is closed for some reason, the fuel filler cap prevents the generation of positive or negative pressure in the fuel tank, protecting it from deformation.

Fuel-filler Cap Construction/Operation

- Consists of a positive pressure valve, negative pressure valve, spring, and O-ring.

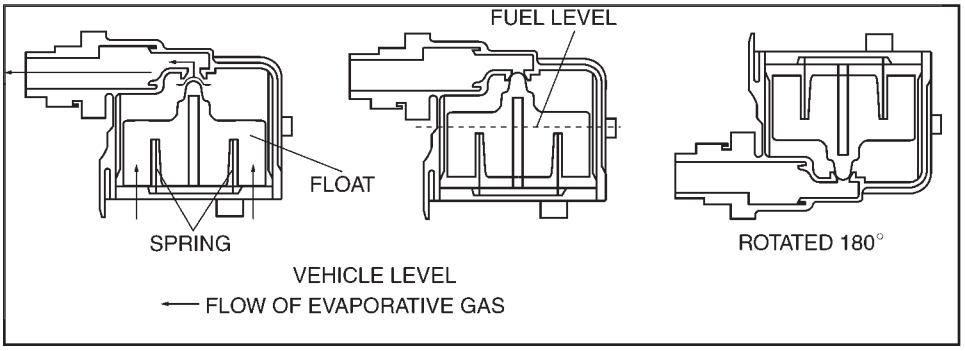


- When there is excessive positive pressure in the fuel tank due to evaporative gas, the positive pressure in the fuel filler cap valve releases the pressure to atmosphere. When there is negative pressure, the negative pressure valve allows air into the fuel tank.
- Under normal operation conditions, evaporative gas is vented through the two-way check valve built into the rollover valve. The positive and negative pressure valves in the fuel filler cap have higher opening pressures than the two-way check valve, so they are normally closed. The valves will open if the evaporative pressure inside the tank is too high.

Rollover Valve Function

- The rollover valve prevents fuel flow into the evaporative gas passage during sudden cornering or vehicle rollover.

Rollover Valve Construction/Operation



- The rollover valve is built into the fuel tank, therefore it is not possible to remove or install it.

- The rollover valve consists of a float, a spring and a two-way check valve.

- The rollover valve utilizes a combination of float weight, spring force, and buoyancy. If the fuel level reaches the top of the fuel tank, the float (valve) closes to block the sealing surface of the passage.

Fuel Shut-off Valve Function

- The fuel shut-off valve prevents fuel from flowing to the charcoal canister during tight turns or vehicle rollover.

- The two-way check valve releases evaporative gas to the charcoal canister.

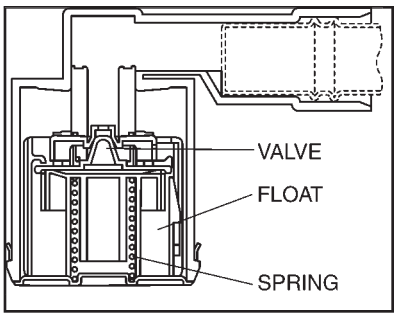
- During refueling, the fuel shut-off valve closes to prevent a fuel overflow.

Fuel Shut-off Valve Construction/Operation

- The fuel shut-off valve is built into the fuel tank.

- The fuel shut-off valve consists of a valve, float, spring, and by-pass valve.

- During refueling or due to fuel sloshing, the float is flooded with fuel and the floating force causes the valve to close. Also, during vehicle rollover, the valve closes due to balance between the float gravity and spring.



Evaporative Emission (EVAP) System Leak Detection Pump

Construction/Operation

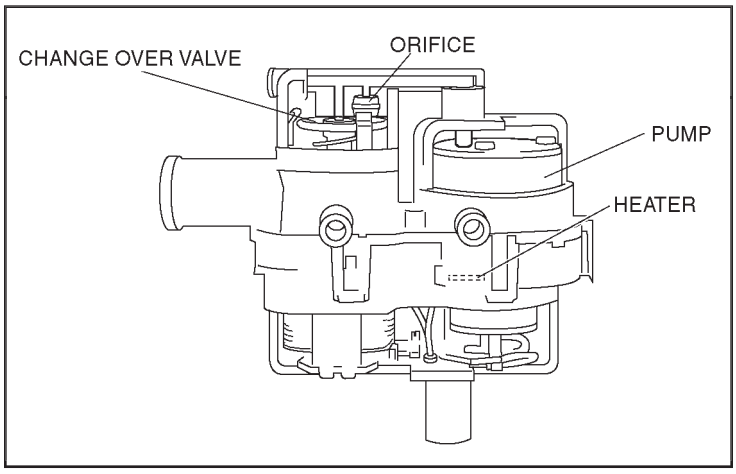
Structure

- Orifice
  — Has a 0.5 mm (0.02 in) hole

- Pump
  — Force-feeds air to the orifice and the EVAP lines

- Heater
  — Removes moisture inside the pump

- Change over valve
  — Operated by a solenoid valve to switch air passages

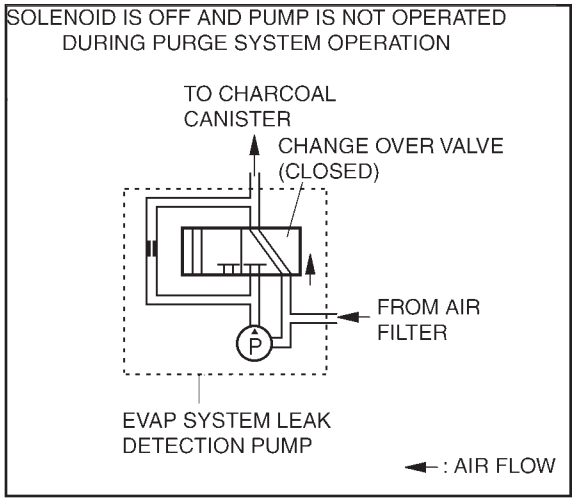


Operation

Evaporative system normal operation

- While driving, air passes through the change over valve through the charcoal canister then to fuel tank to compensate for the fuel being used.

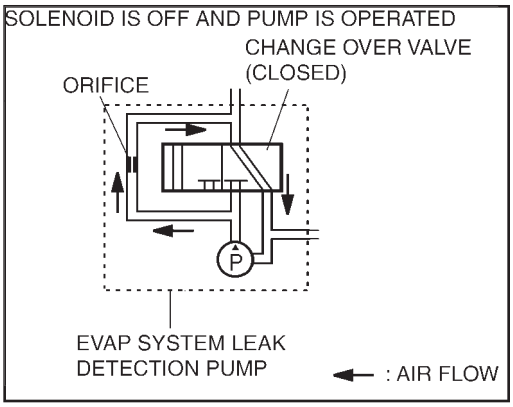
- The passage between the charcoal canister and the air filter is connected. During fuel expansion or when filling the fuel tank, fuel vapor passes through charcoal canister through changeover valve then to atmosphere.



Evaporative Emission (EVAP) System Leak Detection Pump

Construction/Operation

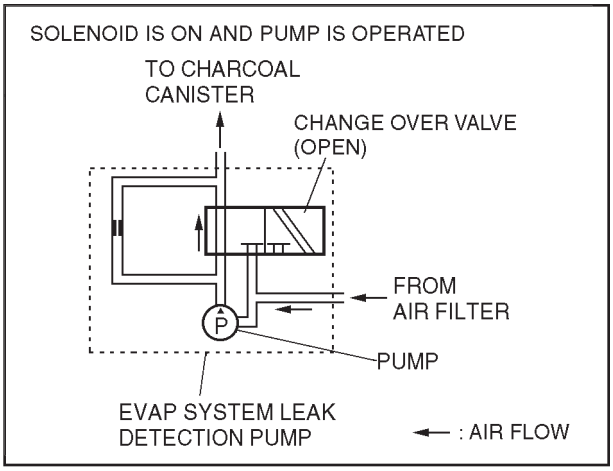
- The PCM performs the evaporative test after the ignition key is turned to the OFF position.



- After the ignition is turned off, the PCM turns on the leak detection pump which forces air through a 0.5 mm (.020 in.) orifice to establish the current reference value.

- Forcing air through the orifice places a load on the leak detection pump which the PCM interprets as a reference (base) value for the evaporative test.

- The leak detection pump draws air from the air filter and sends it to the charcoal canister to pressurize the evaporative system.

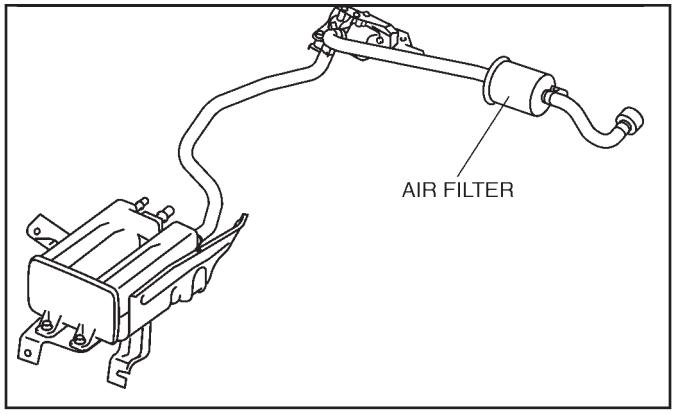


Air Filter Function

- The air filter filters dust from the air drawn to the charcoal canister.

Air Filter Construction/Operation

- The air filter is located in the EVAP system leak detection pump on the atmosphere side.

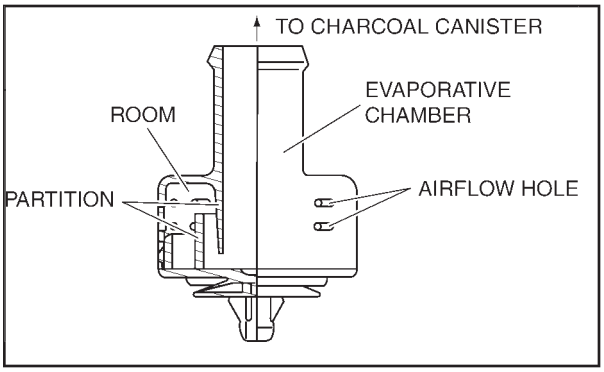


Evaporative Chamber Function

- The evaporative chamber prevents penetration of water and dust in the charcoal canister.

Evaporative Chamber Construction/Operation

- A small section with partitions is located in the evaporative chamber. These partitions protect the charcoal canister by preventing flooding as atmospheric air enters from the airflow holes.



Heated Oxygen Sensor (HO2S) Function

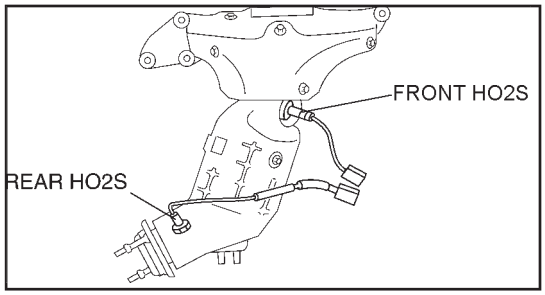
- The front HO2S uses the wide-range air/fuel ratio sensor, which can linearly detect the oxygen concentration (air/fuel ratio of the air-fuel mixture) in the exhaust gas in all ranges, from lean to rich.

- The rear HO2S detects the oxygen concentration in the exhaust gas.

- A heater allows stable detection of the oxygen concentration even when the exhaust gas temperature is low.

HO2S Construction/Operation

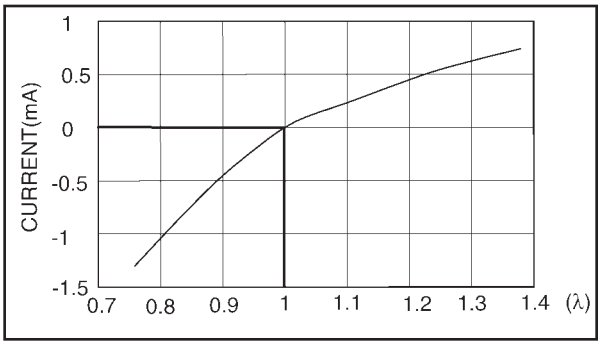
- The HO2S is installed on the front of the WU-TWC and back of the TWC.



Front HO2S

- The wide-range air/fuel ratio sensor is a limited current type sensor, and can detect the oxygen concentration (air/fuel ratio of the air-fuel mixture) in the exhaust gas in all ranges, from lean to rich.

- A heater is built into the sensor to facilitate the activation of the HO2S at engine startup (when the exhaust gas temperature is low).



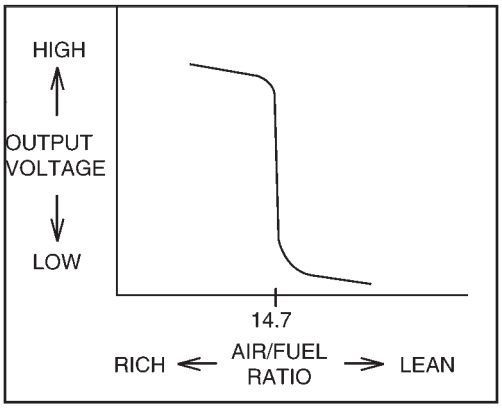
- The wide-range air/fuel ratio sensor converts the oxygen concentration in the exhaust gas into a current value, and sends the value to the PCM.

- The PCM calculates the λ (lambda) value of the air-fuel mixture based on the received current value.

- (λ (lambda)) = (actual air/fuel ratio)/14.7

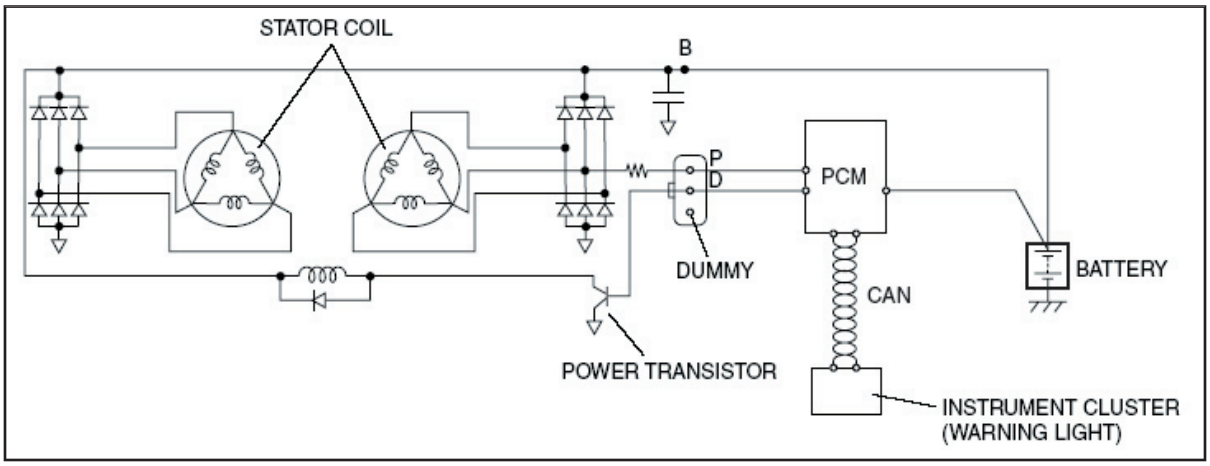
Rear HO2S

- A heater is built into the sensor to facilitate the activation of the HO2S at engine startup (when the exhaust gas temperature is low).

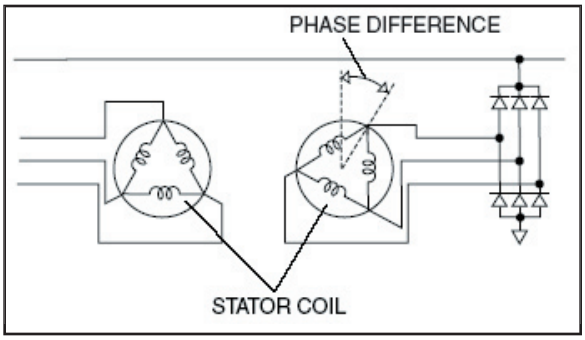


- A zirconium element is used on the sensor. When there is a difference between the oxygen concentration inside and outside the element, electromotive force is generated by the movement of oxygen ions (inside of the zirconium element: atmosphere, outside: exhaust gas). The electromotive force changes significantly at the boundary of the stoichiometric air/fuel ratio (A/F=14.7). The PCM receives the voltage generated from the HO2S directly, and increases or decreases the fuel injection amount by the fuel injection control so that it is close to the stoichiometric air/fuel ratio.

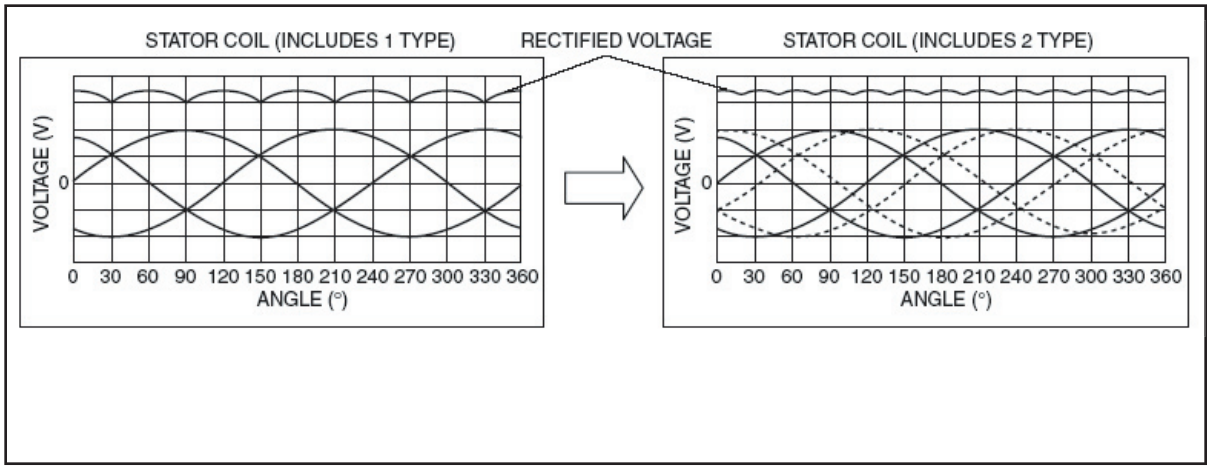
- When the temperature of the zirconium element is low, electromotive force is not generated. Therefore, the HO2S is heated by a built-in heater, facilitating the oxygen sensor activation. Due to this, the sensor is efficiently activated even immediately after cold-engine startup, and a stable sensor output can be obtained.



- The phase difference in the circuit of the two stator coils causes the electromagnetic pull between the rotor and the stator to be eliminated logically. Due to this, electromagnetic vibration and generator operation noise (electromagnetic noise) have been reduced.



- The pulsation occurring through voltage rectifying is minimized, as a result, stable voltage output is supplied due to the adoption of two stator coils with the phase



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02 SUSPENSION

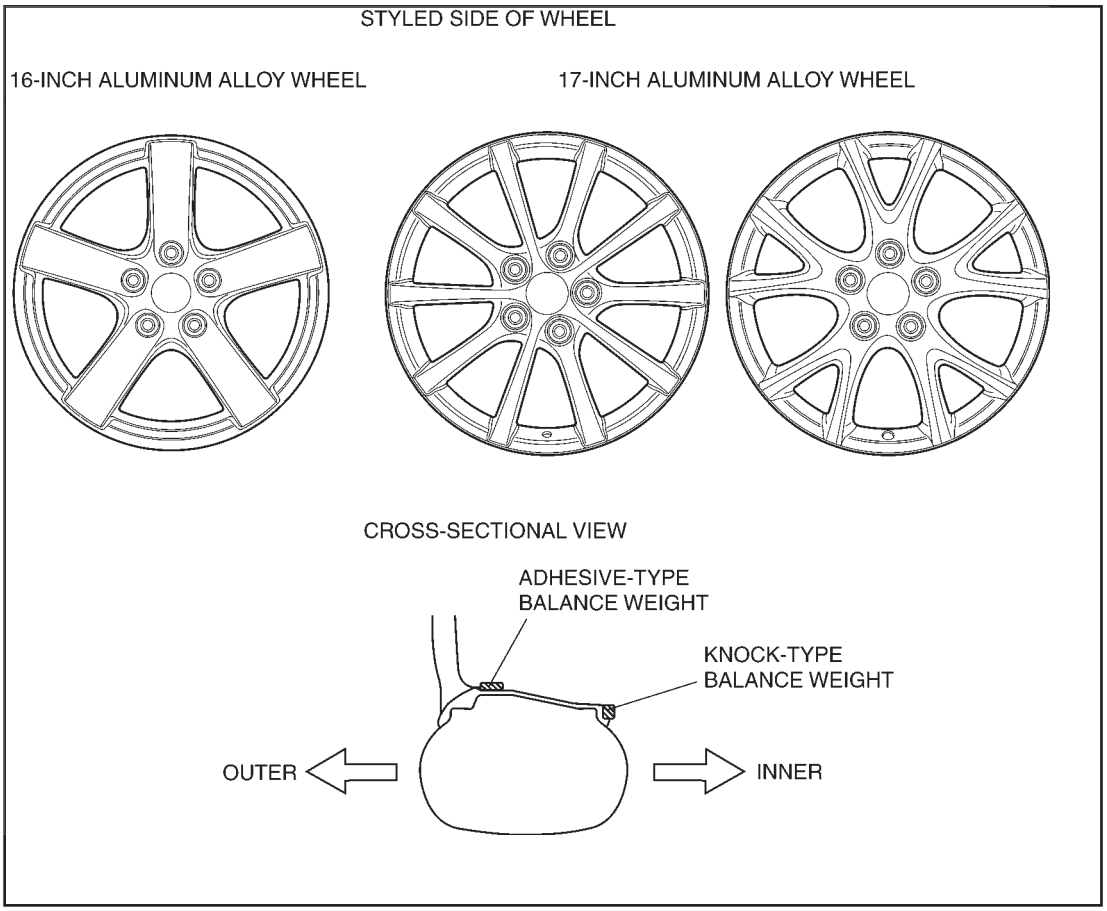
Objectives

After completing this section, you will be able to:

- Explain the operation of run-flat tires.
- Explain the operation of the front suspension system.

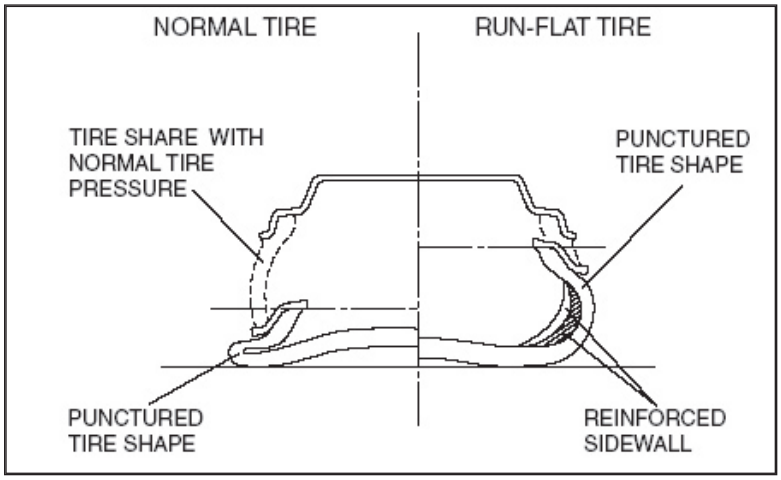
What's in this section:

Wheels and Tires Structural View



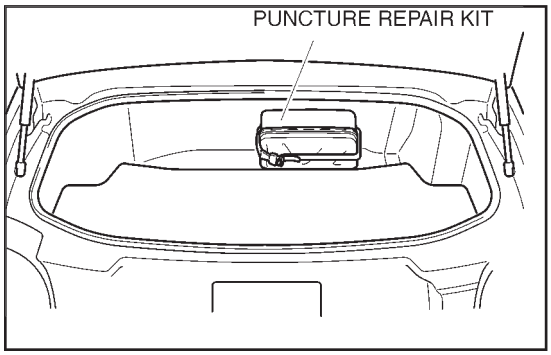
Wheels and Tires

Run-flat Tires Outline



- Because the run-flat tire sidewalls have been reinforced, vehicles with run-flat tires can be driven for 80 km (49.6 mile) at 89 km/h (55.2 MPH) even with air leakage caused by tire damage.

Puncture Repair Kit Outline

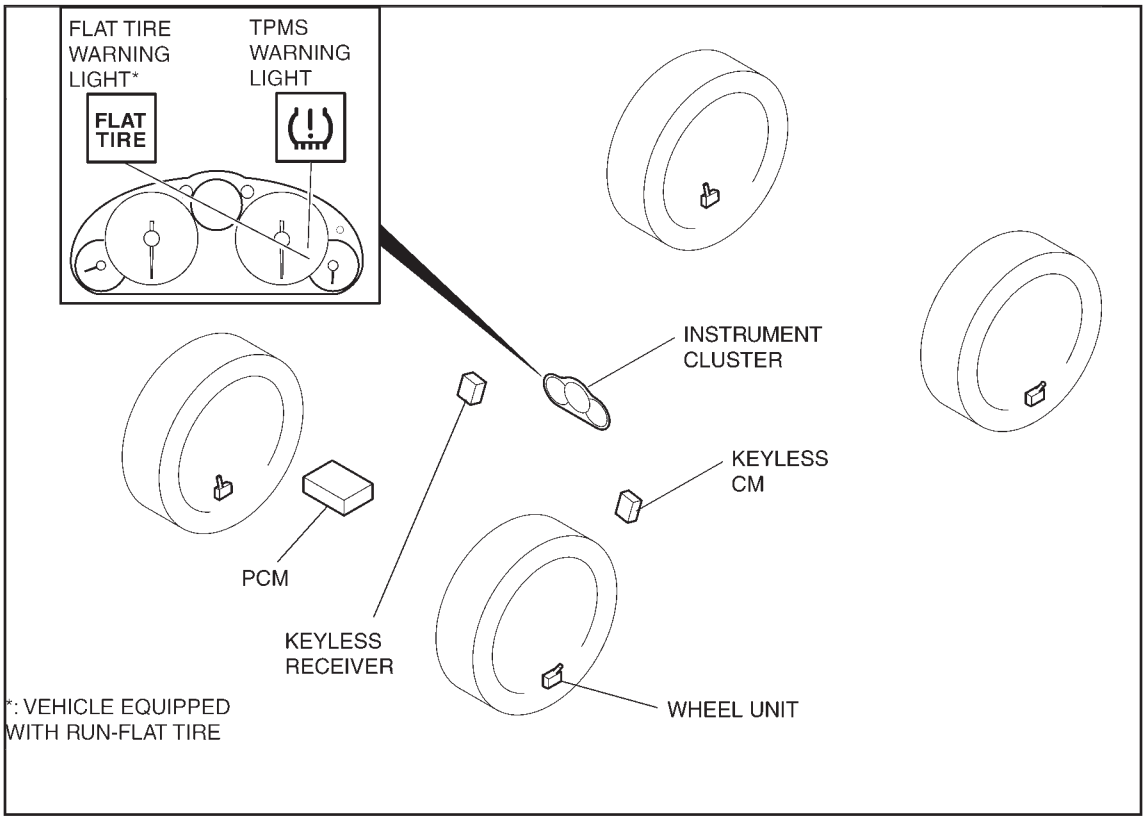


- Vehicles not equipped with run-flat tires have an emergency puncture repair kit. This kit enables temporary repair of a puncture without tire removal.

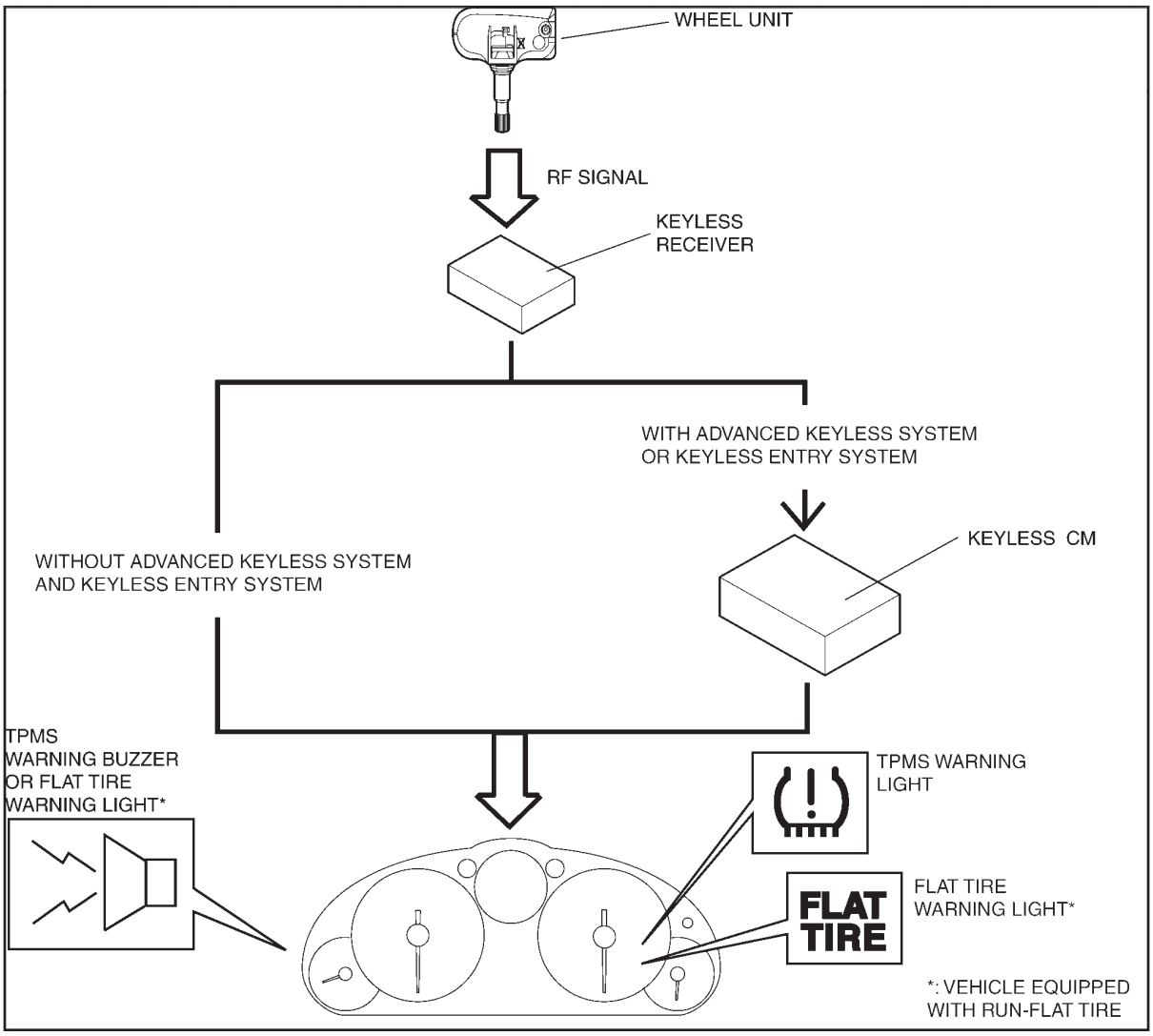
- The emergency puncture repair kit is located in trunk compartment and includes the following:
  - — Repair agent
  - — Repair agent filler hose
  - — Air compressor
  - — Tire valve core
  - — Tire valve core tool
  - — Instruction manual
  - — Speed limit label
  - — Filled tire indication label

- The accessory socket (12 V DC) is used as an input power source for the air compressor and the compressor plug includes a 10 A fuse.

Tire Pressure Monitoring System (TPMS) Structural View



TPMS Construction

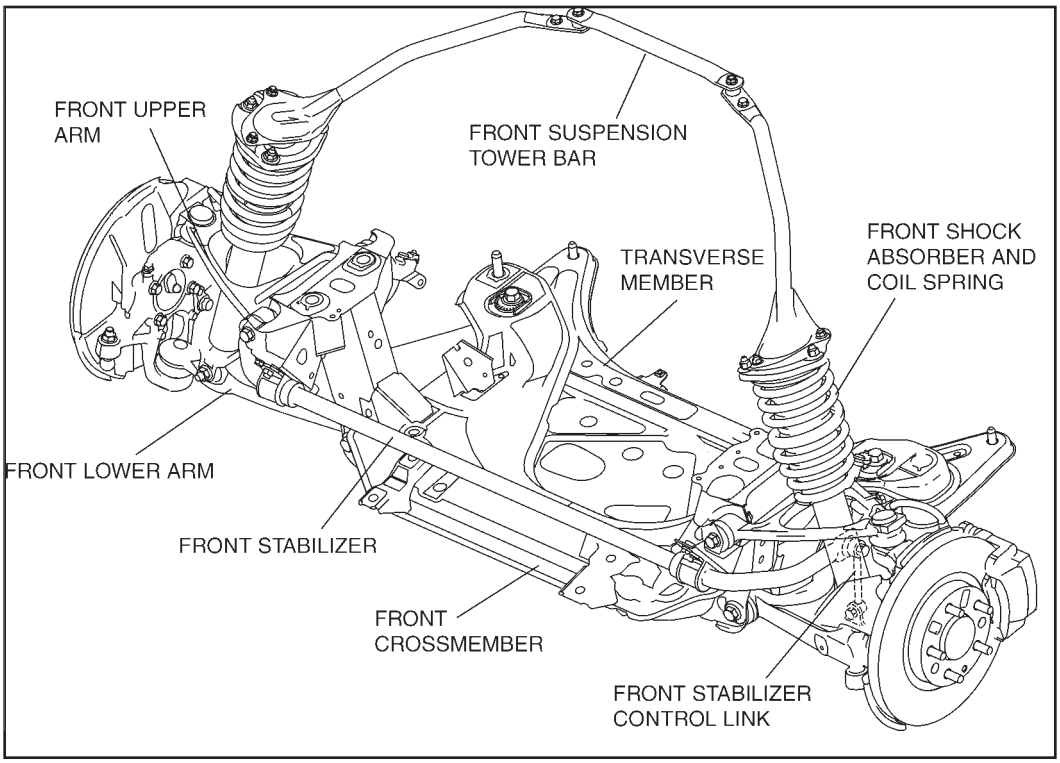


- The TPMS consists of wheel units that detect air pressure, temperature and acceleration of each tire, and a TPMS control module that receives data (RF signals) sent from the wheel units to monitor the air pressure of each tire.

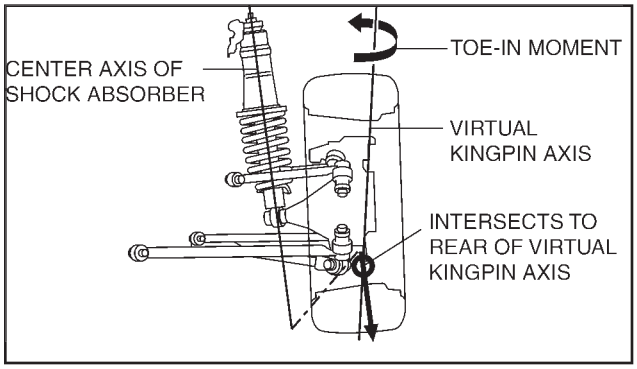
Front Suspension Outline

- The front upper arm and the front lower arm have been lengthened and attached to the highly rigid front crossmember to allow for linear alignment changes during jounce and rebound of the front wheels. This improves handling performance

Front Suspension Structural View

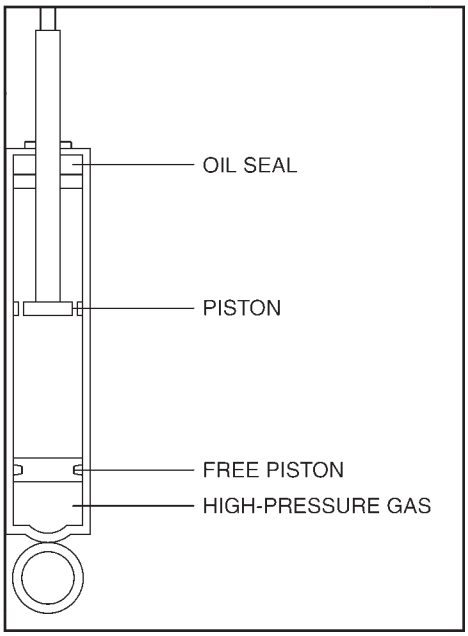


Double Wishbone Front Suspension Construction



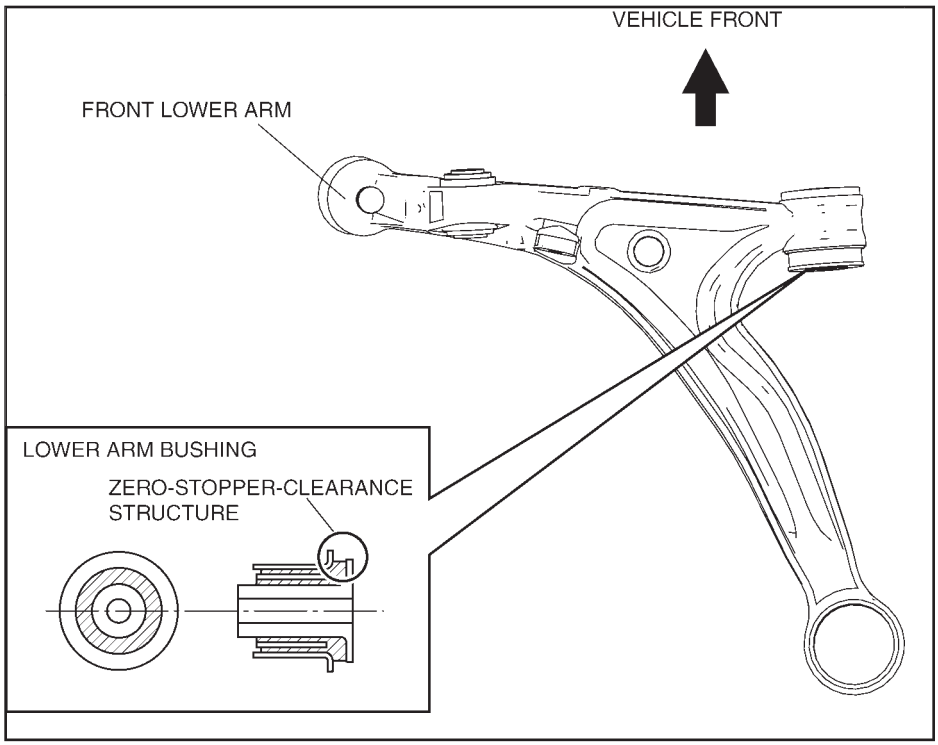
- The heightened damper lever ratio has improved the efficiency of shock absorber operation.
  — Damper lever ratio: shock absorber stroke (B)/wheel vertical stroke (A)
  — The heightened damper lever ratio has made it possible to provide a damping force even during minute strokes. As a result, excellent roadholding is exhibited in a variety of driving conditions.

Front Shock Absorber Construction



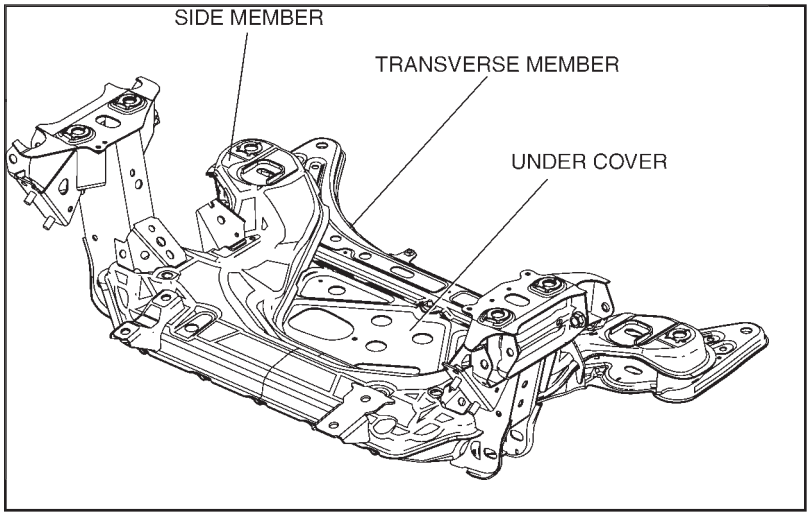
- The high-pressure gas-filled monotube shock absorber minimizes cavitation and provides stable damping force even during hard driving.
  — The large-diameter piston ensures superior response during minute strokes, providing consistent damping force and stroke feeling.
  — The enlarged piston port area also contributes to the improvement of riding comfort.

Front Lower Arm Construction



- The front lower arm is made of aluminum for rigidity and weight reduction.
- As with the front upper arm, the zero-stopper-clearance bushings optimize control over changes in vehicle behavior.

Front Crossmember Construction



- A lightweight, highly rigid front crossmember with integrated side members has been adopted.

- The transverse member is attached to the back of the front crossmember to create a highly rigid square construction.

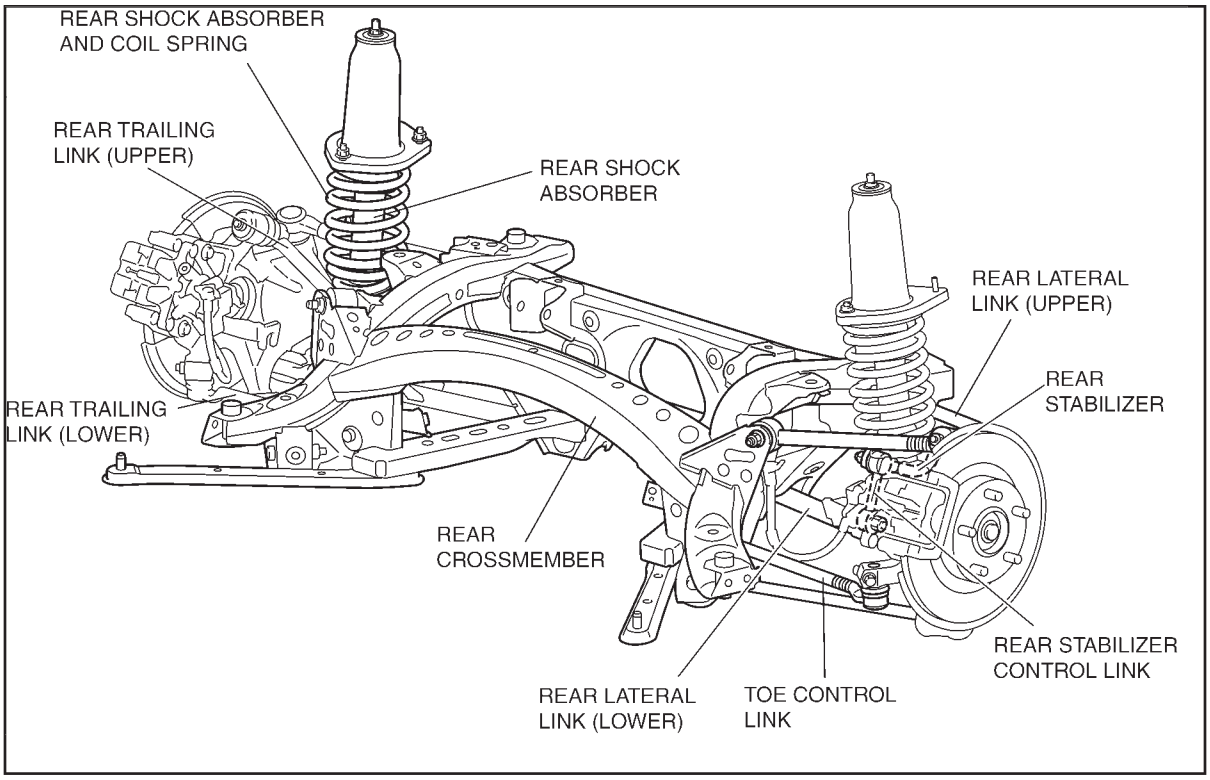
- This front crossmember component is rigidly mounted to the vehicle body at eight points, providing an extremely large amount of suspension support stiffness and alignment precision.

Rear Suspension

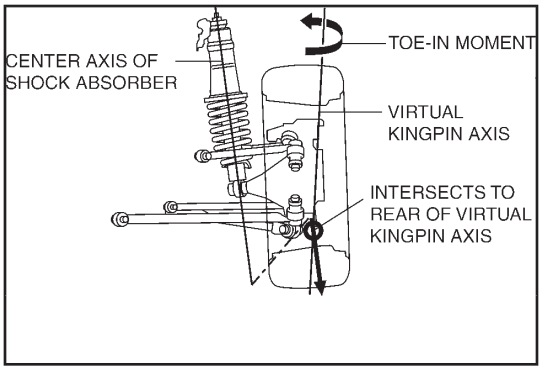
Rear Suspension Outline

- The MX-5 Miata has a multi-link suspension composed of five links.
- The links have been lengthened and optimally positioned. Due to this, they constantly provide ideal geometry to respond to external forces applied during driving, improving handling stability and riding comfort, and reducing road noise.

Rear Suspension Structural View



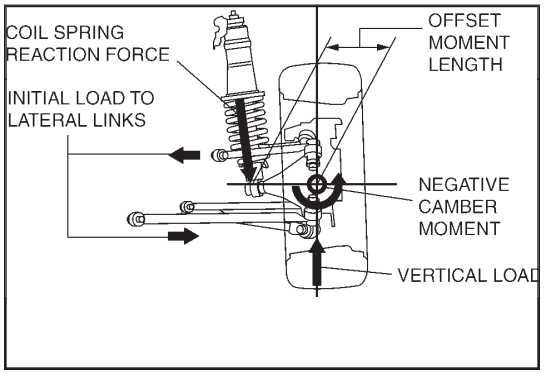
Multi-link Rear Suspension Construction



Optimized Link and Shock Absorber Layout

Compliance toe control

- The suspension system layout is such that the center axis line of the shock absorber intersects to the outside and rear of the virtual kingpin axis. This layout ensures that the toe-in moment is constantly produced around the virtual kingpin axis of the rear wheels. Due to this, the rear wheels constantly and securely provide a high level of gripping power.

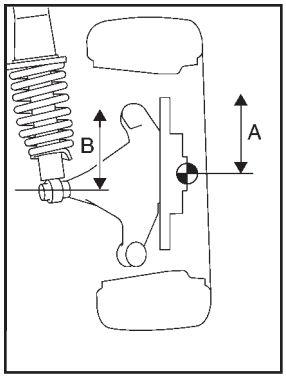


Compliance camber control

- Initial load in the negative camber direction is applied to the rear lateral links (upper/lower). Because of this, the bushings anchoring the rear lateral links (upper/lower) to the rear crossmember are constantly pressed toward the rear lateral links. As a result, the central, nonsensitive region of the bushing is not used, thereby minimizing delayed steering response and suppressing parasitic (unnecessary) wheel movement in response to external disturbances.

Elongated links

- Elongated upper and lower rear lateral links have been adopted. They reduce torsion applied to the bushings on the rear crossmember side during jounce and rebound of the rear wheels, providing smooth link behavior.



- The damper lever ratio has been set at approximately 1 to improve the efficiency of shock absorber operation.
  — Damper lever ratio: shock absorber stroke (B)/wheel vertical stroke (A)
  — A layout with the damper lever ratio close to 1 makes it possible to provide a damping force even during minute strokes. As result, excellent roadholding is exhibited in a variety of driving conditions.

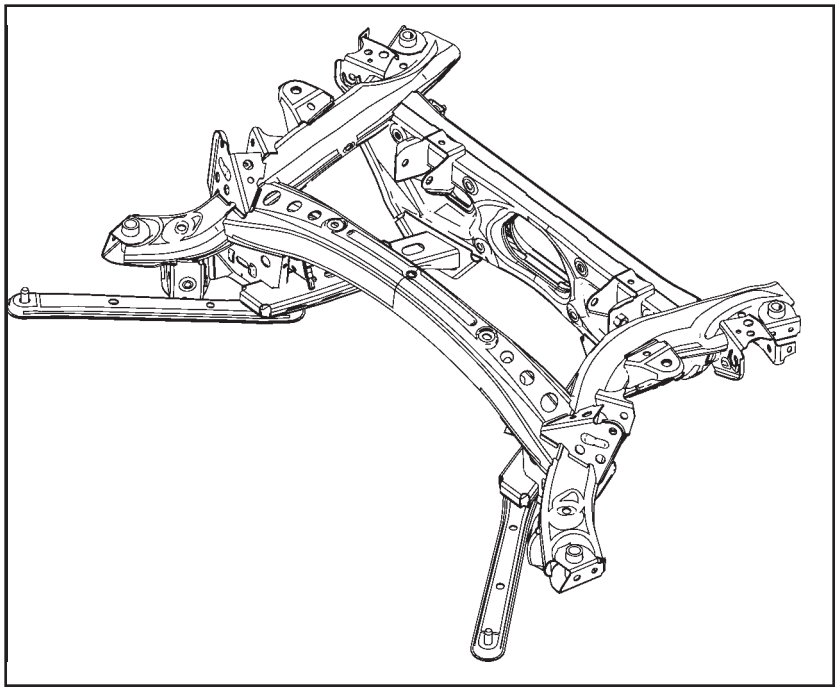
Rear Shock Absorber Construction

- As with the front shock absorber, a high-pressure gas-filled monotube shock absorber has been adopted.

- Placement of the rear coil springs below floor level reduces lateral spring force on the damper rods and thereby minimizes friction.

- This layout also contributes to an enlarged trunk compartment space.

Rear Crossmember Construction



- Adoption of a six-point mounting system rear crossmember ensures link support stiffness and isolates vibration, improving riding comfort and reducing road noise.

03 DRIVELINE/AXLE

Objectives

After completing this section, you will be able to:

- Explain the operation of the super LSD differential.
- Explain the operation of the Power Plant Frame (PPF).
- Perform a PPF height inspection and adjustment procedure.

What's in this section:

Activity	Title	Location
6	Power Plant Frame Height Inspection and Adjustment Procedure	Shop

Rear Differential Outline

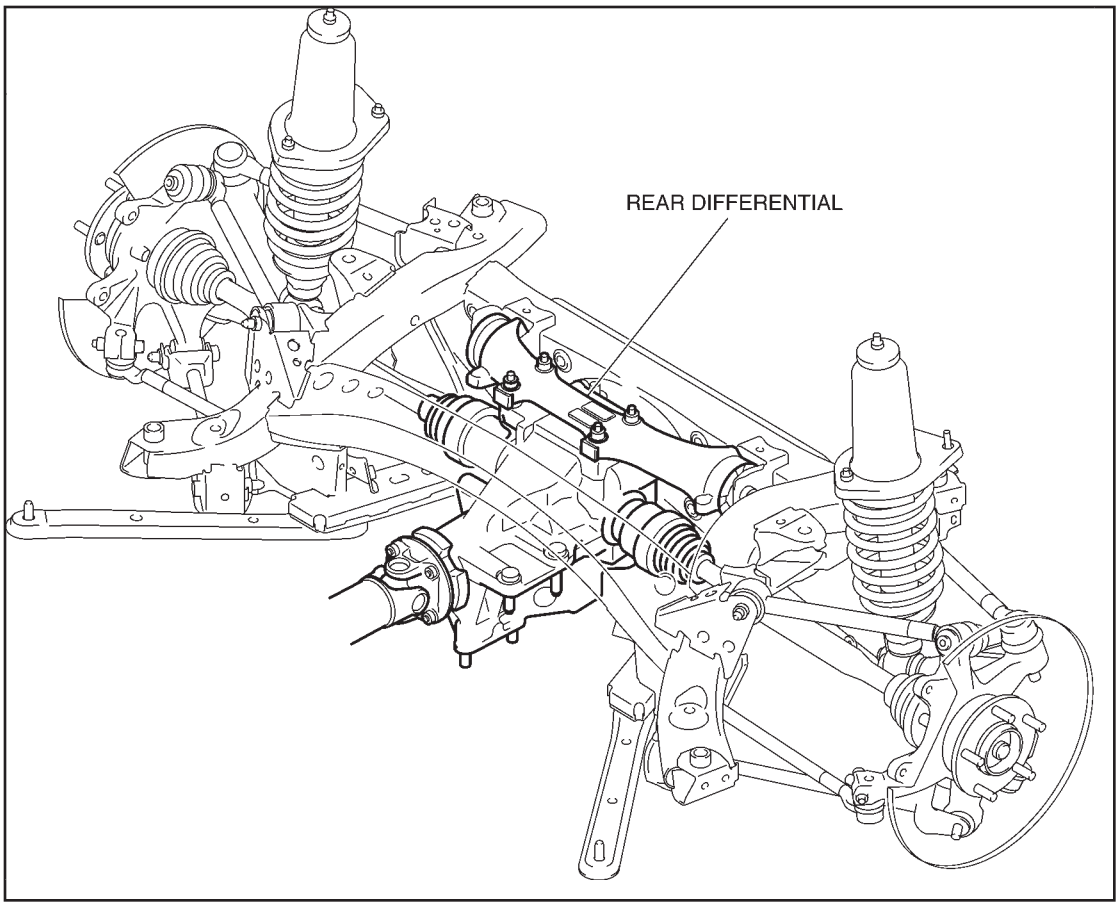
- For vehicles with limited-slip differential (LSD), a super-LSD with a low torque bias ratio* improves performance when starting from a standstill, driving straight-ahead and response.

*Torque bias ratio: When a wheel slips due to a low-traction surface, the LSD provides proportionally more torque to the opposite wheel. The torque bias ratio is the ratio of torque supplied to the right and left wheels in such cases, and represents the performance capability of the LSD.

- It is rigidly attached to the transmission with a power plant frame in order to enhance the feeling of direct drive when starting from a standstill and accelerating.

- A differential rear cover of aluminum alloy reduces weight.

Rear Differential Construction

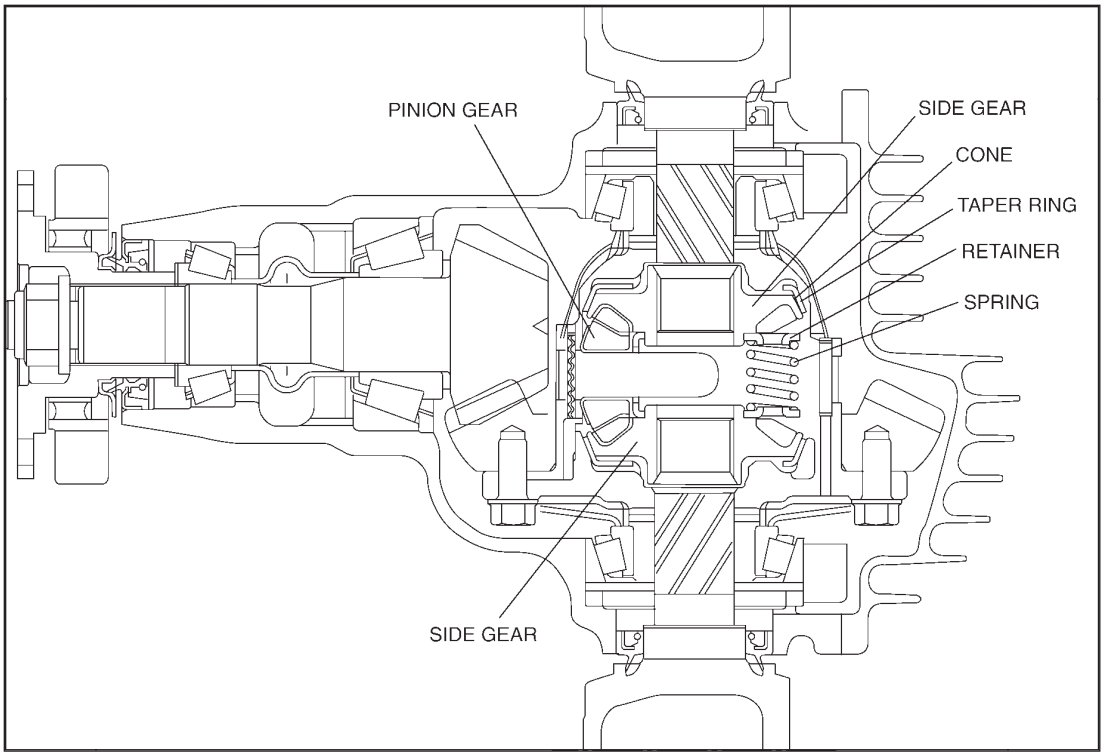


Super-LSD Outline

- The super-LSD is a torque-sensing type that provides improved driving stability due to the following characteristics:
  — Low torque bias ratio provides improved controllability (torque bias ratio: 2.0)
  — Creation of initial torque provides improved starting from a standstill and acceleration/deceleration response, and driving straight-ahead (initial torque: 49 N·m [5.0 kgf·m, 36 ft·lbf])
  — Simplified construction provides weight reduction

- The gear case component of the super-LSD cannot be disassembled.

Super-LSD Construction

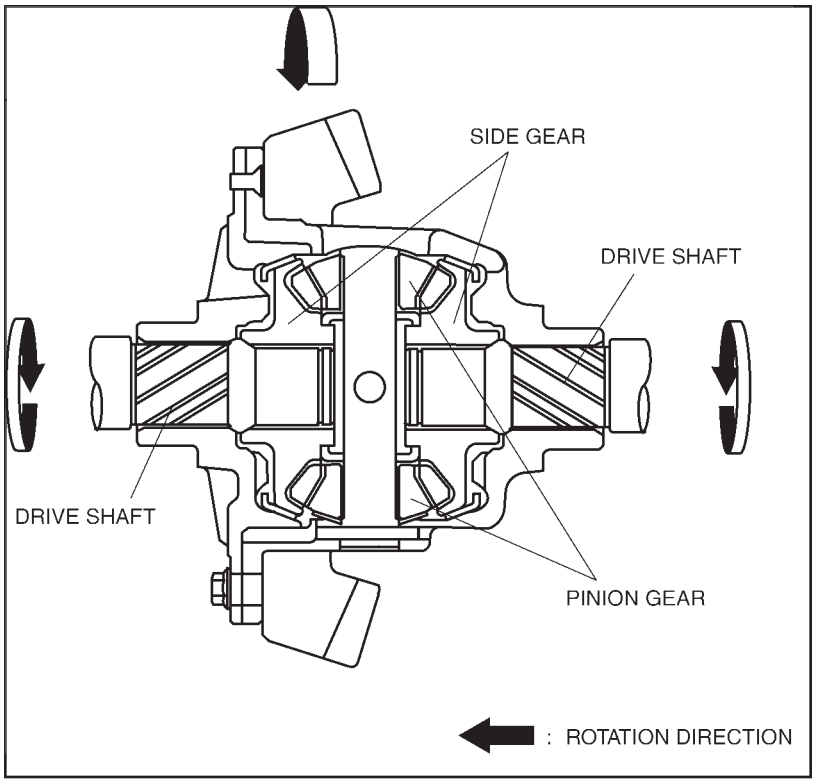


- Inside the super-LSD, taper rings that are fixed to the differential gear case have been placed between the differential gear case and the side gears. Additionally, a cone is provided around the outer surface of the side gear.

- Springs and retainers are positioned between the right and left side gears to provide initial torque to the taper rings.

Super-LSD Operation

Straight ahead driving

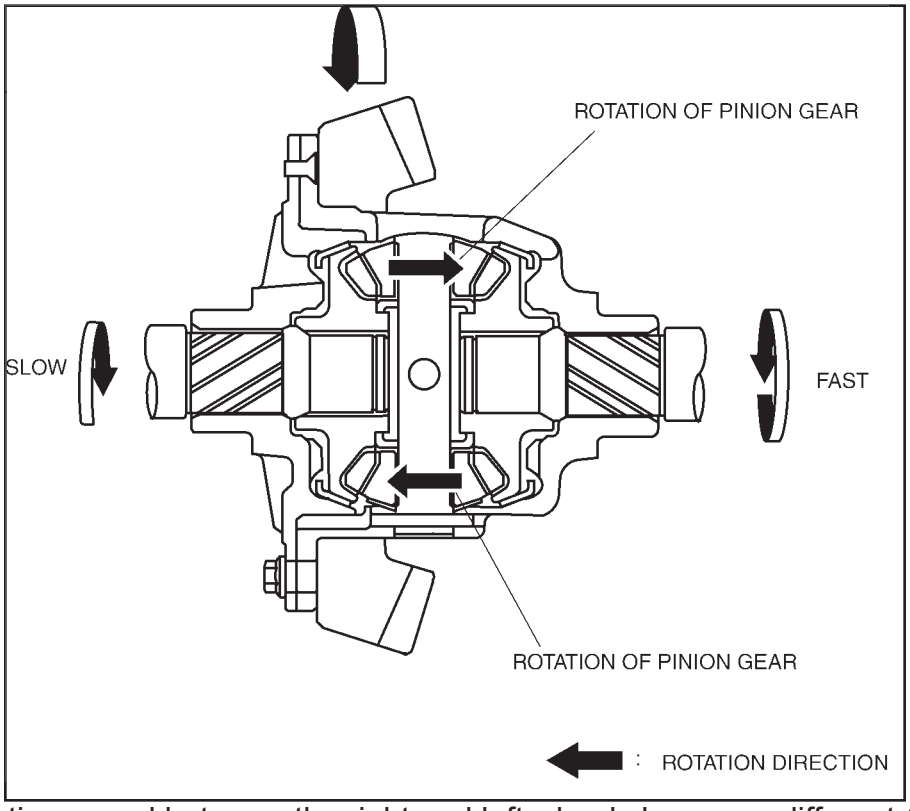


- When driving straight, the right and left side gears rotate at the same speed, and the pinion and side gears rotate together with the differential gear case. Input force from the ring gear is transmitted to the pinion gears via the gear case and to the drive shaft via the side gears. Due to this, a speed difference between right and left in the differential does not occur.

(continued)

Super-LSD Operation (continued)

Differential operation

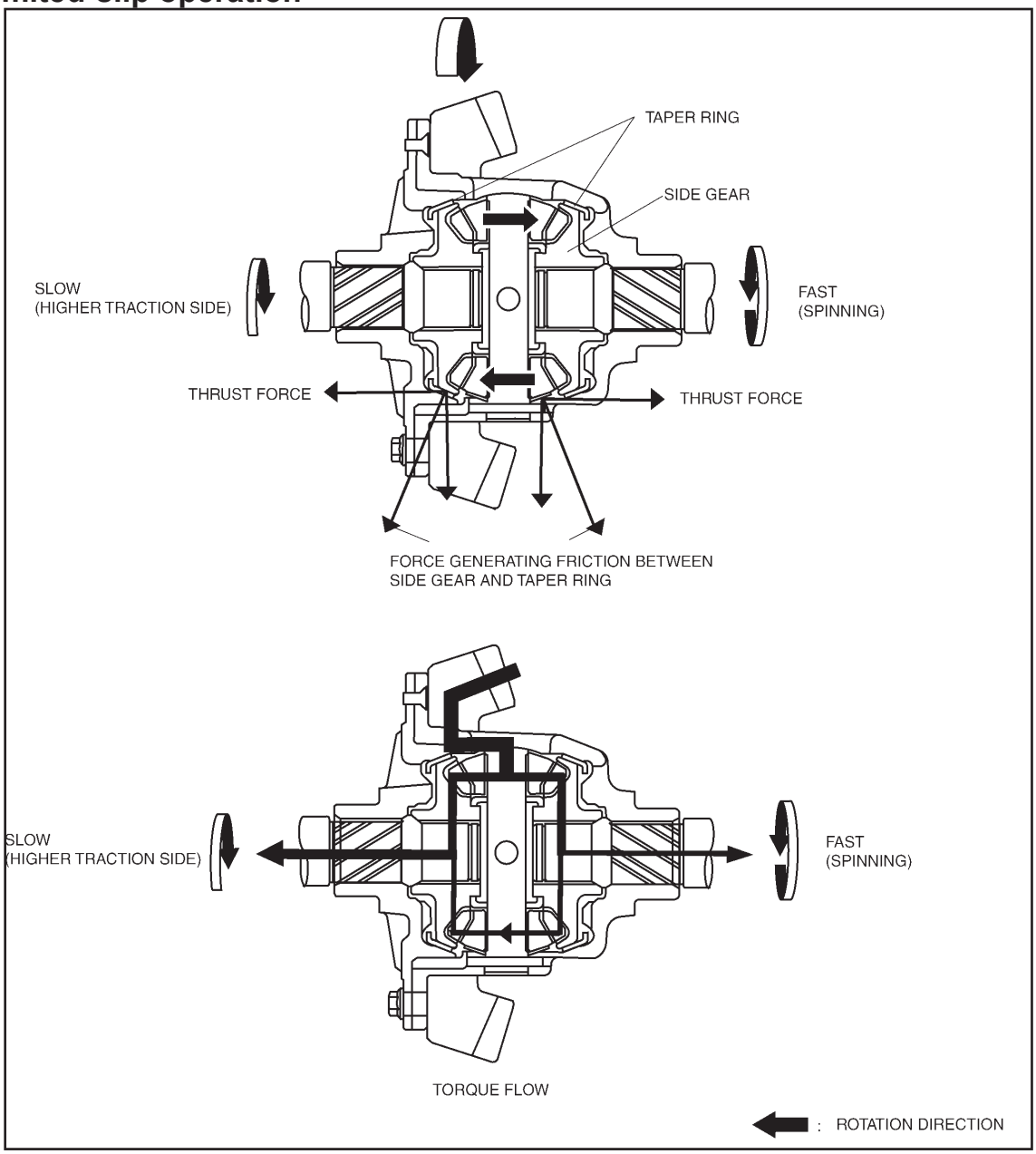


- If the rotation speed between the right and left wheels becomes different (during normal driving), the pinion gears rotate together while revolving around the center axle of the drive shaft, thereby absorbing the difference in rotation speed. This mechanism serves as a differential.

(continued)

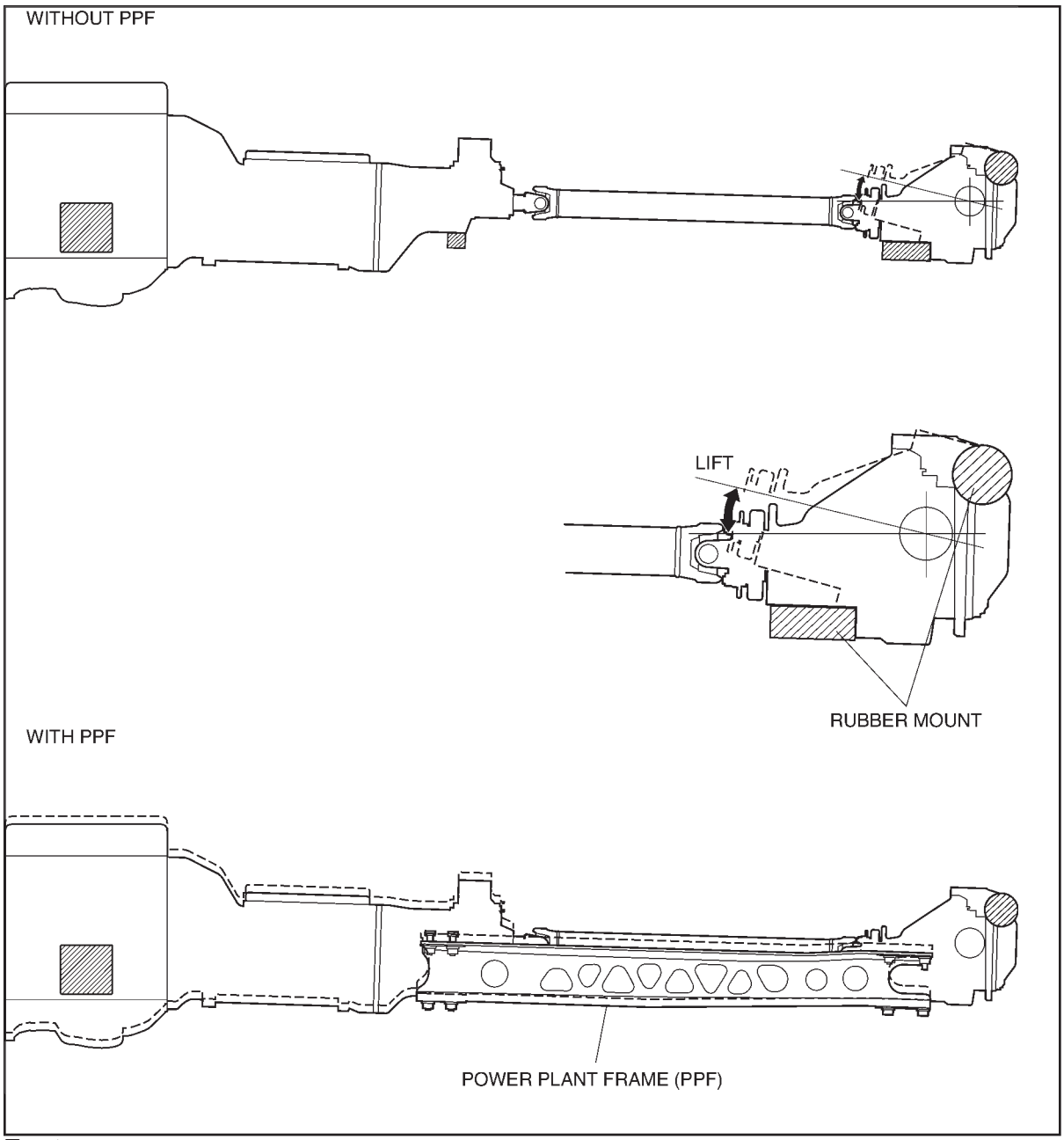
Super-LSD Operation (continued)

Limited-slip operation



- If the differential encounters a condition requiring limited-slip control such as wheel spin, thrust force acts on the side gears due to the reaction force from the meshing of the pinion and side gears. This thrust force presses the side gears against the taper ring, generating friction between the side gear cone and the taper ring and reducing the torque of the slipping wheel. The reduced torque is transmitted without change to the wheel with higher traction, and the limited slip differential function is provided. The torque transmitted to the wheel with higher traction is proportionate to the input torque of the ring gear.

Power Plant Frame (PPF) Function



Features

- The power plant frame (PPF) maintains rigidity with a bracket installed between the transmission and the differential. Due to this, the shift feeling is solid and it creates a feeling of direct drive when starting from a standstill or accelerating.

(continued)

Power Plant Frame (PPF) Function (continued)

Vehicle without PPF

— In order to suppress excessive transmission vibration to the vehicle body, rubber mounts connect the differential to the frame. When accelerating rapidly, the front part of the differential lifts upward which causes a time lag in the actual engine torque being transmitted to the tires and direct drive feeling is lost.

Vehicles with PPF

— With PPF, the transmission and differential are joined in a single unit which, even though the differential can be separated from the body, time lag is lessened due to the near elimination of lift, creating a feeling of direct drive. Furthermore, the PPF reduces shock and vibration during acceleration and deceleration.

04 BRAKES

Objectives

After completing this section, you will be able to:

- Explain the operation of the Anti-lock Brake System (ABS) and Dynamic Stability Control (DSC) system.
- Identify components of the Anti-lock Brake System (ABS) and Dynamic Stability Control (DSC) system.

What's in this section:

On-board Diagnostic System Function (ABS, Dynamic Stability Control)

Malfunction Detection Function

- The malfunction detection function detects malfunctions in the input/output signal system of the ABS HU/CM (vehicles with ABS) or DSC HU/CM (vehicles with DSC) when the ignition switch is at the ON position.

- When the ignition switch is turned to the ON position, the ABS Control Module performs the following malfunction detections.

ABS HU/CM

— The ABS and brake system warning lights illuminate for approximately 3 seconds when the ignition switch is turned to the ON position. At the same time, the fail- safe relay is operated and the input/output signals of each part is monitored for malfunction diagnosis. The first time the vehicle speeds exceeds 10 km/h (6.2 mph) or more, the control module operates the pump motor and performs a malfunction diagnosis.

DSC HU/CM

— The ABS and brake system warning lights, DSC OFF and DSC indicator lights illuminate for approximately 3 seconds when the ignition switch is turned to the ON position. At the same time, the fail-safe relay is operated, and the input/output signals of each part is monitored for malfunction diagnosis. The first time the vehicle speed exceeds 6.2 mph or more, the control module operates the pump motor and performs a malfunction diagnosis.

- When the control module detects a malfunction, the corresponding light illuminates to alert the driver. Using WDS, DTCs can be output through the DLC-2 lines. The control module also sends malfunction detection results to its memory and fail-safe function.

Memory Function

- The memory function stores DTCs of malfunctions in input/output signal systems. With this function, once a DTC is stored it is not cleared after the ignition switch has been turned off (LOCK position), even if the malfunctioning system has returned to normal.

- Since the ABS HU/CM or DSC HU/CM has a built-in non-volatile memory, DTCs are not cleared even if the battery is removed. Therefore, it is necessary to clear the memory after performing repairs. Refer to the Workshop Manual for the DTC clearing procedure.

On-board Diagnostic System Function (ABS, Dynamic Stability Control) (continued)

Fail-safe Function

- When the malfunction detection function determines a malfunction, each light illuminates to advise the driver. At this time, the fail-safe function controls the ABS, EBD, TCS* and DSC* as shown in the fail-safe function table.

* Only vehicles with DSC

CAUTION
If EBD control is suspended, the rear wheels could lock-up before the front wheels. If this occurs, the vehicle could swerve and become unstable. Therefore, always inspect the system immediately if EBD control is suspended.

Fail Safe Function Malfunction Contents (Vehicles with ABS)

- Refer to Service Highlights, page 04-02-4 to view the table.

Fail Safe Function Malfunction Contents (Vehicles with DSC)

- Refer to Service Highlights, page 04-02-5 to view the table.

On-board Diagnostic System PID/DATA Monitor Function (ABS/DSC)

- The PID/DATA monitor function is used for selecting input/output signal monitor items preset in the ABS HU/CM or DSC HU/CM and reading them out in real-time.

PID/DATA Monitor Table (Vehicles with ABS/DSC)

- Refer to Service Highlights, page 04-02-7 to view the table.

On-board Diagnostic System Active Command Modes Function (ABS/DSC)

- The Active command modes function is used for selecting active command modes items of input/output parts preset in the ABS HU/CM or DSC HU/CM and to operate them regardless of CM control.

- To protect the hydraulic unit interior, operate output related parts for only 10 seconds or less when using the active command modes function.

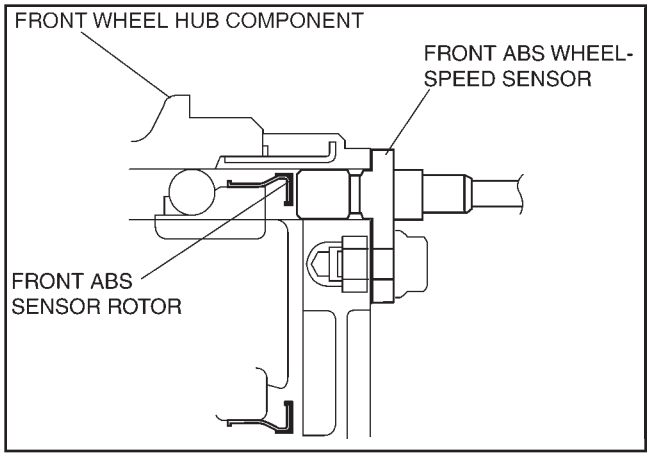
Active Command Modes Table (Vehicles with ABS/DSC)

- Refer to Service Highlights, page 04-02-8 to view the table.

(continued)

ABS Wheel Speed Sensor and ABS Sensor Rotor Construction Operation

Front Construction

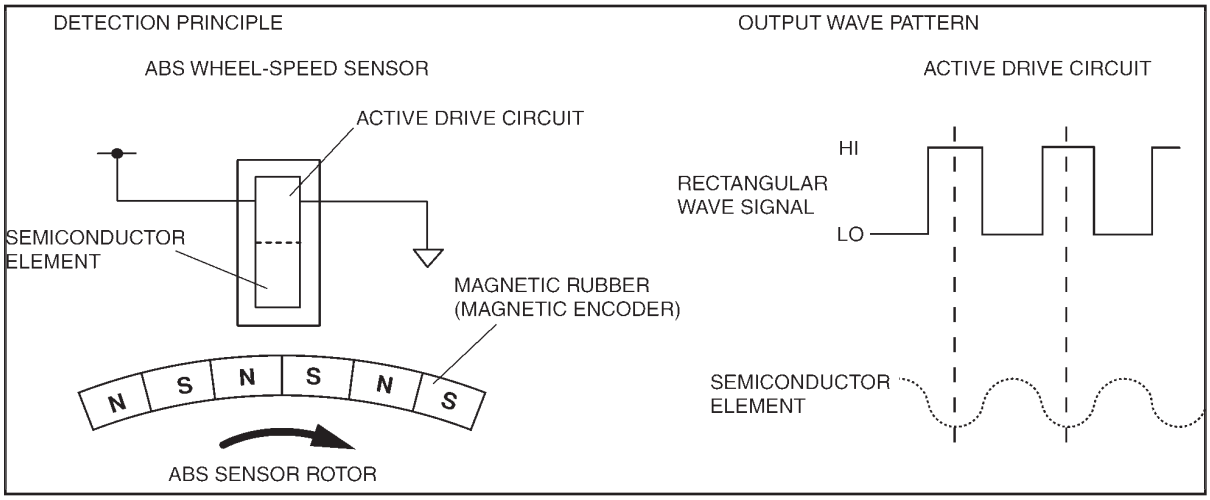


- The front ABS wheel-speed sensor utilizes a semi-conductor element that contains an active drive circuit (MR element*). The front sensor is installed on the front wheel hub.

- The front ABS sensor rotor utilizes a magnetic encoder system that functions with magnetic rubber and is integrated into the wheel hub component. Therefore, if there is any malfunction of the front ABS sensor rotor, replace the wheel hub component.

*: A magneto-resistive force means that an exterior magnetic field acts on the element, changing the resistance of the element.

Front Operation



- As the front ABS sensor rotor rotates, the magnetic flux between the front ABS wheel-speed sensor and the front ABS sensor rotor change periodically. This periodic change is in proportion to the rotation speed.

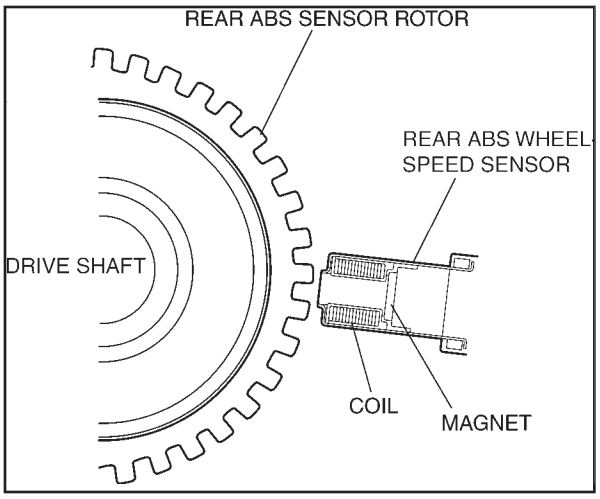
- The semiconductor element in the wheel speed sensor detects the change in magnetic flux and the active drive circuit converts it to a rectangular wave signal for the current, which is transmitted to the ABS HU/CM.

- For every single rotation of the ABS sensor rotor, 44 rectangular wave pulse signals are output. The CM in the ABS HU/CM calculates the wheel speed from the frequency of these pulses.

ABS Wheel Speed Sensor and ABS Sensor Rotor Construction Operation

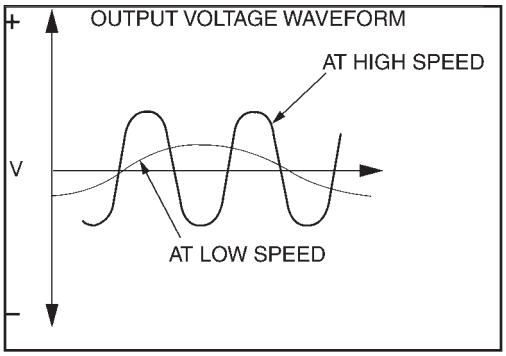
Rear Construction

- The rear ABS wheel-speed sensor is installed on the rear knuckle and the rear ABS sensor rotor is integrated with the drive shaft. Therefore, if there is any malfunction on the rear ABS sensor rotor, replace the drive shaft.



Rear Operation

- As the ABS sensor rotor rotates, magnetic flux formed from the permanent magnet varies and alternating current is formed with an electromagnetic conductor. Using this alternating current, rotation speed is expressed as a varying proportional cycle and from detection of this cycle the CM part of the ABS HU/CM can then detect the wheel rotation speed. While the structures of the front and rear ABS wheel-speed sensor differ, the operation is the same.



04 BRAKES

Dynamic Stability Control

Dynamic Stability Control (DSC) Outline

- The DSC HU/CM, integrates both the hydraulic unit (HU) and control module (CM), resulting in a size and weight reduction.

- A combined sensor, integrating both the yaw rate sensor and lateral-G sensor, improves serviceability.

- The controller area network (CAN) system improves serviceability and reliability for the steering angle sensor.

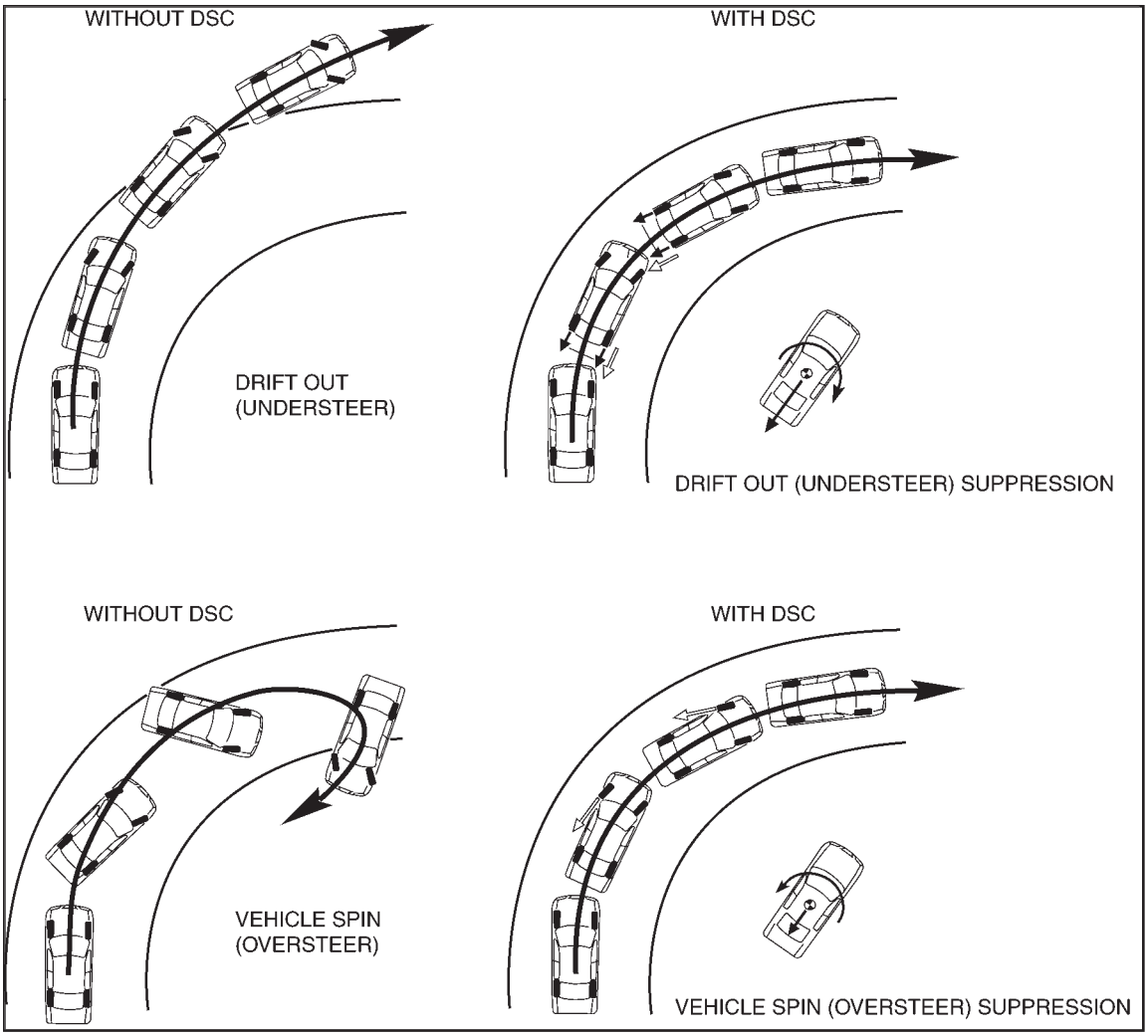
- An enhanced malfunction diagnosis system, used with the WDS improves serviceability.

DSC Operation Outline

- The ABS prevents wheel lock-up during braking. The TCS detects drive wheel spin due to the accelerator pedal being pressed too hard or similar causes and controls engine speed to suppress wheel spin. With these systems, safety is assured when driving or stopping.

- Additionally, the DSC controls sudden changes in vehicle attitude, due to evasive steering or road conditions. The DSC suppresses vehicle sideslip when driving due to vehicle spin (oversteer) or drift-out (understeer) by controlling braking and engine speed. At this time, the DSC indicator light illuminates to alert the driver that the DSC is operating due to a dangerous situation. As a result, the driver can calmly react and is provided leeway for the next maneuver, resulting in safe driving conditions.

Results of DSC Operation



CAUTION

• While the DSC is a steering safety system, it does not improve normal steering function. Therefore, always drive carefully, even if the vehicle has DSC, and do not overestimate the DSC capability.

• The DSC and ABS will not operate normally under the following conditions:
— With tires that are not of the specified size, manufacturer or tread pattern, or not inflated according to specification
— With tires that have significant comparative wear variation
— With tire chains

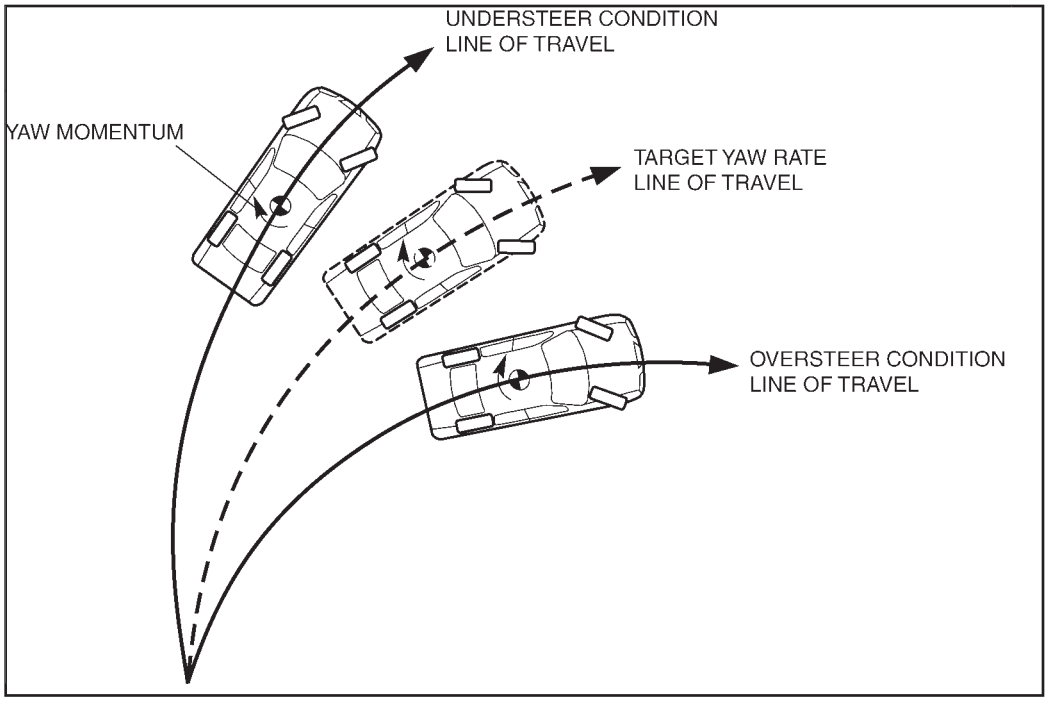
DSC Outline (continued)

- While a vehicle normally turns safely in response to steering operation, there are instances when the limits of tire lateral grip is surpassed due to road surface conditions or vehicle speed, and the influence of evasive steering to avoid an accident or similar situations.

- Tires surpassing lateral grip exhibit one of the following conditions:
  — Strong oversteer tendency: The rear wheels are relatively losing their grip as compared to the front wheels.
  — Strong understeer tendency: The front wheels are relatively losing their grip as compared to the rear wheels.

- DSC operates at vehicle speeds of 10 km/h (6.2 mph) or more in the conditions described above, controlling engine output and wheel braking to suppress oversteer and understeer tendencies.

Vehicle Condition Determination



- The vehicle speed, steering angle, lateral-G and yaw rate are detected by the sensors and used in calculations by the DSC HU/CM to determine the vehicle condition. Then, depending on the difference between the target yaw rate, calculated with the values input from each sensor, and the value detected by the yaw rate sensor, an oversteer or understeer tendency can be determined.

(continued)

Oversteer Tendency Determination

- When turning, if the actual vehicle yaw rate is larger than the target yaw rate (the yaw rate that should normally be formed as determined by the steering angle and vehicle speed), it means that the vehicle is in or about to be in a spin. Therefore the vehicle is determined to have an oversteer tendency.

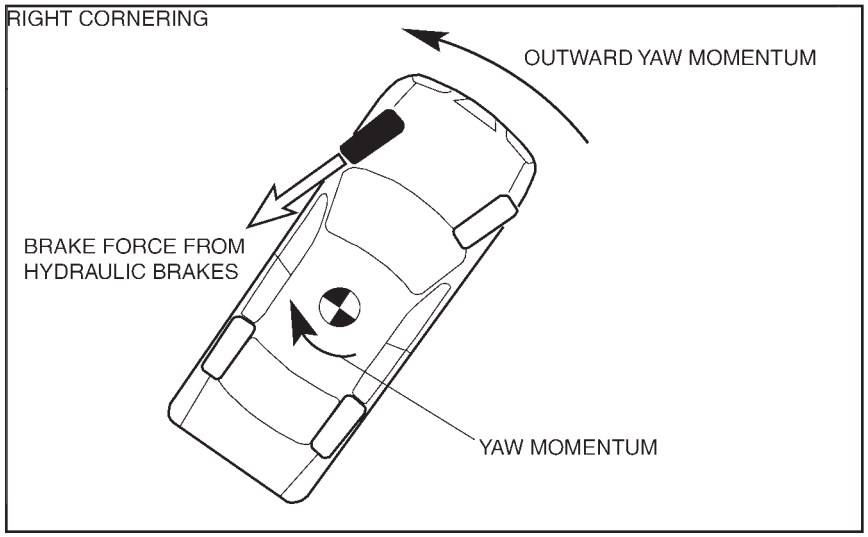
Understeer Tendency Determination

- When turning, if the actual vehicle yaw rate is less than the target yaw rate (the yaw rate that should normally be formed as determined by the steering angle and vehicle speed), it means that the vehicle is not properly turning. Therefore the vehicle is determined to have an understeer tendency.

DSC Operation

- When the DSC HU/CM determines that the vehicle has a strong oversteer or understeer tendency, engine output is lowered and, at the same time, it suppresses the yaw moment by affecting the braking of the front or rear wheels to inhibit the oversteer or understeer tendency.

Oversteer Tendency Suppression

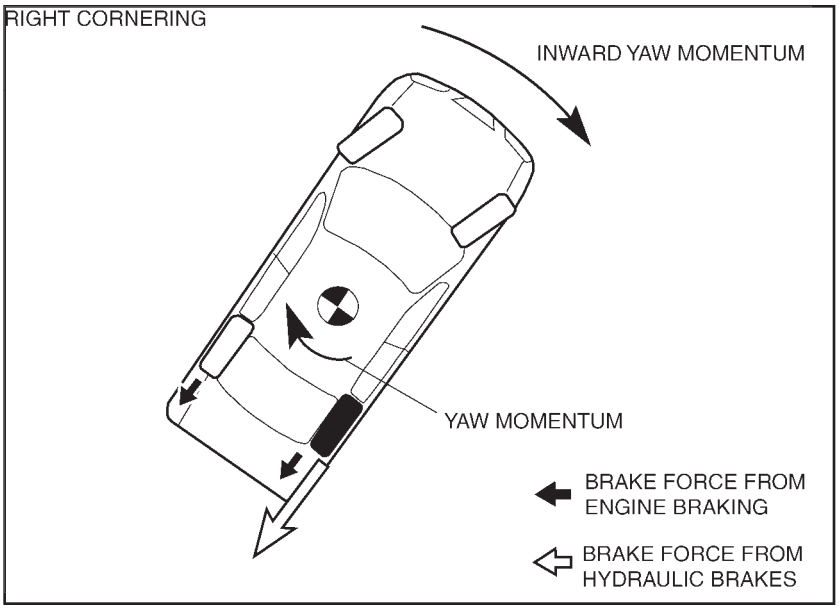


- When a large oversteer tendency is determined, braking is applied the outer front wheel according to the degree of the tendency. As a result, a yaw moment is formed towards the outer side of the vehicle and the oversteer tendency is suppressed.

(continued)

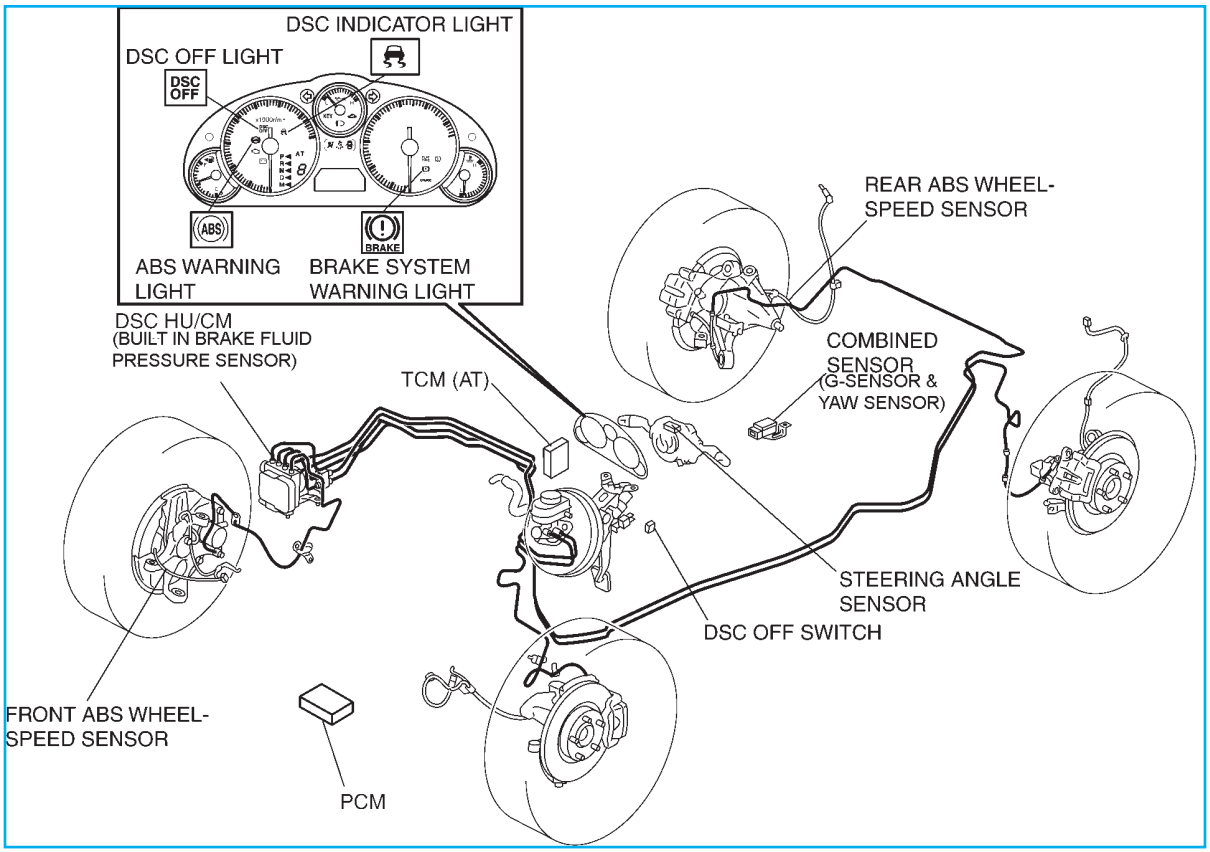
DSC Operation (continued)

Understeer Tendency Suppression



- When a large understeer tendency is determined, engine output is controlled and braking is applied to the inner front wheel according to the degree of the tendency. As a result, a yaw moment is formed towards the inner side of the vehicle and the understeer tendency is suppressed.

DSC Structural View



04 BRAKES

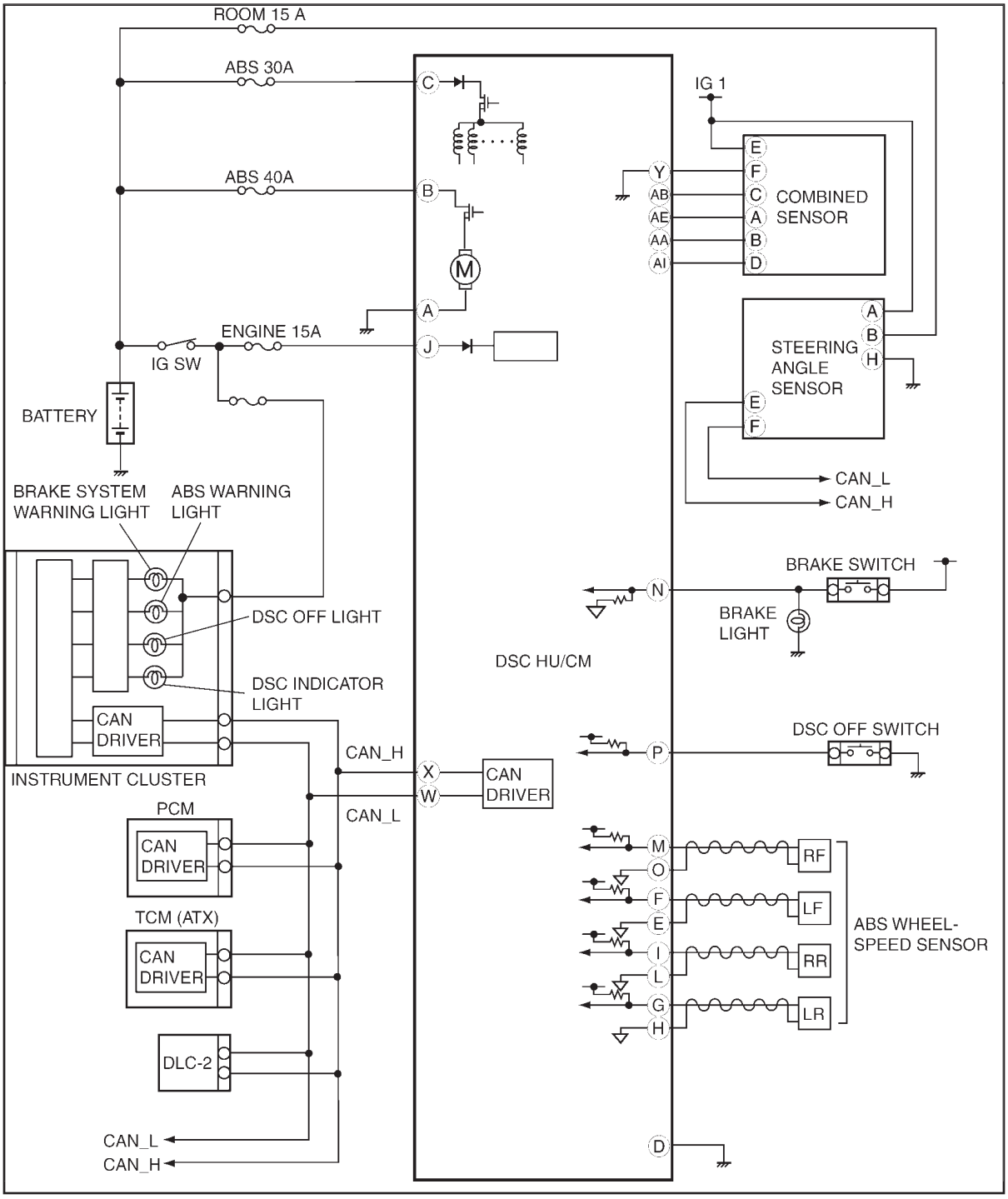
Dynamic Stability Control

DSC Construction

• The DSC system consists of the following parts. While each part has a regular function in other systems, only the function during DSC control is listed.

Part name	Function
DSC HU/CM	• Makes calculations using input signals from each sensor, controls brake fluid pressure to each wheel, and actuates each function (ABS, EBD, TCS and DSC) of the DSC system. • Outputs the torque reduction request signal, vehicle speed signal and DSC system warning control data via CAN lines. • Controls the on-board diagnostic system and fail-safe function when there is a malfunction in the DSC system.
PCM	• Controls engine output based on signals from the DSC HU/CM. • Transmits engine speed, tire and shift position data via CAN communication to the DSC HU/CM.
TCM (AT)	• Transmits gear/selector lever target position data via CAN communication to the DSC HU/CM.
DSC indicator light	• Informs the driver that the DSC is operating (vehicle sideslip occurring). • Informs the driver that the TCS is operating (drive wheel is spinning).
DSC OFF switch	• Transmits driver intention to release DSC control to the DSC HU/CM.
DSC OFF light	• Informs driver that DSC control has been released due to DSC OFF switch operation.
Wheel speed sensor	• Detects the rotation condition of each wheel and transmits it to the DSC HU/CM.
Combined sensor	• Detects the lateral-G (vehicle speed increase) and the yaw rate (vehicle turning angle) of the vehicle and transmits them to the DSC HU/CM.
Brake fluid pressure sensor	• Detects the fluid pressure from the master cylinder and transmits it to the DSC HU/CM.
Steering angle sensor	• Transmits the steering angle and steering angle sensor condition via CAN lines to the DSC HU/CM.

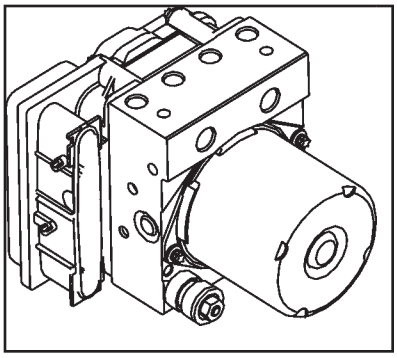
DSC System Wiring Diagram



Dynamic Stability Control

DSC HU/CM Construction

- A high reliability, reduced size and weight DSC HU/CM, integrates both the DSC HU and the DSC CM.



DSC HU Part Function

- According to DSC CM signals, the DSC HU controls (on/off) each solenoid valve and the pump motor, adjusts fluid pressure in each caliper piston, and actuates each function (ABS, EBD, TCS and DSC) of the DSC system.

DSC HU Part Construction/Operation

Construction

Function of main component parts

Part name	Function
Inlet solenoid valve	• Adjusts the fluid pressure in each brake system according to DSC HU/CM signals.
Outlet solenoid valve	• Adjusts the fluid pressure in each brake system according to DSC HU/CM signals.
Stability control solenoid valve	• Switches the brake hydraulic circuits during and according to normal braking, ABS and EBD control, TCS control and DSC control.
Traction control solenoid valve	• Switches the brake hydraulic circuits during and according to normal braking, ABS and EBD control, TCS control and DSC control.
Reservoir	• Temporarily stores brake fluid from the caliper pistons to ensure smooth pressure reduction during ABS and EBD control, TCS control and DSC control.
Pump	• Returns the brake fluid stored in the reservoir to the master cylinder during ABS and DSC control. • Increases brake fluid pressure and sends brake fluid to each caliper piston during TCS control and DSC control.

Operation

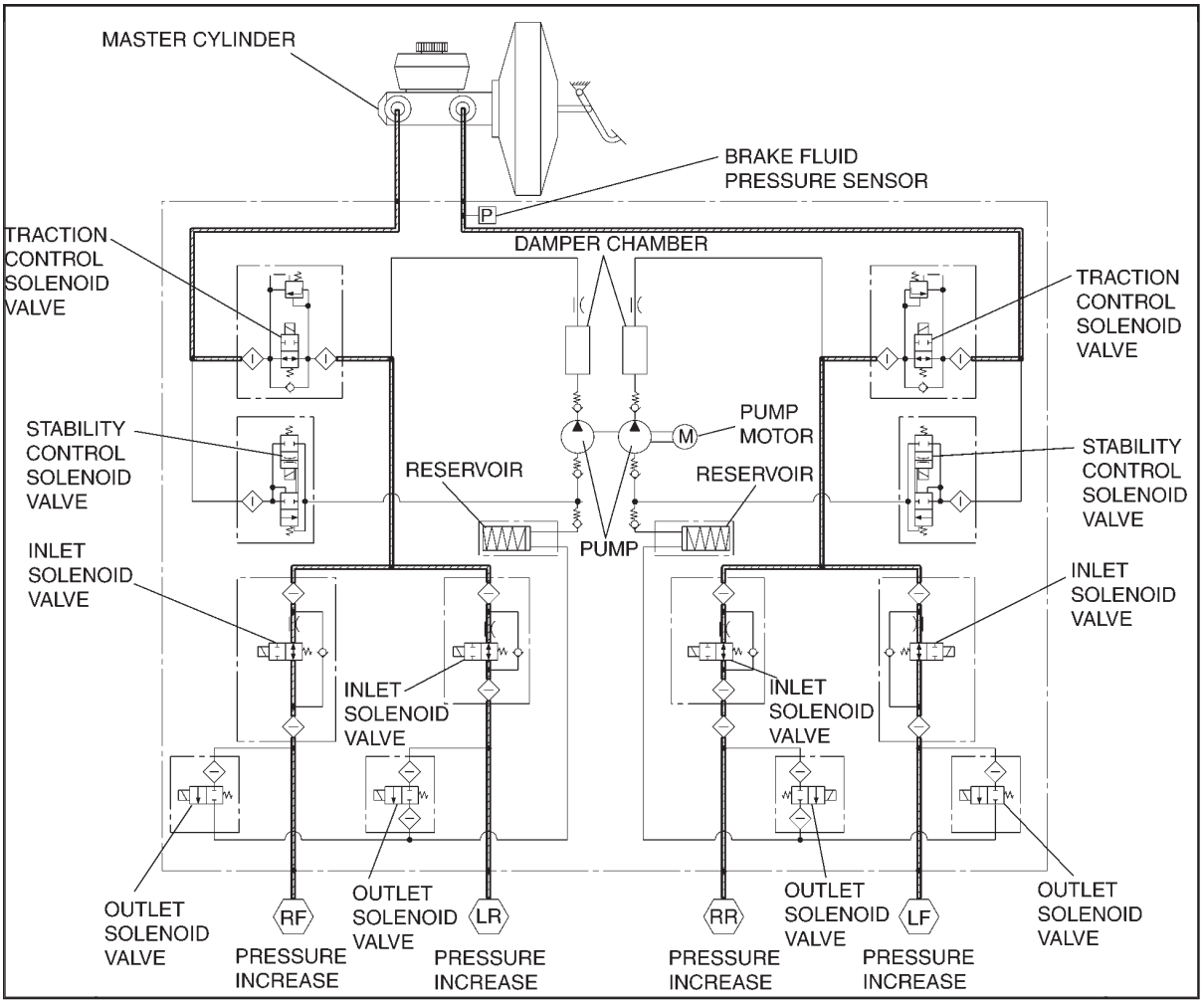
During normal braking

- During normal braking, the solenoid valves are not energized and all of them are off. When the brake pedal is depressed, brake fluid pressure is transmitted from the master cylinder, through the traction control solenoid valve and inlet solenoid valves, and then to the caliper pistons.

Solenoid valve operation table

- Refer to Service Highlights, page 04-15-7 to view the table.

Hydraulic circuit diagram



DSC HU Part Construction/Operation (continued)

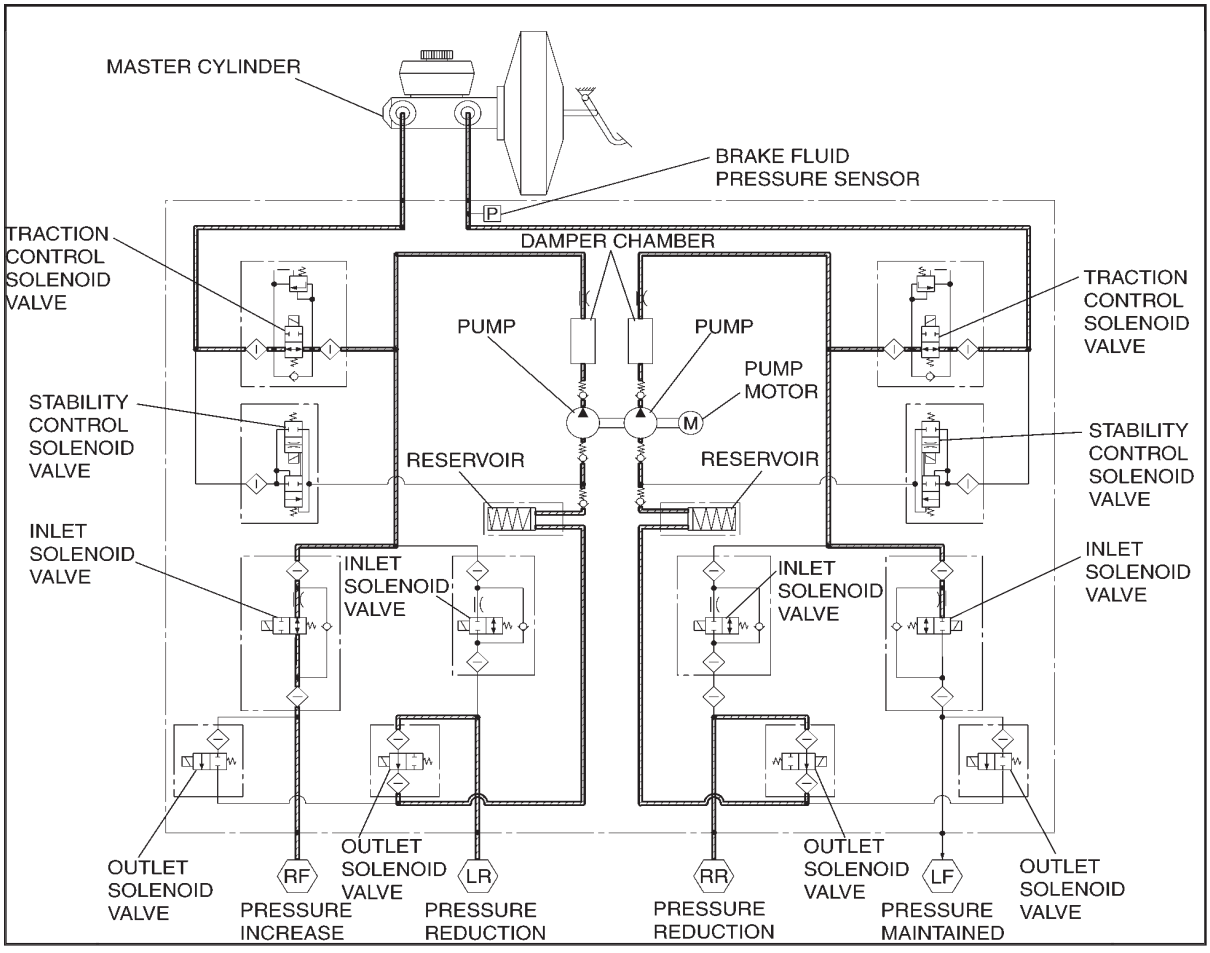
During ABS and EBD control

- During ABS and EBD control, when wheel lock-up is about to occur, the traction control solenoid valve and stability control solenoid valves are not energized, and the inlet and outlet solenoid valves are energized and controlled in three pressure modes (increase, reduction or maintain), thereby adjusting brake fluid pressure. Brake fluid during pressure reduction is temporarily stored in the reservoir and afterwards the pump motor operates the pump to return the fluid to the master cylinder. (The following figure shows these conditions: right front wheel pressure increased, left front wheel pressure maintained, and both rear wheels pressure decreased.)

Solenoid valve operation table

- Refer to Service Highlights, page 04-15-8 to view the table.

Hydraulic circuit diagram



(continued)

DSC HU Part Construction/Operation (continued)

During DSC control (suppress oversteer tendency)

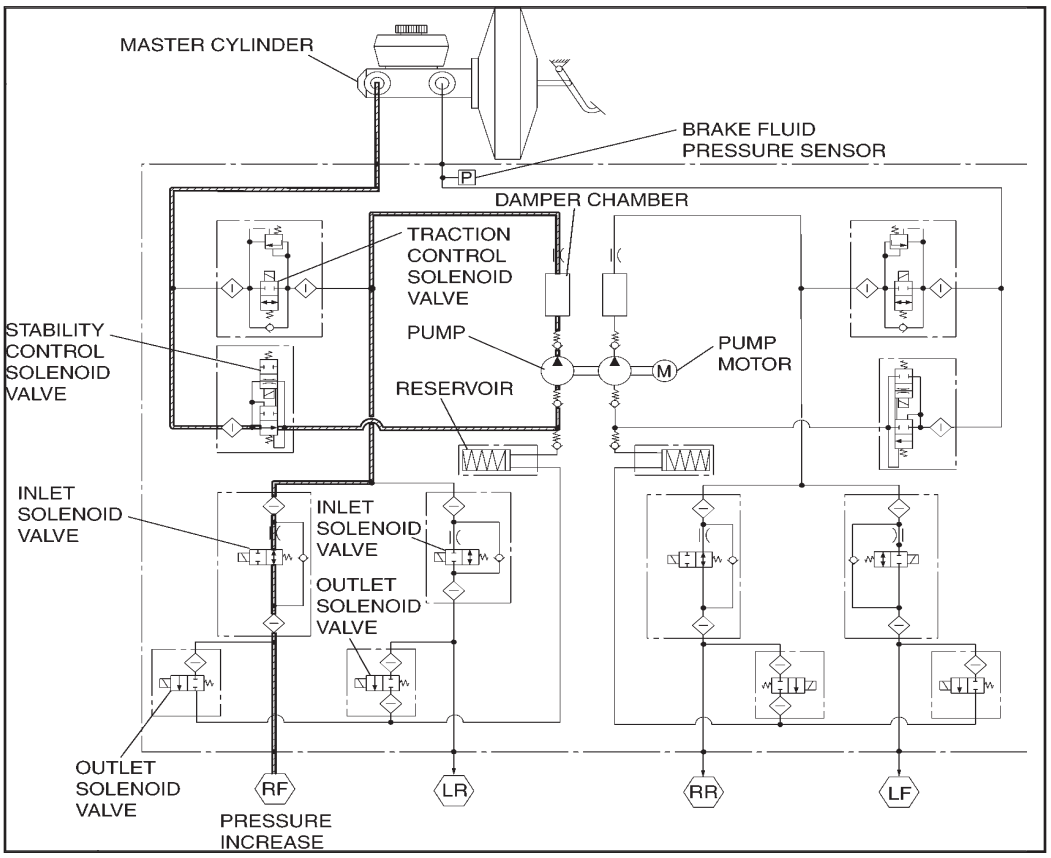
- When the control module detects a large oversteer tendency, it energizes the traction control solenoid valve and stability control solenoid valves to switch the hydraulic circuits. At the same time, control module operates the pump motor to supply brake fluid pressure from the reservoir to the outer front wheel cylinder. Also at this time, the control module energizes the inner rear wheel inlet solenoid valve and closes the hydraulic circuit to this wheel.

- After pressure increases, the pump motor adjusts brake fluid pressure using all three pressure modes (reduction, maintain, increase) to obtain the target wheel speed.

Solenoid valve operation table

- Refer to Service Highlights, page 04-15-9 to view the table.

Hydraulic circuit diagram



DSC HU Part Construction/Operation (continued)

During DSC control (to suppress understeer tendency) and TCS control

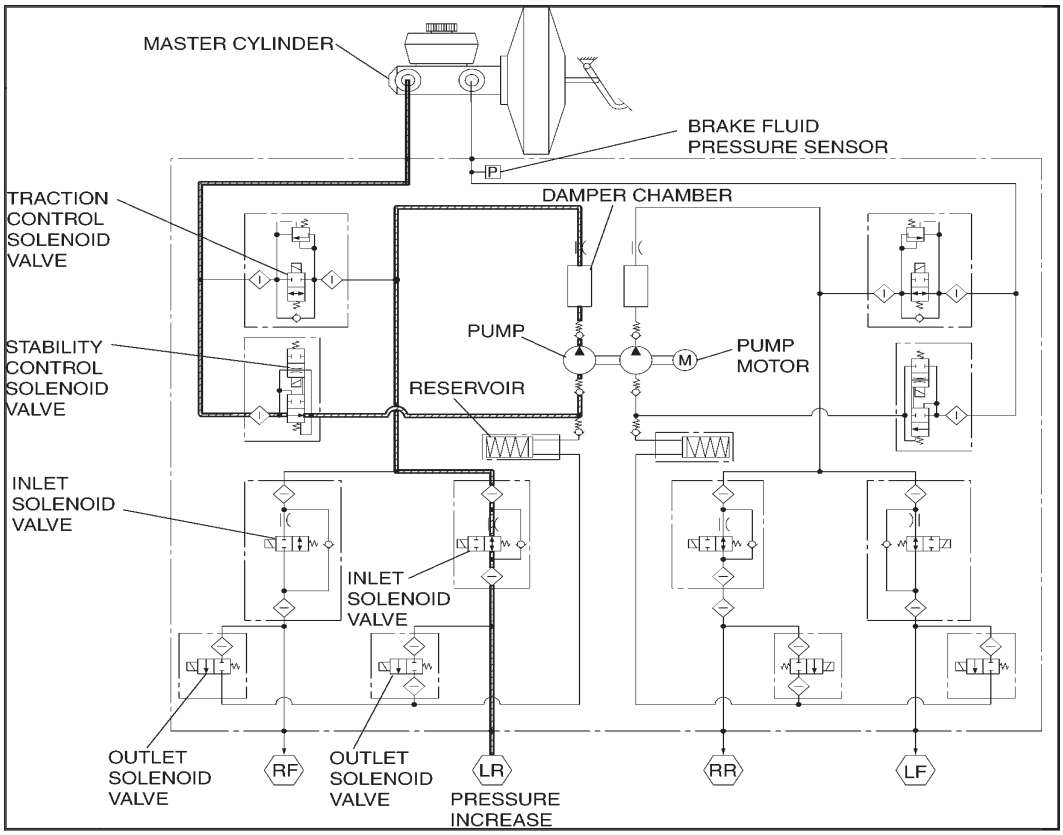
- When the control module detects a large understeer tendency, it energizes the traction control solenoid valve and stability control solenoid valves to switch the hydraulic circuits. At the same time, control module operates the pump motor to increase brake fluid pressure to the inner rear wheel caliper piston or slipping driving wheel. Also at this time, the control module energizes the outer front wheel inlet solenoid valve and closes the hydraulic circuit to the wheel.

- After a pressure increase, the pump motor adjusts brake fluid pressure using all three pressure modes (reduction, maintain, increase) to obtain the target wheel speed.

Solenoid valve operation table

- Refer to Service Highlights, page 04-15-10 to view the table.

Hydraulic circuit diagram



DSC CM Part Function

- The DSC CM makes calculations using signals input from each sensor, outputs a brake fluid pressure control signal to the DSC HU to actuate DSC system functions and outputs an engine output control signal to the PCM.

- The DSC HU/CM controls the following functions:

Function Table

- Refer to Service Highlights, page 04-15-10 to view the table.

Dynamic Stability Control

Controller Area Network (CAN) Outline

• The DSC HU/CM sends and receives data to and from other modules via the CAN system. Refer to Section 09 for a detailed explanation of the CAN system.

Data sent

- Traveled distance
- Brake system status
- Wheel speeds of all four wheels
- ABS wheel-speed sensor status
- Torque reduction request

Data received

- Engine speed
- Throttle valve opening angle
- Engine torque
- Torque reduction disabled
- Transmission/axle specifications
- Tire size
- Target gear position/selector lever position
- Steering angle
- Steering angle sensor status
- Parking brake position

ABS Wheel-speed Sensor Function

- The ABS wheel-speed sensor detects and transmits the rotation condition of each wheel to the DSC HU/CM.

- The signal from the ABS wheel-speed sensors is the primary signal for DSC HU/CM control.

ABS Wheel-speed Sensor Construction/Operation

- The construction and operation of the ABS wheel-speed sensor is the same as that of vehicles with ABS.

Combined Sensor Function

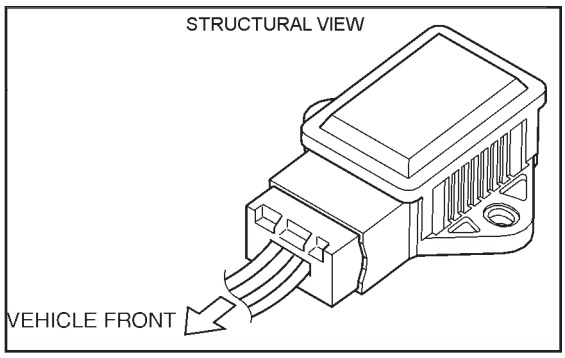
- A combined sensor, integrates the yaw rate and lateral-G sensors.

- The combined sensor, located in the floor under the rear console, detects the vehicle yaw rate (vehicle turning angular speed) and lateral-G and transmits them to the DSC HU/CM.

Combined Sensor Construction/Operation

- The combined sensor, with built-in yaw rate and lateral-G sensors, detects and calculates the vehicle yaw rate and lateral-G, converts them into voltage and transmits this to the DSC HU/CM.

- The output voltage characteristic for the combined sensor is 2.5 V when the vehicle is standing still, and changes accordingly as yaw rate and lateral-G are generated.



- The yaw rate sensor detects a Coriolis force created by, and in proportion to, the rotation speed of a rotating tuning fork.

- The lateral-G sensor detects an inertial force created by, and in proportion to, a G-force acting on a silicon detection component.

CAUTION

Coriolis force: When an object on a rotating disc attempts to move toward the center of the disc, force is produced at a right angle to the intended path of travel of the object. This results in the direction of movement being unchanged from its original point of departure, and the object does not reach the center. When looking at this effect from outside the disc, it appears as if a force is deflecting the object away from the center. This appearance of force is called a Coriolis force, and the object actually advances in a straight course.

04 BRAKES

Dynamic Stability Control

Brake Fluid Pressure Sensor Function

- The brake fluid pressure sensor detects the fluid pressure from the master cylinder and transmits it to the DSC HU/CM.

Brake Fluid Pressure Sensor Construction

- The brake fluid pressure sensor is integrated with the DSC HU/CM. Therefore, if there is any malfunction of the brake fluid pressure sensor, replace the DSC HU/CM.

Steering Angle Sensor Function

- The steering angle sensor, located on the combination switch, detects the steering angle degree and the neutral position, and transmits these to the DSC HU/CM via CAN lines.

WARNING

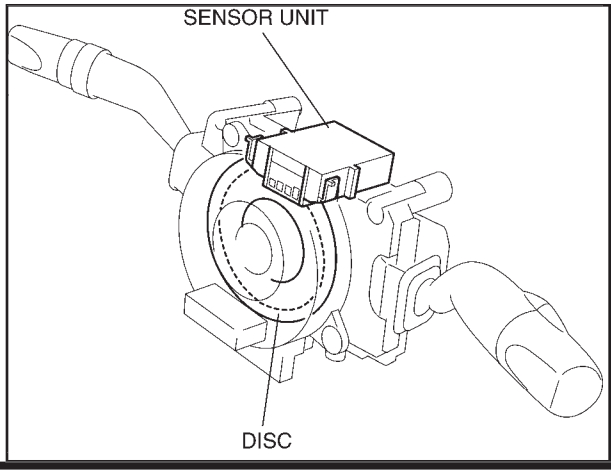
The following circumstances will cause the stored initialization value of the steering angle sensor to clear. This may possibly cause an accident due to the DSC becoming inoperative. Always refer to the Workshop Manual and properly perform the initialization procedure for the steering angle sensor so that the DSC operates properly.
— Negative battery cable disconnection
— Steering angle sensor connector disconnection
— Fuse (ROOM 15A) removal
— Wiring harness disconnection between battery and steering angle sensor connector

NOTE

If the initialization procedure for the steering angle sensor has not been performed when the ignition switch is turned to the ON position, the DSC indicator light illuminates and the DSC OFF light flashes to warn of a malfunction.

Steering Angle Sensor Construction

- The steering angle sensor, integrated with the combination switch body, has a sensor unit straddling a disc that moves together with the steering mechanism. Therefore, if there is any malfunction of the steering angle sensor, replace the combination switch body.

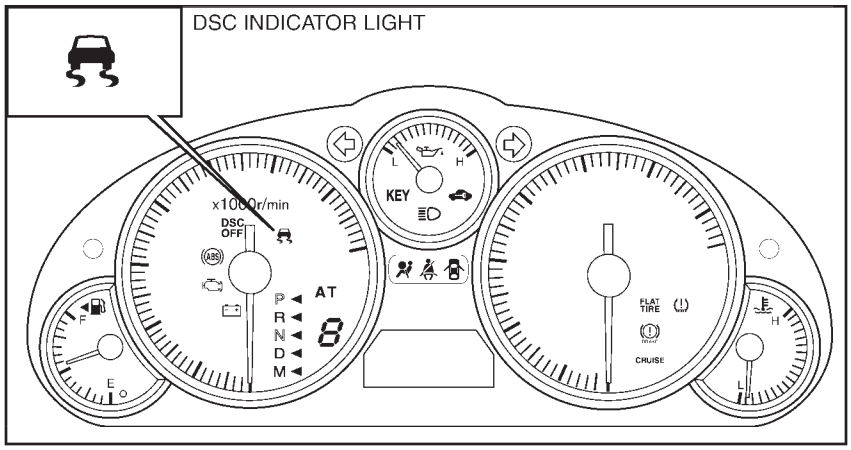


Dynamic Stability Control

DSC Indicator Light Function

- The DSC indicator light, built into the instrument cluster, informs the driver of the following vehicle conditions.
  — DSC is operating (vehicle side-slip)
  — TCS is operating (drive wheel slipping)

DSC Indicator Light Operation



- When the DSC and CAN lines are normal, the DSC indicator light illuminates for approximately 3 seconds when the ignition switch is turned to the ON position to check the light function. When the system is malfunctioning, the DSC indicator light remains illuminated.

- When the DSC or TCS is operating (DSC has not been disabled by pressing the DSC OFF switch), the DSC indicator light operates as follows:

Item	DSC indicator light condition
TCS, DSC not operating	Not Illuminated
TCS Operating	Flashes (0.5 seconds intervals)
DSC Operating	

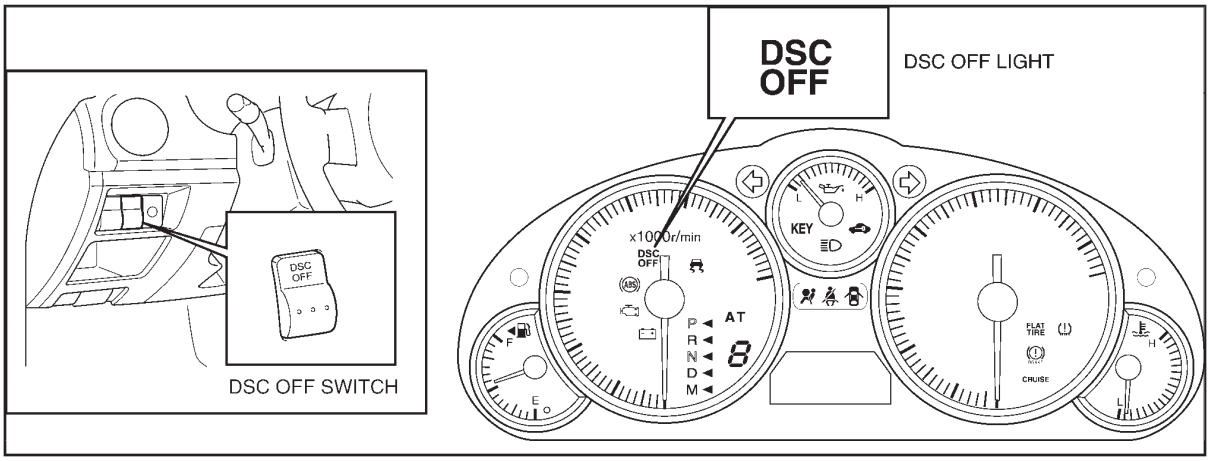
Dynamic Stability Control

DSC OFF switch, DSC OFF Light Function

- The DSC OFF switch, located on the dashboard, allows the driver to enable/ disable the DSC control.

- The DSC OFF light, built into the instrument cluster, informs the driver the operation of the DSC OFF switch has disabled DSC control.

DSC OFF switch, DSC OFF Light Operation



- When the DSC system and CAN lines are functionally normally, the DSC OFF light illuminates for approximately 1.8 seconds when the ignition switch is turned to the ON position to check the light function.

- When the DSC OFF switch is pressed to disable DSC control, the DSC OFF light illuminates.

NOTE

When releasing the DSC, continue to press the DSC OFF switch until the DSC OFF light illuminates.

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05 TRANSMISSION

Objectives

After completing this section, you will be able to:

- Explain the operation of the P66M 6-speed manual transmission.
- Explain the operation of the SJ6A-EL 6-speed automatic transmission.
- Describe the SJ6A-EL transmission fluid level inspection procedure.
- Perform the SJ6A-EL transmission fluid level inspection procedure.

What's in this section:

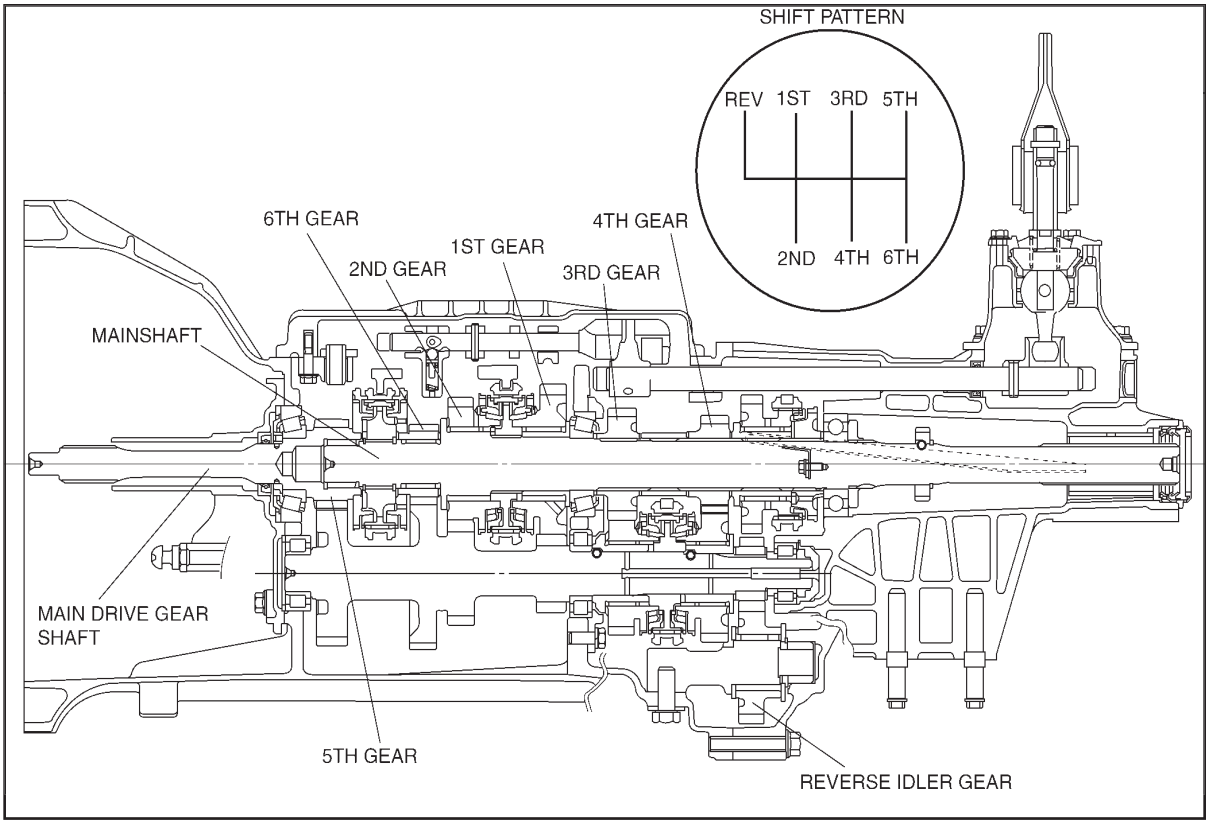
Activity	Title	Location
7	SJ6A-EL Fluid Level Inspection Procedure	Shop

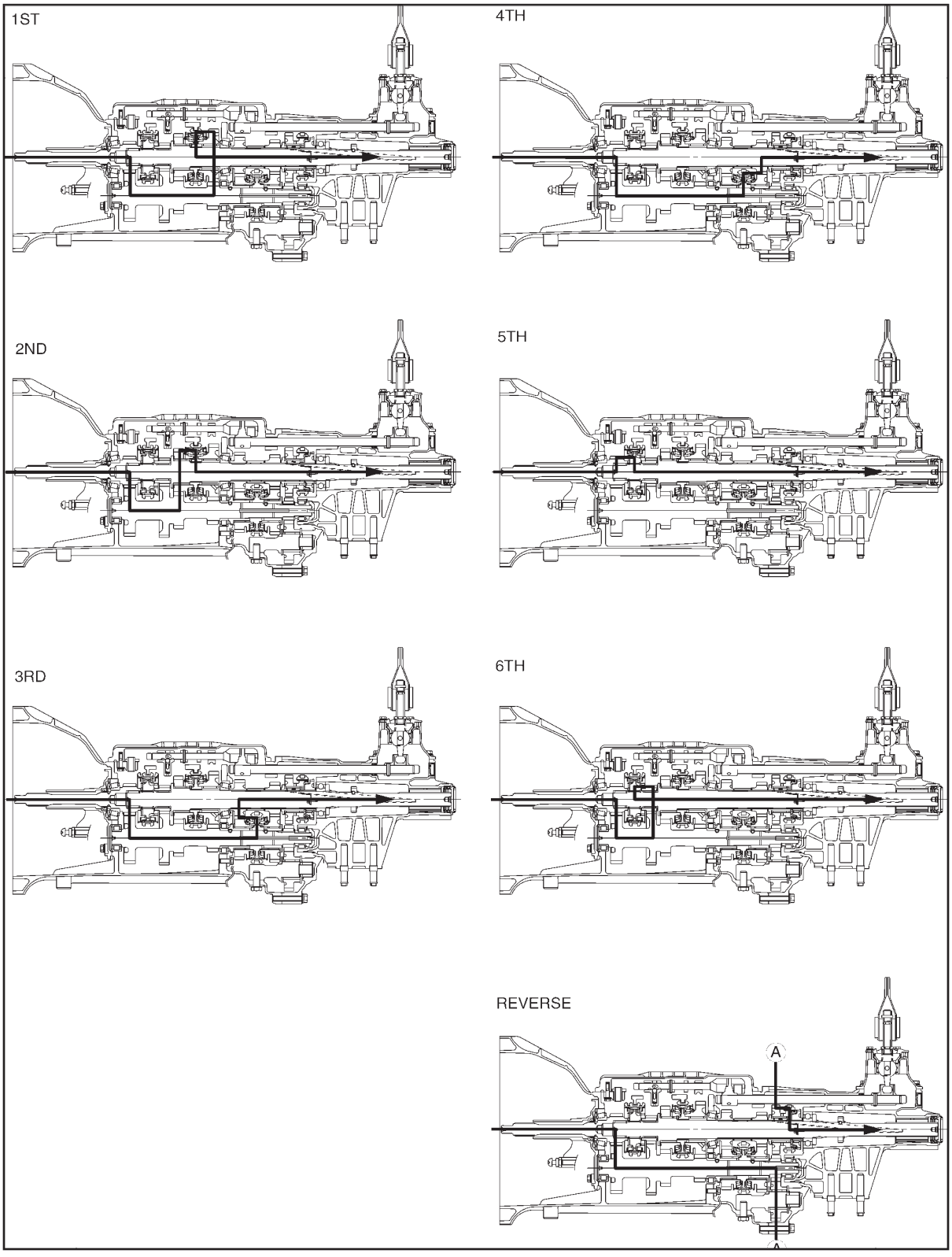
6-Speed Manual Transmission (P66M-D)

Manual Transmission Outline

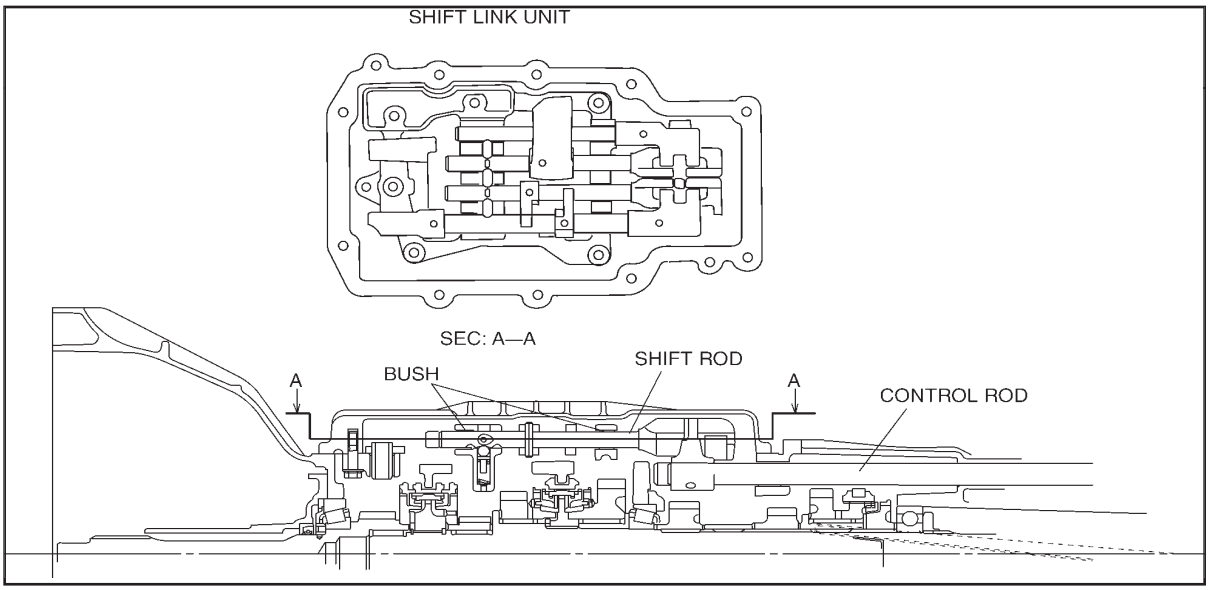
- The 1st, 2nd, 3rd and 4th gears use a linked, triple-cone synchronizer mechanism.
- This transmission uses a guide plate type reverse lockout mechanism.

Manual Transmission Cross-Sectional View




1ST
4TH
2ND
5TH
3RD
6TH
REVERSE
A
A

Shift Rod Structure



- The shift lever stroke is set shorter to provide optimal shift feel.
- To realize assured shift feel, the shift link mechanism has been integrated.
- The use of metal bushings for the sliding parts of the shift rod reduces sliding resistance during shifting thus improving shift quality.

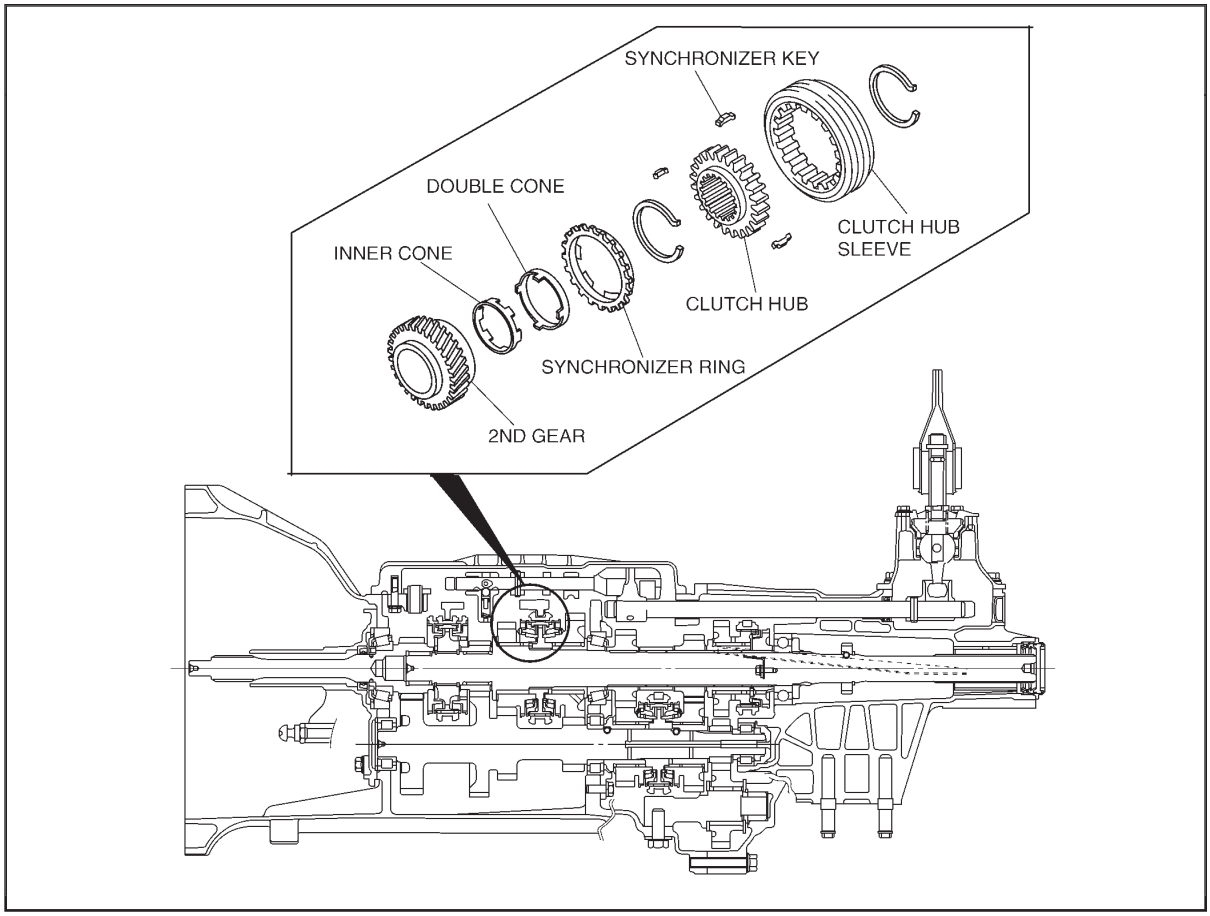
6-Speed Manual Transmission (P66M-D)

Triple Synchronizer Mechanism Structure

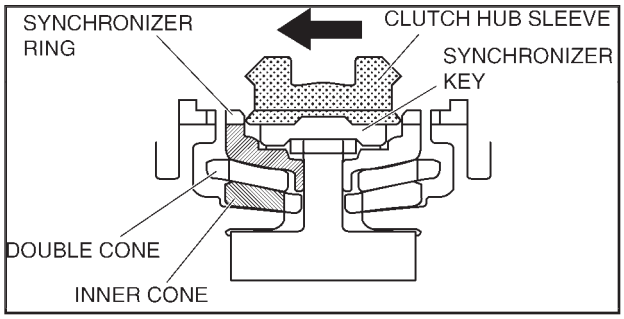
Features

- The 1st, 2nd, 3rd and 4th gears use A triple cone synchronizer mechanism.
- The triple cone synchronizer mechanism is a compact device capable of heavy duty meshing.
- The synchro mechanism reduces meshing time and improves operation.
- The triple cone synchro mechanism includes a synchronizer ring, a double cone, and an inner cone.

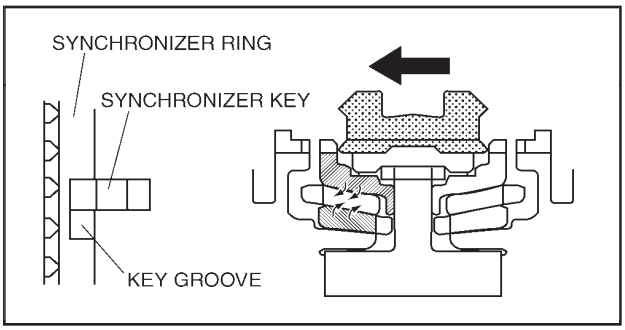
Structural View



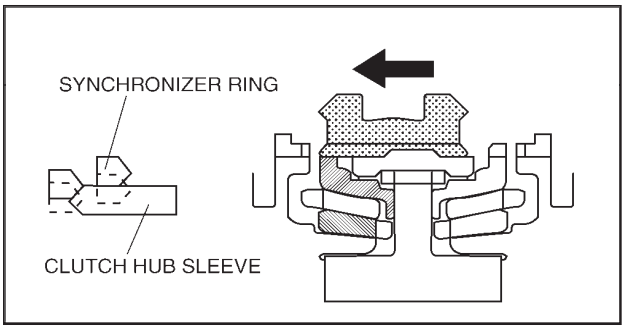
Triple Synchronizer Mechanism Structure



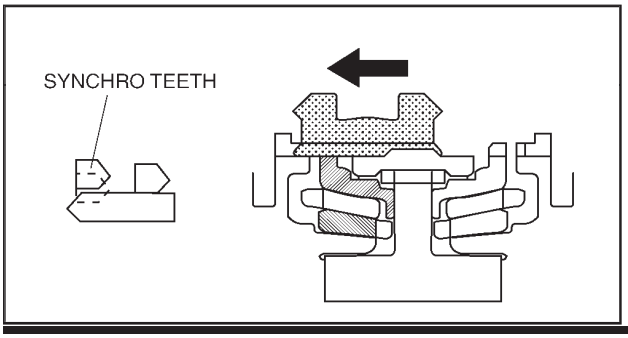
1. When the hub sleeve moves to the left (in the direction of the arrow), the synchronizer key presses against the synchronizer ring.



2. As the hub sleeve continues moving to the left, the key causes friction between the synchronizer ring, double cone, and inner cone. The synchronizer ring turns only the distance that the key groove gap allows, aligning the teeth of the hub sleeve and the synchronizer ring. As the hub sleeve continues moving, the friction between the cones becomes greater, and the difference between the rotational speeds of the synchronizer ring, inner cone, and double cone (unified with the gear) gradually disappears.



3. The hub sleeve then moves up onto the synchronizer key and engages the synchronizer ring.



4. The hub sleeve then engages the synchro teeth of the gear to complete shifting.

6-Speed Manual Transmission (P66M-D)

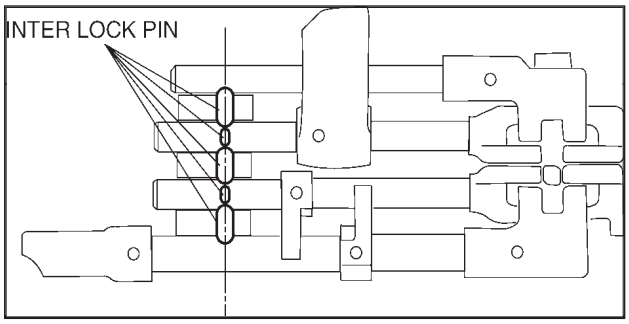
Shift Interlock Mechanism Function

- This provides reliable double-engagement prevention.

Shift Interlock Mechanism Operation

Structure

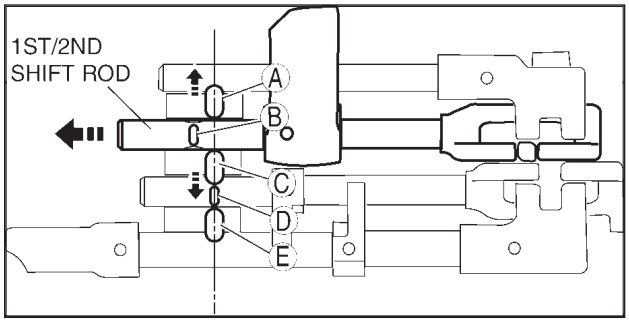
- During shifting, the shift rods, except for the one in operation, are locked in the neutral position by the interlock pins.



Operation

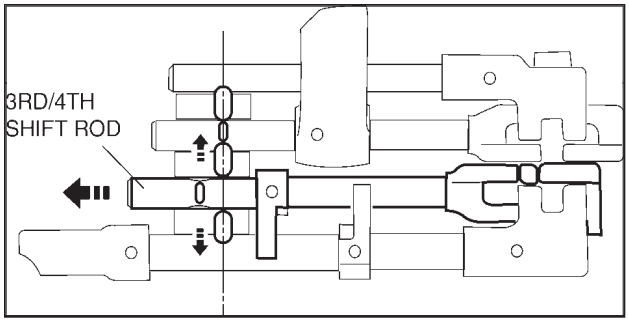
Neutral

- Each interlock pin is in the groove of each shift rod because no shift rod is operating.



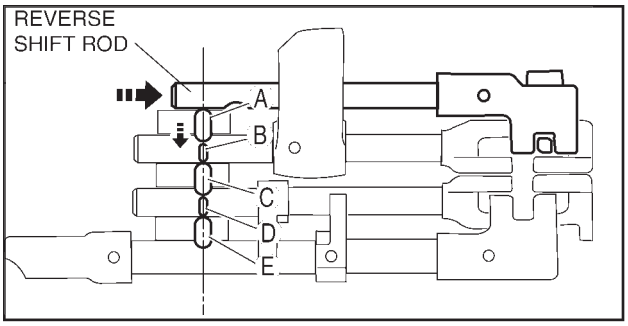
1st/2nd shifting

- Movement of the 1st/2nd shift rod forces interlock pins A and C out of the 1st/2nd shift rod grooves, and the reverse shift rod and 3rd/4th shift rod are locked. In addition, interlock pin C forces interlock pin E out via interlock pin D, and the 5th/6th shift rod is locked.



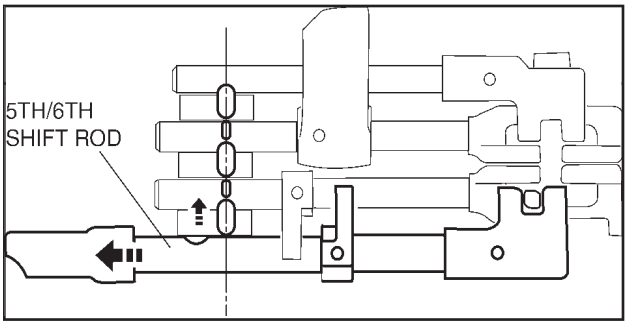
3rd/4th shifting

- When the 3rd/4th shift rod operates, the other three shift rods are locked in the same way as the 1st/2nd shifting.



Reverse shifting

- Movement of the reverse shift rod forces interlock pin A out of the reverse shift rod groove, and the 1/2 shift rod is locked. In addition, interlock pin A forces interlock pins C and E out via interlock pins B and D, and the 3rd/4th shift rod and 5th/6th shift rod are locked.



5th/6th shifting

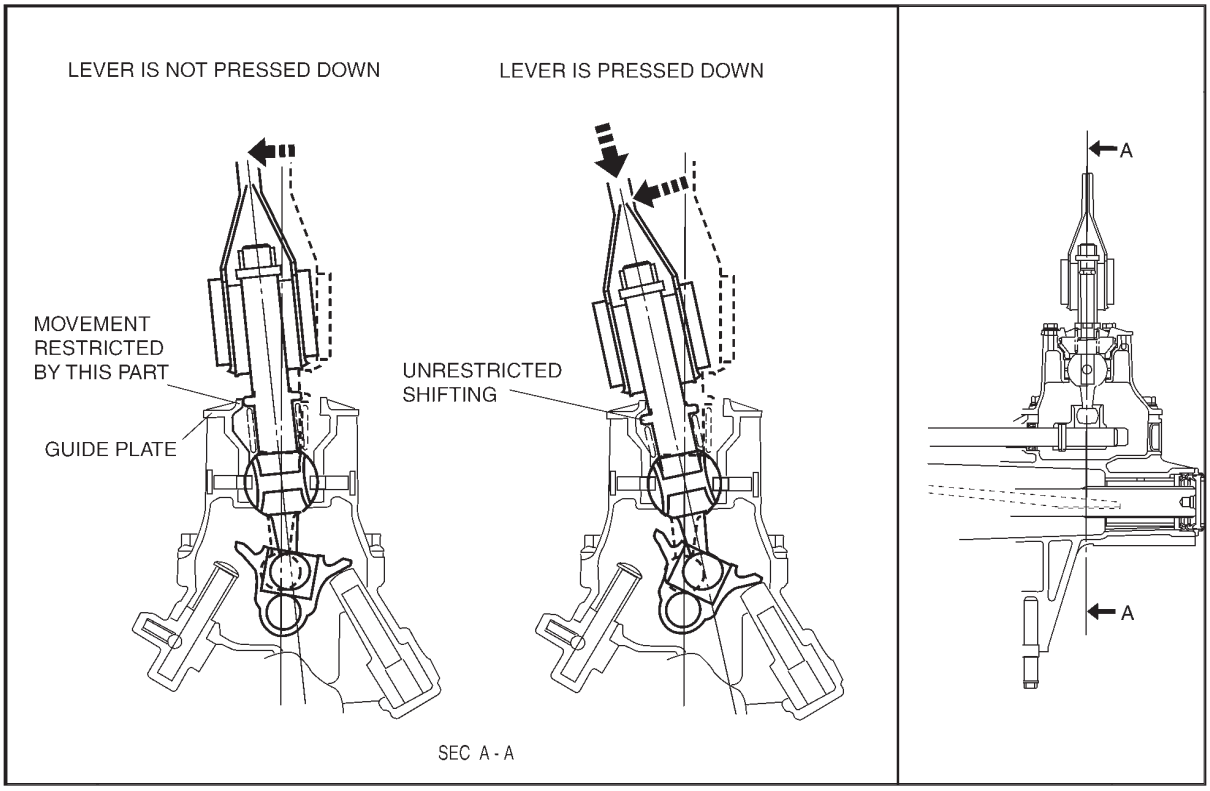
- When the 5th/6th shift rod operates, the other three shift rods are locked in the same way as the reverse shifting.

6-Speed Manual Transmission (P66M-D)

Reverse Lockout Mechanism Function

- The reverse lockout mechanism prevents the driver from accidentally shifting into reverse gear when shifting from neutral to 1st gear.

Reverse Lockout Mechanism Construction/Operation

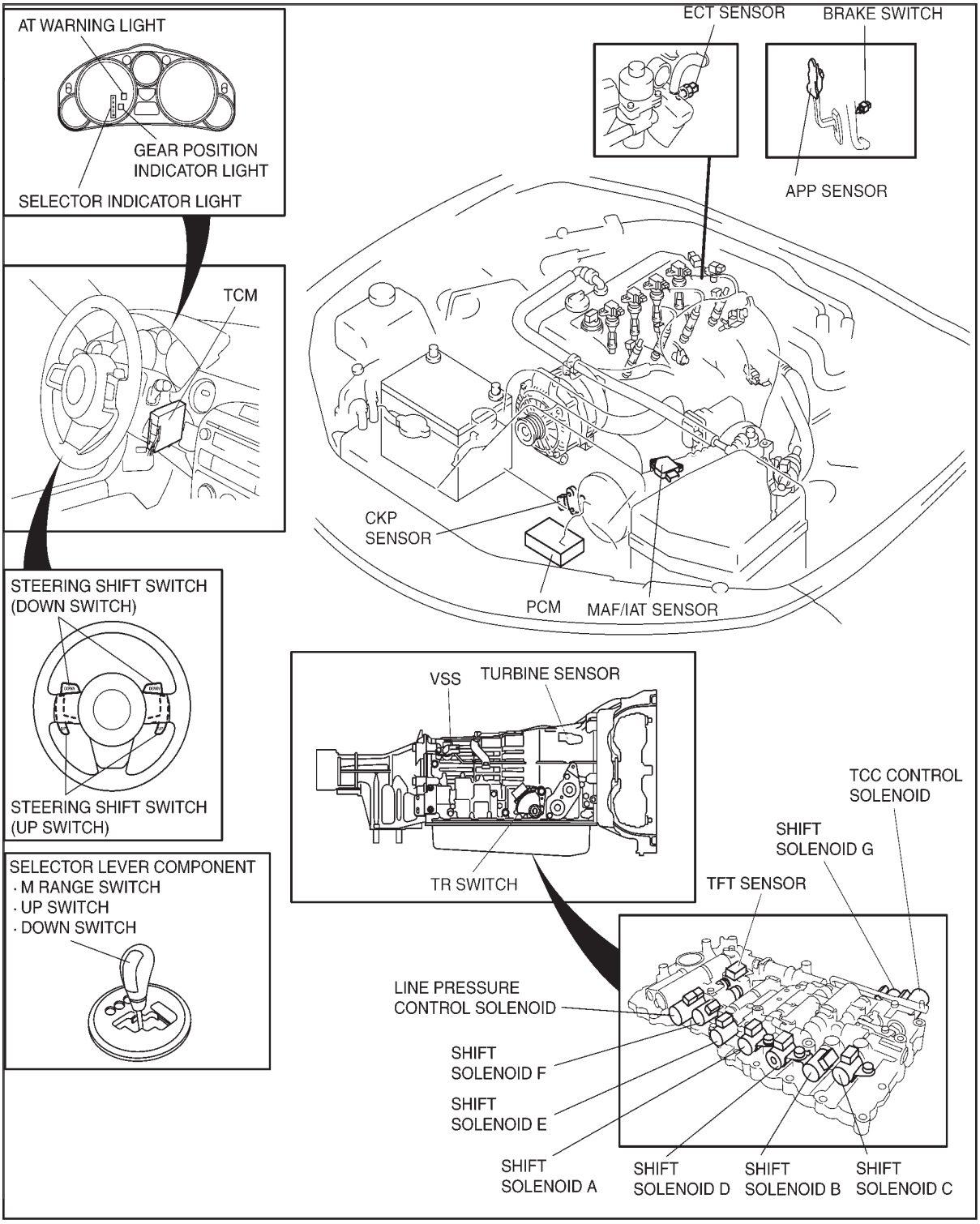


- The reverse lockout mechanism, which utilizes a guide plate, ensures reliability.

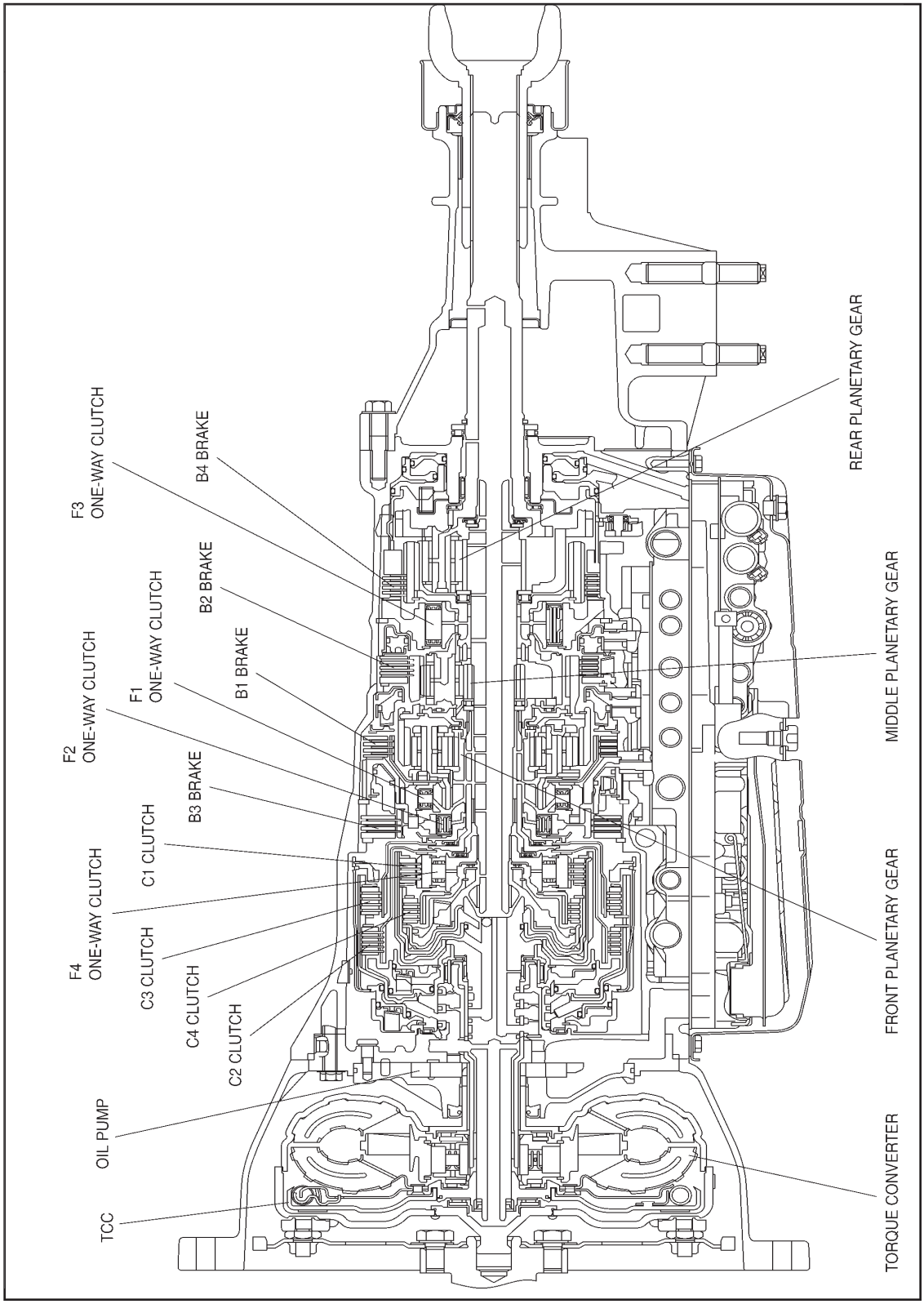
- A guide plate, attached to the extension housing, prevents accidental shifting into reverse when shifting from neutral to 1st gear by restricting the movement of the shift lever. When shifting into reverse, once the shift lever is pressed down and moved towards the reverse position, the projection on the lever goes under the guide plate, releasing the reverse shift restriction and allowing for shifting into reverse.

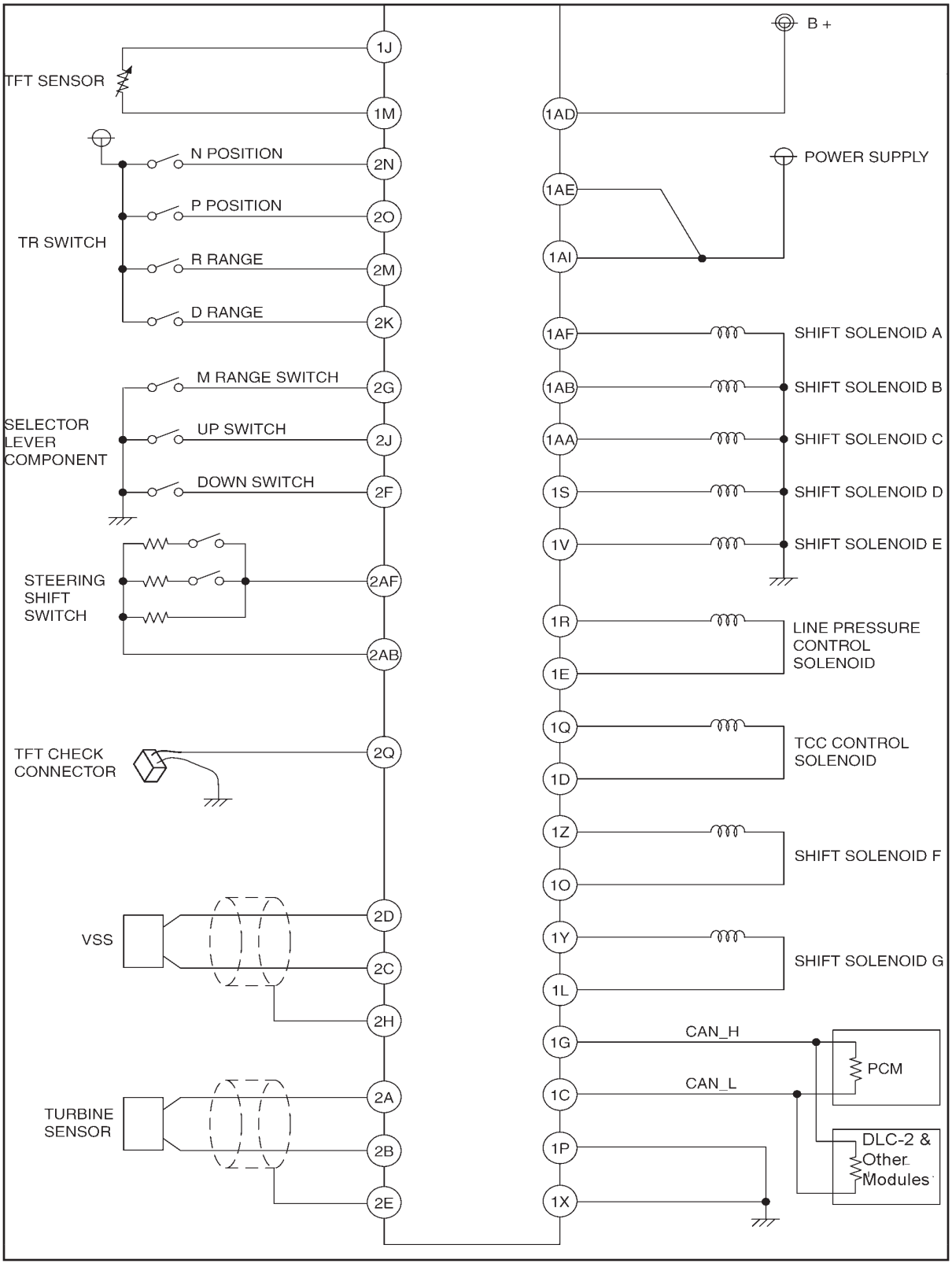
Power Plant Frame (PPF) Function

- For detailed information, refer to the M15M-D manual transmission description in section 05 Transmission.


AT WARNING LIGHT
GEAR POSITION INDICATOR LIGHT
SELECTOR INDICATOR LIGHT
TCM
STEERING SHIFT SWITCH (DOWN SWITCH)
STEERING SHIFT SWITCH (UP SWITCH)
SELECTOR LEVER COMPONENT
· M RANGE SWITCH
· UP SWITCH
· DOWN SWITCH
ECT SENSOR
BRAKE SWITCH
APP SENSOR
CKP SENSOR
PCM
MAF/IAT SENSOR
VSS
TURBINE SENSOR
TR SWITCH
TCC CONTROL SOLENOID
SHIFT SOLENOID G
TFT SENSOR
LINE PRESSURE CONTROL SOLENOID
SHIFT SOLENOID F
SHIFT SOLENOID E
SHIFT SOLENOID A
SHIFT SOLENOID D
SHIFT SOLENOID B
SHIFT SOLENOID C

Automatic Transmission Cross-sectional View




TFT SENSOR
1J
1M
N POSITION
2N
P POSITION
2O
TR SWITCH
R RANGE
2M
D RANGE
2K
M RANGE SWITCH
2G
SELECTOR LEVER COMPONENT
UP SWITCH
2J
DOWN SWITCH
2F
STEERING SHIFT SWITCH
2AF
2AB
TFT CHECK CONNECTOR
2Q
VSS
2D
2C
2H
TURBINE SENSOR
2A
2B
2E
B +
1AD
POWER SUPPLY
1AE
1AI
1AF
SHIFT SOLENOID A
1AB
SHIFT SOLENOID B
1AA
SHIFT SOLENOID C
1S
SHIFT SOLENOID D
1V
SHIFT SOLENOID E
1R
LINE PRESSURE CONTROL SOLENOID
1E
1Q
TCC CONTROL SOLENOID
1D
1Z
SHIFT SOLENOID F
1O
1Y
SHIFT SOLENOID G
1L
1G
CAN_H
PCM
1C
CAN_L
1P
DLC-2 & Other Modules
1X

05 TRANSMISSION

6-Speed Automatic Transmission (SJ6A-EL)

Input/Output Signal and Related Controls

- Refer to Service Highlights, page 05-13-24 to view the table.

EC-AT Operation Chart

- Refer to Service Highlights, page 05-13-4 to view the table.

Shift Control Outline

- Based on the shift diagram, shift solenoids A, B, C, D, E, F, and G are controlled according to the vehicle speed and the throttle opening angle, and the shift control of the transmission is performed.

- When certain conditions are met, the TCM selects a shift mode suitable to the driving conditions and automatically switches to the mode to perform smooth shifting.

POWER MODE

- The POWER MODE in which the shift point is set higher than the normal shift point is automatically selected when certain conditions are met so that high-engine speed high-output conditions are available.

DOWN SLOPE MODE

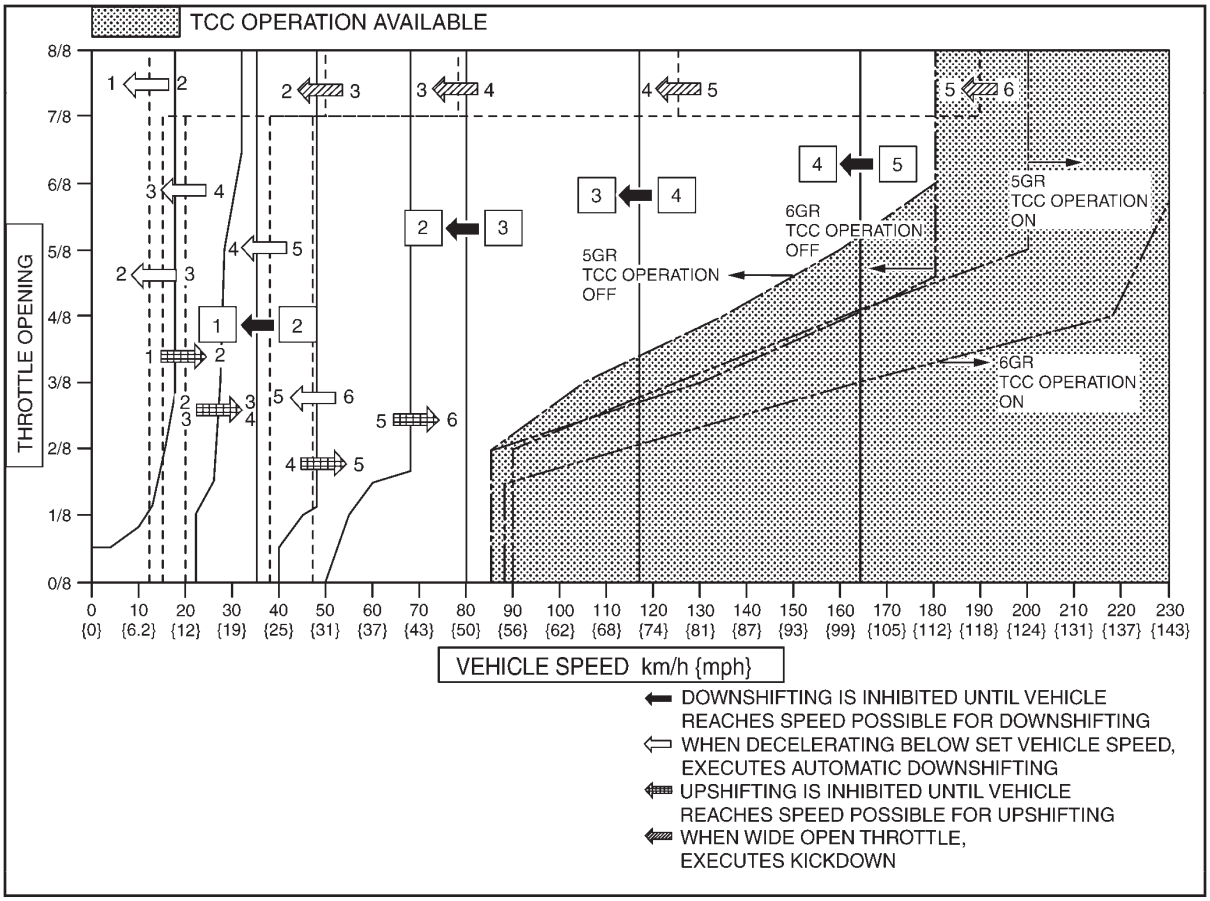
- While the vehicle is being driven on a down slope, the TCM determines that the vehicle is on a down slope based on the signals and output engine speed from the PCM, and switches the driving mode to the DOWN SLOPE MODE. Due to this, load to the brake is reduced.

UP SLOPE MODE

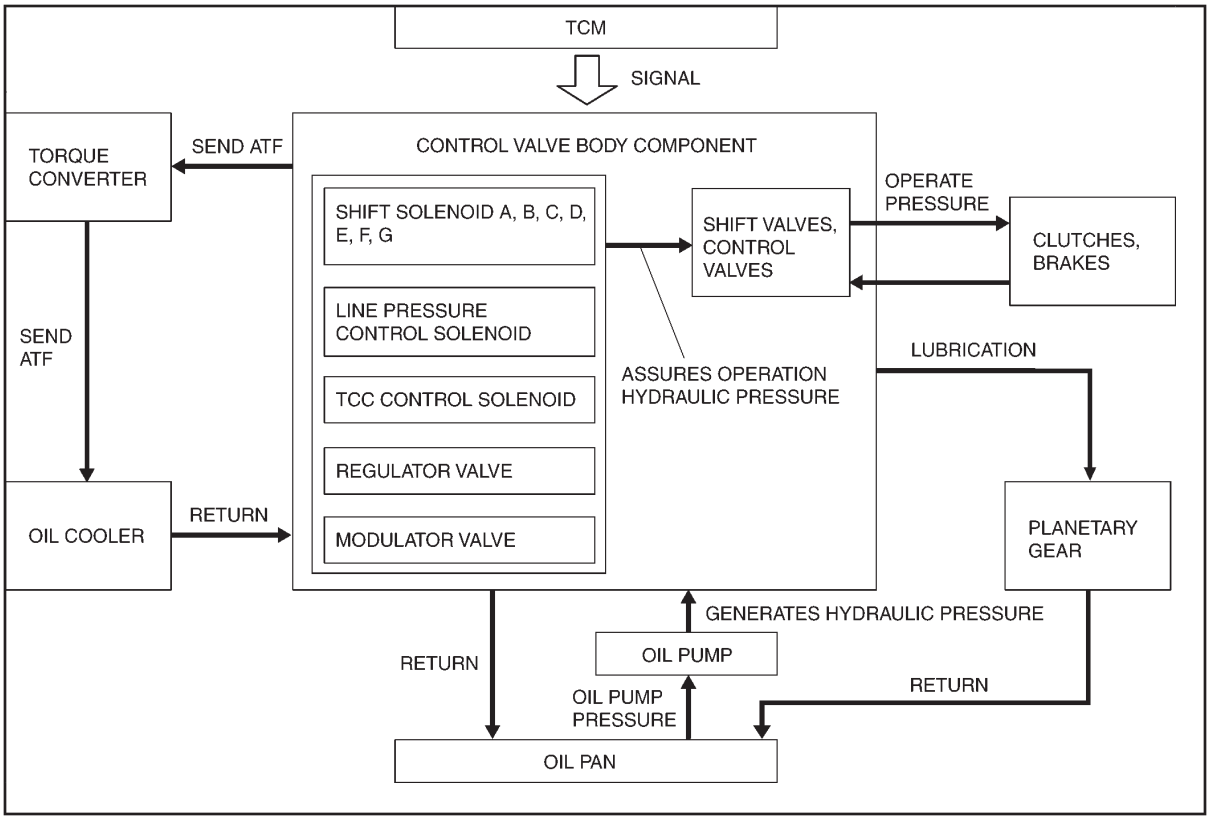
- When the vehicle is climbing a slope, the TCM determines that the vehicle is on an up slope based on the signals and output engine speed from the PCM, and switches the driving mode to the UP SLOPE MODE. Due to this, reduction in traction is prevented.

Shift Control Outline

Shift Diagram



Control Valve Body Component Outline



- The control valve body supplies oil by switching the oil circuit for the hydraulic pressure generated by the oil pump. Based on the control signal from the TCM, the solenoid valves are activated to control the hydraulic pressure to the clutch and brakes, performing gear shift and TCC. In addition, an appropriate amount of oil is supplied to the torque converter, planetary gears and lubricating parts.

Torque Converter Clutch (TCC) Control Outline

- Based on the TCC diagram, the TCC control solenoid is turned on and off according to the vehicle speed and throttle opening angle, and the TCC point control is performed.

- If any of the following three conditions are met, TCC is cancelled.

TCC Cancel Conditions

- Brake switch is ON

- Accelerator is fully closed (determined being idling)

- Engine coolant temperature is low

5-6 Shift Inhibit Control Outline

- The TCM inhibits shift change from the 5th to 6th gears when it determines that the engine is cold based on the engine coolant temperature signal from the

Torque Reduction Control and Line Pressure Control Outline

- While in a shift change between 1st and 6th gears, a torque reduction request signal is output from the TCM to the PCM to cut engine torque amplification caused by shift changes to smooth shifting.

- In addition, line pressure control in which line pressure is controlled during shift change between 1st and 6th gears has been adopted to improve shift shock.

6-Speed Automatic Transmission (SJ6A-EL)

Self-diagnosis Function Outline

- The TCM monitors the communication status of each sensor, electronic component and PCM including the PCM. If any malfunction should occur, the TCM functions to warn the driver and stores the malfunction as a diagnosis code.

On-board diagnosis	• If any malfunction should occur in the automatic transmission, the TCM will cause warning light to light up in order to inform the driver of the malfunction.
Off-board diagnosis	• The TCM stores the malfunction as a diagnosis code. The diagnosis code and TCM data can be inspected by connecting the WDS or equivalent.

CAUTION

- To erase stored DTCs, always perform one of the below procedures. If not performed, a misreading of the DTC may occur.

Stored DTC Erasing Method

• Use the WDS or equivalent.

• Disconnect the negative battery cable and reconnect it after 5 minutes or more.

Fail-safe Outline

- With the fail-safe function, if any malfunction should occur in the automatic transmission system, the TCM will output a control signal and control will be performed to make traveling as short a distance as possible. If shift solenoid malfunction, the TCM will cancel the output of control signals to the solenoid.

Shift learning Function

- Learns optimum hydraulic pressures for each clutch and brake to reduce shift shock during shift change.

On-board Diagnostic

Emergency Mode

- In the fail-safe function, minimum vehicle driveability is obtained by changing the signals that are determined to be malfunctions by the malfunction detection function to the preset values, and limiting TCM control.
- Refer to Service Highlights, page 05-02-7 to view the table.

Simulation Function

- By using the WDS or equivalent, simulation items for input/output parts preset in the TCM can be optionally selected and operated regardless of TCM control conditions.

Simulation Item Table

Simulation Item	Applicable Component	Unit/ Condition	Operation		TCM Terminal
			IG ON	Idle	
LPS	Line pressure control solenoid	A	N/A	X	1E, 1R
SSA	Shift solenoid A	On/Off	N/A	X	1AF
SSB	Shift solenoid B	On/Off	N/A	X	1AB
SSC	Shift solenoid C	On/Off	N/A	X	1AA
SSD	Shift solenoid D	On/Off	N/A	X	1S
SSE	Shift solenoid E	On/Off	N/A	X	1V
SSF	Shift solenoid F	A	N/A	X	1O, 1Z
SSG	Shift solenoid G	A	N/A	X	1L, 1Y
TCC	TCC control solenoid	A	N/A	X	1D, 1Q

09 BODY & ACCESSORIES

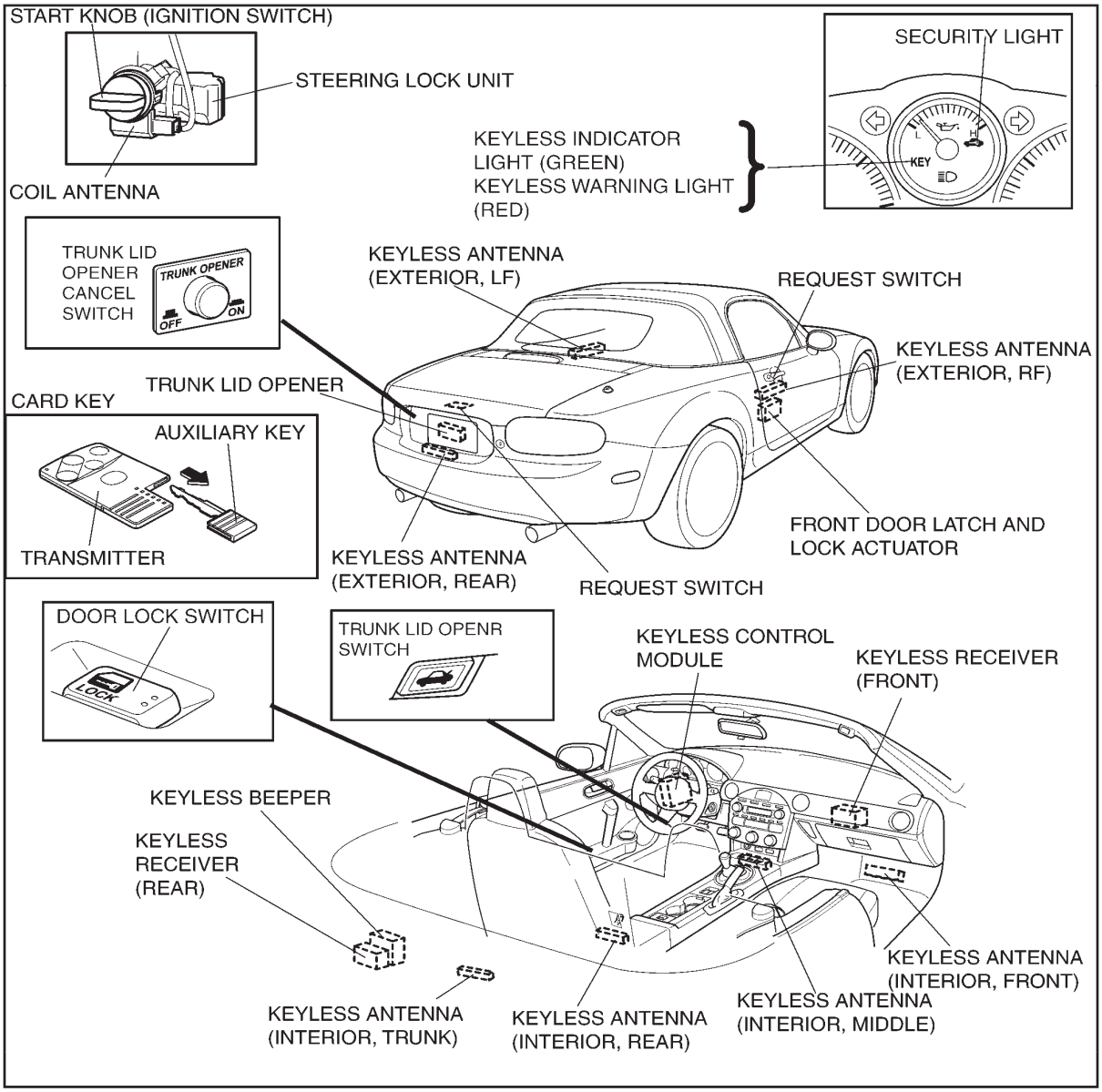
Objectives

After completing this section, you will be able to:

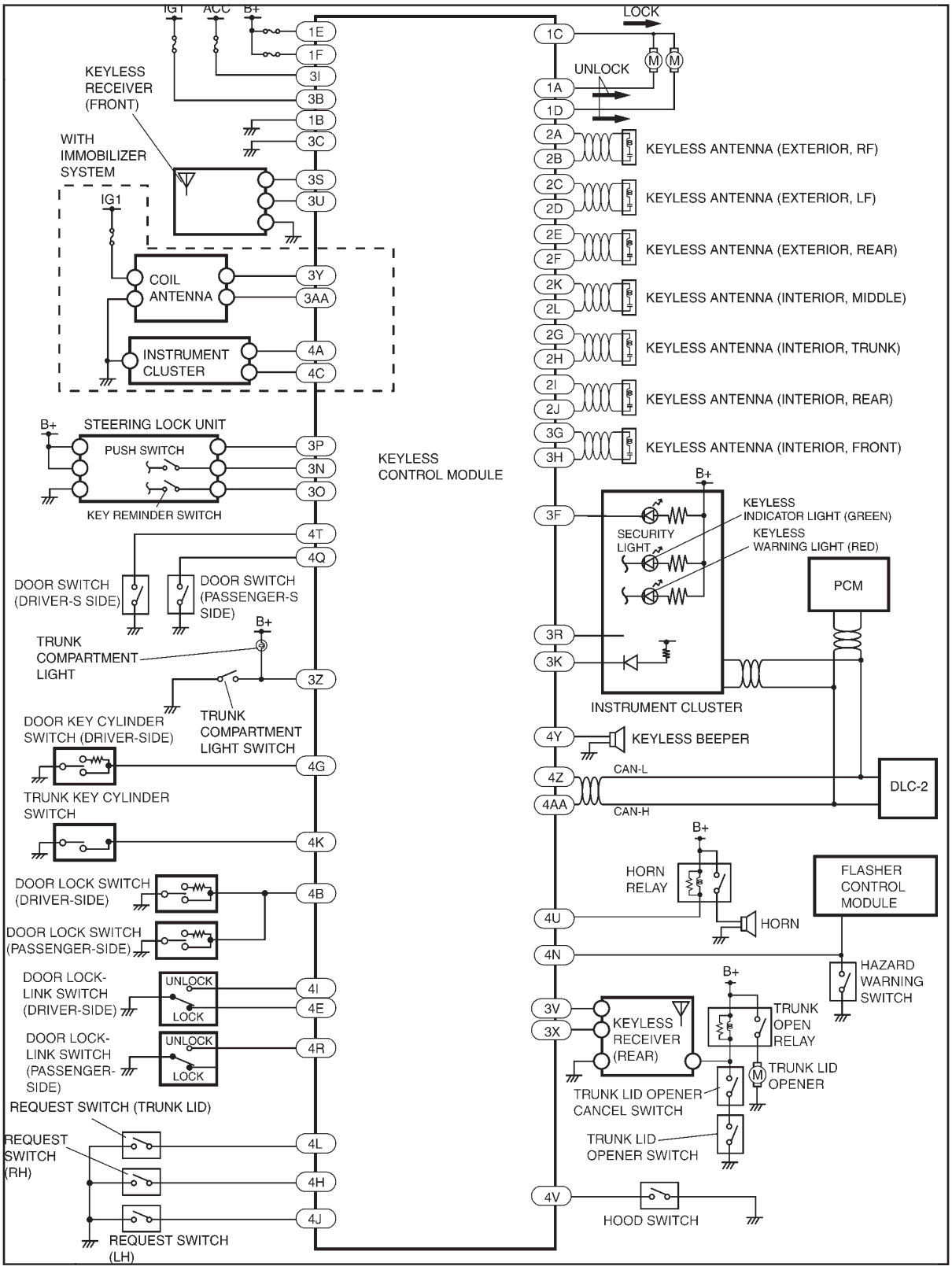
- Identify the Advanced Keyless System components.
- Explain the function of the Advanced Keyless System components.
- Explain the operation of the Advanced Keyless System and perform active commands.
- Identify the Controller Area Network (CAN) modules.

What's in this section:

Security and Locks Structural View



Security and Locks System Wiring Diagram



Security and Locks (Advanced Keyless System)

Keyless Entry System Outline

- An advanced keyless system enables the driver to start the engine or lock/unlock the doors without operating the auxiliary key or transmitter (card key) by carrying the advanced key that has been programmed to the vehicle.

- The doors also can be locked/unlocked by operating the key (auxiliary key) or transmitter (card key).

- The answer-back function confirms that the doors are locked/unlocked by flashing the hazard warning light and sounding a beep.

- A warning and guidance function promotes correction if the system is operated improperly and uses the indicator light in the instrument cluster, a buzzer sound, and the keyless beeper from behind passenger compartment.

- A customized function that switches the activation/deactivation of each function has been adopted.

- A rolling code type transmitter (card key) prevents theft by radiowave interception.

- To prevent improper operation while the vehicle is moving, the doors cannot be locked/unlocked by operating the transmitter (card key) or request switch when the start knob is in any position except LOCK.

Custom Function Outline

- The settings of the following functions, and warning and guidance functions for the advanced keyless entry system can be turned ON/OFF optionally.

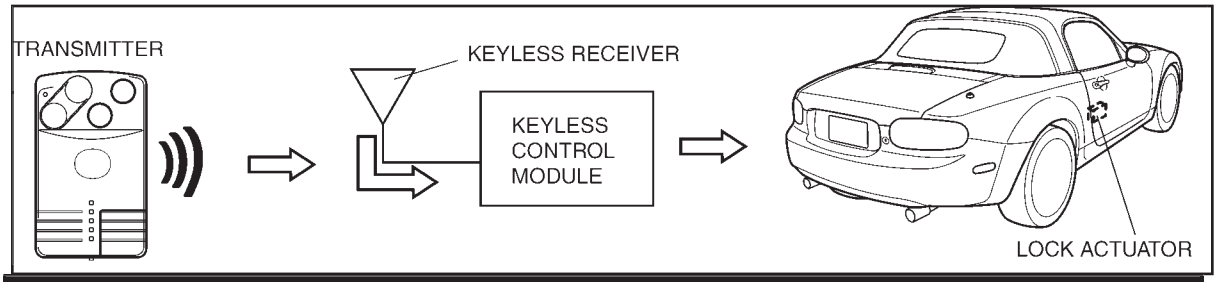
- The WDS or equivalent is necessary for settings. Refer to the Workshop Manual for the detailed setting procedure.

Function Name	WDS or equivalent Display	Initial Setting
Auto lock function (out-of-area type)	Auto lock	OFF
Keyless buzzer answer back	Answer Back Buzzer	OFF
Battery voltage low indications	Low Battery Warning	ON

Keyless Entry System Operation

Normal Keyless Entry Function

Lock/Unlock



NOTE

- If any of the following conditions are met, the doors cannot be locked by operating the transmitter (card key).

— The auxiliary key is inserted in the ignition key cylinder.
— The start knob is not in the LOCK position.
— The start knob is being pressed.
— Any door is open.

- If any of the following conditions are met, the doors cannot be unlocked by operating the transmitter (card key).

— The auxiliary key is inserted in the ignition key cylinder.
— The start knob is not in the LOCK position.
— The start knob is being pressed.

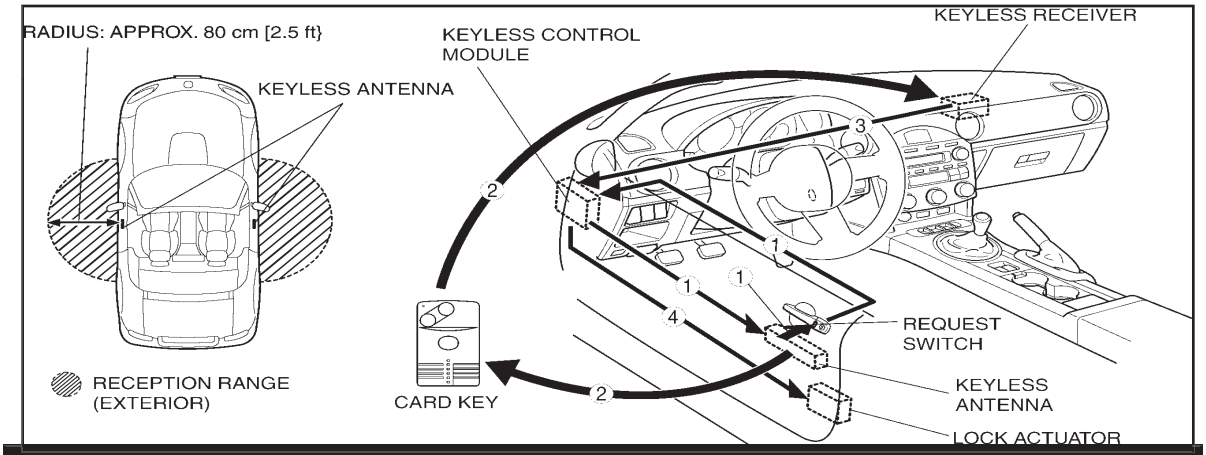
1. When the transmitter (card key) is operated, the card key sends ID data and a rolling code. The keyless receiver receives the data and sends it to the keyless control module.

2. When the keyless control module receives a lock/unlock signal from the transmitter (card key) and verifies the ID, the control module sends the signal to all lock actuators activate to lock/unlock.

3. The keyless control module operates the hazard warning lights flash to flash according to lock/unlock signal from the transmitter (card key).
   — When the LOCK button is pressed, the hazard warning lights flash once.
   — When the UNLOCK button is operated, the hazard warning lights flash twice.

Keyless Entry System Operation (continued)

Advanced Keyless Entry Function: Lock/Unlock



NOTE

- The following conditions must be met in order to lock the doors with the operating switch:

— The card key is not inside the vehicle.
— All doors and trunk lid are closed.
— The auxiliary key is not inserted in the ignition key cylinder.
— The start knob is in the LOCK position and not being pressed.
— The card key is within the reception range outside the vehicle.

- The following conditions must be met in order to unlock the doors with the operating switch

— The auxiliary key is not inserted in the ignition key cylinder.
— The start knob is in the LOCK position and not being pressed.
— The card key is within the reception range outside the vehicle.

1. When a request switch is pressed, the keyless control module sends a request signal from the keyless antenna. The antenna sends the request signal to the area around the door from the pressed request switch and the signal is sent to the cabin area.

2. When the card key receives a request signal, the card key sends back ID data.

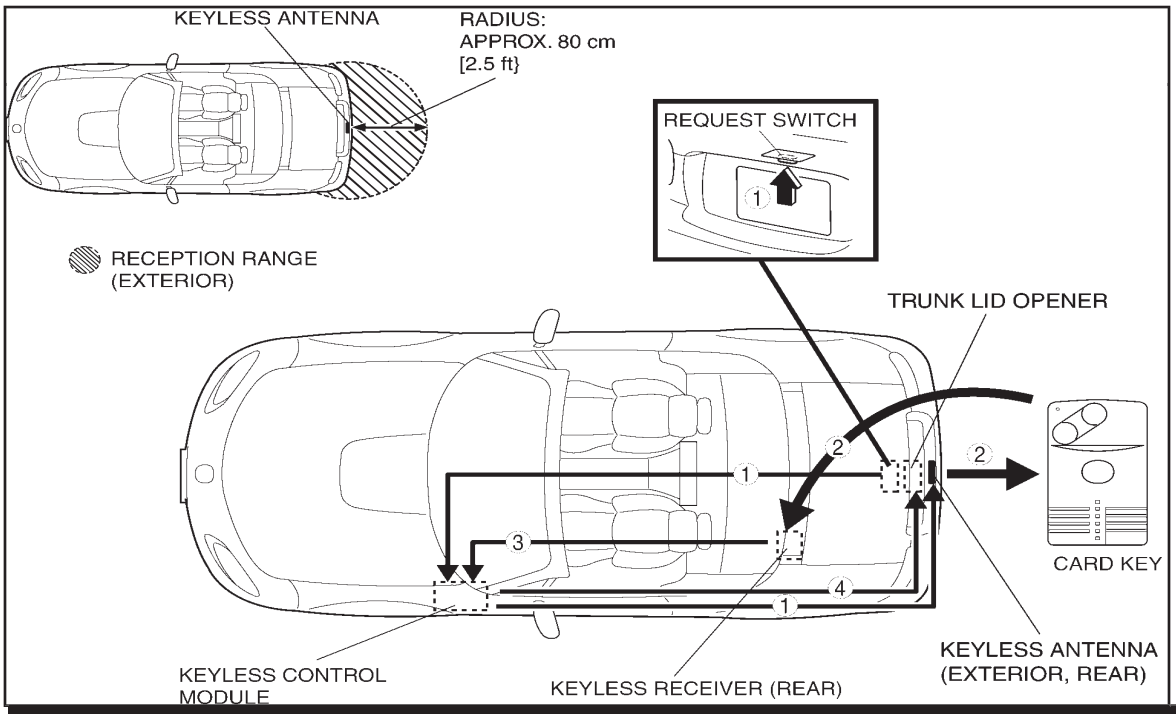
3. The keyless receiver receives the ID data and sends it to the keyless control module.

4. The keyless control module verifies the ID data and determines the card key to be outside the vehicle, it sends a signal to the lock actuators to activated lock/unlock.

5. The keyless control module commands the hazard warning lights to flash.
— When the doors are locked, the hazard warning lights flash once.

Keyless Entry System Operation (continued)

Trunk Lid Opening



NOTE

- The following conditions must be met in order to open the trunk lid with the operating switch:

— The auxiliary key is not inserted in the ignition key cylinder.
— The start knob is in the LOCK position and not being pressed.
— The card key is within the reception range outside the vehicle.
— The trunk lid opener cancel switch is in the ON position.

1. When the trunk lid request switch is pressed and held for 1 second or more, the keyless control module sends a request signal from the keyless antenna. The request signal is sent to the area around the trunk lid, and the signal is sent to the rear area.

2. When the card key receives a request signal, the card key sends back ID data.

3. The keyless receiver (rear) receives the ID data and sends it to the keyless control module.

4. When the keyless control module verifies the ID data and determines to be outside the vehicle, it sends a signal to the trunk lid opener to open the trunk lid.

5. The keyless control module commands the hazard warning lights to flash.
— When the trunk lid is unlocked, the hazard warning lights flash twice.

Keyless Entry System Operation (continued)

Auto re-lock function

- The auto re-lock function automatically locks the doors if any of the following operations are performed within approximately 30 seconds after the UNLOCK button of the card key is pressed, or after the request switch is pressed to unlock the doors.
  — A door or the trunk lid is opened.
  — The auxiliary key is inserted in the ignition key cylinder.
  — The start knob is pressed.
  — The transmitter (card key) is operated. (If the UNLOCK button is pressed, the timer is reset.)
  — A request switch is operated.

Out-of-area (reception area) autolock function

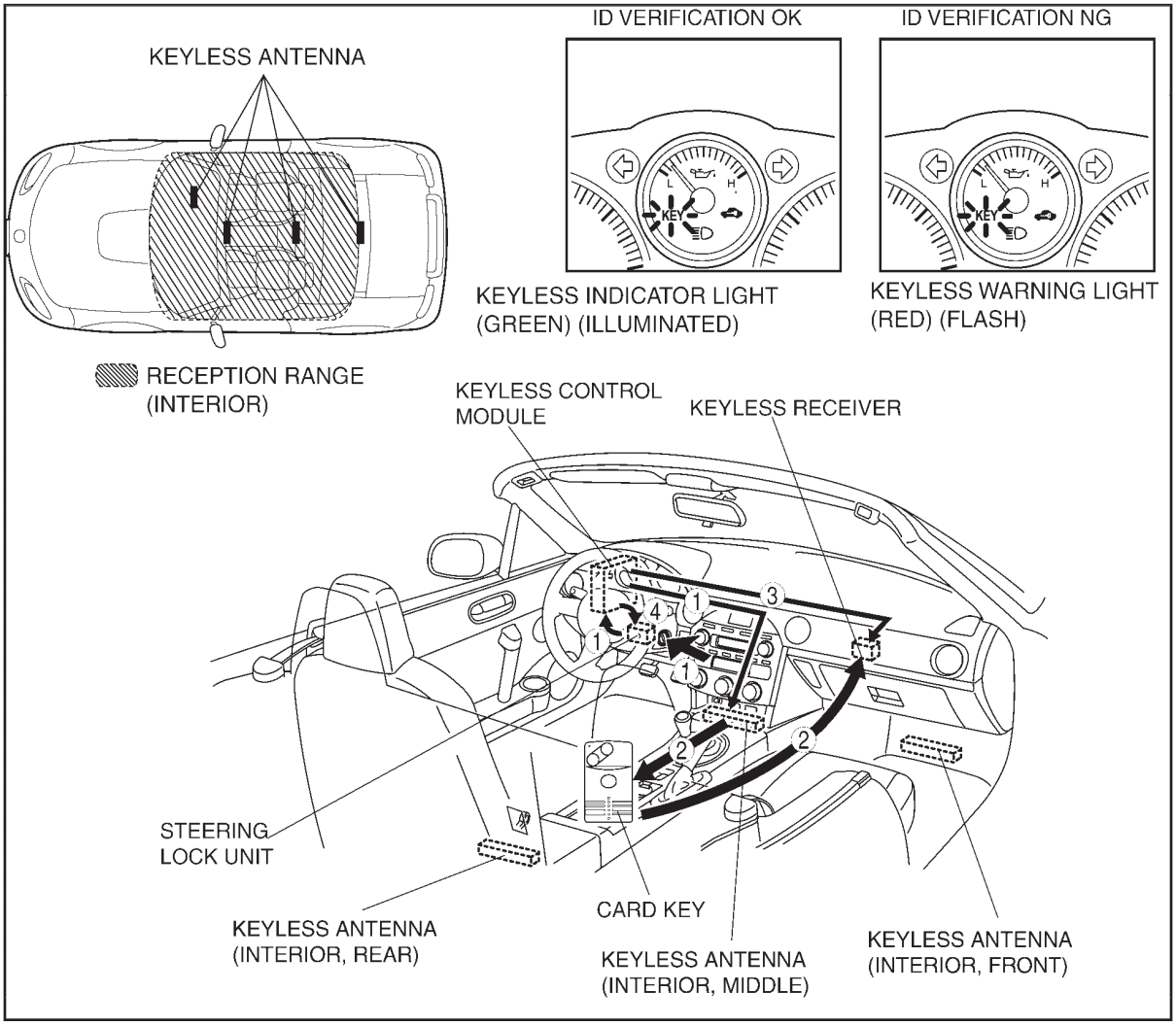
- When all doors are closed and the driver is out of the reception area carrying the card key, the doors are automatically locked. (Initial setting is OFF.)

1. When all the following conditions are met and all doors are closed after any door or the trunk lid is open, the keyless beeper sound is heard and the function starts operation. (The doors are not locked at this time.)
   — The card key is not inside the vehicle.
   — The card key is within the reception area outside the vehicle.
   — The auxiliary key is not inserted in the ignition key cylinder.
   — The start knob is in the LOCK position, and not being pressed.

2. After the operation has started, the card key is monitored within the reception area by the keyless antenna. After about 2 seconds from where the card key has been determined to be out of the reception area, all lock actuatorsactivate to lock. If approximately. 30 seconds have passed since the operation started, the doors also locks regardless of whether the card key is within or out of the reception area.

3. The hazard warning light flashes once and keyless beep sound will be heard once at the same time the door locks.

Advanced Keyless Start Function Operation



Advanced Keyless Start Function Operation (continued)

- The advanced start function activates to start the engine by operating the start knob, and not by inserting the key but by the driver carrying the card key while in the vehicle.

1. When the start knob is pressed, the keyless control module sends a request signal from the keyless antennas (interior).

2. The card key receives the request signal, and sends back ID data.

3. The keyless receiver receives the ID data and sends it to the keyless control module.

4. When the keyless control module verifies the ID data and it determines the card key is inside the vehicle, the start knob of the steering lock unit is released. The keyless indicator light (green) in the instrument cluster illuminates at the same time to indicate that the start knob is operable.
   — If the ID verification is not acceptable (for reasons such as an unprogrammed card key, or card key battery depletion or transmitter interference), the start knob is not released and the keyless warning light (red) illuminates to indicate that the start knob is inoperable.
   — For vehicles with the immobilizer system, ID verification is performed when the start knob is turned to the ON position, and if the verification is acceptable, permission is given to start the engine.

5. Turn the start knob to the START position to start the engine.

Warning/Guidance Function Operation

- If the system is operating improperly, it warns the driver using the indicator light in the instrument cluster, buzzer sound, and keyless beeper in the trunk compartment.

Item		Operation Condition	Keyless buzzer (outside the vehicle)	Instrument Cluster		
				Buzzer (interior)	Keyless Warning Light (red)	Keyless indicator light (green)
Warning	Start knob not in LOCK warning	Driver's door is open with start knob in ACC position	–	Continuous	Flashes	–
	Card key out of vehicle warning*1	Card key cannot be detected inside vehicle with driver's door open and start knob not in LOCK position	–	Continuous	Flashes	–
		Card key cannot be detected inside vehicle with all doors closed and start knob not in LOCK position	Sounds 6 times	–	Flashes	–
		Card key cannot be detected inside vehicle with start knob not in LOCK position and under any condition other than above	–	–	Flashes	–
	Card key left in vehicle warning	Door/trunk lid is open with proper card key inside vehicle and another card key carried	Continuous for 10 s	–	–	–
	Door lock inoperable warning	Request switch is pressed with card key carried and a door open or start knob not in LOCK position	Sounds 6 times	–	–	–
	Battery voltage low indication	Card key battery voltage depleted	–	–	–	Flashes (Approx. 30 s after IG OFF)
Guidance	Start knob operable guidance	Start knob is operable (lock released) when it is pressed	–	–	–	On (Max. 3 s)
	Start knob inoperable guidance	Start knob is inoperable (locked) when it is pressed	–	–	Flashes	–
	Lock/unlock answer back	Doors are locked/ unlocked with normal/ advanced keyless entry function	Locked: Once Unlocked: Twice	–	–	–

Customize Function Outline

• The settings of the following functions, and warning and guidance functions for the advanced keyless entry system can be turned ON/OFF optionally.

• The WDS or equivalent is necessary for settings. Refer to the Workshop Manual for the detailed setting procedure.

Function name	WDS or equivalent display	Inital setting
Auto lock function	Auto lock	OFF
Keyless buzzer answer back	Answer back buzzer	OFF
Battery voltage low indication	Low battery warning	ON

On-board Diagnosis System Outline

Special Features

• The keyless entry system has an on-board diagnostic function to facilitate system diagnosis.

• The on-board diagnostic function consists of the following functions: a malfunction detection function, which detects overall malfunctions in the keyless entry system-related parts; a memory function, which stores detected DTCs; a display function, which indicates system malfunctions by DTC display; and a PID/data monitoring function, which reads out specific input/output signals.

• Using the WDS or equivalent, DTCs can be read out and cleared, and the PID/data monitoring function can be activated.

On-board Diagnosis System PID/Data/Monitor Function Operation

On-board Diagnostic Function

Malfunction detection function

• Detects overall malfunctions in the keyless entry system-related parts.

Display function

• If any malfunction is detected, the keyless warning light (red) in the instrument cluster illuminates to inform the driver of a system malfunction.

Memory function

• Stores malfunctions in the keyless entry system-related parts detected by the malfunction detection function, and the stored malfunction contents are not cleared even if the ignition switch is turned to the LOCK position or `the negative battery cable is disconnected.

(continued)

DTC WDS or equivalent display	System Malfunction location
B1342	Keyless control module internal malfunction
B1134	Unprogrammed card key
B2477	Configuration error
B1317	Keyless control module power supply voltage increases.
B1318	Keyless control module power supply voltage decreases
B2170	Push switch (Steering lock unit)
B1126	Steering lock unit internal malfunction
U0236	Steering lock unit communication system
B1093	Steering lock unit communication error
U0214	Keyless receiver
B1133	Keyless antenna (exterior, RF)
B1132	Keyless antenna (exterior, LF)
B1127	Keyless antenna (Interior, trunk)
B1128	Keyless antenna (Interior, rear)
B1131	Keyless antenna (exterior, rear)
B1129	Keyless antenna (Interior, middle)
B112A	Keyless antenna (Interior, front)
U0323	Communication error to instrument cluster
U0100	Communication error to PCM
U0073	Control module communication error
U2023	Error signal from CAN related module
B1681*	No detected communication with the coil antenna.
B2103*	Coil malfunction

PID/data monitor function

- The WDS PID/data monitor function selects the input/output signal monitor items preset in the keyless control module and displays them in real-time.

- Use the WDS or equivalent to read the PID/data monitor.

(continued)

On-board Diagnosis System PID/Data/Monitor Function Operation (continued)

PID/data monitor table

PID Name	Data Contents	Unit/Operation	Terminal
DTC_CNT	Number of continuous DTCs	–	–
RPM	Engine speed	RPM	4Z, 4AA
VSS	Vehicle speed	KPH	4Z, 4AA
VPWR	Supply voltage	V	1F
NUMCARD	Number of programmed card keys	–	–
NUMKEY*	Number of programmed key ID numbers	–	–
DRSW_D	Door switch (driver's door)	CLOSE/OPEN	4T
DRS_P	Door switch (passenger's door)	CLOSE/ OPEN	4Q
REQ_SW_R	Request switch (right side door)	On/Off	4H
REQ_SW_L	Request switch (left side door)	On/Off	4J
REQ_SW_BK	Request switch (trunk lid)	On/Off	4L
LOCK_SW_D	Door lock-link switch (driver's side)	On/Off	4I, 4E
CLS_LOCK	Door lock switch (lock)	On/Off	4B
CLS_UNLOCK	Door lock switch (unlock)	On/Off	4B
KCS_LOCK	Key cylinder switch (lock)	On/Off	4G
KCS_UNLOCK	Key cylinder switch (unlock)	On/Off	4G
IMMOBI	Immobilizer system equipment or not	On*/Off	–
TR/LG_SW	Trunk compartment light switch	CLOSE/OPEN	3Z
IG_KEY_IN	Key reminder switch	Key-In/Key-Out	3O
IG_SW_ST	Ignition switch (push switch)	Pushed/Not Pushed	3N
BUZZER	Keyless buzzer	On/Off	4Y
PWR_IG1	Power supply (IG1)	On/Off	3B
PWR_ACC	Power supply (ACC)	CLOSE/OPEN	3I
HOOD_SW	Hood latch switch	On/Off	4V
LOCK _SW_P	Door lock-link switch (passenger's side)	On/Off	4R

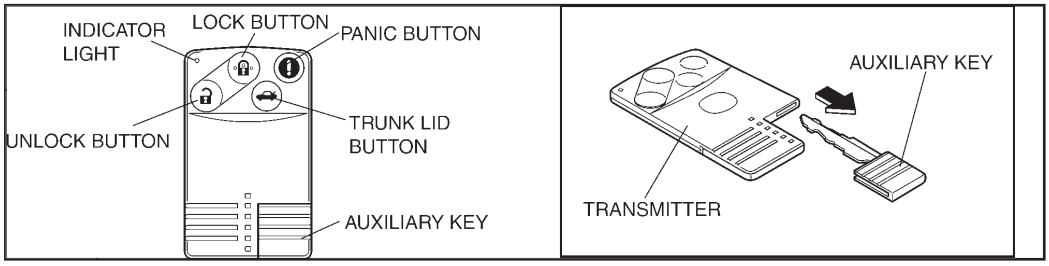
Simulation Function

• The simulation function selects simulation items of output parts preset in the keyless control module and to operate them regardless of control.

Active Command Mode Table

Command name	Data Contents	Unit/Operation	Terminal
BZR_OUT	Keyless beeper	On/Off	4Y
BZR_INN	Interior buzzer (Instrument cluster)	On/Off	4Z, 4AA
LNP_RED	Keyless warning light (red)	On/Off	4Z, 4AA
LNP_GREEN	Keyless indicator light (green)	On/Off	4Z, 4AA
HAZARD	Hazard warning light	On/Off	4N
HORN	Horn	On/Off	4U
ANT_RF	Keyless antenna (exterior, RF)	On/Off	2A, 2B
ANT_LF	Keyless antenna (exterior, LF)	On/Off	2C, 2D
ANT_BK	Keyless antenna (exterior, rear)	On/Off	2E, 2F
ANT_INN1	Keyless antenna (Interior, trunk)	On/Off	2G, 2H
ANT_INN2	Keyless antenna (Interior rear)	On/Off	2I, 2J
ANT_INN3	Keyless antenna (Interior, middle)	On/Off	2K, 2L
ANT_INN4	Keyless antenna (Interior, front)	On/Off	3G, 3H
DR_LOCK	All doors lock	Off/Lock	1A, 1C
DR_UNLOCK	All doors unlock	Off/Unlock	1A, 1C
2STG_UNLK	All doors unlock	Off/Unlock	1A, 1D

Active Command Mode Table



• The card-type transmitter is thin and convenient to carry.

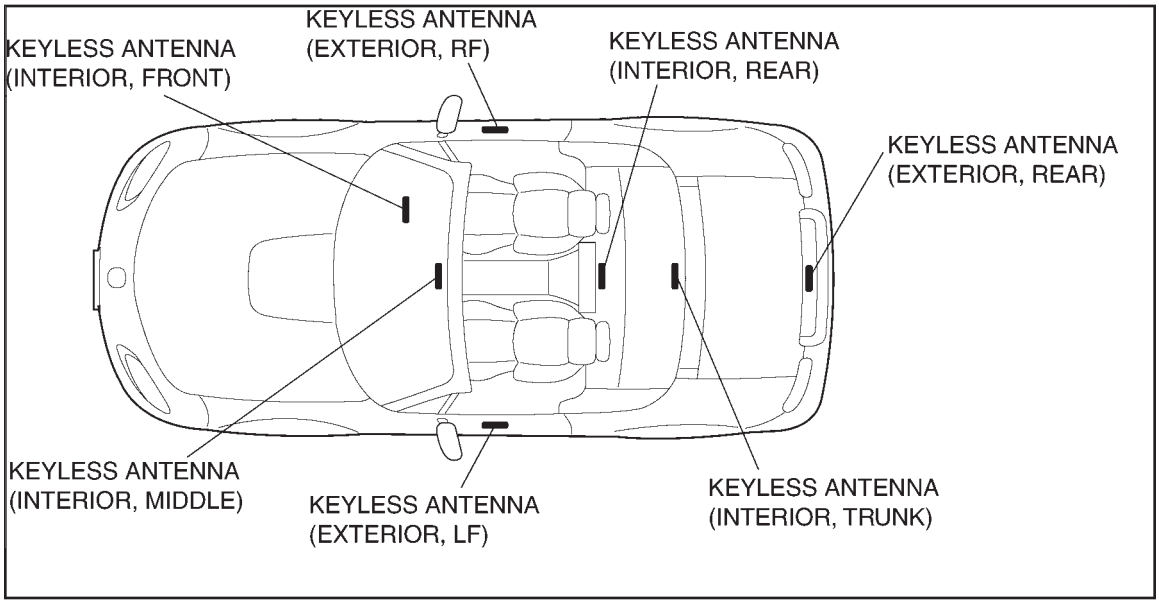
• A maximum of six transmitters can be programmed (with WDS or equivalent) for one vehicle. Refer to WSM 09-14A-19 for programming instructions.

• A built-in operation indicator light illuminates according to LOCK/UNLOCK button operation and request signal from the vehicle.

• In case the transmitter is inoperable due to battery depletion, it is possible to unlock/lock the doors and to start the engine using the auxiliary key.

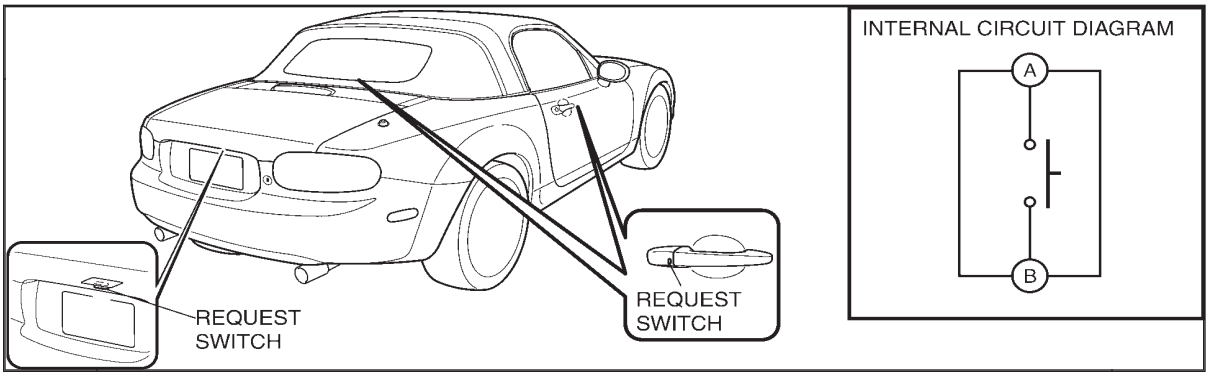
• The auxiliary key has a built-in transponder for vehicles with the immobilizer system.

Keyless Antenna Construction/Operation



- Consists of the antennas for request signal output (7 locations).
- Operated by the keyless control module, the keyless antennas send request signals to produce the reception areas inside and outside the vehicle.
- The keyless antennas built-into the front doors can output signals to both inside or outside the vehicle, and change the level of the radiowave (output to inside or outside the vehicle) according to operation conditions.
- The keyless control module locates the card key by determining the antenna which is receiving the signal the strongest.

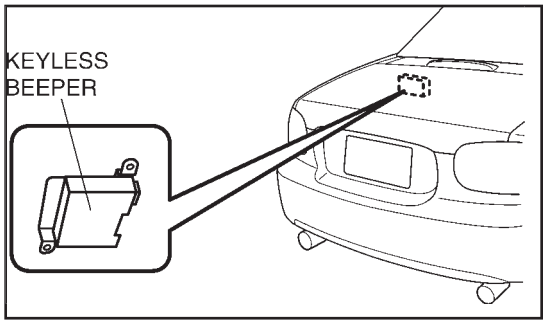
Request Switch Construction



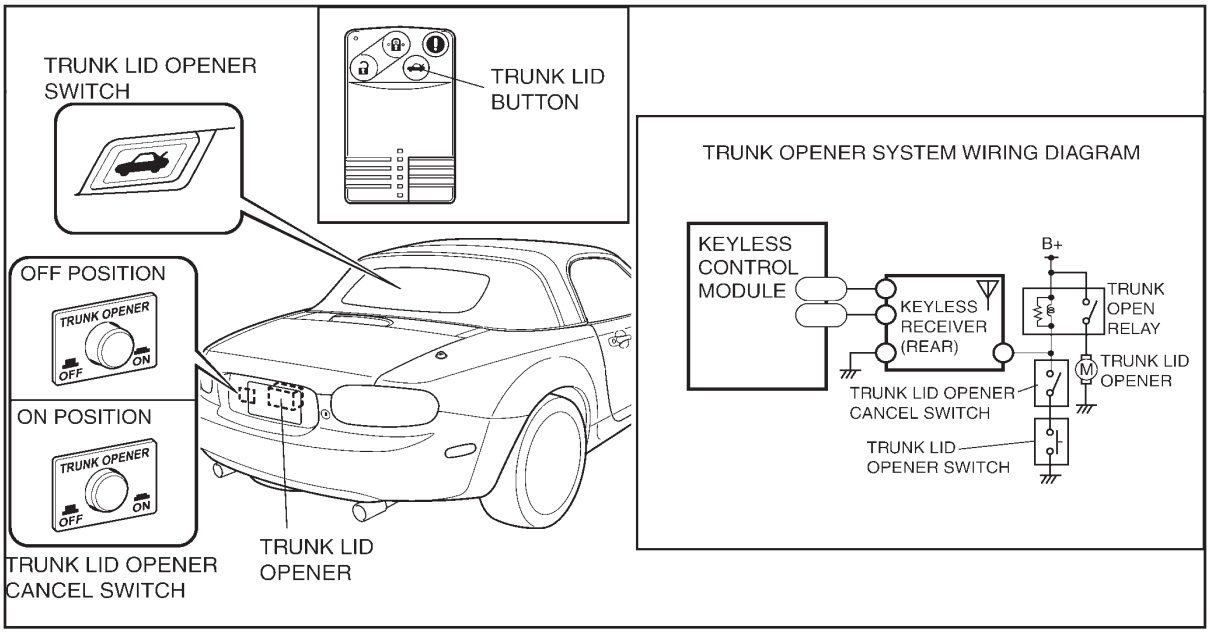
- Installed on both doors and trunk lid.

Keyless Beeper Construction

- The keyless beeper is located in the trunk compartment.



Trunk Lid Opener System Construction/Operation

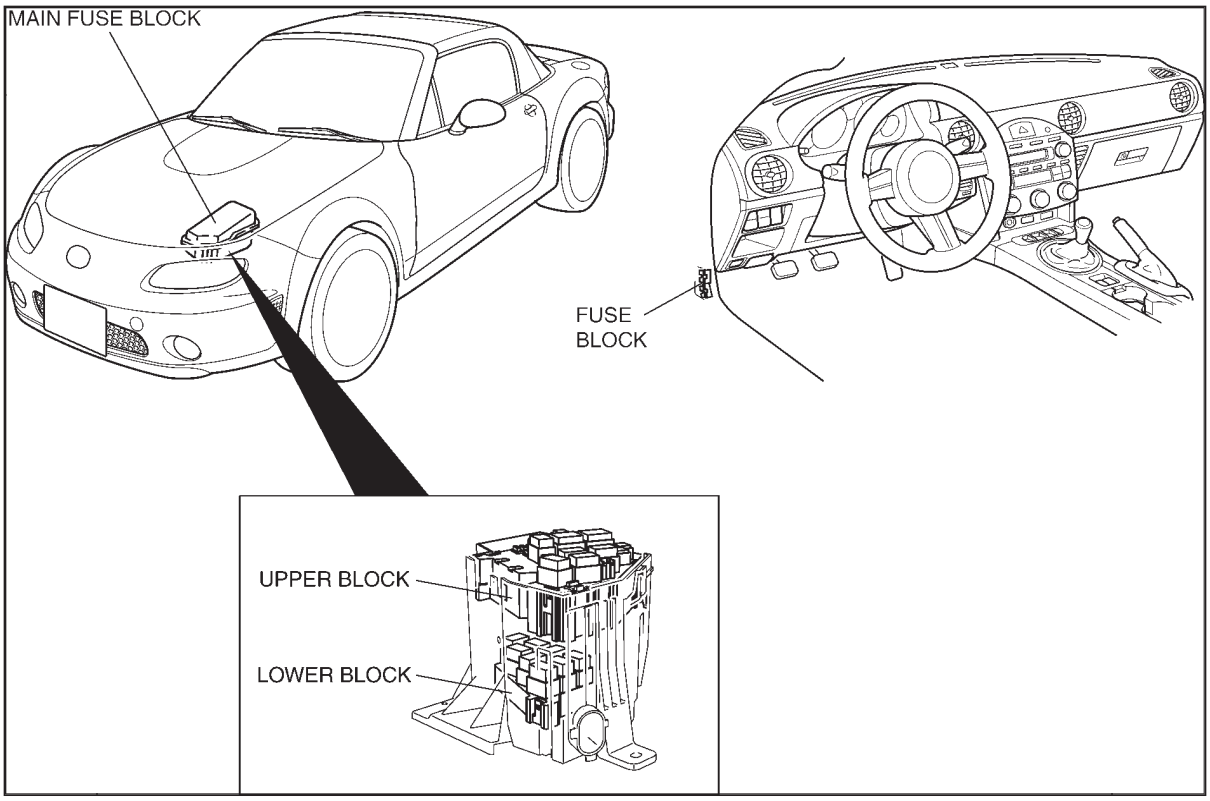


- The following items can open the trunk lid:
  - — Key
  - — Transmitter
  - — Trunk lid opener switch
  - — Trunk lid request switch

Power Systems Outline

- The main fuse block is a double layered type.

Power Systems Structural View



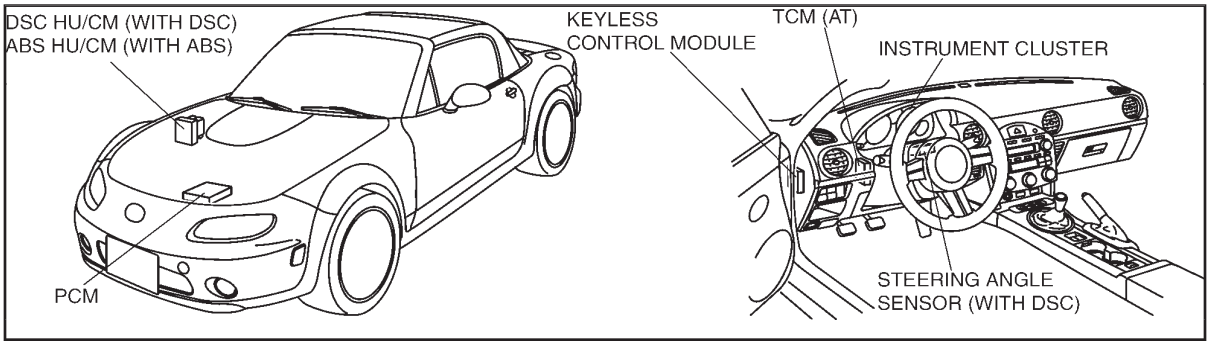
Controller Area Network (CAN) System Outline

• The CAN simplifies multiplex signal transmission between electrical modules.

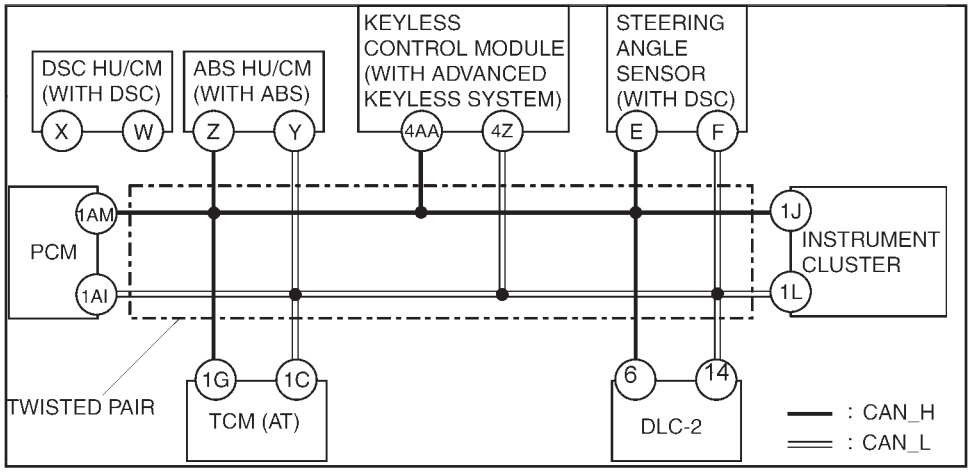
• The following modules use twisted-pair wiring for connections. (Each electrical module hereafter referred to as a CAN system-related module):
  — PCM
  — TCM
  — DSC HU/CM (with DSC)
  — ABS HU/CM (with ABS)
  — Keyless control module (with advanced keyless system)
  — Steering angle sensor (with DSC)
  — Instrument cluster

• With an on-board diagnostic function included for each multiplex module, display of DTCs using the WDS or equivalent has improved serviceability.

CAN System Structural View



CAN System Wiring Diagram



Programmable Module Installation

Module	Programmable Module Installation	Module Reprogramming
PCM	X	X
TCM	X	X
RCM	X	
TPMS	X	
IC/HEC	X	
RKE/AKES	X	
ABS/DSC/TCS	X	

Technician Name _____

Activity No.4: Pressure-based Evaporative System Diagnosis

Purpose: In this activity, you will use WDS and the evaporative system tester to diagnose a leak.

What you will need to complete this activity:

- WDS
- Mazda Approved Evap Tester # 134-01049
- MX-5 Miata

Procedure 1: WDS Evap Test

1. Connect WDS, turn the ignition ON, and ID the vehicle.

2. Select Toolbox – Powertrain – Fuel – Evap Test, then press the tick.

3. Confirm the boxes for Barometric Pressure (Baro), Fuel Level Input (FLI), Intake Air Temperature (IAT), and Battery Voltage (VBAT) are all shaded green. Record the readings in the boxes.

BARO	FLI	IAT	VBAT

4. Press the tick.

5. The “Do you wish to continue with the diagnostics?” appears. Select YES.

6. Press the tick to bypass the “Drive the vehicle or let the engine idle more than 20 minutes” screen.

7. The “Turn the ignition off” screen appears. Press the tick.

8. The “Turn the ignition on” screen appears. Press the tick.

9. Press the tick to bypass the “Evap Test” information screen.

NOTE
Wait. WDS is performing the leak test. Once the test is completed, the screen will change.

10. Record the test results in the boxes.

Small Leak	Very Small Leak	LDP – REF	LDP – IDL

Did the evap test indicate there are any fault codes detected? YES NO

If YES, what code(s)? _____ Continue to step # 12

If NO, contact the instructor to review activity set-up. After the instructor completes the review, press the tick and follow the screen instructions to rerun the evap test.

11. Select the System Option icon  , press EXIT, then press the tick.

NOTE
Exiting the Evap Test mode returns the WDS to the Vehicle Specifications screen.

Mazda Approved Evap Tester # 134-01049
Use WDS with the evap tester to pressurize the system and introduce smoke. Follow procedures 2, 3, and 4 to locate the leak.

Procedure 2: Self- test Instructions

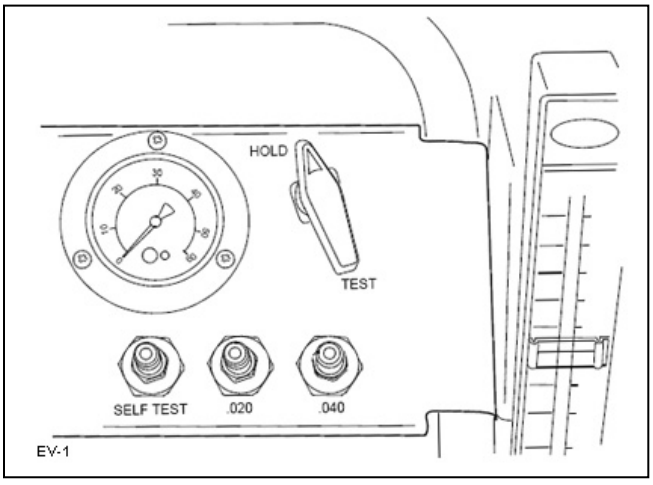
1. Make sure the nitrogen tank is properly positioned and secured to the evap tester.

2. Confirm the control valve on the panel is in the hold position and open the nitrogen bottle.

3. Connect the vehicle interface hose to the self-test port on the panel. Do not over tighten the hose.

4. Turn the control valve to the test position. The gauge should read 14” of water (+/- 1” of H2O).

5. Turn the control valve to the hold position.



6. Verify the gauge holds pressure and that the flow meter reads “no flow”. No flow indicates the tester passed self-test. If the tester didn’t pass, contact the instructor.

Procedure 3: Performing the Evaporative Test

1. Remove the fuel filler cap.

2. Select the correct cap adapter for the vehicle from the chart.

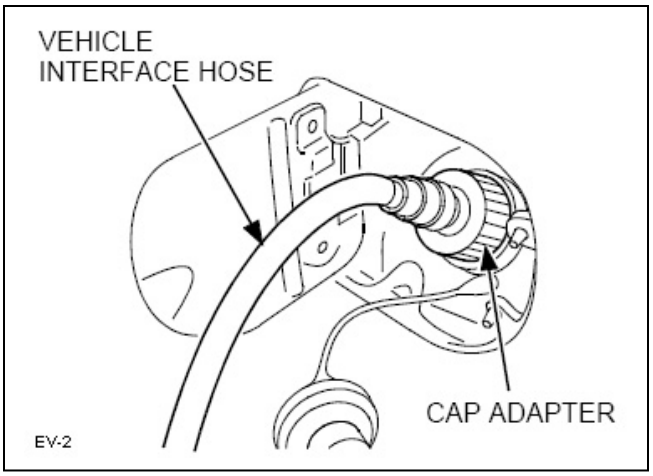
Model / Adapter	134 – 01050	134 – 01052	134 – 01058
626	X		
Mazda6			X
Miata	X		
Millenia	X		
MPV	X		
Protege	X		
RX-8			X
Tribute		X	
Truck		X	

3. Install the correct cap adapter into the fuel filler neck.

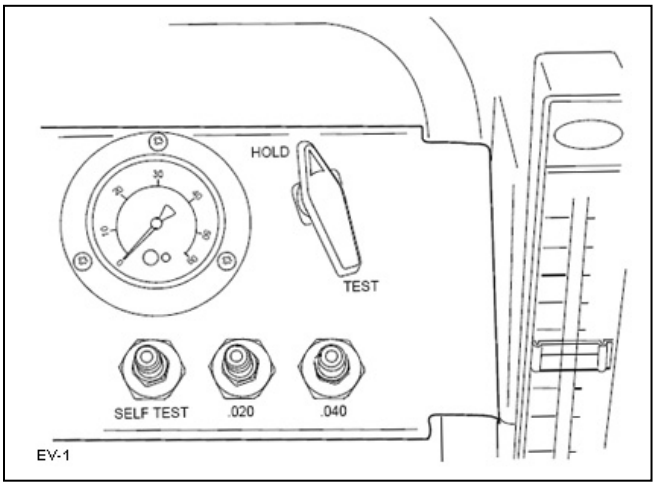
4. Connect the interface hose to the cap adapter and hand tighten it. Don not over tighten.

5. Perform Mode 8 to seal the evaporative system. (Refer to page 5 for Mode 8 instructions)

6. Make sure the control valve is in the hold position and the valve on the nitrogen cylinder is open.



7. Turn the control valve to the open position and let the system fill. There should be a drop in pressure along with the flow meter being pegged at maximum. The length of time the flow meter is pegged will vary depending on how full the tank is and how long it takes to fill and pressurize the emission system.



8. Check the pressure gauge and flow meter readings to determine if there is a leak.
   No Leak: There is “zero flow” on the flow meter and the pressure gauge returns to the pre-set pressure of 14” of water (H2O).
   Leak: When measuring the flow the pressure does not return to the pre-set level of 14” of water (H2O).

9. Connect the smoke generation unit.

Procedure 4: Using the Smoke Generation Unit

NOTE
Never use the smoke generation unit until you have determined a leak exists in the vehicle’s evaporative system. The smoke requires flow from a leak to properly carry the smoke through the system.

1. Ensure the following conditions are met before proceeding.
   - The evap tester must already be connected to the vehicle using one of the test modes.
   - The nitrogen valve must be open.
   - The control valve must be turned to the test position.
   - Make sure the smoke generation unit is filled with the correct type of smoke generation oil (134-01057).

2. Connect the smoke generation battery leads to the vehicle’s battery.

3. Press the remote smoke trigger to fill the system with smoke.

4. Look for signs of smoke around the vehicle emission components, fittings, and connectors.

   Is there a leak? YES NO

   If YES, where is the leak? _____ Repair the leak.

   If NO, keep looking!

5. Run the WDS Evap Test again to confirm a successful repair.

6. Record the test results in the boxes.

Small Leak	Very Small Leak	LDP – REF	LDP – IDL

Did the evap test indicate there are any fault codes detected? YES NO

7. Disconnect WDS and the evap tester.

WDS Mode 8
Mode 8 activates the Leak Detection Pump Change-Over Valve (COV) to seal the evaporative system from atmosphere.

1. Select Toolbox – Powertrain – OBD Test Modes – Mode 8 On-board Device Control, then press the tick.

You should now be able to use WDS and the Mazda approved evap tester to diagnose and repair evaporative system leaks.

Instructor sign-off

Instructor initials: _____

Technician Name _____

Activity No.5: Front Wide-range Oxygen Sensor Evaluation

Purpose: In this activity, you will use WDS to monitor the front wide-range oxygen sensor and interpret results.

What you will need to complete this activity:

- WDS
- MX-5 Miata

Milliamp PID Data Characteristics

WDS Display
The WDS PID data displays the O2S11 in microamps (***µA***) and the WDS display range is set at milliamps (**mA**). Just remember there are 1000 microamps in one milliamp (1000 µA = 1mA). For example: 300 µA = .3mA

Milliamp Values and Air/Fuel Ratios
When monitoring O2S11 PID data, microamps (µA) and milliamps (mA) ***above*** zero indicate a ***lean*** air/fuel ratio. For example: An O2S11 reading of +178 µA means the air/fuel ratio is lean at that moment.
Conversely, microamps (µA) and milliamps (mA) ***below*** zero indicate a ***rich*** air/fuel ratio. For example: An O2S11 reading of -145 µA means the air/fuel ratio is rich at that moment.

Procedure

NOTE
Before starting this activity, be sure the exhaust is properly vented from the shop.

1. Start the vehicle and let idle.
2. Connect WDS and ID the vehicle.
3. Select Toolbox – Datalogger, then press the tick.
4. Select Powertrain – Engine, then press the tick.
5. Erase all the selected PIDs by pressing the “Erase” icon  .
6. Select the O2S11 PID. What display scale is used for the O2S11 PID?

   _____
7. Select the RPM PID.
8. Press the tick.
9. Press “O2S11” on the WDS screen so that the black bars are above and below the O2S11 PID.
10. Select the “Plots, Formats, and Range” icon  located on the right-hand side of the screen to confirm range is set correctly.
11. On the O2S11 mA screen, what are the high and low display ranges set at?

    HIGH _____ LOW _____ (Settings: HIGH = 2.0mA LOW = 2.0mA)
12. Press the tick.
13. Now select the Record Times” icon  and set the Capture Buffer Duration at 30 seconds.
14. Press the tick.
15. For 20 seconds, rev the engine up and down between 2,000 and 4,000 RPMs.
16. After 20 seconds, let the vehicle return to idle and select the

    Record Function” icon  on the right-hand side of the screen.

17. Select the “Playback Display” icon  located on the lower left portion of the WDS screen.

18. Press “O2S11” on the WDS screen so that the black bars are above and below the O2S11 PID.

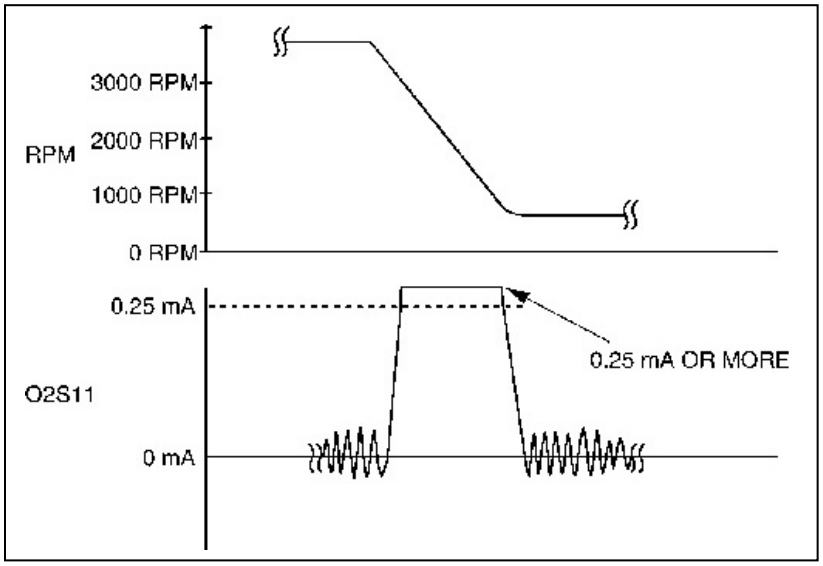
19. Using the arrows in the playback display, move the vertical line to the **highest** recorded O2S11 reading.

    What is the reading? _____ µA or mA

20. Using the arrows in the playback display, move the vertical line to the **lowest** recorded O2S11 reading.

    What is the reading? _____ µA or mA

The illustration below is from the workshop manual Front HO2S Current Inspection section.



21. Did your highest recorded O2S11 reading exceed the specification shown in the illustration?

    YES NO

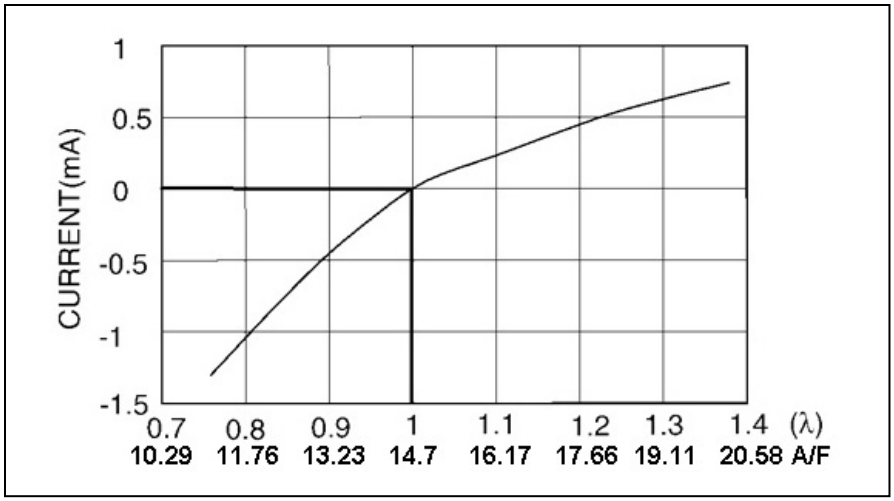
22. Is the front linear oxygen sensor functioning properly?

    YES NO

23. Using the arrows in the playback display, move the vertical line to the **highest** recorded O2S11 **idle** reading.

    What is the reading? _____ µA or mA

24. On the chart below, mark the spot where the idle reading would be placed.



λ = Lambda value A/F = Stoichiometric air/fuel ratio of 14.7

25. What would you estimate your highest idle reading is when converted to an air/fuel ratio?

    _____

Instructor sign-off
You should now be able to monitor and record wide-range oxygen sensor operation and interpret the results.

Instructor initials: _____

Technician Name _____

Activity No.6: Power Plant Frame Height Inspection and Adjustment Procedure

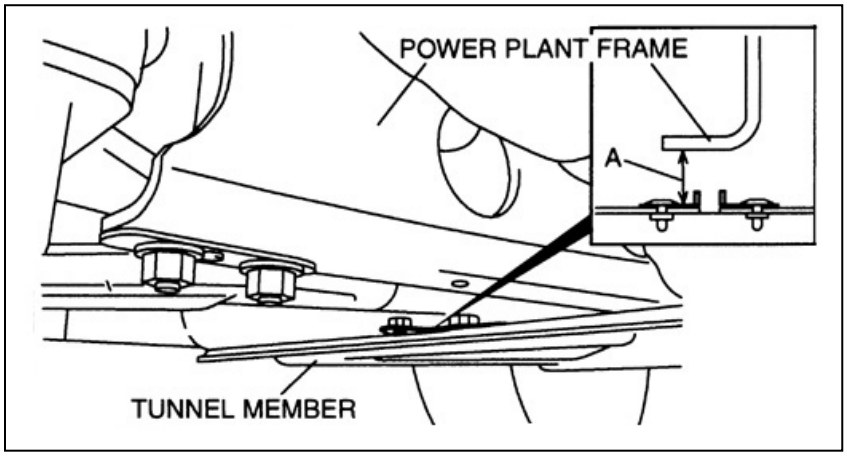
Purpose: In this activity, you will inspect for correct or incorrect PPF height measurement, adjust as necessary, and confirm measurement adjustment.

What you will need to complete this activity:

- MX-5 Miata
- Hand tools
- Tape measure
- ESI

1. Access ESI, find the Power Plant Frame (PPF) installation procedure and print the procedure.

2. Go to the MX-5 Miata located on the hoist and measure dimension A represented in the illustration.



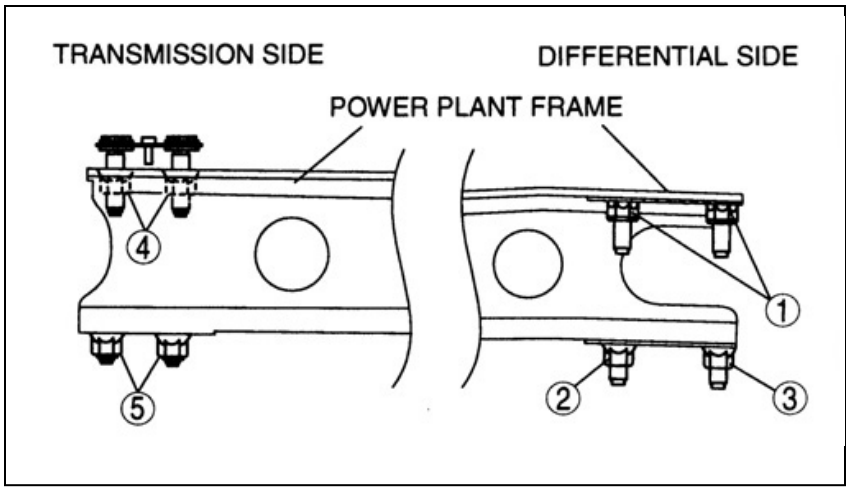
3. What is measurement A? _____

4. Is measurement A out of specification? YES NO

5. If no, no further adjustment is required. If yes, proceed to step #6.

NOTE
To facilitate this activity, the PPF bolts have been started by hand.

6. Temporarily tighten nuts 1, 2, 3 in the order shown.

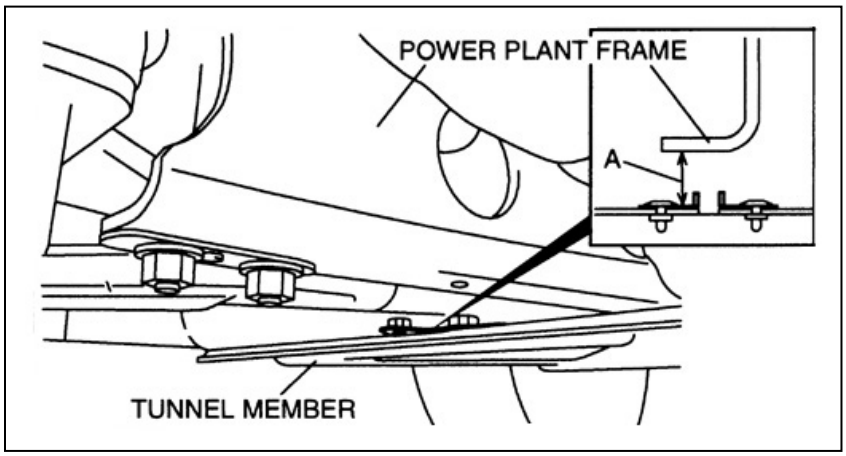


7. Tighten nut 2 until the PPF is seated against the rear differential.

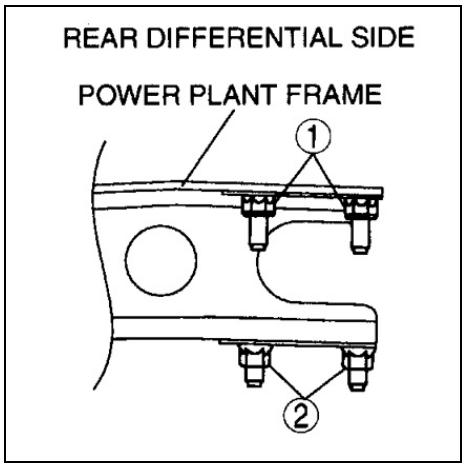
8. Temporarily tighten nuts 4 and 5 in the order shown.

9. Raise the front of the PPF (transmission side) or the transmission with the transmission jack and adjust dimension A to the workshop manual dimension.

10. What is the desired dimension? _____

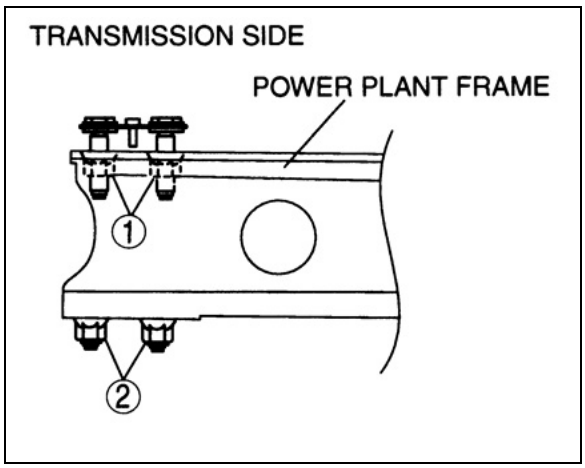


11. Tighten the nuts on the rear differential side in the order shown.



12. What is the workshop manual tightening torque? _____

13. Tighten the nuts on the transmission side in the order shown.



14. Verify that dimension A is within the specification with the transmission jack removed. If it is not, adjust dimension A again.

Instructor sign-off
You should now be able to properly adjust the PPF after transmission or differential removal.

Instructor initials: _____

Data Link Connector CAN Diagnosis

1. Connect WDS and ID the vehicle.

2. Retrieve codes from All CMDTCs

3. List all the DTCs currently set.
   Be sure to scroll down the code list to view all the codes.

4. Erase the codes. To erase all the codes may take a couple KOEO or KOER cycles.

5. Perform a KOER and let idle for one minute.

6. Turn the ignition key to the OFF position, then back to ON.

7. Retrieve codes from All CMDTCs.

8. List all the DTCs that set after the KOER cycle.
   Be sure to scroll down the code list to view all the codes.

9. Turn the ignition key to the OFF position and remove the WDS cable from the DLC.

10. Connect a DLC Breakout Box (BOB) or use the appropriate male pin to make the DLC CAN connections.

Information Point
Using a DLC BOB is the best way to connect to the DLC. If a DLC BOB is not available, use the correct size male pin to connect to the DLC. Damage may result to DLC female terminal pins if DVOM probes are used to test the DLC.

11. Using a DVOM, measure the network resistance by probing the CAN_H and CAN_L circuits at the DLC BOB.

    What is the resistance? _____ Ohms

Information Point
When testing a medium-speed network (MS-CAN), be sure all the doors are closed. Open doors during MS-CAN testing will cause incorrect Ohm readings.
On a normally functioning network, the readings will be:
Resistance – Approx. 60 Ohms

12. Using the DVOM, measure CAN_H voltage by connecting the black probe to a good chassis ground and the red probe to the CAN_H circuit, then turn the key to the ON position.

    What is CAN_H voltage? _____ Volts

13. Measure the CAN_L voltage by moving the red probe to the CAN_L circuit.

    What is CAN_H voltage? _____ Volts

Information Point
On a normally functioning network, the readings will be:
Resistance – Approx. 60 Ohms

CAN_H – 2.6 +/-.2

CAN_L – 2.3 +/-.2

Data Link Connector CAN Diagnosis

14. Turn the key to the OFF position.

15. Disconnect all the modules on the network.

Information Point
Use the wiring diagram to identify the correct module connector. On modules with multiple connectors, it may be easier to disconnect just the connector containing the CAN_H and CAN_L wires for the network being diagnosed.

16. With all the modules disconnected from the network perform the following resistance tests at the DLC BOB:
    - Probe CAN_H to CAN_L
    - Probe CAN_H to Ground
    - Probe CAN_L to Ground

    Turn the key to the ON position and perform the following voltage tests:
    - Probe CAN_H to CAN_L
    - Probe CAN_H to Ground
    - Probe CAN_L to Ground

Information Point
On the resistance tests, the expected resistance is infinity / open circuit. Resistance indicates a short between CAN_H and CAN_L or a short to ground.
On the voltage tests, the expected voltage is 0 volts. Voltage indicates a short to a power source.

17. Connect one module to the network, then turn the key to the ON position.

18. Using the DVOM, measure CAN_H voltage by connecting the black probe to a good chassis ground and the red probe to the CAN_H circuit.

    What is CAN_H voltage? _____ Volts

19. Measure the CAN_L voltage by moving the red probe to the CAN_L circuit.

    What is CAN_H voltage? _____ Volts

20. Disconnect the module and turn the key to the OFF position.

21. Repeat steps # 17 through 20 for each module on the network being tested.

Information Point
Testing one module at a time on the network helps determine the integrity of the network between the connected module and the DLC.
CAN_H and CAN_L module voltage varies from module to module. For example, the voltages measured on a PCM could be:
CAN_H 2.53V
CAN_L 2.47V
An IC module could be:
CAN_H 3.29V
CAN_L 1.71V
What is important to remember is:
- CAN_H and CAN_L voltages combined will equal 5.0 volts +/- .2
- 0 voltage measured between ground and CAN_H or CAN_L indicates an open circuit.
  OR
  A faulty driver inside the module.
- Equal voltage indicates CAN_H and CAN_L are shorted together either inside the module or on the network bus.

00 GENERAL INFORMATION

What's in this section:

00 GENERAL INFORMATION
Walkaround

Introduction

- The new MX-5 Miata strives to continue with the long-held tradition of “oneness between car and driver.” Mazda engineers kept this goal in mind when creating every aspect of the MX-5 Miata.

Engine

- The MX-5 Miata is equipped with the 2.0 liter, 4 cylinder LF engine. This engine boasts 170 HP at 6700 RPM (6AT: 166 HP at 6700 RPM) and 140 lb/ft torque at 5000 RPM.

- The MX-5 Miata uses 5W-20 oil and has an oil and oil filter capacity of 4.5 quarts.

Suspension

- The MX-5 Miata is equipped with Tire Pressure Monitoring System (TPMS). TPMS is an optional features for vehicles equipped with either the Sport or Grand Touring models. Vehicles equipped with TPMS are also equipped with run-flat tires. Like the RX-8, the MX-5 Miata does not come with a spare tire, but rather a tire-repair kit.

For 16-inch wheels

- Front camber is between -0°41′ and 0°21′ based on vehicle height. Front caster is set between 6°27′ and 5°31′, depending on vehicle height. Front toe is set at 2 mm ± 4. (0.08 in ± 0.15). All three are adjustable.

- Rear camber is set between -1°33′ and -0°45′, depending on height. Rear toe is set at 3 mm ± 4 (0.12 in ± 0.15). Both are adjustable.

For 17-inch wheels

- Rear camber is between -0°51′ and 0°15′ based on vehicle height. Front caster is set between 6°34′ and 5°39′, depending on vehicle height. Front toe is set at 2 mm ± 4. (0.08 in ± 0.15). All three are adjustable.

- Rear camber is set between -1°42′ and -0°49′, depending on height. Rear toe is set at 3 mm ± 4 (0.12 in ± 0.15). Both are adjustable.

Front suspension

- A newly developed in-wheel-type double-wishbone suspension takes full advantage of the low hood line enabled by the optimized engine layout. The front upper arm and the front lower arm have been lengthened and attached to the highly rigid front crossmember to allow for linear alignment changes during jounce and rebound of the front wheels. Due to this, roadholding and handling performance have been improved.

Walkaround

Brakes

- The MX-5 Miata is equipped with 11.4 inch ventilated front discs and 11 inch solid rear discs. An Anti-lock Brake System is optional with the MX-5 trim level and standard on vehicles equipped with the Touring and Sport and Grand Touring packages.

- Like the RX-8, Dynamic Stability Control is an option on MX-5 Miatas equipped

Transmission

- The MX-5 Miata is equipped with three different transmissions: a 5-speed MT (M15M-D), a 6-speed MT (P66M-D) and a 6-speed AT (SJ6A-EL)

- Both 6-speed transmissions are all-new. The 6-speed AT uses a unique method for checking fluid. We will discuss this in further detail during the course.
  The 6-speed AT offers steering-wheel mounted paddle shifters.

Steering

- The MX-5 Miata uses a standard hydraulic power assist-steering, not EHPAS.

Walkaround

Body and Accessories

- The all-new Z-folding top is simple to use.
  To open the top, simply lower the windows, release the single center-mounted latch, and fold the top into the rear compartment and push down gently, to latch the top.
  To close, press this button to release the top, pull-up and secure it with the central latch.

- Like the RX-8, Xenon, HID Lights are an available option.

- The MX-5 Miata has optional all-new advanced keyless system. This system allows the driver to perform many common functions (unlocking door, starting the vehicle, etc) without using a traditional key or fob.

- The MX-5 Miata uses a high speed Controller Area Network (CAN). The following modules are on the high speed network: PCM, TCM, DSC HU/CM (with DSC), ABS HU/CM (with ABS), Keyless Control Module, Steering Angle Sensor (with DSC), Instrument Cluster.

01 ENGINE

Objectives

After completing this section, you will be able to:

- Explain the operation of the pressure-based evaporative emission system.
- Explain the operation of the wide-range air/fuel ratio sensor.
- Perform pressure-based evaporative emission system diagnosis using WDS and the Mazda approved evaporative system tester.
- Perform a wide-range air/fuel ratio sensor evaluation using WDS.

What's in this section:

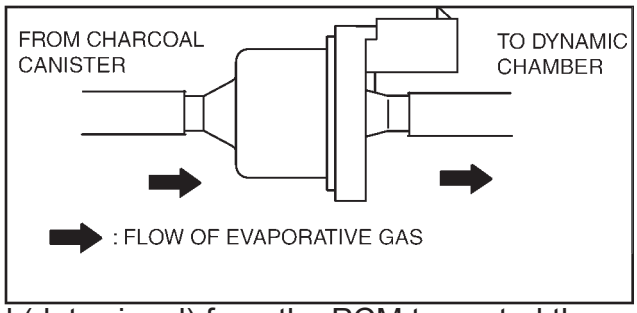
Activity	Title	Location
4	Pressure-based Evaporative System Diagnosis	Shop
5	Front Wide-range Oxygen Sensor Evaluation	Shop

Purge Solenoid Valve Function

- The purge solenoid valve adjusts the amount of evaporative gas to be introduced to the intake air system.

Purge Solenoid Valve Construction/Function

- The purge solenoid valve is installed on the evaporative hose.



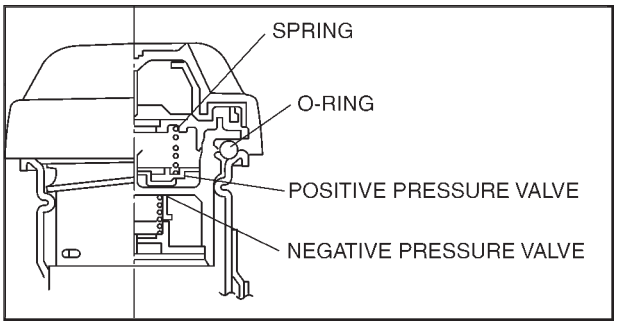
- It consists of a electromagnet, spring and plunger.
- It opens and closes the passage in the solenoid valve according to the purge solenoid valve control signal (duty signal) from the PCM to control the amount of evaporative gas to be introduced to the dynamic chamber according to engine operation conditions.
- The signal the PCM sends energizes and magnetizes the electromagnet, pulling the plunger. The passage between the ports opens when the plunger is pulled, and evaporative gas is introduced to the intake air system according to intake manifold vacuum.

Fuel-filler Cap Function

- If the evaporative gas passage is closed for some reason, the fuel filler cap prevents the generation of positive or negative pressure in the fuel tank, protecting it from deformation.

Fuel-filler Cap Construction/Operation

- Consists of a positive pressure valve, negative pressure valve, spring, and O-ring.

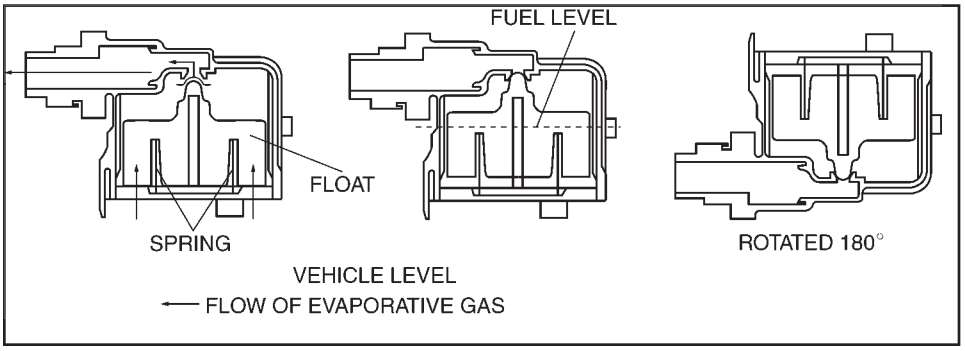


- When there is excessive positive pressure in the fuel tank due to evaporative gas, the positive pressure in the fuel filler cap valve releases the pressure to atmosphere. When there is negative pressure, the negative pressure valve allows air into the fuel tank.
- Under normal operation conditions, evaporative gas is vented through the two-way check valve built into the rollover valve. The positive and negative pressure valves in the fuel filler cap have higher opening pressures than the two-way check valve, so they are normally closed. The valves will open if the evaporative pressure inside the tank is too high.

Rollover Valve Function

- The rollover valve prevents fuel flow into the evaporative gas passage during sudden cornering or vehicle rollover.

Rollover Valve Construction/Operation



- The rollover valve is built into the fuel tank, therefore it is not possible to remove or install it.

- The rollover valve consists of a float, a spring and a two-way check valve.

- The rollover valve utilizes a combination of float weight, spring force, and buoyancy. If the fuel level reaches the top of the fuel tank, the float (valve) closes to block the sealing surface of the passage.

Fuel Shut-off Valve Function

- The fuel shut-off valve prevents fuel from flowing to the charcoal canister during tight turns or vehicle rollover.

- The two-way check valve releases evaporative gas to the charcoal canister.

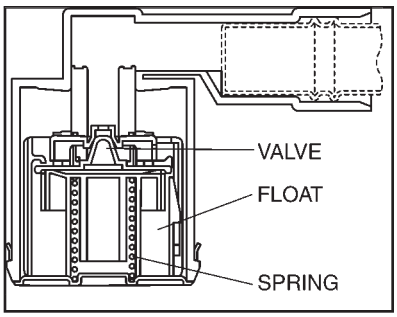
- During refueling, the fuel shut-off valve closes to prevent a fuel overflow.

Fuel Shut-off Valve Construction/Operation

- The fuel shut-off valve is built into the fuel tank.

- The fuel shut-off valve consists of a valve, float, spring, and by-pass valve.

- During refueling or due to fuel sloshing, the float is flooded with fuel and the floating force causes the valve to close. Also, during vehicle rollover, the valve closes due to balance between the float gravity and spring.



Evaporative Emission (EVAP) System Leak Detection Pump

Construction/Operation

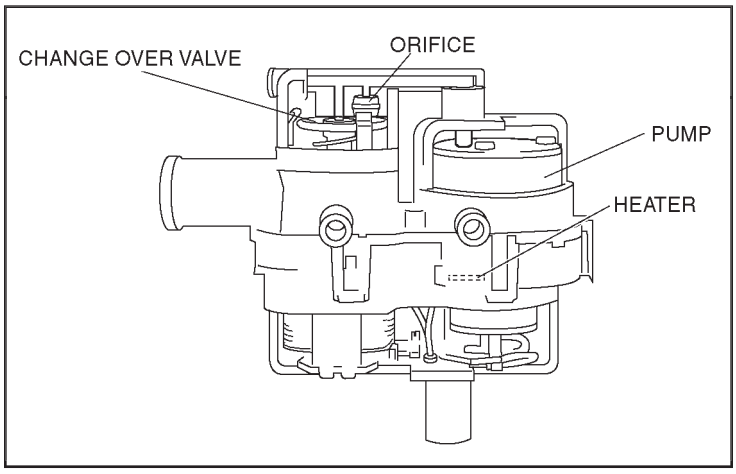
Structure

- Orifice
  — Has a 0.5 mm (0.02 in) hole

- Pump
  — Force-feeds air to the orifice and the EVAP lines

- Heater
  — Removes moisture inside the pump

- Change over valve
  — Operated by a solenoid valve to switch air passages

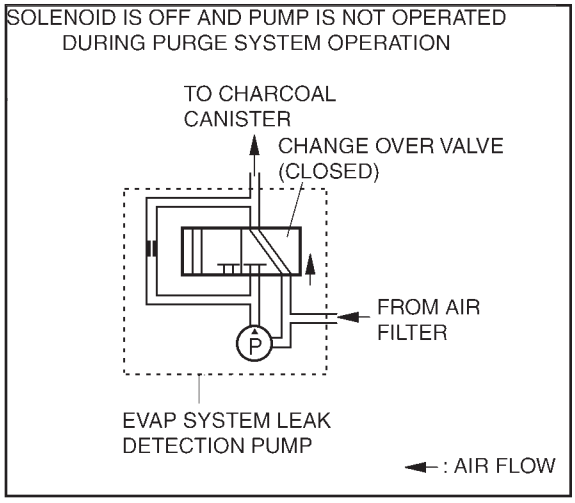


Operation

Evaporative system normal operation

- While driving, air passes through the change over valve through the charcoal canister then to fuel tank to compensate for the fuel being used.

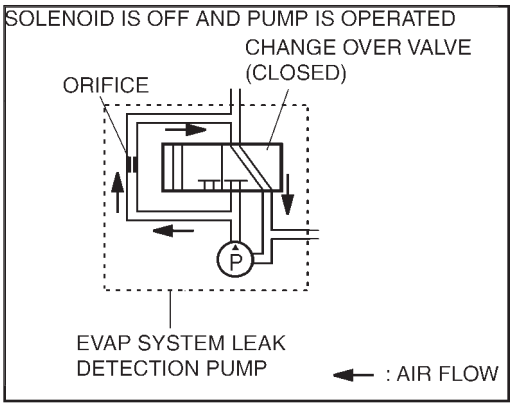
- The passage between the charcoal canister and the air filter is connected. During fuel expansion or when filling the fuel tank, fuel vapor passes through charcoal canister through changeover valve then to atmosphere.



Evaporative Emission (EVAP) System Leak Detection Pump

Construction/Operation

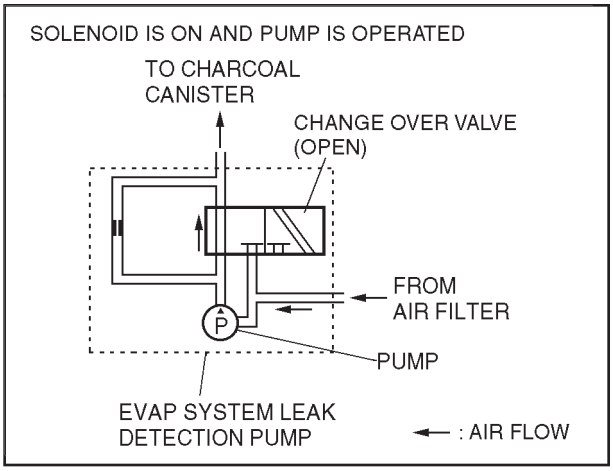
- The PCM performs the evaporative test after the ignition key is turned to the OFF position.



- After the ignition is turned off, the PCM turns on the leak detection pump which forces air through a 0.5 mm (.020 in.) orifice to establish the current reference value.

- Forcing air through the orifice places a load on the leak detection pump which the PCM interprets as a reference (base) value for the evaporative test.

- The leak detection pump draws air from the air filter and sends it to the charcoal canister to pressurize the evaporative system.

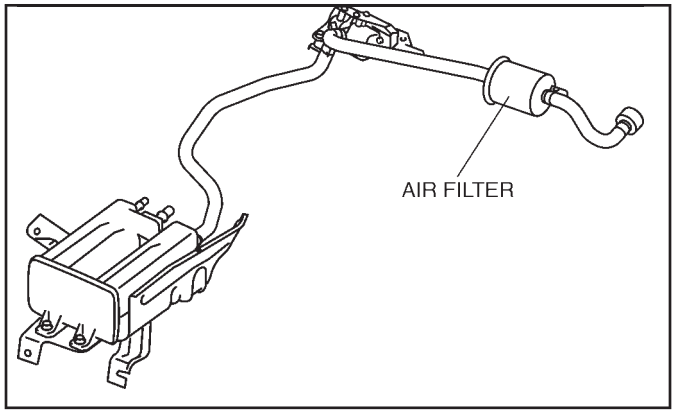


Air Filter Function

- The air filter filters dust from the air drawn to the charcoal canister.

Air Filter Construction/Operation

- The air filter is located in the EVAP system leak detection pump on the atmosphere side.

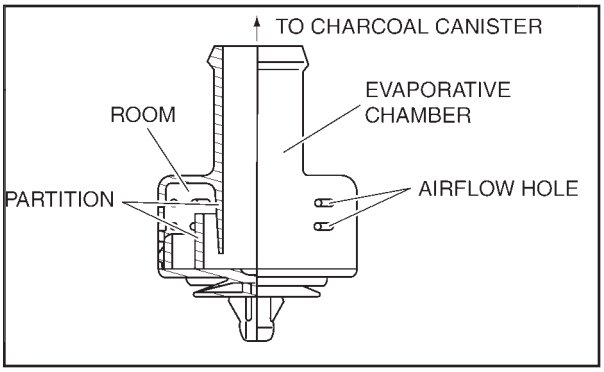


Evaporative Chamber Function

- The evaporative chamber prevents penetration of water and dust in the charcoal canister.

Evaporative Chamber Construction/Operation

- A small section with partitions is located in the evaporative chamber. These partitions protect the charcoal canister by preventing flooding as atmospheric air enters from the airflow holes.



Heated Oxygen Sensor (HO2S) Function

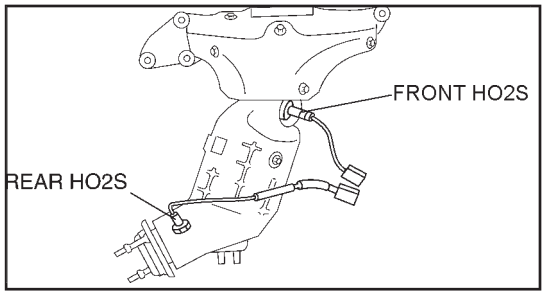
- The front HO2S uses the wide-range air/fuel ratio sensor, which can linearly detect the oxygen concentration (air/fuel ratio of the air-fuel mixture) in the exhaust gas in all ranges, from lean to rich.

- The rear HO2S detects the oxygen concentration in the exhaust gas.

- A heater allows stable detection of the oxygen concentration even when the exhaust gas temperature is low.

HO2S Construction/Operation

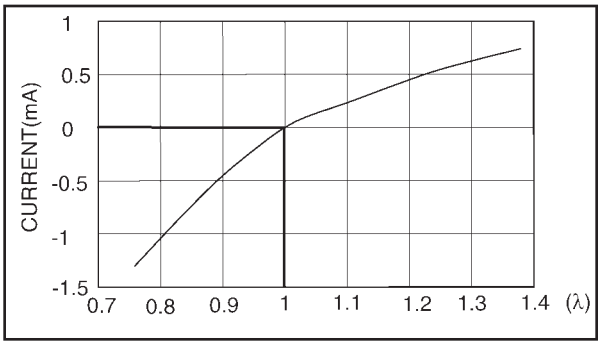
- The HO2S is installed on the front of the WU-TWC and back of the TWC.



Front HO2S

- The wide-range air/fuel ratio sensor is a limited current type sensor, and can detect the oxygen concentration (air/fuel ratio of the air-fuel mixture) in the exhaust gas in all ranges, from lean to rich.

- A heater is built into the sensor to facilitate the activation of the HO2S at engine startup (when the exhaust gas temperature is low).



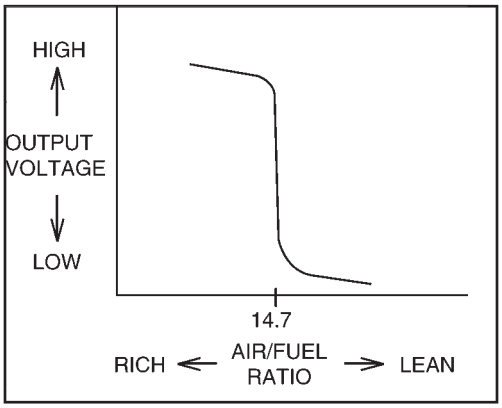
- The wide-range air/fuel ratio sensor converts the oxygen concentration in the exhaust gas into a current value, and sends the value to the PCM.

- The PCM calculates the λ (lambda) value of the air-fuel mixture based on the received current value.

- (λ (lambda)) = (actual air/fuel ratio)/14.7

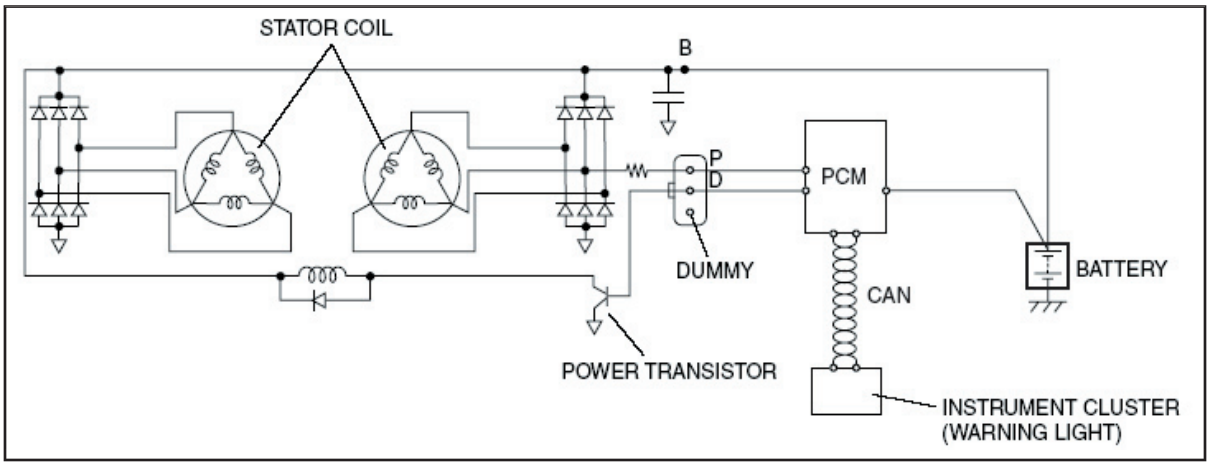
Rear HO2S

- A heater is built into the sensor to facilitate the activation of the HO2S at engine startup (when the exhaust gas temperature is low).

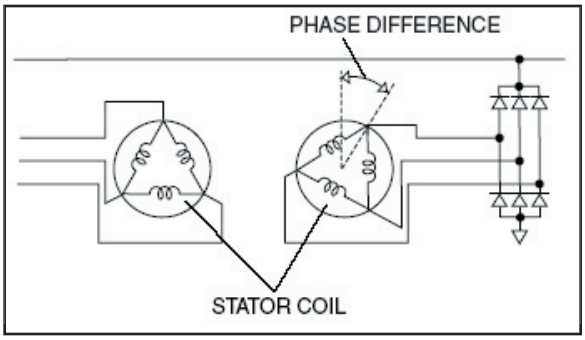


- A zirconium element is used on the sensor. When there is a difference between the oxygen concentration inside and outside the element, electromotive force is generated by the movement of oxygen ions (inside of the zirconium element: atmosphere, outside: exhaust gas). The electromotive force changes significantly at the boundary of the stoichiometric air/fuel ratio (A/F=14.7). The PCM receives the voltage generated from the HO2S directly, and increases or decreases the fuel injection amount by the fuel injection control so that it is close to the stoichiometric air/fuel ratio.

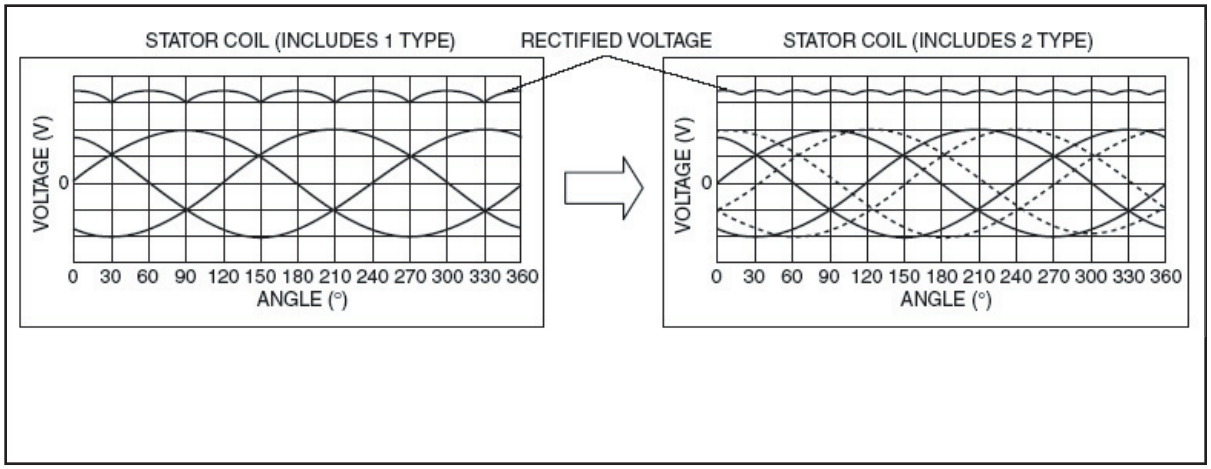
- When the temperature of the zirconium element is low, electromotive force is not generated. Therefore, the HO2S is heated by a built-in heater, facilitating the oxygen sensor activation. Due to this, the sensor is efficiently activated even immediately after cold-engine startup, and a stable sensor output can be obtained.



- The phase difference in the circuit of the two stator coils causes the electromagnetic pull between the rotor and the stator to be eliminated logically. Due to this, electromagnetic vibration and generator operation noise (electromagnetic noise) have been reduced.



- The pulsation occurring through voltage rectifying is minimized, as a result, stable voltage output is supplied due to the adoption of two stator coils with the phase



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02 SUSPENSION

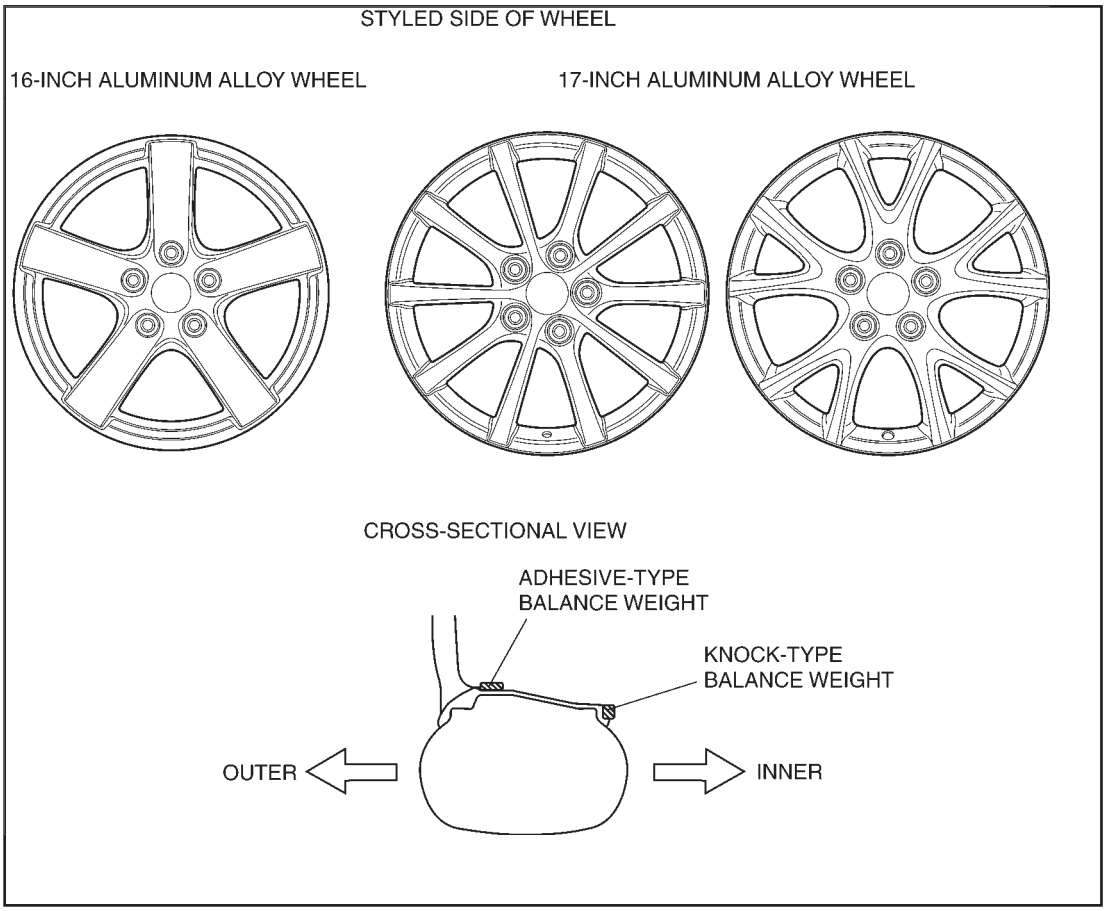
Objectives

After completing this section, you will be able to:

- Explain the operation of run-flat tires.
- Explain the operation of the front suspension system.

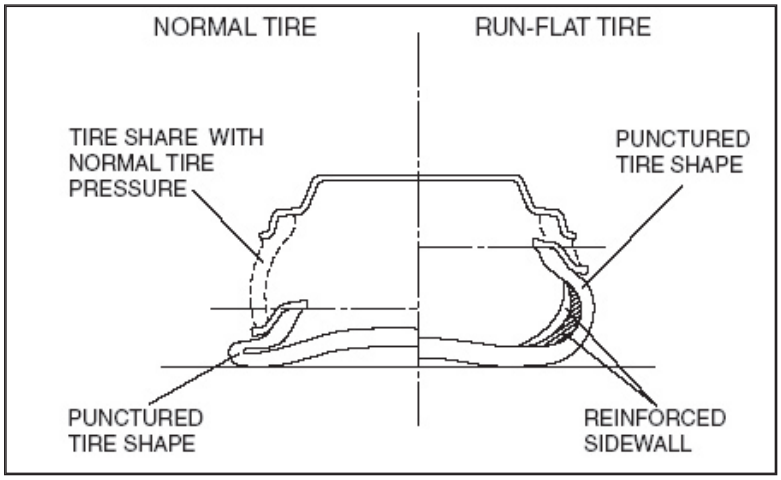
What's in this section:

Wheels and Tires Structural View



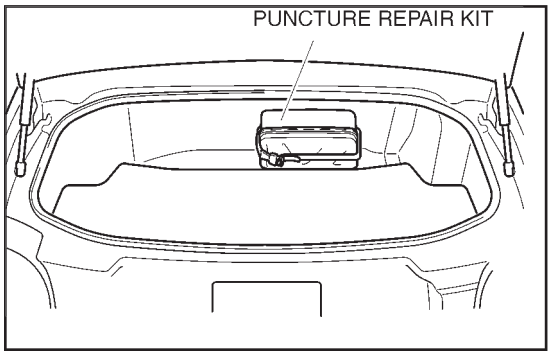
Wheels and Tires

Run-flat Tires Outline



- Because the run-flat tire sidewalls have been reinforced, vehicles with run-flat tires can be driven for 80 km (49.6 mile) at 89 km/h (55.2 MPH) even with air leakage caused by tire damage.

Puncture Repair Kit Outline

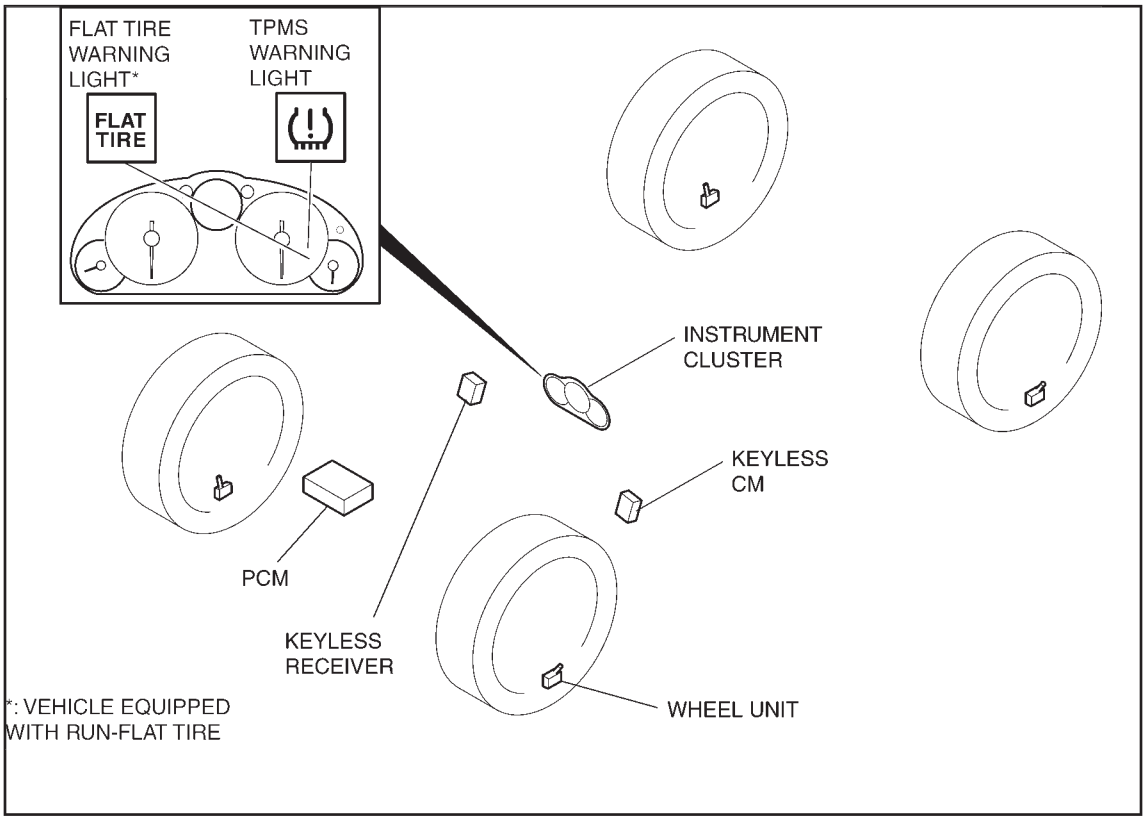


- Vehicles not equipped with run-flat tires have an emergency puncture repair kit. This kit enables temporary repair of a puncture without tire removal.

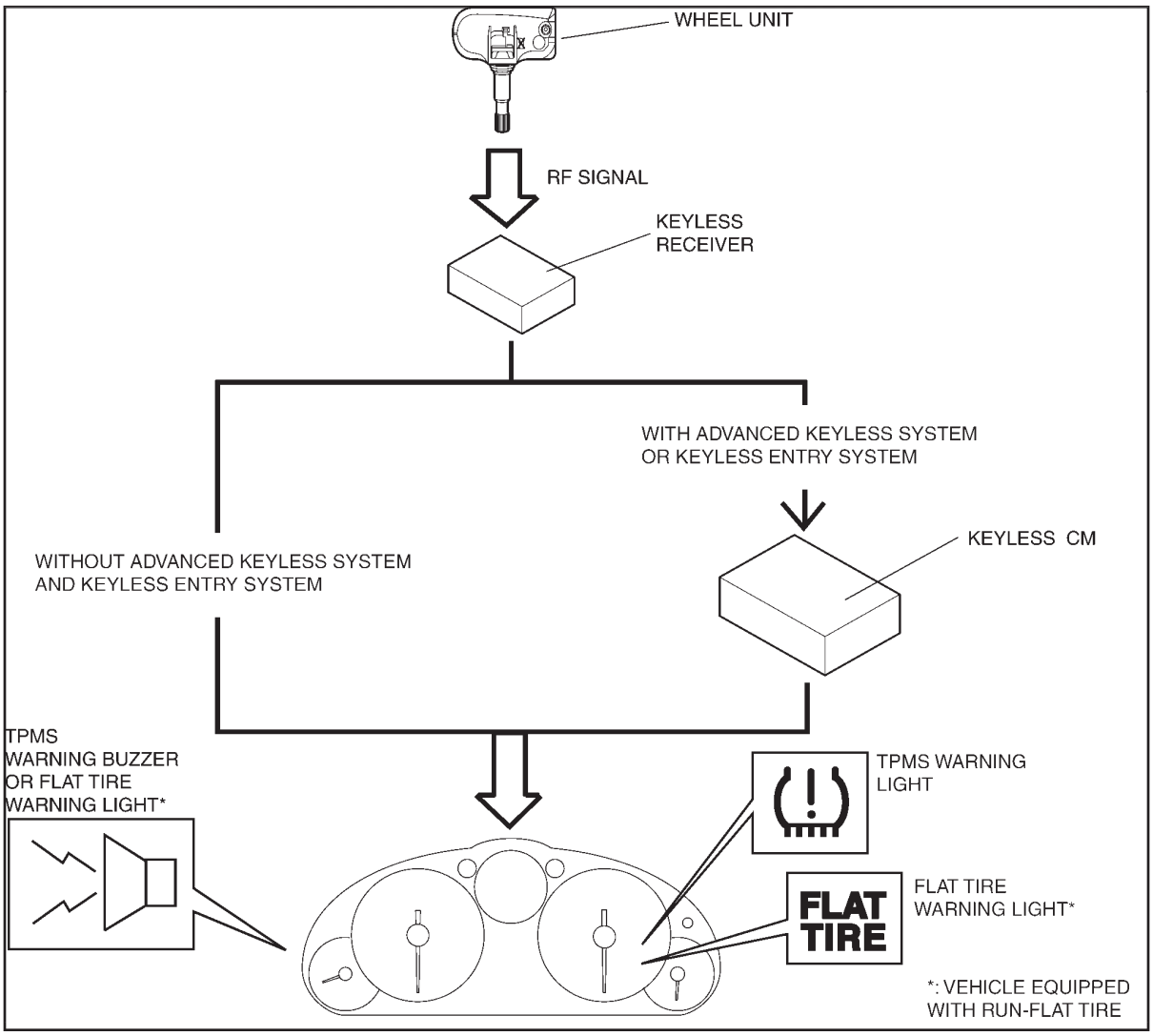
- The emergency puncture repair kit is located in trunk compartment and includes the following:
  - — Repair agent
  - — Repair agent filler hose
  - — Air compressor
  - — Tire valve core
  - — Tire valve core tool
  - — Instruction manual
  - — Speed limit label
  - — Filled tire indication label

- The accessory socket (12 V DC) is used as an input power source for the air compressor and the compressor plug includes a 10 A fuse.

Tire Pressure Monitoring System (TPMS) Structural View



TPMS Construction

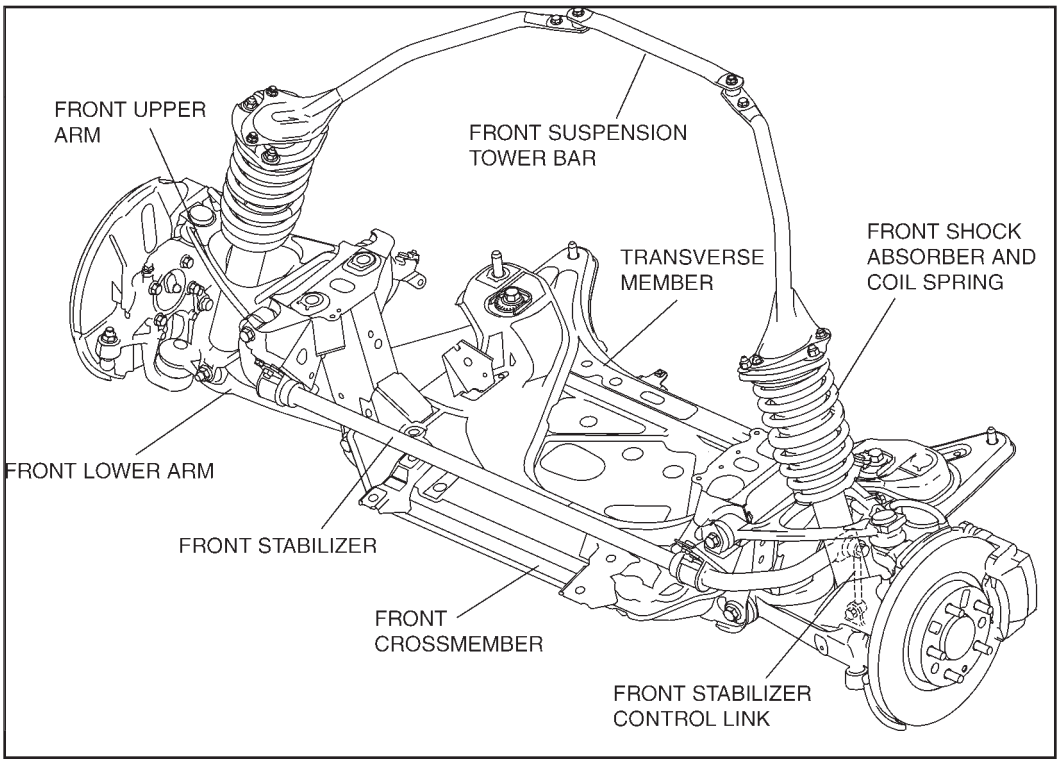


- The TPMS consists of wheel units that detect air pressure, temperature and acceleration of each tire, and a TPMS control module that receives data (RF signals) sent from the wheel units to monitor the air pressure of each tire.

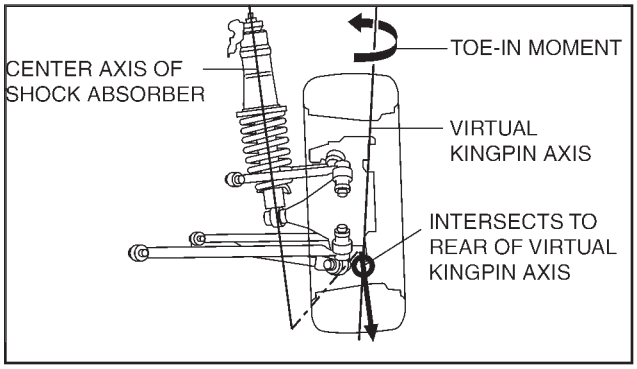
Front Suspension Outline

- The front upper arm and the front lower arm have been lengthened and attached to the highly rigid front crossmember to allow for linear alignment changes during jounce and rebound of the front wheels. This improves handling performance

Front Suspension Structural View

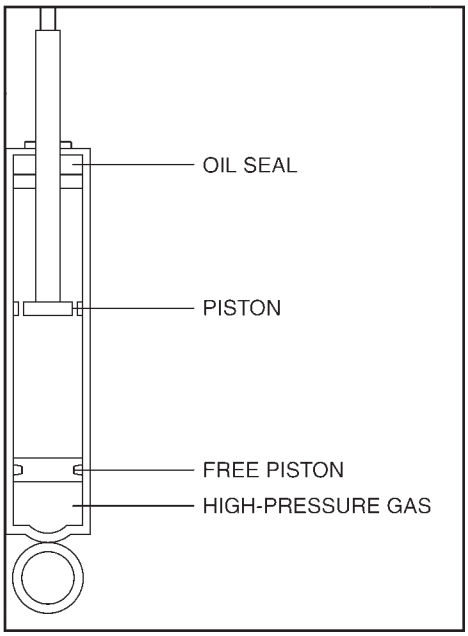


Double Wishbone Front Suspension Construction



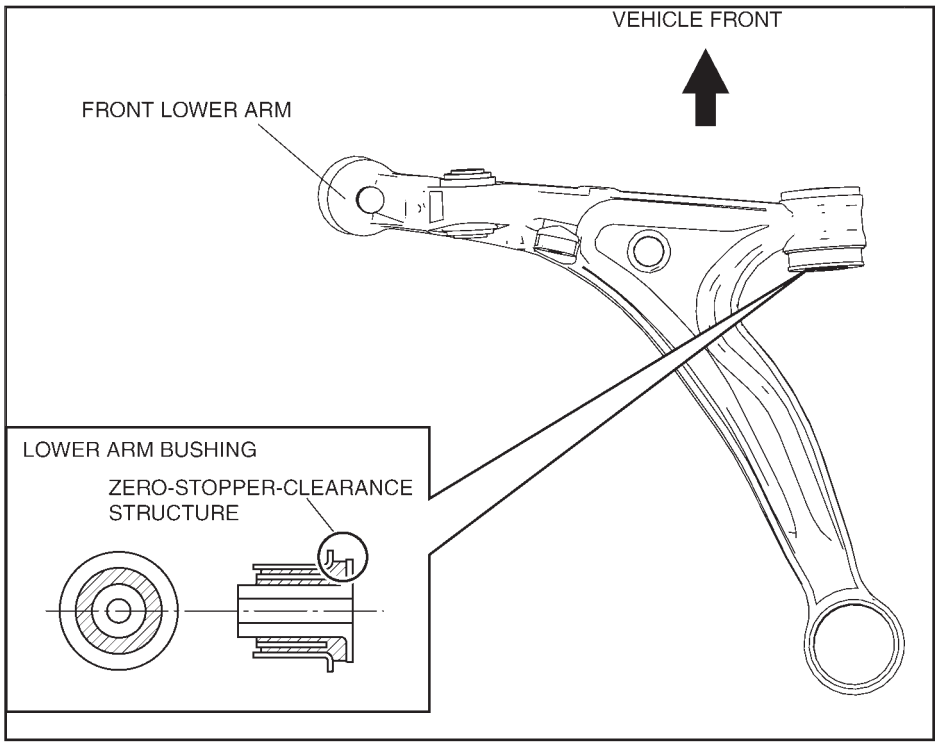
- The heightened damper lever ratio has improved the efficiency of shock absorber operation.
  — Damper lever ratio: shock absorber stroke (B)/wheel vertical stroke (A)
  — The heightened damper lever ratio has made it possible to provide a damping force even during minute strokes. As a result, excellent roadholding is exhibited in a variety of driving conditions.

Front Shock Absorber Construction



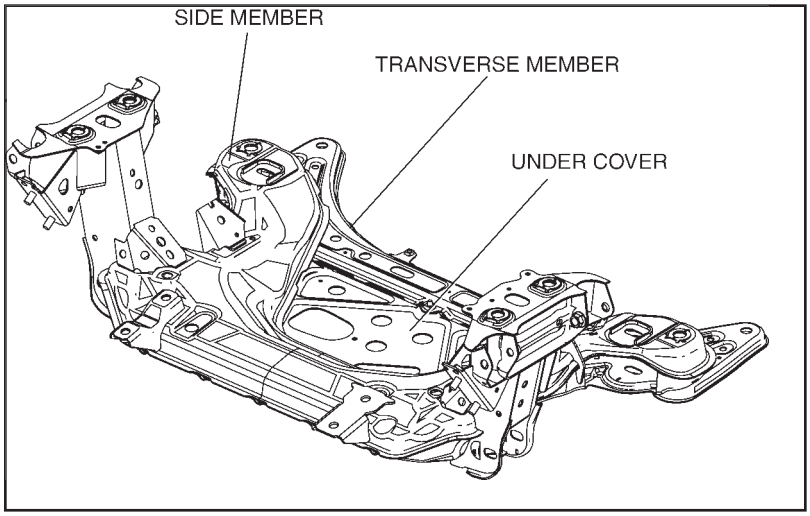
- The high-pressure gas-filled monotube shock absorber minimizes cavitation and provides stable damping force even during hard driving.
  — The large-diameter piston ensures superior response during minute strokes, providing consistent damping force and stroke feeling.
  — The enlarged piston port area also contributes to the improvement of riding comfort.

Front Lower Arm Construction



- The front lower arm is made of aluminum for rigidity and weight reduction.
- As with the front upper arm, the zero-stopper-clearance bushings optimize control over changes in vehicle behavior.

Front Crossmember Construction



- A lightweight, highly rigid front crossmember with integrated side members has been adopted.

- The transverse member is attached to the back of the front crossmember to create a highly rigid square construction.

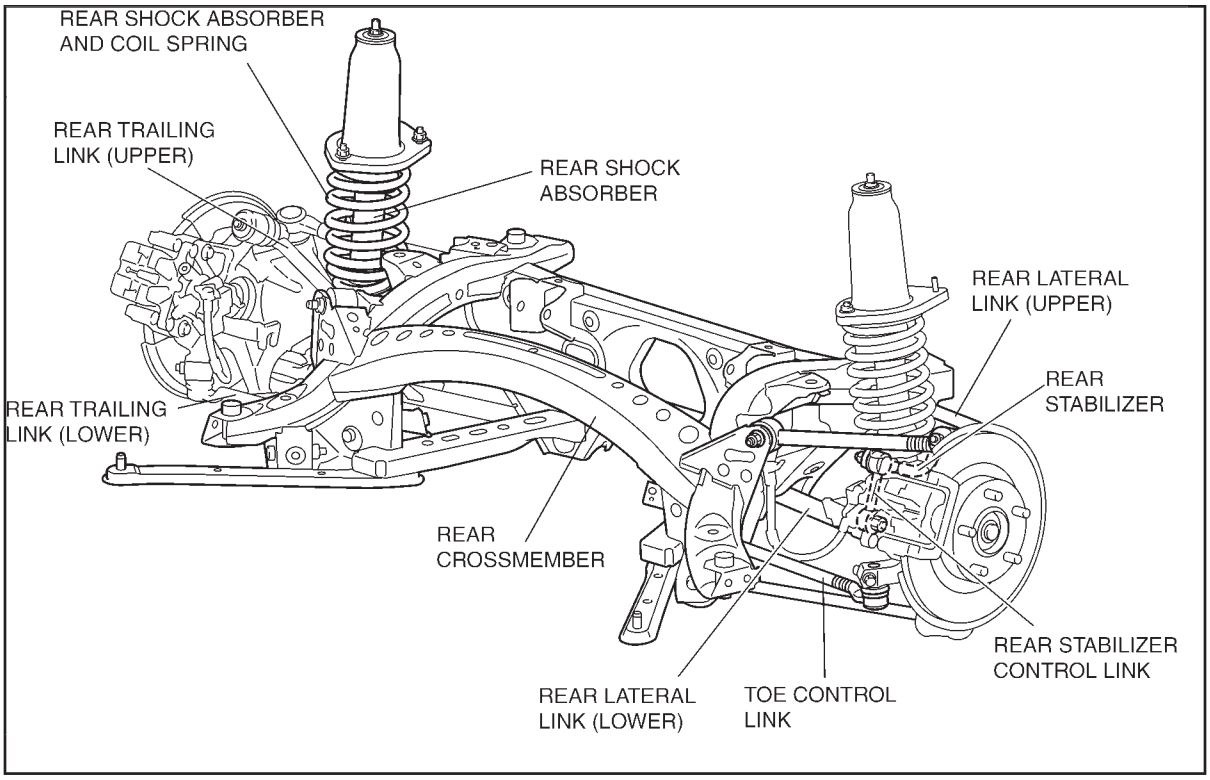
- This front crossmember component is rigidly mounted to the vehicle body at eight points, providing an extremely large amount of suspension support stiffness and alignment precision.

Rear Suspension

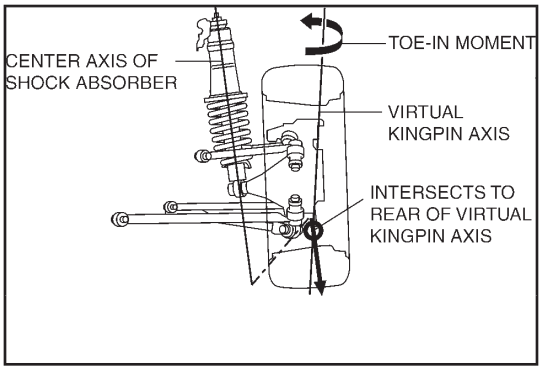
Rear Suspension Outline

- The MX-5 Miata has a multi-link suspension composed of five links.
- The links have been lengthened and optimally positioned. Due to this, they constantly provide ideal geometry to respond to external forces applied during driving, improving handling stability and riding comfort, and reducing road noise.

Rear Suspension Structural View



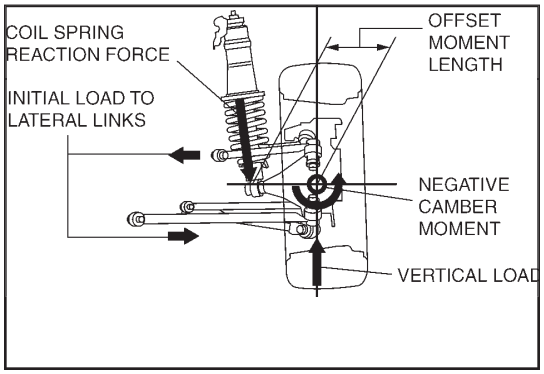
Multi-link Rear Suspension Construction



Optimized Link and Shock Absorber Layout

Compliance toe control

- The suspension system layout is such that the center axis line of the shock absorber intersects to the outside and rear of the virtual kingpin axis. This layout ensures that the toe-in moment is constantly produced around the virtual kingpin axis of the rear wheels. Due to this, the rear wheels constantly and securely provide a high level of gripping power.

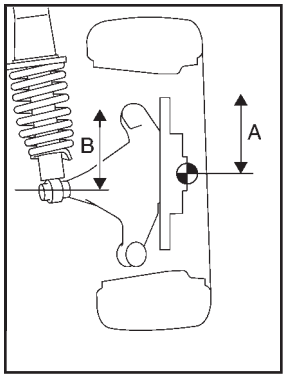


Compliance camber control

- Initial load in the negative camber direction is applied to the rear lateral links (upper/lower). Because of this, the bushings anchoring the rear lateral links (upper/lower) to the rear crossmember are constantly pressed toward the rear lateral links. As a result, the central, nonsensitive region of the bushing is not used, thereby minimizing delayed steering response and suppressing parasitic (unnecessary) wheel movement in response to external disturbances.

Elongated links

- Elongated upper and lower rear lateral links have been adopted. They reduce torsion applied to the bushings on the rear crossmember side during jounce and rebound of the rear wheels, providing smooth link behavior.



- The damper lever ratio has been set at approximately 1 to improve the efficiency of shock absorber operation.
  — Damper lever ratio: shock absorber stroke (B)/wheel vertical stroke (A)
  — A layout with the damper lever ratio close to 1 makes it possible to provide a damping force even during minute strokes. As result, excellent roadholding is exhibited in a variety of driving conditions.

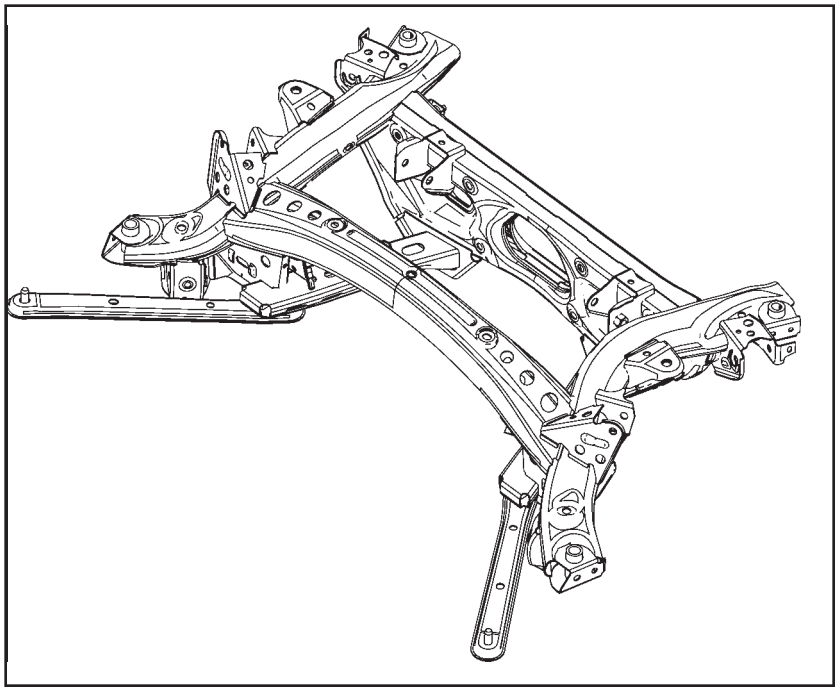
Rear Shock Absorber Construction

- As with the front shock absorber, a high-pressure gas-filled monotube shock absorber has been adopted.

- Placement of the rear coil springs below floor level reduces lateral spring force on the damper rods and thereby minimizes friction.

- This layout also contributes to an enlarged trunk compartment space.

Rear Crossmember Construction



- Adoption of a six-point mounting system rear crossmember ensures link support stiffness and isolates vibration, improving riding comfort and reducing road noise.

03 DRIVELINE/AXLE

Objectives

After completing this section, you will be able to:

- Explain the operation of the super LSD differential.
- Explain the operation of the Power Plant Frame (PPF).
- Perform a PPF height inspection and adjustment procedure.

What's in this section:

Activity	Title	Location
6	Power Plant Frame Height Inspection and Adjustment Procedure	Shop

Rear Differential Outline

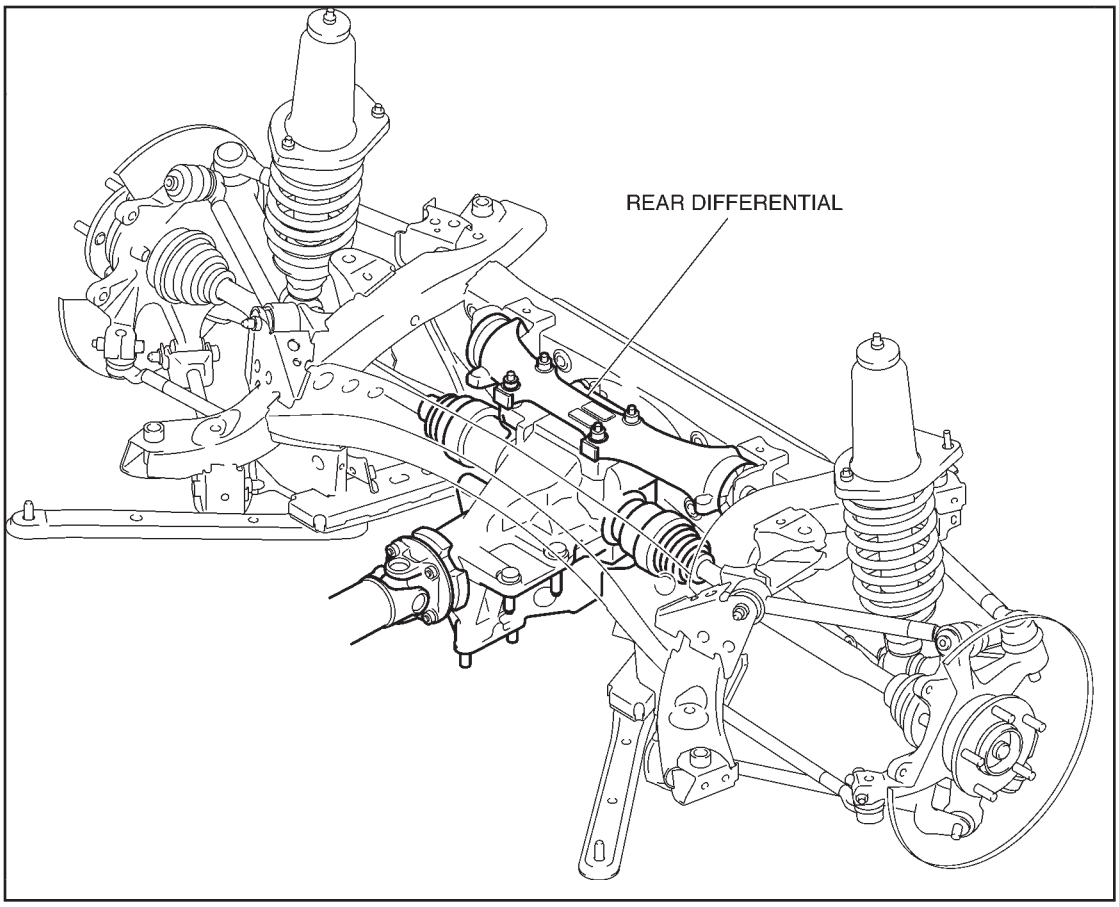
- For vehicles with limited-slip differential (LSD), a super-LSD with a low torque bias ratio* improves performance when starting from a standstill, driving straight-ahead and response.

*Torque bias ratio: When a wheel slips due to a low-traction surface, the LSD provides proportionally more torque to the opposite wheel. The torque bias ratio is the ratio of torque supplied to the right and left wheels in such cases, and represents the performance capability of the LSD.

- It is rigidly attached to the transmission with a power plant frame in order to enhance the feeling of direct drive when starting from a standstill and accelerating.

- A differential rear cover of aluminum alloy reduces weight.

Rear Differential Construction

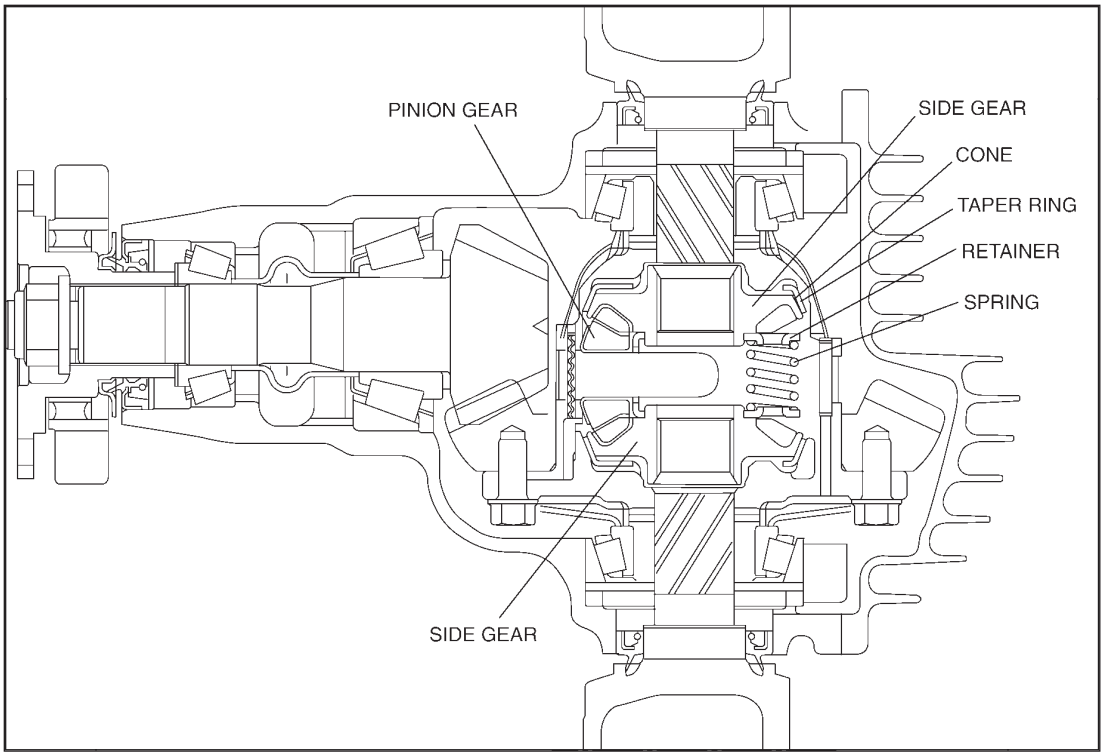


Super-LSD Outline

- The super-LSD is a torque-sensing type that provides improved driving stability due to the following characteristics:
  — Low torque bias ratio provides improved controllability (torque bias ratio: 2.0)
  — Creation of initial torque provides improved starting from a standstill and acceleration/deceleration response, and driving straight-ahead (initial torque: 49 N·m [5.0 kgf·m, 36 ft·lbf])
  — Simplified construction provides weight reduction

- The gear case component of the super-LSD cannot be disassembled.

Super-LSD Construction

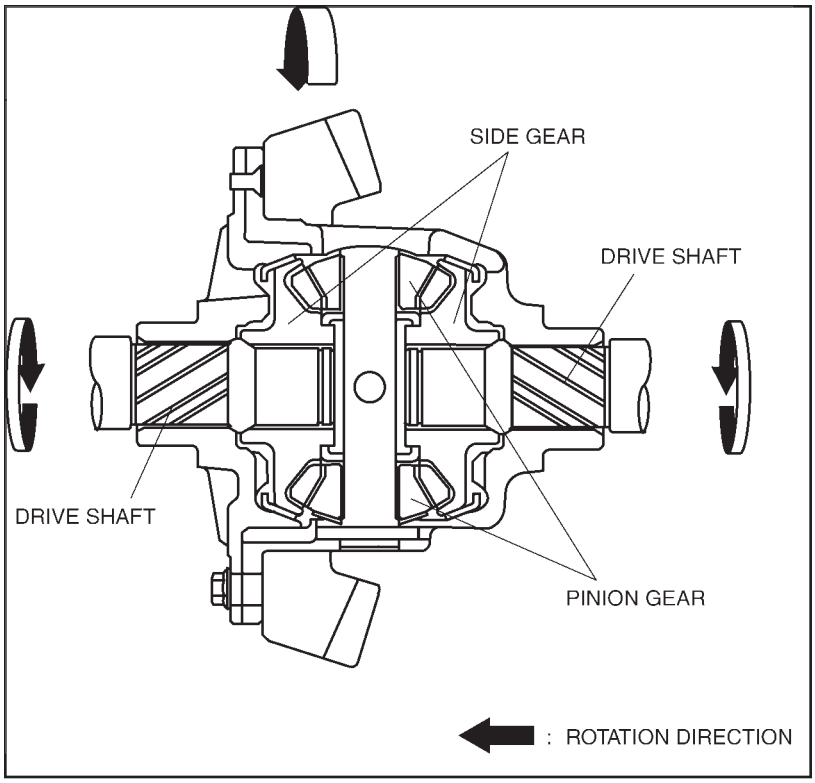


- Inside the super-LSD, taper rings that are fixed to the differential gear case have been placed between the differential gear case and the side gears. Additionally, a cone is provided around the outer surface of the side gear.

- Springs and retainers are positioned between the right and left side gears to provide initial torque to the taper rings.

Super-LSD Operation

Straight ahead driving

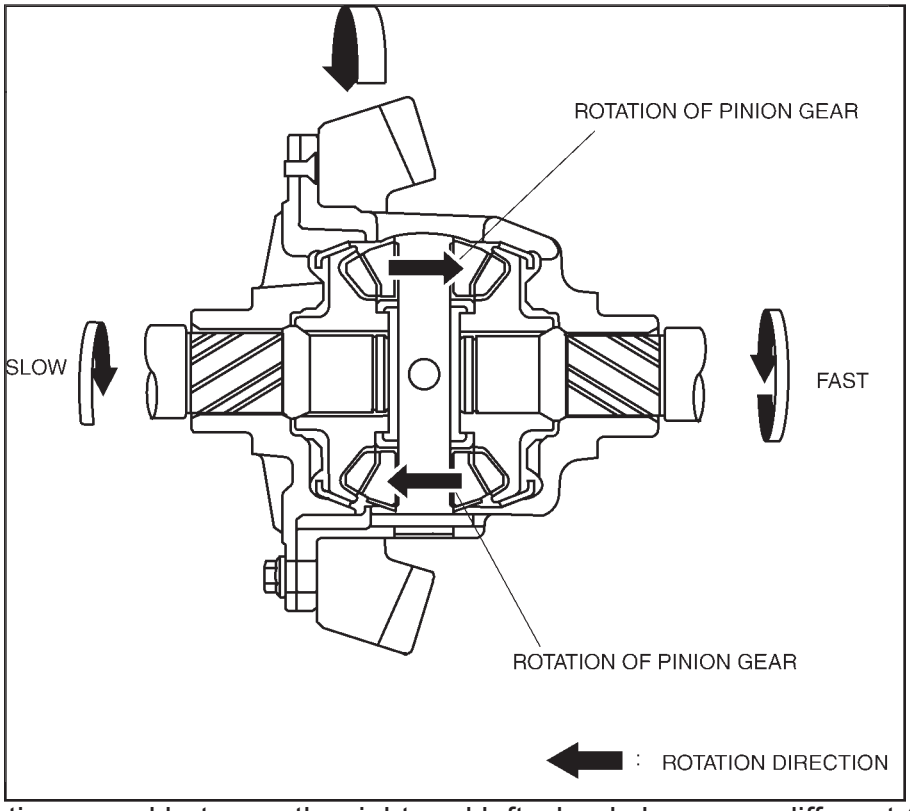


- When driving straight, the right and left side gears rotate at the same speed, and the pinion and side gears rotate together with the differential gear case. Input force from the ring gear is transmitted to the pinion gears via the gear case and to the drive shaft via the side gears. Due to this, a speed difference between right and left in the differential does not occur.

(continued)

Super-LSD Operation (continued)

Differential operation

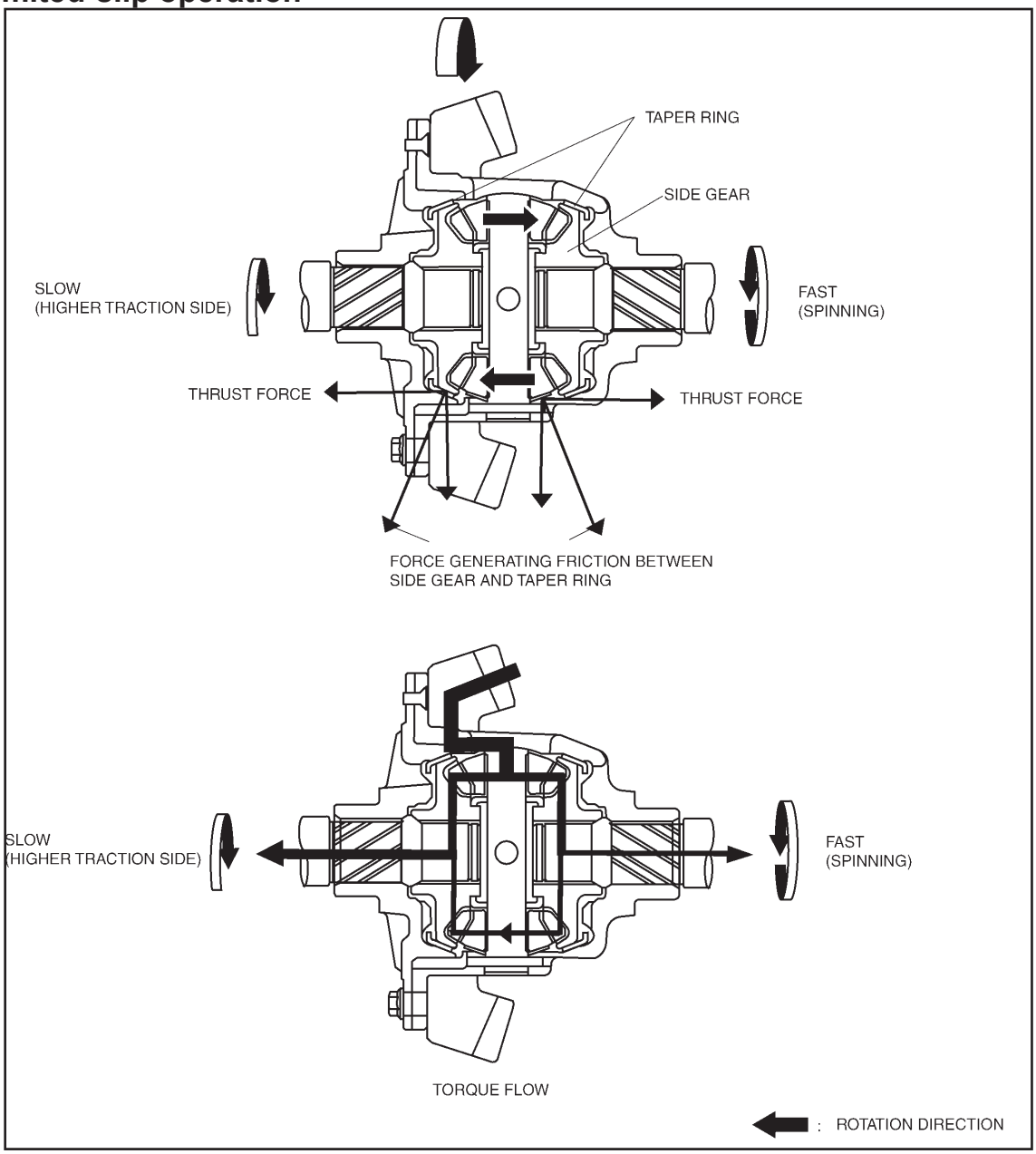


- If the rotation speed between the right and left wheels becomes different (during normal driving), the pinion gears rotate together while revolving around the center axle of the drive shaft, thereby absorbing the difference in rotation speed. This mechanism serves as a differential.

(continued)

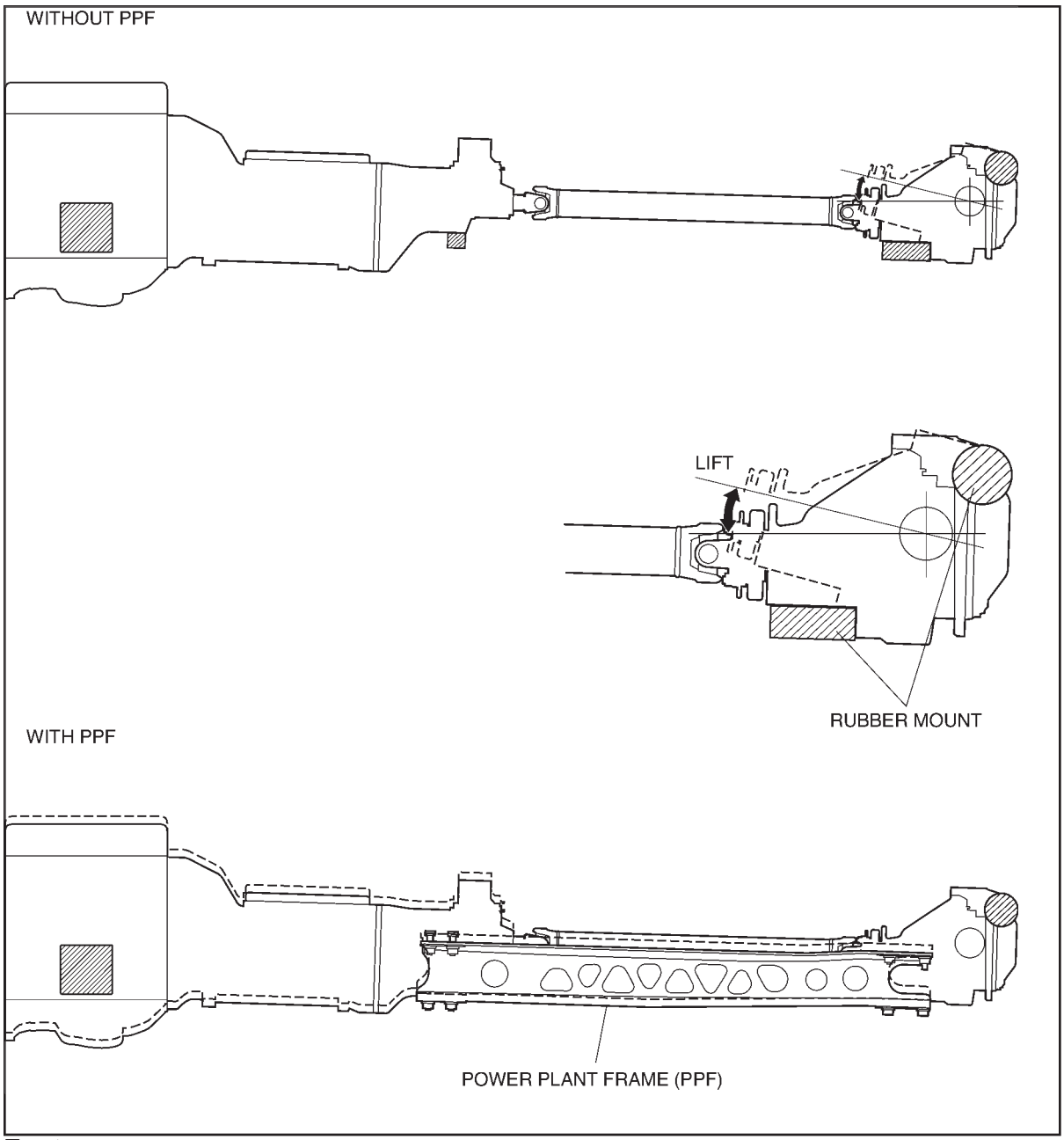
Super-LSD Operation (continued)

Limited-slip operation



- If the differential encounters a condition requiring limited-slip control such as wheel spin, thrust force acts on the side gears due to the reaction force from the meshing of the pinion and side gears. This thrust force presses the side gears against the taper ring, generating friction between the side gear cone and the taper ring and reducing the torque of the slipping wheel. The reduced torque is transmitted without change to the wheel with higher traction, and the limited slip differential function is provided. The torque transmitted to the wheel with higher traction is proportionate to the input torque of the ring gear.

Power Plant Frame (PPF) Function



Features

- The power plant frame (PPF) maintains rigidity with a bracket installed between the transmission and the differential. Due to this, the shift feeling is solid and it creates a feeling of direct drive when starting from a standstill or accelerating.

(continued)

Power Plant Frame (PPF) Function (continued)

Vehicle without PPF

— In order to suppress excessive transmission vibration to the vehicle body, rubber mounts connect the differential to the frame. When accelerating rapidly, the front part of the differential lifts upward which causes a time lag in the actual engine torque being transmitted to the tires and direct drive feeling is lost.

Vehicles with PPF

— With PPF, the transmission and differential are joined in a single unit which, even though the differential can be separated from the body, time lag is lessened due to the near elimination of lift, creating a feeling of direct drive. Furthermore, the PPF reduces shock and vibration during acceleration and deceleration.

04 BRAKES

Objectives

After completing this section, you will be able to:

- Explain the operation of the Anti-lock Brake System (ABS) and Dynamic Stability Control (DSC) system.
- Identify components of the Anti-lock Brake System (ABS) and Dynamic Stability Control (DSC) system.

What's in this section:

On-board Diagnostic System Function (ABS, Dynamic Stability Control)

Malfunction Detection Function

- The malfunction detection function detects malfunctions in the input/output signal system of the ABS HU/CM (vehicles with ABS) or DSC HU/CM (vehicles with DSC) when the ignition switch is at the ON position.

- When the ignition switch is turned to the ON position, the ABS Control Module performs the following malfunction detections.

ABS HU/CM

— The ABS and brake system warning lights illuminate for approximately 3 seconds when the ignition switch is turned to the ON position. At the same time, the fail- safe relay is operated and the input/output signals of each part is monitored for malfunction diagnosis. The first time the vehicle speeds exceeds 10 km/h (6.2 mph) or more, the control module operates the pump motor and performs a malfunction diagnosis.

DSC HU/CM

— The ABS and brake system warning lights, DSC OFF and DSC indicator lights illuminate for approximately 3 seconds when the ignition switch is turned to the ON position. At the same time, the fail-safe relay is operated, and the input/output signals of each part is monitored for malfunction diagnosis. The first time the vehicle speed exceeds 6.2 mph or more, the control module operates the pump motor and performs a malfunction diagnosis.

- When the control module detects a malfunction, the corresponding light illuminates to alert the driver. Using WDS, DTCs can be output through the DLC-2 lines. The control module also sends malfunction detection results to its memory and fail-safe function.

Memory Function

- The memory function stores DTCs of malfunctions in input/output signal systems. With this function, once a DTC is stored it is not cleared after the ignition switch has been turned off (LOCK position), even if the malfunctioning system has returned to normal.

- Since the ABS HU/CM or DSC HU/CM has a built-in non-volatile memory, DTCs are not cleared even if the battery is removed. Therefore, it is necessary to clear the memory after performing repairs. Refer to the Workshop Manual for the DTC clearing procedure.

On-board Diagnostic System Function (ABS, Dynamic Stability Control) (continued)

Fail-safe Function

- When the malfunction detection function determines a malfunction, each light illuminates to advise the driver. At this time, the fail-safe function controls the ABS, EBD, TCS* and DSC* as shown in the fail-safe function table.

* Only vehicles with DSC

CAUTION
If EBD control is suspended, the rear wheels could lock-up before the front wheels. If this occurs, the vehicle could swerve and become unstable. Therefore, always inspect the system immediately if EBD control is suspended.

Fail Safe Function Malfunction Contents (Vehicles with ABS)

- Refer to Service Highlights, page 04-02-4 to view the table.

Fail Safe Function Malfunction Contents (Vehicles with DSC)

- Refer to Service Highlights, page 04-02-5 to view the table.

On-board Diagnostic System PID/DATA Monitor Function (ABS/DSC)

- The PID/DATA monitor function is used for selecting input/output signal monitor items preset in the ABS HU/CM or DSC HU/CM and reading them out in real-time.

PID/DATA Monitor Table (Vehicles with ABS/DSC)

- Refer to Service Highlights, page 04-02-7 to view the table.

On-board Diagnostic System Active Command Modes Function (ABS/DSC)

- The Active command modes function is used for selecting active command modes items of input/output parts preset in the ABS HU/CM or DSC HU/CM and to operate them regardless of CM control.

- To protect the hydraulic unit interior, operate output related parts for only 10 seconds or less when using the active command modes function.

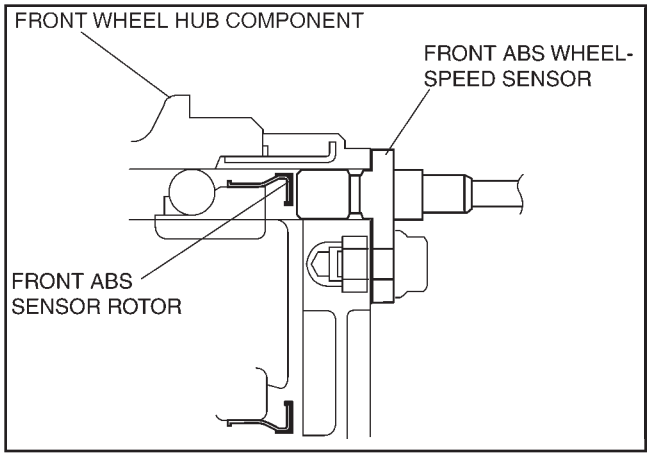
Active Command Modes Table (Vehicles with ABS/DSC)

- Refer to Service Highlights, page 04-02-8 to view the table.

(continued)

ABS Wheel Speed Sensor and ABS Sensor Rotor Construction Operation

Front Construction

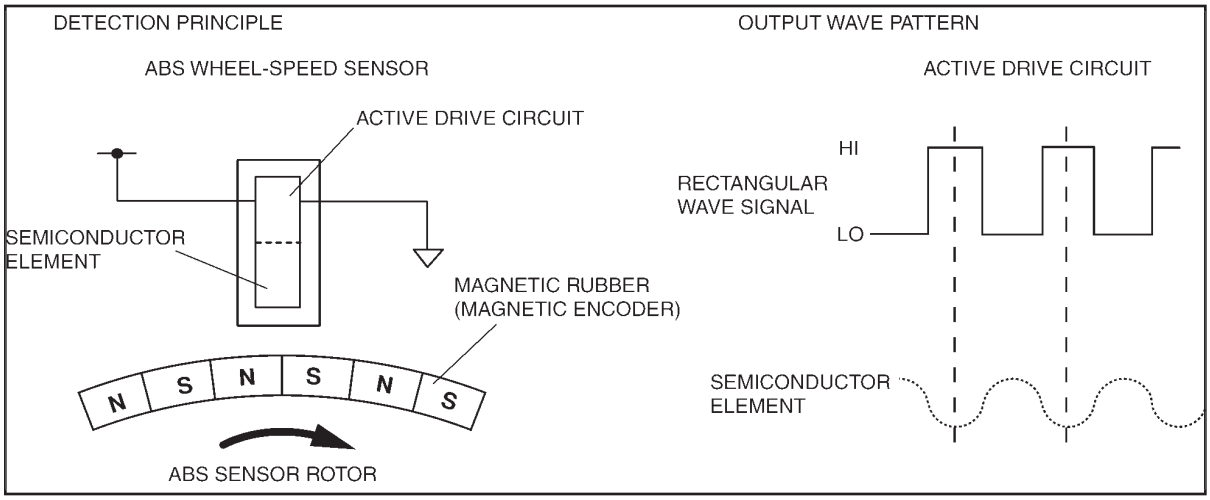


- The front ABS wheel-speed sensor utilizes a semi-conductor element that contains an active drive circuit (MR element*). The front sensor is installed on the front wheel hub.

- The front ABS sensor rotor utilizes a magnetic encoder system that functions with magnetic rubber and is integrated into the wheel hub component. Therefore, if there is any malfunction of the front ABS sensor rotor, replace the wheel hub component.

*: A magneto-resistive force means that an exterior magnetic field acts on the element, changing the resistance of the element.

Front Operation



- As the front ABS sensor rotor rotates, the magnetic flux between the front ABS wheel-speed sensor and the front ABS sensor rotor change periodically. This periodic change is in proportion to the rotation speed.

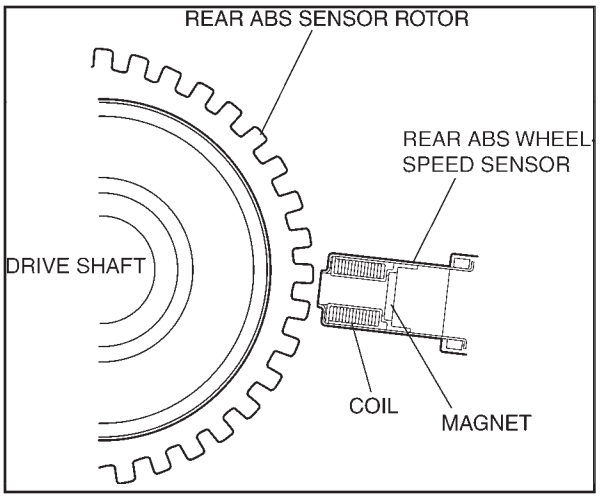
- The semiconductor element in the wheel speed sensor detects the change in magnetic flux and the active drive circuit converts it to a rectangular wave signal for the current, which is transmitted to the ABS HU/CM.

- For every single rotation of the ABS sensor rotor, 44 rectangular wave pulse signals are output. The CM in the ABS HU/CM calculates the wheel speed from the frequency of these pulses.

ABS Wheel Speed Sensor and ABS Sensor Rotor Construction Operation

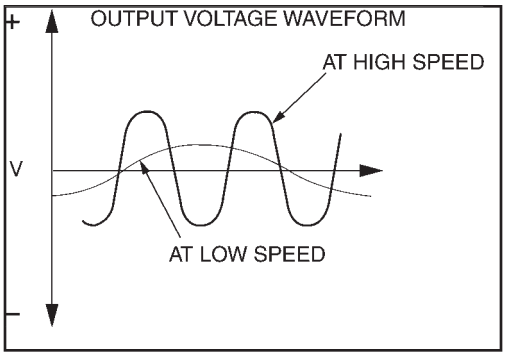
Rear Construction

- The rear ABS wheel-speed sensor is installed on the rear knuckle and the rear ABS sensor rotor is integrated with the drive shaft. Therefore, if there is any malfunction on the rear ABS sensor rotor, replace the drive shaft.



Rear Operation

- As the ABS sensor rotor rotates, magnetic flux formed from the permanent magnet varies and alternating current is formed with an electromagnetic conductor. Using this alternating current, rotation speed is expressed as a varying proportional cycle and from detection of this cycle the CM part of the ABS HU/CM can then detect the wheel rotation speed. While the structures of the front and rear ABS wheel-speed sensor differ, the operation is the same.



04 BRAKES

Dynamic Stability Control

Dynamic Stability Control (DSC) Outline

- The DSC HU/CM, integrates both the hydraulic unit (HU) and control module (CM), resulting in a size and weight reduction.

- A combined sensor, integrating both the yaw rate sensor and lateral-G sensor, improves serviceability.

- The controller area network (CAN) system improves serviceability and reliability for the steering angle sensor.

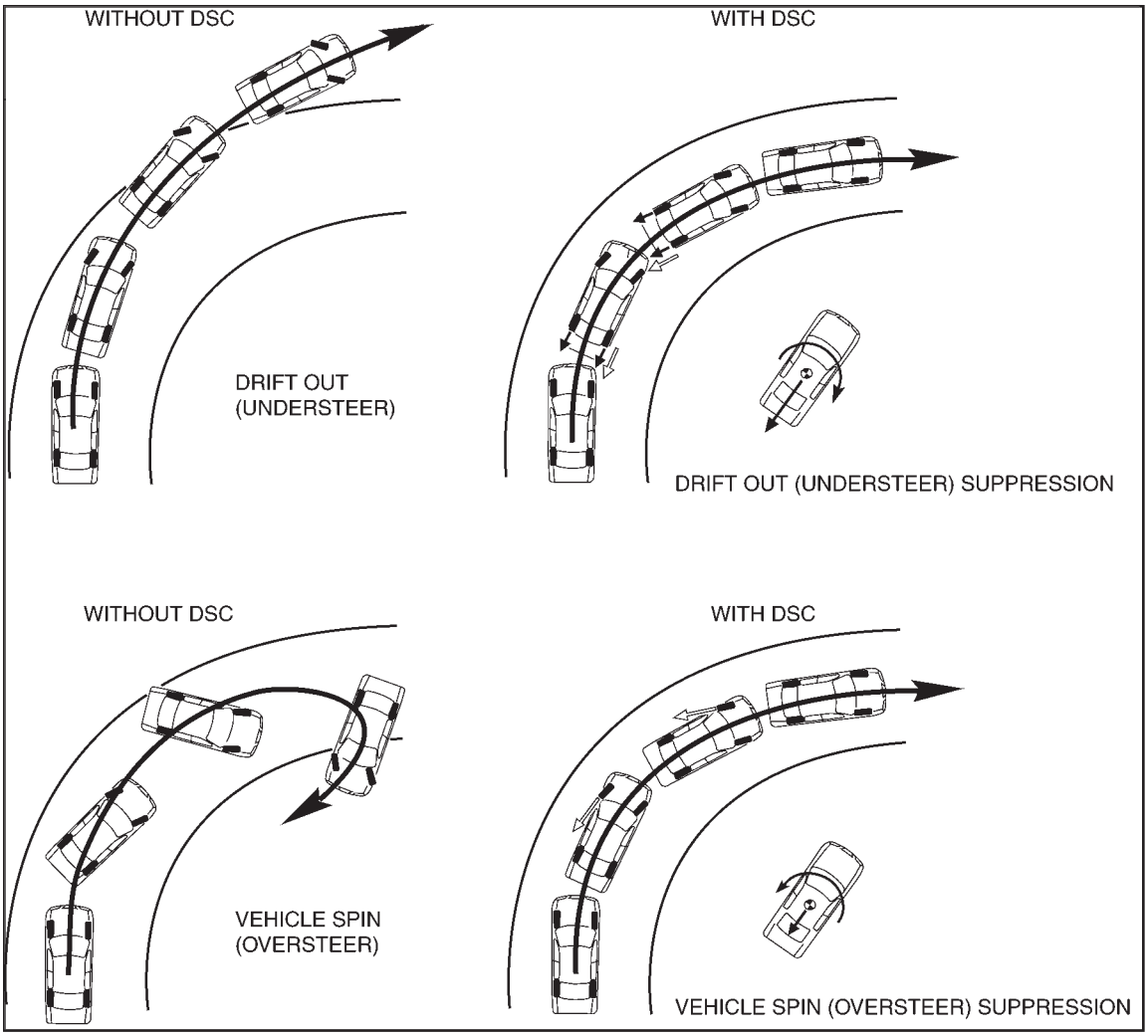
- An enhanced malfunction diagnosis system, used with the WDS improves serviceability.

DSC Operation Outline

- The ABS prevents wheel lock-up during braking. The TCS detects drive wheel spin due to the accelerator pedal being pressed too hard or similar causes and controls engine speed to suppress wheel spin. With these systems, safety is assured when driving or stopping.

- Additionally, the DSC controls sudden changes in vehicle attitude, due to evasive steering or road conditions. The DSC suppresses vehicle sideslip when driving due to vehicle spin (oversteer) or drift-out (understeer) by controlling braking and engine speed. At this time, the DSC indicator light illuminates to alert the driver that the DSC is operating due to a dangerous situation. As a result, the driver can calmly react and is provided leeway for the next maneuver, resulting in safe driving conditions.

Results of DSC Operation



CAUTION

• While the DSC is a steering safety system, it does not improve normal steering function. Therefore, always drive carefully, even if the vehicle has DSC, and do not overestimate the DSC capability.

• The DSC and ABS will not operate normally under the following conditions:
— With tires that are not of the specified size, manufacturer or tread pattern, or not inflated according to specification
— With tires that have significant comparative wear variation
— With tire chains

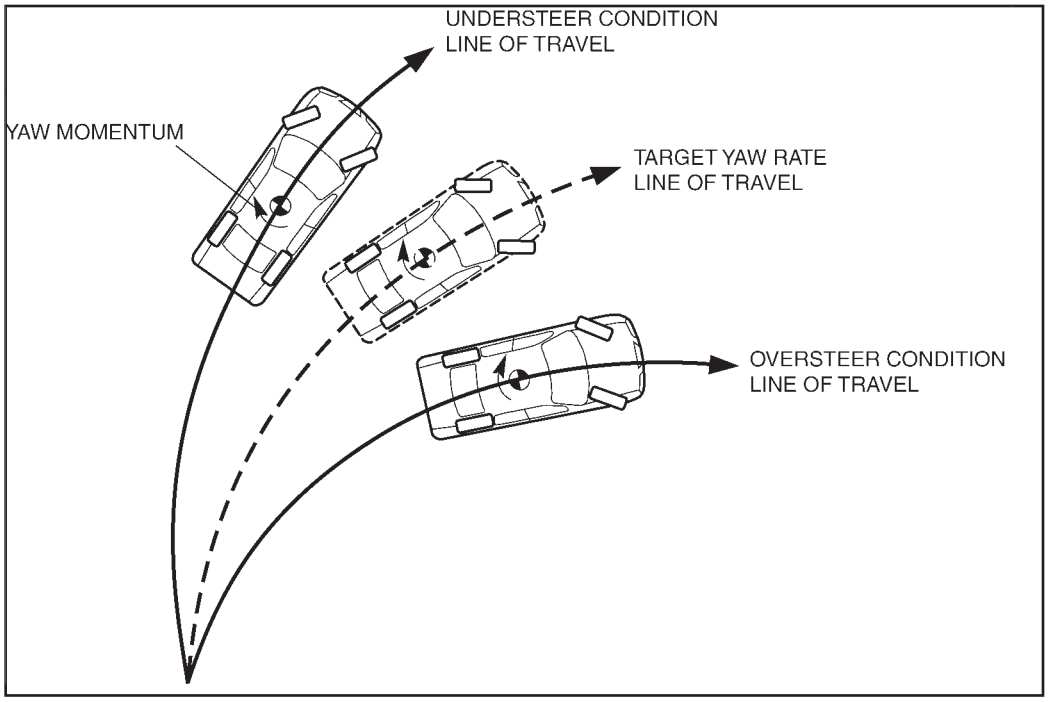
DSC Outline (continued)

- While a vehicle normally turns safely in response to steering operation, there are instances when the limits of tire lateral grip is surpassed due to road surface conditions or vehicle speed, and the influence of evasive steering to avoid an accident or similar situations.

- Tires surpassing lateral grip exhibit one of the following conditions:
  — Strong oversteer tendency: The rear wheels are relatively losing their grip as compared to the front wheels.
  — Strong understeer tendency: The front wheels are relatively losing their grip as compared to the rear wheels.

- DSC operates at vehicle speeds of 10 km/h (6.2 mph) or more in the conditions described above, controlling engine output and wheel braking to suppress oversteer and understeer tendencies.

Vehicle Condition Determination



- The vehicle speed, steering angle, lateral-G and yaw rate are detected by the sensors and used in calculations by the DSC HU/CM to determine the vehicle condition. Then, depending on the difference between the target yaw rate, calculated with the values input from each sensor, and the value detected by the yaw rate sensor, an oversteer or understeer tendency can be determined.

(continued)

Oversteer Tendency Determination

- When turning, if the actual vehicle yaw rate is larger than the target yaw rate (the yaw rate that should normally be formed as determined by the steering angle and vehicle speed), it means that the vehicle is in or about to be in a spin. Therefore the vehicle is determined to have an oversteer tendency.

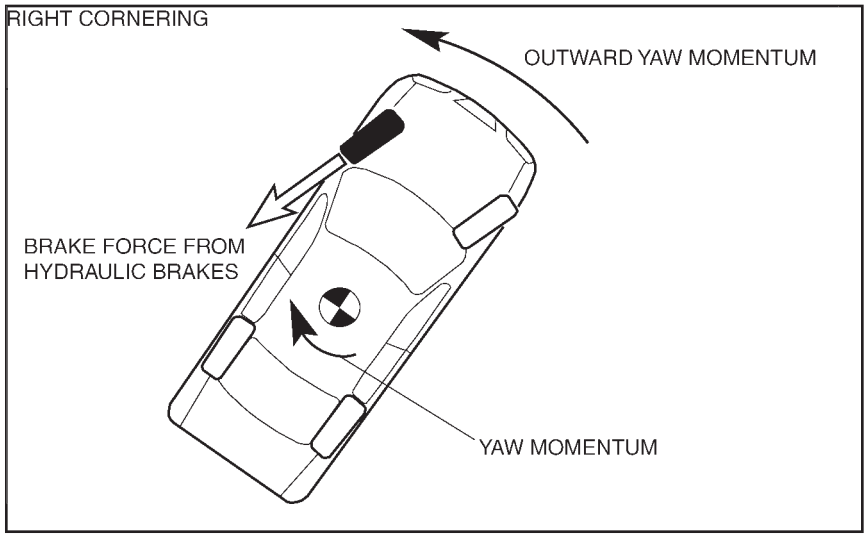
Understeer Tendency Determination

- When turning, if the actual vehicle yaw rate is less than the target yaw rate (the yaw rate that should normally be formed as determined by the steering angle and vehicle speed), it means that the vehicle is not properly turning. Therefore the vehicle is determined to have an understeer tendency.

DSC Operation

- When the DSC HU/CM determines that the vehicle has a strong oversteer or understeer tendency, engine output is lowered and, at the same time, it suppresses the yaw moment by affecting the braking of the front or rear wheels to inhibit the oversteer or understeer tendency.

Oversteer Tendency Suppression

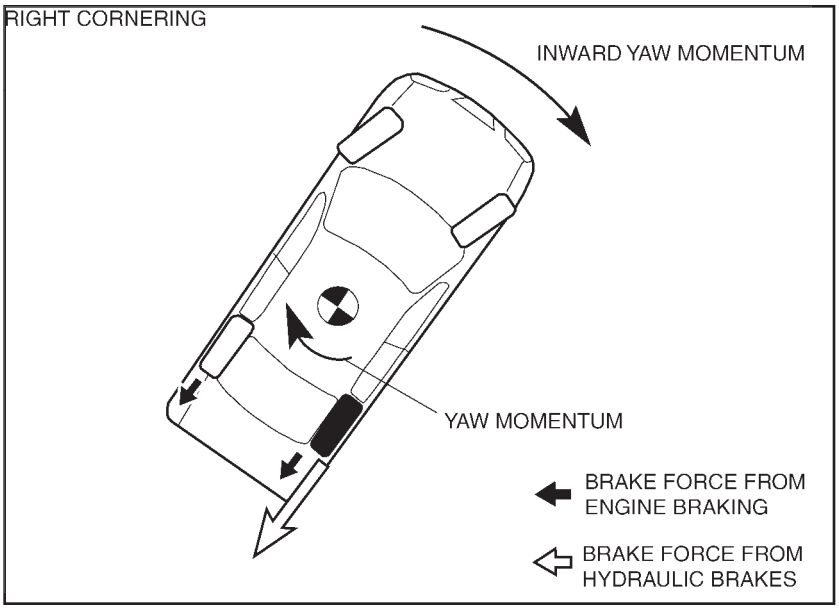


- When a large oversteer tendency is determined, braking is applied the outer front wheel according to the degree of the tendency. As a result, a yaw moment is formed towards the outer side of the vehicle and the oversteer tendency is suppressed.

(continued)

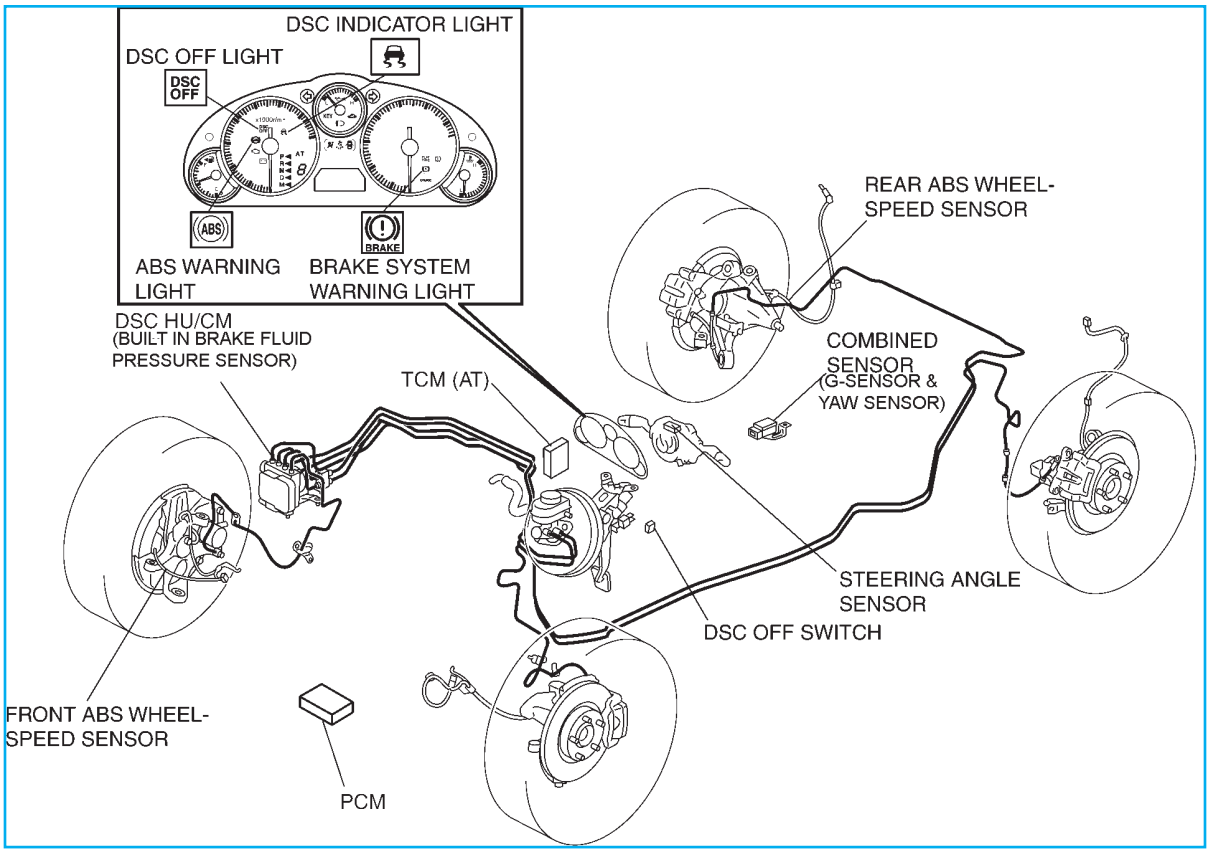
DSC Operation (continued)

Understeer Tendency Suppression



- When a large understeer tendency is determined, engine output is controlled and braking is applied to the inner front wheel according to the degree of the tendency. As a result, a yaw moment is formed towards the inner side of the vehicle and the understeer tendency is suppressed.

DSC Structural View



04 BRAKES

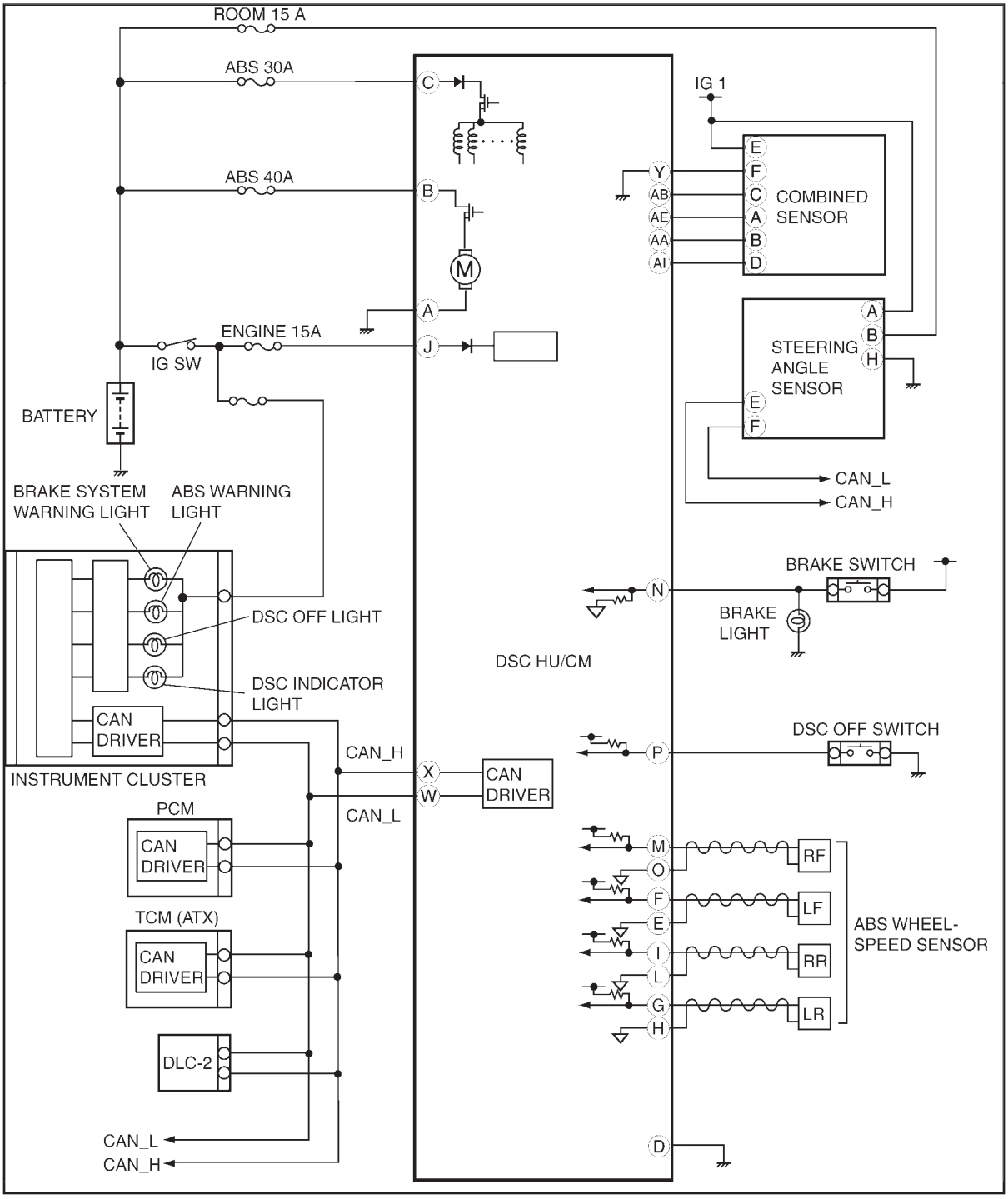
Dynamic Stability Control

DSC Construction

• The DSC system consists of the following parts. While each part has a regular function in other systems, only the function during DSC control is listed.

Part name	Function
DSC HU/CM	• Makes calculations using input signals from each sensor, controls brake fluid pressure to each wheel, and actuates each function (ABS, EBD, TCS and DSC) of the DSC system. • Outputs the torque reduction request signal, vehicle speed signal and DSC system warning control data via CAN lines. • Controls the on-board diagnostic system and fail-safe function when there is a malfunction in the DSC system.
PCM	• Controls engine output based on signals from the DSC HU/CM. • Transmits engine speed, tire and shift position data via CAN communication to the DSC HU/CM.
TCM (AT)	• Transmits gear/selector lever target position data via CAN communication to the DSC HU/CM.
DSC indicator light	• Informs the driver that the DSC is operating (vehicle sideslip occurring). • Informs the driver that the TCS is operating (drive wheel is spinning).
DSC OFF switch	• Transmits driver intention to release DSC control to the DSC HU/CM.
DSC OFF light	• Informs driver that DSC control has been released due to DSC OFF switch operation.
Wheel speed sensor	• Detects the rotation condition of each wheel and transmits it to the DSC HU/CM.
Combined sensor	• Detects the lateral-G (vehicle speed increase) and the yaw rate (vehicle turning angle) of the vehicle and transmits them to the DSC HU/CM.
Brake fluid pressure sensor	• Detects the fluid pressure from the master cylinder and transmits it to the DSC HU/CM.
Steering angle sensor	• Transmits the steering angle and steering angle sensor condition via CAN lines to the DSC HU/CM.

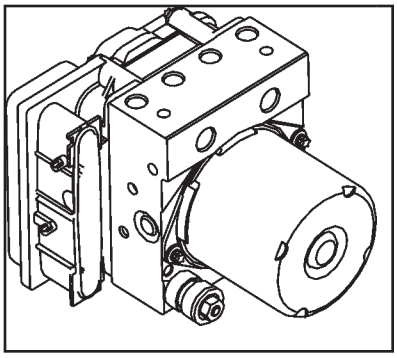
DSC System Wiring Diagram



Dynamic Stability Control

DSC HU/CM Construction

- A high reliability, reduced size and weight DSC HU/CM, integrates both the DSC HU and the DSC CM.



DSC HU Part Function

- According to DSC CM signals, the DSC HU controls (on/off) each solenoid valve and the pump motor, adjusts fluid pressure in each caliper piston, and actuates each function (ABS, EBD, TCS and DSC) of the DSC system.

DSC HU Part Construction/Operation

Construction

Function of main component parts

Part name	Function
Inlet solenoid valve	• Adjusts the fluid pressure in each brake system according to DSC HU/CM signals.
Outlet solenoid valve	• Adjusts the fluid pressure in each brake system according to DSC HU/CM signals.
Stability control solenoid valve	• Switches the brake hydraulic circuits during and according to normal braking, ABS and EBD control, TCS control and DSC control.
Traction control solenoid valve	• Switches the brake hydraulic circuits during and according to normal braking, ABS and EBD control, TCS control and DSC control.
Reservoir	• Temporarily stores brake fluid from the caliper pistons to ensure smooth pressure reduction during ABS and EBD control, TCS control and DSC control.
Pump	• Returns the brake fluid stored in the reservoir to the master cylinder during ABS and DSC control. • Increases brake fluid pressure and sends brake fluid to each caliper piston during TCS control and DSC control.

Operation

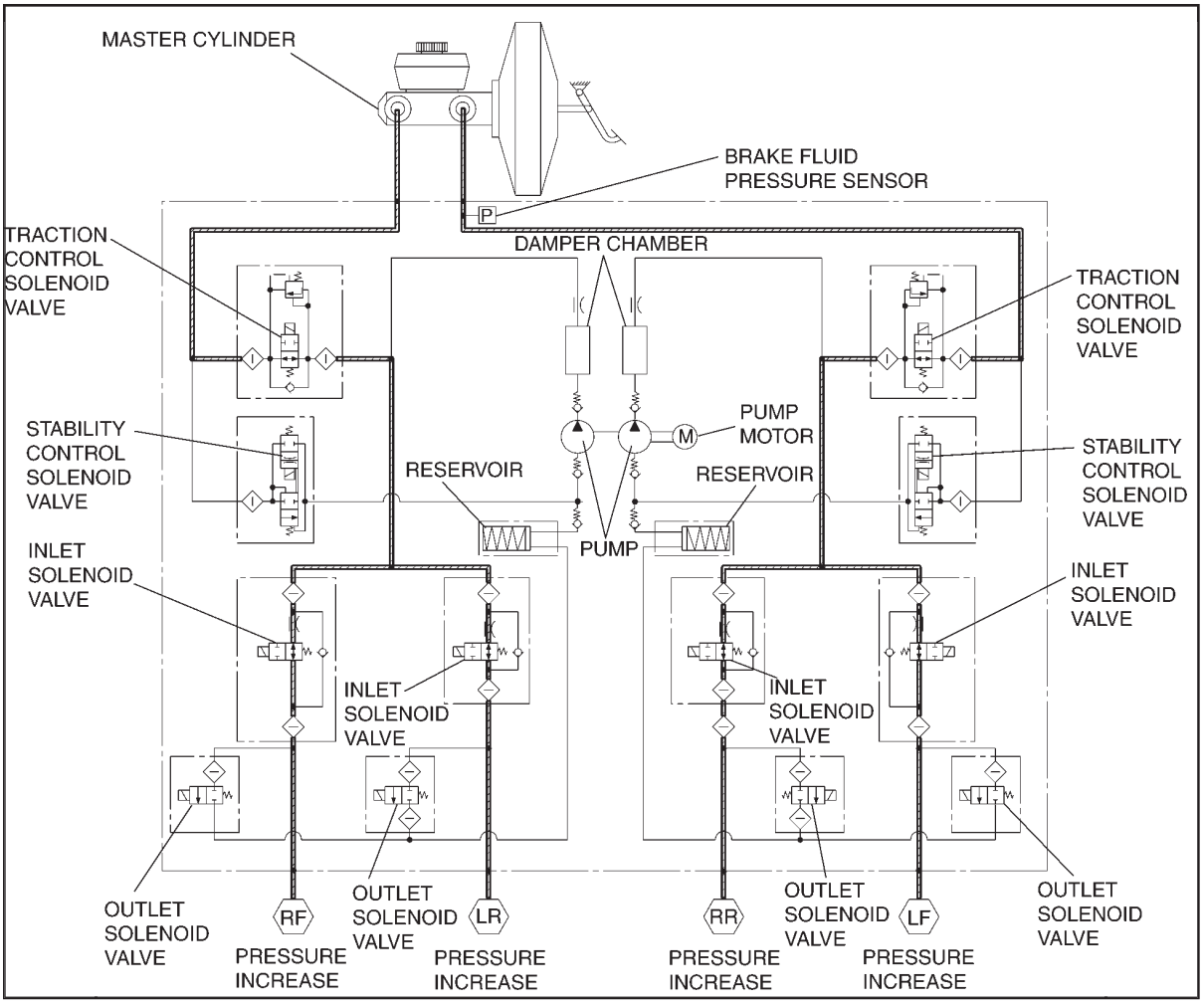
During normal braking

- During normal braking, the solenoid valves are not energized and all of them are off. When the brake pedal is depressed, brake fluid pressure is transmitted from the master cylinder, through the traction control solenoid valve and inlet solenoid valves, and then to the caliper pistons.

Solenoid valve operation table

- Refer to Service Highlights, page 04-15-7 to view the table.

Hydraulic circuit diagram



DSC HU Part Construction/Operation (continued)

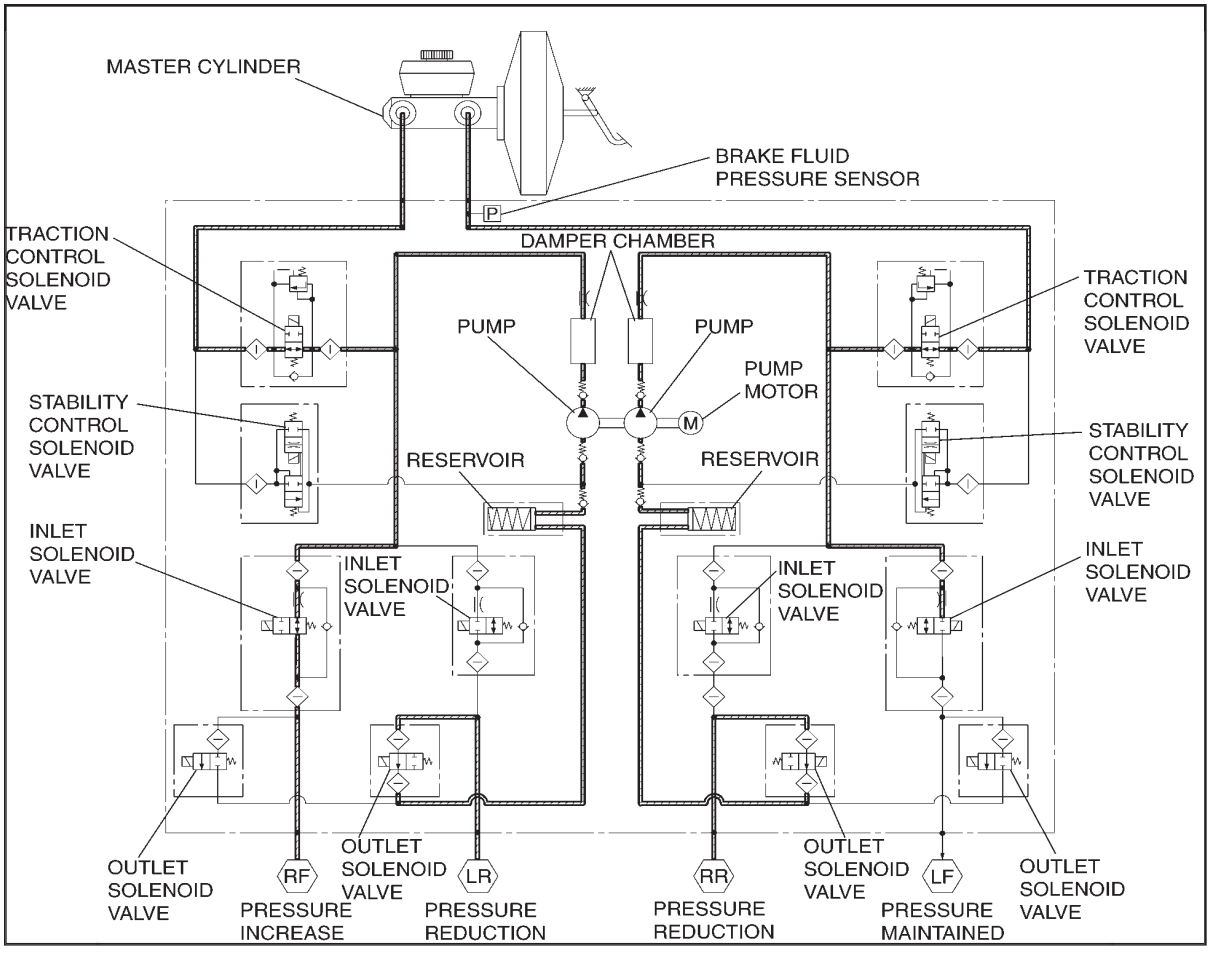
During ABS and EBD control

- During ABS and EBD control, when wheel lock-up is about to occur, the traction control solenoid valve and stability control solenoid valves are not energized, and the inlet and outlet solenoid valves are energized and controlled in three pressure modes (increase, reduction or maintain), thereby adjusting brake fluid pressure. Brake fluid during pressure reduction is temporarily stored in the reservoir and afterwards the pump motor operates the pump to return the fluid to the master cylinder. (The following figure shows these conditions: right front wheel pressure increased, left front wheel pressure maintained, and both rear wheels pressure decreased.)

Solenoid valve operation table

- Refer to Service Highlights, page 04-15-8 to view the table.

Hydraulic circuit diagram



(continued)

DSC HU Part Construction/Operation (continued)

During DSC control (suppress oversteer tendency)

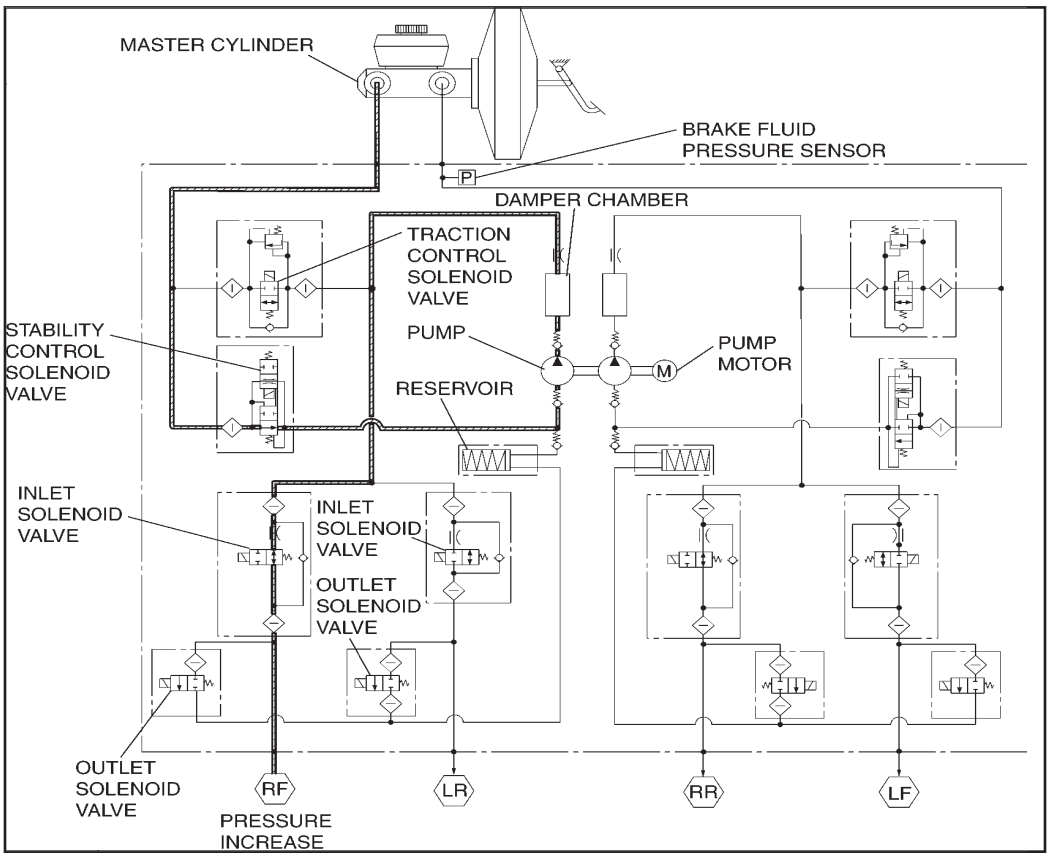
- When the control module detects a large oversteer tendency, it energizes the traction control solenoid valve and stability control solenoid valves to switch the hydraulic circuits. At the same time, control module operates the pump motor to supply brake fluid pressure from the reservoir to the outer front wheel cylinder. Also at this time, the control module energizes the inner rear wheel inlet solenoid valve and closes the hydraulic circuit to this wheel.

- After pressure increases, the pump motor adjusts brake fluid pressure using all three pressure modes (reduction, maintain, increase) to obtain the target wheel speed.

Solenoid valve operation table

- Refer to Service Highlights, page 04-15-9 to view the table.

Hydraulic circuit diagram



DSC HU Part Construction/Operation (continued)

During DSC control (to suppress understeer tendency) and TCS control

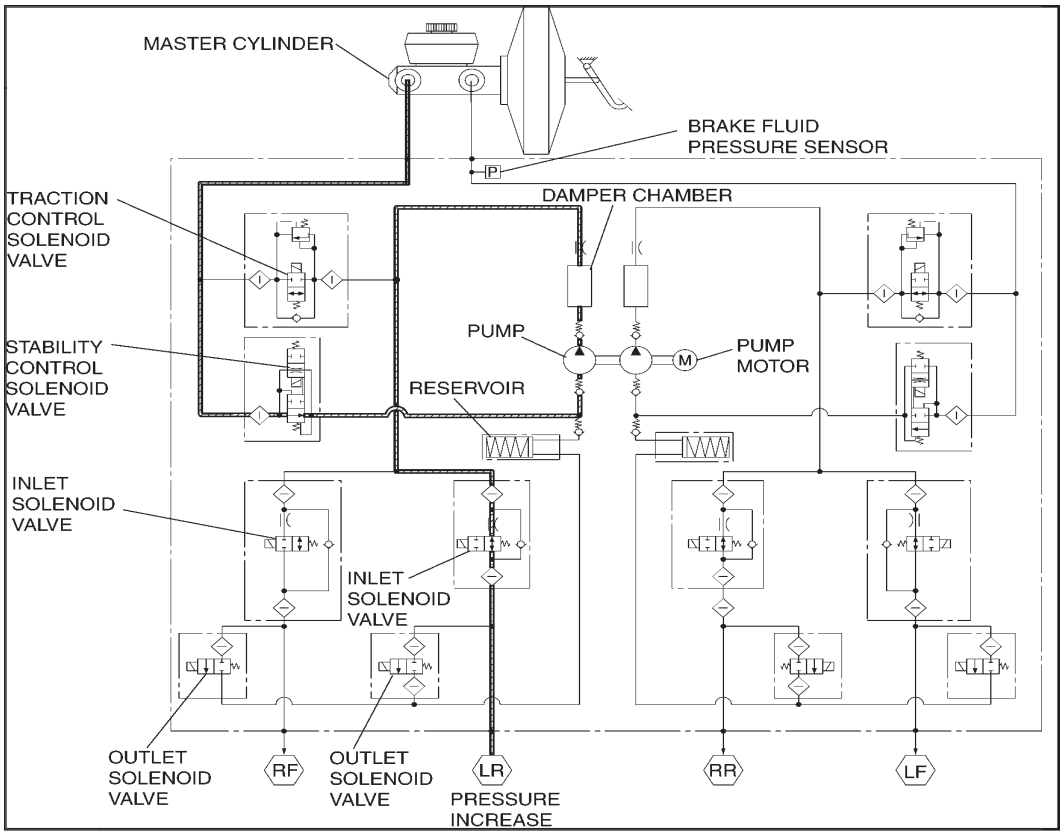
- When the control module detects a large understeer tendency, it energizes the traction control solenoid valve and stability control solenoid valves to switch the hydraulic circuits. At the same time, control module operates the pump motor to increase brake fluid pressure to the inner rear wheel caliper piston or slipping driving wheel. Also at this time, the control module energizes the outer front wheel inlet solenoid valve and closes the hydraulic circuit to the wheel.

- After a pressure increase, the pump motor adjusts brake fluid pressure using all three pressure modes (reduction, maintain, increase) to obtain the target wheel speed.

Solenoid valve operation table

- Refer to Service Highlights, page 04-15-10 to view the table.

Hydraulic circuit diagram



DSC CM Part Function

- The DSC CM makes calculations using signals input from each sensor, outputs a brake fluid pressure control signal to the DSC HU to actuate DSC system functions and outputs an engine output control signal to the PCM.

- The DSC HU/CM controls the following functions:

Function Table

- Refer to Service Highlights, page 04-15-10 to view the table.

Dynamic Stability Control

Controller Area Network (CAN) Outline

• The DSC HU/CM sends and receives data to and from other modules via the CAN system. Refer to Section 09 for a detailed explanation of the CAN system.

Data sent

- Traveled distance
- Brake system status
- Wheel speeds of all four wheels
- ABS wheel-speed sensor status
- Torque reduction request

Data received

- Engine speed
- Throttle valve opening angle
- Engine torque
- Torque reduction disabled
- Transmission/axle specifications
- Tire size
- Target gear position/selector lever position
- Steering angle
- Steering angle sensor status
- Parking brake position

ABS Wheel-speed Sensor Function

- The ABS wheel-speed sensor detects and transmits the rotation condition of each wheel to the DSC HU/CM.

- The signal from the ABS wheel-speed sensors is the primary signal for DSC HU/CM control.

ABS Wheel-speed Sensor Construction/Operation

- The construction and operation of the ABS wheel-speed sensor is the same as that of vehicles with ABS.

Combined Sensor Function

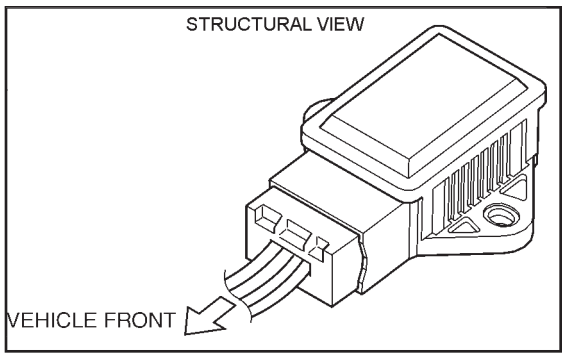
- A combined sensor, integrates the yaw rate and lateral-G sensors.

- The combined sensor, located in the floor under the rear console, detects the vehicle yaw rate (vehicle turning angular speed) and lateral-G and transmits them to the DSC HU/CM.

Combined Sensor Construction/Operation

- The combined sensor, with built-in yaw rate and lateral-G sensors, detects and calculates the vehicle yaw rate and lateral-G, converts them into voltage and transmits this to the DSC HU/CM.

- The output voltage characteristic for the combined sensor is 2.5 V when the vehicle is standing still, and changes accordingly as yaw rate and lateral-G are generated.



- The yaw rate sensor detects a Coriolis force created by, and in proportion to, the rotation speed of a rotating tuning fork.

- The lateral-G sensor detects an inertial force created by, and in proportion to, a G-force acting on a silicon detection component.

CAUTION

Coriolis force: When an object on a rotating disc attempts to move toward the center of the disc, force is produced at a right angle to the intended path of travel of the object. This results in the direction of movement being unchanged from its original point of departure, and the object does not reach the center. When looking at this effect from outside the disc, it appears as if a force is deflecting the object away from the center. This appearance of force is called a Coriolis force, and the object actually advances in a straight course.

04 BRAKES

Dynamic Stability Control

Brake Fluid Pressure Sensor Function

- The brake fluid pressure sensor detects the fluid pressure from the master cylinder and transmits it to the DSC HU/CM.

Brake Fluid Pressure Sensor Construction

- The brake fluid pressure sensor is integrated with the DSC HU/CM. Therefore, if there is any malfunction of the brake fluid pressure sensor, replace the DSC HU/CM.

Steering Angle Sensor Function

- The steering angle sensor, located on the combination switch, detects the steering angle degree and the neutral position, and transmits these to the DSC HU/CM via CAN lines.

WARNING

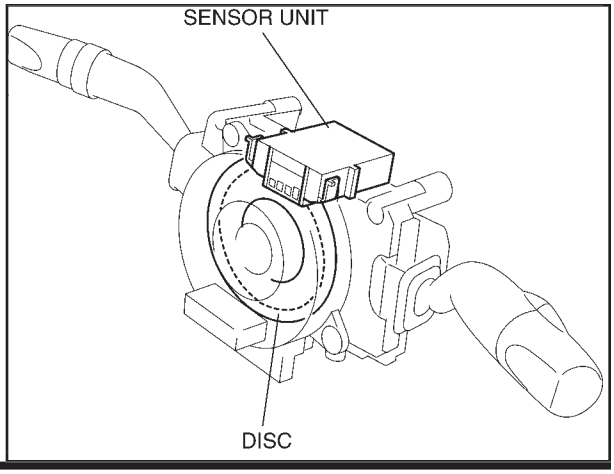
The following circumstances will cause the stored initialization value of the steering angle sensor to clear. This may possibly cause an accident due to the DSC becoming inoperative. Always refer to the Workshop Manual and properly perform the initialization procedure for the steering angle sensor so that the DSC operates properly.
— Negative battery cable disconnection
— Steering angle sensor connector disconnection
— Fuse (ROOM 15A) removal
— Wiring harness disconnection between battery and steering angle sensor connector

NOTE

If the initialization procedure for the steering angle sensor has not been performed when the ignition switch is turned to the ON position, the DSC indicator light illuminates and the DSC OFF light flashes to warn of a malfunction.

Steering Angle Sensor Construction

- The steering angle sensor, integrated with the combination switch body, has a sensor unit straddling a disc that moves together with the steering mechanism. Therefore, if there is any malfunction of the steering angle sensor, replace the combination switch body.

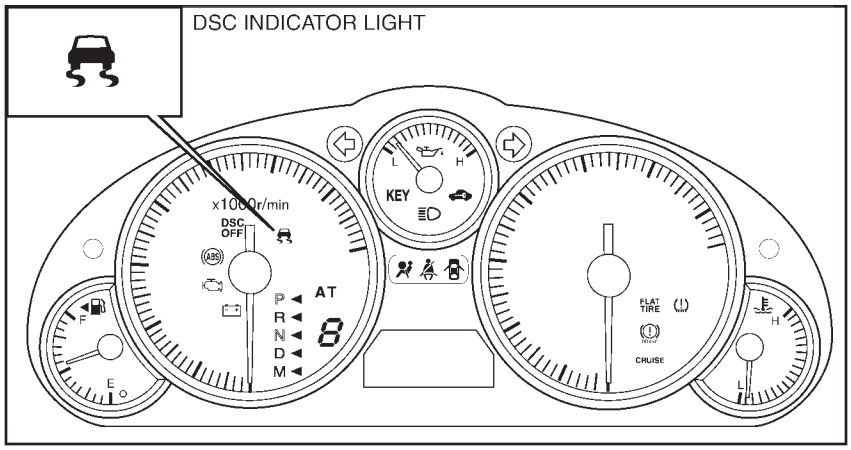


Dynamic Stability Control

DSC Indicator Light Function

- The DSC indicator light, built into the instrument cluster, informs the driver of the following vehicle conditions.
  — DSC is operating (vehicle side-slip)
  — TCS is operating (drive wheel slipping)

DSC Indicator Light Operation



- When the DSC and CAN lines are normal, the DSC indicator light illuminates for approximately 3 seconds when the ignition switch is turned to the ON position to check the light function. When the system is malfunctioning, the DSC indicator light remains illuminated.

- When the DSC or TCS is operating (DSC has not been disabled by pressing the DSC OFF switch), the DSC indicator light operates as follows:

Item	DSC indicator light condition
TCS, DSC not operating	Not Illuminated
TCS Operating	Flashes (0.5 seconds intervals)
DSC Operating	

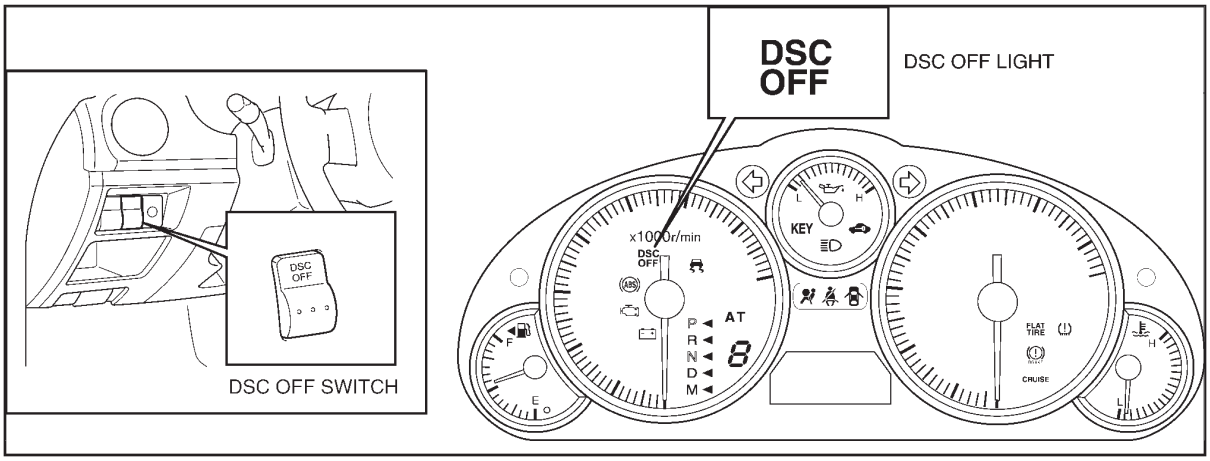
Dynamic Stability Control

DSC OFF switch, DSC OFF Light Function

- The DSC OFF switch, located on the dashboard, allows the driver to enable/ disable the DSC control.

- The DSC OFF light, built into the instrument cluster, informs the driver the operation of the DSC OFF switch has disabled DSC control.

DSC OFF switch, DSC OFF Light Operation



- When the DSC system and CAN lines are functionally normally, the DSC OFF light illuminates for approximately 1.8 seconds when the ignition switch is turned to the ON position to check the light function.

- When the DSC OFF switch is pressed to disable DSC control, the DSC OFF light illuminates.

NOTE

When releasing the DSC, continue to press the DSC OFF switch until the DSC OFF light illuminates.

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05 TRANSMISSION

Objectives

After completing this section, you will be able to:

- Explain the operation of the P66M 6-speed manual transmission.
- Explain the operation of the SJ6A-EL 6-speed automatic transmission.
- Describe the SJ6A-EL transmission fluid level inspection procedure.
- Perform the SJ6A-EL transmission fluid level inspection procedure.

What's in this section:

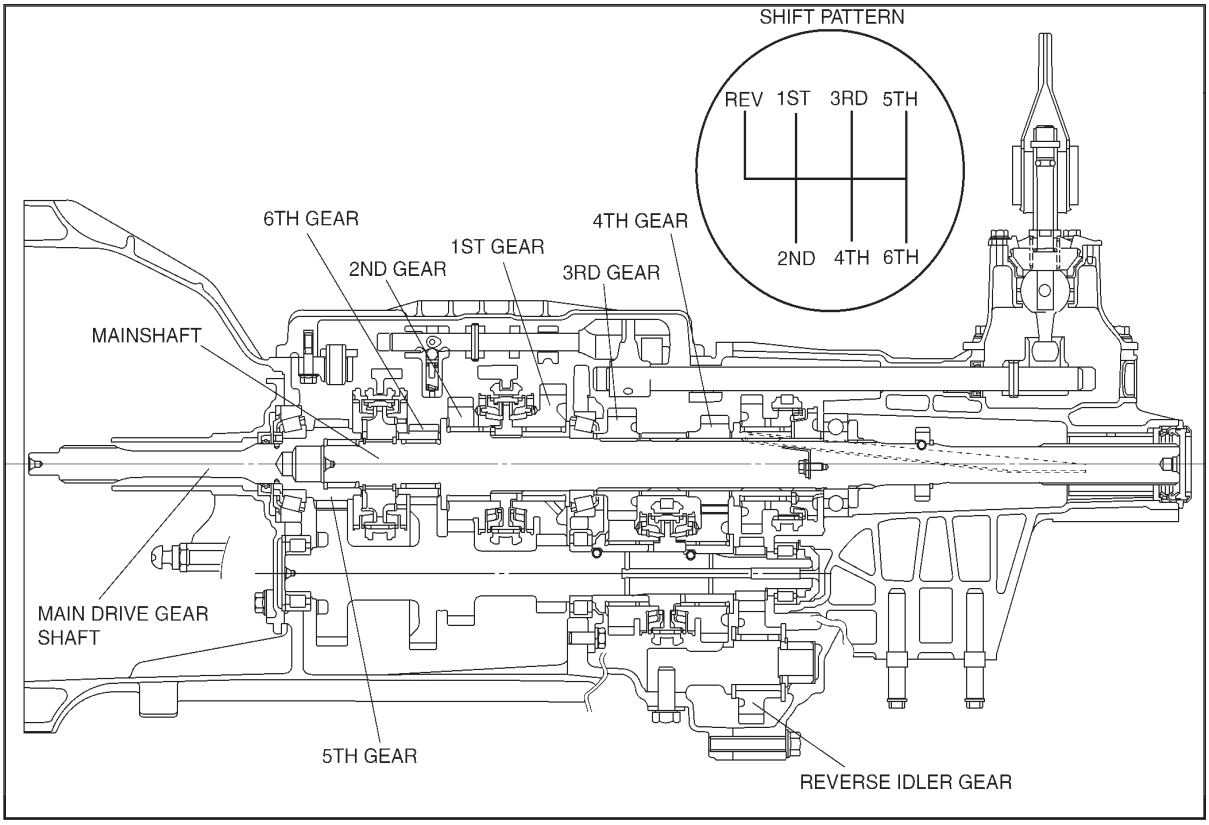
Activity	Title	Location
7	SJ6A-EL Fluid Level Inspection Procedure	Shop

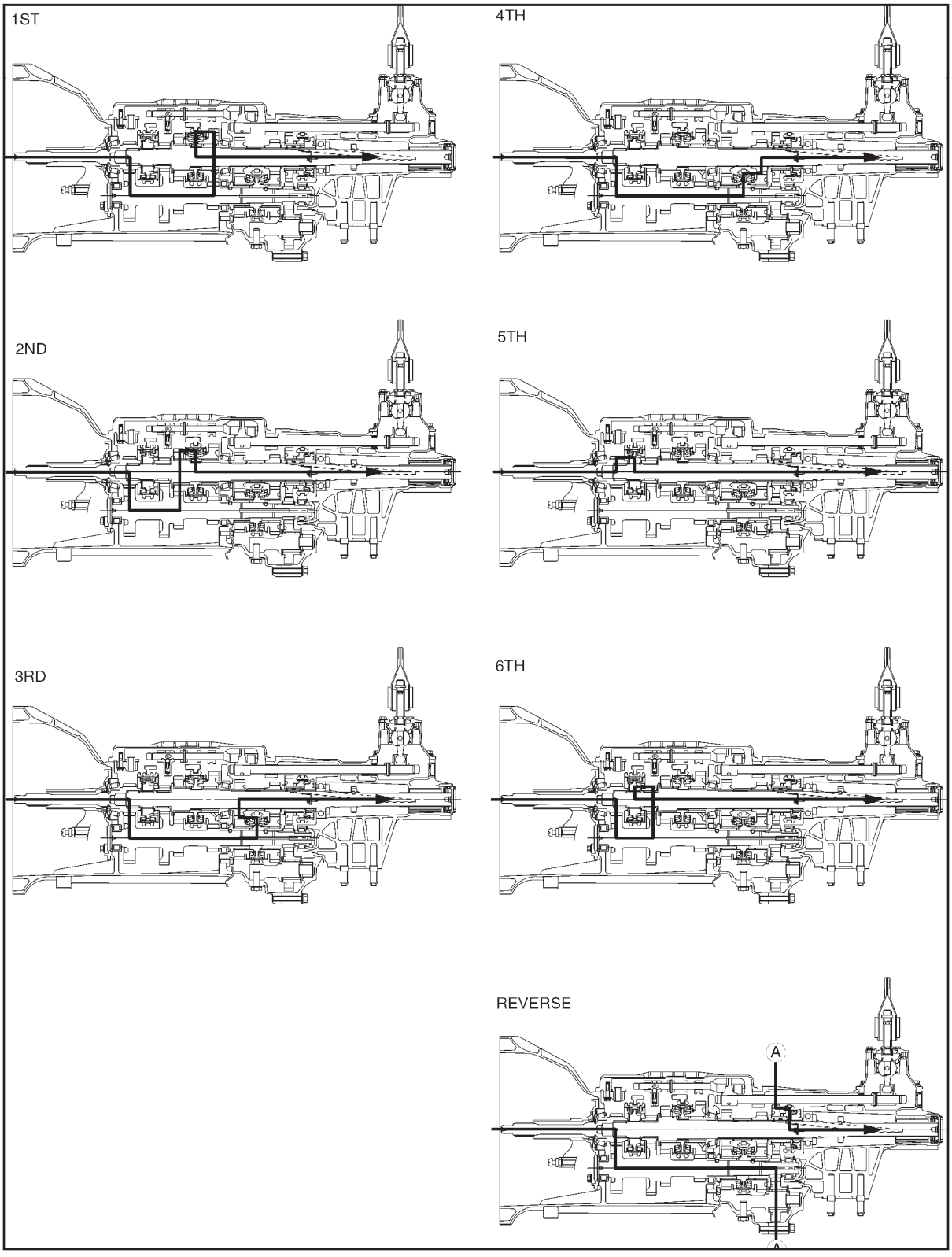
6-Speed Manual Transmission (P66M-D)

Manual Transmission Outline

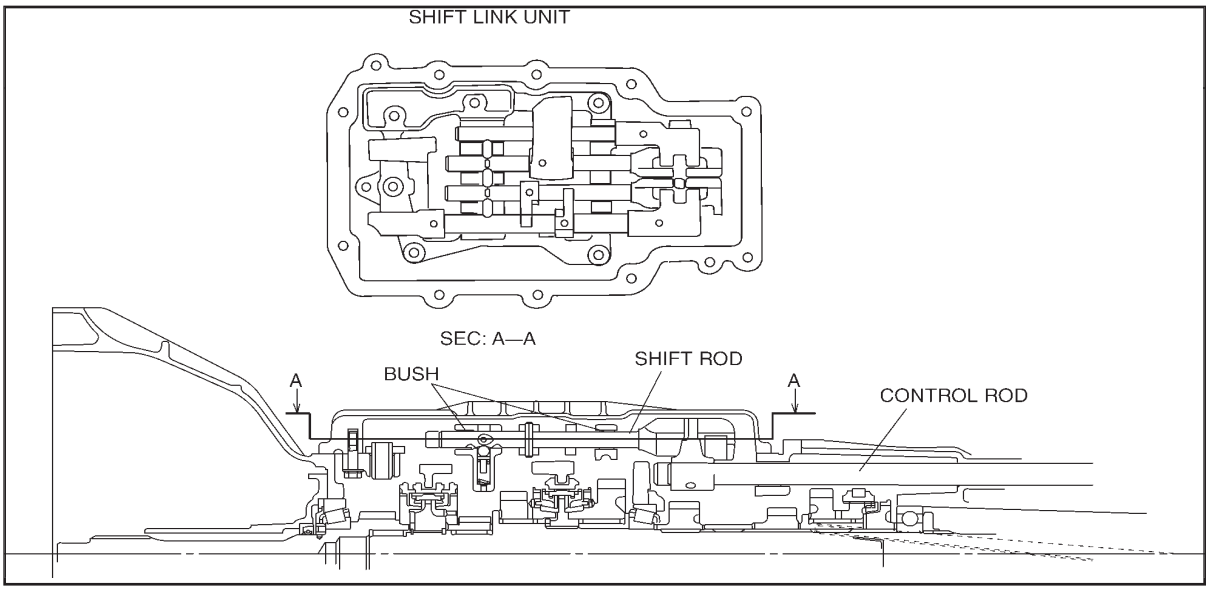
- The 1st, 2nd, 3rd and 4th gears use a linked, triple-cone synchronizer mechanism.
- This transmission uses a guide plate type reverse lockout mechanism.

Manual Transmission Cross-Sectional View




1ST
4TH
2ND
5TH
3RD
6TH
REVERSE
A
A

Shift Rod Structure



- The shift lever stroke is set shorter to provide optimal shift feel.
- To realize assured shift feel, the shift link mechanism has been integrated.
- The use of metal bushings for the sliding parts of the shift rod reduces sliding resistance during shifting thus improving shift quality.

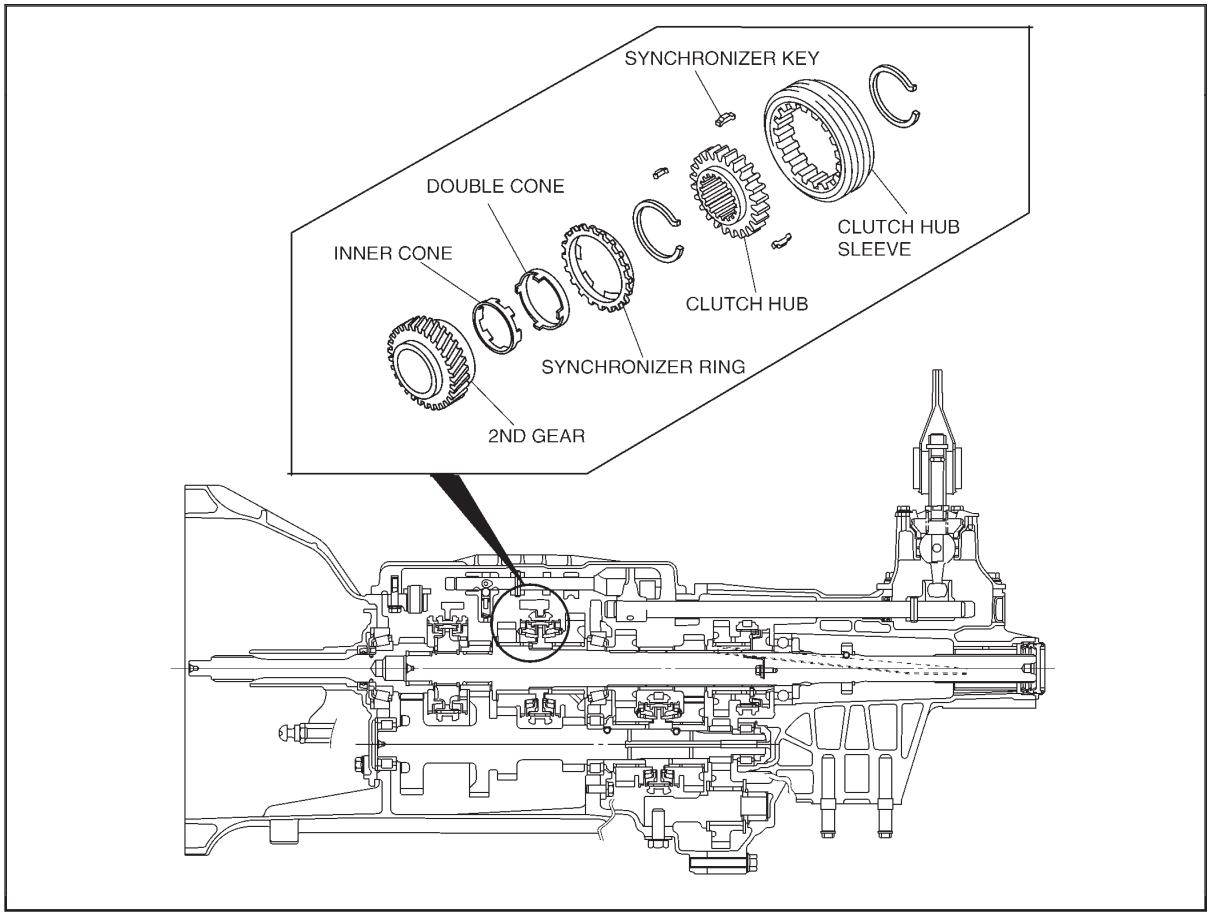
6-Speed Manual Transmission (P66M-D)

Triple Synchronizer Mechanism Structure

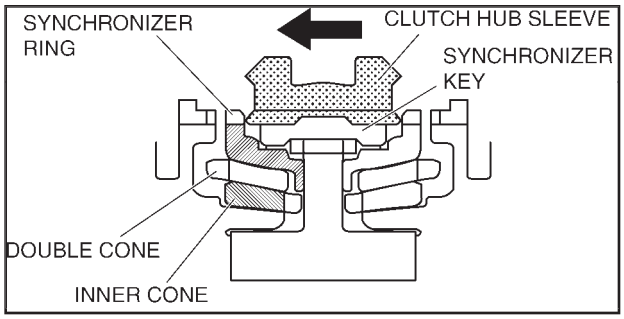
Features

- The 1st, 2nd, 3rd and 4th gears use A triple cone synchronizer mechanism.
- The triple cone synchronizer mechanism is a compact device capable of heavy duty meshing.
- The synchro mechanism reduces meshing time and improves operation.
- The triple cone synchro mechanism includes a synchronizer ring, a double cone, and an inner cone.

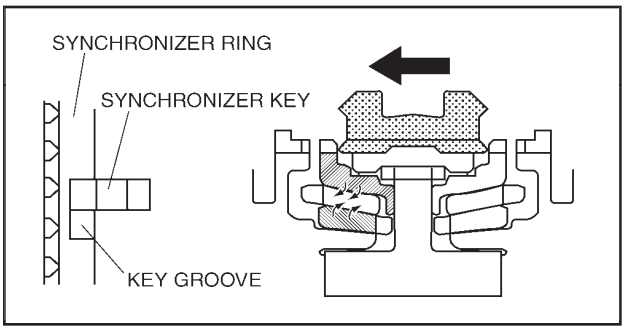
Structural View



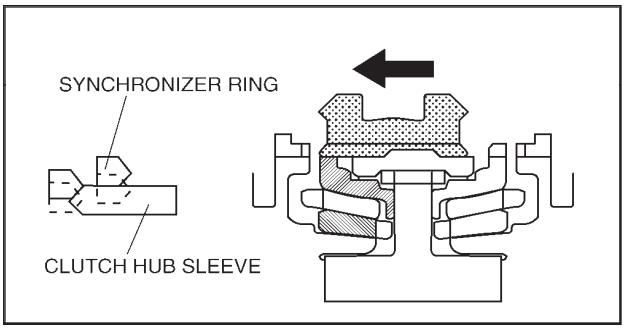
Triple Synchronizer Mechanism Structure



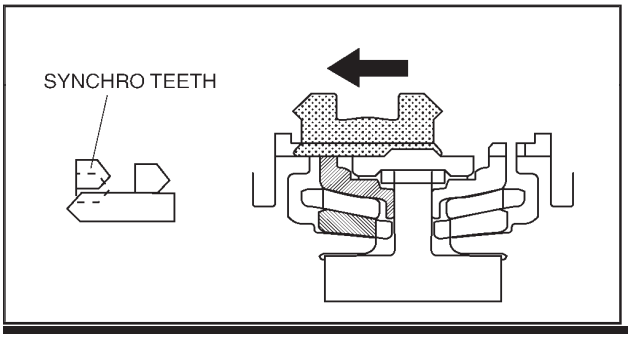
1. When the hub sleeve moves to the left (in the direction of the arrow), the synchronizer key presses against the synchronizer ring.



2. As the hub sleeve continues moving to the left, the key causes friction between the synchronizer ring, double cone, and inner cone. The synchronizer ring turns only the distance that the key groove gap allows, aligning the teeth of the hub sleeve and the synchronizer ring. As the hub sleeve continues moving, the friction between the cones becomes greater, and the difference between the rotational speeds of the synchronizer ring, inner cone, and double cone (unified with the gear) gradually disappears.



3. The hub sleeve then moves up onto the synchronizer key and engages the synchronizer ring.



4. The hub sleeve then engages the synchro teeth of the gear to complete shifting.

6-Speed Manual Transmission (P66M-D)

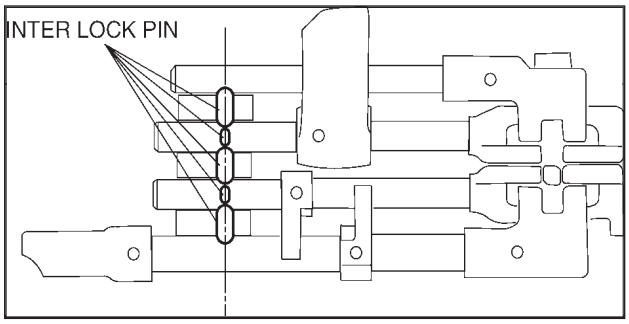
Shift Interlock Mechanism Function

- This provides reliable double-engagement prevention.

Shift Interlock Mechanism Operation

Structure

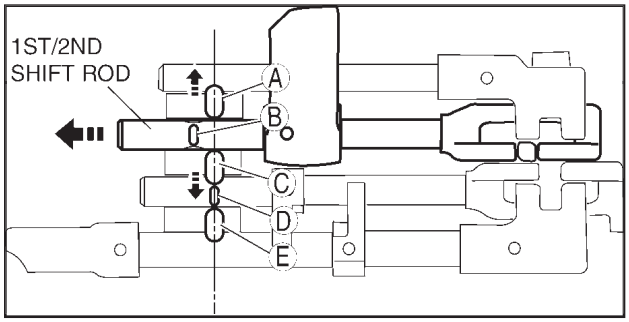
- During shifting, the shift rods, except for the one in operation, are locked in the neutral position by the interlock pins.



Operation

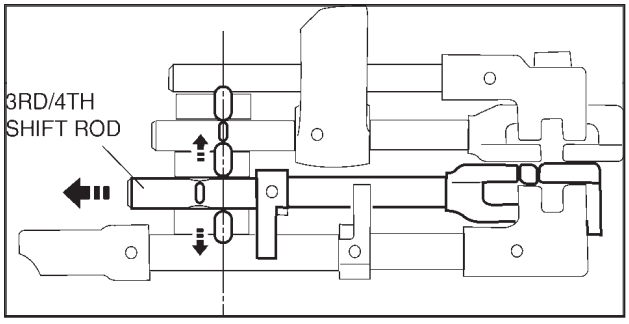
Neutral

- Each interlock pin is in the groove of each shift rod because no shift rod is operating.



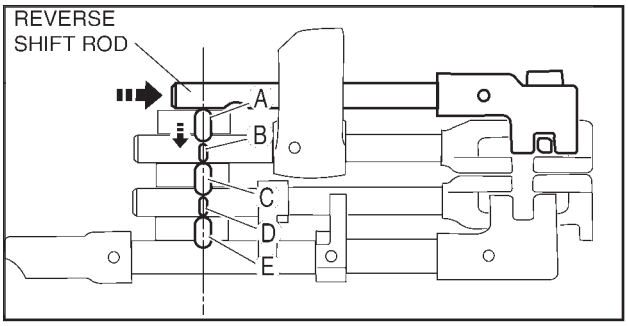
1st/2nd shifting

- Movement of the 1st/2nd shift rod forces interlock pins A and C out of the 1st/2nd shift rod grooves, and the reverse shift rod and 3rd/4th shift rod are locked. In addition, interlock pin C forces interlock pin E out via interlock pin D, and the 5th/6th shift rod is locked.



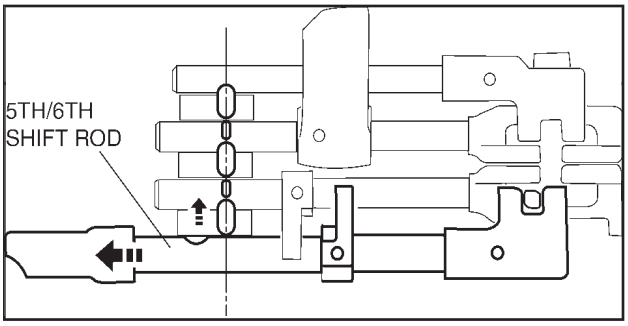
3rd/4th shifting

- When the 3rd/4th shift rod operates, the other three shift rods are locked in the same way as the 1st/2nd shifting.



Reverse shifting

- Movement of the reverse shift rod forces interlock pin A out of the reverse shift rod groove, and the 1/2 shift rod is locked. In addition, interlock pin A forces interlock pins C and E out via interlock pins B and D, and the 3rd/4th shift rod and 5th/6th shift rod are locked.



5th/6th shifting

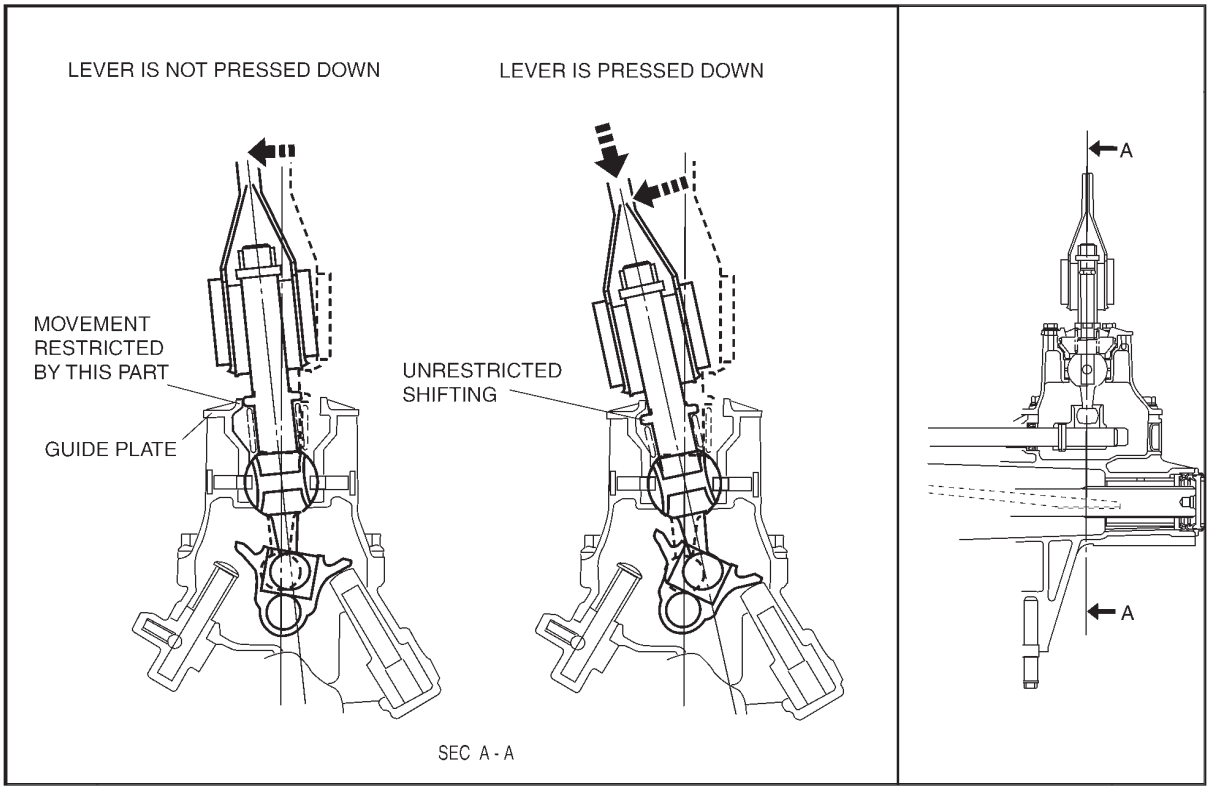
- When the 5th/6th shift rod operates, the other three shift rods are locked in the same way as the reverse shifting.

6-Speed Manual Transmission (P66M-D)

Reverse Lockout Mechanism Function

- The reverse lockout mechanism prevents the driver from accidentally shifting into reverse gear when shifting from neutral to 1st gear.

Reverse Lockout Mechanism Construction/Operation

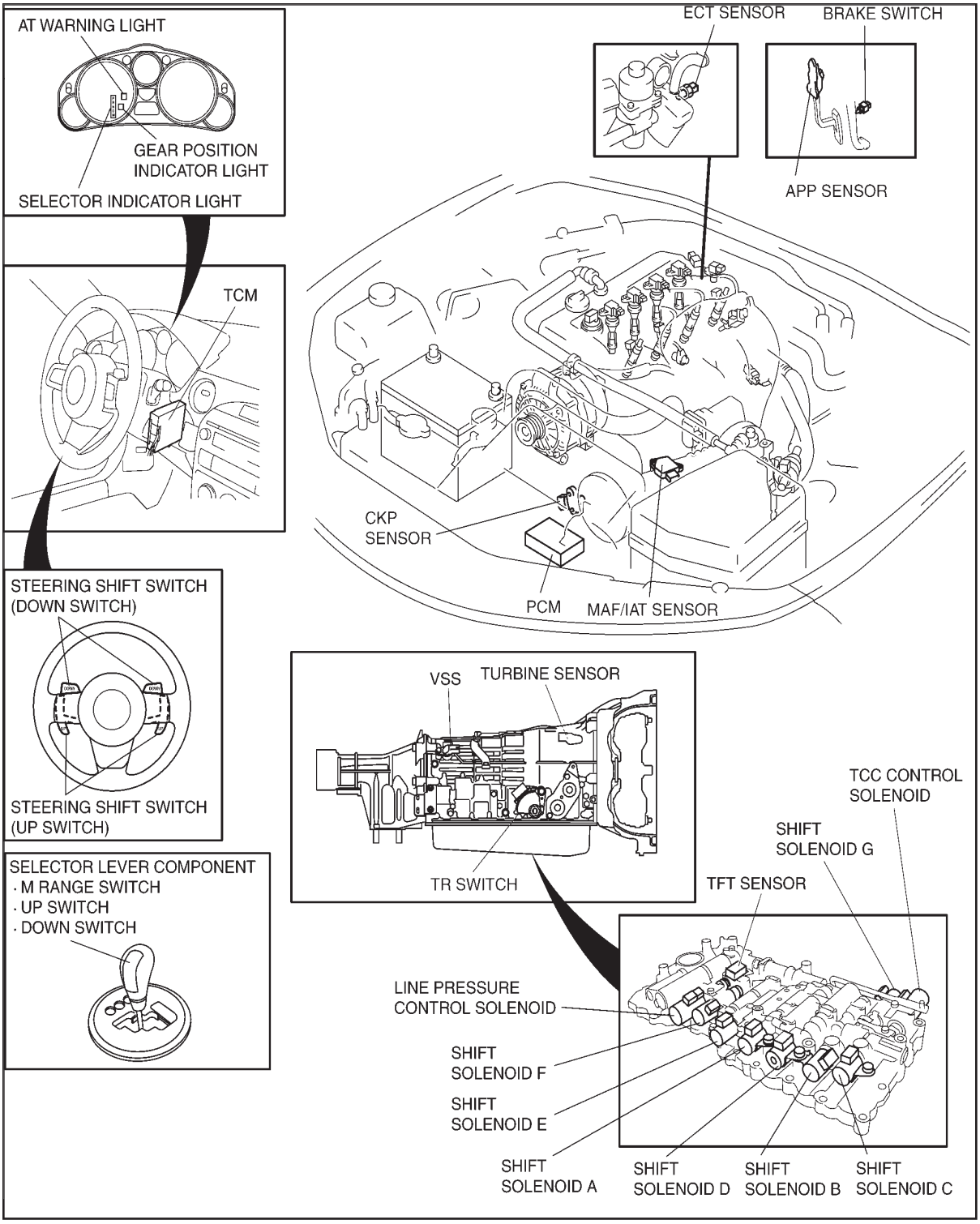


- The reverse lockout mechanism, which utilizes a guide plate, ensures reliability.

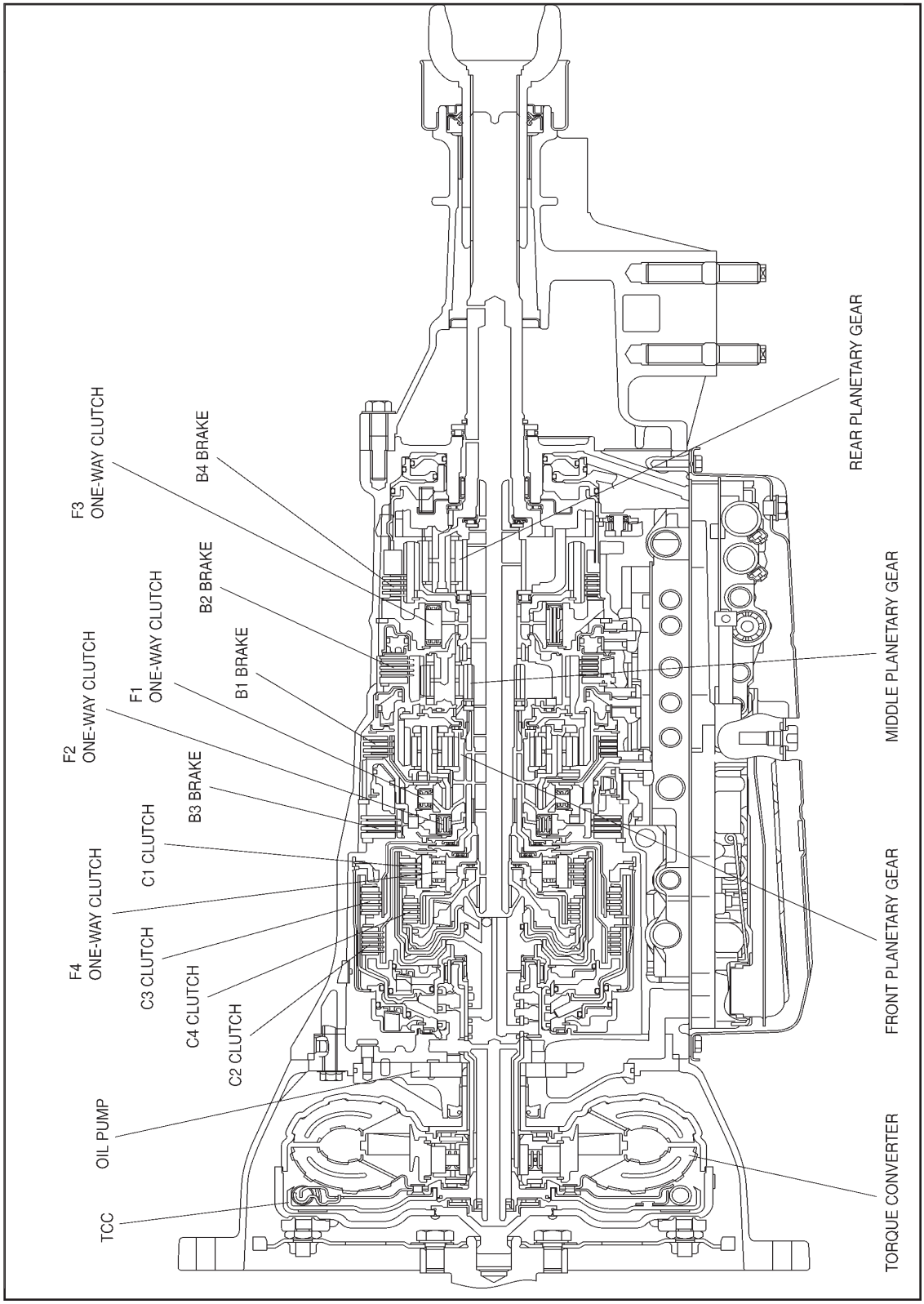
- A guide plate, attached to the extension housing, prevents accidental shifting into reverse when shifting from neutral to 1st gear by restricting the movement of the shift lever. When shifting into reverse, once the shift lever is pressed down and moved towards the reverse position, the projection on the lever goes under the guide plate, releasing the reverse shift restriction and allowing for shifting into reverse.

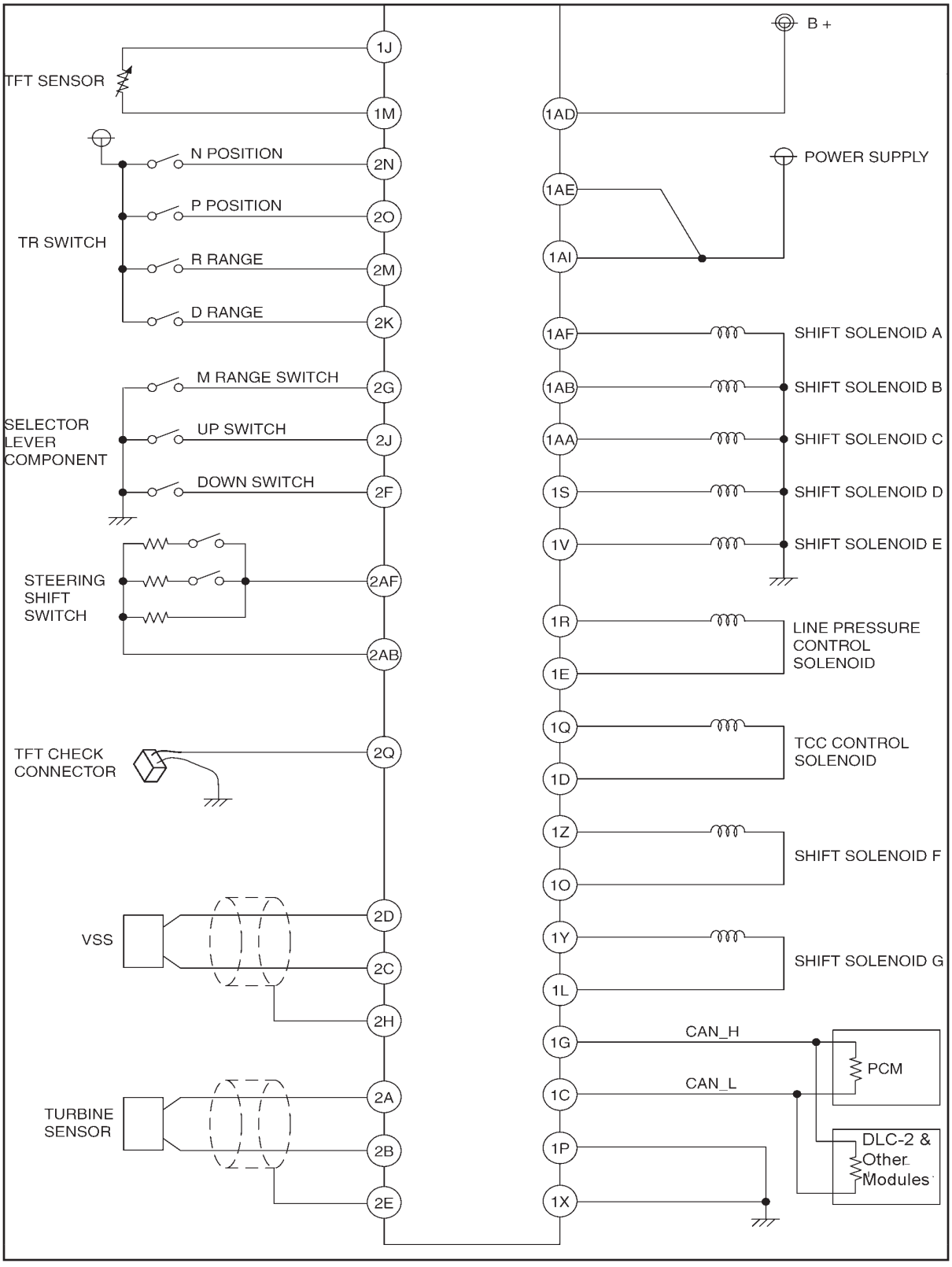
Power Plant Frame (PPF) Function

- For detailed information, refer to the M15M-D manual transmission description in section 05 Transmission.


AT WARNING LIGHT
GEAR POSITION INDICATOR LIGHT
SELECTOR INDICATOR LIGHT
TCM
STEERING SHIFT SWITCH (DOWN SWITCH)
STEERING SHIFT SWITCH (UP SWITCH)
SELECTOR LEVER COMPONENT
· M RANGE SWITCH
· UP SWITCH
· DOWN SWITCH
ECT SENSOR
BRAKE SWITCH
APP SENSOR
CKP SENSOR
PCM
MAF/IAT SENSOR
VSS
TURBINE SENSOR
TR SWITCH
TCC CONTROL SOLENOID
SHIFT SOLENOID G
TFT SENSOR
LINE PRESSURE CONTROL SOLENOID
SHIFT SOLENOID F
SHIFT SOLENOID E
SHIFT SOLENOID A
SHIFT SOLENOID D
SHIFT SOLENOID B
SHIFT SOLENOID C

Automatic Transmission Cross-sectional View




TFT SENSOR
1J
1M
N POSITION
2N
P POSITION
2O
TR SWITCH
R RANGE
2M
D RANGE
2K
M RANGE SWITCH
2G
SELECTOR LEVER COMPONENT
UP SWITCH
2J
DOWN SWITCH
2F
STEERING SHIFT SWITCH
2AF
2AB
TFT CHECK CONNECTOR
2Q
VSS
2D
2C
2H
TURBINE SENSOR
2A
2B
2E
B +
1AD
POWER SUPPLY
1AE
1AI
1AF
SHIFT SOLENOID A
1AB
SHIFT SOLENOID B
1AA
SHIFT SOLENOID C
1S
SHIFT SOLENOID D
1V
SHIFT SOLENOID E
1R
LINE PRESSURE CONTROL SOLENOID
1E
1Q
TCC CONTROL SOLENOID
1D
1Z
SHIFT SOLENOID F
1O
1Y
SHIFT SOLENOID G
1L
1G
CAN_H
PCM
1C
CAN_L
1P
DLC-2 & Other Modules
1X

05 TRANSMISSION

6-Speed Automatic Transmission (SJ6A-EL)

Input/Output Signal and Related Controls

- Refer to Service Highlights, page 05-13-24 to view the table.

EC-AT Operation Chart

- Refer to Service Highlights, page 05-13-4 to view the table.

Shift Control Outline

- Based on the shift diagram, shift solenoids A, B, C, D, E, F, and G are controlled according to the vehicle speed and the throttle opening angle, and the shift control of the transmission is performed.

- When certain conditions are met, the TCM selects a shift mode suitable to the driving conditions and automatically switches to the mode to perform smooth shifting.

POWER MODE

- The POWER MODE in which the shift point is set higher than the normal shift point is automatically selected when certain conditions are met so that high-engine speed high-output conditions are available.

DOWN SLOPE MODE

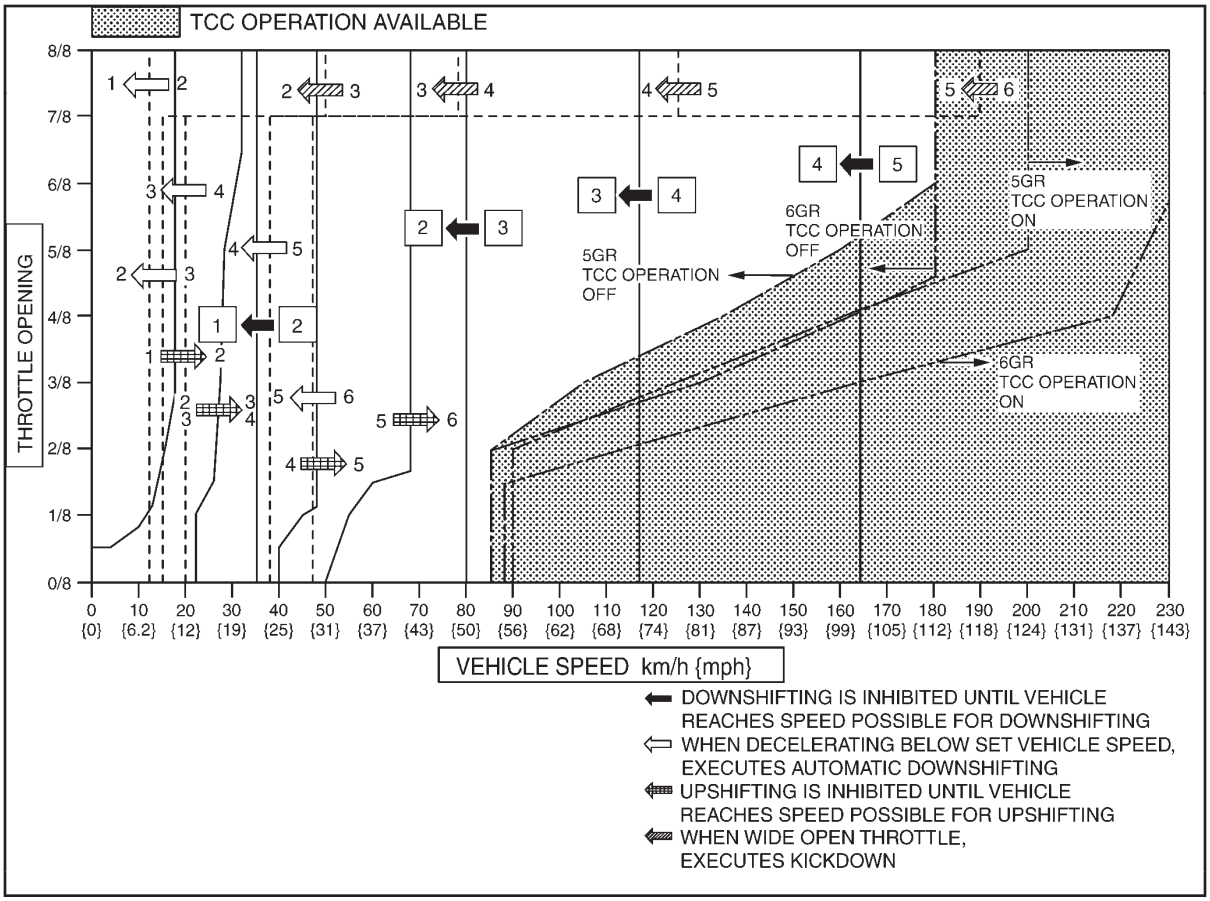
- While the vehicle is being driven on a down slope, the TCM determines that the vehicle is on a down slope based on the signals and output engine speed from the PCM, and switches the driving mode to the DOWN SLOPE MODE. Due to this, load to the brake is reduced.

UP SLOPE MODE

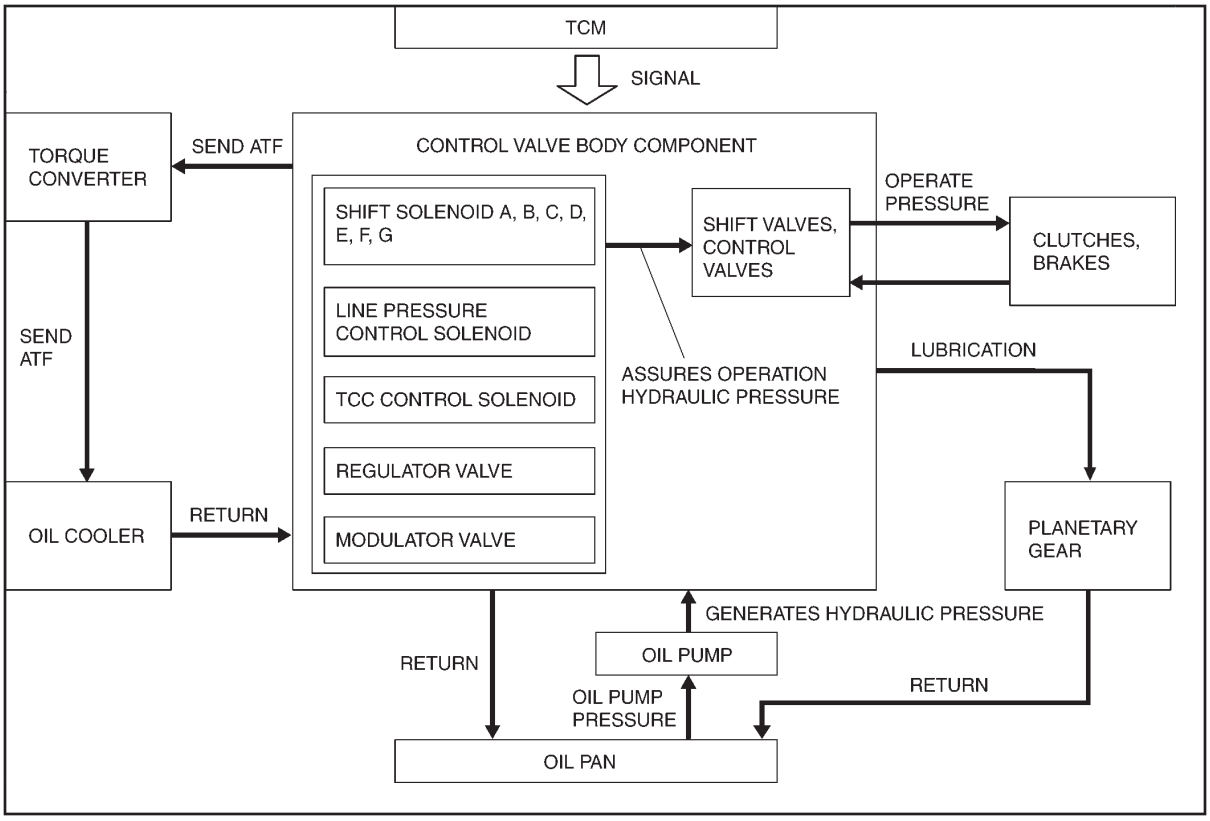
- When the vehicle is climbing a slope, the TCM determines that the vehicle is on an up slope based on the signals and output engine speed from the PCM, and switches the driving mode to the UP SLOPE MODE. Due to this, reduction in traction is prevented.

Shift Control Outline

Shift Diagram



Control Valve Body Component Outline



- The control valve body supplies oil by switching the oil circuit for the hydraulic pressure generated by the oil pump. Based on the control signal from the TCM, the solenoid valves are activated to control the hydraulic pressure to the clutch and brakes, performing gear shift and TCC. In addition, an appropriate amount of oil is supplied to the torque converter, planetary gears and lubricating parts.

Torque Converter Clutch (TCC) Control Outline

- Based on the TCC diagram, the TCC control solenoid is turned on and off according to the vehicle speed and throttle opening angle, and the TCC point control is performed.

- If any of the following three conditions are met, TCC is cancelled.

TCC Cancel Conditions

- Brake switch is ON

- Accelerator is fully closed (determined being idling)

- Engine coolant temperature is low

5-6 Shift Inhibit Control Outline

- The TCM inhibits shift change from the 5th to 6th gears when it determines that the engine is cold based on the engine coolant temperature signal from the

Torque Reduction Control and Line Pressure Control Outline

- While in a shift change between 1st and 6th gears, a torque reduction request signal is output from the TCM to the PCM to cut engine torque amplification caused by shift changes to smooth shifting.

- In addition, line pressure control in which line pressure is controlled during shift change between 1st and 6th gears has been adopted to improve shift shock.

6-Speed Automatic Transmission (SJ6A-EL)

Self-diagnosis Function Outline

- The TCM monitors the communication status of each sensor, electronic component and PCM including the PCM. If any malfunction should occur, the TCM functions to warn the driver and stores the malfunction as a diagnosis code.

On-board diagnosis	• If any malfunction should occur in the automatic transmission, the TCM will cause warning light to light up in order to inform the driver of the malfunction.
Off-board diagnosis	• The TCM stores the malfunction as a diagnosis code. The diagnosis code and TCM data can be inspected by connecting the WDS or equivalent.

CAUTION

- To erase stored DTCs, always perform one of the below procedures. If not performed, a misreading of the DTC may occur.

Stored DTC Erasing Method

• Use the WDS or equivalent.

• Disconnect the negative battery cable and reconnect it after 5 minutes or more.

Fail-safe Outline

- With the fail-safe function, if any malfunction should occur in the automatic transmission system, the TCM will output a control signal and control will be performed to make traveling as short a distance as possible. If shift solenoid malfunction, the TCM will cancel the output of control signals to the solenoid.

Shift learning Function

- Learns optimum hydraulic pressures for each clutch and brake to reduce shift shock during shift change.

On-board Diagnostic

Emergency Mode

- In the fail-safe function, minimum vehicle driveability is obtained by changing the signals that are determined to be malfunctions by the malfunction detection function to the preset values, and limiting TCM control.
- Refer to Service Highlights, page 05-02-7 to view the table.

Simulation Function

- By using the WDS or equivalent, simulation items for input/output parts preset in the TCM can be optionally selected and operated regardless of TCM control conditions.

Simulation Item Table

Simulation Item	Applicable Component	Unit/ Condition	Operation		TCM Terminal
			IG ON	Idle	
LPS	Line pressure control solenoid	A	N/A	X	1E, 1R
SSA	Shift solenoid A	On/Off	N/A	X	1AF
SSB	Shift solenoid B	On/Off	N/A	X	1AB
SSC	Shift solenoid C	On/Off	N/A	X	1AA
SSD	Shift solenoid D	On/Off	N/A	X	1S
SSE	Shift solenoid E	On/Off	N/A	X	1V
SSF	Shift solenoid F	A	N/A	X	1O, 1Z
SSG	Shift solenoid G	A	N/A	X	1L, 1Y
TCC	TCC control solenoid	A	N/A	X	1D, 1Q

09 BODY & ACCESSORIES

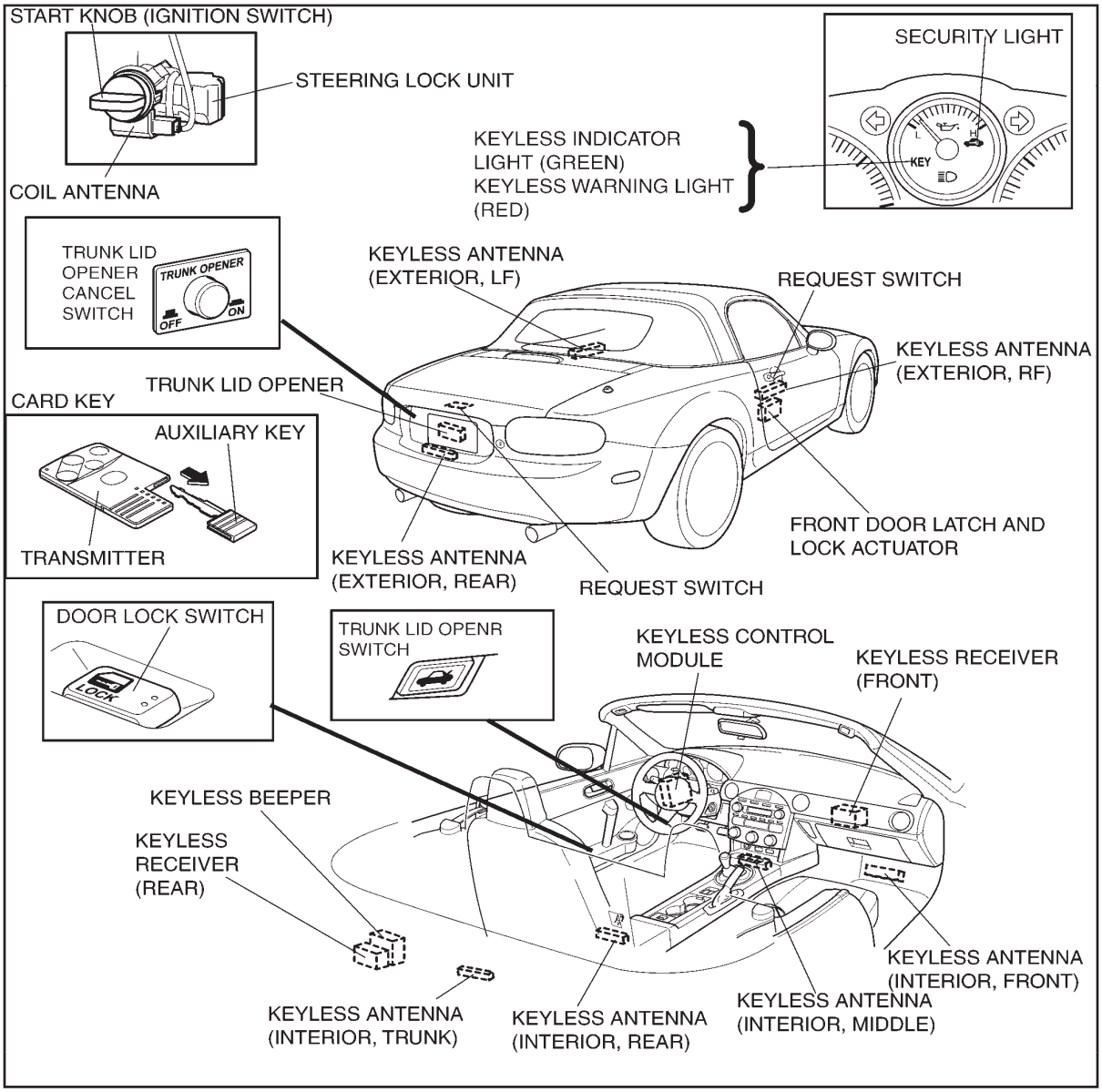
Objectives

After completing this section, you will be able to:

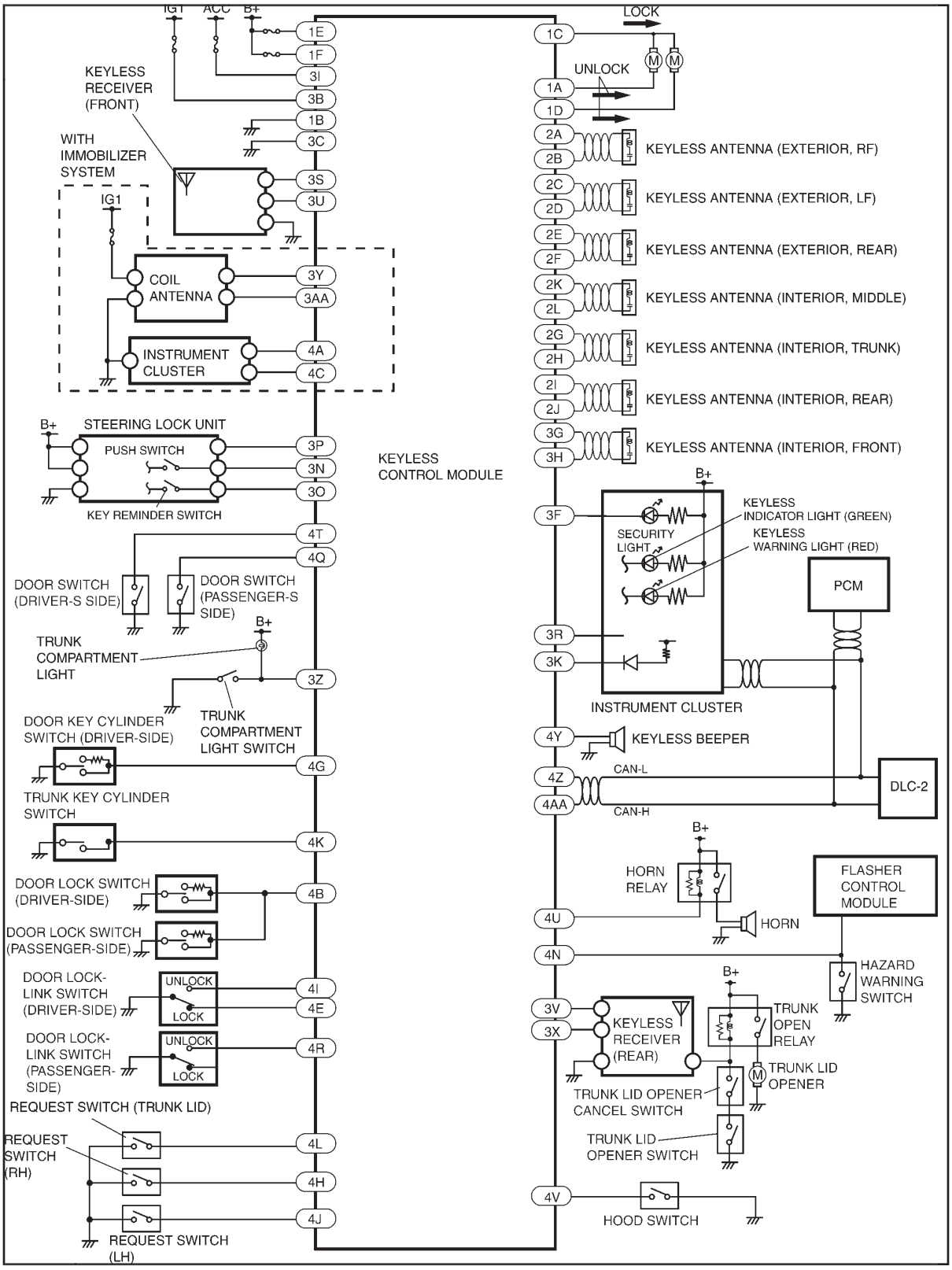
- Identify the Advanced Keyless System components.
- Explain the function of the Advanced Keyless System components.
- Explain the operation of the Advanced Keyless System and perform active commands.
- Identify the Controller Area Network (CAN) modules.

What's in this section:

Security and Locks Structural View



Security and Locks System Wiring Diagram



Security and Locks (Advanced Keyless System)

Keyless Entry System Outline

- An advanced keyless system enables the driver to start the engine or lock/unlock the doors without operating the auxiliary key or transmitter (card key) by carrying the advanced key that has been programmed to the vehicle.

- The doors also can be locked/unlocked by operating the key (auxiliary key) or transmitter (card key).

- The answer-back function confirms that the doors are locked/unlocked by flashing the hazard warning light and sounding a beep.

- A warning and guidance function promotes correction if the system is operated improperly and uses the indicator light in the instrument cluster, a buzzer sound, and the keyless beeper from behind passenger compartment.

- A customized function that switches the activation/deactivation of each function has been adopted.

- A rolling code type transmitter (card key) prevents theft by radiowave interception.

- To prevent improper operation while the vehicle is moving, the doors cannot be locked/unlocked by operating the transmitter (card key) or request switch when the start knob is in any position except LOCK.

Custom Function Outline

- The settings of the following functions, and warning and guidance functions for the advanced keyless entry system can be turned ON/OFF optionally.

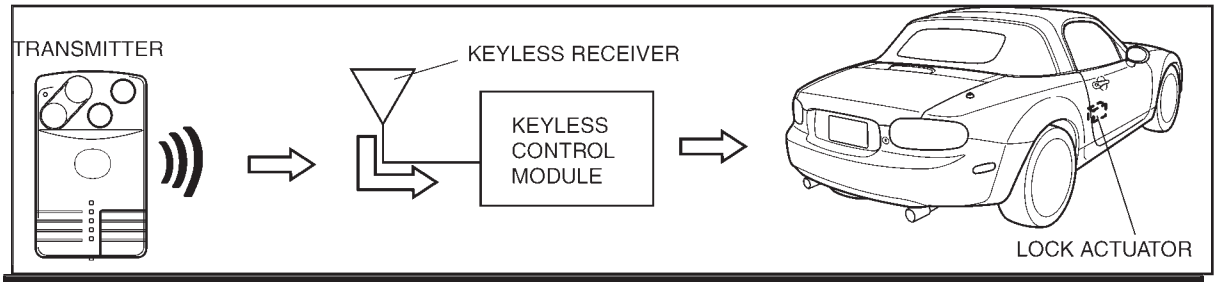
- The WDS or equivalent is necessary for settings. Refer to the Workshop Manual for the detailed setting procedure.

Function Name	WDS or equivalent Display	Initial Setting
Auto lock function (out-of-area type)	Auto lock	OFF
Keyless buzzer answer back	Answer Back Buzzer	OFF
Battery voltage low indications	Low Battery Warning	ON

Keyless Entry System Operation

Normal Keyless Entry Function

Lock/Unlock



NOTE

- If any of the following conditions are met, the doors cannot be locked by operating the transmitter (card key).

— The auxiliary key is inserted in the ignition key cylinder.
— The start knob is not in the LOCK position.
— The start knob is being pressed.
— Any door is open.

- If any of the following conditions are met, the doors cannot be unlocked by operating the transmitter (card key).

— The auxiliary key is inserted in the ignition key cylinder.
— The start knob is not in the LOCK position.
— The start knob is being pressed.

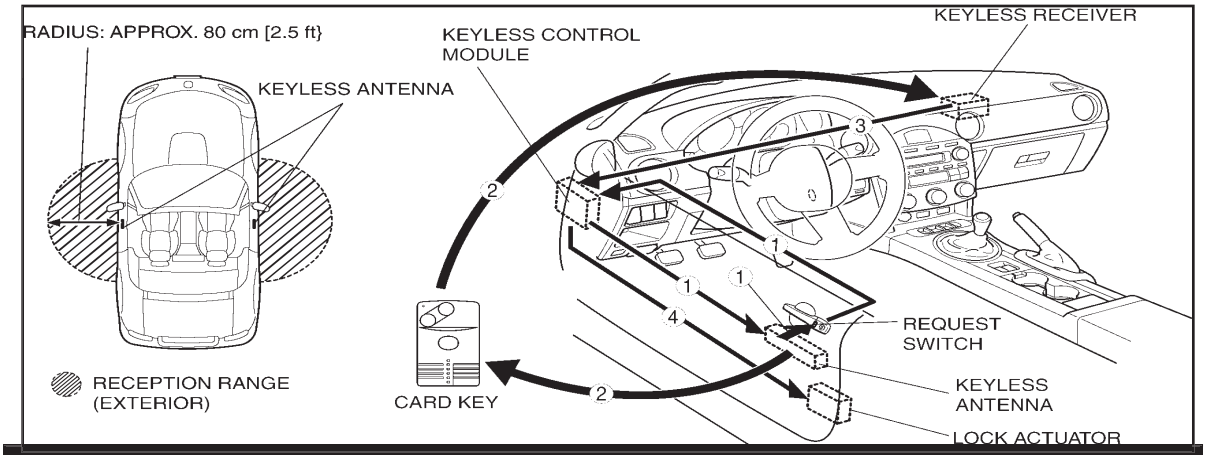
1. When the transmitter (card key) is operated, the card key sends ID data and a rolling code. The keyless receiver receives the data and sends it to the keyless control module.

2. When the keyless control module receives a lock/unlock signal from the transmitter (card key) and verifies the ID, the control module sends the signal to all lock actuators activate to lock/unlock.

3. The keyless control module operates the hazard warning lights flash to flash according to lock/unlock signal from the transmitter (card key).
   — When the LOCK button is pressed, the hazard warning lights flash once.
   — When the UNLOCK button is operated, the hazard warning lights flash twice.

Keyless Entry System Operation (continued)

Advanced Keyless Entry Function: Lock/Unlock



NOTE

- The following conditions must be met in order to lock the doors with the operating switch:

— The card key is not inside the vehicle.
— All doors and trunk lid are closed.
— The auxiliary key is not inserted in the ignition key cylinder.
— The start knob is in the LOCK position and not being pressed.
— The card key is within the reception range outside the vehicle.

- The following conditions must be met in order to unlock the doors with the operating switch

— The auxiliary key is not inserted in the ignition key cylinder.
— The start knob is in the LOCK position and not being pressed.
— The card key is within the reception range outside the vehicle.

1. When a request switch is pressed, the keyless control module sends a request signal from the keyless antenna. The antenna sends the request signal to the area around the door from the pressed request switch and the signal is sent to the cabin area.

2. When the card key receives a request signal, the card key sends back ID data.

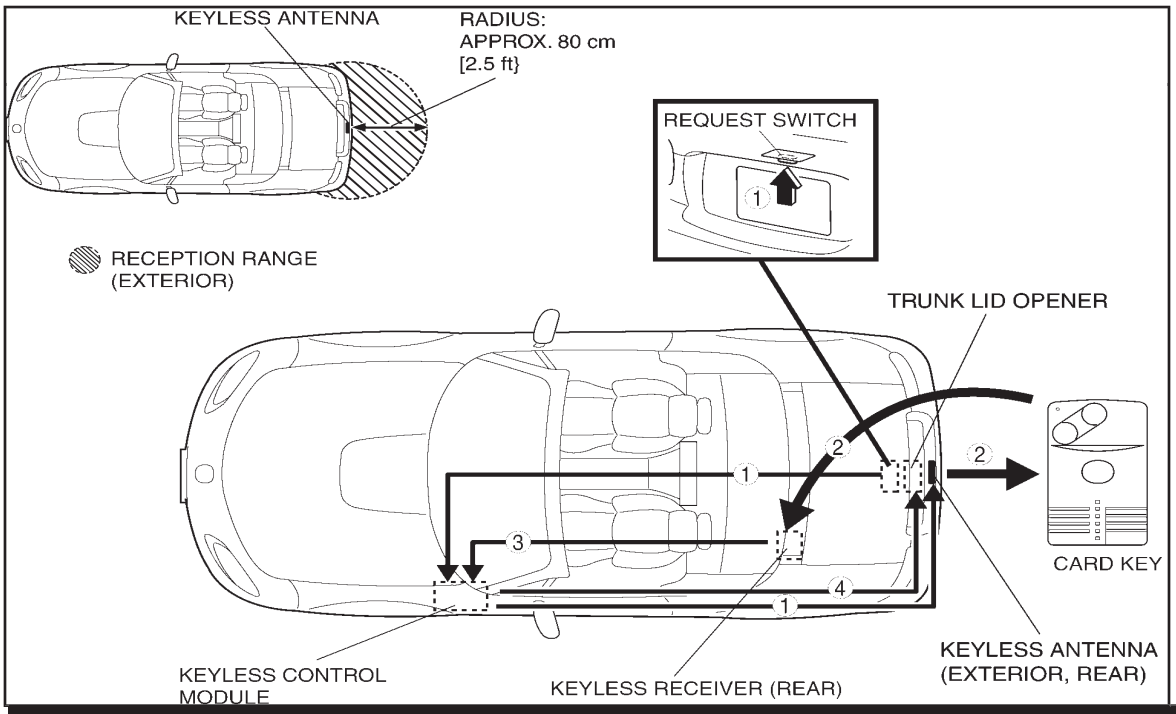
3. The keyless receiver receives the ID data and sends it to the keyless control module.

4. The keyless control module verifies the ID data and determines the card key to be outside the vehicle, it sends a signal to the lock actuators to activated lock/unlock.

5. The keyless control module commands the hazard warning lights to flash.
— When the doors are locked, the hazard warning lights flash once.

Keyless Entry System Operation (continued)

Trunk Lid Opening



NOTE

- The following conditions must be met in order to open the trunk lid with the operating switch:

— The auxiliary key is not inserted in the ignition key cylinder.
— The start knob is in the LOCK position and not being pressed.
— The card key is within the reception range outside the vehicle.
— The trunk lid opener cancel switch is in the ON position.

1. When the trunk lid request switch is pressed and held for 1 second or more, the keyless control module sends a request signal from the keyless antenna. The request signal is sent to the area around the trunk lid, and the signal is sent to the rear area.

2. When the card key receives a request signal, the card key sends back ID data.

3. The keyless receiver (rear) receives the ID data and sends it to the keyless control module.

4. When the keyless control module verifies the ID data and determines to be outside the vehicle, it sends a signal to the trunk lid opener to open the trunk lid.

5. The keyless control module commands the hazard warning lights to flash.
— When the trunk lid is unlocked, the hazard warning lights flash twice.

Keyless Entry System Operation (continued)

Auto re-lock function

- The auto re-lock function automatically locks the doors if any of the following operations are performed within approximately 30 seconds after the UNLOCK button of the card key is pressed, or after the request switch is pressed to unlock the doors.
  — A door or the trunk lid is opened.
  — The auxiliary key is inserted in the ignition key cylinder.
  — The start knob is pressed.
  — The transmitter (card key) is operated. (If the UNLOCK button is pressed, the timer is reset.)
  — A request switch is operated.

Out-of-area (reception area) autolock function

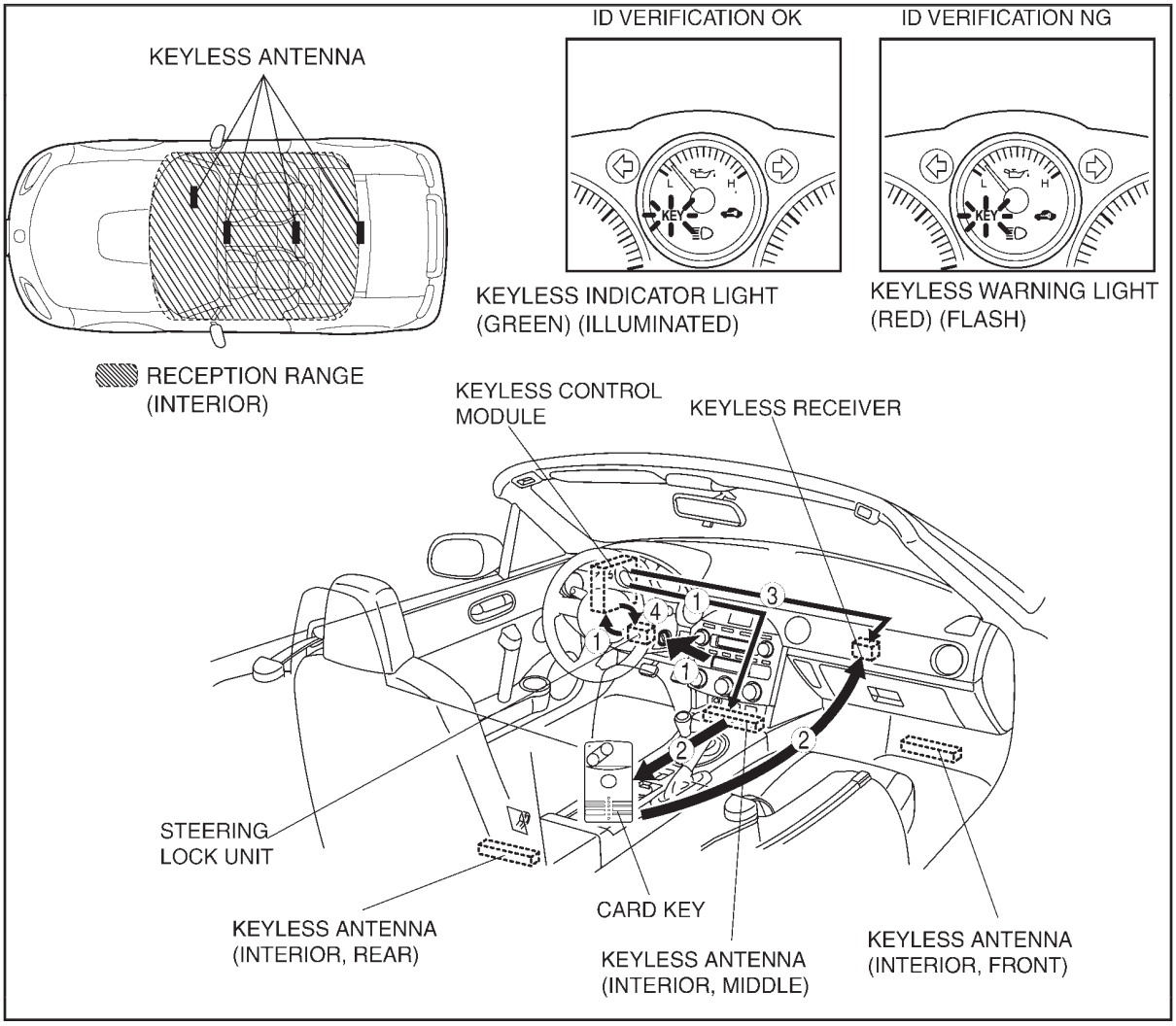
- When all doors are closed and the driver is out of the reception area carrying the card key, the doors are automatically locked. (Initial setting is OFF.)

1. When all the following conditions are met and all doors are closed after any door or the trunk lid is open, the keyless beeper sound is heard and the function starts operation. (The doors are not locked at this time.)
   — The card key is not inside the vehicle.
   — The card key is within the reception area outside the vehicle.
   — The auxiliary key is not inserted in the ignition key cylinder.
   — The start knob is in the LOCK position, and not being pressed.

2. After the operation has started, the card key is monitored within the reception area by the keyless antenna. After about 2 seconds from where the card key has been determined to be out of the reception area, all lock actuatorsactivate to lock. If approximately. 30 seconds have passed since the operation started, the doors also locks regardless of whether the card key is within or out of the reception area.

3. The hazard warning light flashes once and keyless beep sound will be heard once at the same time the door locks.

Advanced Keyless Start Function Operation



Advanced Keyless Start Function Operation (continued)

- The advanced start function activates to start the engine by operating the start knob, and not by inserting the key but by the driver carrying the card key while in the vehicle.

1. When the start knob is pressed, the keyless control module sends a request signal from the keyless antennas (interior).

2. The card key receives the request signal, and sends back ID data.

3. The keyless receiver receives the ID data and sends it to the keyless control module.

4. When the keyless control module verifies the ID data and it determines the card key is inside the vehicle, the start knob of the steering lock unit is released. The keyless indicator light (green) in the instrument cluster illuminates at the same time to indicate that the start knob is operable.
   — If the ID verification is not acceptable (for reasons such as an unprogrammed card key, or card key battery depletion or transmitter interference), the start knob is not released and the keyless warning light (red) illuminates to indicate that the start knob is inoperable.
   — For vehicles with the immobilizer system, ID verification is performed when the start knob is turned to the ON position, and if the verification is acceptable, permission is given to start the engine.

5. Turn the start knob to the START position to start the engine.

Warning/Guidance Function Operation

- If the system is operating improperly, it warns the driver using the indicator light in the instrument cluster, buzzer sound, and keyless beeper in the trunk compartment.

Item		Operation Condition	Keyless buzzer (outside the vehicle)	Instrument Cluster		
				Buzzer (interior)	Keyless Warning Light (red)	Keyless indicator light (green)
Warning	Start knob not in LOCK warning	Driver's door is open with start knob in ACC position	–	Continuous	Flashes	–
	Card key out of vehicle warning*1	Card key cannot be detected inside vehicle with driver's door open and start knob not in LOCK position	–	Continuous	Flashes	–
		Card key cannot be detected inside vehicle with all doors closed and start knob not in LOCK position	Sounds 6 times	–	Flashes	–
		Card key cannot be detected inside vehicle with start knob not in LOCK position and under any condition other than above	–	–	Flashes	–
	Card key left in vehicle warning	Door/trunk lid is open with proper card key inside vehicle and another card key carried	Continuous for 10 s	–	–	–
	Door lock inoperable warning	Request switch is pressed with card key carried and a door open or start knob not in LOCK position	Sounds 6 times	–	–	–
	Battery voltage low indication	Card key battery voltage depleted	–	–	–	Flashes (Approx. 30 s after IG OFF)
Guidance	Start knob operable guidance	Start knob is operable (lock released) when it is pressed	–	–	–	On (Max. 3 s)
	Start knob inoperable guidance	Start knob is inoperable (locked) when it is pressed	–	–	Flashes	–
	Lock/unlock answer back	Doors are locked/ unlocked with normal/ advanced keyless entry function	Locked: Once Unlocked: Twice	–	–	–

Customize Function Outline

• The settings of the following functions, and warning and guidance functions for the advanced keyless entry system can be turned ON/OFF optionally.

• The WDS or equivalent is necessary for settings. Refer to the Workshop Manual for the detailed setting procedure.

Function name	WDS or equivalent display	Inital setting
Auto lock function	Auto lock	OFF
Keyless buzzer answer back	Answer back buzzer	OFF
Battery voltage low indication	Low battery warning	ON

On-board Diagnosis System Outline

Special Features

• The keyless entry system has an on-board diagnostic function to facilitate system diagnosis.

• The on-board diagnostic function consists of the following functions: a malfunction detection function, which detects overall malfunctions in the keyless entry system-related parts; a memory function, which stores detected DTCs; a display function, which indicates system malfunctions by DTC display; and a PID/data monitoring function, which reads out specific input/output signals.

• Using the WDS or equivalent, DTCs can be read out and cleared, and the PID/data monitoring function can be activated.

On-board Diagnosis System PID/Data/Monitor Function Operation

On-board Diagnostic Function

Malfunction detection function

• Detects overall malfunctions in the keyless entry system-related parts.

Display function

• If any malfunction is detected, the keyless warning light (red) in the instrument cluster illuminates to inform the driver of a system malfunction.

Memory function

• Stores malfunctions in the keyless entry system-related parts detected by the malfunction detection function, and the stored malfunction contents are not cleared even if the ignition switch is turned to the LOCK position or `the negative battery cable is disconnected.

(continued)

DTC WDS or equivalent display	System Malfunction location
B1342	Keyless control module internal malfunction
B1134	Unprogrammed card key
B2477	Configuration error
B1317	Keyless control module power supply voltage increases.
B1318	Keyless control module power supply voltage decreases
B2170	Push switch (Steering lock unit)
B1126	Steering lock unit internal malfunction
U0236	Steering lock unit communication system
B1093	Steering lock unit communication error
U0214	Keyless receiver
B1133	Keyless antenna (exterior, RF)
B1132	Keyless antenna (exterior, LF)
B1127	Keyless antenna (Interior, trunk)
B1128	Keyless antenna (Interior, rear)
B1131	Keyless antenna (exterior, rear)
B1129	Keyless antenna (Interior, middle)
B112A	Keyless antenna (Interior, front)
U0323	Communication error to instrument cluster
U0100	Communication error to PCM
U0073	Control module communication error
U2023	Error signal from CAN related module
B1681*	No detected communication with the coil antenna.
B2103*	Coil malfunction

PID/data monitor function

- The WDS PID/data monitor function selects the input/output signal monitor items preset in the keyless control module and displays them in real-time.

- Use the WDS or equivalent to read the PID/data monitor.

(continued)

On-board Diagnosis System PID/Data/Monitor Function Operation (continued)

PID/data monitor table

PID Name	Data Contents	Unit/Operation	Terminal
DTC_CNT	Number of continuous DTCs	–	–
RPM	Engine speed	RPM	4Z, 4AA
VSS	Vehicle speed	KPH	4Z, 4AA
VPWR	Supply voltage	V	1F
NUMCARD	Number of programmed card keys	–	–
NUMKEY*	Number of programmed key ID numbers	–	–
DRSW_D	Door switch (driver's door)	CLOSE/OPEN	4T
DRS_P	Door switch (passenger's door)	CLOSE/ OPEN	4Q
REQ_SW_R	Request switch (right side door)	On/Off	4H
REQ_SW_L	Request switch (left side door)	On/Off	4J
REQ_SW_BK	Request switch (trunk lid)	On/Off	4L
LOCK_SW_D	Door lock-link switch (driver's side)	On/Off	4I, 4E
CLS_LOCK	Door lock switch (lock)	On/Off	4B
CLS_UNLOCK	Door lock switch (unlock)	On/Off	4B
KCS_LOCK	Key cylinder switch (lock)	On/Off	4G
KCS_UNLOCK	Key cylinder switch (unlock)	On/Off	4G
IMMOBI	Immobilizer system equipment or not	On*/Off	–
TR/LG_SW	Trunk compartment light switch	CLOSE/OPEN	3Z
IG_KEY_IN	Key reminder switch	Key-In/Key-Out	3O
IG_SW_ST	Ignition switch (push switch)	Pushed/Not Pushed	3N
BUZZER	Keyless buzzer	On/Off	4Y
PWR_IG1	Power supply (IG1)	On/Off	3B
PWR_ACC	Power supply (ACC)	CLOSE/OPEN	3I
HOOD_SW	Hood latch switch	On/Off	4V
LOCK _SW_P	Door lock-link switch (passenger's side)	On/Off	4R

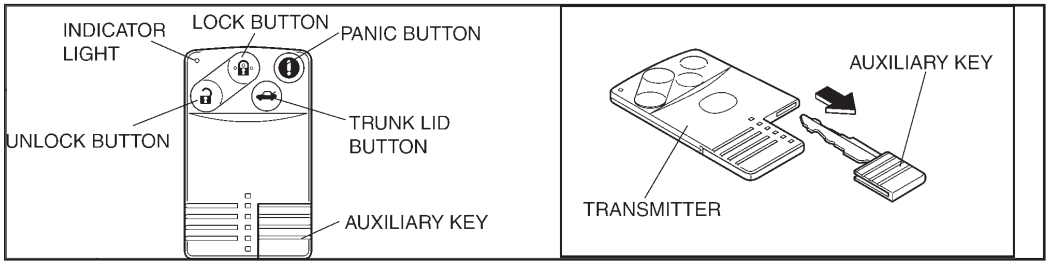
Simulation Function

• The simulation function selects simulation items of output parts preset in the keyless control module and to operate them regardless of control.

Active Command Mode Table

Command name	Data Contents	Unit/Operation	Terminal
BZR_OUT	Keyless beeper	On/Off	4Y
BZR_INN	Interior buzzer (Instrument cluster)	On/Off	4Z, 4AA
LNP_RED	Keyless warning light (red)	On/Off	4Z, 4AA
LNP_GREEN	Keyless indicator light (green)	On/Off	4Z, 4AA
HAZARD	Hazard warning light	On/Off	4N
HORN	Horn	On/Off	4U
ANT_RF	Keyless antenna (exterior, RF)	On/Off	2A, 2B
ANT_LF	Keyless antenna (exterior, LF)	On/Off	2C, 2D
ANT_BK	Keyless antenna (exterior, rear)	On/Off	2E, 2F
ANT_INN1	Keyless antenna (Interior, trunk)	On/Off	2G, 2H
ANT_INN2	Keyless antenna (Interior rear)	On/Off	2I, 2J
ANT_INN3	Keyless antenna (Interior, middle)	On/Off	2K, 2L
ANT_INN4	Keyless antenna (Interior, front)	On/Off	3G, 3H
DR_LOCK	All doors lock	Off/Lock	1A, 1C
DR_UNLOCK	All doors unlock	Off/Unlock	1A, 1C
2STG_UNLK	All doors unlock	Off/Unlock	1A, 1D

Active Command Mode Table



• The card-type transmitter is thin and convenient to carry.

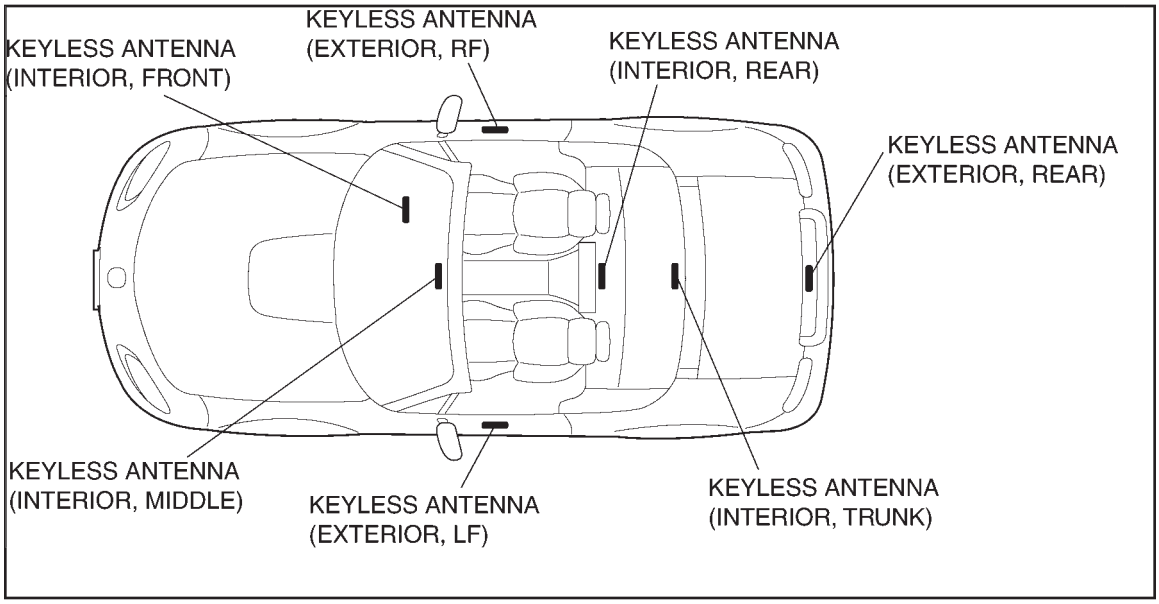
• A maximum of six transmitters can be programmed (with WDS or equivalent) for one vehicle. Refer to WSM 09-14A-19 for programming instructions.

• A built-in operation indicator light illuminates according to LOCK/UNLOCK button operation and request signal from the vehicle.

• In case the transmitter is inoperable due to battery depletion, it is possible to unlock/lock the doors and to start the engine using the auxiliary key.

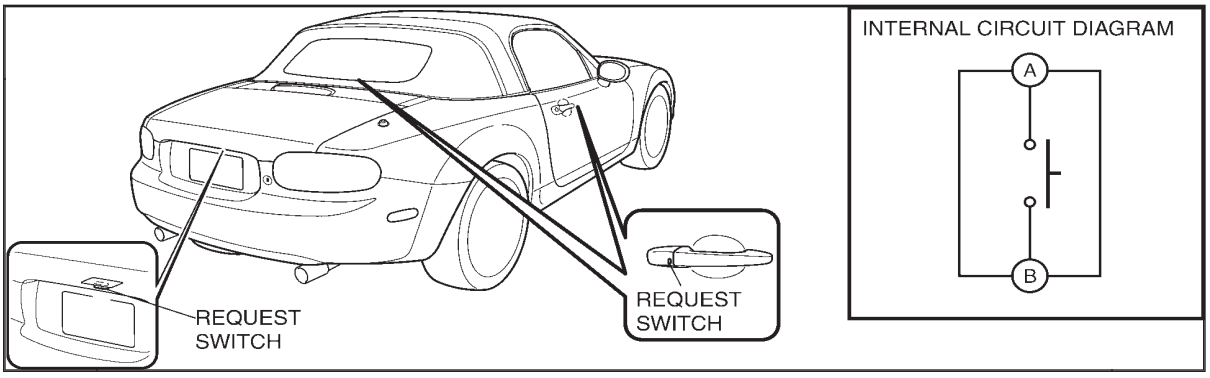
• The auxiliary key has a built-in transponder for vehicles with the immobilizer system.

Keyless Antenna Construction/Operation



- Consists of the antennas for request signal output (7 locations).
- Operated by the keyless control module, the keyless antennas send request signals to produce the reception areas inside and outside the vehicle.
- The keyless antennas built-into the front doors can output signals to both inside or outside the vehicle, and change the level of the radiowave (output to inside or outside the vehicle) according to operation conditions.
- The keyless control module locates the card key by determining the antenna which is receiving the signal the strongest.

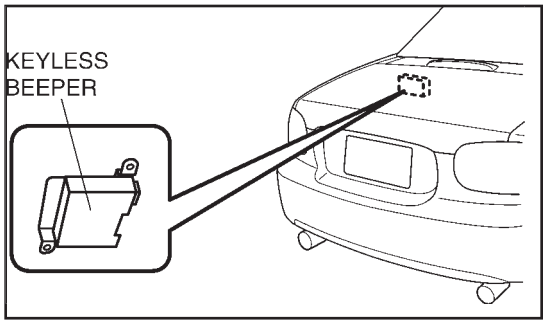
Request Switch Construction



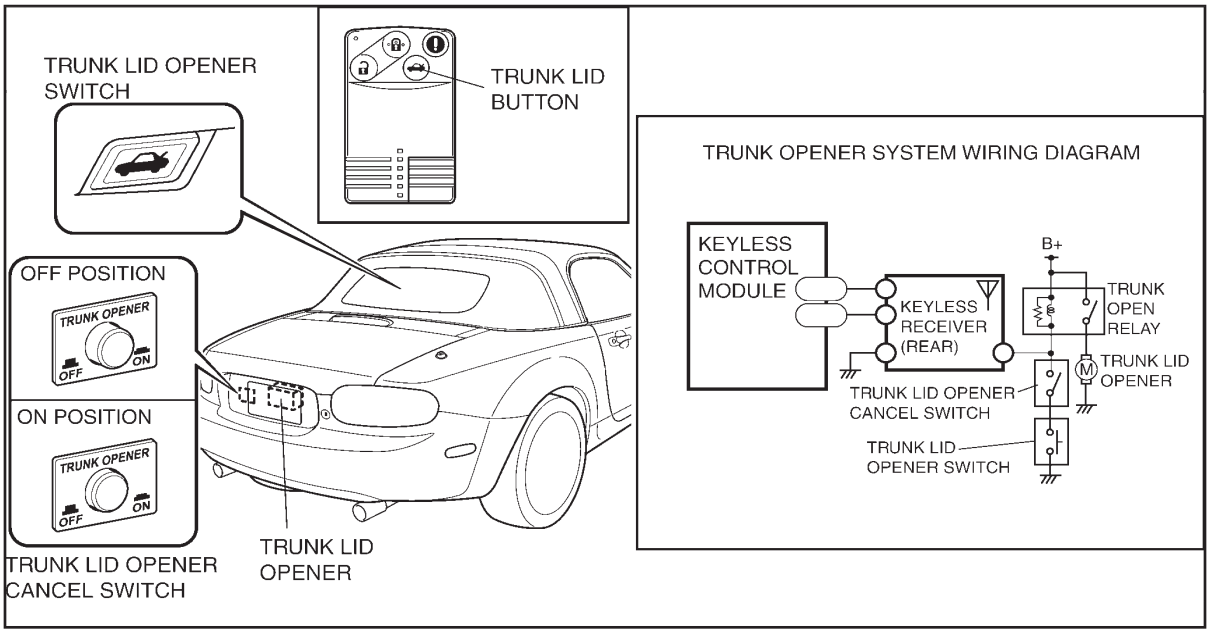
- Installed on both doors and trunk lid.

Keyless Beeper Construction

- The keyless beeper is located in the trunk compartment.



Trunk Lid Opener System Construction/Operation

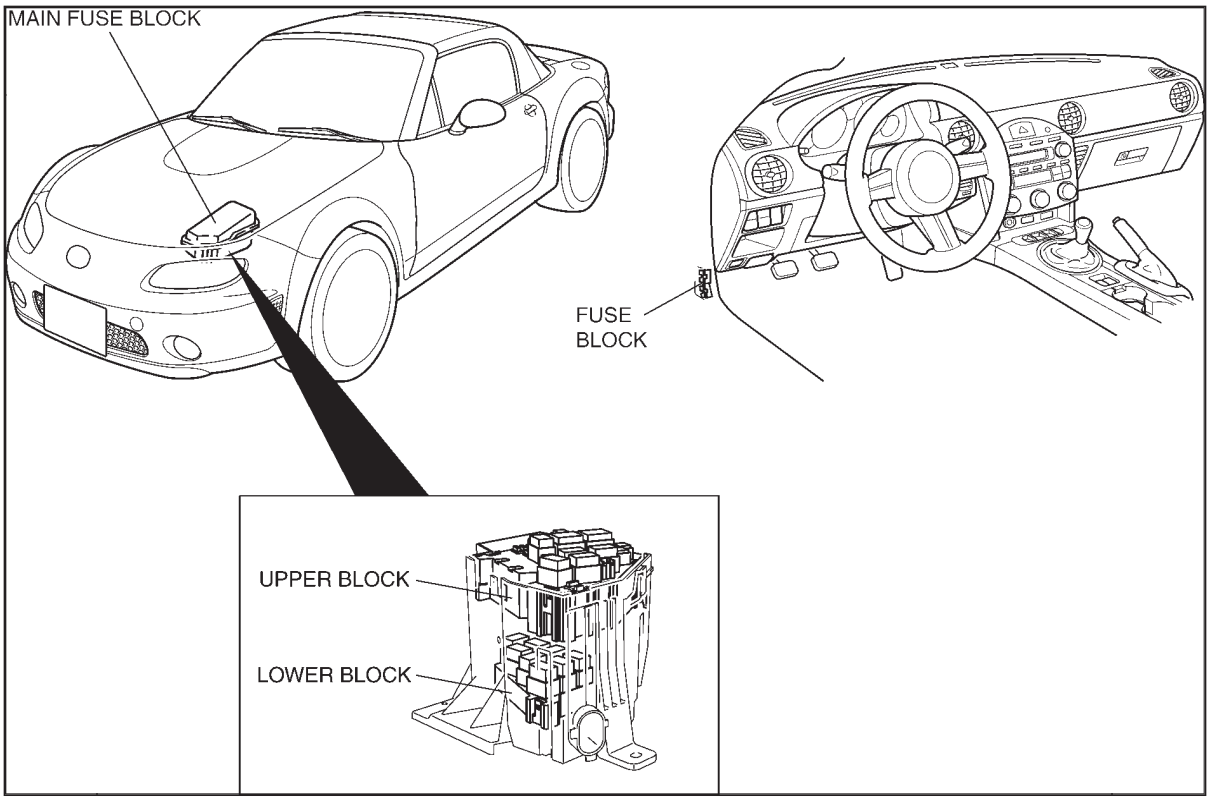


- The following items can open the trunk lid:
  - — Key
  - — Transmitter
  - — Trunk lid opener switch
  - — Trunk lid request switch

Power Systems Outline

- The main fuse block is a double layered type.

Power Systems Structural View



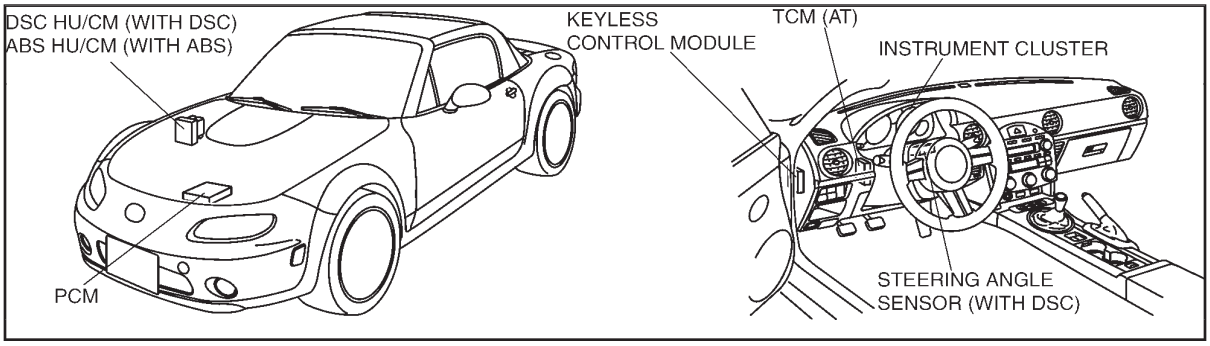
Controller Area Network (CAN) System Outline

• The CAN simplifies multiplex signal transmission between electrical modules.

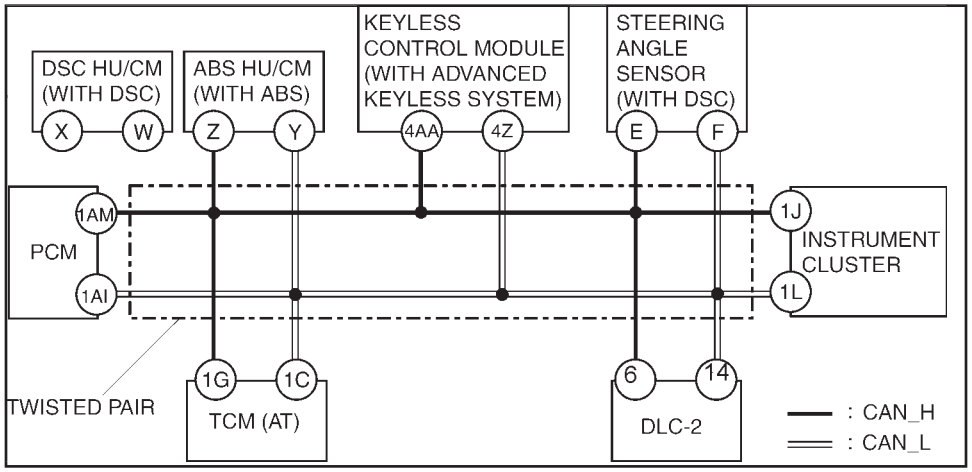
• The following modules use twisted-pair wiring for connections. (Each electrical module hereafter referred to as a CAN system-related module):
  — PCM
  — TCM
  — DSC HU/CM (with DSC)
  — ABS HU/CM (with ABS)
  — Keyless control module (with advanced keyless system)
  — Steering angle sensor (with DSC)
  — Instrument cluster

• With an on-board diagnostic function included for each multiplex module, display of DTCs using the WDS or equivalent has improved serviceability.

CAN System Structural View



CAN System Wiring Diagram



Programmable Module Installation

Module	Programmable Module Installation	Module Reprogramming
PCM	X	X
TCM	X	X
RCM	X	
TPMS	X	
IC/HEC	X	
RKE/AKES	X	
ABS/DSC/TCS	X	

Technician Name _____

Activity No.4: Pressure-based Evaporative System Diagnosis

Purpose: In this activity, you will use WDS and the evaporative system tester to diagnose a leak.

What you will need to complete this activity:

- WDS
- Mazda Approved Evap Tester # 134-01049
- MX-5 Miata

Procedure 1: WDS Evap Test

1. Connect WDS, turn the ignition ON, and ID the vehicle.

2. Select Toolbox – Powertrain – Fuel – Evap Test, then press the tick.

3. Confirm the boxes for Barometric Pressure (Baro), Fuel Level Input (FLI), Intake Air Temperature (IAT), and Battery Voltage (VBAT) are all shaded green. Record the readings in the boxes.

BARO	FLI	IAT	VBAT

4. Press the tick.

5. The “Do you wish to continue with the diagnostics?” appears. Select YES.

6. Press the tick to bypass the “Drive the vehicle or let the engine idle more than 20 minutes” screen.

7. The “Turn the ignition off” screen appears. Press the tick.

8. The “Turn the ignition on” screen appears. Press the tick.

9. Press the tick to bypass the “Evap Test” information screen.

NOTE
Wait. WDS is performing the leak test. Once the test is completed, the screen will change.

10. Record the test results in the boxes.

Small Leak	Very Small Leak	LDP – REF	LDP – IDL

Did the evap test indicate there are any fault codes detected? YES NO

If YES, what code(s)? _____ Continue to step # 12

If NO, contact the instructor to review activity set-up. After the instructor completes the review, press the tick and follow the screen instructions to rerun the evap test.

11. Select the System Option icon  , press EXIT, then press the tick.

NOTE
Exiting the Evap Test mode returns the WDS to the Vehicle Specifications screen.

Mazda Approved Evap Tester # 134-01049
Use WDS with the evap tester to pressurize the system and introduce smoke. Follow procedures 2, 3, and 4 to locate the leak.

Procedure 2: Self- test Instructions

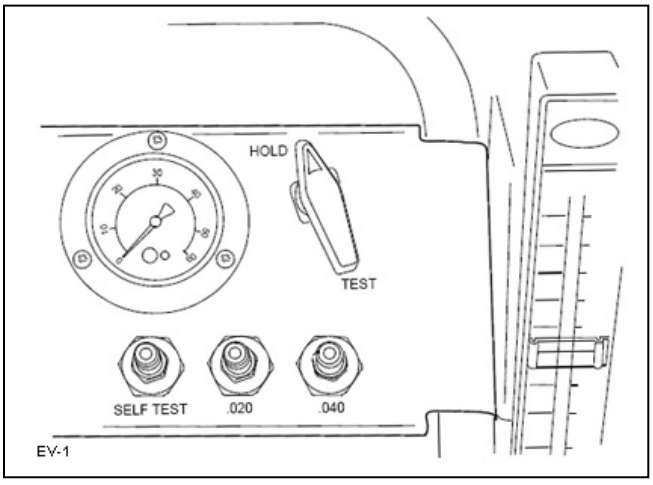
1. Make sure the nitrogen tank is properly positioned and secured to the evap tester.

2. Confirm the control valve on the panel is in the hold position and open the nitrogen bottle.

3. Connect the vehicle interface hose to the self-test port on the panel. Do not over tighten the hose.

4. Turn the control valve to the test position. The gauge should read 14” of water (+/- 1” of H2O).

5. Turn the control valve to the hold position.



6. Verify the gauge holds pressure and that the flow meter reads “no flow”. No flow indicates the tester passed self-test. If the tester didn’t pass, contact the instructor.

Procedure 3: Performing the Evaporative Test

1. Remove the fuel filler cap.

2. Select the correct cap adapter for the vehicle from the chart.

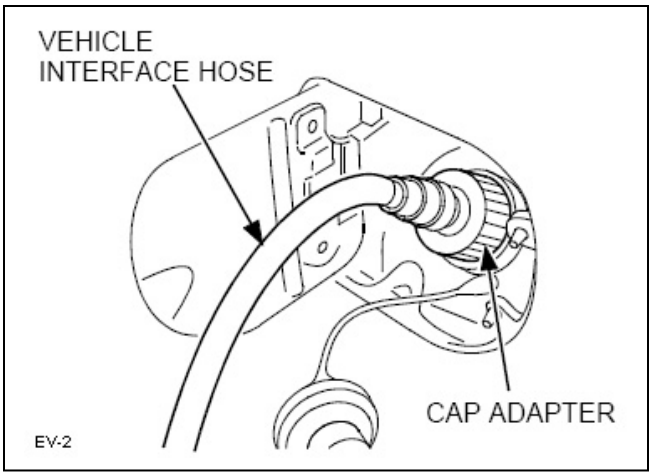
Model / Adapter	134 – 01050	134 – 01052	134 – 01058
626	X		
Mazda6			X
Miata	X		
Millenia	X		
MPV	X		
Protege	X		
RX-8			X
Tribute		X	
Truck		X	

3. Install the correct cap adapter into the fuel filler neck.

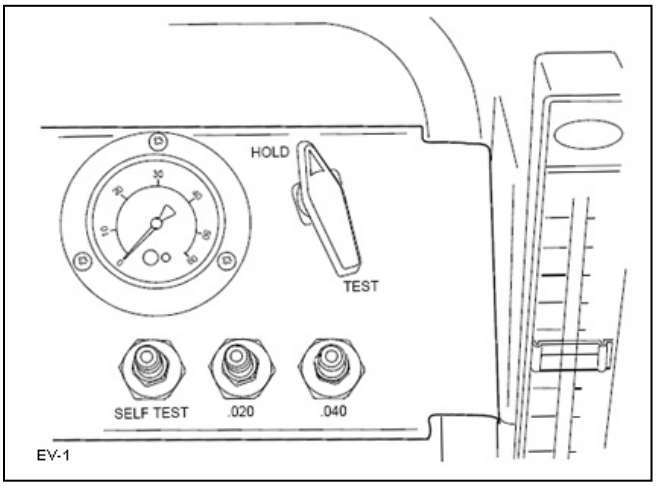
4. Connect the interface hose to the cap adapter and hand tighten it. Don not over tighten.

5. Perform Mode 8 to seal the evaporative system. (Refer to page 5 for Mode 8 instructions)

6. Make sure the control valve is in the hold position and the valve on the nitrogen cylinder is open.



7. Turn the control valve to the open position and let the system fill. There should be a drop in pressure along with the flow meter being pegged at maximum. The length of time the flow meter is pegged will vary depending on how full the tank is and how long it takes to fill and pressurize the emission system.



8. Check the pressure gauge and flow meter readings to determine if there is a leak.
   No Leak: There is “zero flow” on the flow meter and the pressure gauge returns to the pre-set pressure of 14” of water (H2O).
   Leak: When measuring the flow the pressure does not return to the pre-set level of 14” of water (H2O).

9. Connect the smoke generation unit.

Procedure 4: Using the Smoke Generation Unit

NOTE
Never use the smoke generation unit until you have determined a leak exists in the vehicle’s evaporative system. The smoke requires flow from a leak to properly carry the smoke through the system.

1. Ensure the following conditions are met before proceeding.
   - The evap tester must already be connected to the vehicle using one of the test modes.
   - The nitrogen valve must be open.
   - The control valve must be turned to the test position.
   - Make sure the smoke generation unit is filled with the correct type of smoke generation oil (134-01057).

2. Connect the smoke generation battery leads to the vehicle’s battery.

3. Press the remote smoke trigger to fill the system with smoke.

4. Look for signs of smoke around the vehicle emission components, fittings, and connectors.

   Is there a leak? YES NO

   If YES, where is the leak? _____ Repair the leak.

   If NO, keep looking!

5. Run the WDS Evap Test again to confirm a successful repair.

6. Record the test results in the boxes.

Small Leak	Very Small Leak	LDP – REF	LDP – IDL

Did the evap test indicate there are any fault codes detected? YES NO

7. Disconnect WDS and the evap tester.

WDS Mode 8
Mode 8 activates the Leak Detection Pump Change-Over Valve (COV) to seal the evaporative system from atmosphere.

1. Select Toolbox – Powertrain – OBD Test Modes – Mode 8 On-board Device Control, then press the tick.

You should now be able to use WDS and the Mazda approved evap tester to diagnose and repair evaporative system leaks.

Instructor sign-off

Instructor initials: _____

Technician Name _____

Activity No.5: Front Wide-range Oxygen Sensor Evaluation

Purpose: In this activity, you will use WDS to monitor the front wide-range oxygen sensor and interpret results.

What you will need to complete this activity:

- WDS
- MX-5 Miata

Milliamp PID Data Characteristics

WDS Display
The WDS PID data displays the O2S11 in microamps (***µA***) and the WDS display range is set at milliamps (**mA**). Just remember there are 1000 microamps in one milliamp (1000 µA = 1mA). For example: 300 µA = .3mA

Milliamp Values and Air/Fuel Ratios
When monitoring O2S11 PID data, microamps (µA) and milliamps (mA) ***above*** zero indicate a ***lean*** air/fuel ratio. For example: An O2S11 reading of +178 µA means the air/fuel ratio is lean at that moment.
Conversely, microamps (µA) and milliamps (mA) ***below*** zero indicate a ***rich*** air/fuel ratio. For example: An O2S11 reading of -145 µA means the air/fuel ratio is rich at that moment.

Procedure

NOTE
Before starting this activity, be sure the exhaust is properly vented from the shop.

1. Start the vehicle and let idle.
2. Connect WDS and ID the vehicle.
3. Select Toolbox – Datalogger, then press the tick.
4. Select Powertrain – Engine, then press the tick.
5. Erase all the selected PIDs by pressing the “Erase” icon  .
6. Select the O2S11 PID. What display scale is used for the O2S11 PID?

   _____
7. Select the RPM PID.
8. Press the tick.
9. Press “O2S11” on the WDS screen so that the black bars are above and below the O2S11 PID.
10. Select the “Plots, Formats, and Range” icon  located on the right-hand side of the screen to confirm range is set correctly.
11. On the O2S11 mA screen, what are the high and low display ranges set at?

    HIGH _____ LOW _____ (Settings: HIGH = 2.0mA LOW = 2.0mA)
12. Press the tick.
13. Now select the Record Times” icon  and set the Capture Buffer Duration at 30 seconds.
14. Press the tick.
15. For 20 seconds, rev the engine up and down between 2,000 and 4,000 RPMs.
16. After 20 seconds, let the vehicle return to idle and select the

    Record Function” icon  on the right-hand side of the screen.

17. Select the “Playback Display” icon  located on the lower left portion of the WDS screen.

18. Press “O2S11” on the WDS screen so that the black bars are above and below the O2S11 PID.

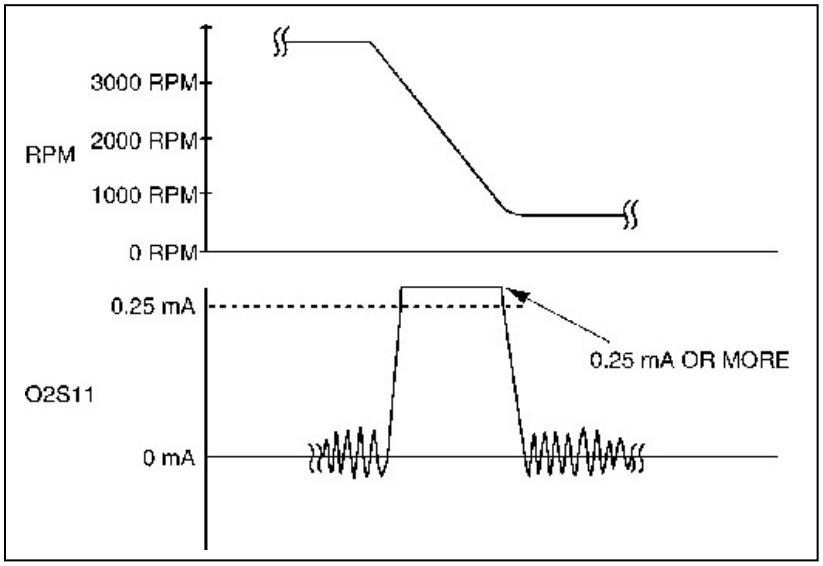
19. Using the arrows in the playback display, move the vertical line to the **highest** recorded O2S11 reading.

    What is the reading? _____ µA or mA

20. Using the arrows in the playback display, move the vertical line to the **lowest** recorded O2S11 reading.

    What is the reading? _____ µA or mA

The illustration below is from the workshop manual Front HO2S Current Inspection section.



21. Did your highest recorded O2S11 reading exceed the specification shown in the illustration?

    YES NO

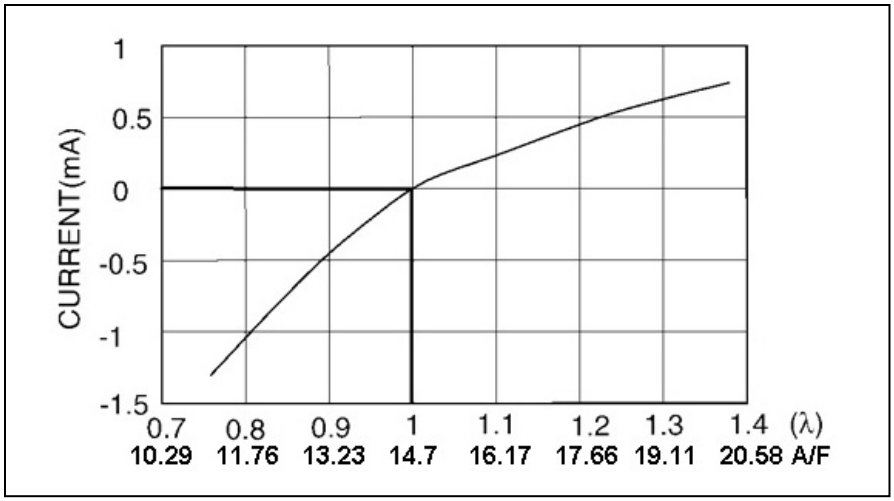
22. Is the front linear oxygen sensor functioning properly?

    YES NO

23. Using the arrows in the playback display, move the vertical line to the **highest** recorded O2S11 **idle** reading.

    What is the reading? _____ µA or mA

24. On the chart below, mark the spot where the idle reading would be placed.



λ = Lambda value A/F = Stoichiometric air/fuel ratio of 14.7

25. What would you estimate your highest idle reading is when converted to an air/fuel ratio?

    _____

Instructor sign-off
You should now be able to monitor and record wide-range oxygen sensor operation and interpret the results.

Instructor initials: _____

Technician Name _____

Activity No.6: Power Plant Frame Height Inspection and Adjustment Procedure

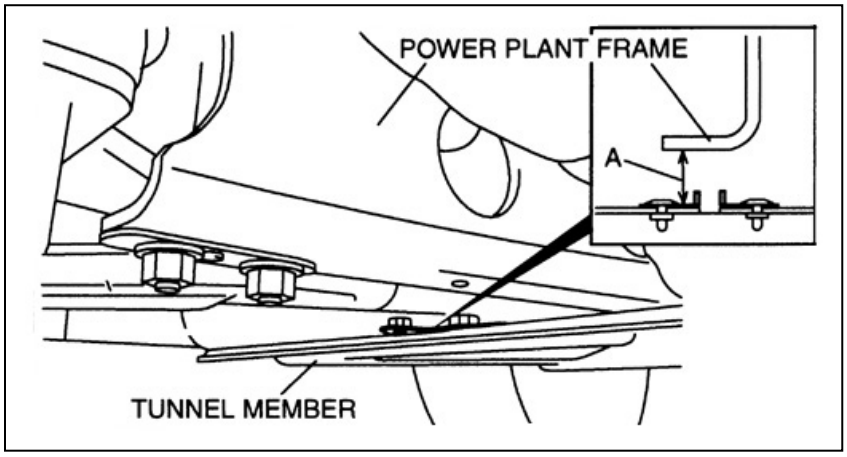
Purpose: In this activity, you will inspect for correct or incorrect PPF height measurement, adjust as necessary, and confirm measurement adjustment.

What you will need to complete this activity:

- MX-5 Miata
- Hand tools
- Tape measure
- ESI

1. Access ESI, find the Power Plant Frame (PPF) installation procedure and print the procedure.

2. Go to the MX-5 Miata located on the hoist and measure dimension A represented in the illustration.



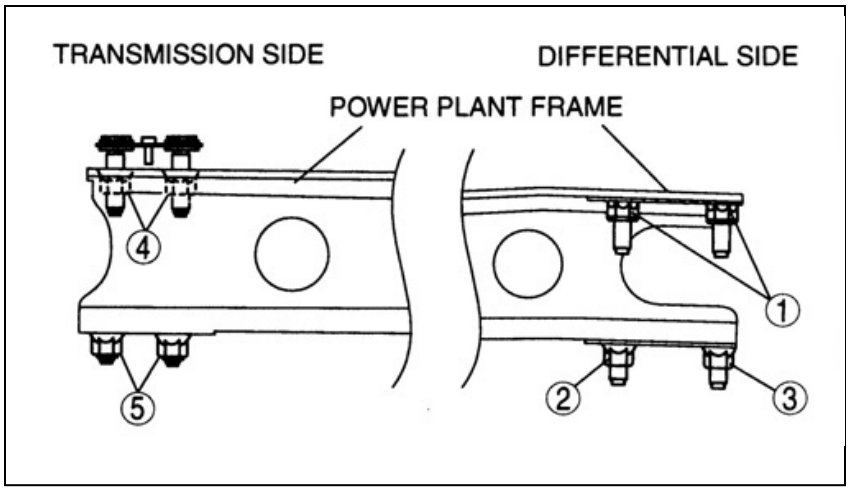
3. What is measurement A? _____

4. Is measurement A out of specification? YES NO

5. If no, no further adjustment is required. If yes, proceed to step #6.

NOTE
To facilitate this activity, the PPF bolts have been started by hand.

6. Temporarily tighten nuts 1, 2, 3 in the order shown.

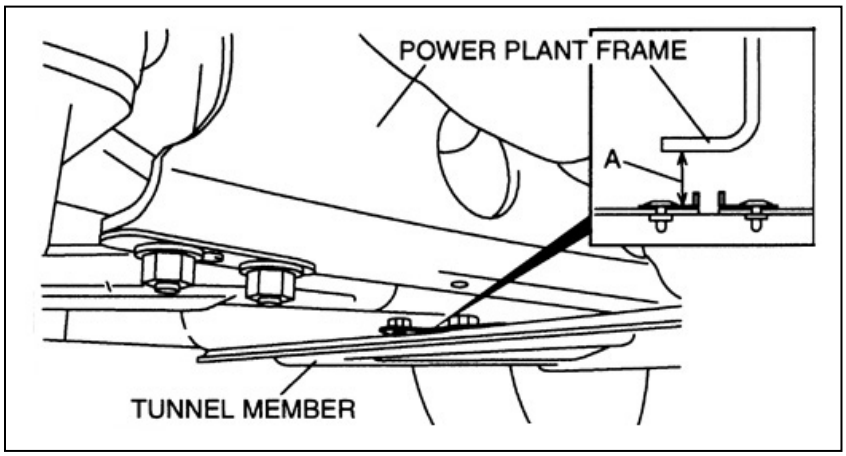


7. Tighten nut 2 until the PPF is seated against the rear differential.

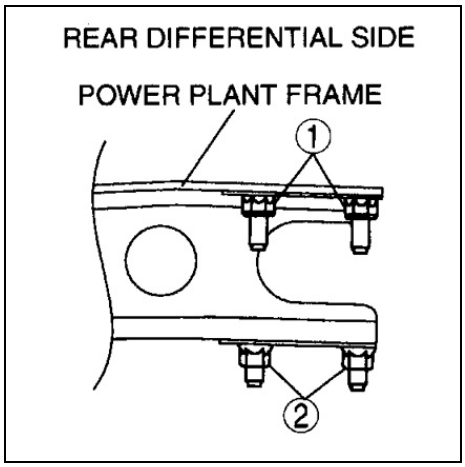
8. Temporarily tighten nuts 4 and 5 in the order shown.

9. Raise the front of the PPF (transmission side) or the transmission with the transmission jack and adjust dimension A to the workshop manual dimension.

10. What is the desired dimension? _____

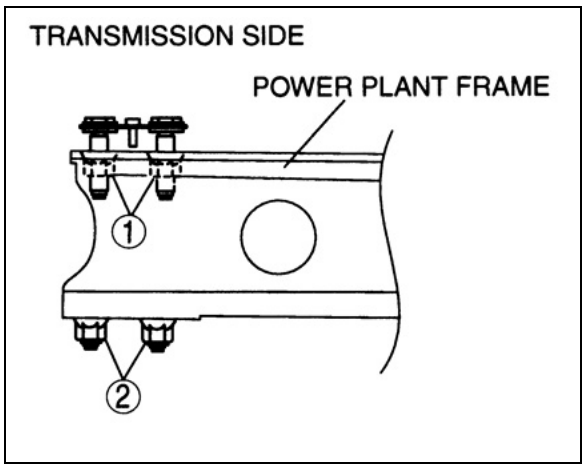


11. Tighten the nuts on the rear differential side in the order shown.



12. What is the workshop manual tightening torque? _____

13. Tighten the nuts on the transmission side in the order shown.



14. Verify that dimension A is within the specification with the transmission jack removed. If it is not, adjust dimension A again.

Instructor sign-off
You should now be able to properly adjust the PPF after transmission or differential removal.

Instructor initials: _____

Technician Name _____

Activity No.7: SJ6A-EL Fluid Level Inspection Procedure

Purpose: In this activity, you will perform the fluid level inspection procedure.

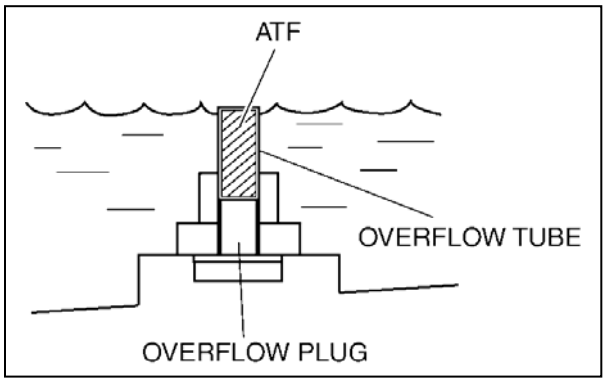
What you will need to complete this activity:

- MX-5 Miata with automatic transmission
- WDS
- Jumper wire for TFT check connector
- Drain pan

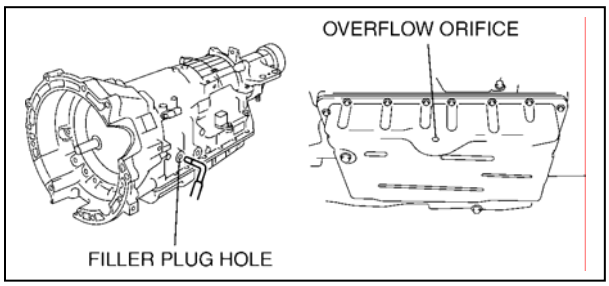
NOTE
▪ Be sure the engine and transmission are cool before proceeding with this procedure. ▪ Set the emergency brake. ▪ Be sure the exhaust is properly vented from the shop.

Procedure

1. Raise the vehicle on the hoist and remove the overflow plug from the bottom of the pan. Confirm there is transmission fluid dripping from the overflow orifice. If there is no fluid dripping add fluid through the filler plug until it drips out the overflow.



NOTE
For this activity, there may not be fluid dripping from the overflow. Continue to the next step.



2. Lower the vehicle until the tires are approximately four inches off the ground.

3. Start the vehicle and let idle.

4. Connect WDS and ID the vehicle.

NOTE
WDS is not required to perform the fluid level inspection procedure. For this activity, we use WDS to monitor TFT and confirm AT warning light operation. For the SJ6A-EL fluid level inspection procedure, refer to the 2006 MX-5 Miata WSM page 05-13-8.

5. Select Toolbox – Datalogger, then press the tick.

6. Select Powertrain – Transmission, then press the tick.

7. Erase all the selected PIDs by pressing the “Erase” icon.

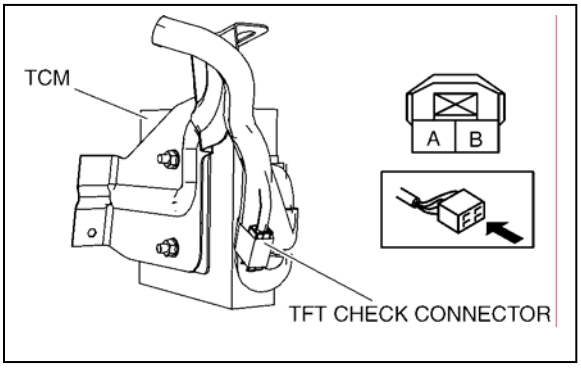
8. Select the Transmission Fluid Temperature (TFT) PID, and then press the tick.

   What is the TFT indicated by the WDS PID? _____

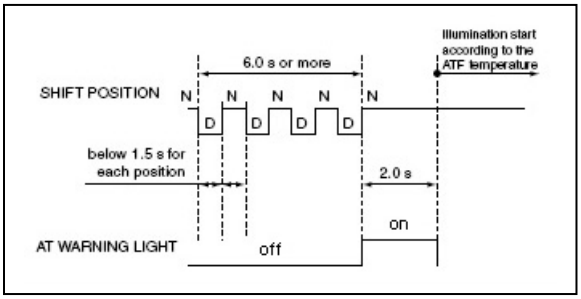
9. Shift the transmission from P to D and back to P, staying in each position for 2s or more. Perform this step two times.

10. Locate the TFT check connector taped to the harness leading to the TCM. The TCM is located under the dash, to left of the steering column.

11. Using a jumper wire, short terminals A and B of the check connector.



12. Shift from N to D and D to N within 1.5s as illustrated in the diagram. Be sure to end the cycle in the N position and watch the AT warning light in the cluster.



   After the 2.0s illumination, is the AT warning light:

   OFF ON FLASHING

   What is the TFT indicated by the WDS PID? _____

NOTE

The AT warning light only stays illuminated for 2 seconds when the transmission fluid temperature is below 122° F. Refer to chart on page 4.

13. Continue to shift from N to D and D to N while monitoring the TFT until the TFT reaches 122° F. When the TFT reaches 122° F, shift to the N position.

14. After the 2.0s illumination, is the AT warning light:

    OFF ON FLASHING

NOTE

The TFT level inspection range is 122° F – 140° F. Inside this range, the TFT warning light will stay illuminated and is okay to proceed with the level inspection. If the TFT rises above 140° F, the AT warning light will flash in 1s intervals.

15. Raise the vehicle and confirm fluid is dripping from the overflow orifice. If no fluid is dripping, add fluid through the filler plug until it drips out the overflow.

NOTE

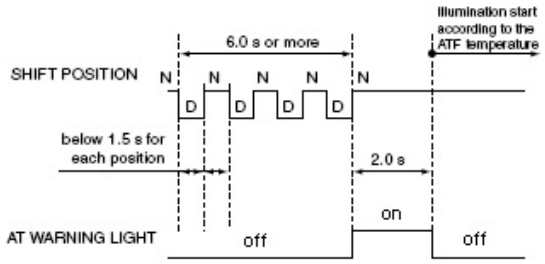
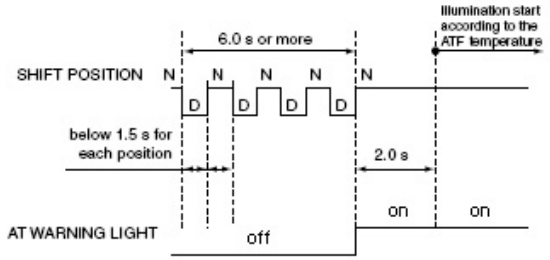
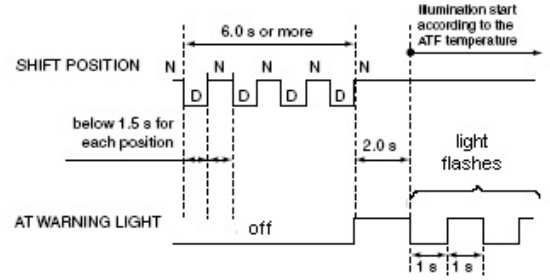
For this activity, there may not be fluid dripping from the overflow. Continue to the next step.

16. Install the fill and overflow plugs and tighten.

17. Wipe off any excess fluid.

18. Lower the vehicle, turn off the ignition, and remove the TFT jumper wire.

The following chart is from the WSM fluid level inspection procedure. Review the chart and answer the questions that follow.

ATF condition	Time chart
Below 122° F the ATF temperature is not within the level adjustment range. After performing the shift sequence, the AT warning light illuminates for 2.0s then goes out.	
Between 122° F and 140° F, the ATF temperature is within the level adjustment range. After performing the shift sequence, the AT warning light illuminates and stays on while the temperature is between 122° F and 140° F.	
Above 140° F the ATF temperature is not within the level adjustment range. After performing the shift sequence, the AT warning light flashes in 1s intervals.	

1. Below 122° F, does the AT warning light stay illuminated after 2.0s? _____

2. Between what temperatures is the fluid within the level adjustment range?

   _____

   In the adjustment range, the AT warning light is: OFF ON FLASHING

3. Above 140° F, the AT warning light is: OFF ON FLASHING

Instructor sign-off
You should now be able to properly inspect the fluid level on the SJ6A-EL transmission.

Instructor initials: _____

Data Link Connector CAN Diagnosis

1. Connect WDS and ID the vehicle.

2. Retrieve codes from All CMDTCs

3. List all the DTCs currently set.
   Be sure to scroll down the code list to view all the codes.

4. Erase the codes. To erase all the codes may take a couple KOEO or KOER cycles.

5. Perform a KOER and let idle for one minute.

6. Turn the ignition key to the OFF position, then back to ON.

7. Retrieve codes from All CMDTCs.

8. List all the DTCs that set after the KOER cycle.
   Be sure to scroll down the code list to view all the codes.

9. Turn the ignition key to the OFF position and remove the WDS cable from the DLC.

10. Connect a DLC Breakout Box (BOB) or use the appropriate male pin to make the DLC CAN connections.

Information Point
Using a DLC BOB is the best way to connect to the DLC. If a DLC BOB is not available, use the correct size male pin to connect to the DLC. Damage may result to DLC female terminal pins if DVOM probes are used to test the DLC.

11. Using a DVOM, measure the network resistance by probing the CAN_H and CAN_L circuits at the DLC BOB.

    What is the resistance? _____ Ohms

Information Point
When testing a medium-speed network (MS-CAN), be sure all the doors are closed. Open doors during MS-CAN testing will cause incorrect Ohm readings.
On a normally functioning network, the readings will be:
Resistance – Approx. 60 Ohms

12. Using the DVOM, measure CAN_H voltage by connecting the black probe to a good chassis ground and the red probe to the CAN_H circuit, then turn the key to the ON position.

    What is CAN_H voltage? _____ Volts

13. Measure the CAN_L voltage by moving the red probe to the CAN_L circuit.

    What is CAN_H voltage? _____ Volts

Information Point
On a normally functioning network, the readings will be:
Resistance – Approx. 60 Ohms

CAN_H – 2.6 +/-.2

CAN_L – 2.3 +/-.2

Data Link Connector CAN Diagnosis

14. Turn the key to the OFF position.

15. Disconnect all the modules on the network.

Information Point
Use the wiring diagram to identify the correct module connector. On modules with multiple connectors, it may be easier to disconnect just the connector containing the CAN_H and CAN_L wires for the network being diagnosed.

16. With all the modules disconnected from the network perform the following resistance tests at the DLC BOB:
    - Probe CAN_H to CAN_L
    - Probe CAN_H to Ground
    - Probe CAN_L to Ground

    Turn the key to the ON position and perform the following voltage tests:
    - Probe CAN_H to CAN_L
    - Probe CAN_H to Ground
    - Probe CAN_L to Ground

Information Point
On the resistance tests, the expected resistance is infinity / open circuit. Resistance indicates a short between CAN_H and CAN_L or a short to ground.
On the voltage tests, the expected voltage is 0 volts. Voltage indicates a short to a power source.

17. Connect one module to the network, then turn the key to the ON position.

18. Using the DVOM, measure CAN_H voltage by connecting the black probe to a good chassis ground and the red probe to the CAN_H circuit.

    What is CAN_H voltage? _____ Volts

19. Measure the CAN_L voltage by moving the red probe to the CAN_L circuit.

    What is CAN_H voltage? _____ Volts

20. Disconnect the module and turn the key to the OFF position.

21. Repeat steps # 17 through 20 for each module on the network being tested.

Information Point
Testing one module at a time on the network helps determine the integrity of the network between the connected module and the DLC.
CAN_H and CAN_L module voltage varies from module to module. For example, the voltages measured on a PCM could be:
CAN_H 2.53V
CAN_L 2.47V
An IC module could be:
CAN_H 3.29V
CAN_L 1.71V
What is important to remember is:
- CAN_H and CAN_L voltages combined will equal 5.0 volts +/- .2
- 0 voltage measured between ground and CAN_H or CAN_L indicates an open circuit.
  OR
  A faulty driver inside the module.
- Equal voltage indicates CAN_H and CAN_L are shorted together either inside the module or on the network bus.