SUBARU

Confidence in Motion

Technician Reference Booklet

Vehicle Dynamics and Driver Assist Systems

AUTOMOTIVE Youth Educational Systems PROUD PARTNER

WE SUPPORT PROFESSIONAL CERTIFICATION THROUGH THE National Institute for AUTOMOTIVE SERVICE EXCELLENCE

SUBARU UNIVERSITY

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This Technician Reference Booklet (TRB) is designed to be used in a classroom environment or as a guide for self study.
The TRB is not intended to be used as a supplement or substitute for the Subaru Service Manual. Always consult the appropriate Service Manual when performing any diagnostics, maintenance or repair to any Subaru vehicle.

Subaru of America, Inc. reserves the right at any time to make changes or modifications to systems, procedures, descriptions, and illustrations contained in this book without necessarily updating this document. Information contained herein is considered current as of May 2017.

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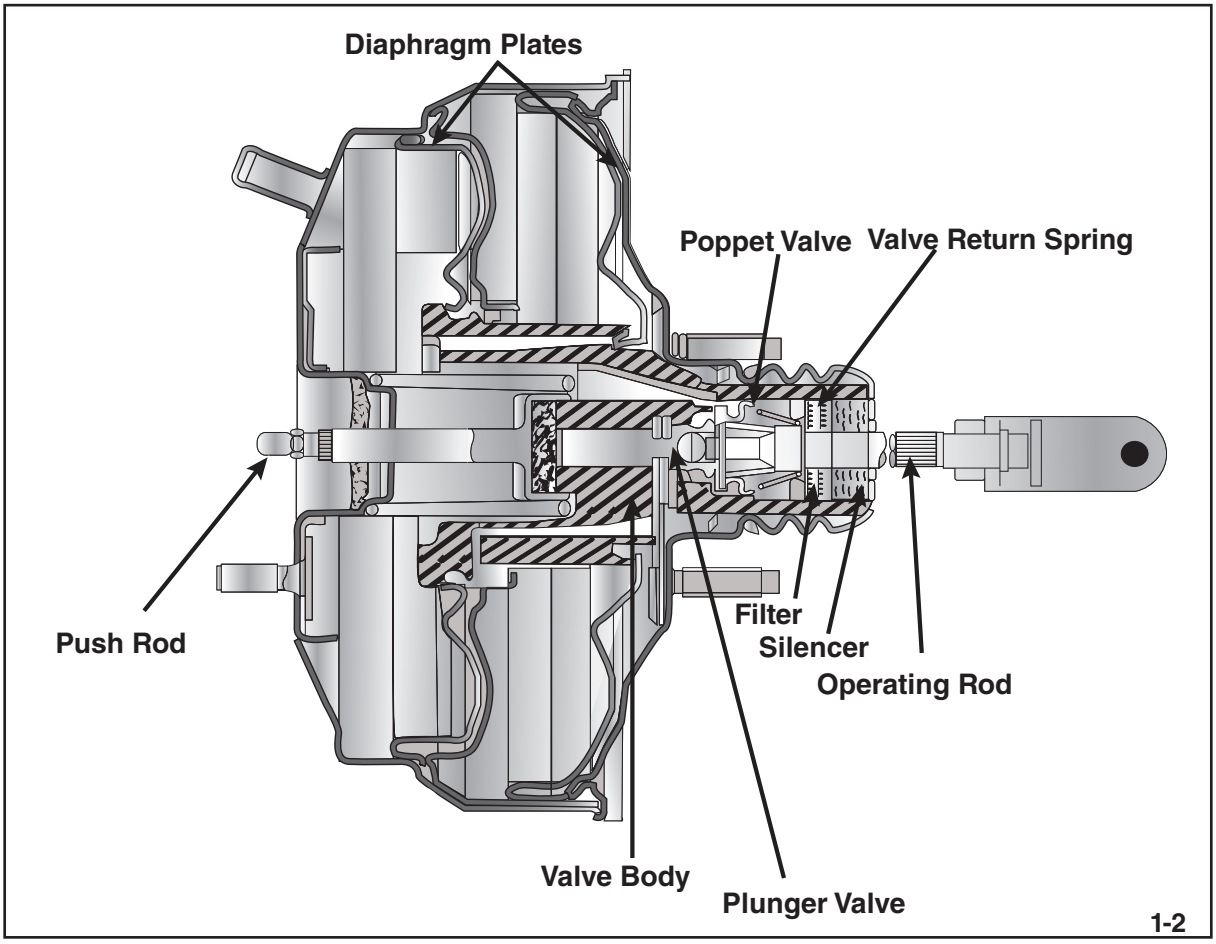
NOTES:

Brake Vacuum Pump Systems

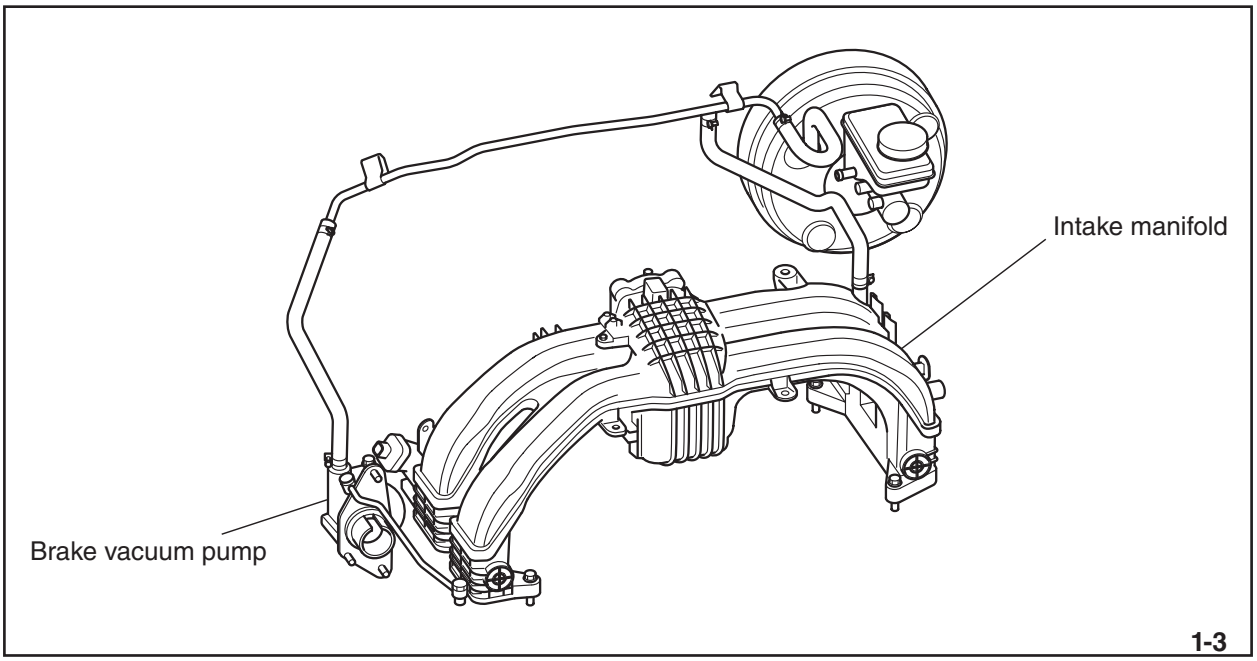
During normal braking the intake manifold vacuum creates a reservoir of negative pressure in the power brake booster. A check valve located in the vacuum hose next to the booster traps the negative pressure in the booster. This ensures that adequate negative pressure is available, even during times when the intake manifold vacuum is reduced, to assist with the braking application. Some vehicles require additional vacuum sources to provide consistent braking application during low manifold vacuum conditions. To overcome this, these vehicles utilize an additional vacuum pump to supplement the booster. Depending on the model/generation, vehicles may use a mechanically driven or electric brake vacuum pump.



Conventional Brake Booster

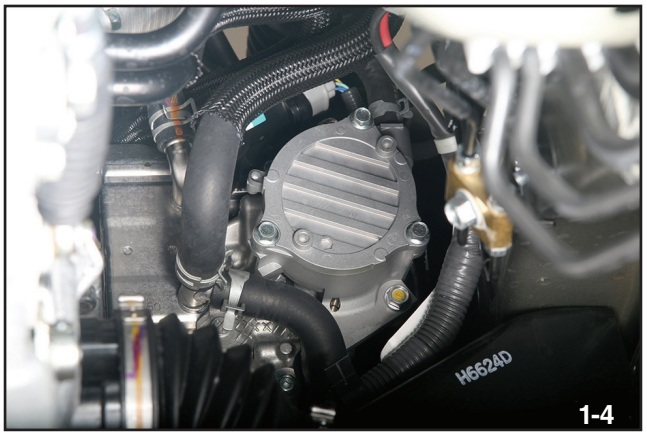
Mechanical Pump Systems

Beginning with BRZ and then on 2017MY Impreza models, a mechanical vacuum pump was installed on the passenger side cylinder head. The pump is mechanically driven by the RH Intake camshaft when the engine is rotating. The pump assists in overcoming conditions where the engine is cold, ignition timing is significantly delayed, or the altitude is very high.

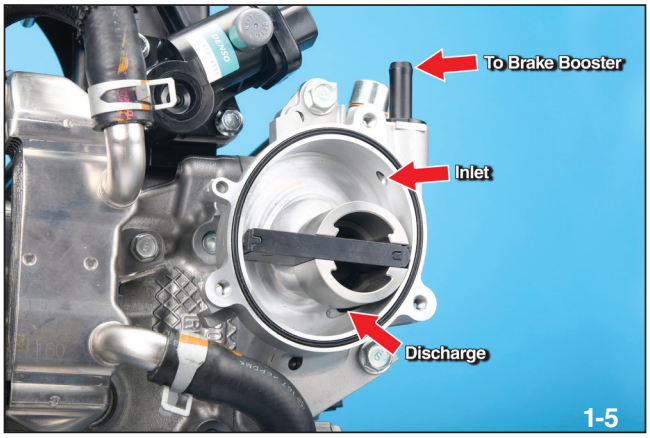


Brake Vacuum Pump System — Mechanical

As the pump rotates, air is drawn in through the inlet and discharged into the crank case.

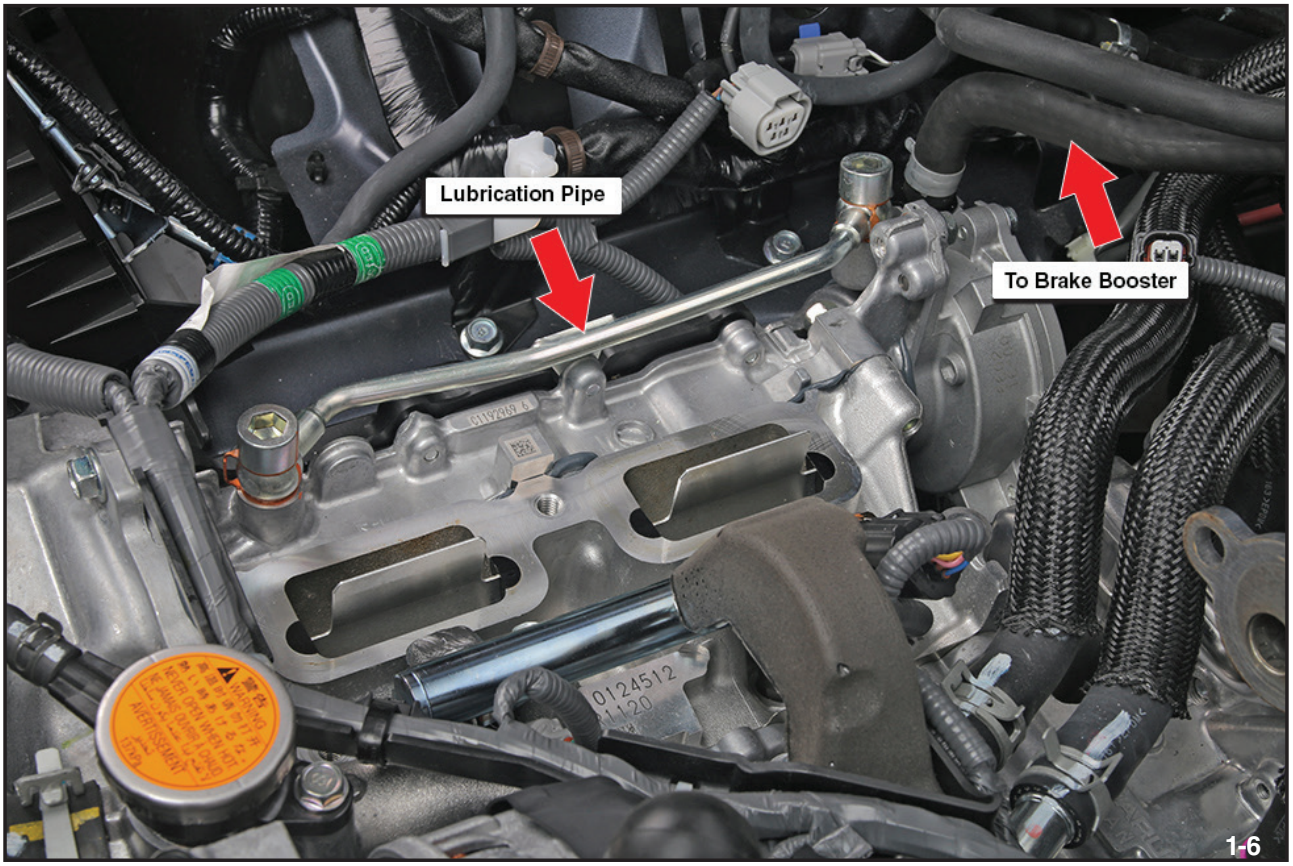


Brake Vacuum Pump



Vacuum Pump — Ports

The pump receives engine oil lubrication via a hard line located on top of the cylinder head.



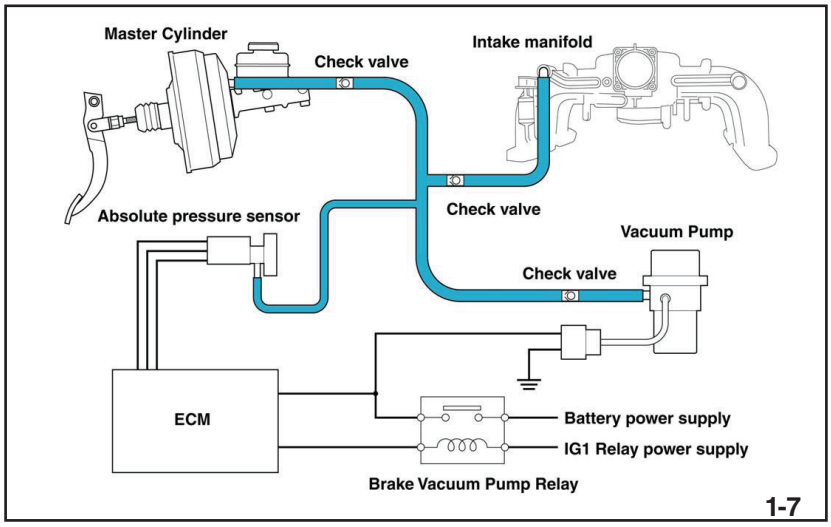
Brake Vacuum Pump — Lubrication

Note: BRZ models recommend an inspection of the Brake Vacuum Pump every 200,000 km (125,000 miles). This inspection involves a visual and performance inspection using a vacuum gauge. Consult the appropriate service manual for detailed procedure and specifications.

Electric Pump Systems (Tribeca)

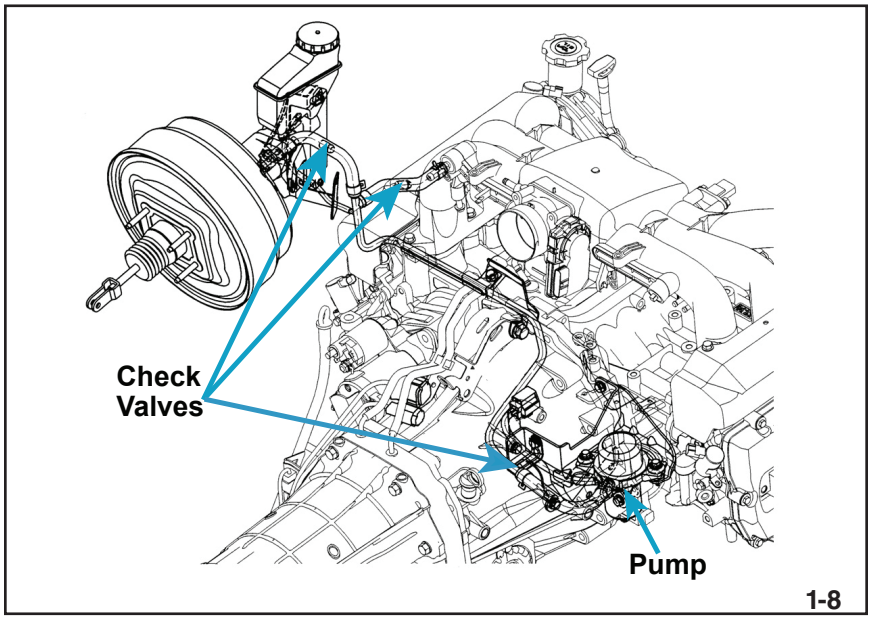
Beginning with the 2006 Tribeca, an electric brake vacuum pump was equipped to supplement engine manifold vacuum during braking in low manifold vacuum conditions. Compared to a conventional brake booster system the brake vacuum pump system contained the following additional components;

- Vacuum Pump
- Pressure Sensor
- Vacuum Pump Relay
- 2 additional check valves



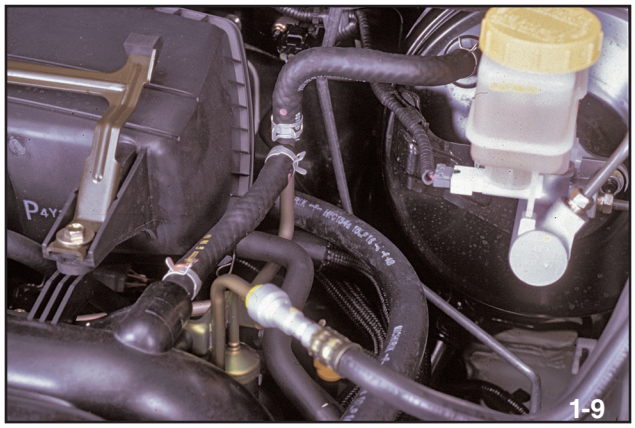
Tribeca System Overview

Two additional check valves have been incorporated into the design of this brake vacuum pump system to isolate the major components. When the vacuum pump is OFF, the check valve closest to the pump prevents the vacuum in the intake manifold from being drawn through the pump. When the vacuum pump is ON, the check valve closest to the intake manifold prevents the pump from drawing through the engine intake tract.

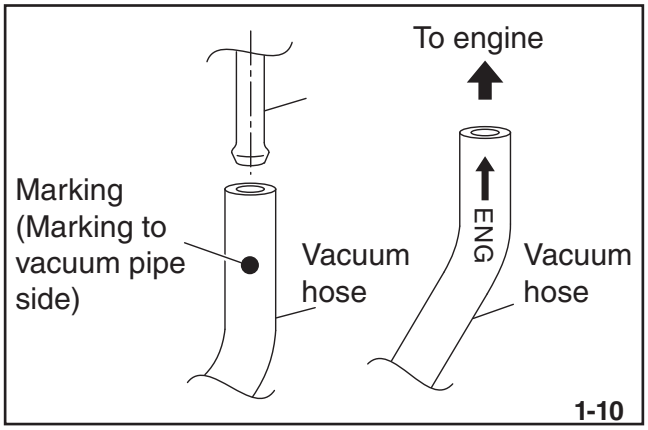


Check Valve Locations

When servicing the system, always pay close attention to the direction and or markings on the vacuum hoses. Incorrect orientation will cause the system to malfunction and not provide sufficient brake booster assist at the necessary times.



Hose Connection Points

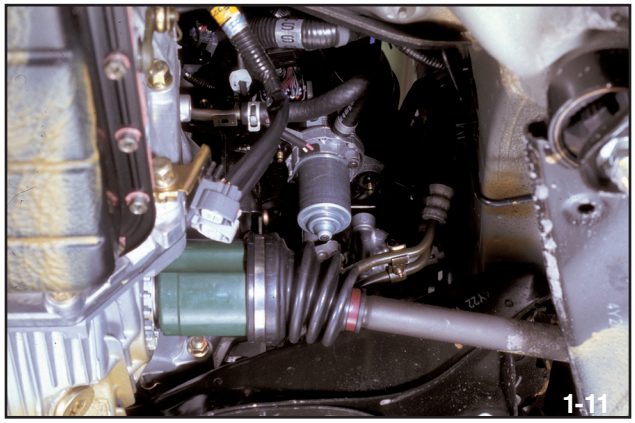


Hose Connection Cautions

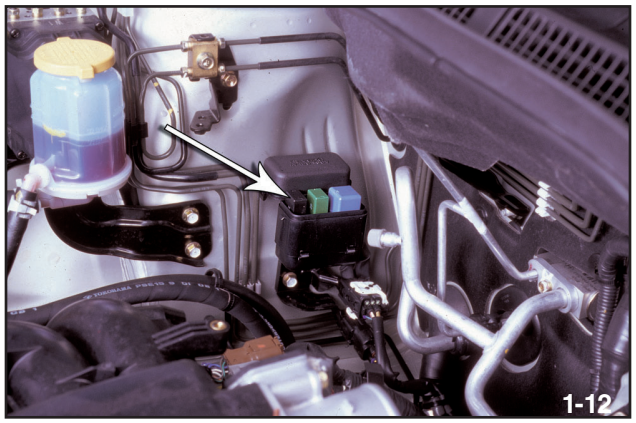
Note: Do not use the vacuum pump hose to introduce top engine cleaner chemicals into the intake manifold. Damage may occur to the vacuum pump.

The vacuum pump is located on the lower right side of the engine and is supplied voltage by the Vacuum Pump Relay. The Vacuum Pump Relay is located in the rear of the engine compartment.

Note: On Tribeca models, the vacuum pump must be removed before access to the engine/bell housing/transmission bolts can be obtained.

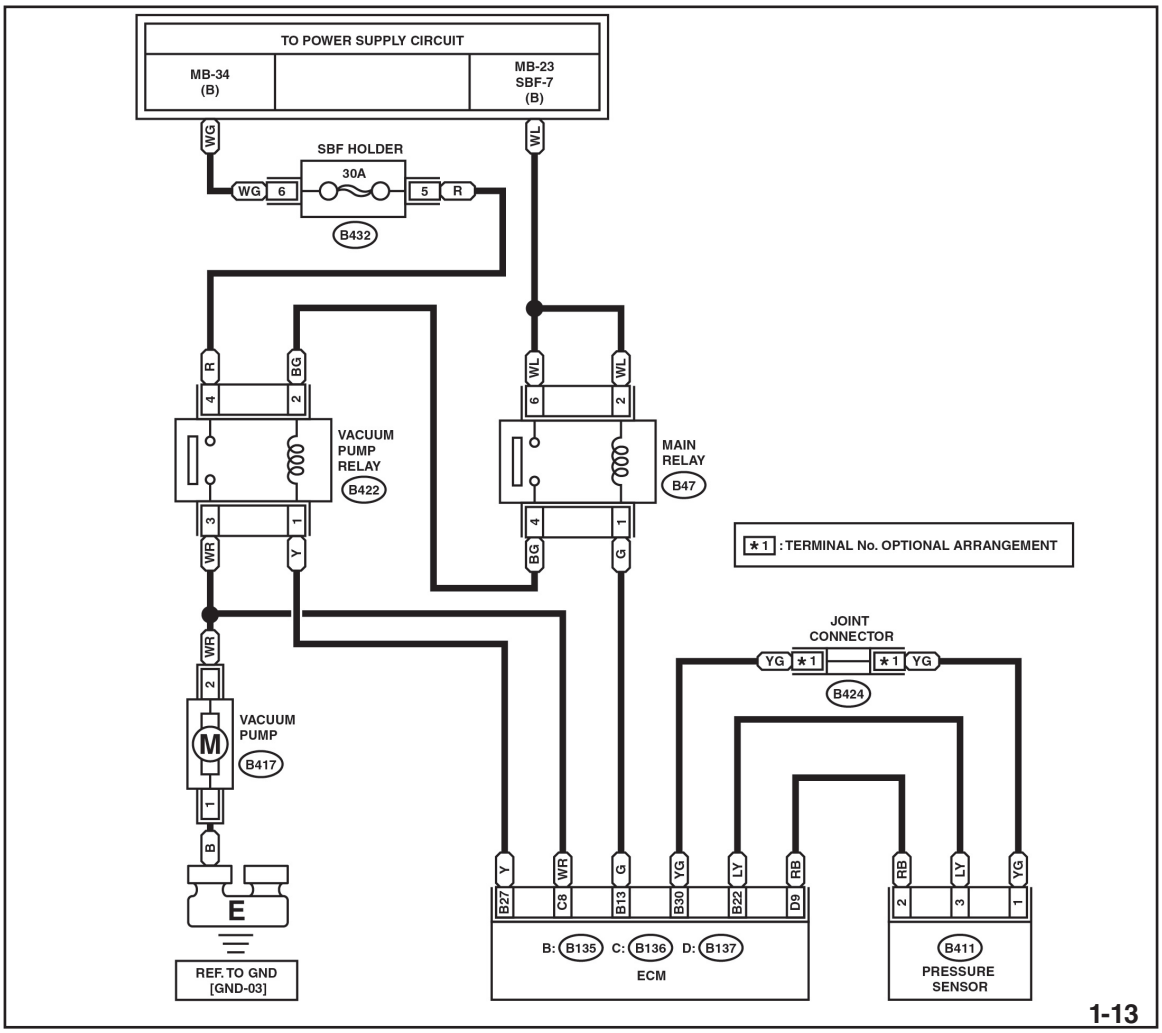


Brake Vacuum Pump Location



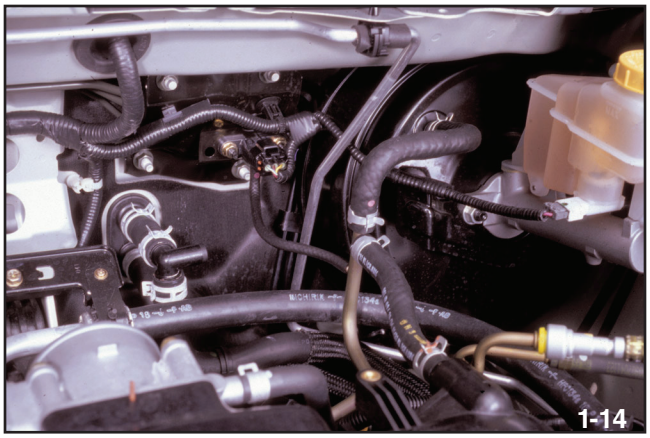
Brake Vacuum Pump Relay Location

The Vacuum Pump Relay is controlled by the Engine Control Module (ECM)



Brake Vacuum Pump Circuit

The ECM determines the correct time to energize the brake vacuum pump based on information from the brake vacuum Pressure Sensor. The Pressure Sensor is secured to the bulkhead in the engine compartment.



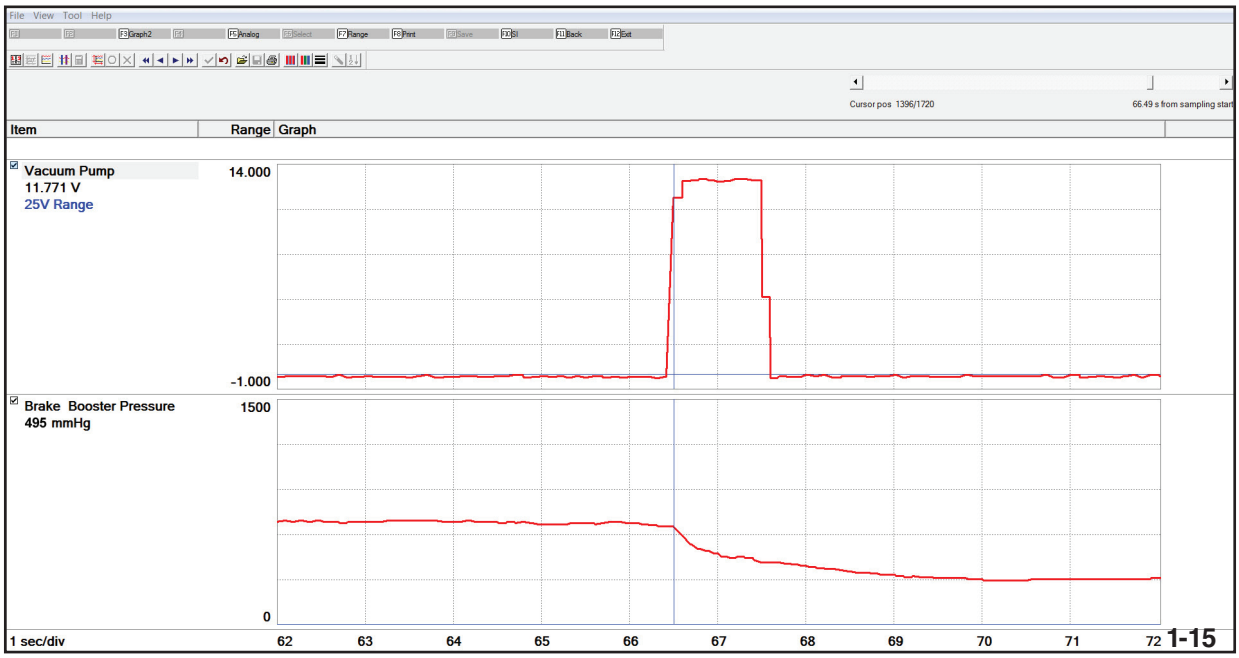
Pressure Sensor Location

Conditions where the manifold vacuum is more positive and the vacuum in the brake booster has been depleted can be divided into two situations.

The first situation is created as the vehicle is moving slowly and the brake has been applied and released several times in a short time period. This will increase the pressure in the brake booster supply line to 468 to 538 mmHg (As determined by the absolute pressure sensor).

The difference between atmospheric pressure (example 758 mmHg) and brake booster pressure must be 280 to 290 mmHg) or less. At this time the ECM will activate the brake vacuum pump relay which in turn supplies positive battery power to the vacuum pump.

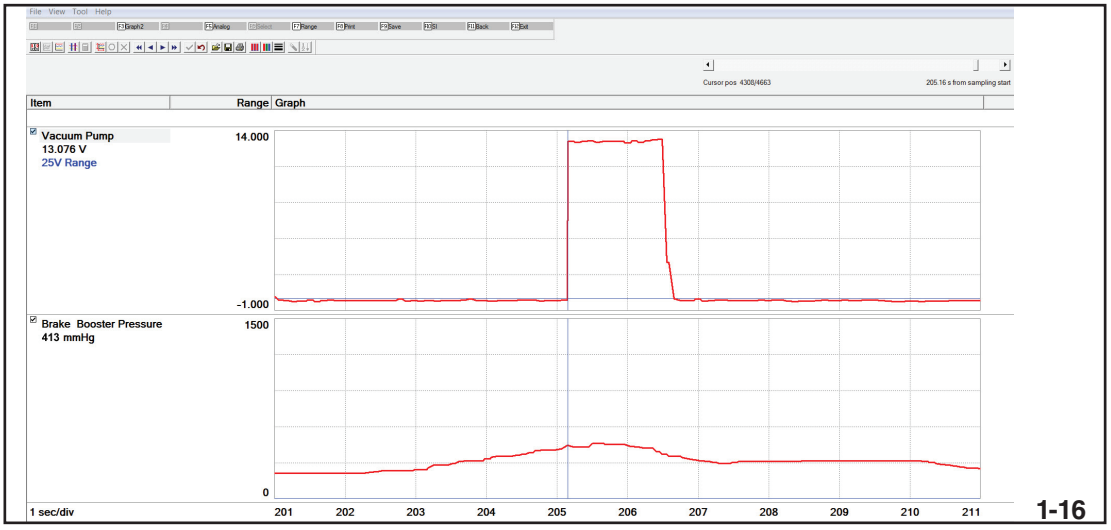
The vacuum pump will decrease the pressure in the booster vacuum supply hose. A check valve located near the intake manifold and the vacuum pump isolates the negative pressure, ensuring the negative pressure is directed only to the brake booster. The vacuum pump will continue to operate until the difference between atmospheric pressure and booster pressure is approximately 345 mmHg. (example 413 mmHg).



Vacuum Pump Operation (Situation 1)

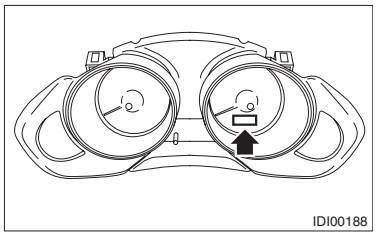
The second situation occurs only above vehicle speeds greater than 49 m.p.h. (80 km/h). A difference of 355 to 365 mmHg or less between atmospheric pressure and brake booster pressure activates the vacuum pump (for example 413 mmHg booster pressure and 758 mmHg atmospheric pressure). The pump will continue to operate until the difference between atmospheric pressure and brake booster pressure is 400 mmHg (example 358 mmHg booster pressure and 758 mmHg atmospheric pressure).

This system normally activates after the accelerator pedal has been released and requires no input from any sensors except the brake booster pressure sensor. The system can activate while the accelerator is depressed, if the brake is pressed at the same time, exhausting the negative pressure in the brake booster reservoir.



Vacuum Pump Operation (Situation 2)

Tribeca models will use the combination meter to alert the driver to malfunctions in the brake vacuum pump system. In these instances, the combination meter may display “Er bb” or Error Brake Booster.



Error code	Remarks
Er IU	Malfunction in integrated unit
Er —	Simultaneous malfunction of high/low speed CAN communication
Er HC	High speed CAN communication failure
Er LC	Malfunction of low-speed CAN communication
Er EG	EGI communication failure
Er tC	TCM communication failure
Er Ab	VDCCM communication failure
Er SP	VDCCM DTC information and vehicle speed pulse malfunction
Er SS	Wheel speed data malfunction
Er bb	Vacuum pump system malfunction

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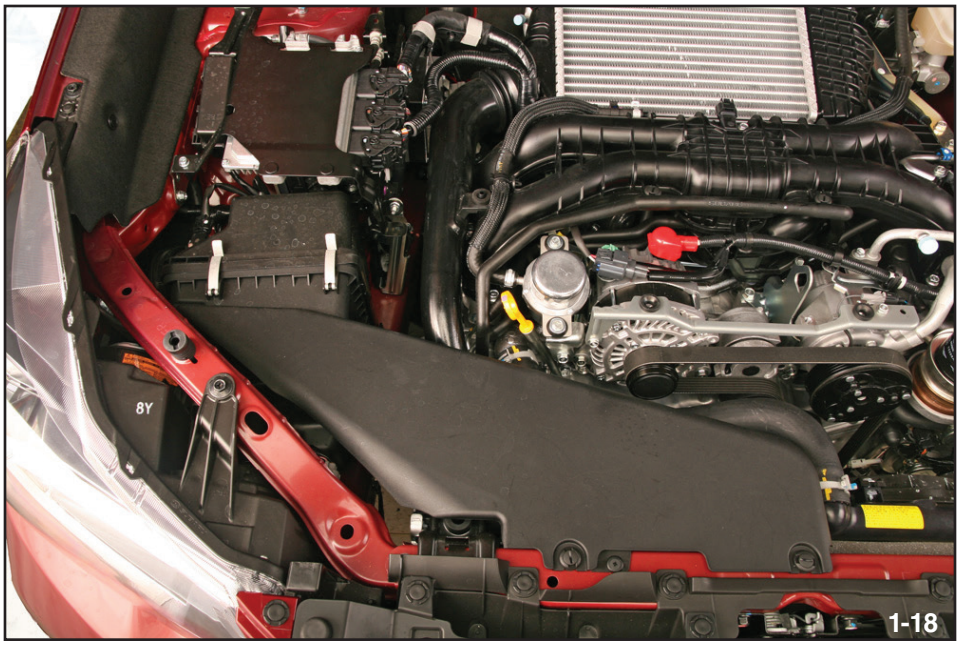
Brake Booster System Error Code

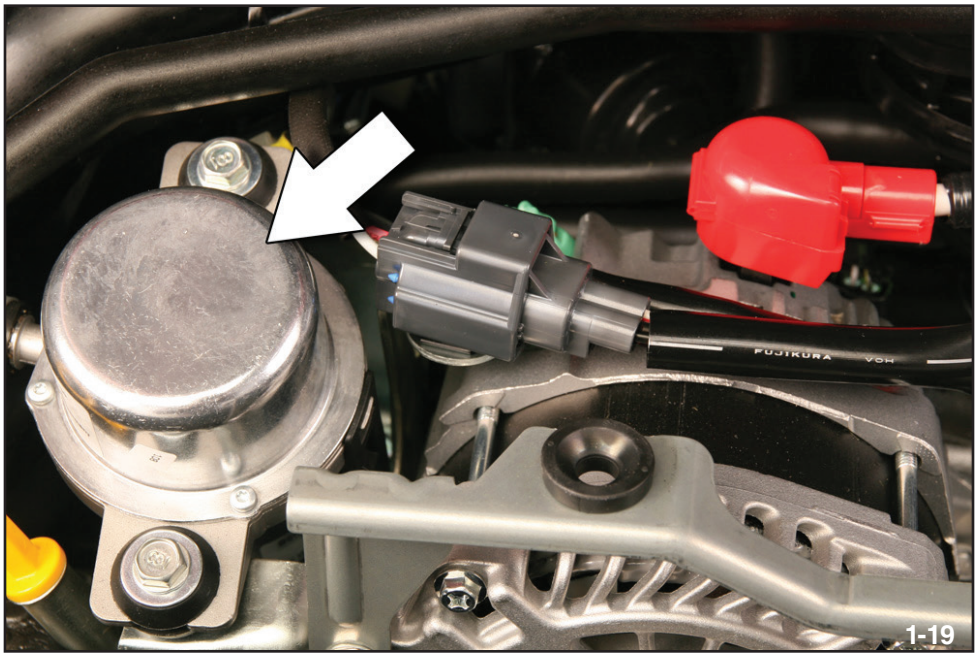
Electric Pump Systems (from 14MY)

Beginning with the 2014 Forester XT, a new brake vacuum pump system was adopted to compliment the Subaru Direct Injection system.



DIT Vacuum Pump System

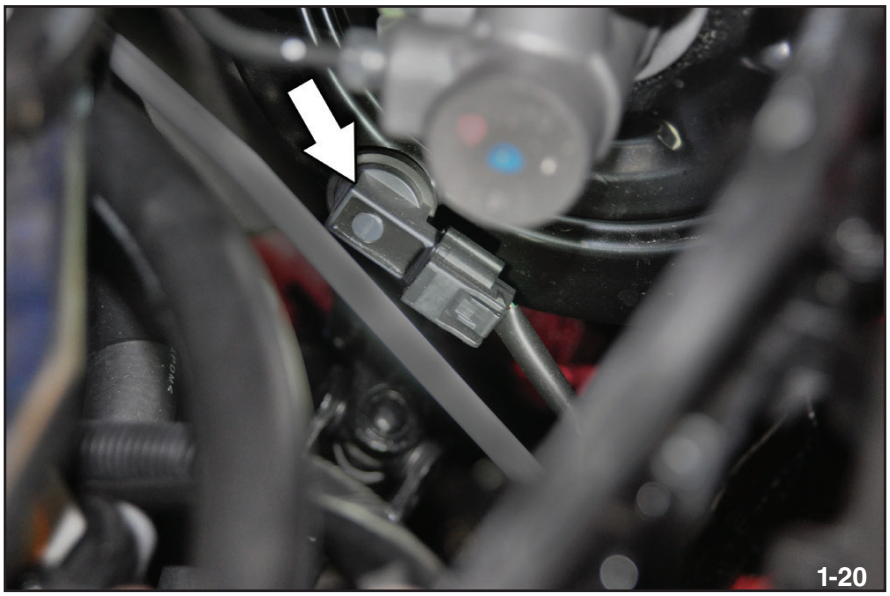
The vacuum pump is connected to the brake booster by a hose that is connected in parallel with the hose from the intake manifold. A check valve is installed inside the intake manifold hose and at the vacuum pump, to close the intake manifold off from the brake booster when the intake manifold pressure is positive.



Vacuum Pump

Pressure Sensor(s) mounted in the brake booster communicate the brake booster pressure to the engine control module.

Note: The sensor(s) are not serviceable; replace the booster for a failed sensor.

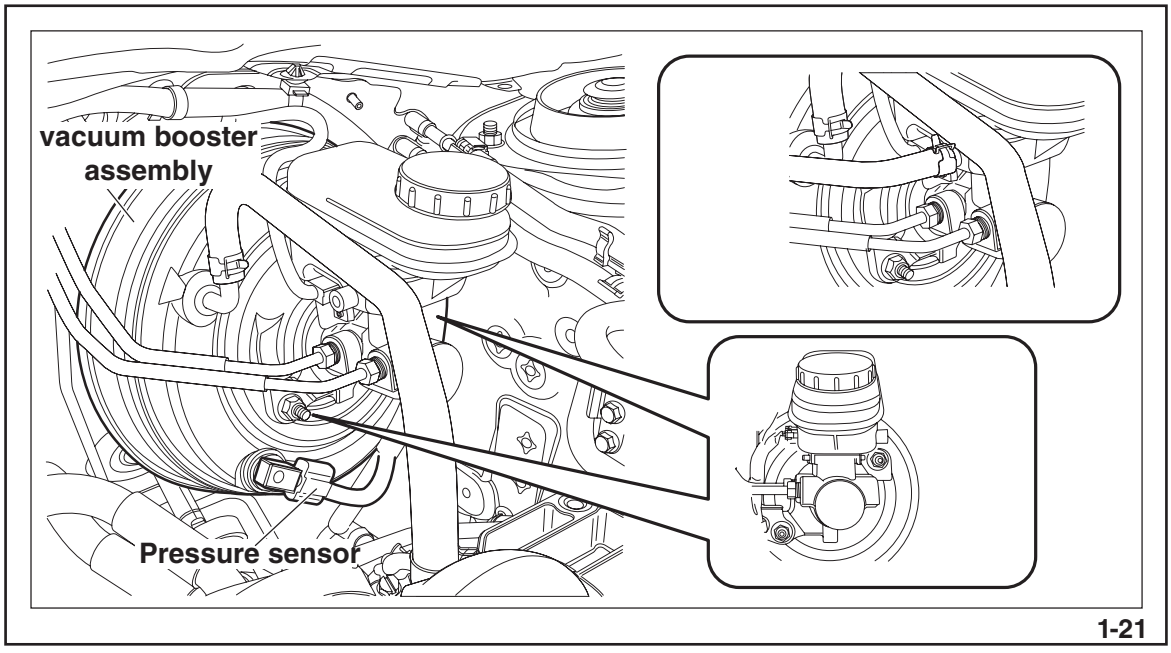


Pressure Sensor

CAUTION: DO NOT REMOVE THE VACUUM SENSOR. IF REMOVED, REPLACE THE VACUUM BOOSTER ASSEMBLY WITH A NEW PART.

DO NOT ROTATE THE VACUUM SENSOR (A) WHEN DISCONNECTING THE CONNECTOR OF VACUUM SENSOR.

OTHERWISE THE GROMMET ON THE MOUNTING LOCATION OF THE VACUUM SENSOR MAY BE DAMAGED.

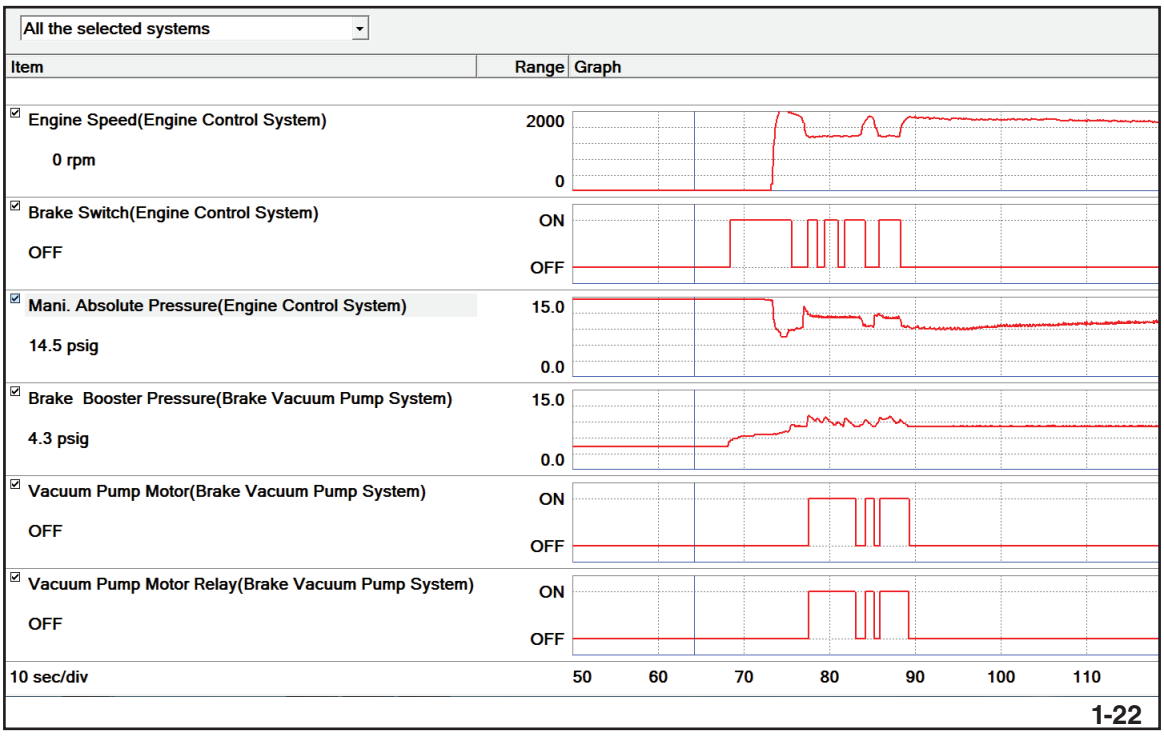


Pressure Sensor Location

The following conditions must be met before the vacuum pump will operate:

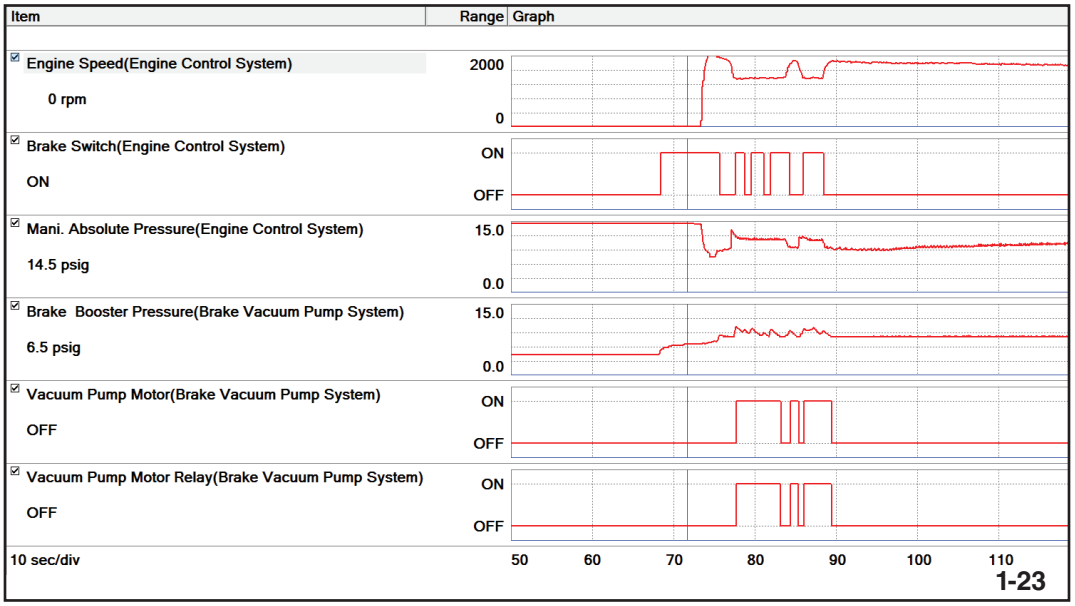
1. The engine is running
2. The brake pedal is depressed
3. The vehicle is in a gear range other than park or neutral
4. Manifold pressure is greater than 9.2 P.S.I. absolute
5. Brake pressure is greater than 9.2 P.S.I. absolute

This data is from a vehicle parked overnight without any depression of the brake pedal. Manifold pressure should equal atmospheric pressure. The brake booster pressure should be negative if the brake pedal has not been depressed and if the check valves are holding.



Engine OFF Data

The brake booster pressure will increase as the brake pedal is depressed to activate the start circuit (KAC vehicles). If the brake pedal is held stationary the pressure will remain constant. Continued movement of the brake pedal, up or down, will increase the brake booster pressure.



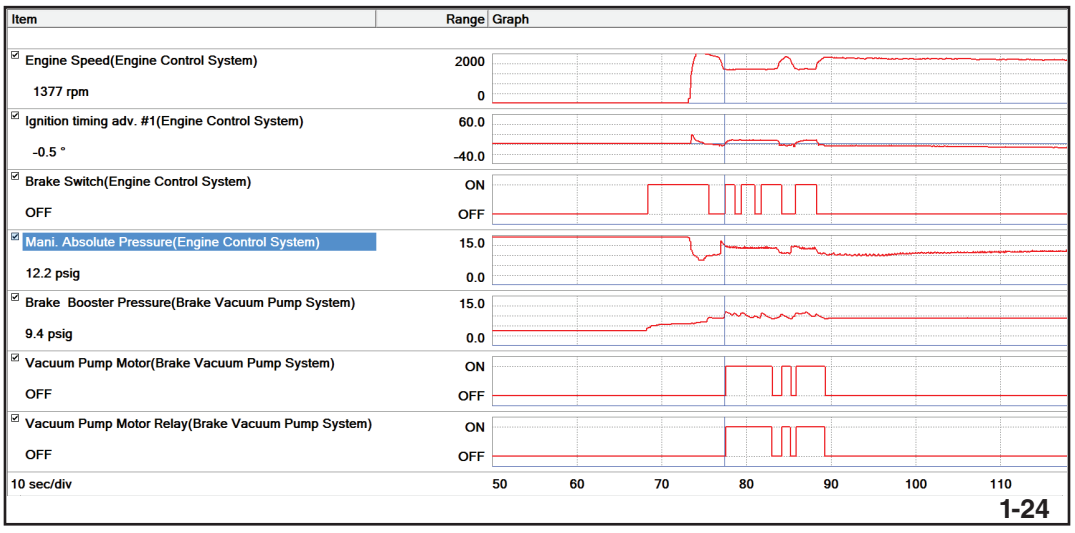
Brake Pedal Depressed, Engine OFF

During this condition the ignition timing is retarded to assist with catalytic converter warm up. The engine speed is increased to provide additional airflow to improve cylinder scavenging (retarded ignition timing reduces normal airflow through the cylinders).

The increased airflow from the higher engine speed and reduced combustion gas exit from the cylinder result in increased manifold pressure.

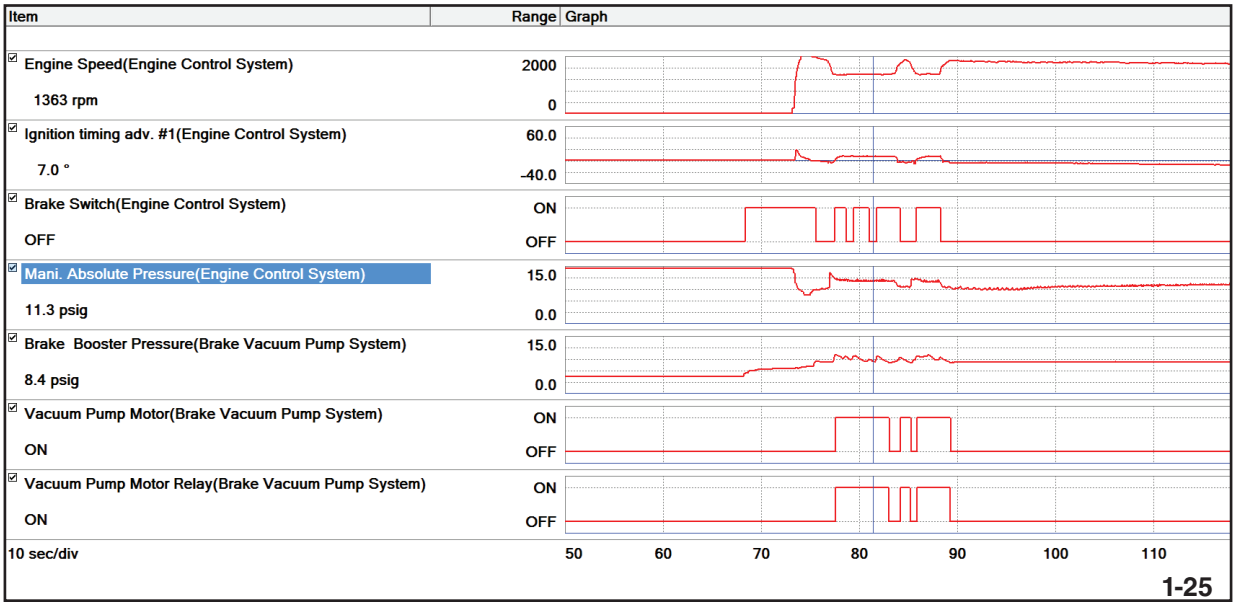
The vacuum pump must turn on to lower the brake booster pressure so that a pressure differential exists in the brake booster.

The vacuum pump turns on when the intake manifold pressure and brake booster pressure are both greater than 9.2 P.S.I. absolute.



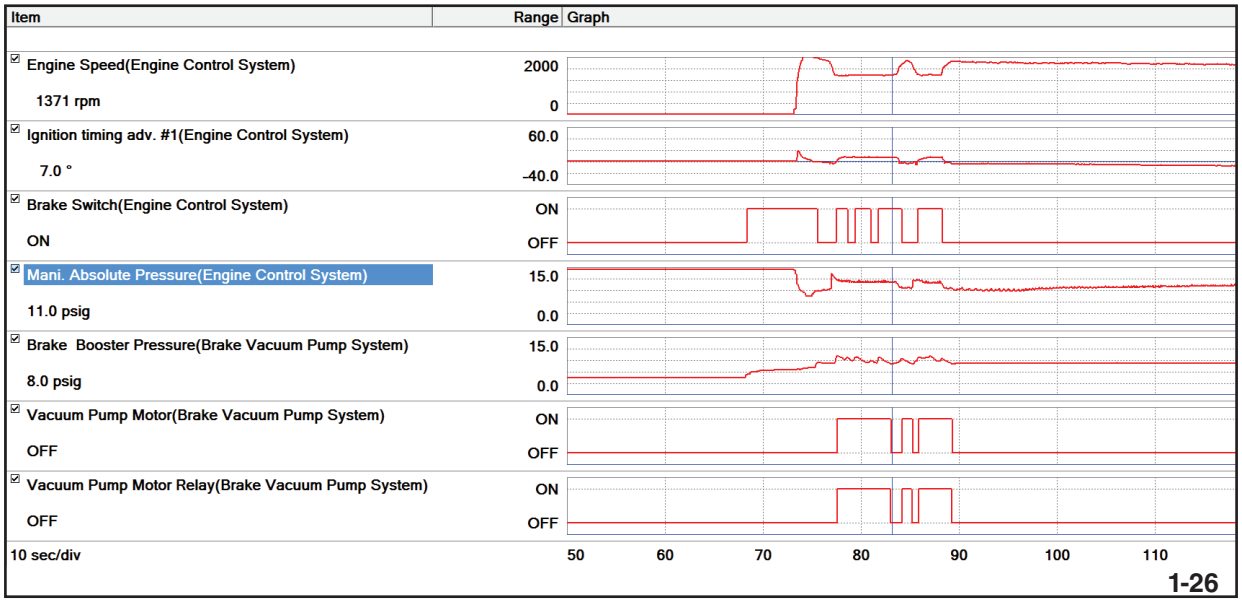
Values Just Before the Pump Activates

During this condition the manifold absolute pressure is greater than the brake booster pressure. The check valves will be closed to isolate the vacuum pump and brake booster from the intake manifold.



Vacuum Pump ON

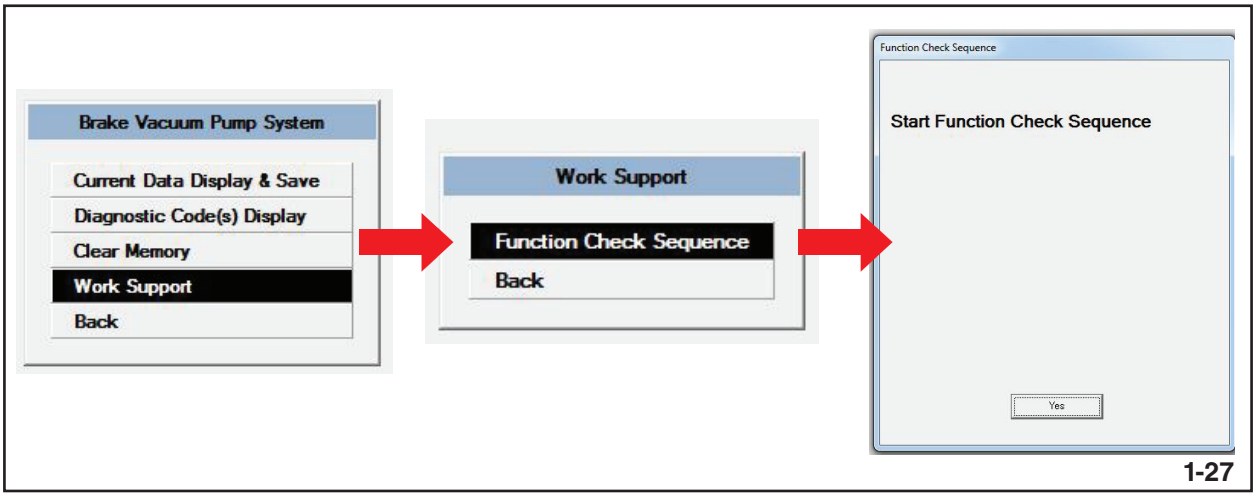
Vacuum pump turns off when brake booster pressure is less than 8.2 P.S.I. absolute.



Values as the Pump Turns OFF

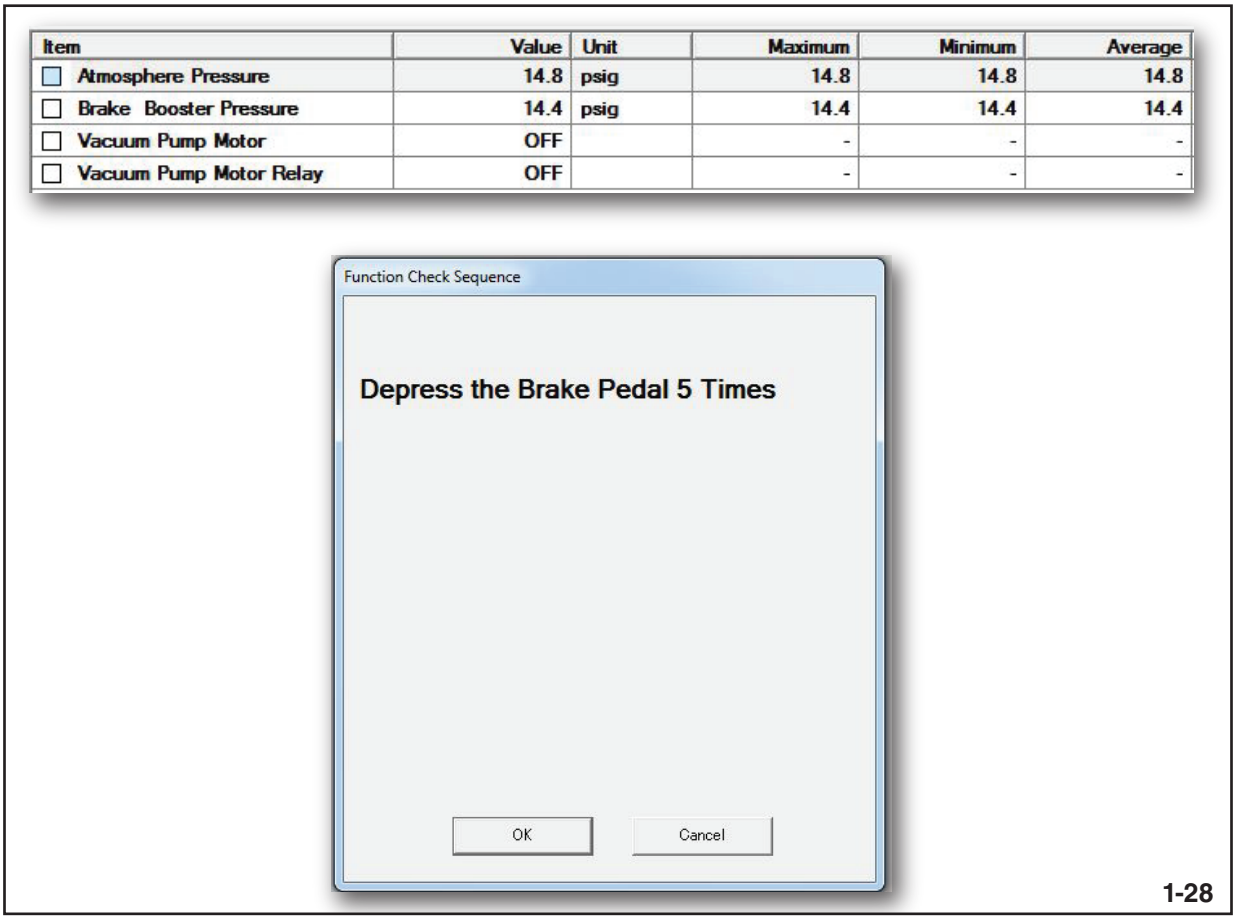
Diagnostics

Work support functions can be utilized to test the function of the brake vacuum pump system.



System Operation Check Mode

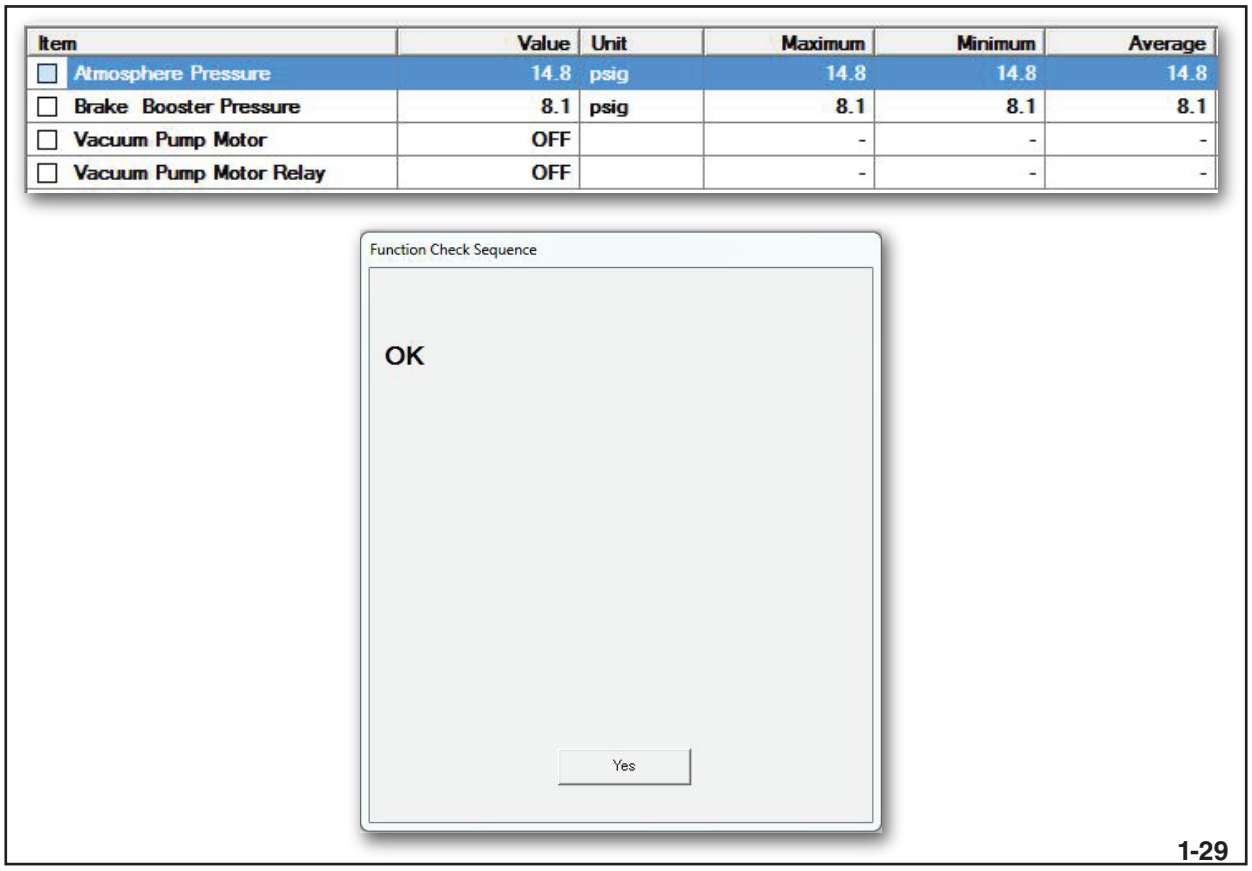
The function check sequence will direct you to depress the brake pedal 5 times. The brake booster pressure will be at or near atmospheric pressure after pumping the brake pedal 5 times.



Deplete Vacuum

Pressing OK again will activate the brake vacuum pump. As the pump operates, brake booster pressure should decrease by approximately 6 psi.

Note: Actual values may vary depending on altitude and other barometric variable.

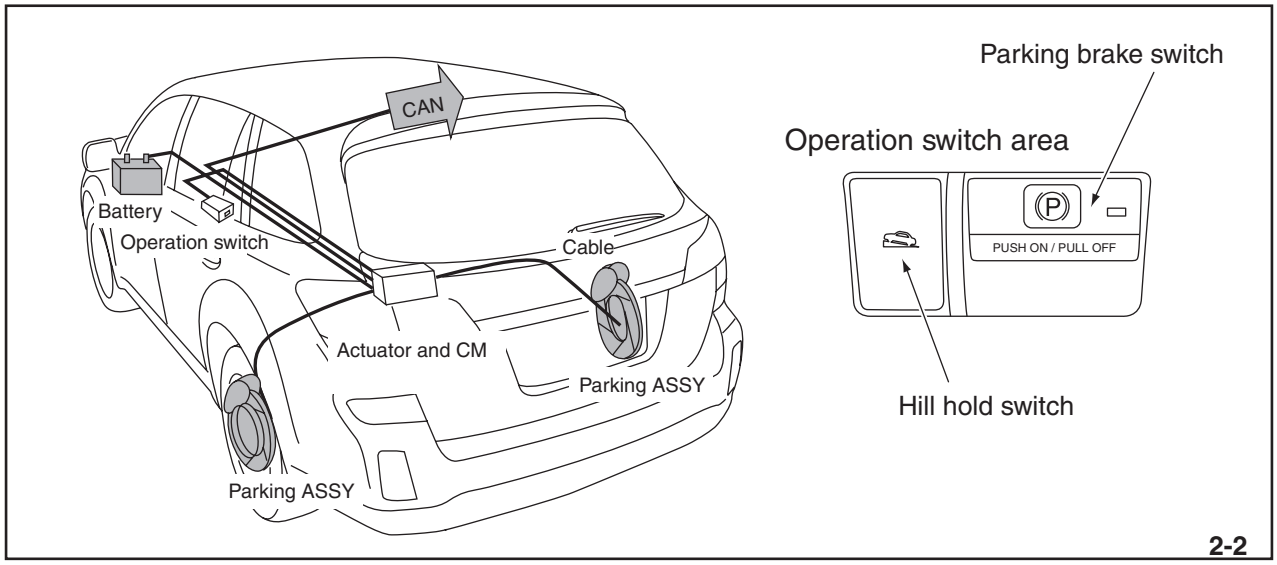


Pump Operation Test

Electronic Parking Brake Systems (EPB)

Electronic Parking Brake (From 10MY)

Equipped on all 10MY to 14MY Legacy and Outback models feature an Electronic Parking Brake (EPB) system. The EPB system provides convenient and consistent application of the parking brake and maximizes center console efficiency. The EPB system also features a Hill Holder system to aid acceleration on inclined surfaces.



EPB System Overview

When the Parking Brake or Hill Holder systems are activated the corresponding lights on the combination meter will be illuminated.

EPB (Brake) and Hill Holder Indicator Lights

Basic Operation

Parking Brake Application

There are three methods of applying the Parking Brake:

1. **Ignition switch OFF** - Briefly depressing the Parking Brake Switch inward will apply the parking brake. The parking brake cannot be released with the ignition switch off (electrically).
2. **Ignition switch ON and/or engine operating** – Briefly depressing the Parking Brake Switch inward will apply the parking brake.
3. **Emergency braking** - The Electronic Parking Brake can serve as an emergency brake by continually depressing on the Parking Brake Switch. If the Parking Brake Switch is continually depressed while the vehicle is moving, the EPB applies partial parking brake pressure to prevent the rear wheels from locking. When the vehicle speed reaches zero vehicle, the parking brake will fully apply.

EPB and Hill Holder Switches

Parking Brake Release

There are two methods releasing the Parking Brake:

1. **Manual Release** - The EPB is manually released by briefly pulling the EPB switch outward when the ignition is in the ON position (or engine running) and the brake pedal is depressed.
2. **Automatic release** - The EPB will automatically release upon vehicle acceleration provided the doors of the vehicle are closed and the driver seat belt is connected. (MT vehicles must accelerate and release the clutch to utilize automatic release.)

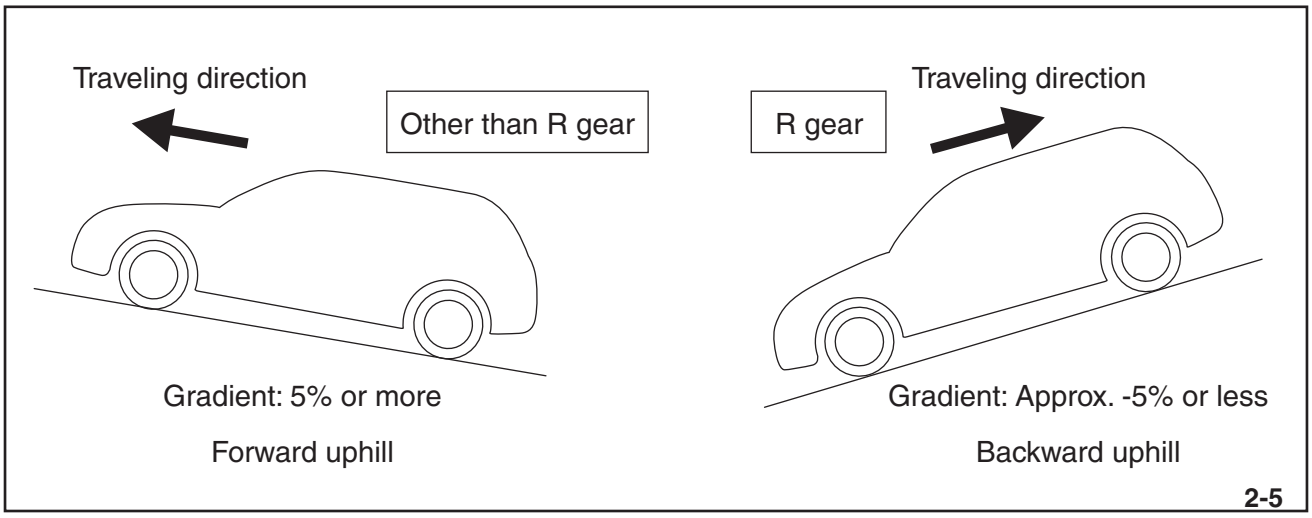
On Manual transmission vehicles, the EPB is set to recognize the clutch engagement point so a smooth release of the brake pedal and clutch application is achieved. Automatic transmission vehicles utilize the accelerator angle as the necessary input to release the Hill Holder. Steeper inclines require higher percentages of the accelerator input. (Higher throttle opening angles allow a higher engine torque to develop ensuring a smooth acceleration of the vehicle during Hill Holder release).

Hill Holder

Hill Holder holds the vehicle stationary when the vehicle is stopped at a 5% or greater incline angle. The input of the G Sensor to the VDC control unit is networked to the EPB control unit and controls when the EPB is activated for Hill Holder operation. The Hill Holder will release when the vehicle is accelerated or the clutch is engaged.

Notes:

- The Hill Holder is equipped on all models regardless of transmission type.
- The Hill Holder system must be activated at each engine start.

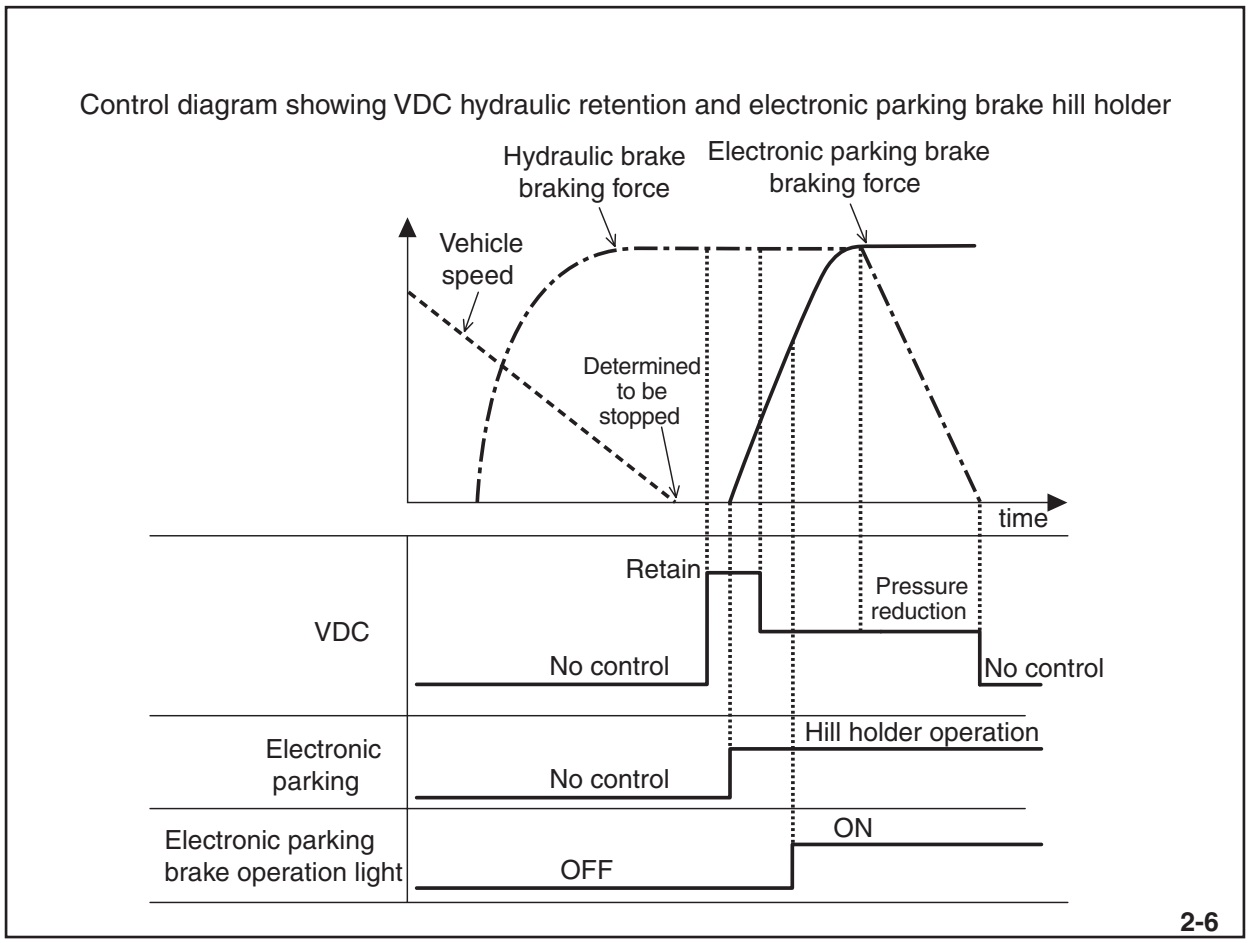


Hill Holder Operating Conditions

The G Sensor provides the incline input to the VDCCM and H/U. The gear range signal from the TCM (AT vehicles) or BIU (MT vehicles) is delivered to the EPB actuator / CM via the high speed CAN.

When the Hill Holder activates, the VDC system “Holds” the fluid pressure generated to bring the vehicle to a stop (parking judgment). This temporary hold allows the electronic parking brake actuator to apply the parking brake, holding the vehicle on the incline until the accelerator pedal is depressed or the clutch pedal is released.

Once the Hill Holder has been released a vehicle speed input is needed for the Hill Holder to set again, provided the other required conditions have been met.



Hill Holder Operating Logic

Notes:

- If the engine is turned off while the Hill Holder is active the Hill Holder function becomes the parking brake.
- The Hill Holder Switch must be activated after each engine start or the Hill Holder will not operate. The Hill Holder light in the combination meter will illuminate when the system has been activated. During actual Hill Holder operation the brake light will be illuminated.
- The daytime running lights will turn off while the Hill Holder is active.

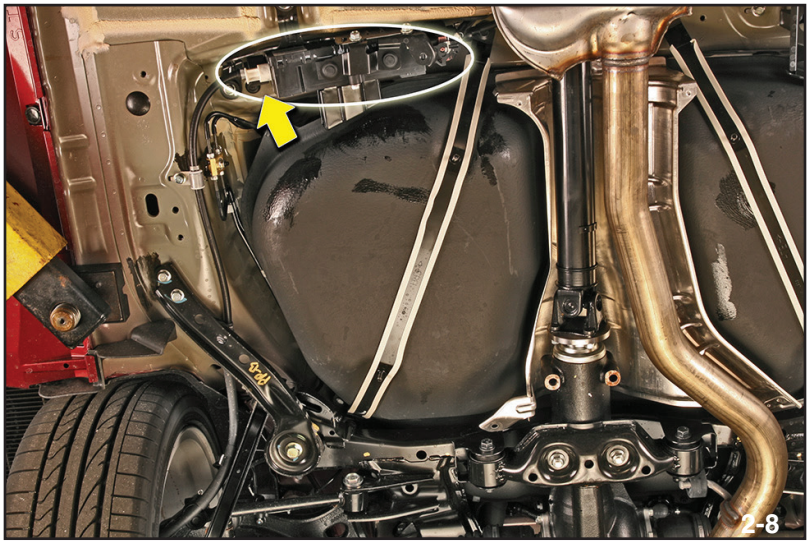
Operational habits of the EPB and Hill Holder systems can be monitored using the Subaru Select Monitor. Each mode of operation is recorded and counted to measure total usage.

Item	Value	Unit	Maximum	Minimum
☐ Total Operation Number	799	Time	799	799
☐ Hill Hold Operation Number	495	Time	495	495
☐ Auto Operation Number	0	Time	0	0
☐ Auto Cancel Number	493	Time	493	493
☐ Parking Operation Number when driving	119	Time	119	119
☐ Manual Parking Operation	1		-	-
☐ Auto Parking Operation	0		-	-
☐ Parking Operation when driving	0		-	-
☐ Parking Cancel	0		-	-
				2-7

SSMIII Normal Sampling Data

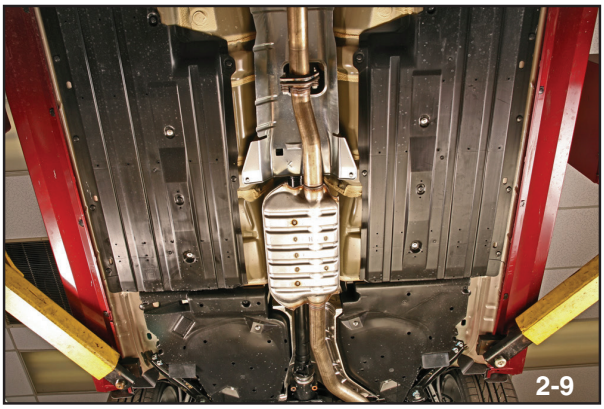
System Construction

The EPB actuator and control module are integrated into a single unit located underneath the vehicle in front of the fuel tank.

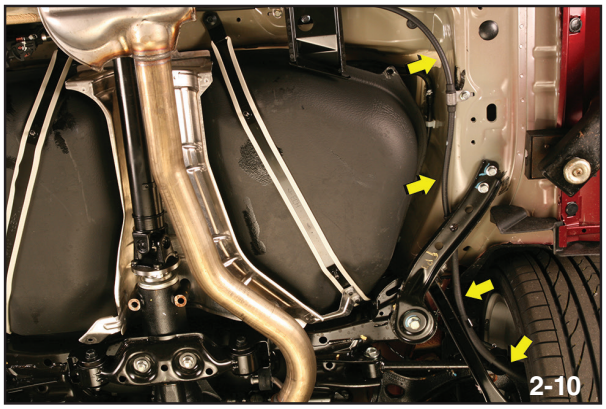


EPB Control Unit Location

Access to service the unit and cables is achieved by removing the protective shielding under the vehicle.



Protective Shielding

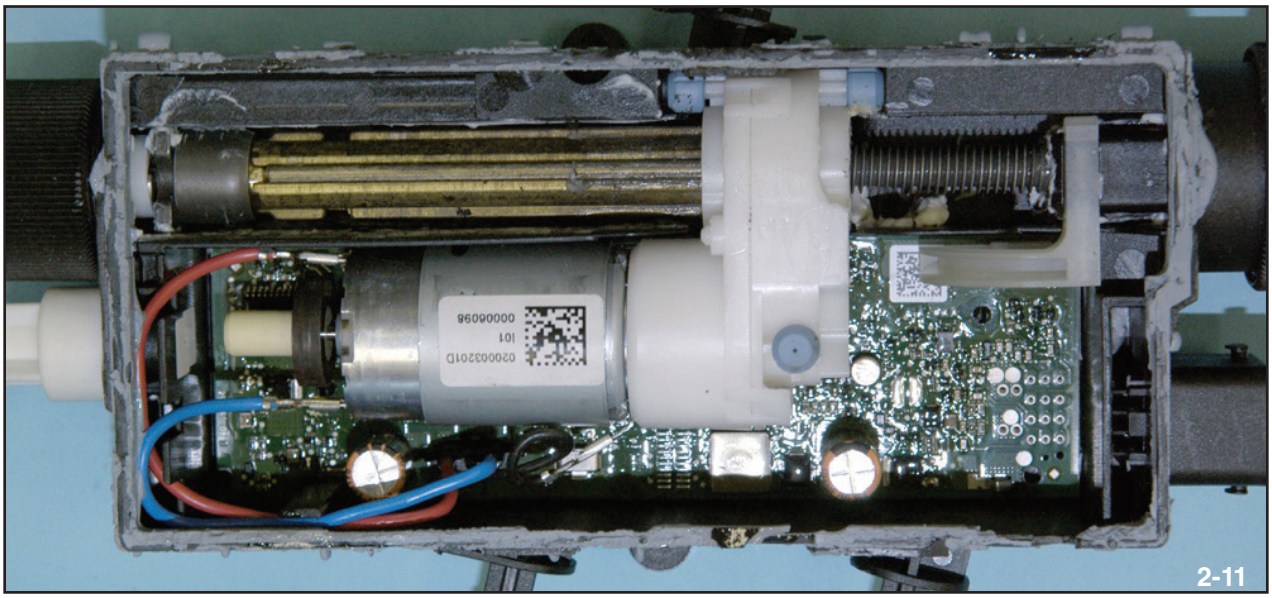


EPB Cable

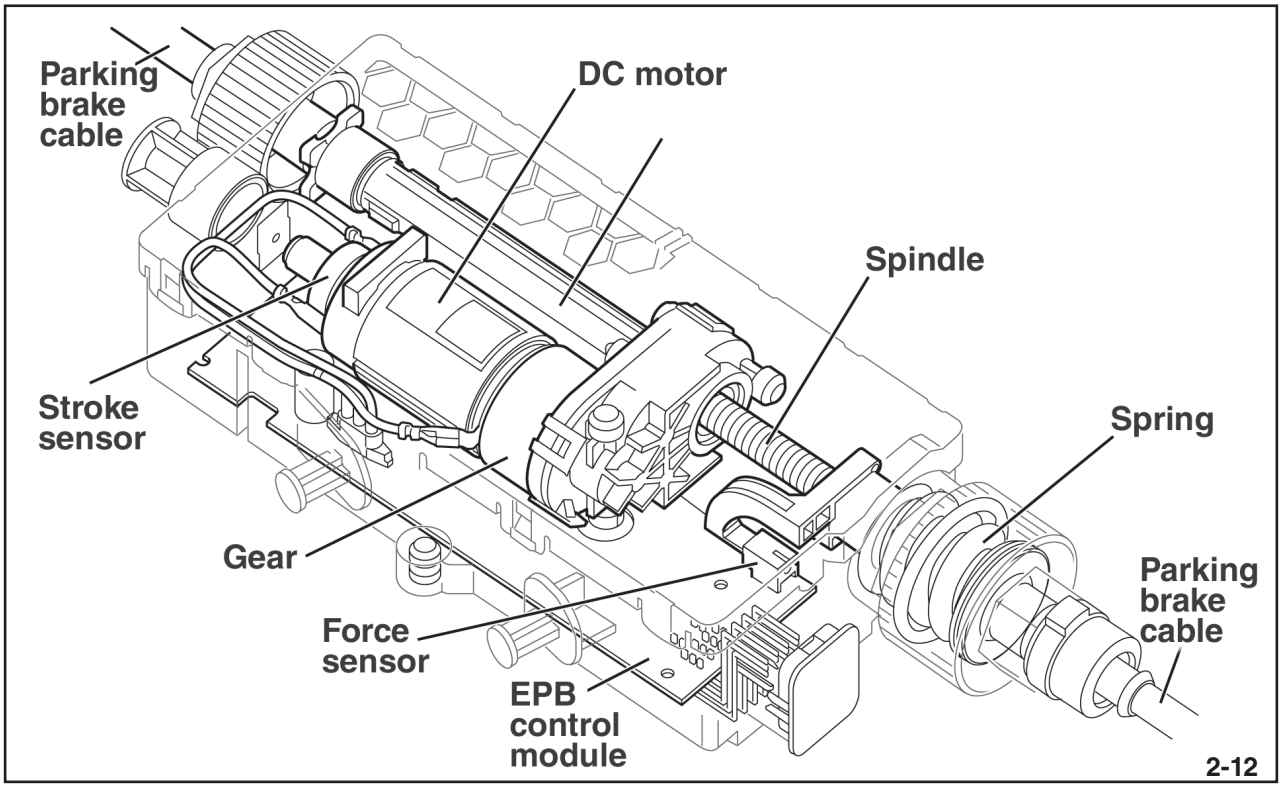
Note: The cables are not serviceable separate from the EPB control unit and must be replaced as an assembly.

The EPB actuator consists of the EPB control unit, motor, cables, force sensor and stroke sensor.

The cables for the left and right parking brake assemblies thread into each other. When the motor operates the cables are threaded in to activate the parking brake or out to release the parking brake.



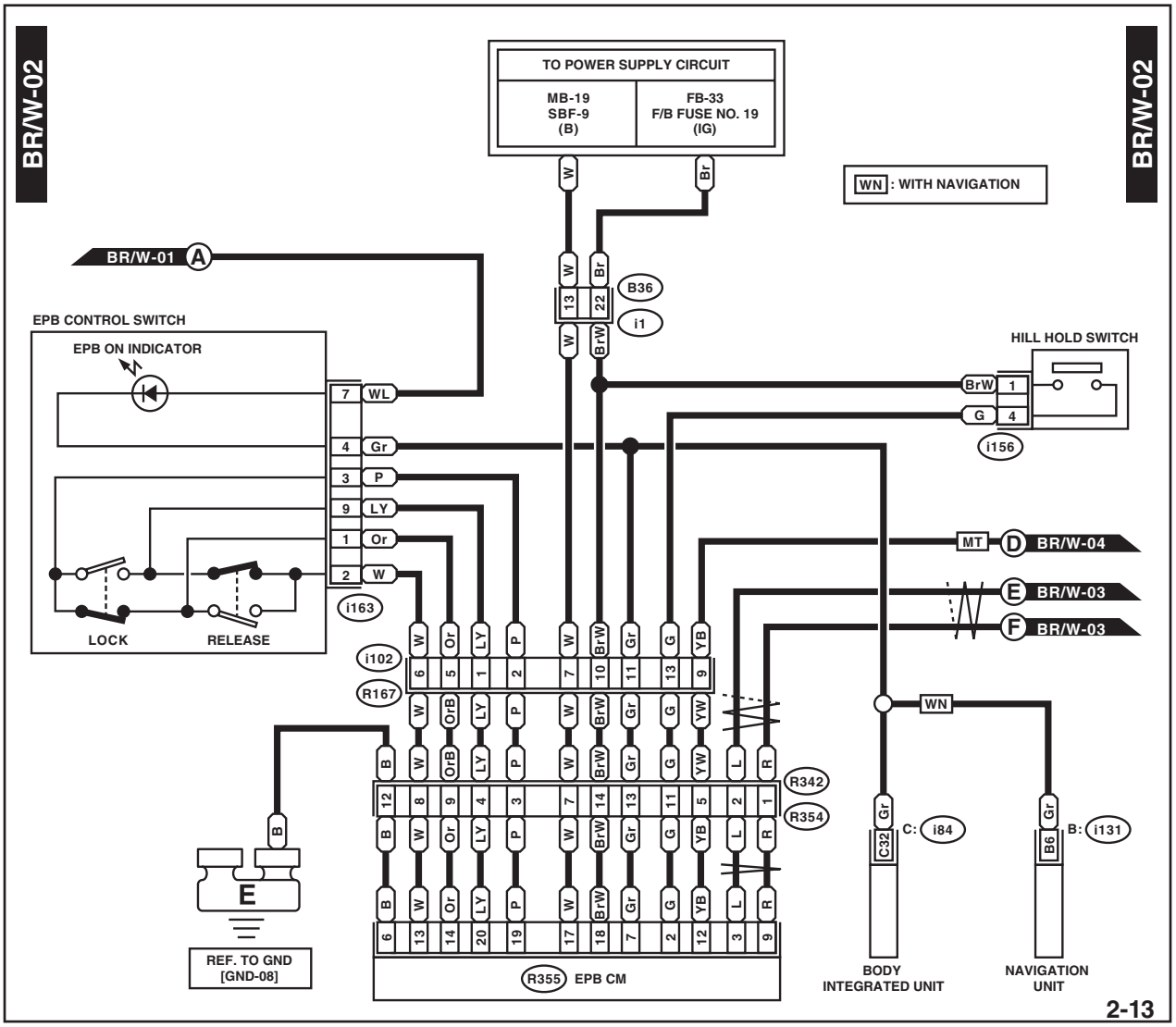
EPB Control Unit Cutaway



EPB Control Unit Schematic

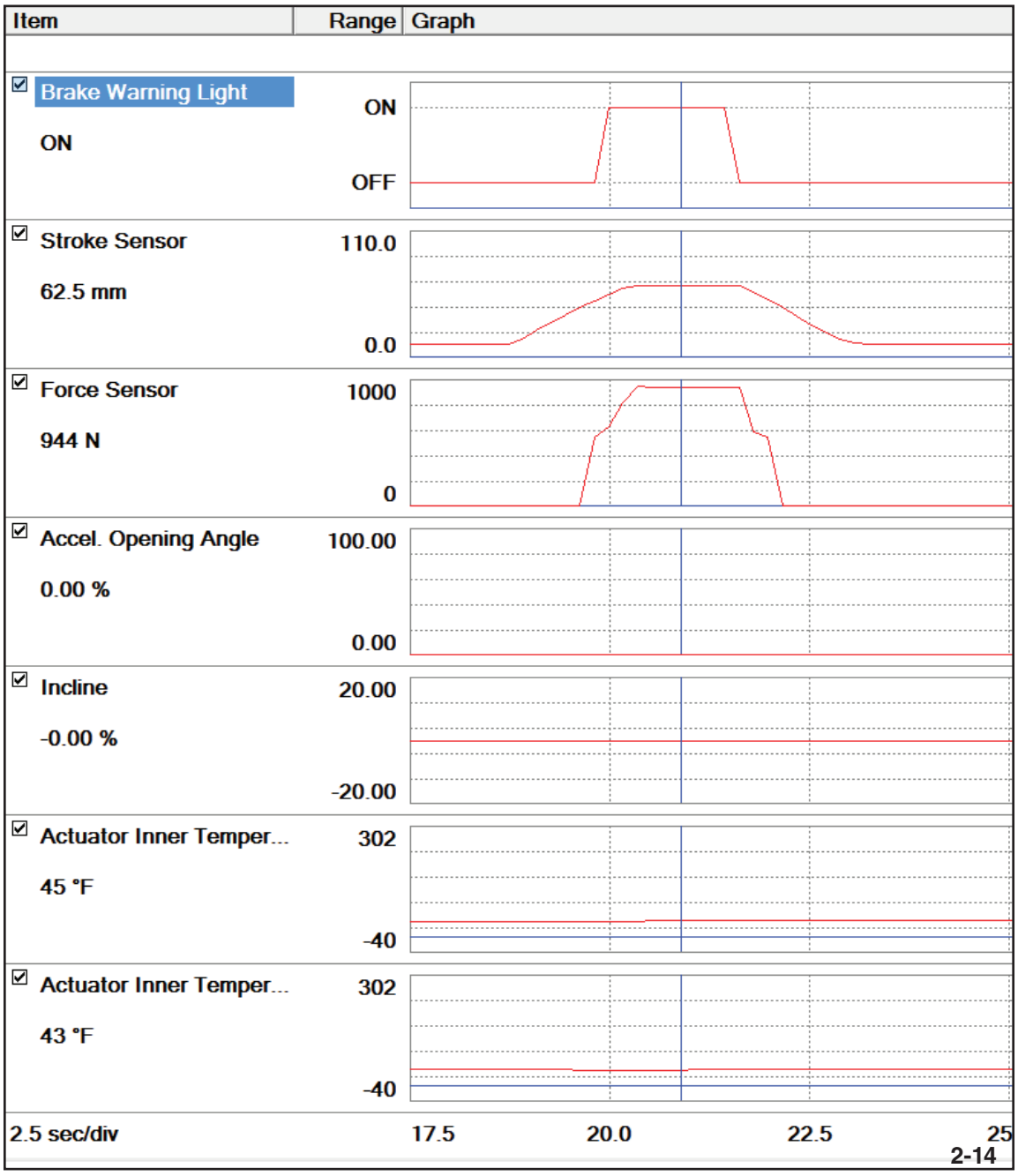
Electrical Operation

The EPB CM receives driver inputs directly from the console mounted EPB Control and Hill Holder Switches. When commanded, the EPB CM operates the internal DC motor while monitoring the Stroke and Force Sensors. The EPB CM also communicates via the vehicle's CAN for Engine, Transmission, and VDC related data.



EPB Wiring Diagram

As the DC motor turns the revolutions are counted by the stroke sensor and calculated into a travel measurement (mm). A sliding force sensor built onto the cable drive mechanism and is combined with amperage detecting circuits in the control unit which determines the tension (N) placed on the parking brake cables.

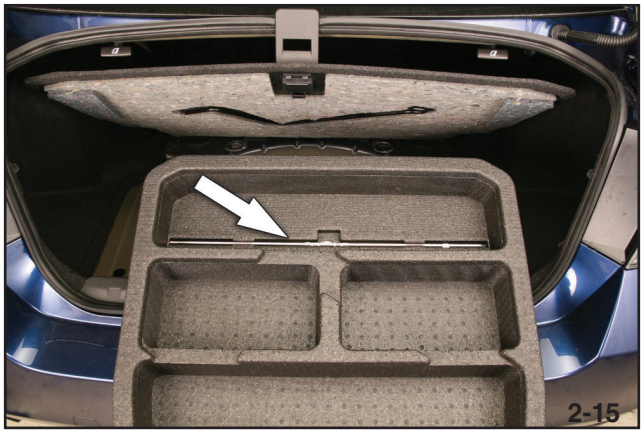


EPB Operation

Emergency Release

The EPB manual release tool is located at the forward end of the storage compartment. (The screwdriver handle of the tool kit is used with this tool). The manual release is located on the passenger side of the vehicle just in front of the right rear tire. A slot in the underside of the vehicle body allows the release tool, located in the spare tire area of the vehicle, to align with the mechanical release port of the EPB Actuator/CM.

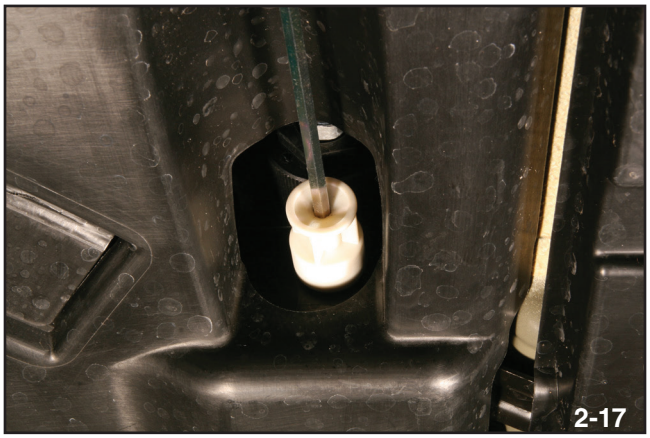
Caution: ***Always check that the ignition is in the off position and the vehicle is in the "P" range ("1st" or "R" for MT model) before mechanically releasing the EPB.***



Tool Storage

EPB Manual Release

Remove the white colored cap by turning the tool counter clockwise. Then puncture the protective plastic film covering the release lug. The lug is made onto the end of the armature of the EPB motor. Turn the armature 200-250 times CLOCKWISE to fully release the EPB. Install the cap immediately after to prevent contamination.



Removing Cap

Engaging Armature

Service

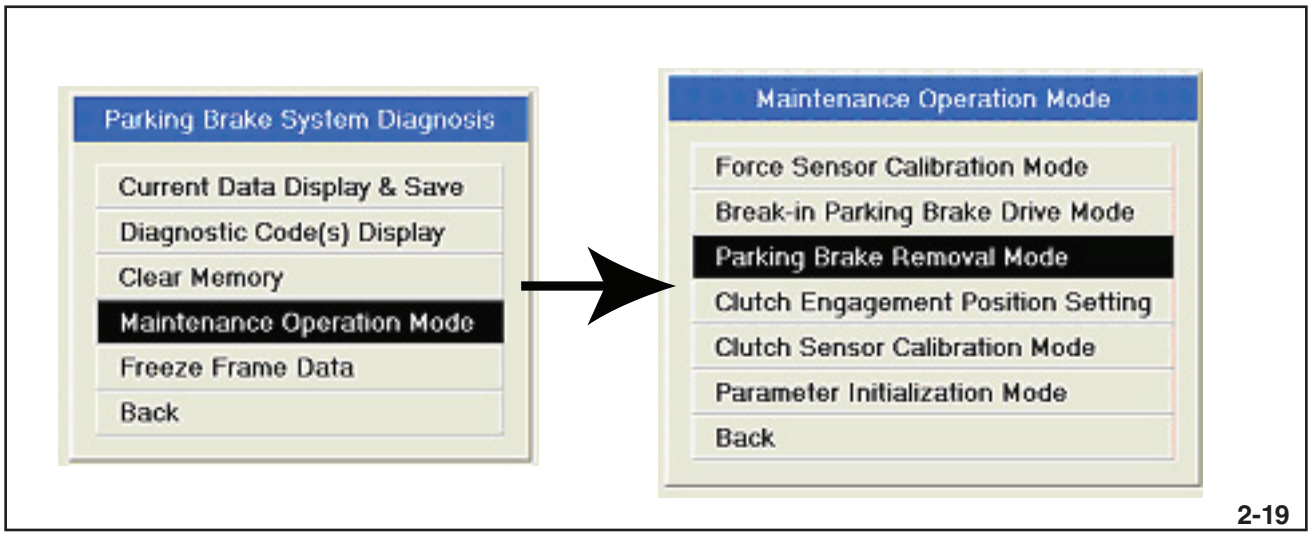
The EBP features 6 service modes using the Subaru Select Monitor.

1. Parking Brake Removal Mode
   When removing the rear drum-in-hat brake rotors
2. Force Sensor Calibration Mode
   After removal, assembly, or adjustments have been performed
3. Brake-In Parking Brake Drive Mode
   After replacing parking brake linings with new parts
4. Parameter Initialization Mode
   When the EPB control unit has been replaced with a new part
5. Clutch Sensor Calibration Mode (MT Models Only)
   After replacing the EPB control unit or clutch related components
6. Clutch Engagement Position Setting (MT Models Only)
   After replacing or adjusting clutch related components

Caution: ***Always consult Subaru Service Manual for detailed procedures and cautions before attempting.***

Parking Brake Removal Mode

Before the parking brake shoes can be removed the EPB cables must be relaxed. Connect the SSM to the vehicle and navigate to the EPB menu. Select Maintenance Operation Mode and Parking Brake Removal Mode.



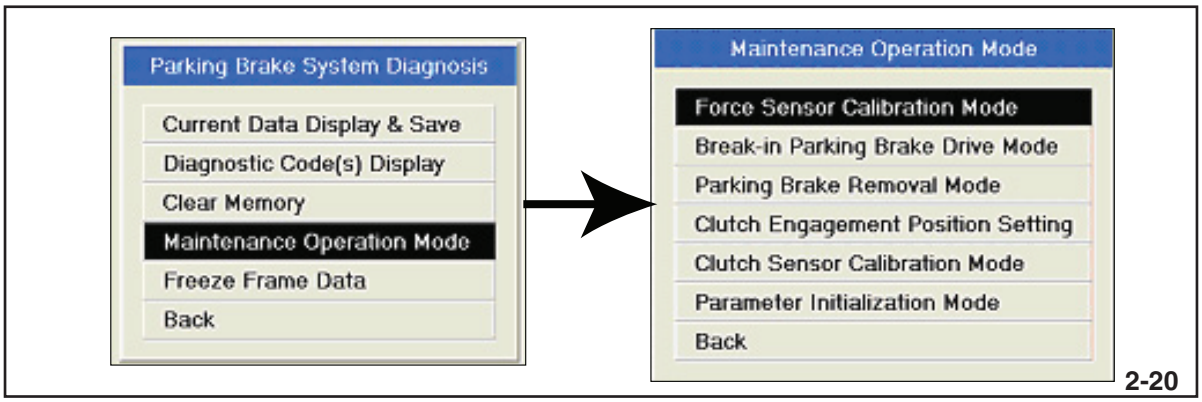
SSMIII Parking Brake Removal Mode

Force Sensor Calibration Mode

Since the EPB Control Unit uses the Force Sensor data and the Stroke Sensor data to determine how many revolutions are needed to apply or release the parking brake or Hill Holder, The Force Sensor must be calibrated any time the relationship between the brake shoes, rotor/drum, or EPB Actuator is changed.

The Force Sensor Calibration Mode applies and releases the parking brake several times to determine applied and released state of the parking brake. As the parking brake is applied the motor in the EPB actuator begins to draw more amperage which is detected by the EPB control unit. The distance is calculated by the revolutions of the motor.

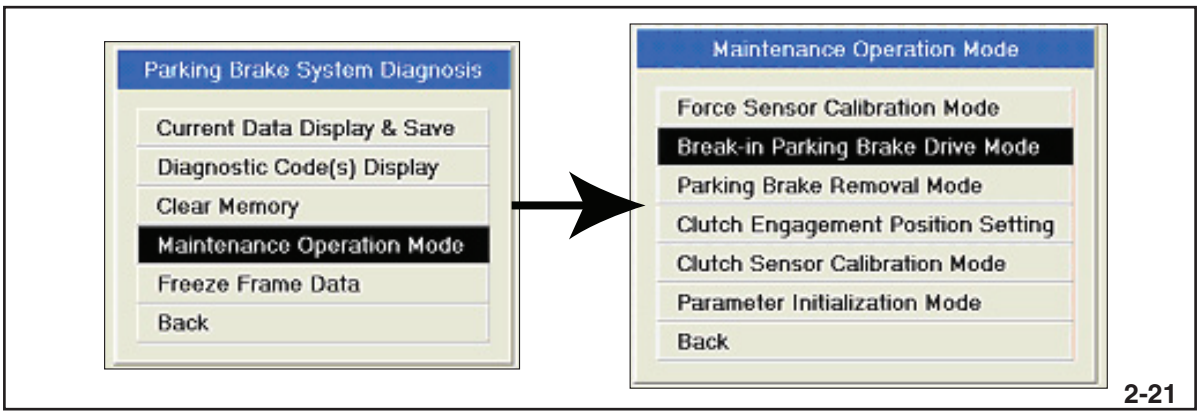
Note: If the EPB control module assembly is replaced, the "Brake" warning light on the Combination Meter will flash until the Force Sensor Calibration and Clutch Sensor Calibration (if applicable) modes are performed.



SSMIII Force Sensor Calibration Mode

Break-In Parking Brake Drive Mode

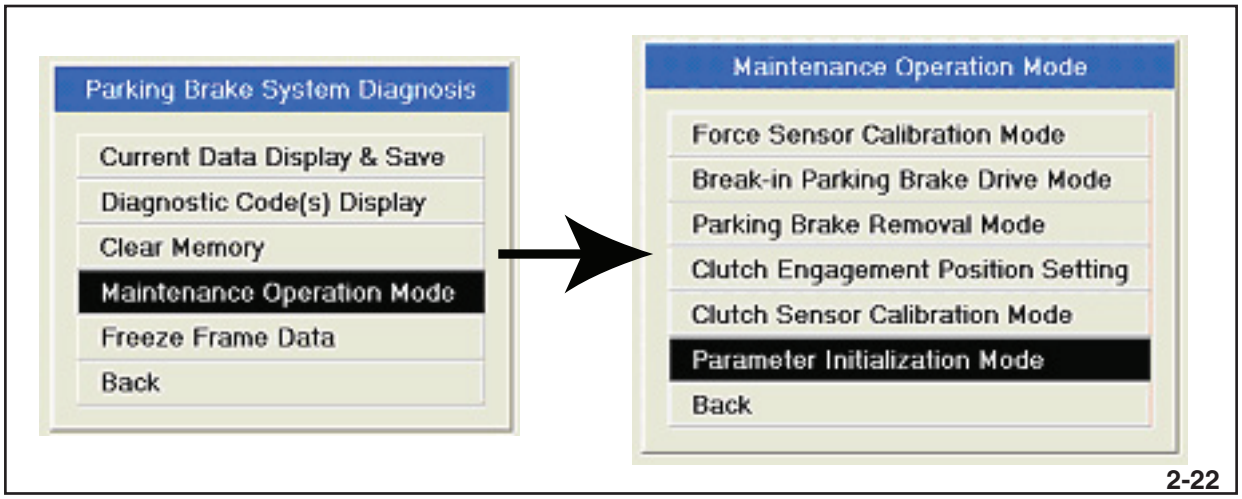
Following the installation of new parking brake shoes, the linings must be broken-in to ensure proper mating to the drum surface. After manually adjusting the parking brake shoes, drive the vehicle in a safe area to a speed of approx. 22 mph and depress the parking brake switch. Drive for approximately 200m (0.12 miles) and feel for brake drag. This procedure may be repeated multiple times based on the results. Once the linings have been broken in to satisfaction, the manual adjustment must be performed again.



SSMIII Break in Parking Brake Drive Mode

Parameter Initialization Mode

After replacing the EPB control unit with a new part, the Parameter must be initialized.

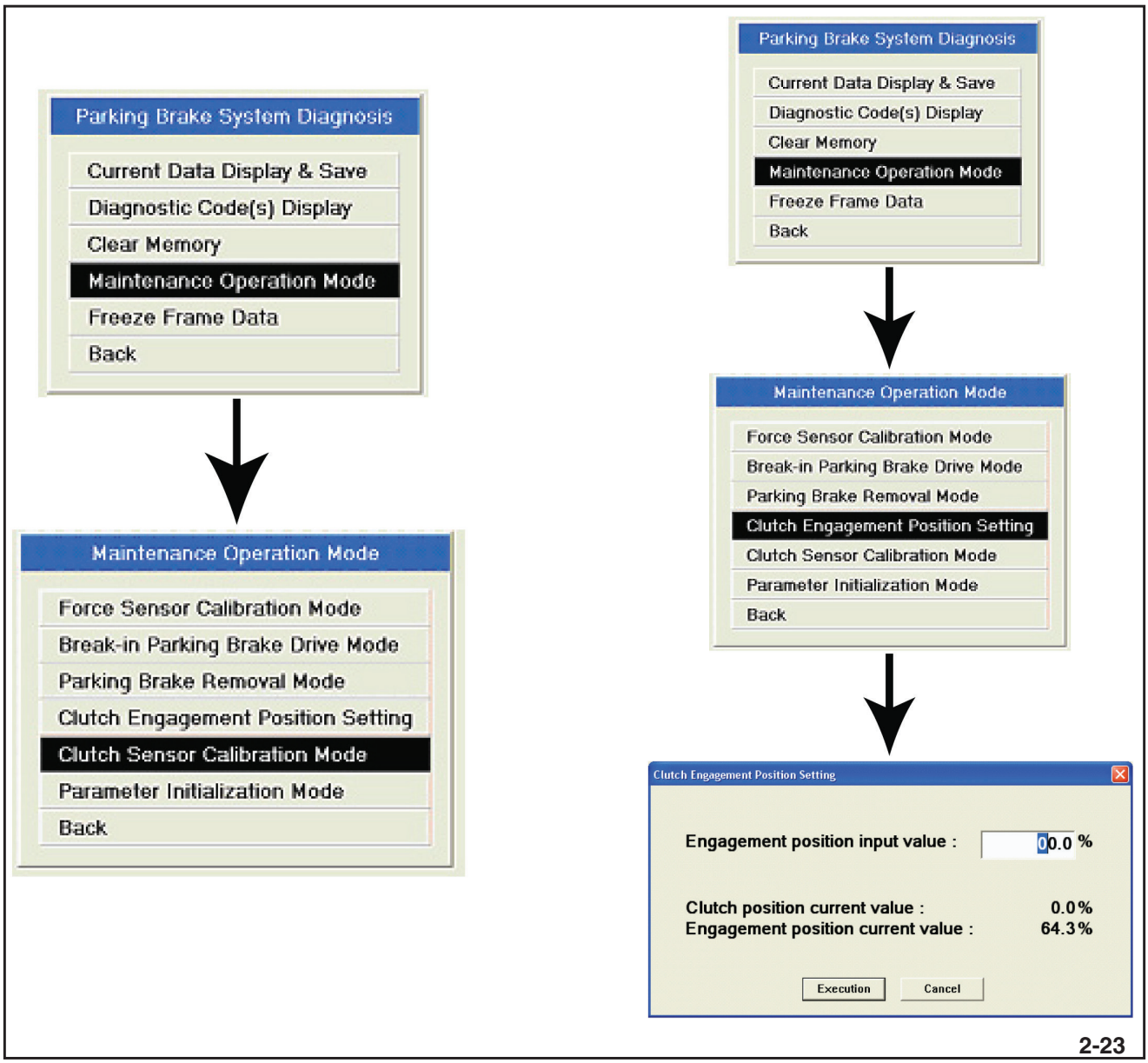


SSMIII Parameter Initialization Mode

Clutch Sensor Calibration and Engagement Position Setting Modes

After the clutch has been replaced, the relationship of the new clutch engagement point and the release of the Hill Holder must be established. Navigate through the SSMIII and select "Clutch Engagement Position Setting". Slowly release the clutch pedal while having the SSMIII data monitored. The numerical value that appears in the lower scale must be entered into the upper scale. This will establish the release point of the EPB during Hill Holder operation.

To allow for a slightly advanced release of the EPB use a Higher number.



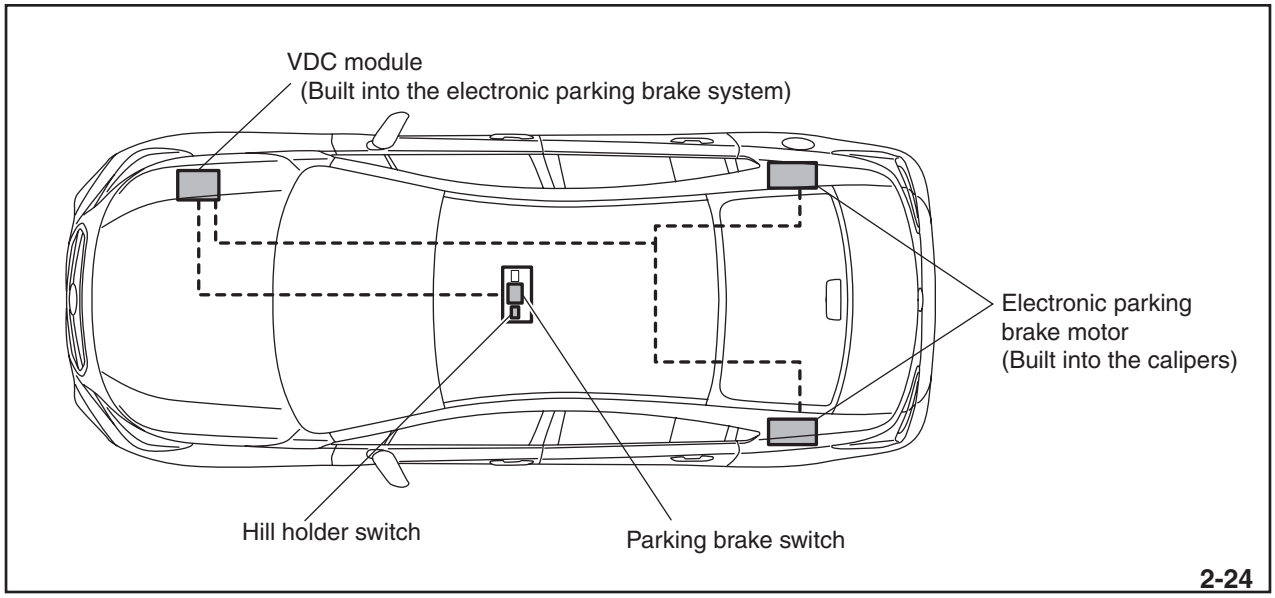
SSMIII Clutch Sensor Calibration Mode *SSMIII Clutch Engagement Position Setting*

Note: After replacing the Clutch Stroke Sensor select Clutch Sensor Calibration Mode.

The EPB Control Unit will automatically perform this process. Then select clutch engagement position setting and enter the engagement position value. If the EPB control module assembly is replaced, the "Brake" warning light on the Combination Meter will flash until the Force Sensor Calibration and Clutch Sensor Calibration (if applicable) modes are performed.

Electronic Parking Brake (From 15MY)

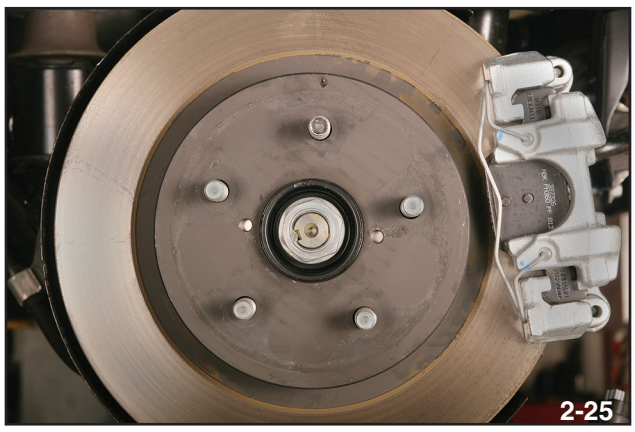
Equipped 15MY (and later, trim dependent) vehicles feature a redesigned “caliper integrated” Electronic Parking Brake (EPB) system. The redesigned system eliminates the need for a separate control module and simplifies the mechanical application of the rear brakes.



EPB System Overview

The enhanced 15MY system eliminates the drum-in-hat style parking brake and utilizes an internal motor actuator to apply the disc brake pads to the brake rotor.

Caution: There is no manual release for the EPB. Servicing of the rear brake pads requires the use of the Subaru Select Monitor or generic caliper tool.



Rear Brakes

Electronic Parking Brake

Basic Operation

Parking Brake Application

There are three methods of applying the Parking Brake:

1. **Ignition switch OFF** - Briefly pulling the Parking Brake Switch upward will apply the parking brake. The parking brake cannot be released with the ignition switch off (electrically).
2. **Ignition switch ON and/or engine operating** – Briefly pulling the Parking Brake Switch upward will apply the parking brake.
3. **Emergency braking** - The Electronic Parking Brake can serve as an emergency brake by continually pulling upward on the Parking Brake Switch.

EPB Switch

Parking Brake Release

There are two methods releasing the Parking Brake:

1. **Manual Release** - The EPB is manually released by briefly depressing the EPB switch downward when the ignition is in the ON position (or engine running) and the brake pedal is depressed.
2. **Automatic release** - The EPB will automatically release upon vehicle acceleration provided the doors of the vehicle are closed and the driver seat belt is connected. (MT vehicles must accelerate and release the clutch to utilize automatic release.)

On Manual transmission vehicles, the EPB is set to recognize the clutch engagement point so a smooth release of the brake pedal and clutch application is achieved. Automatic transmission vehicles utilize the accelerator angle as the necessary input to release the Hill Holder. Steeper inclines require higher percentages of the accelerator input. (Higher throttle opening angles allow a higher engine torque to develop ensuring a smooth acceleration of the vehicle during Hill Holder release).

Note: 15MY Systems retain the same Hill Holder functions as 10MY Systems

Sliding Prevention

The Sliding Prevention feature of the EPB allows for self-activation of the EPB motor to increase the tension to the brake pads, if the parking brake had been previously set. Sliding Prevention is activated if the wheel speed sensors detect vehicle movement within 15 minutes of the EPB activation.

Temperature Compensation

The Temperature Compensation feature of the EPB functions by calculating brake component temperature from information obtained by the CAN and HCU. The Ambient air temperature, vehicle speed, road incline, service brake use frequency, and other vehicle information are considered when calculating brake component temperature. Higher temperatures equate to expanded parts which will contract as they cool. This could produce a situation where the initial EPB activation is not strong enough to maintain vehicle position. Compensation for high temperature is achieved by two methods;

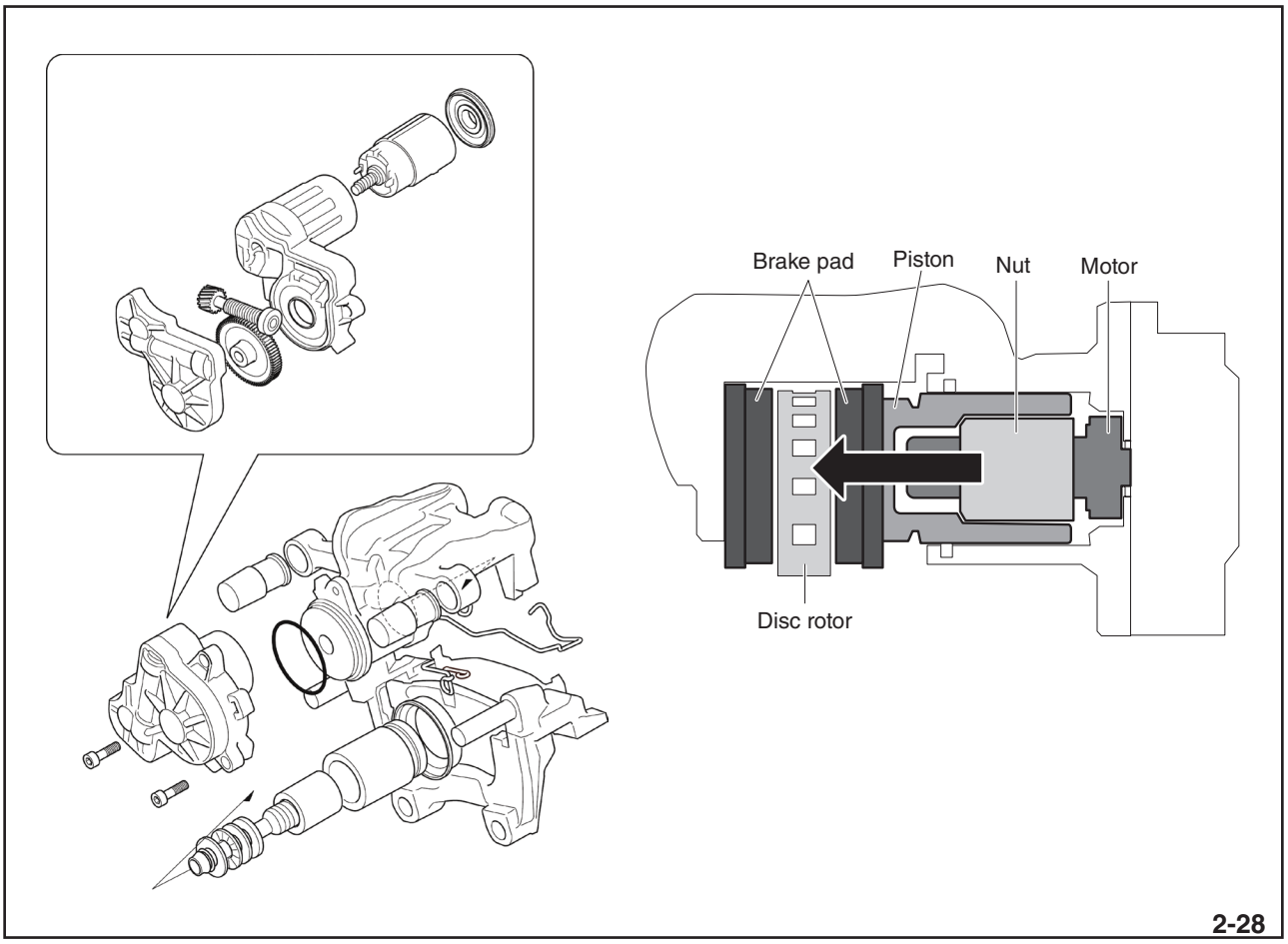
1. The EPB is activated with the Engine operating or CAN still operating. All necessary data is available to the EPB control unit (HCU) and the EPB motor applies additional mechanical force to the brake pads.
2. The EPB is activated with the Engine off and the CAN in sleep mode. Data to determine brake component temperature is not available to the EPB control unit (HCU). The initial EPB activation will be limited to learned values. An additional application of the EPB motor will be self-activated by the EPB control unit (HCU) 2 minutes and 30 seconds after the EPB was initially set. This will tighten any clearances that may have developed from contracting brake parts.

Note: An Automatic adjustment procedure is performed if no EPB operation is detected. The EPB control unit (HCU) monitors the driving mileage and will self-activate the EPB with the engine off once every 1864 miles (3000 kilometers). This procedure repositions the ball nut clearance from the back face of the hydraulic piston and tests the EPB motor drive circuits. The EPB will remain on after the adjustment. EPB release is accomplished with the automatic release feature or manual release while pressing the brake pedal.

System Construction

The EPB operates from the movement of a brushed DC voltage motor which is controlled by the Hydraulic Control Unit. A series of worm gears and reduction gears provide bidirectional movement of a ball nut that is keyed to the hydraulic piston. If the EPB is activated, the ball nut is screwed downward into the back face of the hydraulic piston and the piston moves into the inner brake pad. The pushing force pulls the caliper inward which pulls the outer brake pad into the rotor. When the EPB is released, the ball nut is reversed and the square cut caliper seal pulls the piston away from the inner brake pad and releases tension to the caliper and the outer brake pad.

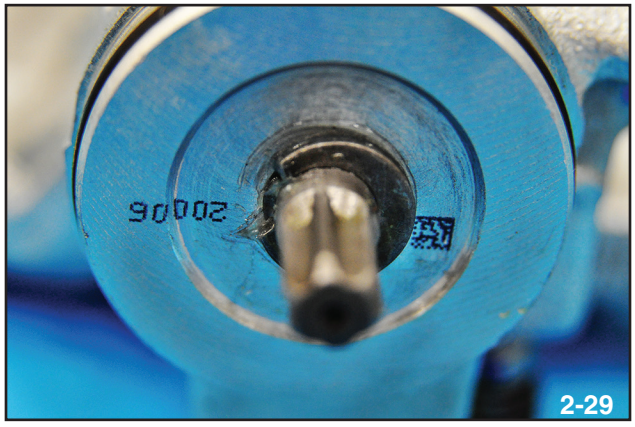
Note: The caliper and motor are not serviceable. Do not disassemble for inspection or diagnosis. Calipers and motors are available as replacement parts and can be ordered separately or as an assembly.



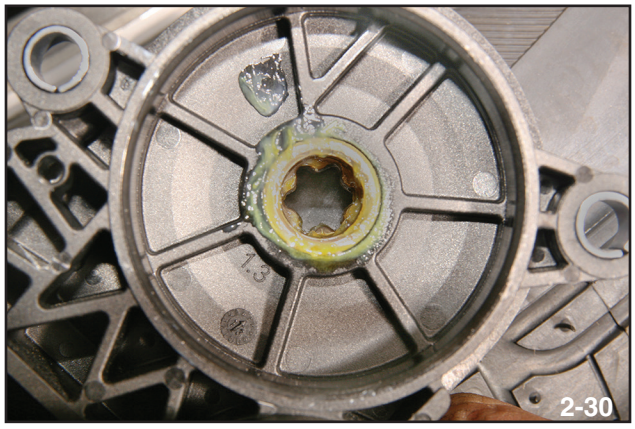
Caliper (Artwork)

A dust seal O-ring is positioned around the circumference of the caliper to seal the motor to the caliper. This O-ring should be replaced if the motor is ever removed from the caliper.

The motor output gear is splined to the ball nut worm gear.



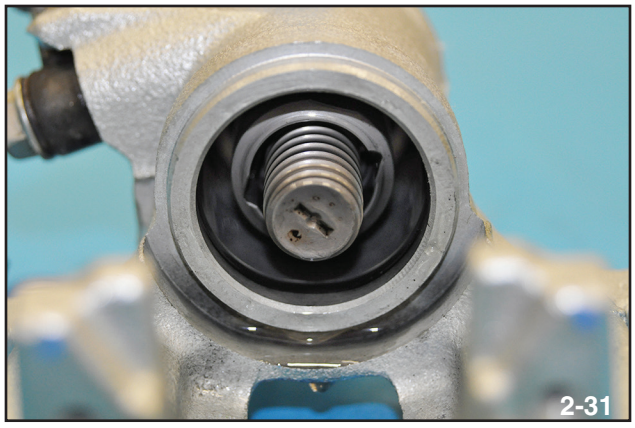
Dust O-ring and Ball Nut Worm Gear



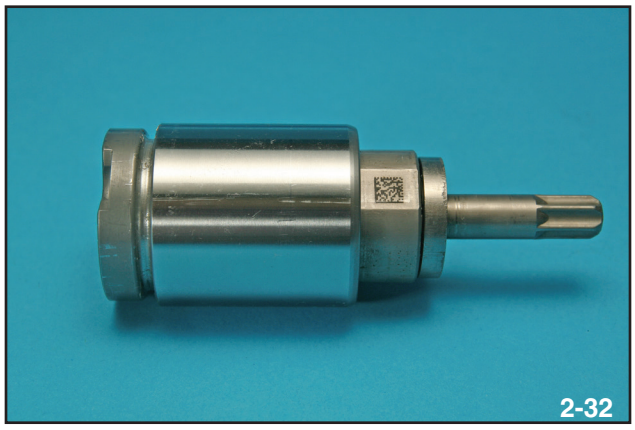
EPB Motor Drive

The ball nut moves up and down on the threads of the worm gear to apply and release mechanical pressure to the back or inside face of the hydraulic piston.

Note: The physical fit of the ball nut to the piston provides areas that can trap air. Air bleeding procedures are the same as existing models. *Brake pedal stroke length should always be checked after installing a new caliper or brake component to ensure all air is removed from the brake system.*

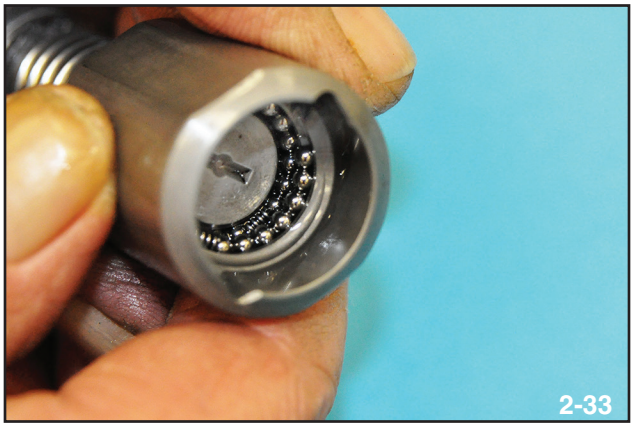


Worm Gear

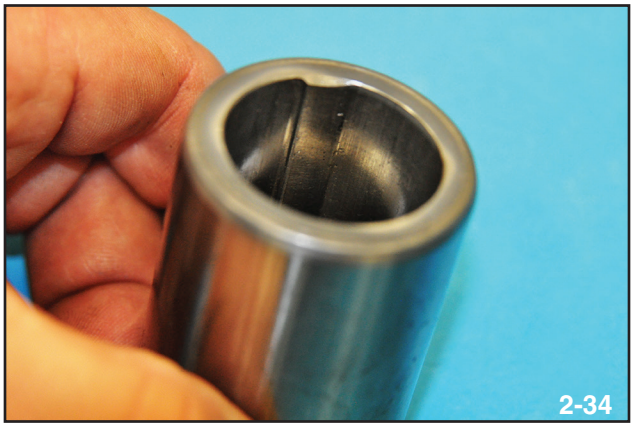


Ball Nut and Piston

The ball nut is constructed of many ball bearings and keeper springs that provide for smooth movement and strength. A flat edge made onto each side of the ball nut keys into the notches made into the inside of the hydraulic piston.



Ball Nut Bearings

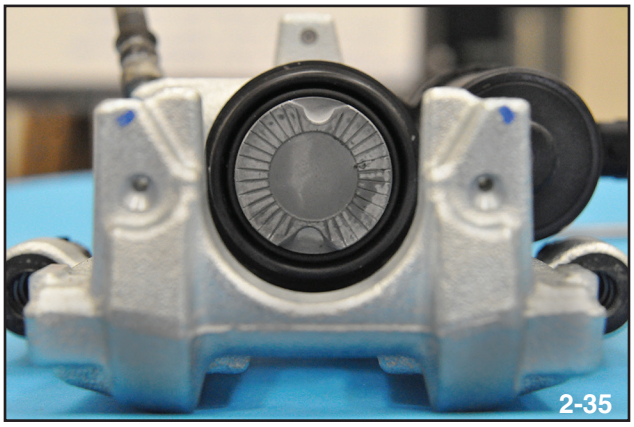


Piston Internal View

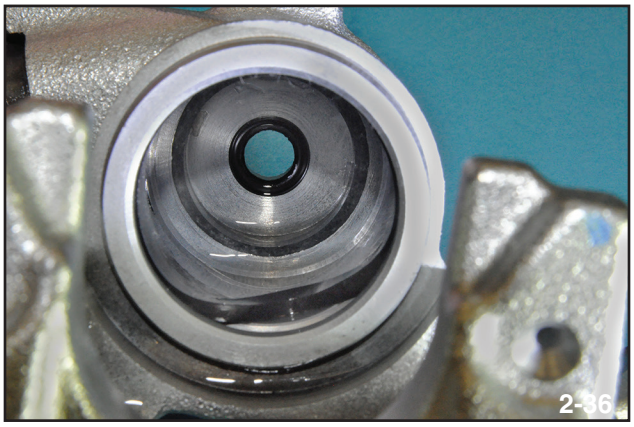
As the piston moves towards the inner brake pad, the serrations machined into the outer face of the piston bite into the inner brake pad shim (permanently mounted to the brake pad) to prevent the piston from rotating when mechanical force begins to increase. Do not lubricate or apply any anti-seize paste to this area.

The notches located at 12:00 and 6:00 in this picture are used to turn the piston clockwise when the Subaru Select Monitor is not available. The piston must be turned during service work to rotate the ball nut back to a service park position if the Subaru Select Monitor is not available.

Note: The service notches can be located in any direction and have no effect to hydraulic or parking brake operation.

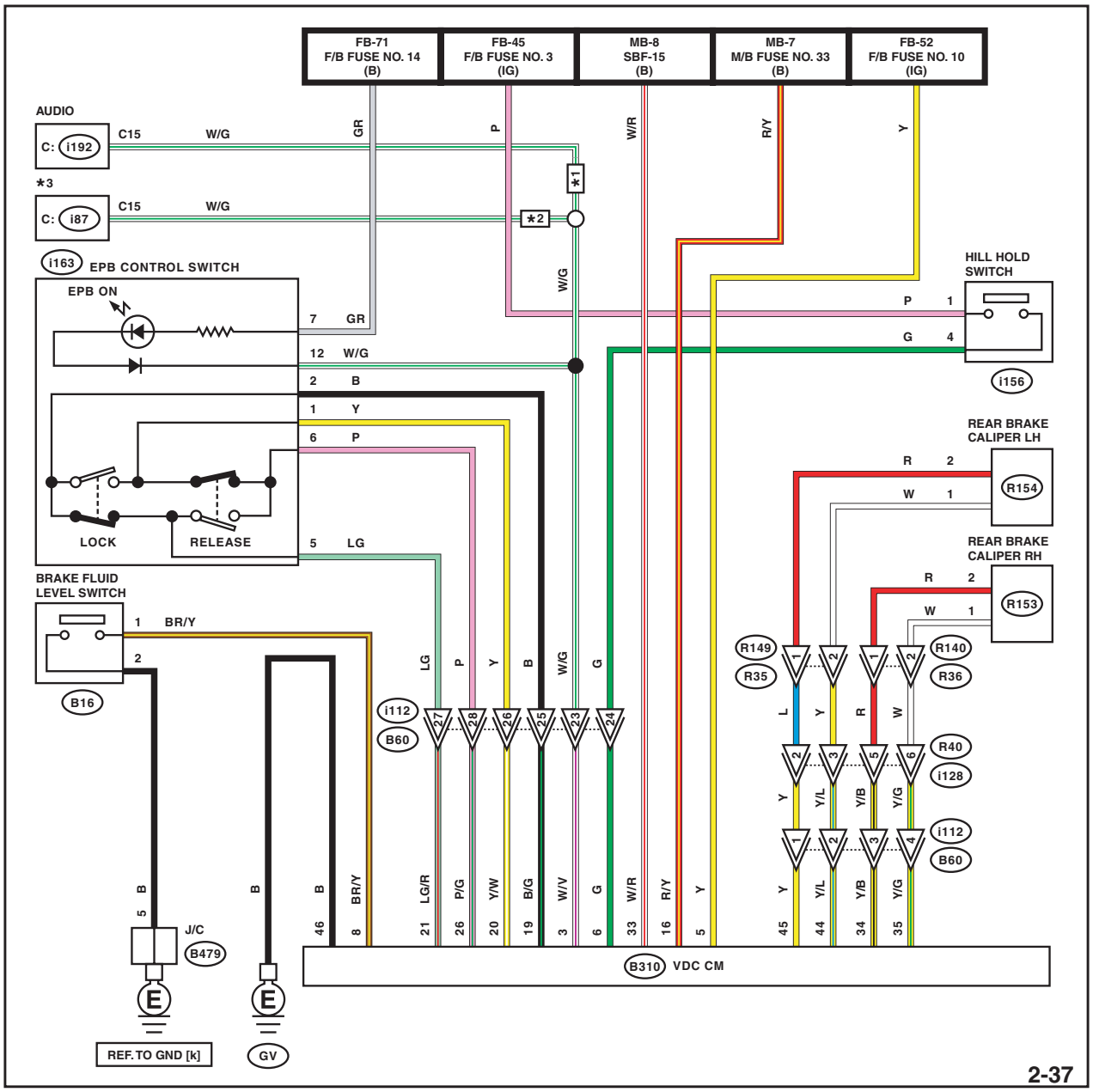


Piston Serrations



Caliper Hydraulic Seals

The operation of the EPB at each rear brake caliper is accomplished using two wires that operate the bidirectional movement of the EPB motors. There are no sensors incorporated into the caliper. Sensing for apply and release is determined by the amount of amperage measured in the Hydraulic Control Unit.

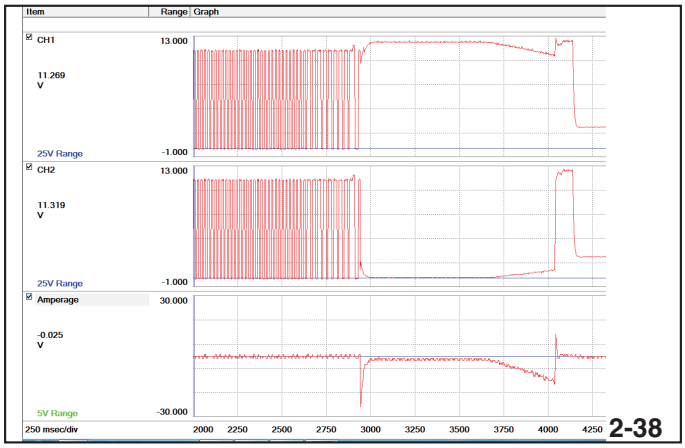


EPB Wiring Schematic

Electrical Operation

Parking Brake Application

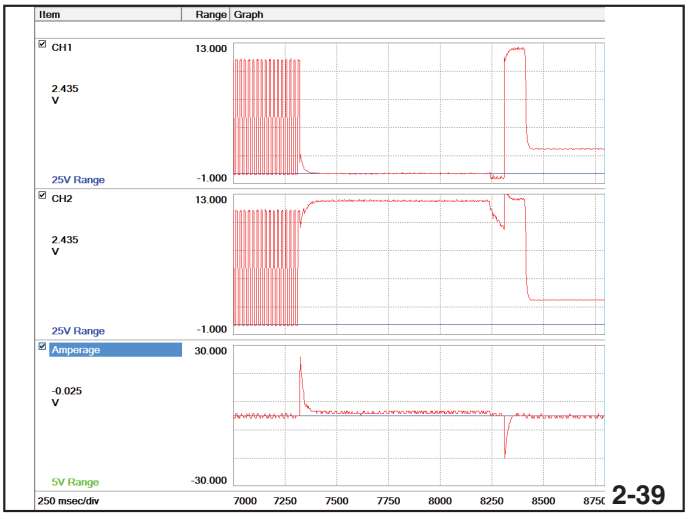
During apply control, the polarity of the wires is controlled to turn the ball nut counter clockwise. This will screw the ball nut into the piston and place mechanical force on the inner brake pad, pulling the caliper inward to force the outer brake pad into the rotor. An initial current spike will occur as the motor first starts to turn and then level off as the motor turns without opposing any mechanical force. As the Hydraulic piston makes contact with the inner brake pad, current starts to increase and continues to increase as the brake caliper is pulled inward. The amperage will reach maximum level after both brake pads are contacting the rotor with a predetermined amount of mechanical force.



EPB ON

Time is measured during the application of the EPB until a pre-established amperage level is reached. This represents the normal EPB on state. This value is also used to determine how long to operate the motor in the reverse direction when the EPB is turned off. As the brake pads wear, the ball nut parks at a lower position on the worm gear. The EPB release motor operation time, determines the final position.

Note: The amount of time and amperage needed to release the EPB is always lower than the application time and amperage due to the reduced work load.

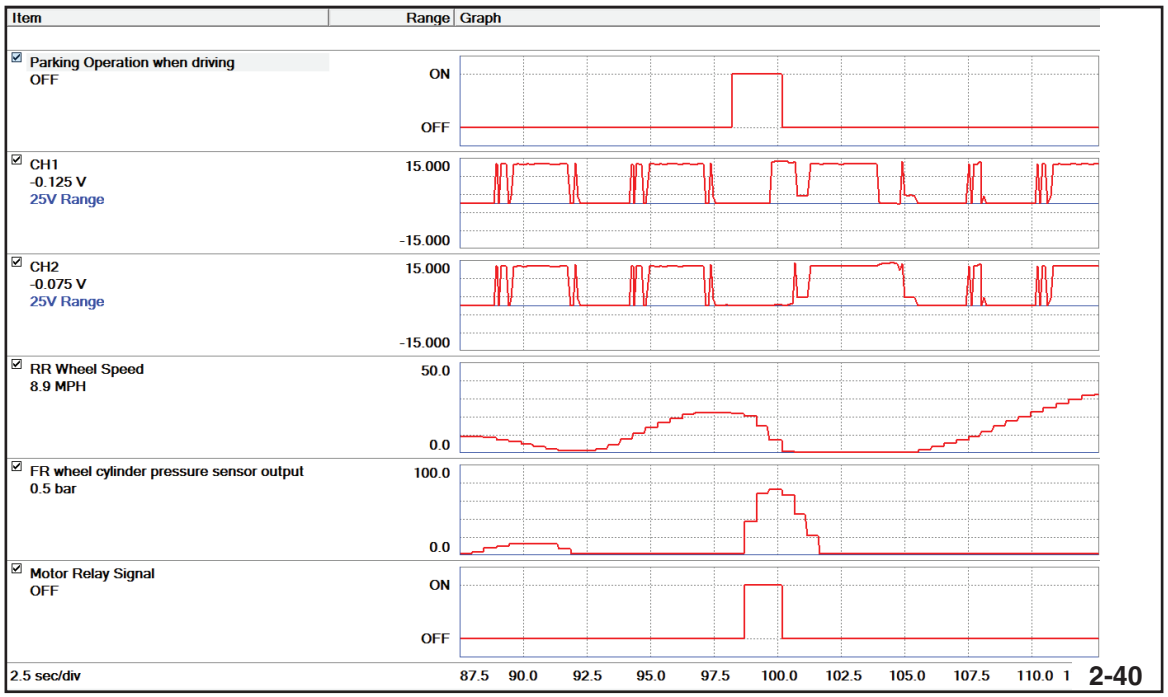


EPB OFF

Emergency Braking

The EPB can also serve as an emergency brake that can be activated while the vehicle is in motion. Pulling up on the EPB control lever and holding the lever upward will activate the Emergency Brake. The 2015 Legacy and Outback Emergency Brake will first attempt to slow down through the use of the normal hydraulic components. The Motor Relay and Valve Relay in the HCU will activate, supplying hydraulic pressure to all brake calipers (Front and Rear). Once maximum braking is occurring (just before wheel lock up), the pump will turn off and hold mode of ABS will maintain the current braking pressure. The EPB motor will activate only after the vehicle speed drops below a set value.

If hydraulic pressure cannot be established, the EPB motor will activate immediately. The rear wheels will lock up and unlock while the EPB switch is held in the on position. The EPB control unit (HCU) will control the application and release of the EPB based on wheel speed sensor input and always pulse the two sides together.



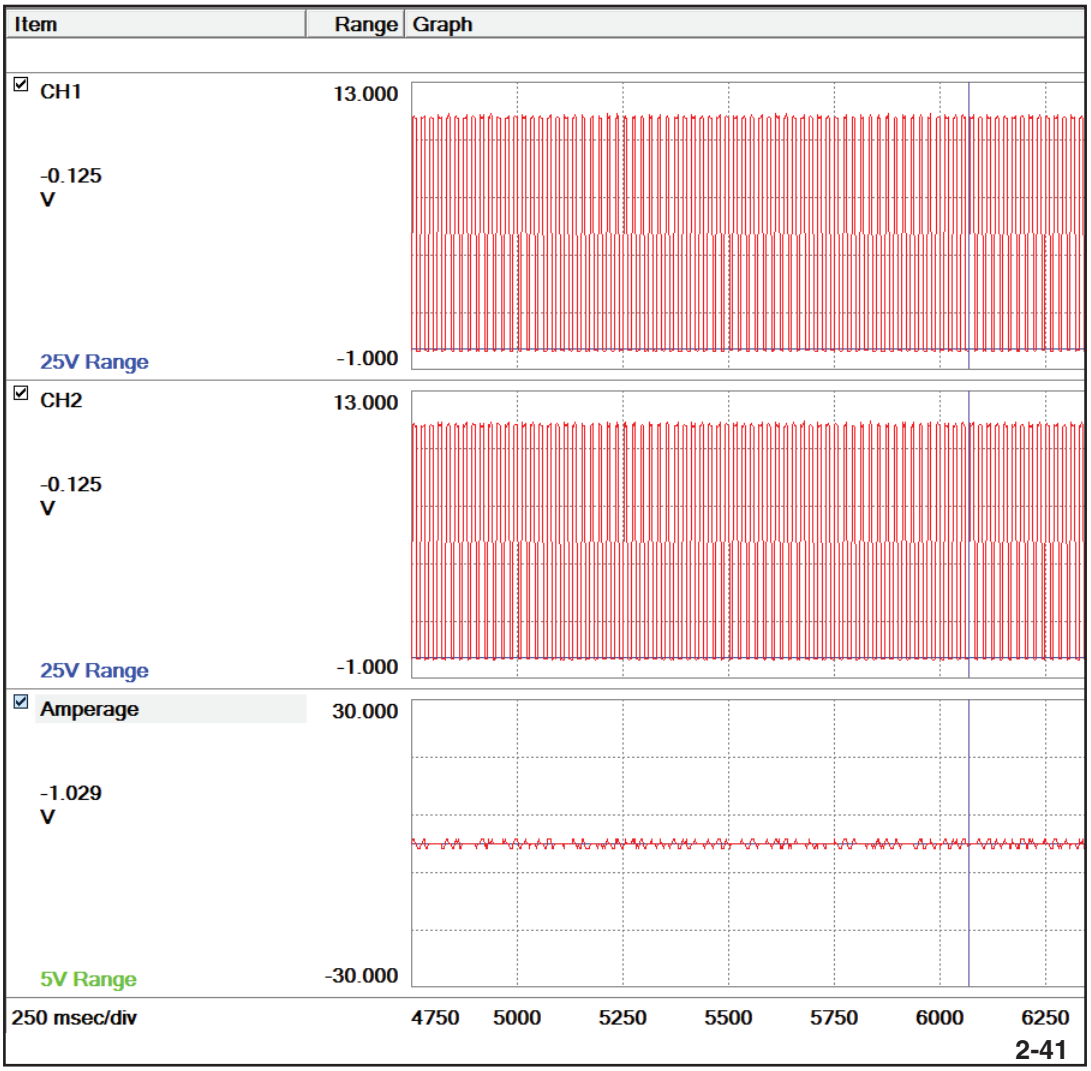
Emergency Brake ON

Parking Brake Release

During EPB release, the polarity of the wires to the EPB motor is reversed and the ball nut rotates clockwise to release the mechanical tension on the inner brake pad and caliper.

Voltage to the two caliper wires is pulsed at the same polarity which allows for faster control.

The HCU can ground either wire while leaving the other at 12 volts positive to activate the EPB motor.



Normal Voltage at EPB Motor in OFF Condition

Emergency Release

In emergency situations (such as motor failure), it may be necessary to manually release the parking brakes to allow the rear wheels to freely spin.

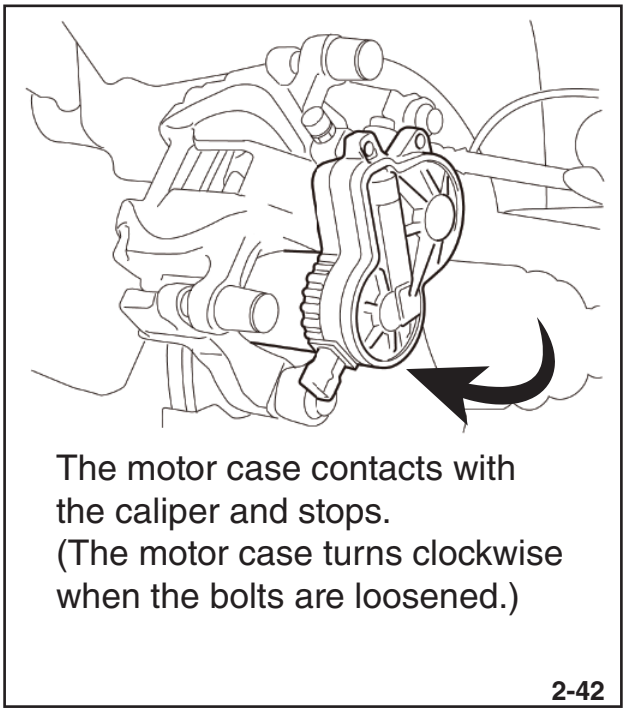
How to release:

1. Disconnect the ground cable from the battery sensor.
2. Set wheel stoppers (chocks) for the front wheels.

   Caution: If you release the parking brake, the vehicle can start moving. Therefore, check the slope of the road and be sure the vehicle is securely stopped and front wheels are chocked.

3. Safely jack up the rear of the vehicle and support with jack stands.
4. Remove the rear wheels.
5. Remove the parking brake actuator assembly.

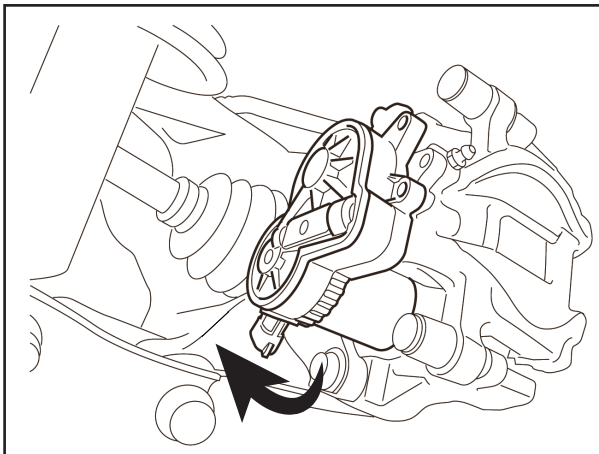
   Caution: When loosening the actuator bolts with the parking brake engaged, the motor body will rotate. Use caution to prevent pinching of fingers. Support and hold the actuator assembly in place using the tip of a screwdriver wrapped with a cloth and slowly allow the tension to be released.



The motor case contacts with the caliper and stops.
(The motor case turns clockwise when the bolts are loosened.)

2-42

Left Side



The motor case contacts with the caliper housing and stops.
(The motor case turns clockwise when the bolts are loosened.)

2-43

Right Side

6. Pry the actuator assembly away from the caliper.
7. Prepare a TORX E12 socket and rotate the caliper spindle (appx. 1 rotation) until the rear rotors rotate freely.

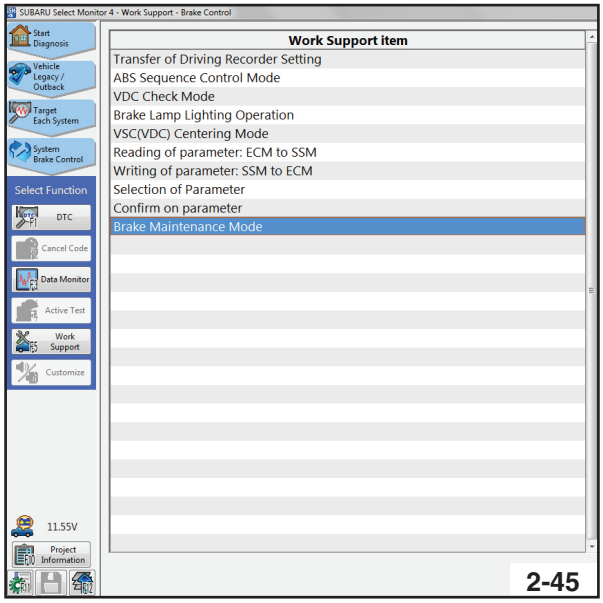
Retracting Ball Nut

8. Temporally re-install the actuator assembly to prevent contamination of the caliper. It is also recommended to cover the electrical connections with tape to prevent contamination.

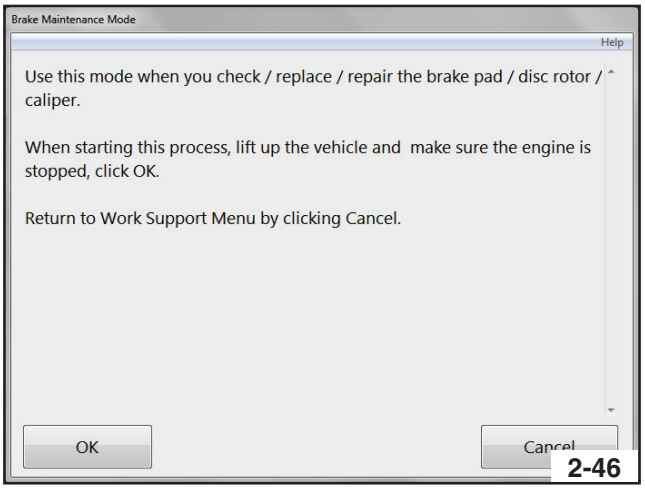
   * **Install a new actuator seal after normal EPB function has been restored.**

Service

Prior to removing rear brake components such as the calipers, pads, or rotors, it is necessary to use the Subaru Select Monitor (SSM) to electrically release the EPB actuator assembly. This procedure is referred to as “Brake Maintenance Mode” and can be found in the Work Support section of the Brake Control System. Failure to perform the Brake Maintenance Mode functions may result in damage to the EPB assembly.

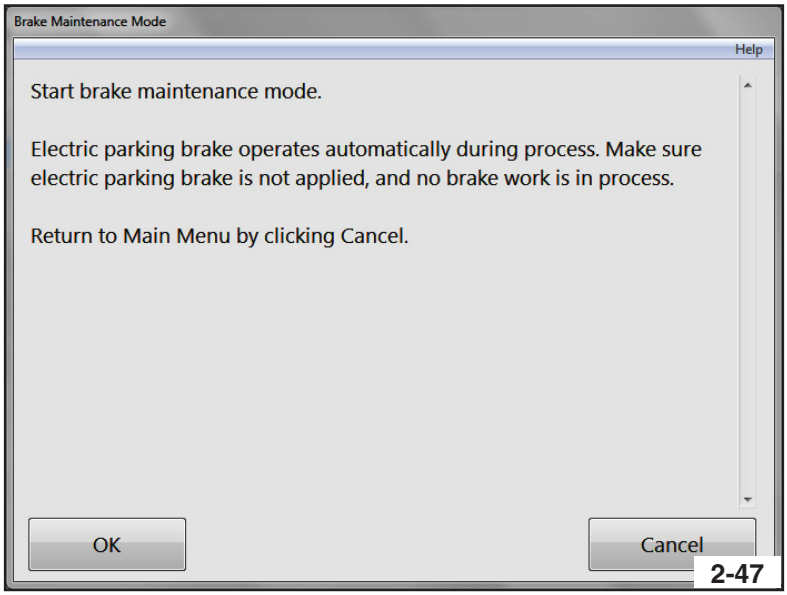


Brake Control System – Work Support



Brake Maintenance Mode

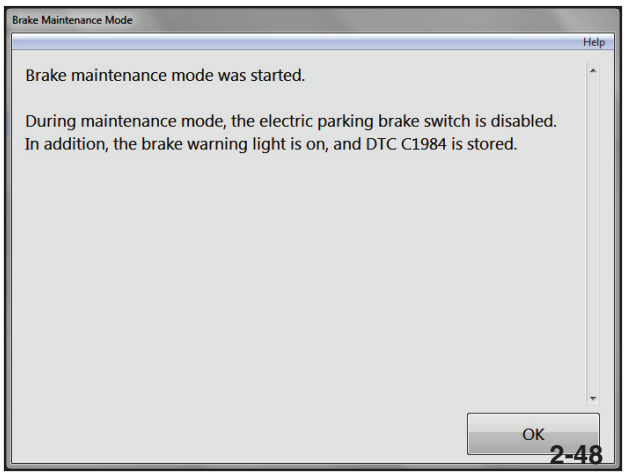
The SSM will display messages directing the user on the necessary actions. During Brake Maintenance Mode, the Parking Brake switch will be disabled to prevent unintended application or release. However, care should still be taken when working around the systems components. Always refer to the appropriate service manual for complete directions when servicing the rear brakes and utilizing the Brake Maintenance Mode



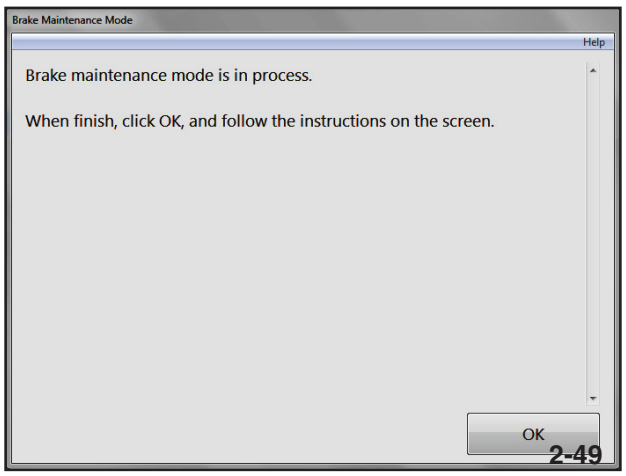
Brake Maintenance Mode – SSM

During Brake Maintenance Mode, the “Brake” warning light on the Combination will be illuminated and DTC C1984 (Brake Maintenance Mode) will be stored in VDC system memory. Once service is complete and the system is returned to “normal” the DTC should be cleared. Always perform overall repair verifications by test driving and inspection for DTCs (Such as C1984) before returning the vehicle to the customer.

Note: 15MY systems do not utilize the Parking Brake, Break-In procedure found on 10MY systems. Rear brake linings should be bedded in using conventional methods.



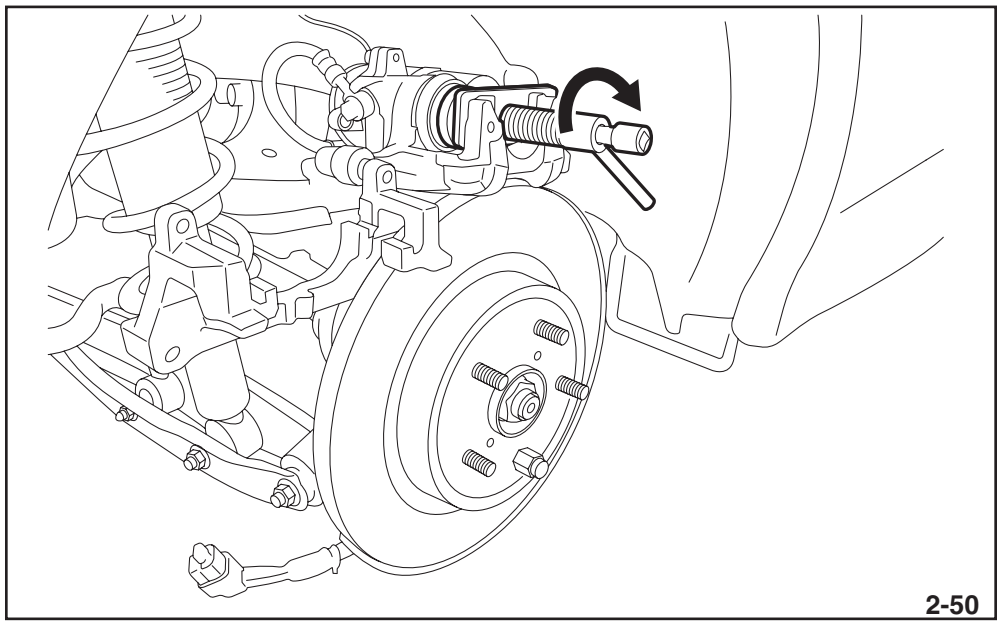
Maintenance Mode – Started



Maintenance Mode – Return to Normal

When the SSM is not used (Facilitates that do not have SDS/SSM), a generic caliper tools must be used to turn the caliper piston clockwise (release direction).

Note: Regardless of the procedure used, apply and release the parking brake five times to ensure the brake operates normally.



Caliper Retraction (Generic tool)

Vehicle Dynamics Control (VDC) Systems

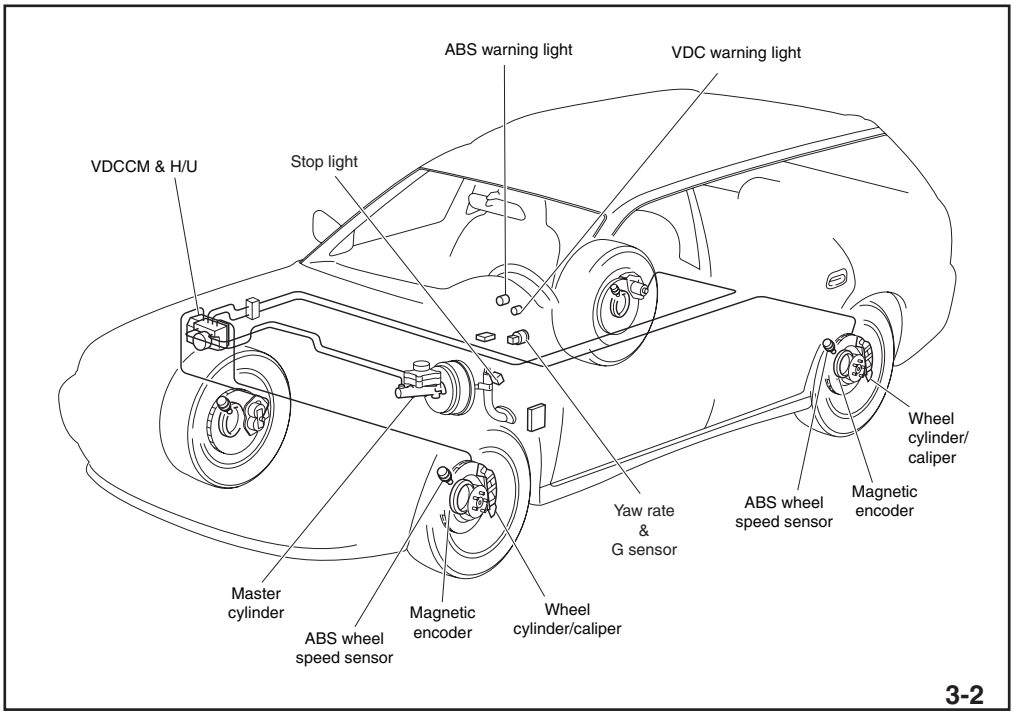
Subaru vehicles feature numerous systems that assist the driver to maintain stability and control during wheelspin and/or skidding on a slippery road surface and/or an evasive maneuver. These systems adjust the engine's output and the wheel's respective braking forces to help maintain traction and directional control.

System Construction

Regardless of which driver assist system is operating, the situational judgements and reactions are performed by the same collection of input and output devices. The sum of these components is commonly referred to as the Vehicle Dynamics Control (VDC) System. The Vehicle Dynamics Control System consists of the following:

- Stop Light Switch (Brake Light Switch)
- Steering Angle Sensor
- Speed Sensors
- G Sensor (Longitudinal & Lateral)
- Yaw Rate Sensor
- Vehicle Dynamics Control Module and Hydraulic Unit (VDCCM & H/U)
  - Pump/Solenoids
- Brake Fluid Pressure Sensor
- VDC OFF Switch
- ABS and VDC Warning Lamps

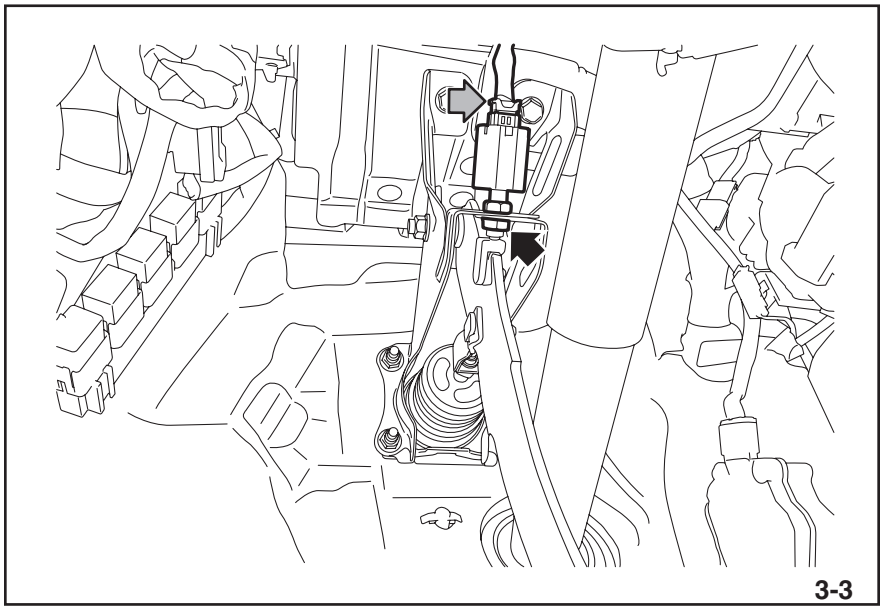
The Subaru VDC system is classified as a 4-sensor, 4-channel system, meaning each of the vehicle's 4 wheels is individually monitored by a sensor and can be individually controlled.



VDC System Component Locations

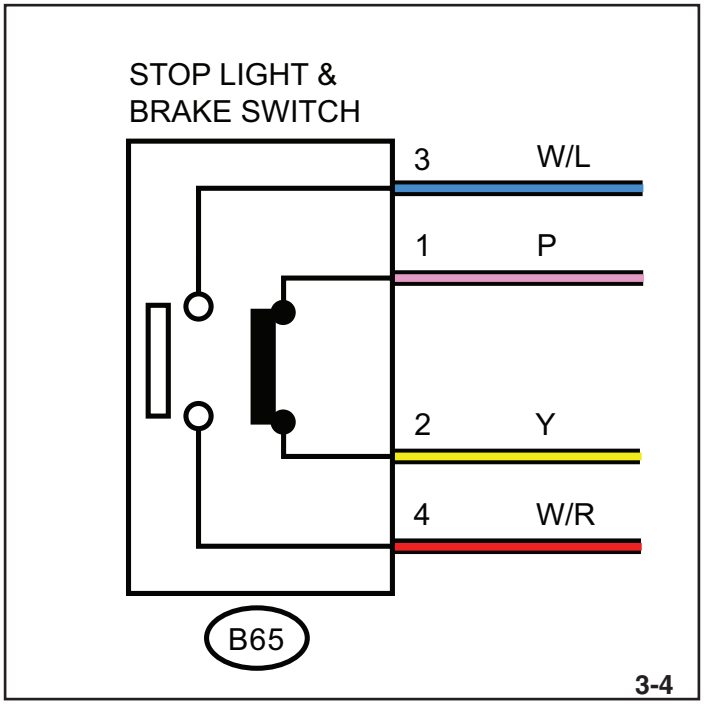
Stop Light Switch

The Stop Light switch (Brake Light Switch) serves as the primary input to the VDCCM to indicate the driver's application of the brake pedal. The Switch is located just above the brake pedal and generates ON/OFF signals to illuminate the Stop lights and provide the VDCCM (and various other Control Modules) with driver input information.



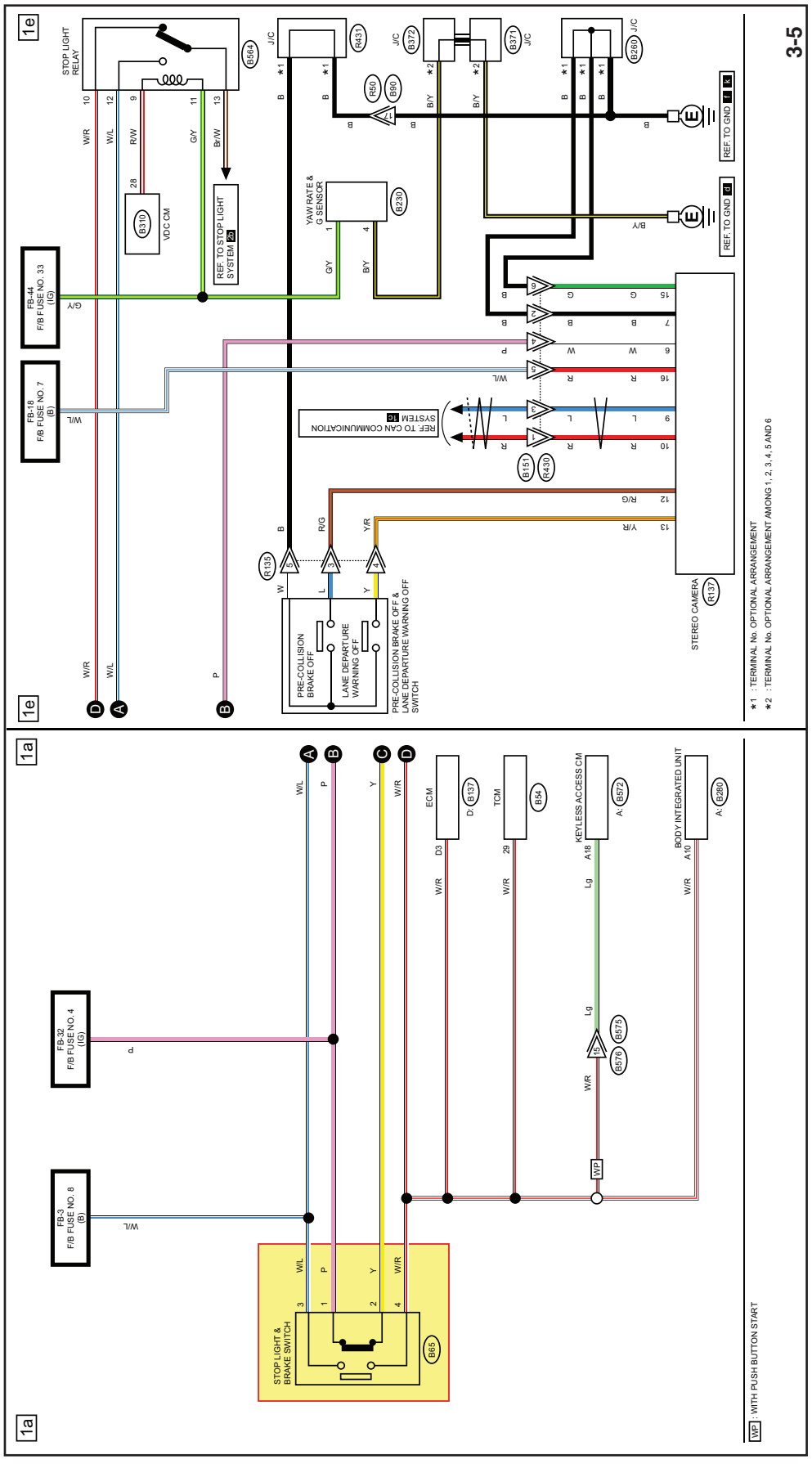
Stop Light Switch

Conventional Stop Light Switches are constructed with 1 or 2 conventional contact switches internally (2 or 4 pin). In the example below, one switch is normally closed (1-2) and the other is normally open (3-4).



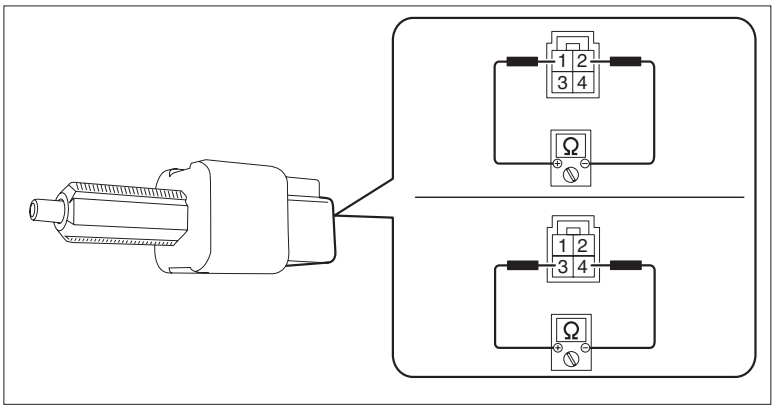
Stop Light Switch – Wiring Diagram

Models with EyeSight utilize an additional Stop Light Relay to allow for independent control of the Stop Lights by the VDC CM or Stereo Camera assembly.



EyeSight Equipped – Wiring Diagram

Conventional Stop Light Switches can be inspected by measuring the continuity between the specified terminals.

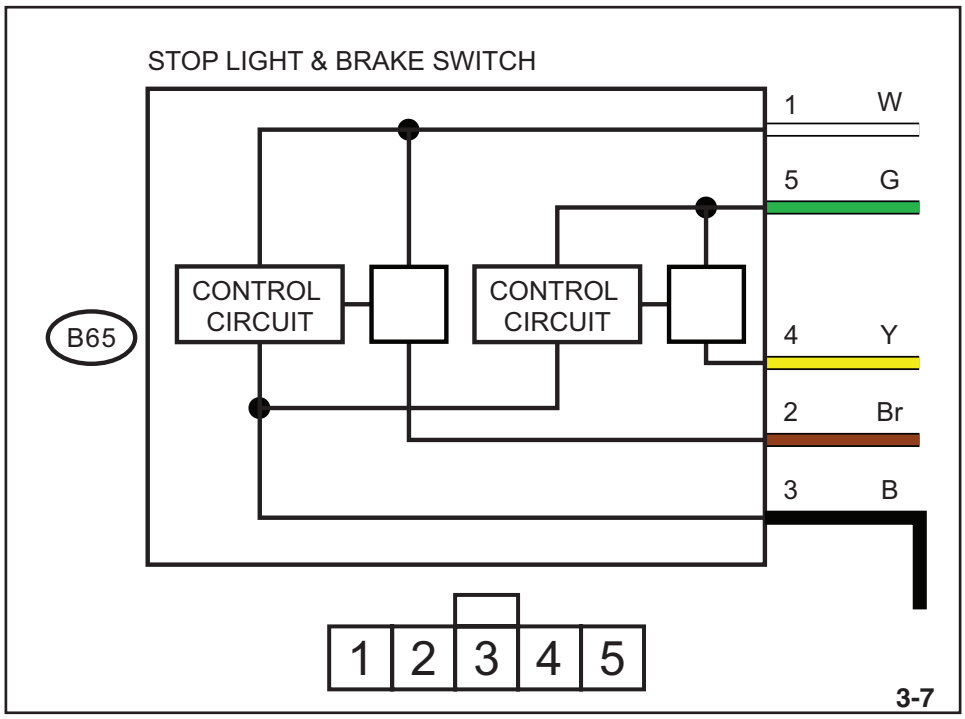


Terminal No.	Inspection conditions	Standard
1 — 2	When brake pedal is depressed	1 MΩ or more
	When brake pedal is released	Less than 1 Ω
3 — 4	When brake pedal is depressed	Less than 1 Ω
	When brake pedal is released	1 MΩ or more

3-6

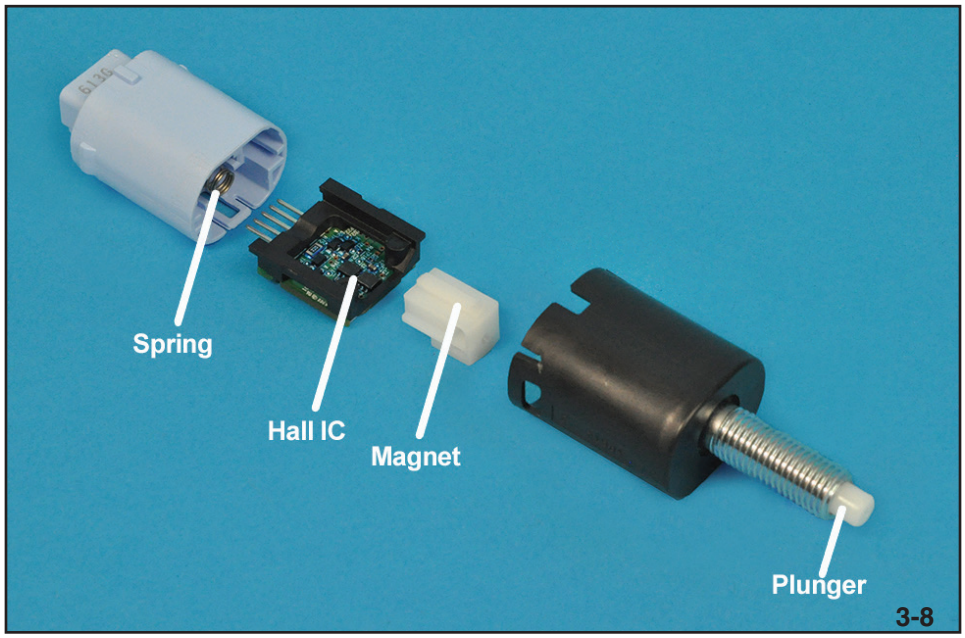
Stop Light Switch – Inspection

Newer models receive an improved Stop Light Switch that is constructed with two Hall Element switches internally. The Hall Elements are illustrated as “Control Circuits” in service manual wiring diagrams. These switches are distinguished by their 5-wire construction.



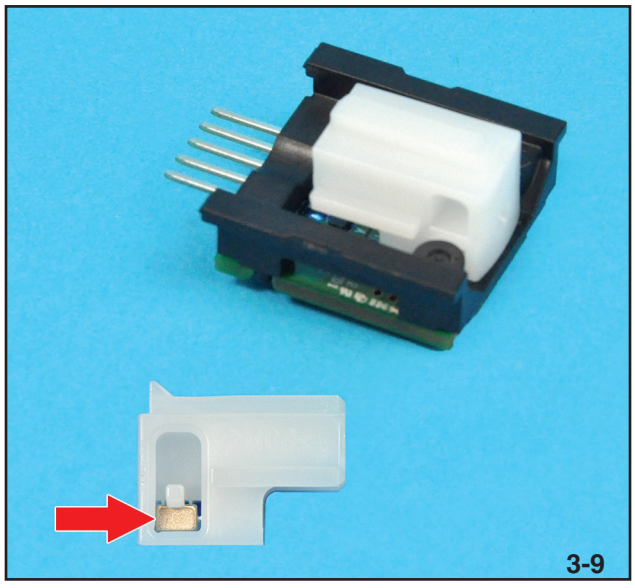
Stop Light Switch – Wiring Diagram

Internally the switch contains a plunger, magnet, Hall Integrated Circuit (IC), and spring. When the brake pedal is depressed, the plunger moves the magnet against the spring's tension. This causes the magnetic field over the Hall IC to fluctuate indicating a change in brake pedal position. When the brake pedal is released, the spring forces the magnet and plunger to return to their original position.

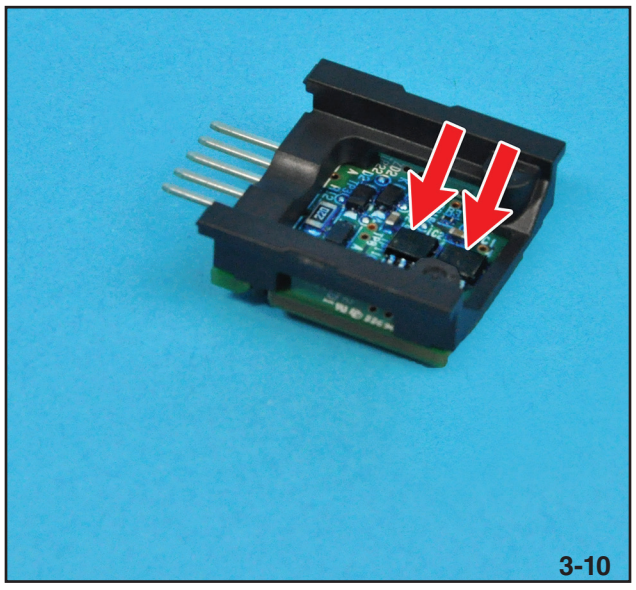


Hall Type Stop Light Switch

The Hall IC contains two Hall element switches attached to the wiring board. As the resin magnet holder position changes, the individual hall switches sense the varying density of magnetic flux lines surrounding the magnet. When the intensity of these flux lines are above/below predetermined values, the Integrated Circuit (IC) judges the hall switch to be open or closed. As this happens, the IC generates a 0v or 12V signal which is identified as ON/OFF by the Engine Control Module (ECM).



Magnet



Hall Switches

Due to the Hall IC design, inspection of the switch requires the application of battery voltage (aprx. 12.6V) between terminals 1 (+) and 3 (-). Always ensure proper connection and polarity before testing to prevent potential damage to the switch or other vehicle components.

2. INSPECT THE RESISTANCE

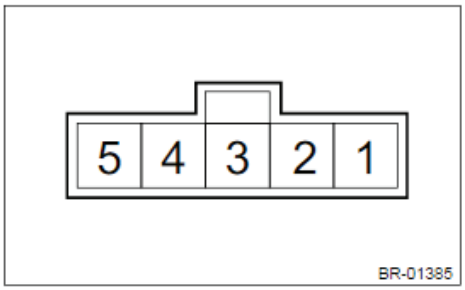
1. Check the resistance between connector terminals.

Caution:

Be sure to apply battery voltage between connector terminals 1 — 3 while checking.

Preparation tool:

Circuit tester



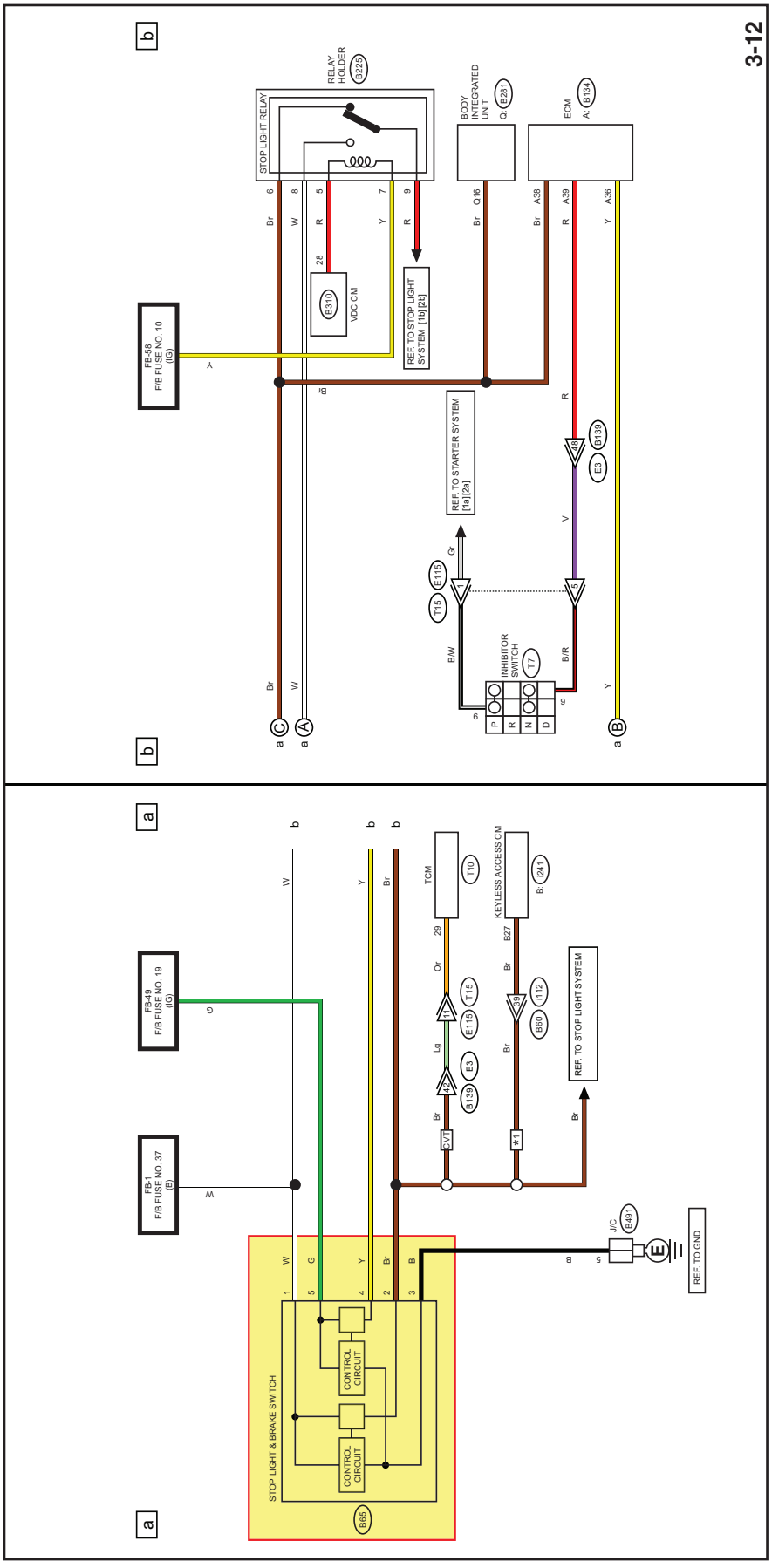
Terminal No.	Inspection conditions	Standard
1 — 2	When brake pedal is depressed	Less than 1 Ω
	When brake pedal is released	1 MΩ or more

2. Replace the stop light switch if the inspection result is not within the standard value.

3-11

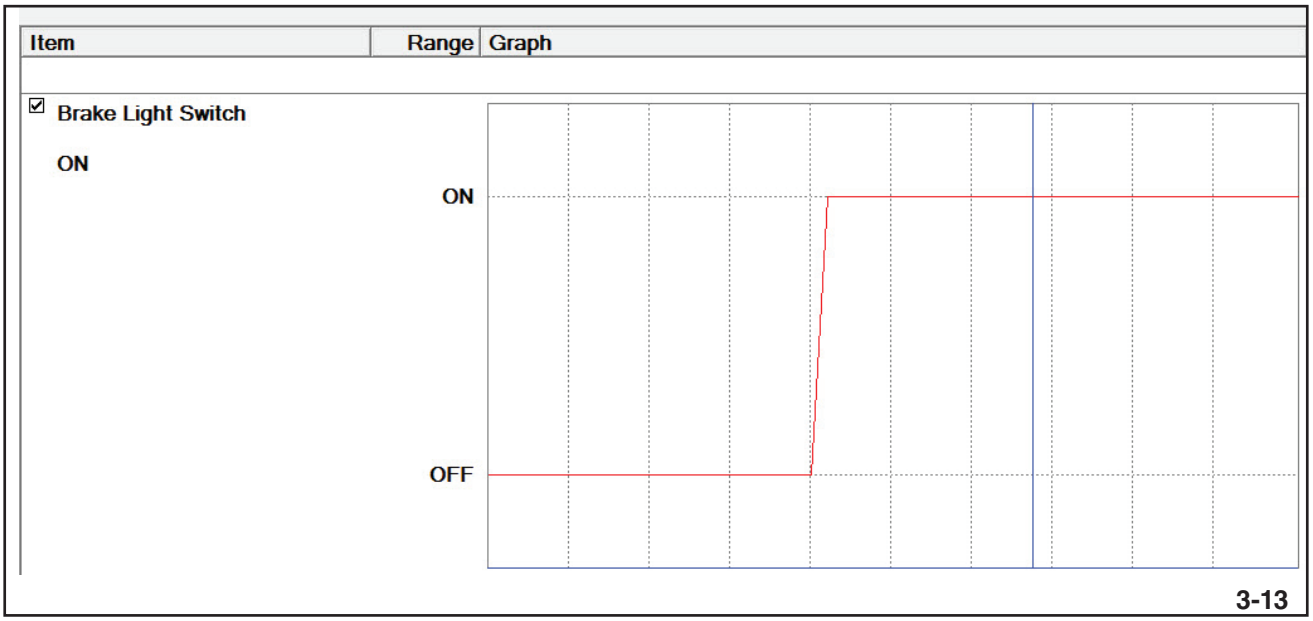
Hall Type Stop Light Switch - Inspection

Models with EyeSight may utilize an additional Stop Light Relay to allow for independent control of the Stop Lights by the VDC CM or Stereo Camera assembly.



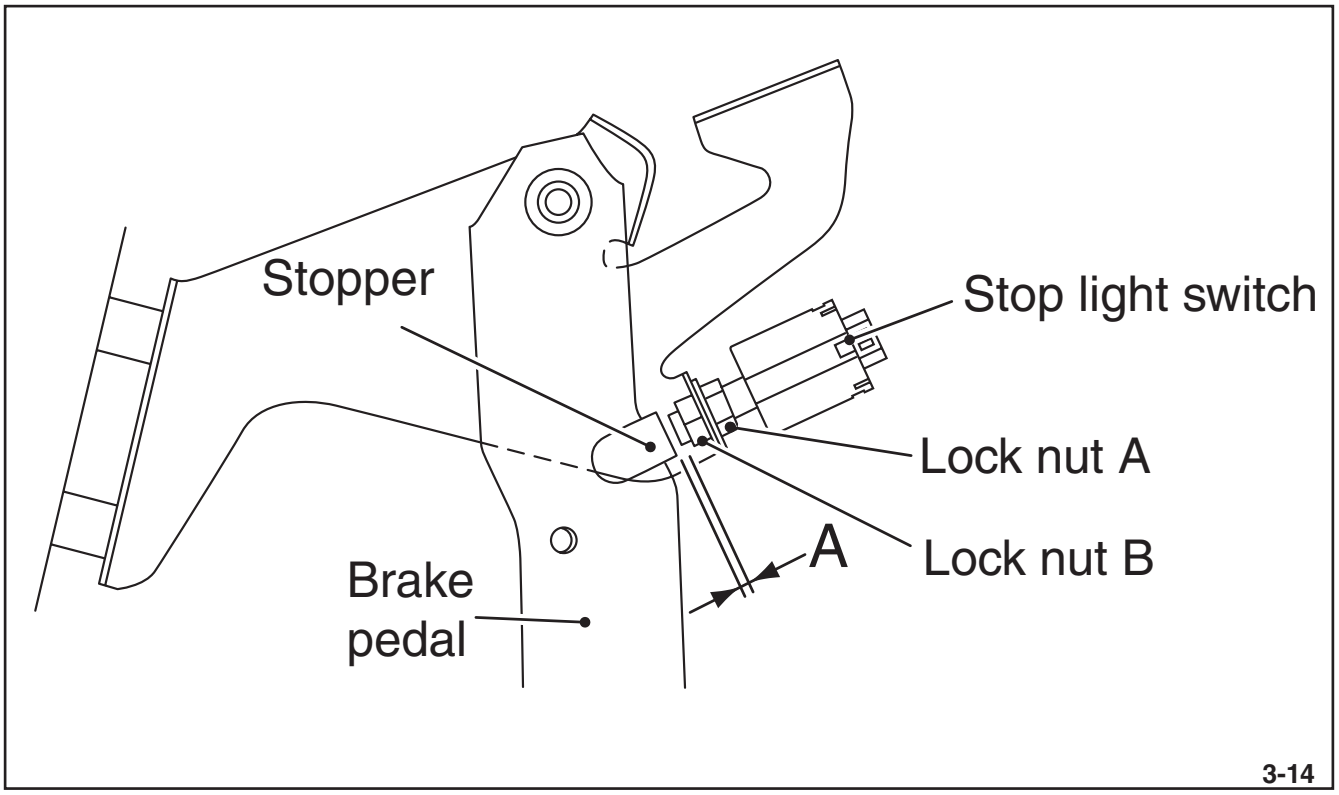
EyeSight Equipped – Wiring Diagram

Regardless of the Switch type, the SSM provides ON/OFF data on the position of the Brake Light Switch.



Stop Light Switch-SSM Data

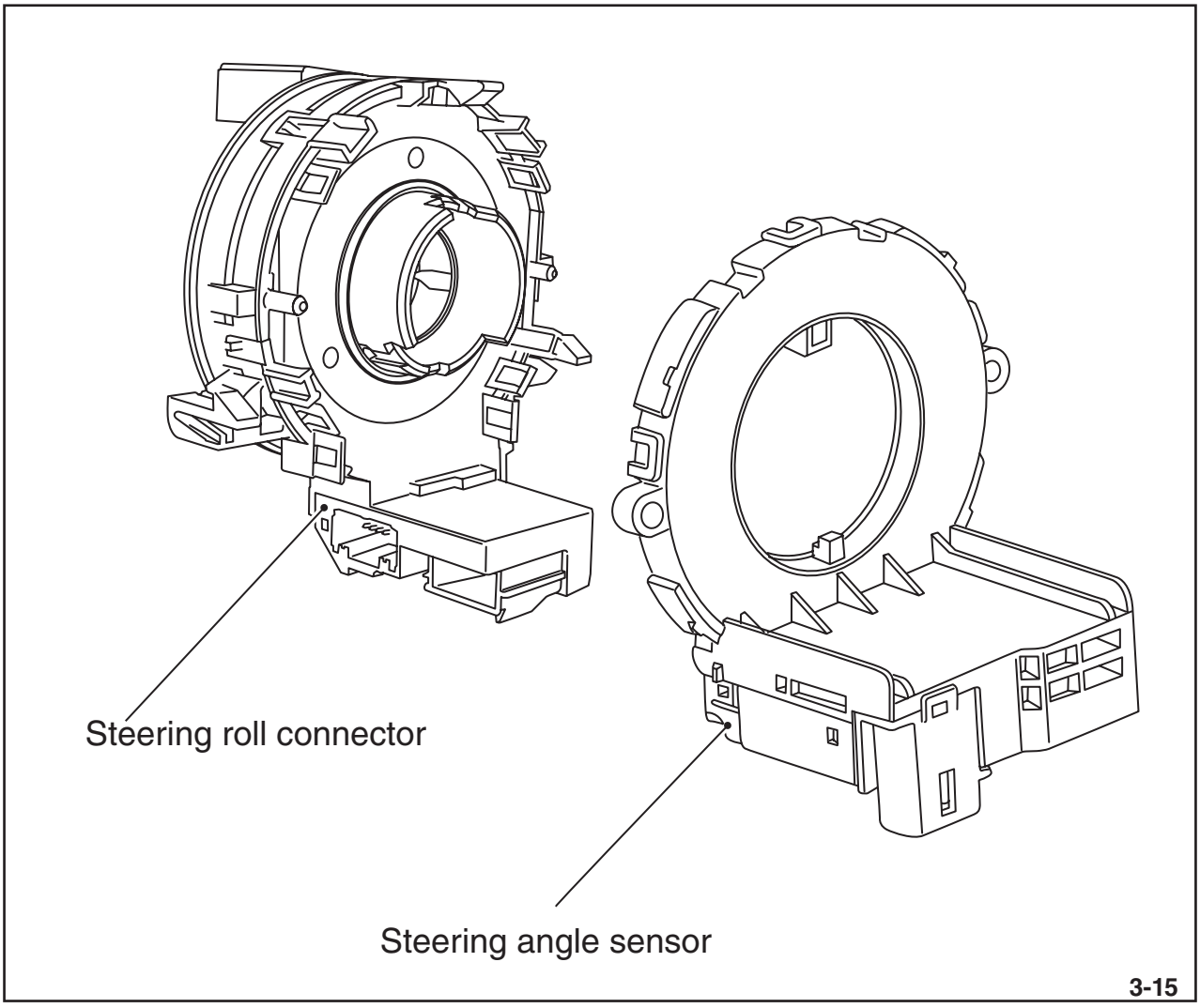
Regardless of the switch type, the Brake Light Switch requires careful adjustment during service or replacement to ensure a proper gap (A) is present. Always refer to the appropriate service manual for procedures and specifications.



Stop Light Switch Adjustment

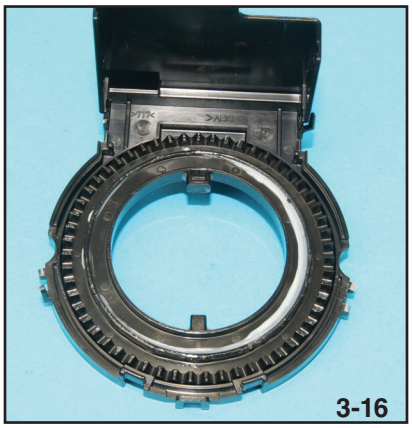
Steering Angle Sensor

The Steering Angle Sensor measures the driver's rotational input of the steering wheel to the VDCCM. With this information, the VDCCM can calculate the driver's intended path and compare that to the vehicle's actual path. The vehicle's actual path is determined calculated by the Yaw Rate and G Sensor.

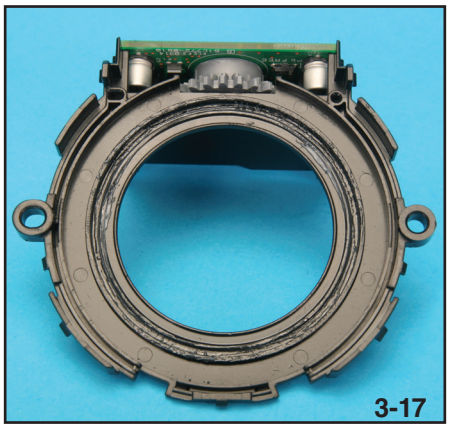


Steering Angle Sensor & Roll Connector

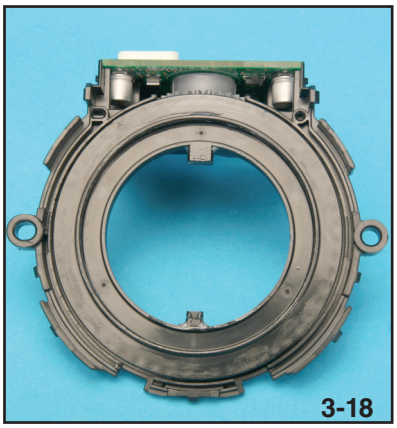
As the steering wheel is rotated, the alignment tabs rotate internal gear teeth.



Drive Gear

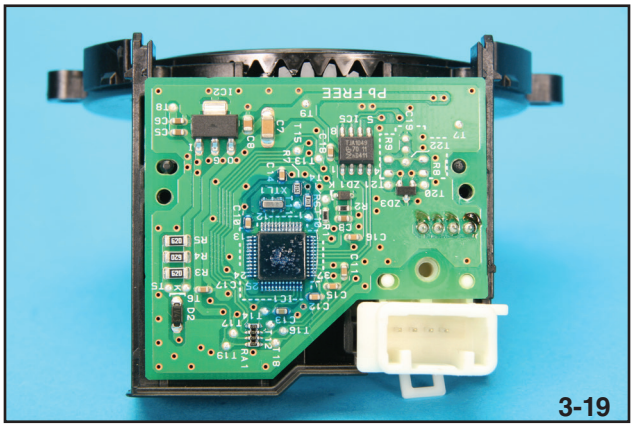


Driven Gear

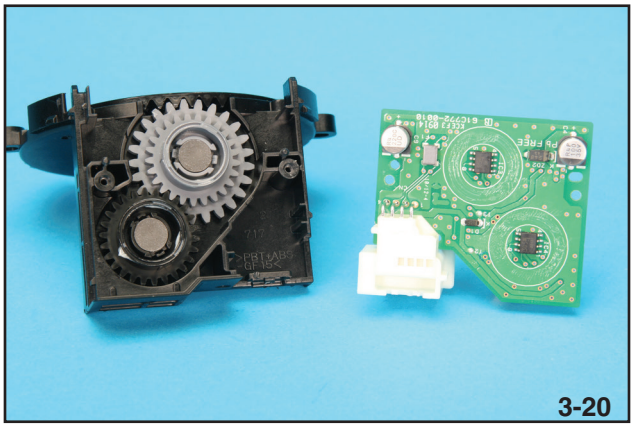


Gears Assembled

The gear teeth rotate two gears that contain magnetic discs. Rotation is detected using two magneto-resistance element (MRE) style sensors.

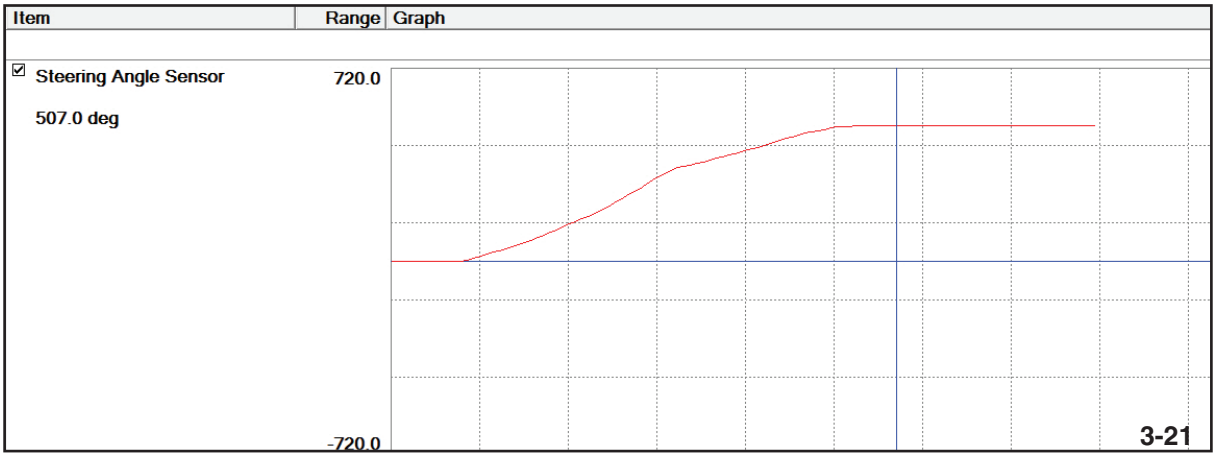


Steering Angle Sensor Gear Mesh

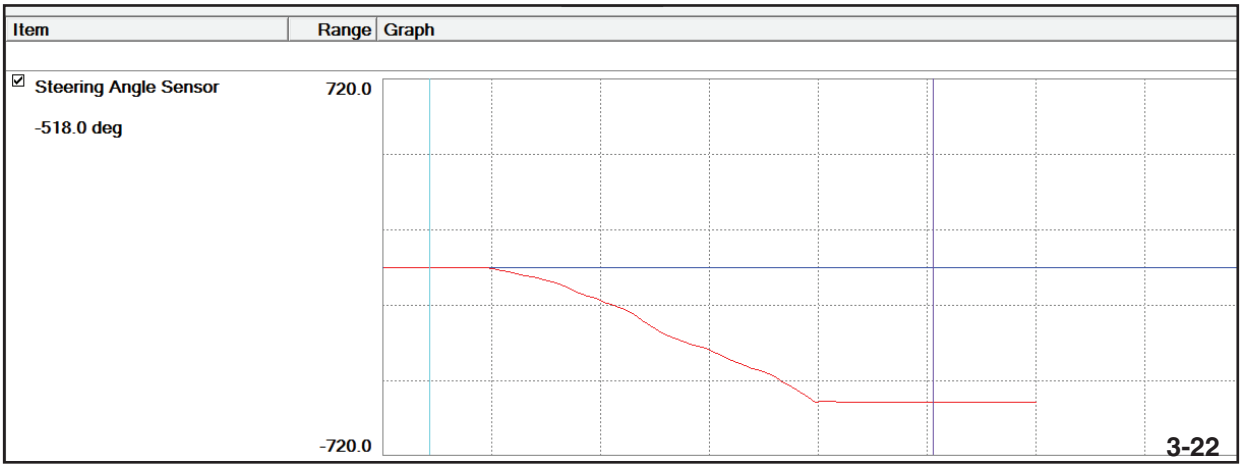


Steering Angle Sensor MRE

Based on the information from these sensors, direction and degree of rotation can be determined. The Steering Angle Sensor can be monitored using the Subaru Select Monitor (SSM). Accuracy and total degrees of rotation from lock to lock may vary by year and model.

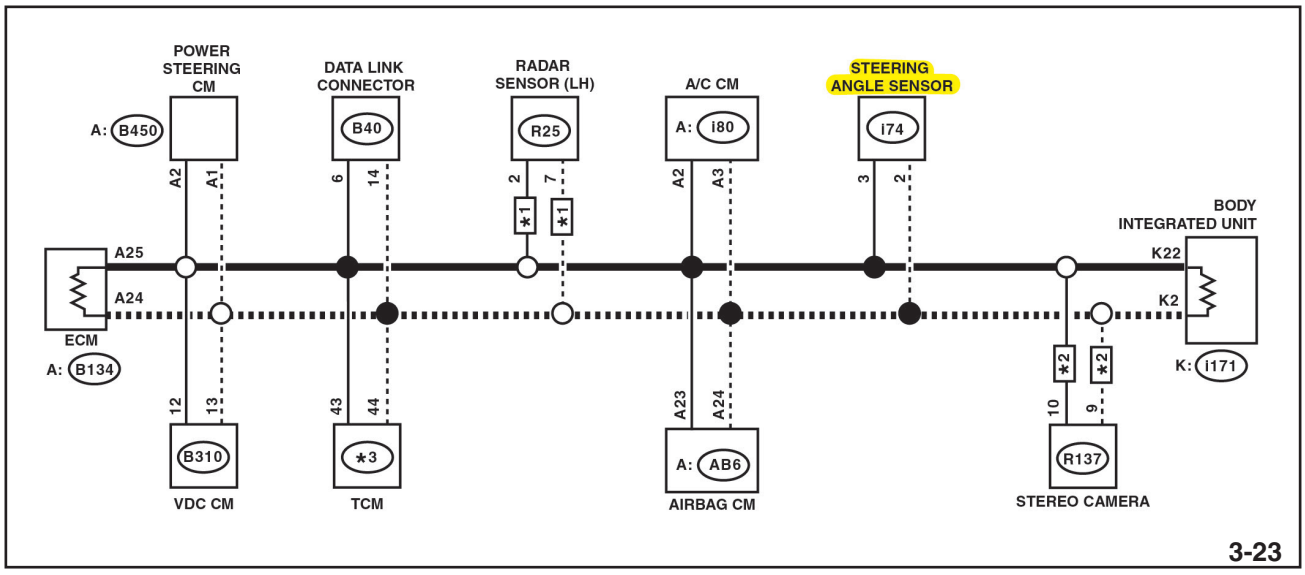


Steering Wheel - Turned Left



Steering Wheel - Turned Right

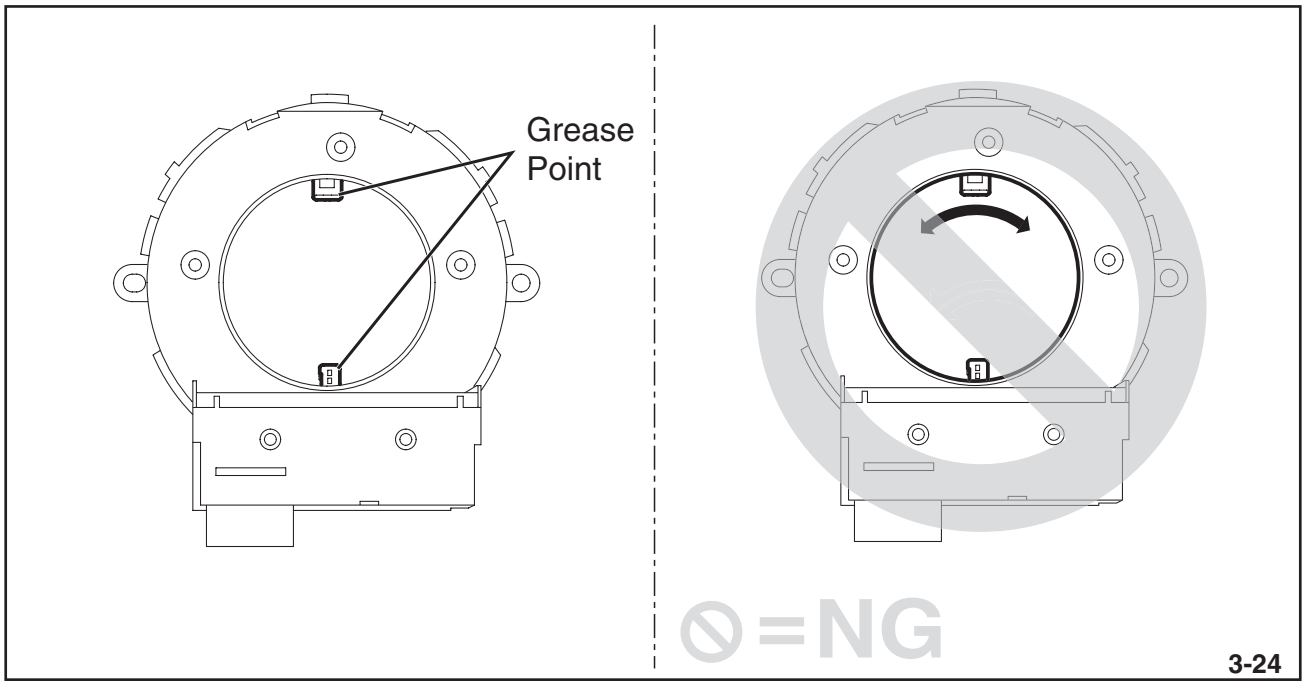
Information obtained from the Steering Angle Sensor is sent via the CAN to the VDCCM.



Steering Angle Sensor CAN Circuit

During Service of the Steering Angle Sensor, always ensure the orientating marks/features are not disturbed. Sensors may also require the application of a small amount of grease.

Caution: Refer to all Airbag System related safety precautions before attempting service of the Steering Angle Sensor.

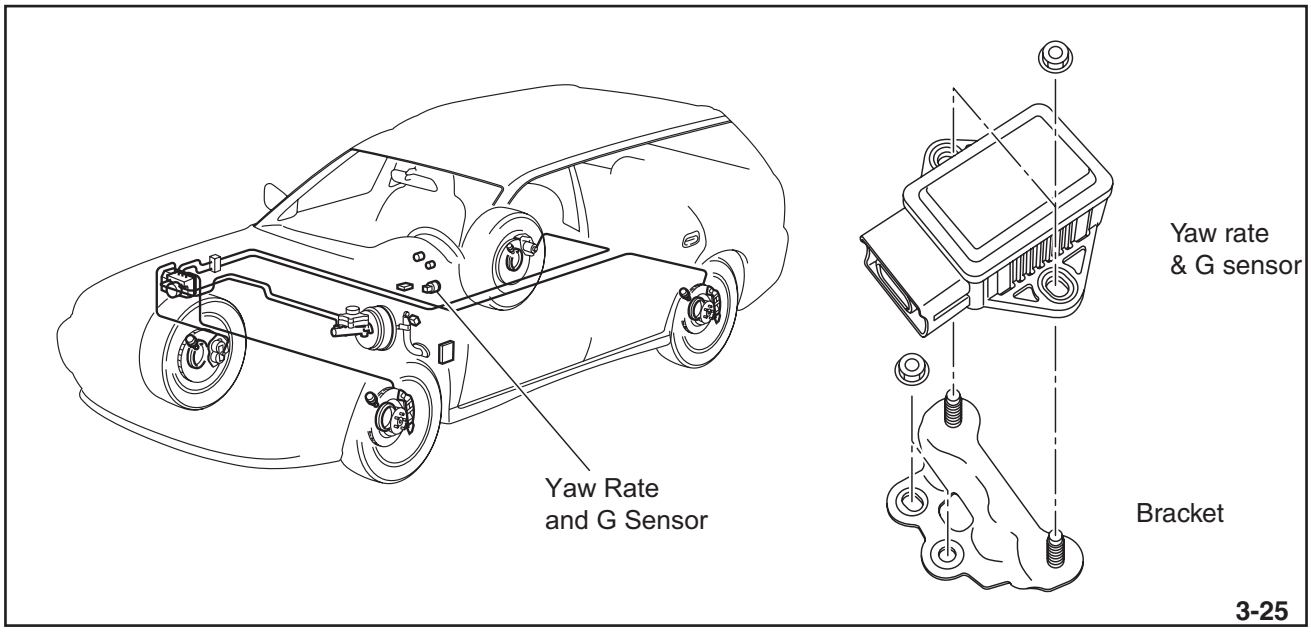


Steering Angle Sensor Service

Yaw Rate & G Sensor

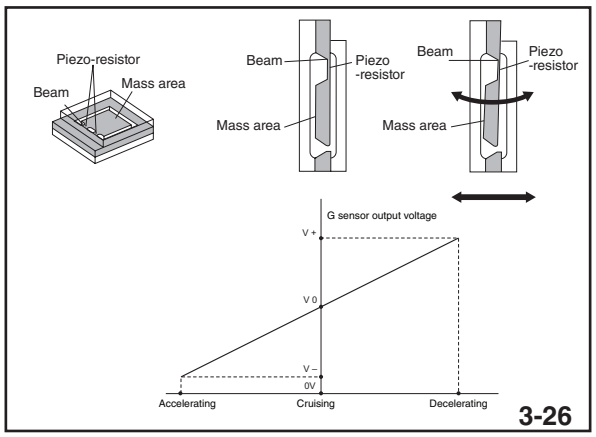
The Yaw Rate and G Sensor detect the acceleration, deceleration, and rotation/angular speed (yaw) of the vehicle using piezoelectric resistor type sensors. The Yaw Rate and G Sensor is typically located in the center of the vehicle.

Note: Beginning with 2010 MY Legacy/Outback models, the Yaw Rate and G sensor has been incorporated into the VDCCM.

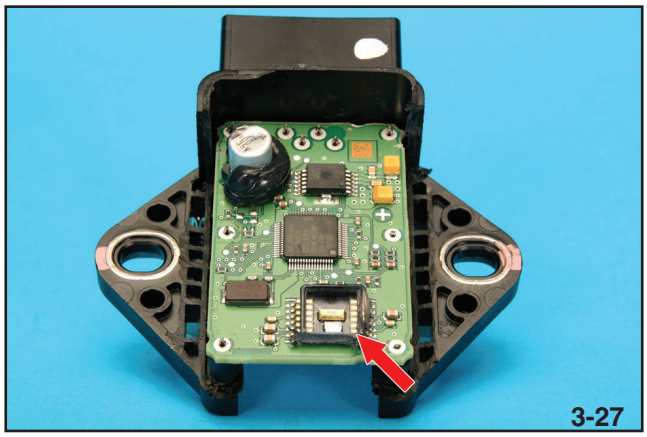


Yaw Rate and G Sensor Location

Internally, the Yaw Rate and G Sensor contains piezo-resistors formed on deflecting beams (tuning forks) in the longitudinal and lateral directions of the vehicle. The beam masses will deform during acceleration and deceleration causing resistance changes in the piezo-resistors. The resistance change alters the signal voltage being sent to the VDCCM.

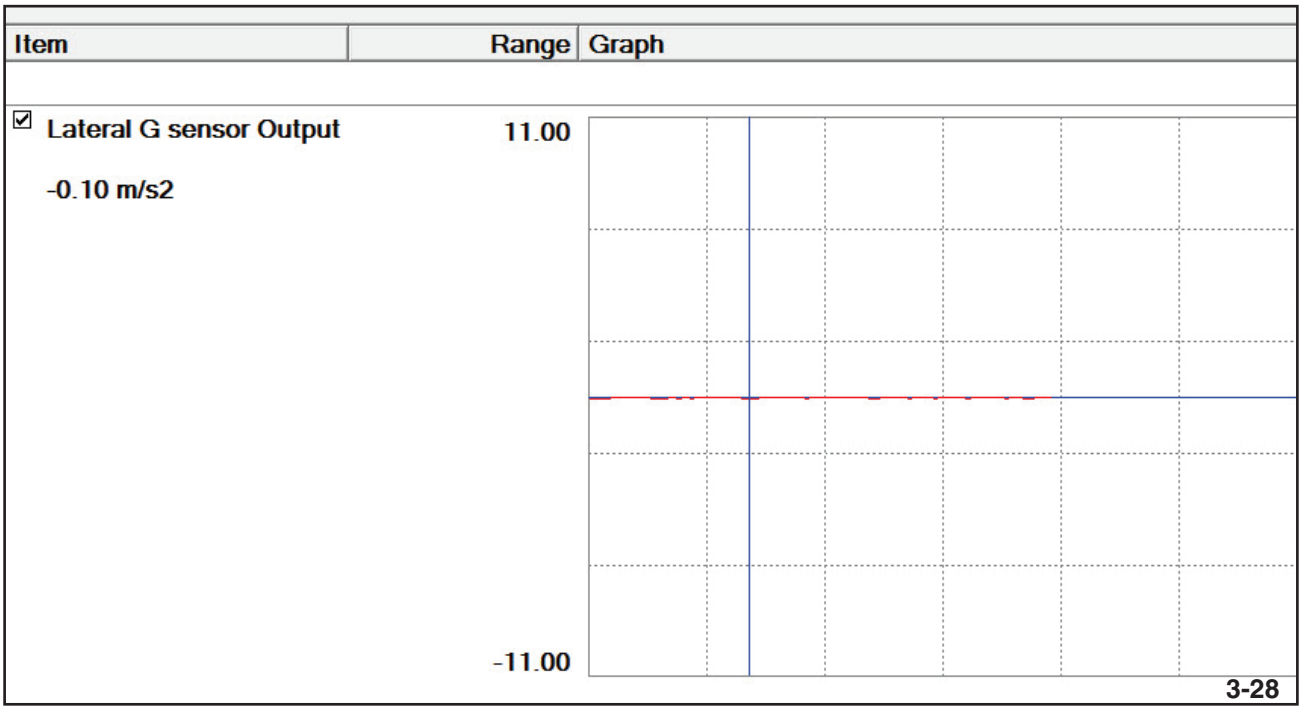


Piezo - Resistor - Artwork

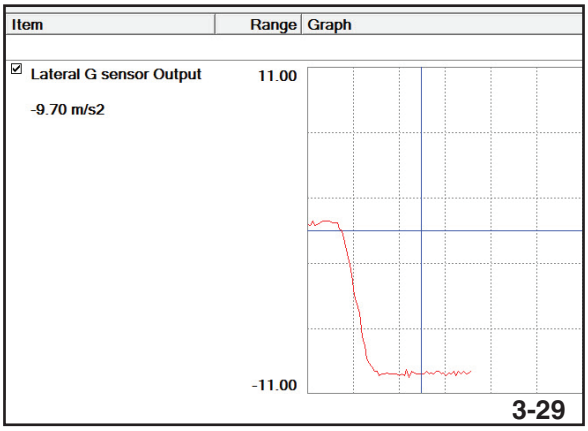


Piezo - Resistor - Cutaway

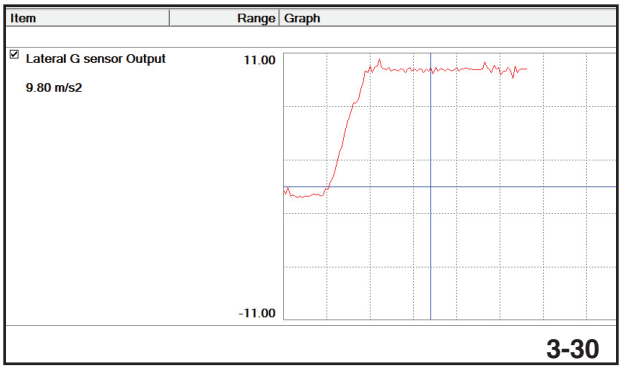
The Yaw Rate and G Sensor can be inspected be removing the unit from its mounting location (if applicable) and rotating it in the lateral and longitudinal directions.



Yaw Rate and G Sensor - Neutral



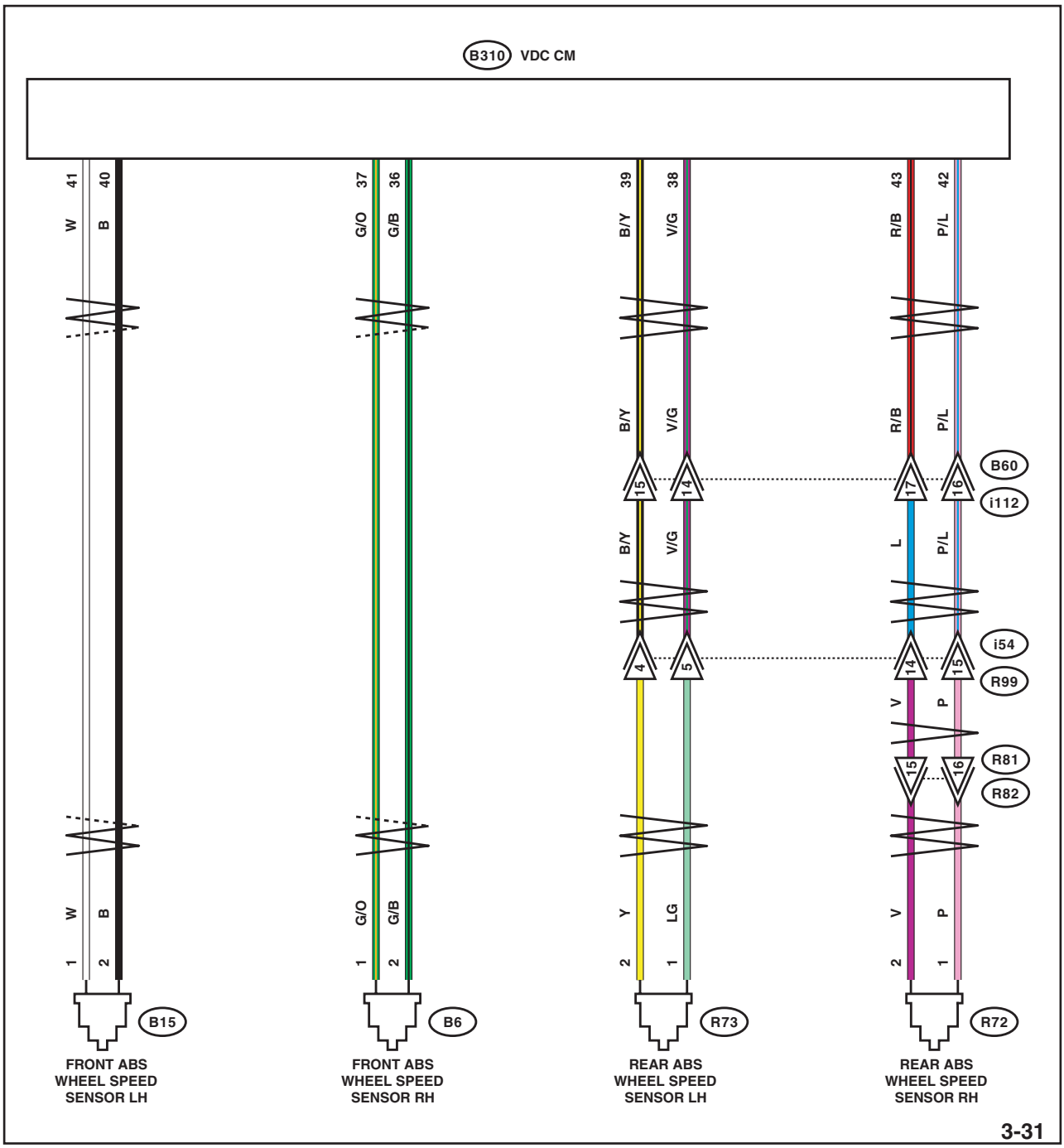
Yaw Rate and G Sensor - 90° Left



Yaw Rate and G Sensor - 90° Right

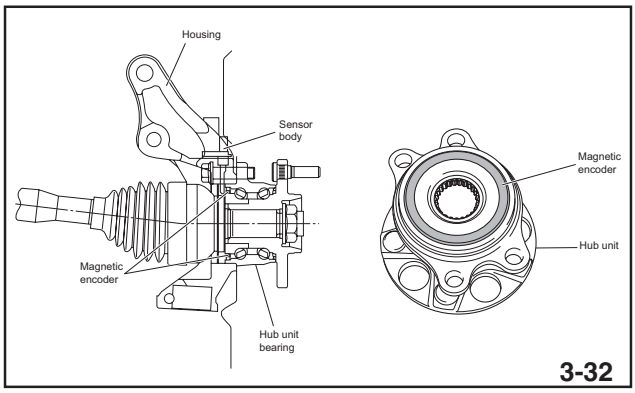
Wheel Speed Sensors

The VDC system uses a 4-sensor system to monitor the speed of the vehicle's four wheels. Each sensor independently provides data to the VDCCM.

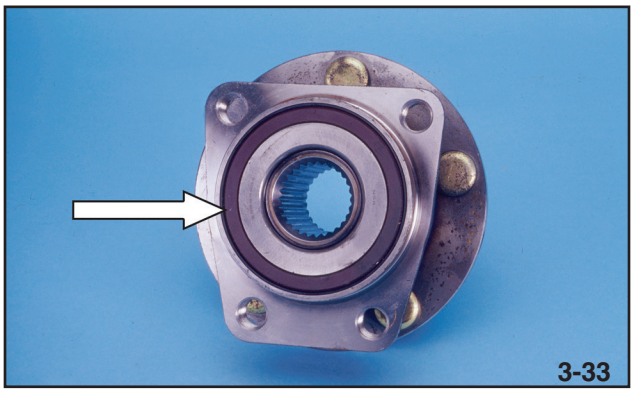


Wheel Speed Sensor - Circuit

The wheel bearing and hub assembly contains an integrated Encoder Ring. Small magnetic strips are incorporated into the ring which generate pulses in the Wheel Speed Sensor hall switch element. If the encoder ring is cracked or otherwise damaged, the Hub Assembly must be replaced.



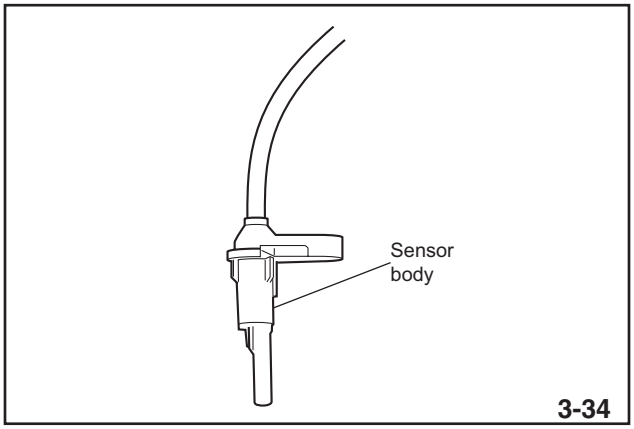
Encoder Ring - Artwork



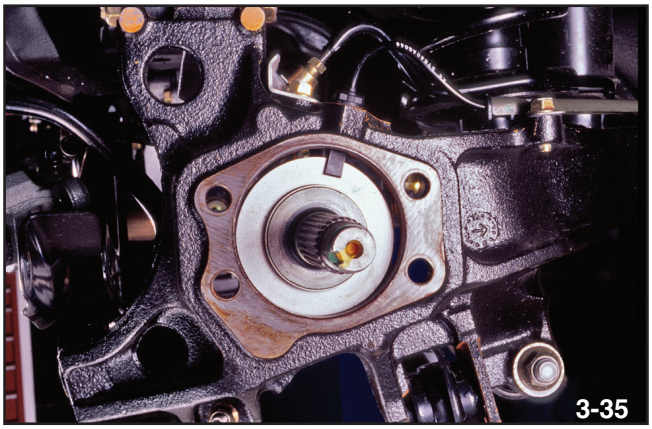
Encoder Ring

Each sensor is a hall switch element type that generates a square wave pattern based on the influence of the alternating magnetic strips located in the Encoder Ring.

Note: During diagnostics, always inspect for foreign material that may have become adhered to either the sensor tip or Encoder Ring.

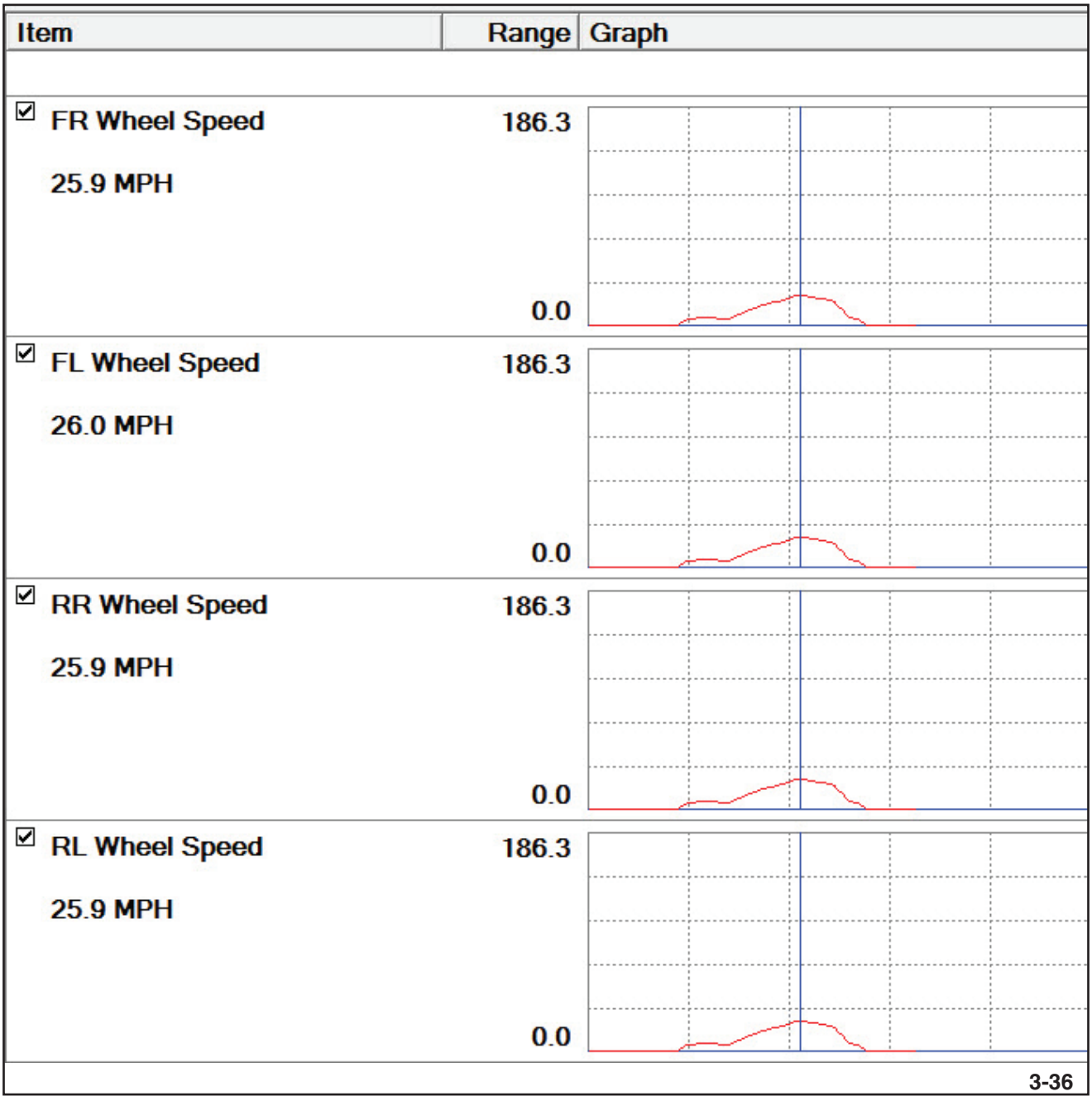


Wheel Speed Sensor - Artwork



Wheel Speed Sensor Installed

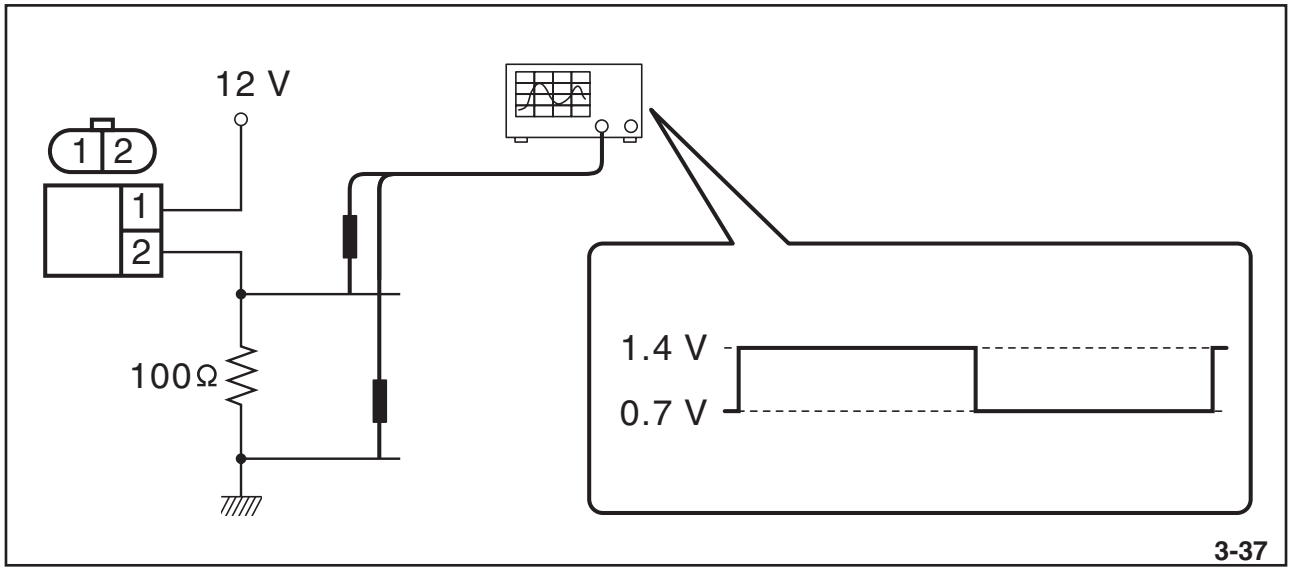
Inspection of the Wheel Speed Sensors can be accomplished using the Subaru Select Monitor or with an oscilloscope. Inconsistent wheel speeds under normal driving conditions may indicate mismatched tires or malfunctions in the system.



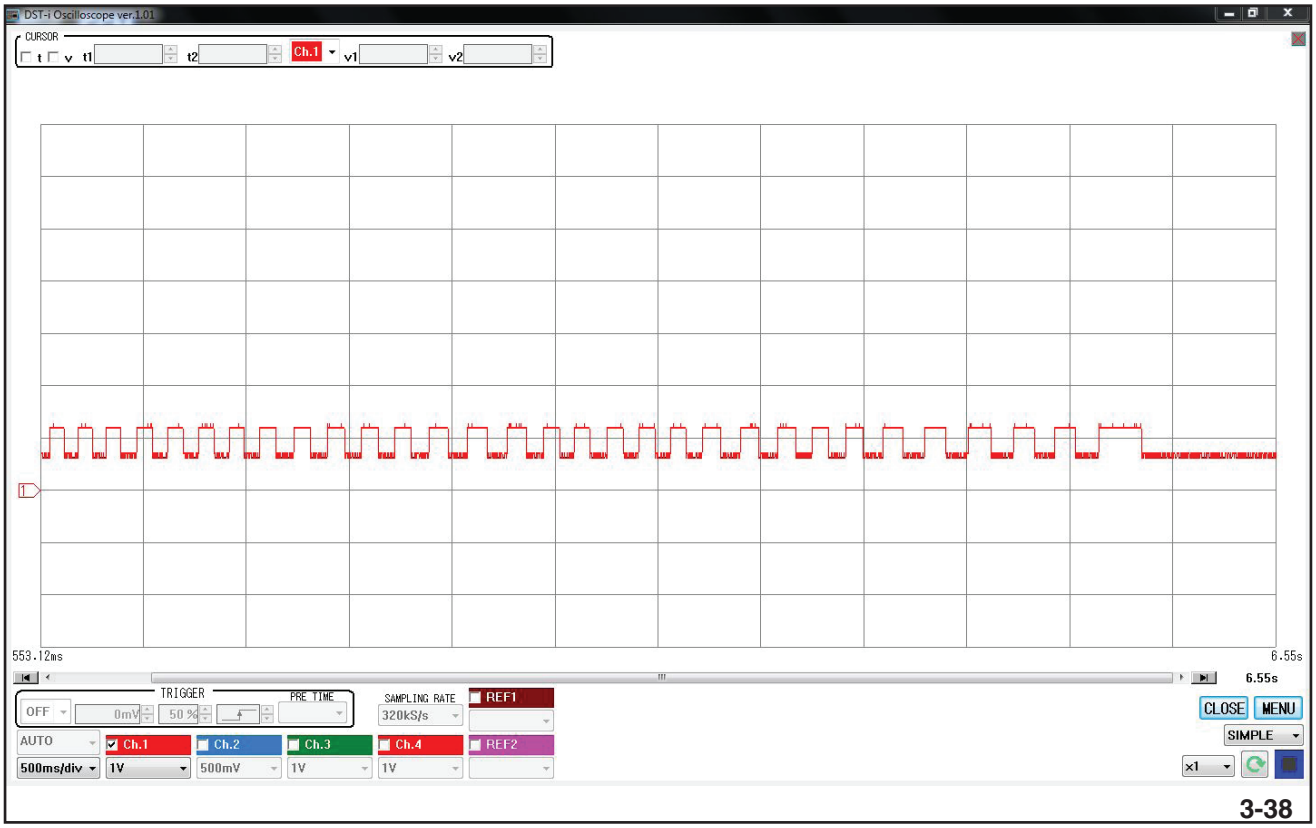
Wheel Speed Sensor -SSM Data

Diagnostics with an oscilloscope requires the preparation of a temporary circuit containing a 100Ω resistor and 12v power supply to generate a signal from the wheel speed sensor. Once the temporary circuit is prepared, the wheel is manually rotated at approximately 2 MPH.

Caution: Always verify the oscilloscope, resistor, and ground connections before connecting the 12v power supply. Reversing sensor polarity may cause damage to the sensor.



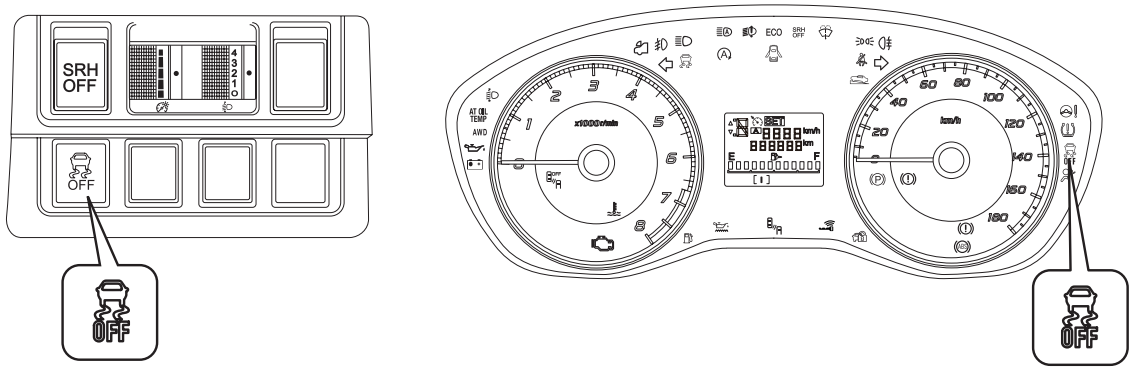
Wheel Speed Sensor Diagnostic Set-up



Wheel Speed Sensor Oscilloscope Pattern

VDC OFF Switch

The VDC system features an OFF switch that can be controlled by the driver. Depending on the model there may be several levels of VDC OFF functions. Pressing and Holding the VDC OFF switch will cancel engine torque suppression which may be helpful if the vehicle is stuck in mud or snow. Always consult the appropriate Owner's Manual for detailed information. The SSM provides a data on the current operation of both the VDC OFF switch and VDC OFF light.



VDC OFF switch

VDC OFF indicator light

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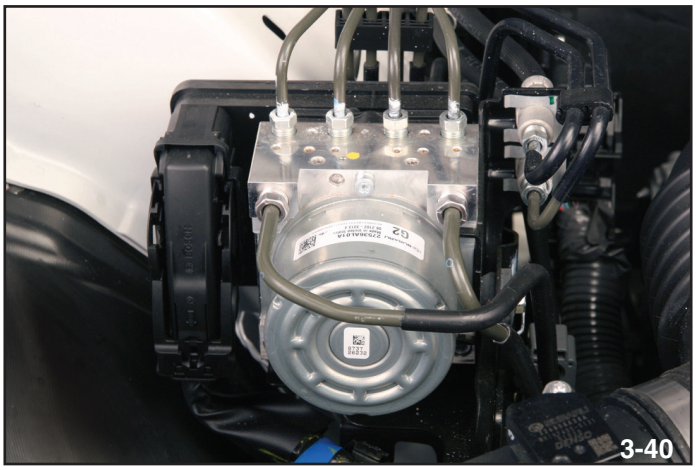
VDC OFF Switch and OFF Light

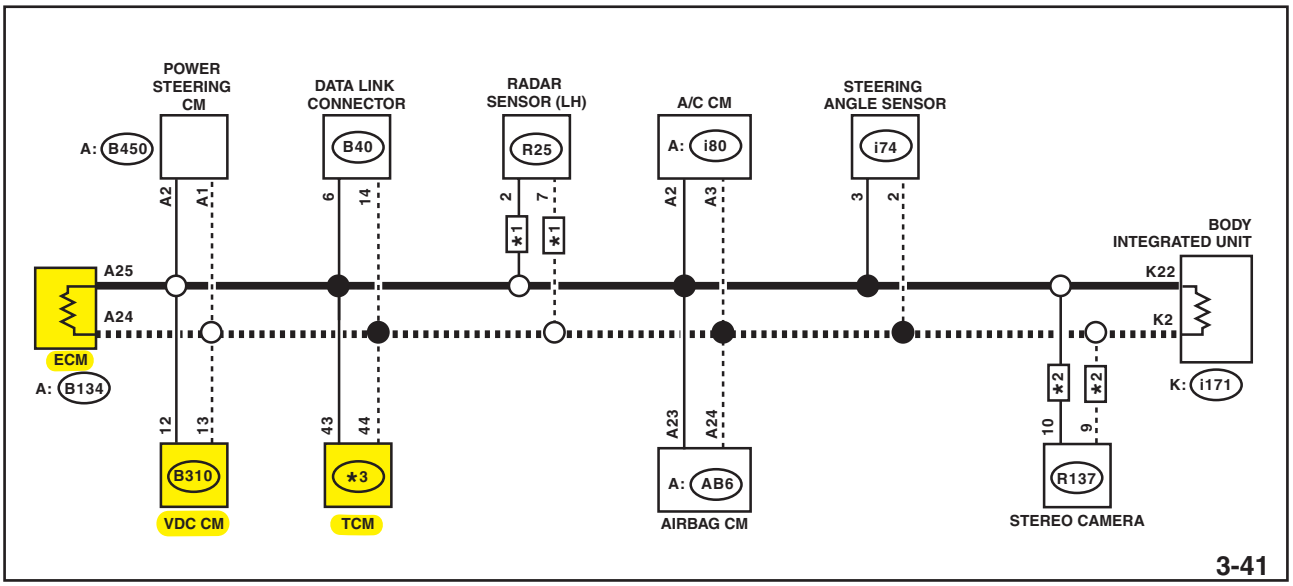
Vehicle Dynamics Control Module & Hydraulic Unit (VDCCM & H/U)

The Vehicle Dynamics Control Module & Hydraulic Unit (VDCCM & H/U) assesses the vehicles condition based on input signals from various sensors throughout the vehicle. As the vehicle's condition is assessed, the VDCCM commands the operation of an internal pump and series of electronic solenoid valves to regulate brake fluid pressure to each of the 4 wheels. The Hydraulic Unit (H/U) portion of the VDCCM controls the braking force of each wheel by increasing, decreasing, or holding brake fluid pressure.



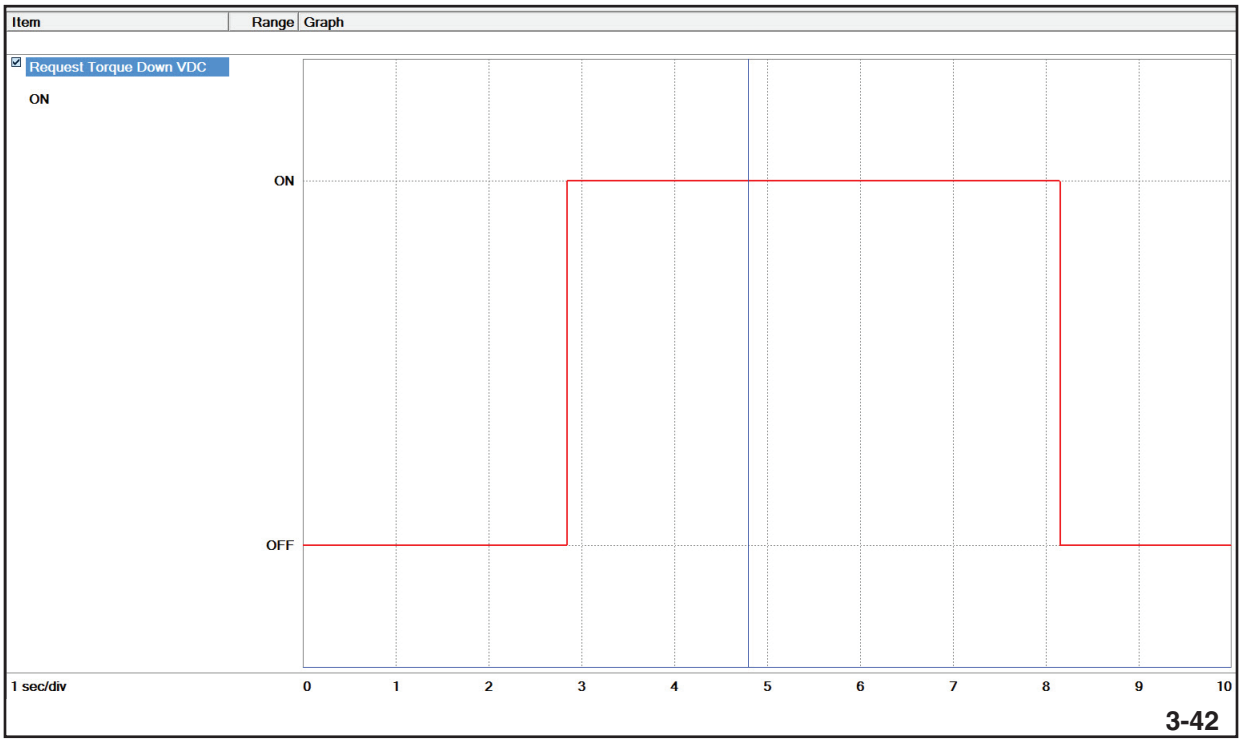
VDCCM & H/U

The VDCCM communicates via the CAN with the Engine Control Module (ECM) and Transmission Control Module (TCM) generating requests to improve vehicle assistance characteristics.



VDCCM CAN Communication

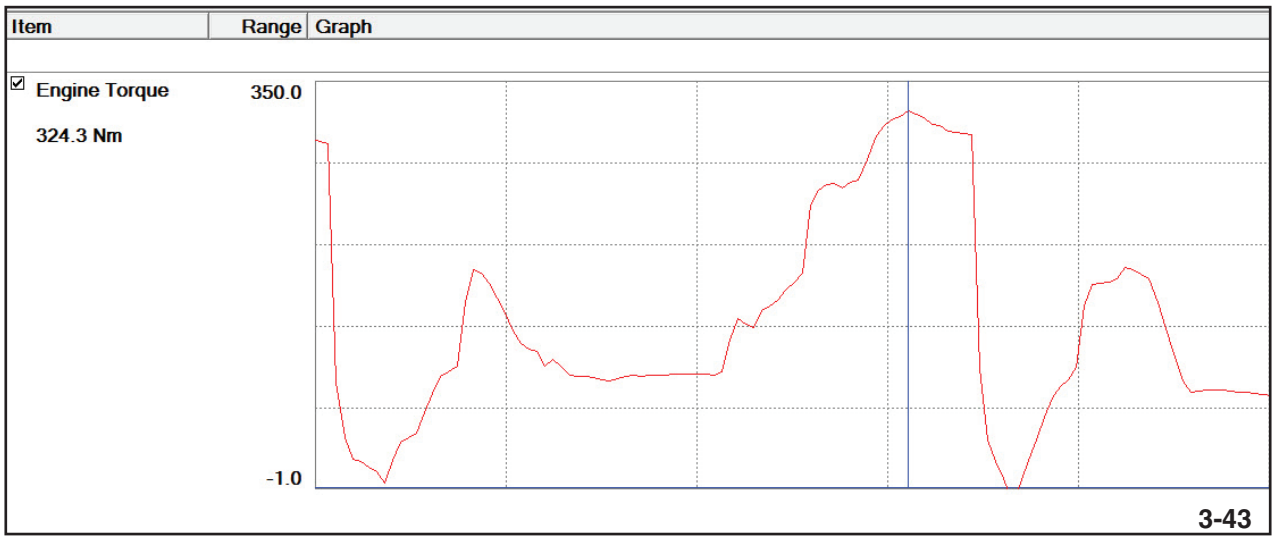
The VDCCM sends a command to the TCM to control the gear position and transfer clutch so that torque is optimally distributed between the front and rear axles.



Request Torque Down Signal

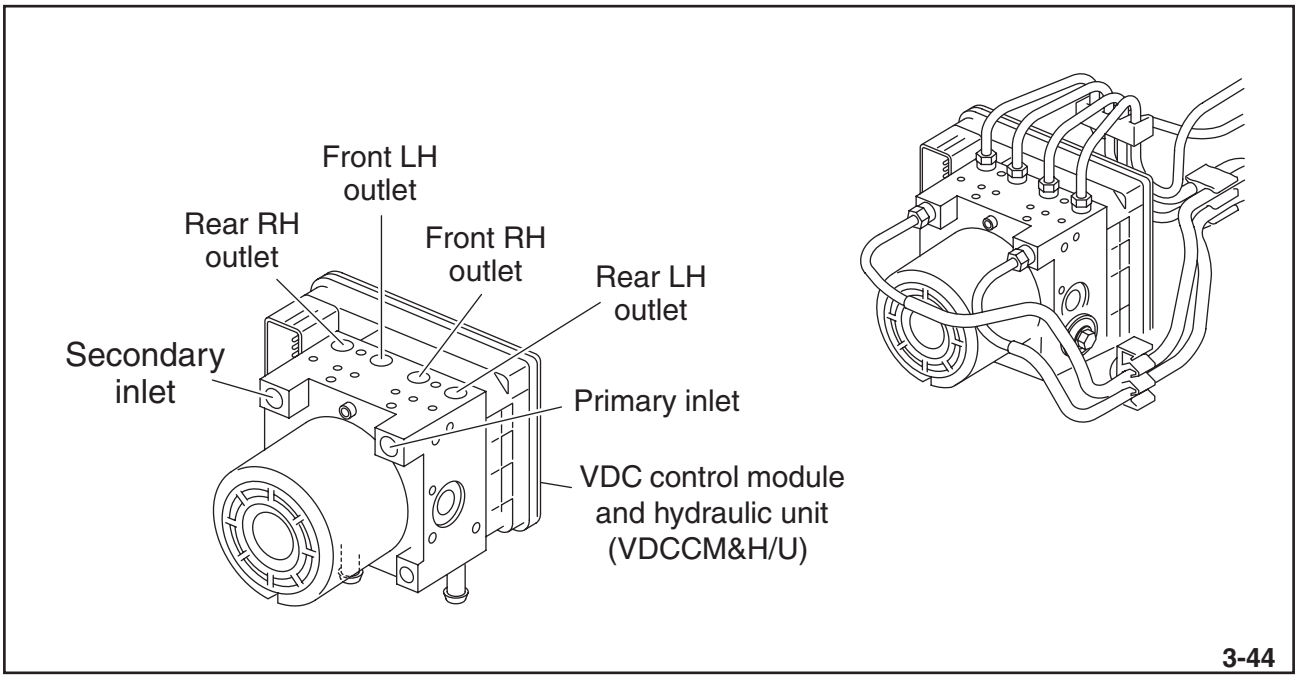
The VDCCM calculates the target engine output for each vehicle condition and sends commands to the ECM.

The ECM compares the target engine output with the current engine output and adjusts throttle opening and/or fuel injection until the target is achieved.



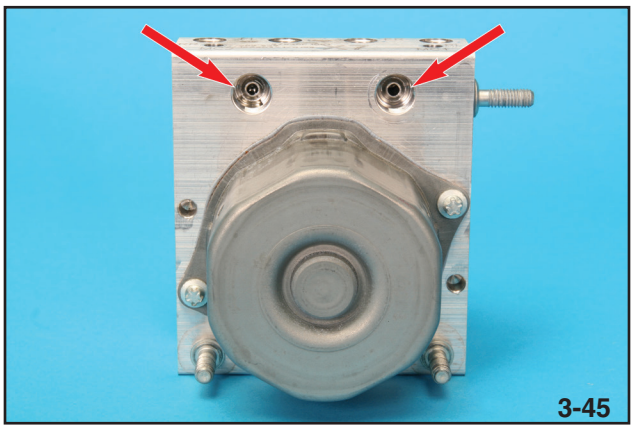
Calculated Engine Torque

The H/U is the central distribution point for the brake hydraulic system. Hydraulic pressure from the master cylinder is supplied through the Primary and Secondary Inlet passages.



Hydraulic Unit (H/U)

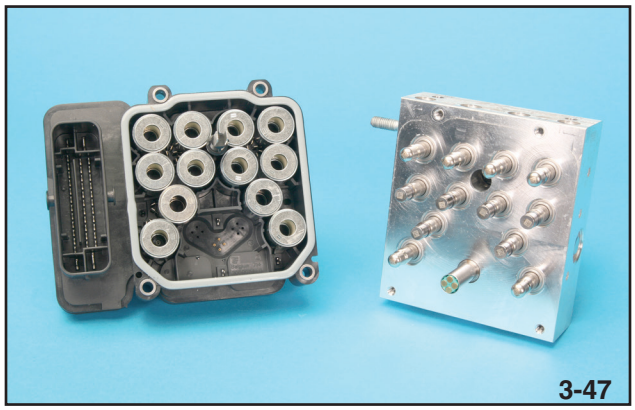
Under normal operation, fluid is distributed to wheels in a diagonal split configuration. The H/U has outlets for each of the wheel cylinders/calipers.



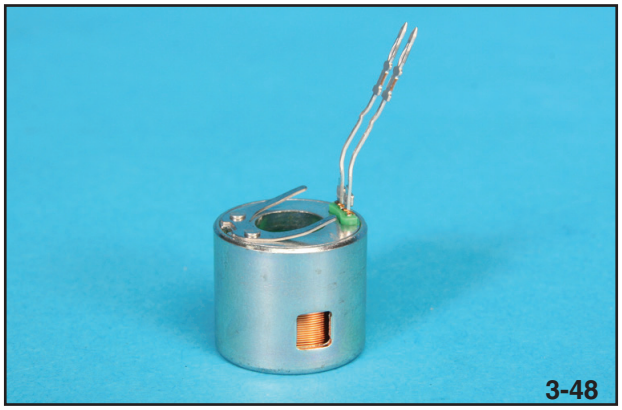
Primary and Secondary Inlets

Wheel Cylinder/Caliper Outlets

The H/U contains a hydraulic motor pump, solenoid valves (up to 12), housing, and relays to control the inlet and outlet of brake fluid to each wheel cylinder/caliper. This design is referred to as a 4-channel type system.

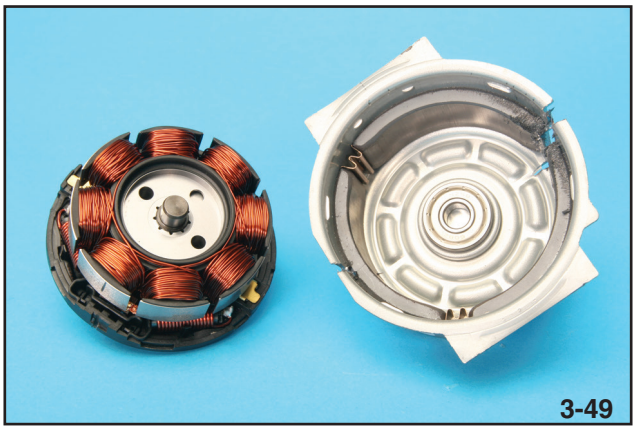


H/U Solenoids and Valves

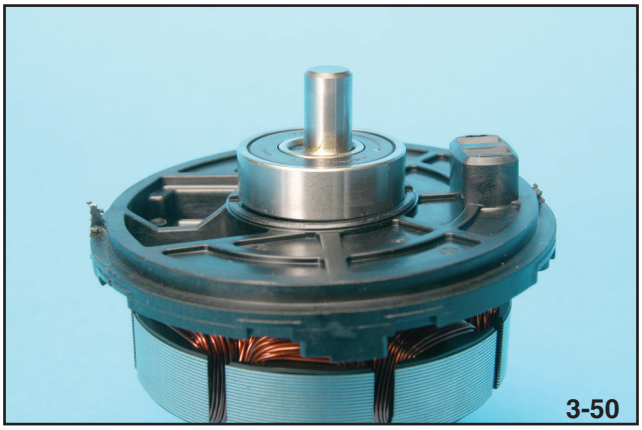


H/U Solenoid

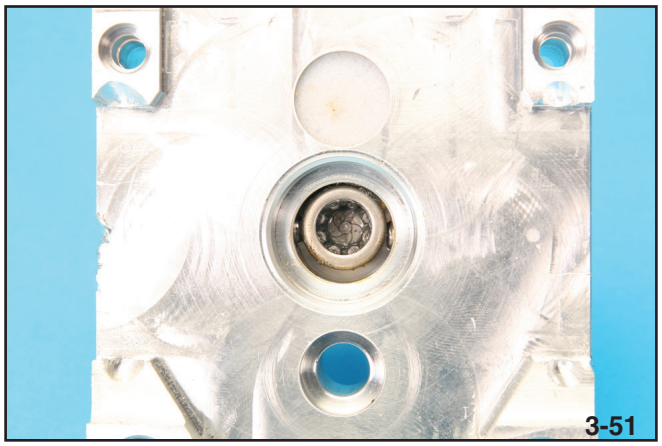
The motor pump drives an eccentric cam which in turn moves a plunger pump to generate hydraulic pressure. When operated, the plunger pump may draw brake fluid from the master cylinder reservoir, drain fluid from a wheel cylinder/caliper, and/or force fluid into the master cylinder.



Motor Pump

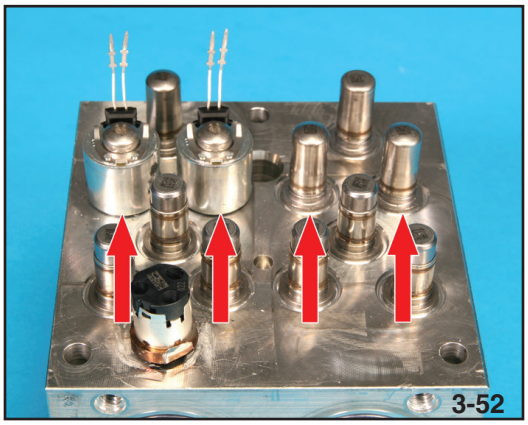


Eccentric Cam

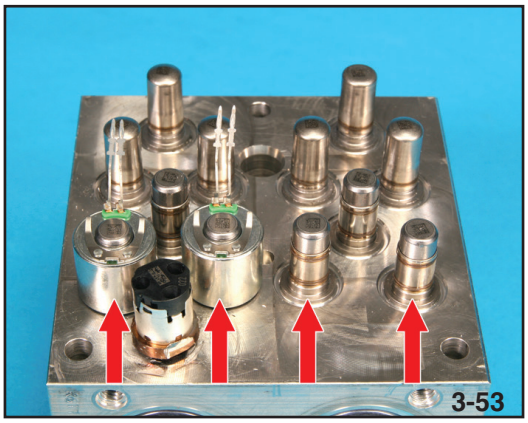


Plunger Pump

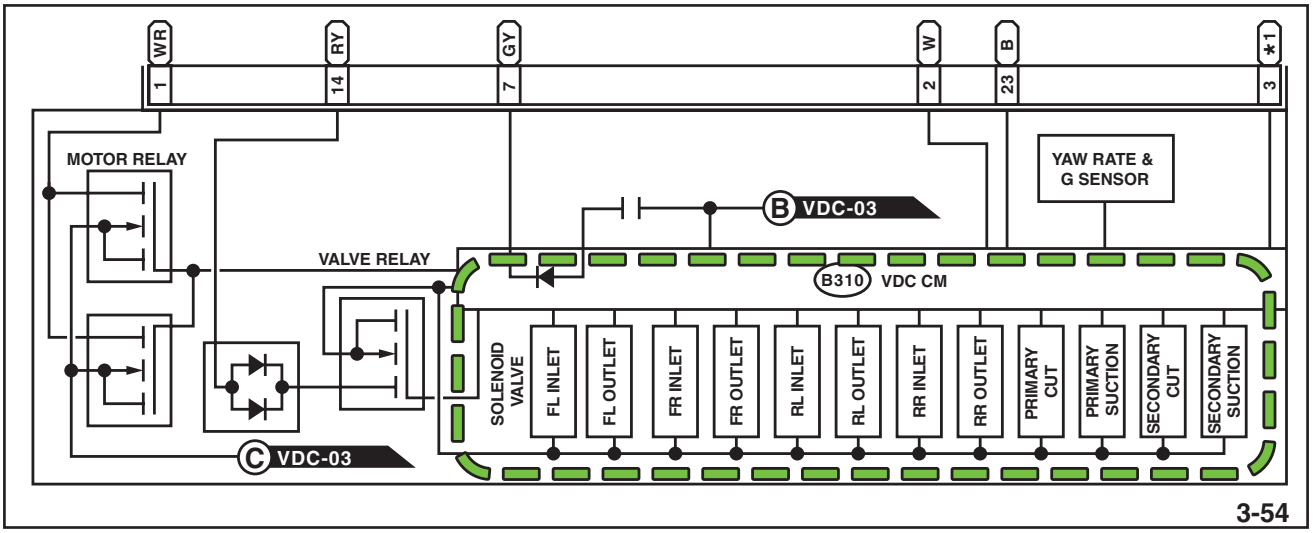
The H/U contains an inlet solenoid and outlet solenoid for each wheel cylinder/caliper. The inlet solenoids are duty controlled to reduce brake fluid pulsation and operation noise. The outlet solenoids are 2 positions, ON/OFF type to control the brake fluid passage between a wheel cylinder/caliper and the H/U internal reservoir. Primary/Secondary Cut and Suction solenoids and also incorporated for specific VDC functions.



Inlet Valves/Solenoids



Outlet Valves/Solenoids



Valves/Solenoids Diagram

The H/U contains a valve relay and motor relay to control the power supplies to the motor pump and solenoid valves. Operation of the valve and motor relays are controlled by the VDCCM. The control signals and voltages for the valve and motor relays can be monitored with the Subaru Select Monitor (SSM)

Note: When errors occur in the VDC system, the valve and motor relays are turned off to retain normal braking functions. During that time, the brake and VDC related warning lights should illuminate and no VDC related functions will be possible.

Item	Value	Unit
☑ Voltage of IGN	14.2	V
☑ M. Relay monitor Voltage	0.0	V
☑ Motor Relay Signal	OFF	
☑ Valve Relay Signal	OFF	

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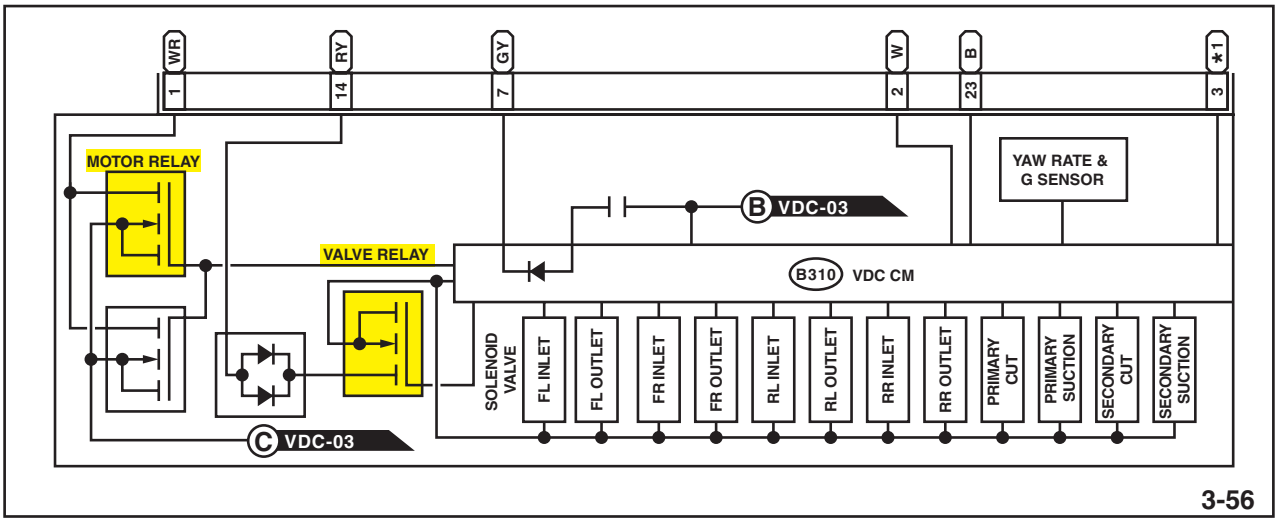
H/U SSM Data

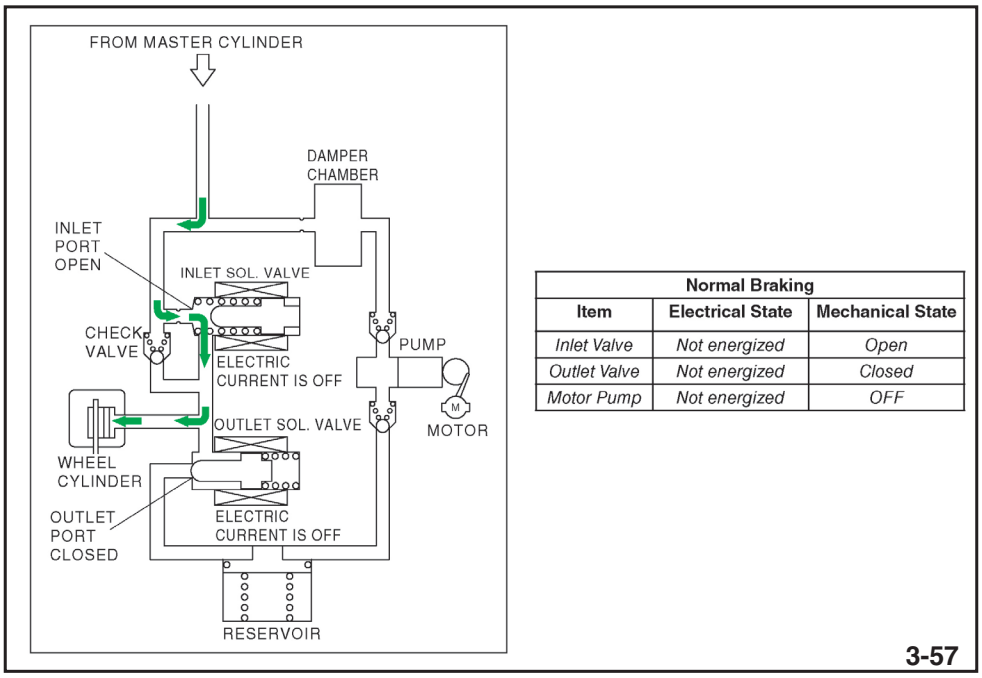
The H/U utilizes the inlet and outlet solenoids to control each wheel independently. Aside from normal braking, the ON and OFF combinations of these solenoids produces three modes of operation; Pressure Increase, Pressure Decrease, and Pressure Hold.



H/U Diagrams

Normal Braking

Since both solenoids are not energized, fluid pressure generated in the master cylinder is transmitted directly to the wheel cylinder/caliper. This fluid path/valve state also represents conditions when the VDC system is inactive due to a malfunction.

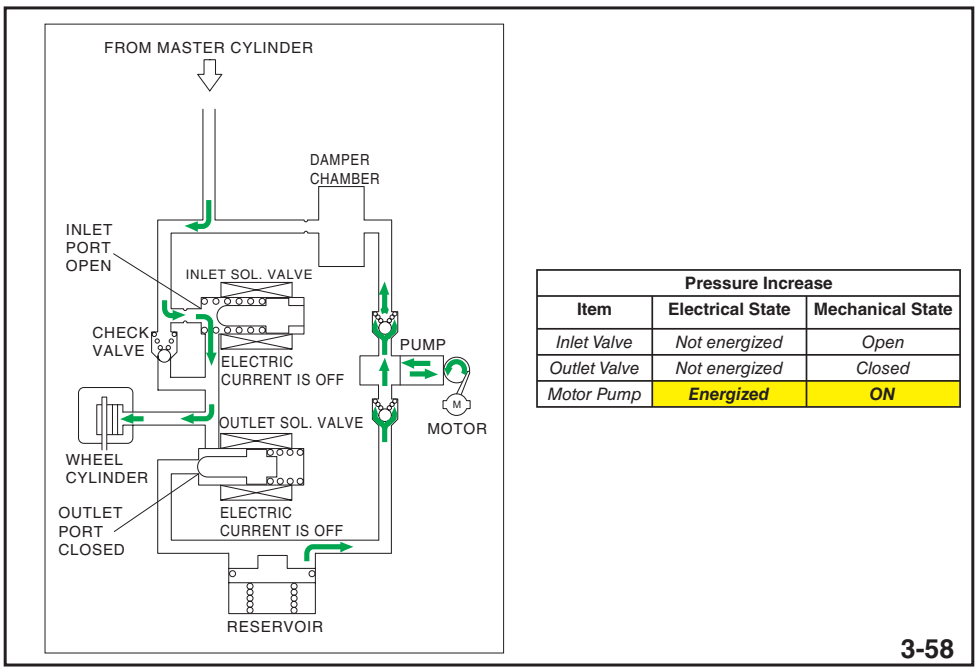


Normal Braking		
Item	**Electrical State**	**Mechanical State**
Inlet Valve	*Not energized*	*Open*
Outlet Valve	*Not energized*	*Closed*
Motor Pump	*Not energized*	*OFF*

Normal Braking

Pressure Increase Mode

During Pressure Increase mode, the H/U motor pump is energized to produce additional hydraulic pressure. Since the inlet valve is open and the outlet valve is closed, pressure is increased in the wheel cylinder/caliper.

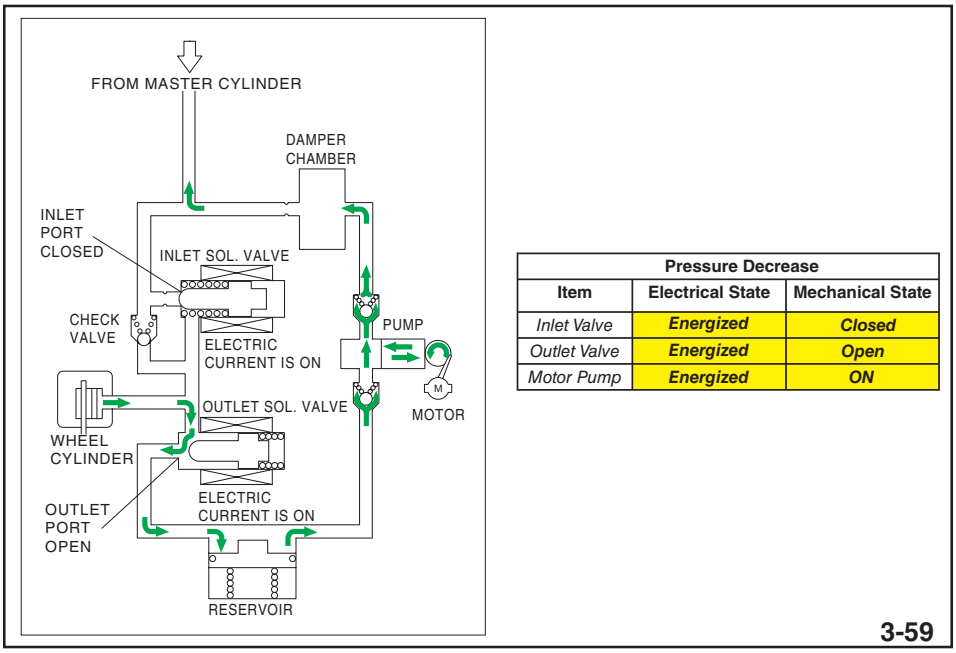


Pressure Increase		
Item	**Electrical State**	**Mechanical State**
Inlet Valve	*Not energized*	*Open*
Outlet Valve	*Not energized*	*Closed*
Motor Pump	***Energized***	***ON***

Pressure Increase Mode

Pressure Decrease Mode

During Pressure Decrease mode, the H/U motor pump is energized to produce additional hydraulic pressure. However, the inlet valve is energized/closed preventing pressure from increasing in the wheel cylinder/caliper. At the same time, the outlet valve is opened and brake fluid is allowed to drain from the wheel cylinder/caliper decreasing pressure.

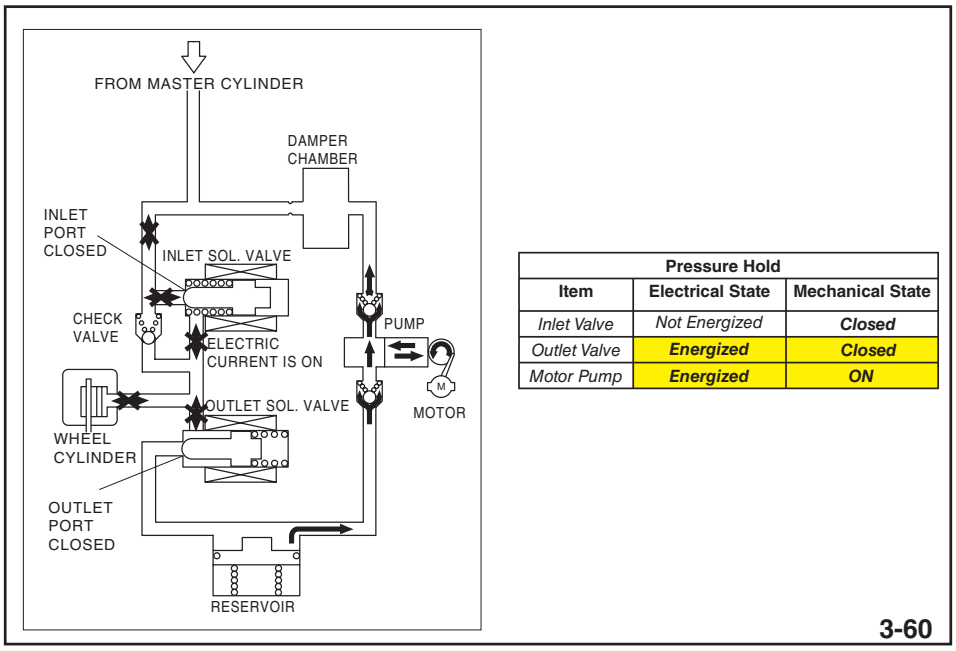


Pressure Decrease		
Item	**Electrical State**	**Mechanical State**
Inlet Valve	***Energized***	***Closed***
Outlet Valve	***Energized***	***Open***
Motor Pump	***Energized***	***ON***

Pressure Decrease Mode

Pressure Hold Mode

During Pressure Increase mode, the H/U motor pump is energized to produce additional hydraulic pressure. Since the inlet valve is open and the outlet valve is closed, pressure is increased in the wheel cylinder/caliper.



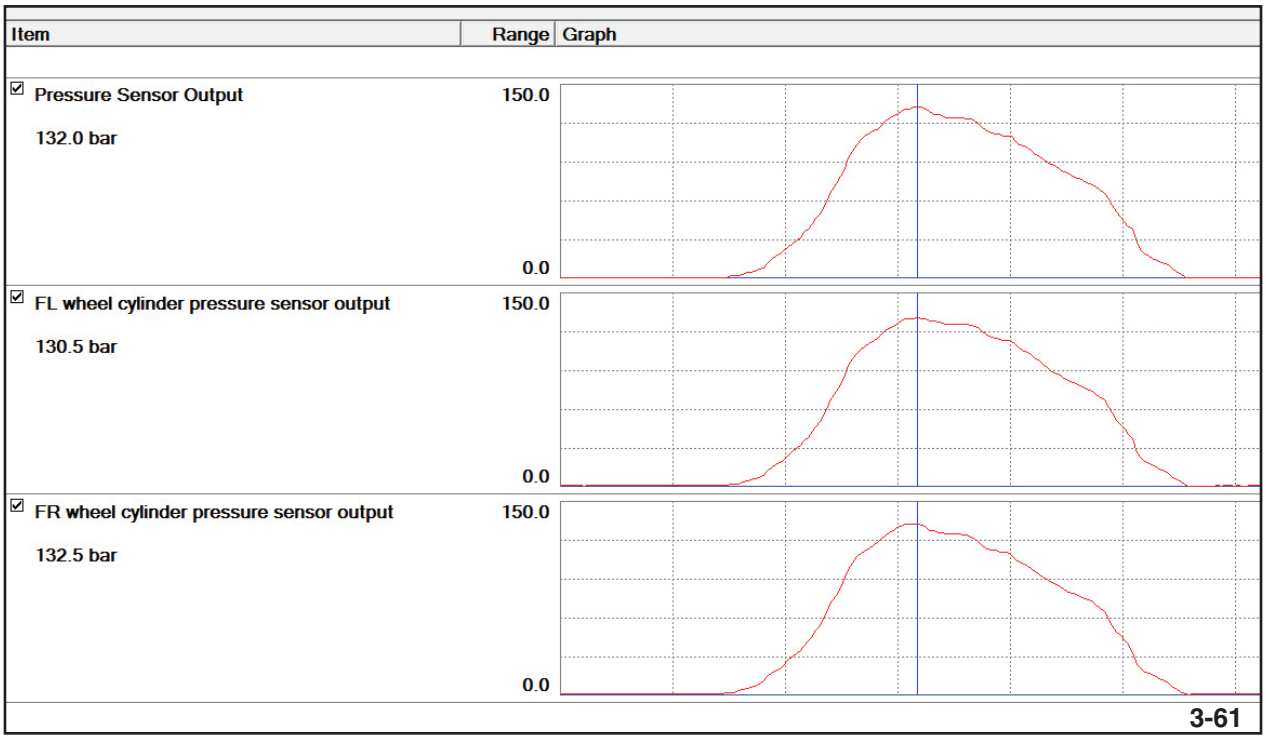
Pressure Hold		
Item	**Electrical State**	**Mechanical State**
Inlet Valve	*Not Energized*	***Closed***
Outlet Valve	***Energized***	***Closed***
Motor Pump	***Energized***	***ON***

Pressure Hold Mode

Brake Fluid Pressure Sensor(s)

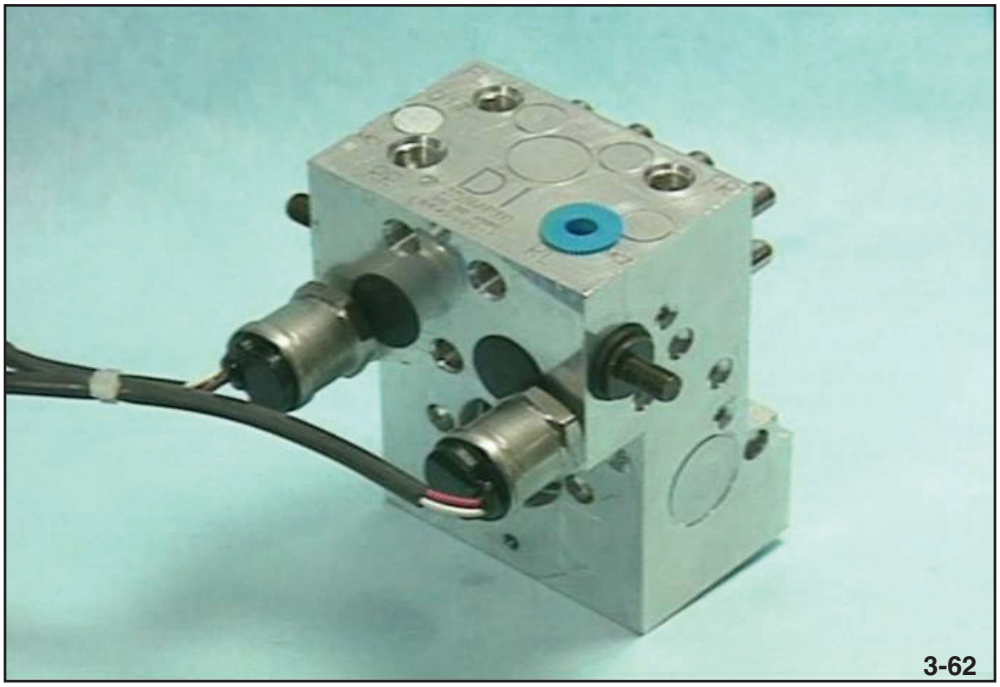
The VDCCM contains up to three internal Brake Fluid Pressure sensors. The sensors detect the hydraulic pressure resulting from the driver's brake pedal operation and the H/U motor pump.

Note: 1 BAR = 14.5 PSI



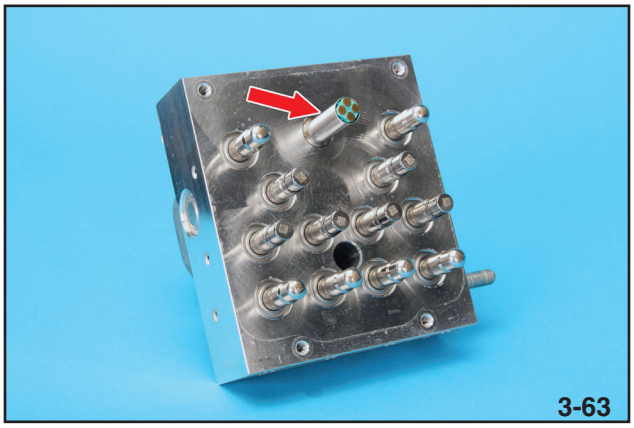
Brake Fluid Pressure Sensor - SSM Data

Earlier VDC systems utilized external pressure sensors / switches.

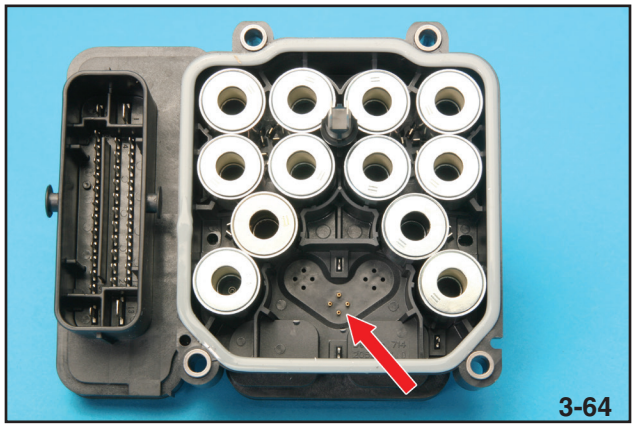


Brake Fluid Pressure Sensor(s) - External

Late model systems have incorporated the brake fluid pressure sensor(s) into the VDCCM & H/U assembly. Therefore, the sensor is not serviceable separately. Models with the Eyesight Driver Assist system may contain three pressure sensors to additionally monitor the FL and FR wheel hydraulic circuits.



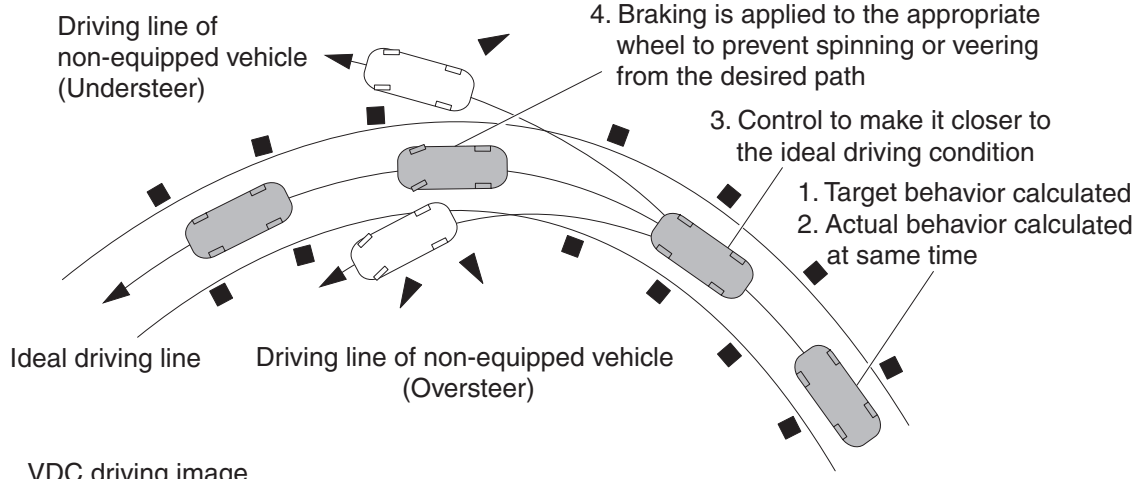
Brake Fluid Pressure Sensor - Internal



Brake Fluid Pressure Sensor - Internal Connection

System Functions

Each system performs unique driving condition assessments and reactions based on information from a multitude of sensors located throughout the vehicle. Availability of these driver assist systems vary based on year and model. In general, VDC systems are designed to improve vehicle stability during running (driving/accelerating), braking, and/or turning.



VDC driving image

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1. **Anti-Lock Braking System (ABS)**
   Stability during braking
2. **Electronic Brake Force Distribution (EBD)**
   Replaces mechanical proportioning systems
3. **Brake Assist**
   Increased brake pressure during emergency braking
4. **Optimized Hydraulic Braking (OHB)**
   Ensures sufficient braking force if Brake Booster pressure is less than optimal
5. **Vehicle Dynamics Control (VDC)**
   Stability during Turns
6. **Super Sport ABS**
   Stability under heavy braking
7. **Active Torque Vectoring (ATV)**
   Performance cornering control
8. **Traction Control System (TCS)**
   Stability during acceleration
9. **Hill Start Assist**
   Momentary hold for manual transmission vehicles on an incline
10. **X-Mode™ & Hill Decent Control**
    Low Speed, low traction improvement
11. **Brake Override System (BOS)**
    Unintended acceleration prevention

Anti-Lock Braking System (ABS)

The Anti-Lock Braking System (ABS) is designed to minimize wheel lock-up during braking events. This allows the driver to retain the ability to steer the vehicle. When the brake pedal is depressed during driving, both the wheel speed and vehicle speed decrease. However, due to environmental variables such as the condition of roads, tires, and vehicle components, the decrease in the vehicle speed is not always proportional to the decrease in the wheel speed. The VDCCM calculates this difference between the wheel speed and vehicle speed and is referred to as the "slip ratio."

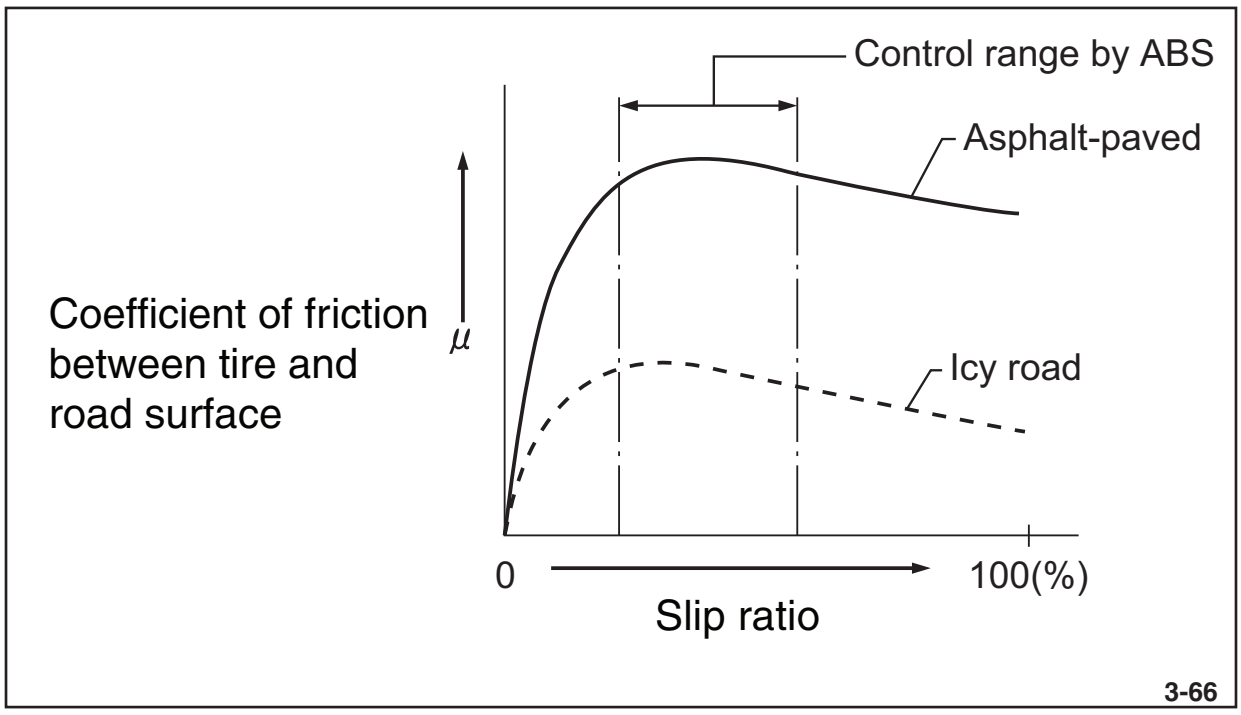
Slip ratio = (Vehicle speed – Wheel speed)/Vehicle speed Ч 100%)

When the slip ratio is 0%, the vehicle speed corresponds exactly to the wheel speed.

When it is 100%, the wheels are completely locked while the vehicle is still moving.

The slip ratio is dependent on braking effectiveness in relation to the environmental variables. Braking effectiveness is represented by the "coefficient of friction" between the tire and road surface. The larger the coefficient, the higher the braking effectiveness.

The ABS controls the fluid pressure to each wheel to maintain the slip ratio within the 8 — 30% range.



ABS Slip Ratio Theory

Depressing the brake pedal increases the brake fluid pressure in each wheel cylinder, which decreases the wheel speed (or increases the wheel deceleration rate). When the brake fluid pressure is increased to a level (point "A"), the brake fluid pressure curve in the diagram (at which the wheel deceleration rate exceeds threshold "–b0"), the VDCCM commands pressure "hold" control.

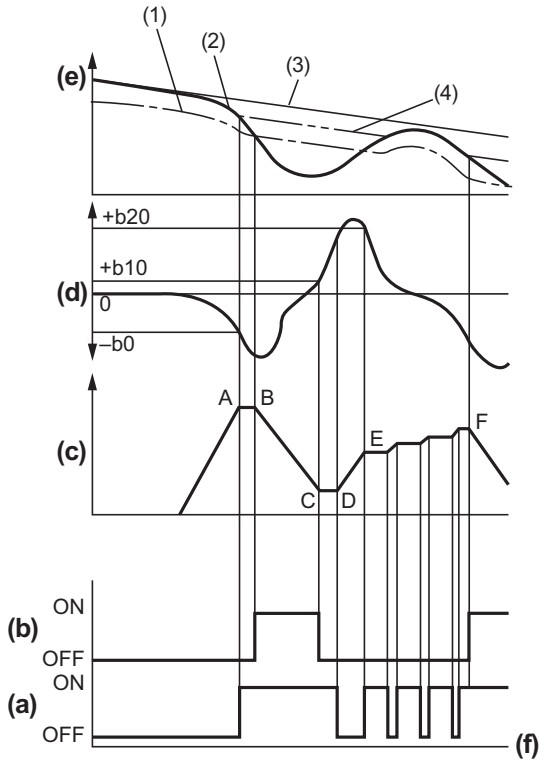
At the same time, the VDCCM calculates a "dummy" vehicle speed which is a reference speed it uses in the next stage of control. When the wheel speed then drops below the slip ratio setting or speed lower than the "dummy" vehicle speed (point "B"), the VDCCM commands pressure "decrease" control to prevent the wheels from locking-up.

As the wheel cylinder pressure decreases, the wheel speed starts increasing. When the wheel acceleration rate exceeds threshold "+b10" (point "C") the VDCCM commands pressure "hold" control. When the wheel acceleration rate exceeds threshold "+b20" (point "D"), the VDCCM recognizes that wheel lock-up will not occur and then commands pressure "increase" control.

When the wheel acceleration rate drops below threshold "+b20", (point "E"), the VDCCM starts pressure "hold" and "increase" control cycles at a given interval. When the wheel deceleration rate then exceeds threshold "–b0" (point "F"), the VDCCM immediately commands pressure "decrease" control.

(a) Inlet solenoid valve
(b) Outlet solenoid valve
(c) Brake fluid pressure
(d) Wheel acceleration/deceleration
(e) Speed
(f) Time

(1) Slip ratio setting
(2) Wheel speed
(3) Vehicle speed
(4) Dummy vehicle speed



Brake fluid pressure	Inlet solenoid valve	Outlet solenoid valve
Increase	OFF	OFF
Hold	ON	OFF
Decrease	ON	ON

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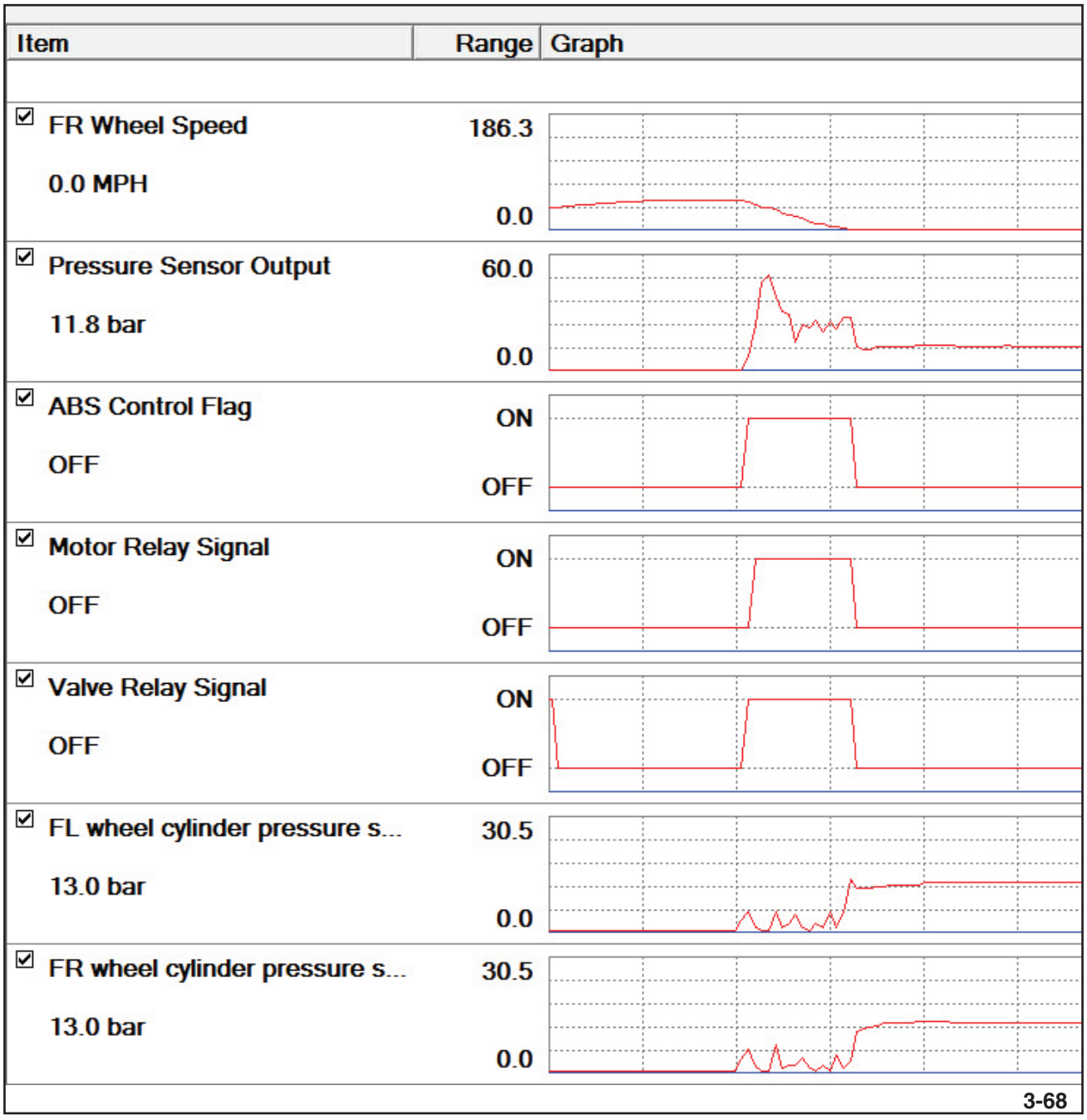
ABS Operation Theory

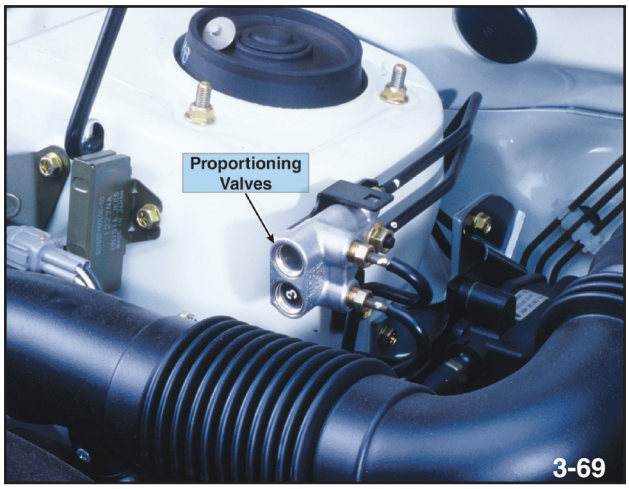
During ABS operation, the SSM will display an “ABS Control Flag” and energize the Motor Relay and Valve Relay. Once energized, the motor pump begins rotating and the individual Inlet and Outlet solenoids are controlled. Brake fluid pressure, wheel speeds, and Yaw/G rate are monitored to achieve a desirable rate of braking while maintaining steering control and vehicle stability.



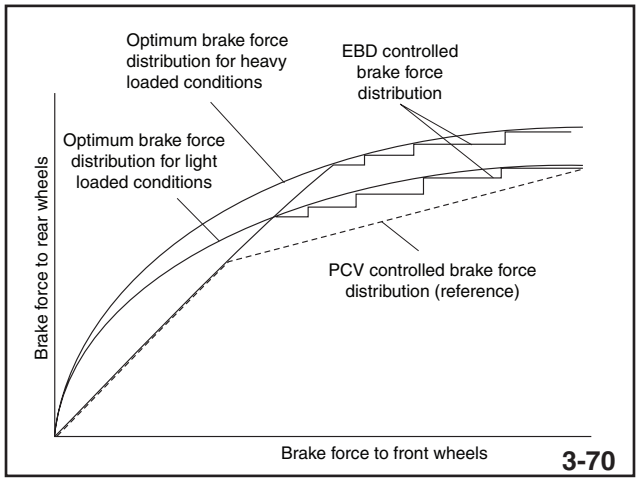
ABS Operation

Electronic Brake Force Distribution (EBD)

Electronic Brake Force Distribution (EBD) utilizes the inlet and outlet valve control of the VDCCM & H/U to prevent premature locking of the rear wheels. This system eliminates the need for the proportioning valve and optimizes brake force distribution based on vehicle load.

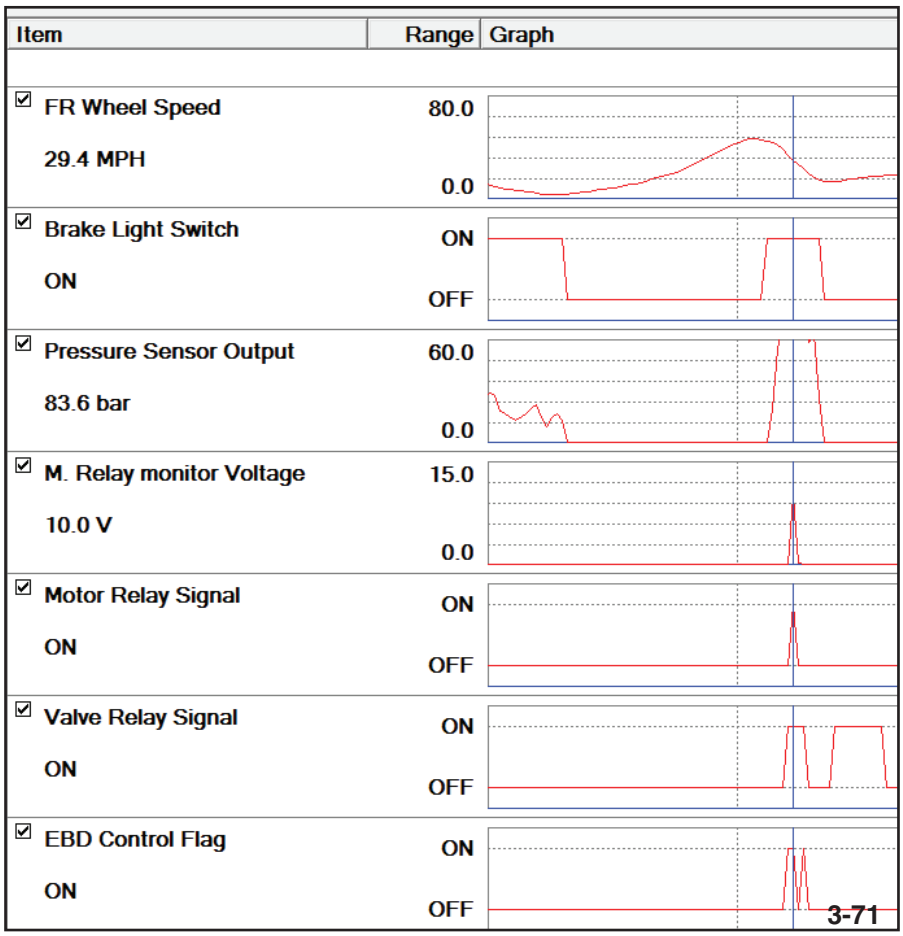


Proportioning Valve



EBD Logic

The VDCCM calculates the optimum brake force based on information from the wheel speed sensors and G Sensor. An “EBD Control Flag” is displayed on the SSM during EBD operation.



EBD Operation

Brake Assist

Introduced with some 2007 MY vehicles, a Brake Assist system was added to assist in deceleration during panic situations. In an emergency stopping situation, a driver has the natural tendency not to brake hard enough and soon enough. Brake Assist helps the driver by monitoring the depression speed applied to the brake pedal. In an emergency stopping situation, the system senses the rapid depression of the brake pedal and simultaneously boosts the driver's braking force to the brake system using the VDCCM & H/U pressure increase function. Brake Assist maintains braking force until the driver releases the brake pedal. In conjunction with ABS, Brake Assist results in faster and safer braking.

Optimized Hydraulic Braking (OHB)

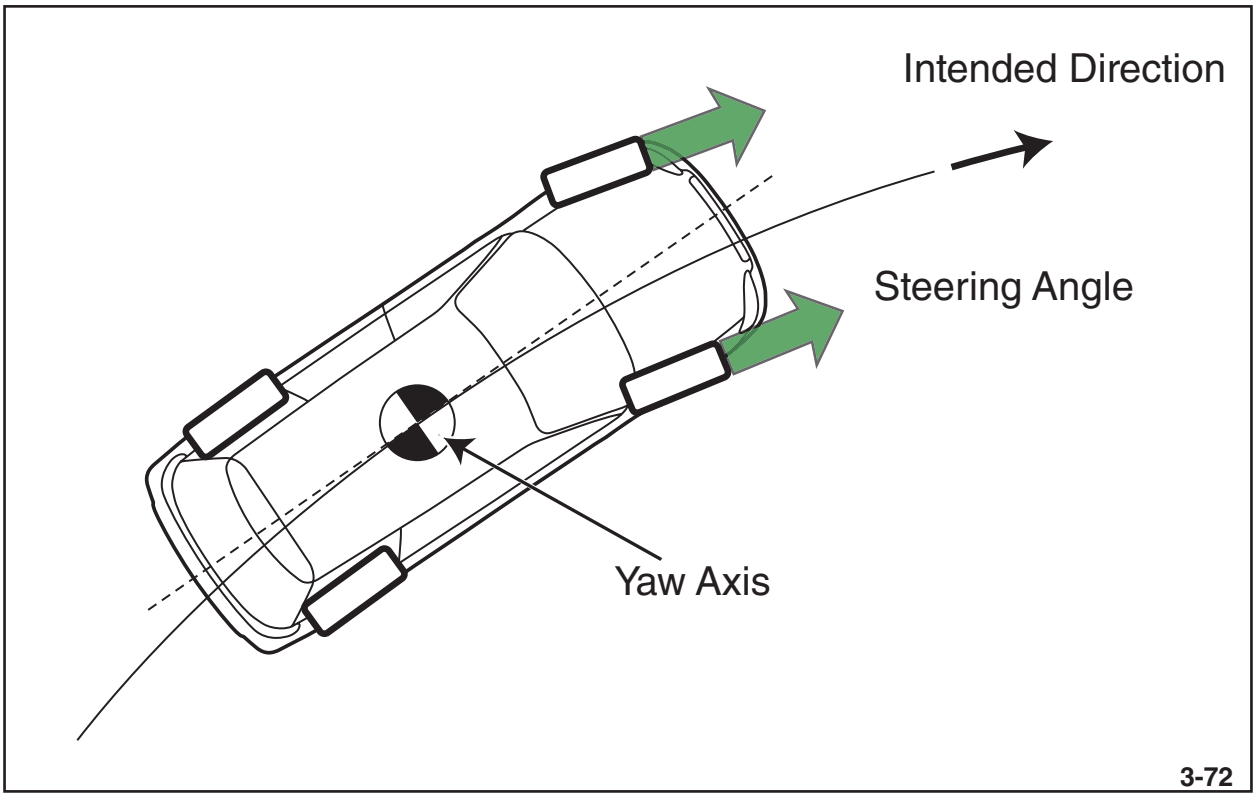
Introduced with 2017MY Impreza models, the Optimized Hydraulic Braking (OHB) system ensures sufficient braking force is available for the driver if the Brake Booster pressure is less than optimal. This is accomplished by energizing the VDC motor pump to provide additional hydraulic pressure assist.

Vehicle Dynamics Control (VDC)

The VDC system monitors vehicle stability and reacts to minimize understeer, oversteer, and drift conditions helping to maintain the directional stability of the vehicle on all road surfaces. VDC can sense impending loss of control at either the front or rear of the vehicle and momentarily apply the brake on one or more wheels to restore stability. The VDC system enhances the vehicles stability when cornering by comparing the driver's intended path to the vehicle's actual path. This is monitored using inputs from the Wheel Speed, Steering Angle and Yaw Rate & G Sensors.

Yaw

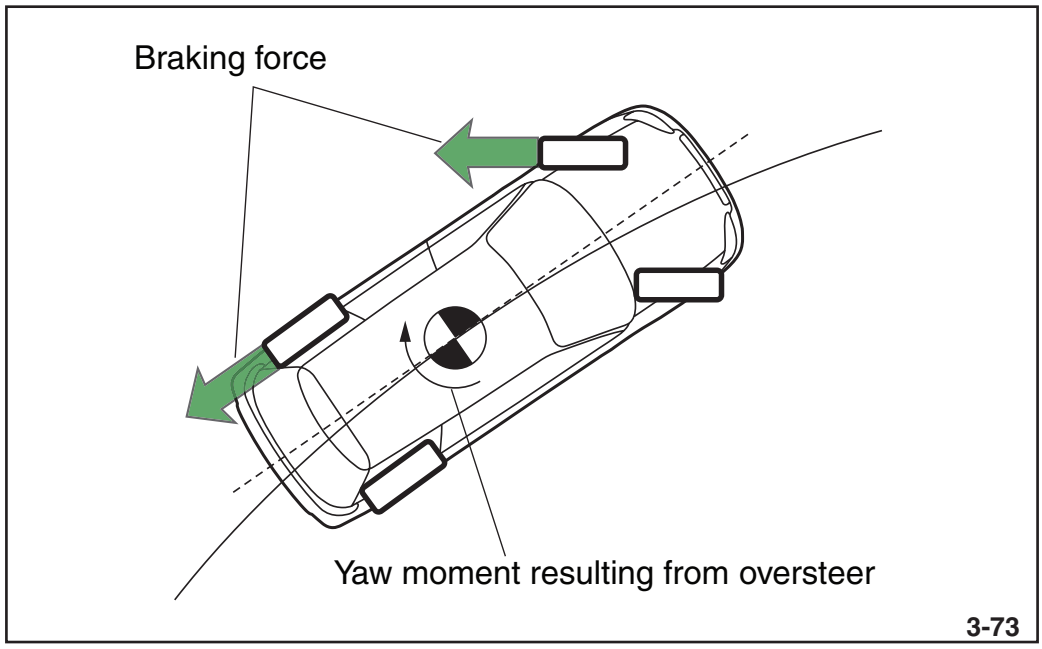
Yaw is defined as the rotation or angular speed around the axis of an object. On a vehicle, yaw is measured at the yaw axis which is commonly located in the center of the vehicle. If the yaw rate is significantly more or less than the intended steering angle input, the VDCCM provides braking to bring the yaw rate into an acceptable range.



Vehicle Physics

Oversteer

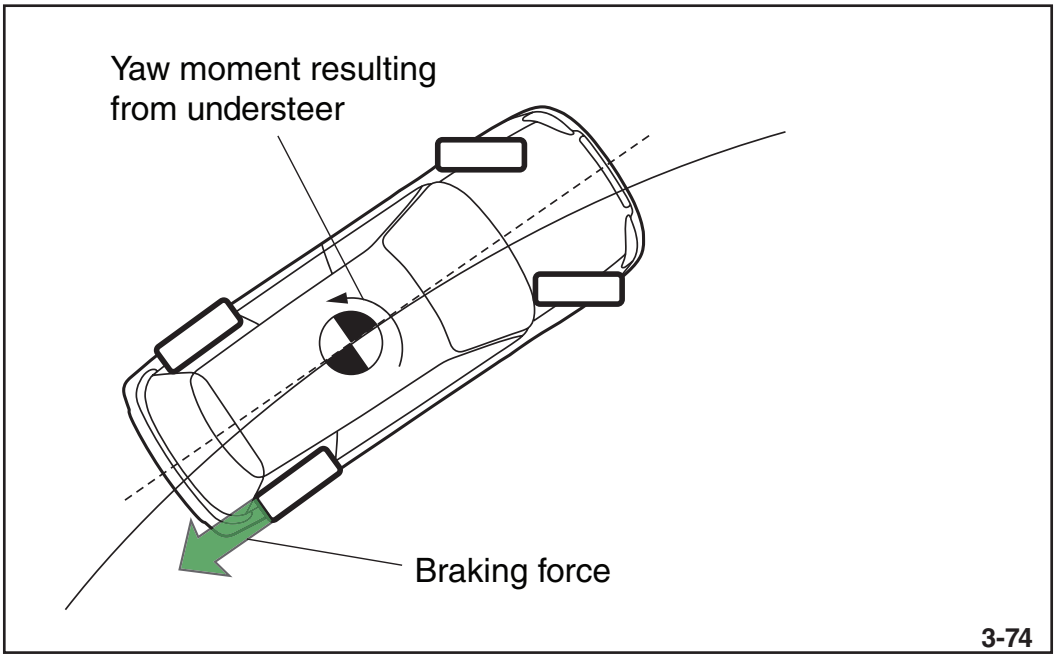
If the vehicle begins to spin during cornering (oversteer), the VDCCM actuates the brakes on the front and rear outer wheels. As a result, a yaw moment is generated in a direction that counteracts the oversteer improving the vehicle's stability.



Oversteer Assistance

Understeer

If the vehicle begins drift outward during cornering (understeer), the VDCCM actuates the brake on the rear inner wheel. As a result, a yaw moment is generated in a direction that counteracts the understeer improving the vehicle's stability.

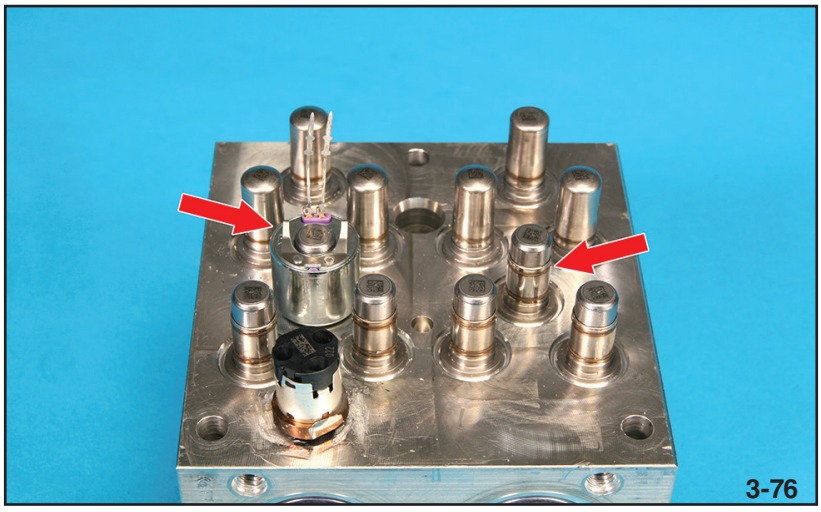


Understeer Assistance

Hydraulic Control

While the VDC system hydraulically operates identically to the ABS (during brake pedal depression), it also has the ability to function while the brake pedal is not depressed. In order to achieve this function, vehicles with VDC utilize four additional solenoid valves (2 Suction/ 2 Cut) that activate based on brake pedal depression to establish the role of the master cylinder. Each circuit of the brake hydraulic system (Primary and Secondary) contains its own Suction Solenoid and Cut Solenoid.

Suction Valves/Solenoid



Cut Valves/Solenoid

A “VDC Control Flag” is displayed on the SSM during VDC operation.

Item	Value
☑ VDC Control Flag	OFF

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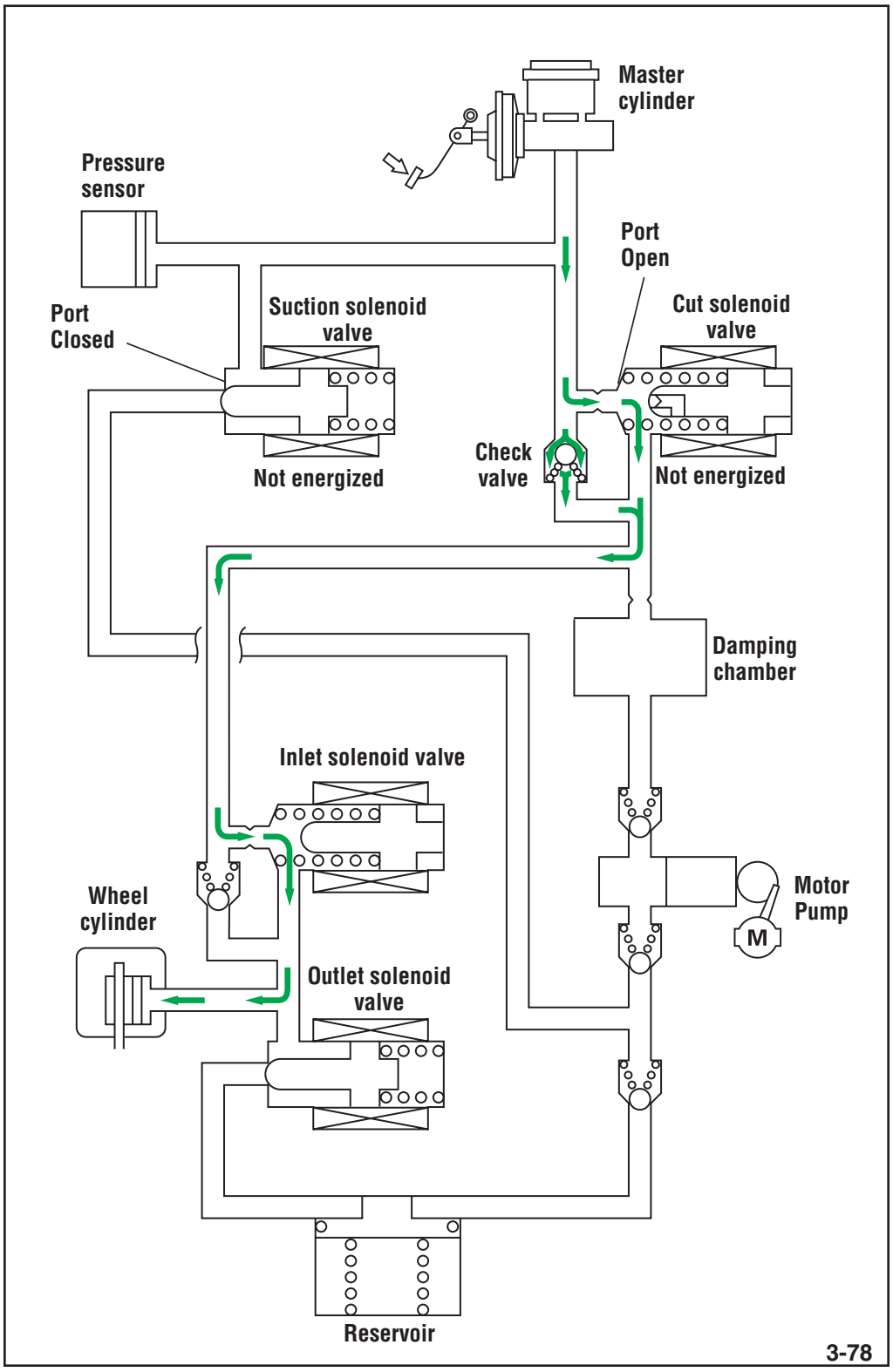
VDC Control Flag

Normal Braking

Normal braking utilizes the conventional hydraulic path. In this state all solenoids are de-energized and in their resting positions. This fluid path/valve state also represents conditions when the VDC system is inactive due to a malfunction.

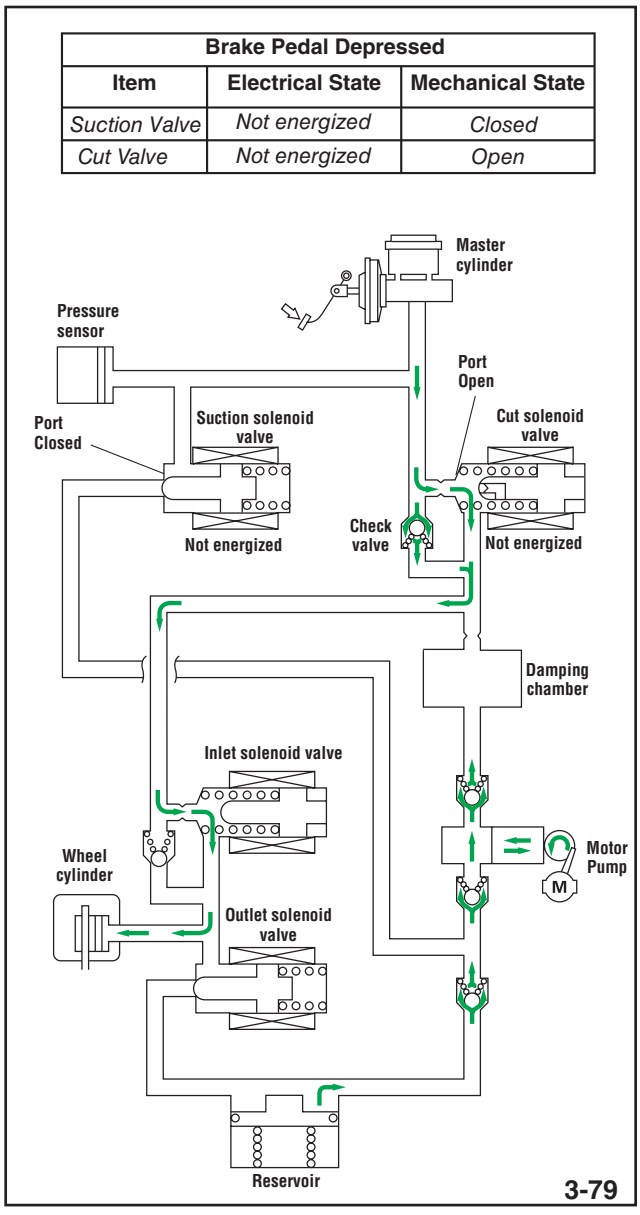


VDC Normal Braking

Operation: Brake Pedal Depressed

Having the brake pedal depressed during any VDC related functions places the Master Cylinder as the primary pressure source for braking operation. The Suction Valve allows the Master Cylinder Pressure into the wheel cylinder/caliper circuits. The Cut Solenoid directs pressure from the Motor Pump into the same circuit.

Brake Pedal Depressed		
Item	**Electrical State**	**Mechanical State**
Suction Valve	*Not energized*	*Closed*
Cut Valve	*Not energized*	*Open*

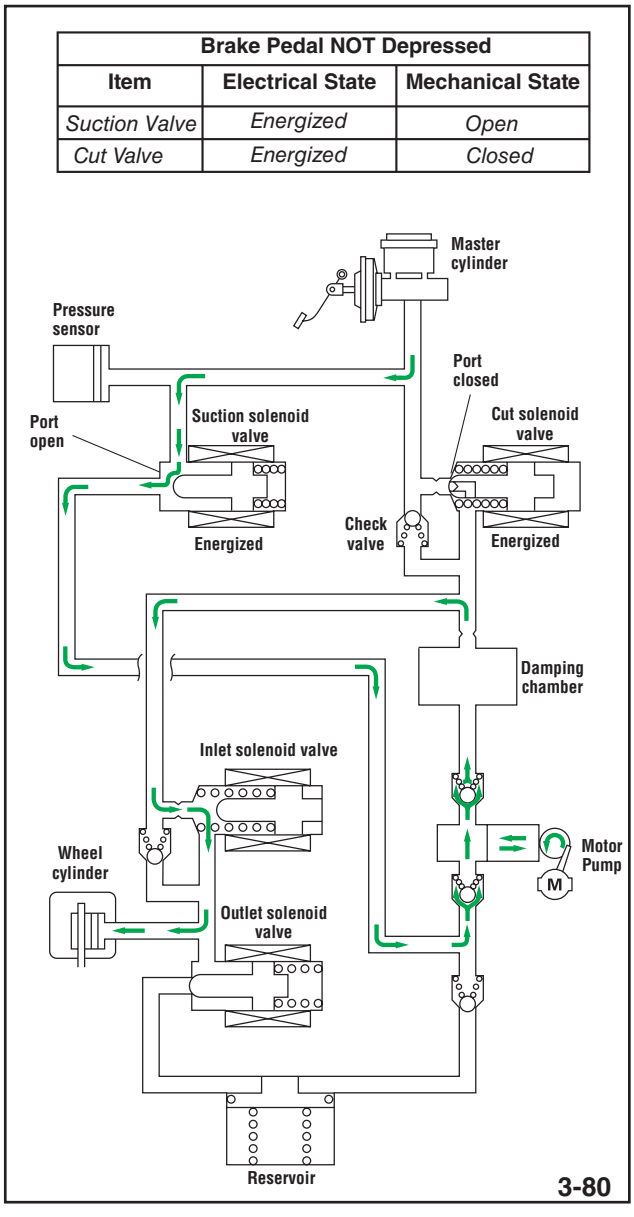


VDC Pressure Increase - Brake Pedal Depressed

Operation: Brake Pedal NOT Depressed

When the brake pedal is not depressed, the primary source of brake fluid pressure is the H/U Motor Pump. The now energized Cut Valve directs the pressure generated from the Motor Pump directly to the wheel cylinder/caliper. At the same the time, the now energized suction valve provides a path for the Master Cylinder to serve as brake fluid reservoir for the Motor Pump.

Brake Pedal NOT Depressed		
Item	**Electrical State**	**Mechanical State**
Suction Valve	*Energized*	*Open*
Cut Valve	*Energized*	*Closed*

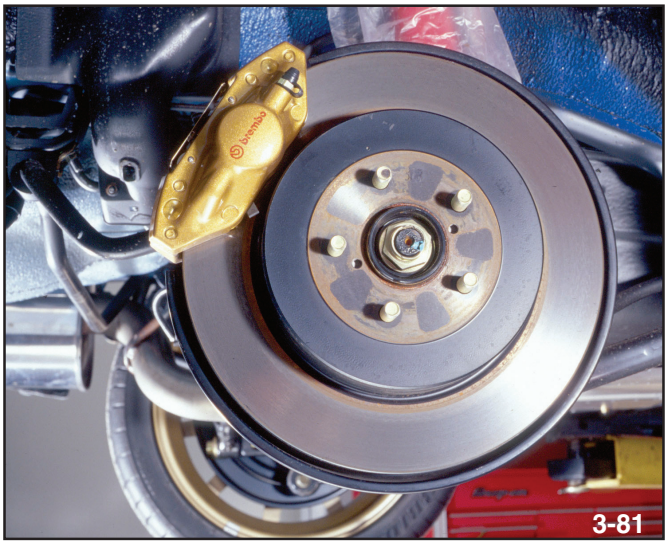


VDC Pressure Increase - Brake Pedal NOT Depressed

Note: The Suction Valve and Cut Valve functions are the same for pressure increase decrease, and hold modes

Super Sport ABS

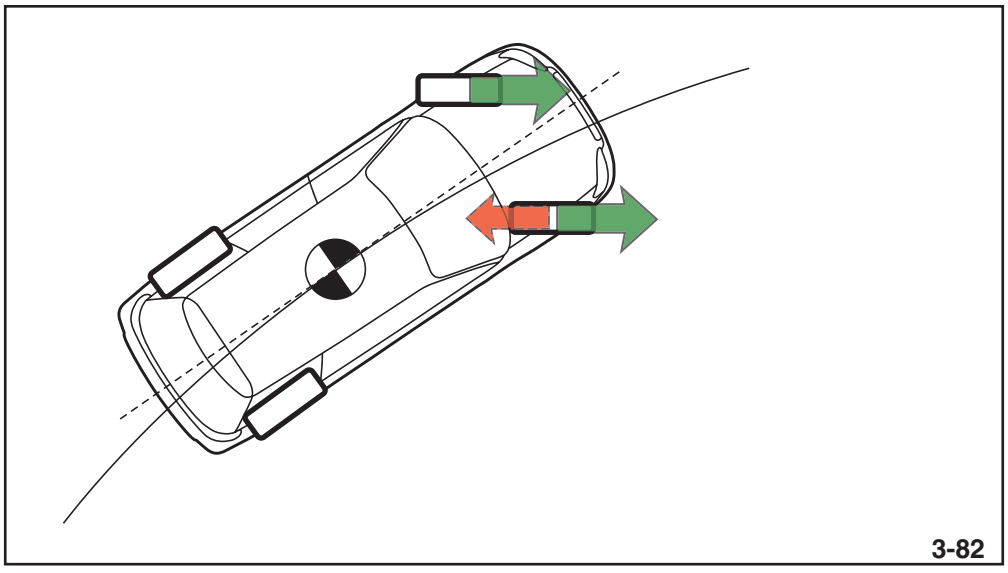
Introduced with the 2004 Impreza WRX STi, a Super Sport ABS system was added to improve vehicle stability while under heavy braking. In the Super sports ABS system, brake fluid pressure control for the rear wheels is switched to independent control while turning. This design helps to increase the cornering force of the front wheels to reduce under steer.



STi Rear Brakes

Active Torque Vectoring (ATV)

Introduced with some 2015 MY models an Active Torque Vectoring system was introduced to help enhance vehicle handling performance when cornering. The system monitors steering angle, accelerator pedal, lateral G, longitudinal G, and yaw rate of the vehicle to detect an understeer condition. When understeer is detected, the system will apply brake pressure independently to the inside cornering front wheel. This action results in higher torque being transferred to the outside wheel which creates a more neutral steering force for the driver and their intended path.

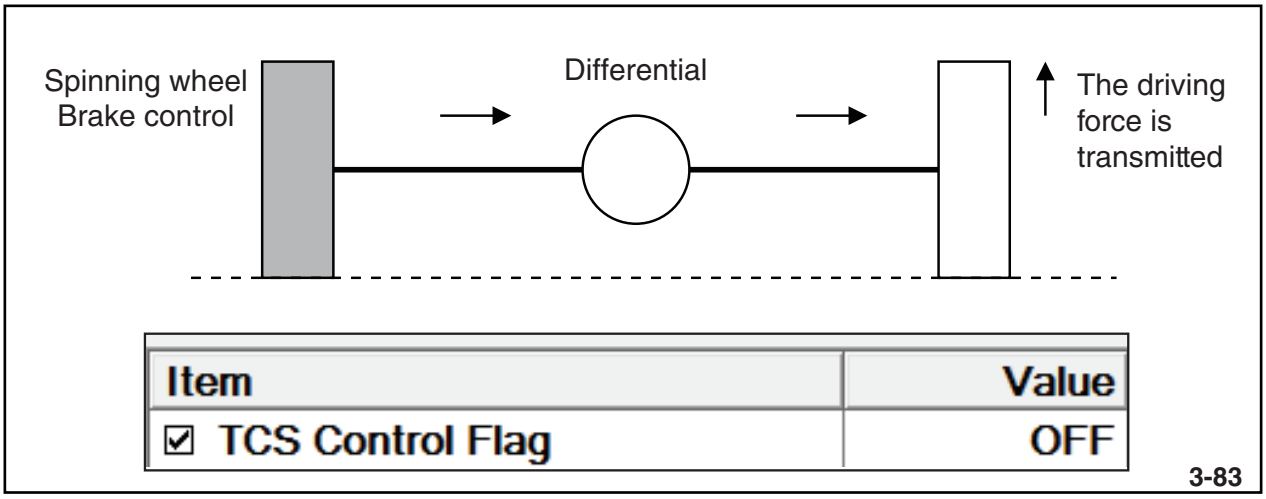


Active Torque Vectoring

Traction Control System (TCS)

The Traction Control System (TCS) is designed to prevent spinning of the drive wheels on slippery road surfaces in order to maintain traction and directional control. TCS operates similar to Limited Slip Differentials (LSD) in that torque is reduced from a slipping wheel and applied to a wheel with traction. The VDCCM may use any combination of the pressure increase, decrease, or hold modes and request AWD control from the TCM to obtain a desirable coefficient of friction between the wheels and road surface. A “TCS Control Flag” is displayed on the SSM during TCS operation.

Note: Turning the VDC system to the OFF position will disable the “Torque Down Request” control from the VDCCM to the Engine Control Module (ECM). This may be effective when attempting to drive out of deep snow or gravel.



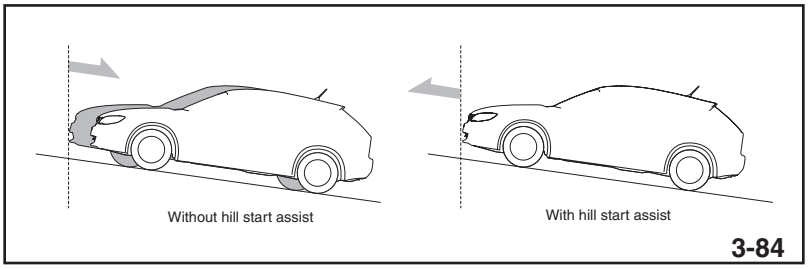
TCS Function

Hill Start Assist

Introduced with some 2008 MY vehicles, a Hill Start Assist system was added to prevent the vehicle from rolling downhill when the vehicle is on an incline. The system assists the driver in the transitional period of moving one's foot from the brake pedal to the accelerator pedal during clutch engagement. The Hill Start Assist system does not function when the vehicle is facing downhill.

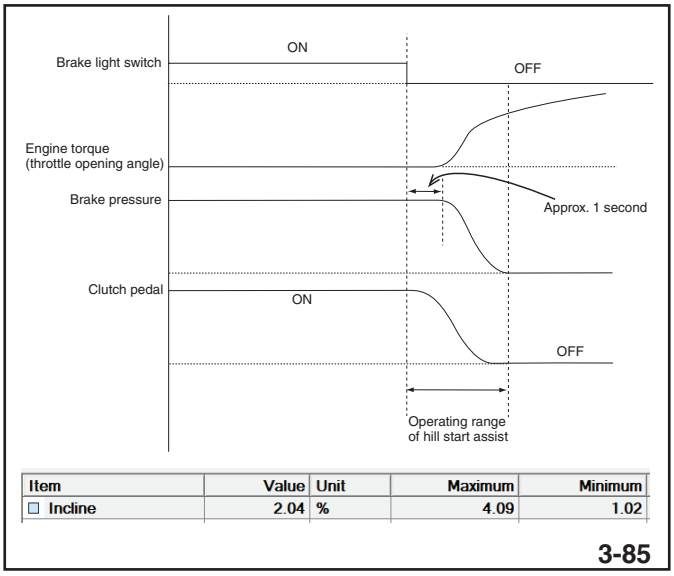
Caution: To prevent accidents when the vehicle is parked on a slope, be sure to firmly set the parking brake. Make sure the vehicle remains stationary when the clutch pedal is released.

Note: Models with an Electronic Parking Brake System (EPB) feature a different Hill Holder™ system that utilizes both the VDC system and the parking brake. Refer to the Electronic Parking Brake chapter for further details. On some models it may be possible to temporally disable the Hill Start Assist system by pressing the "VDC OFF" button in a specific sequence. Consult the appropriate Owner's Manual for specific procedures.



Hill Start Assist Comparison

As the driver depresses the brake pedal, the VDCCM recognizes that the vehicle has come to a complete stop on an incline based on wheel speed sensor and G sensor inputs. The VDCCM will command brake pressure hold from the H/U for approximately one second when the brake pedal is released (based on brake pedal switch input). The SSM displays data relating to the vehicle incline



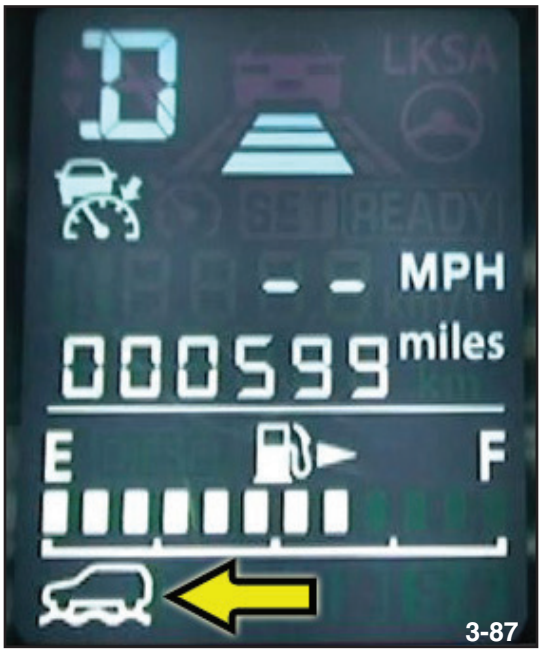
Hill Start Assist Logic

X-Mode™

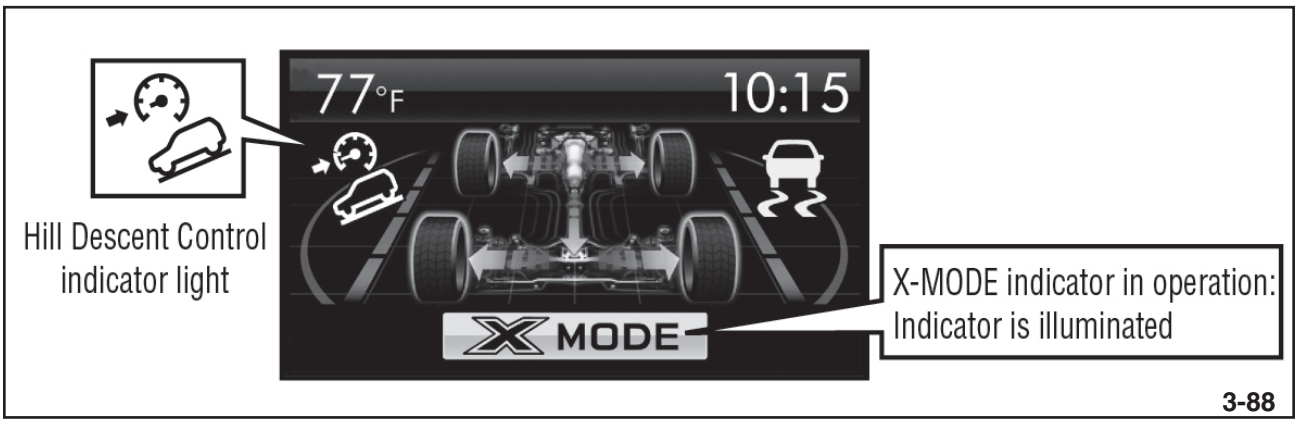
Introduced with some 2014 Forester models, X-Mode™ is a driver assistance system that increases driveability on rough roads and maintains the driver's sense of security by performing optimized integrated control of the engine, AWD system, and brakes. X-Mode™ also includes Hill Decent Control (HDC) which allows the driver to maintain a constant speed when driving down slopes. X-Mode™ and HDC functions are automatically turned off when the vehicle speed is above 12 MPH, and the X-MODE™ indicator lamp goes out at around 18 MPH.

The X-MODE™ switch is located in the center console area. In order to activate the system, the button must be pressed below 18 MPH to activate X-MODE™. Pressing the button at higher vehicle speeds will result in a beeping sound, indicating the vehicle is traveling too fast to activate X-MODE™.

`X-MODE™ Button



X-MODE™ "ON" Indicator



HDC and X-MODE™

X-MODE™ performs the following functions:

Description	Contents	Effect			Details	Operation range
		Control improvement	Traction improvement	Merchantability improvement		
ECM	Dedicated torque map setting	❍			Low load range: Late throttle opening characteristics. Prevents abrupt changes in torque to improve driving on slippery roads. High load range: Early throttle opening characteristics. Provides maximum torque quickly to improve driving on rough road surfaces.	40 km/h or less
TCM	Dedicated AWD control		❍		AWD clutch engagement force is increased by approx. 25%. Suppresses differences in rotational speed between the front and rear wheels to improve traction.	
	Dedicated shift control	❍			When compared with regular control, the gear ratio is lower and lock-up is turned off. This dedicated shift control maximizes the use of driving power to improve vehicle control	
VDC	Strengthened LSD control		❍		To improve traction on slippery road surfaces, when there is a difference in the rotational speed between the left and right wheels this dedicated control: ① Makes the brake boost speed faster, ② Slows down the timing of brake pressure decrease when the rotational speed difference returns to normal.	
	Hill descent control	❍			To maintain a constant vehicle speed when accelerating or releasing the brake when driving down a steep hill, this controls the brakes to provide the driver with safety and security by allowing them to concentrate on steering without having to worry about braking.	20 km/h or less
MID	MID display when in X MODE			❍	[High Grade Meter] • The Preventive safety screen comes up and "X-Mode" is displayed. The tire image/arrow changes from green → blue. • The "Hill decent" indicator illuminates when ready and flashes when in operation. [Standard Meter] The "X-Mode" indicator illuminates.	40 km/h or less
Meters	Meter display when in X MODE			❍	• The "X-Mode" indicator on the LCD illuminates. • The dedicated "Hill decent" indicator illuminates when ready and flashes when in operation.	

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X-MODE™ Functions

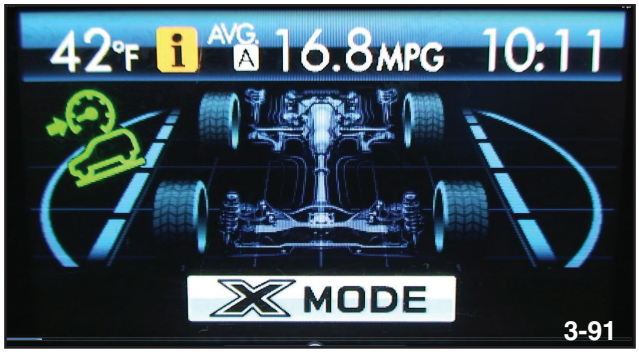
Hill Descent Control (HDC)

HDC provides braking automatically to maintain the vehicle's speed which existed at the time the driver released the gas pedal or the brake pedal.

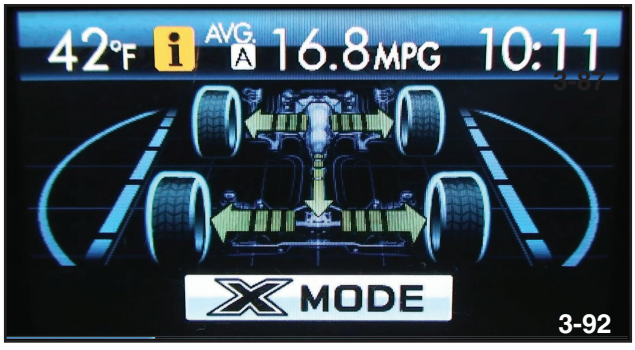
NOTE: HDC is not a cruise control function. It will not advance the throttle setting to increase speed. HDC functions during downhill driving or on any terrain where the vehicle's speed may increase from gravity or vehicle inertia.

When HDC is in operation, an indicator lamp on the combination meter and multifunction display starts flashing so that the driver can visually check that the system is operating. (During standby, the HDC indicator lamp stays ON steadily.) The brake lights activate when the HDC is operating.

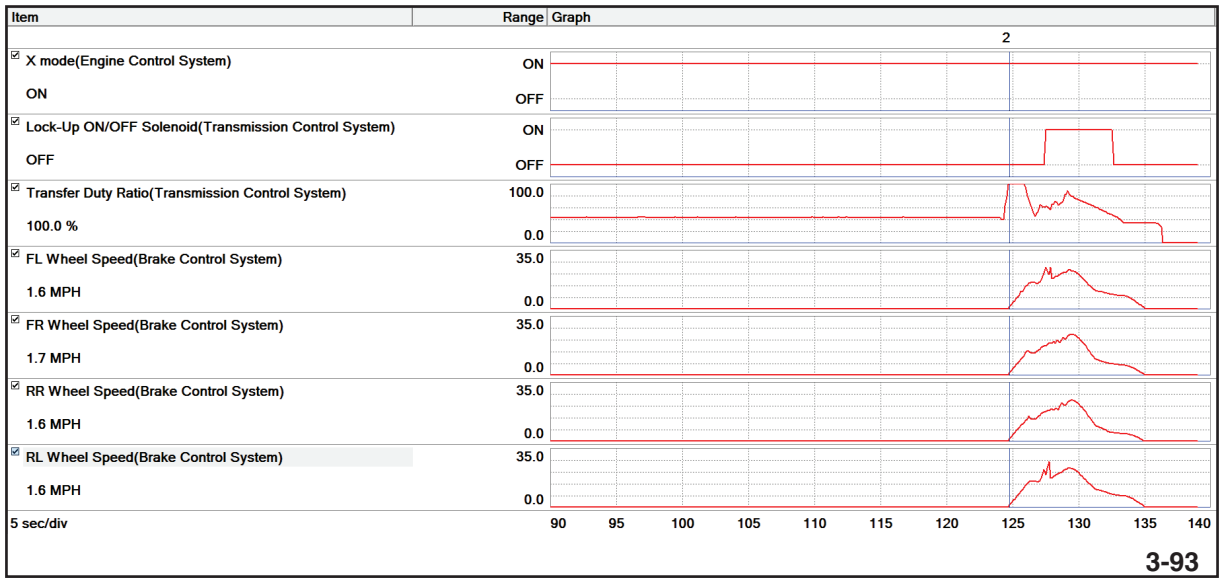
HDC "ON" Indicator



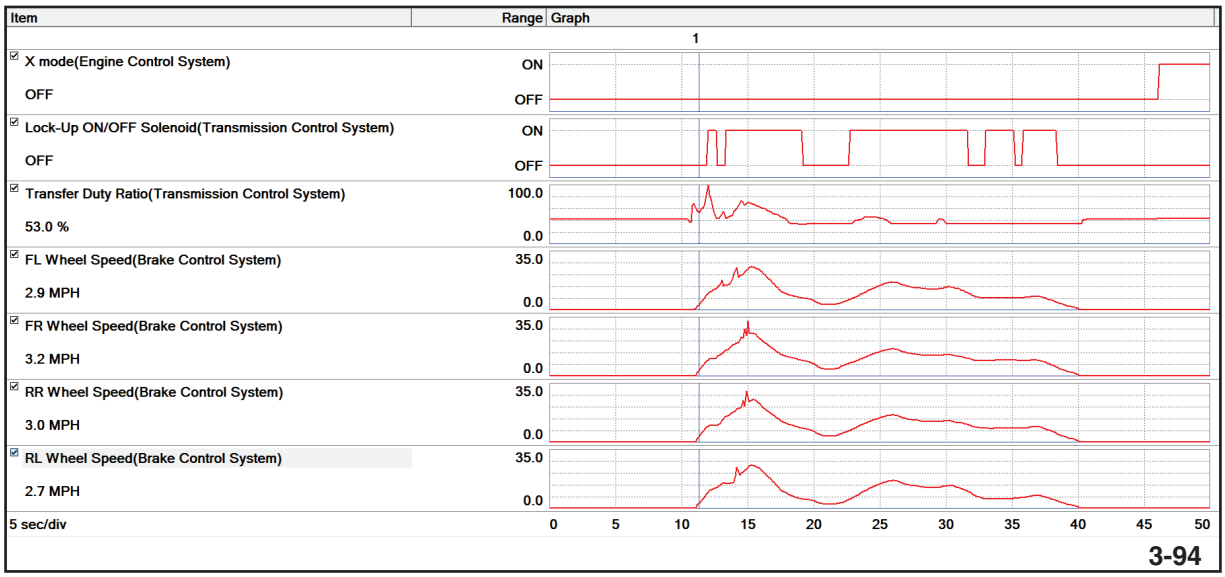
X-MODE™ "ON" with Vehicle Stopped



HDC Off with X-MODE™ with Vehicle Moving



Subaru Select Monitor III Data X-MODE™ ON



Subaru Select Monitor III Data X-MODE™ OFF

Brake Override System (BOS)

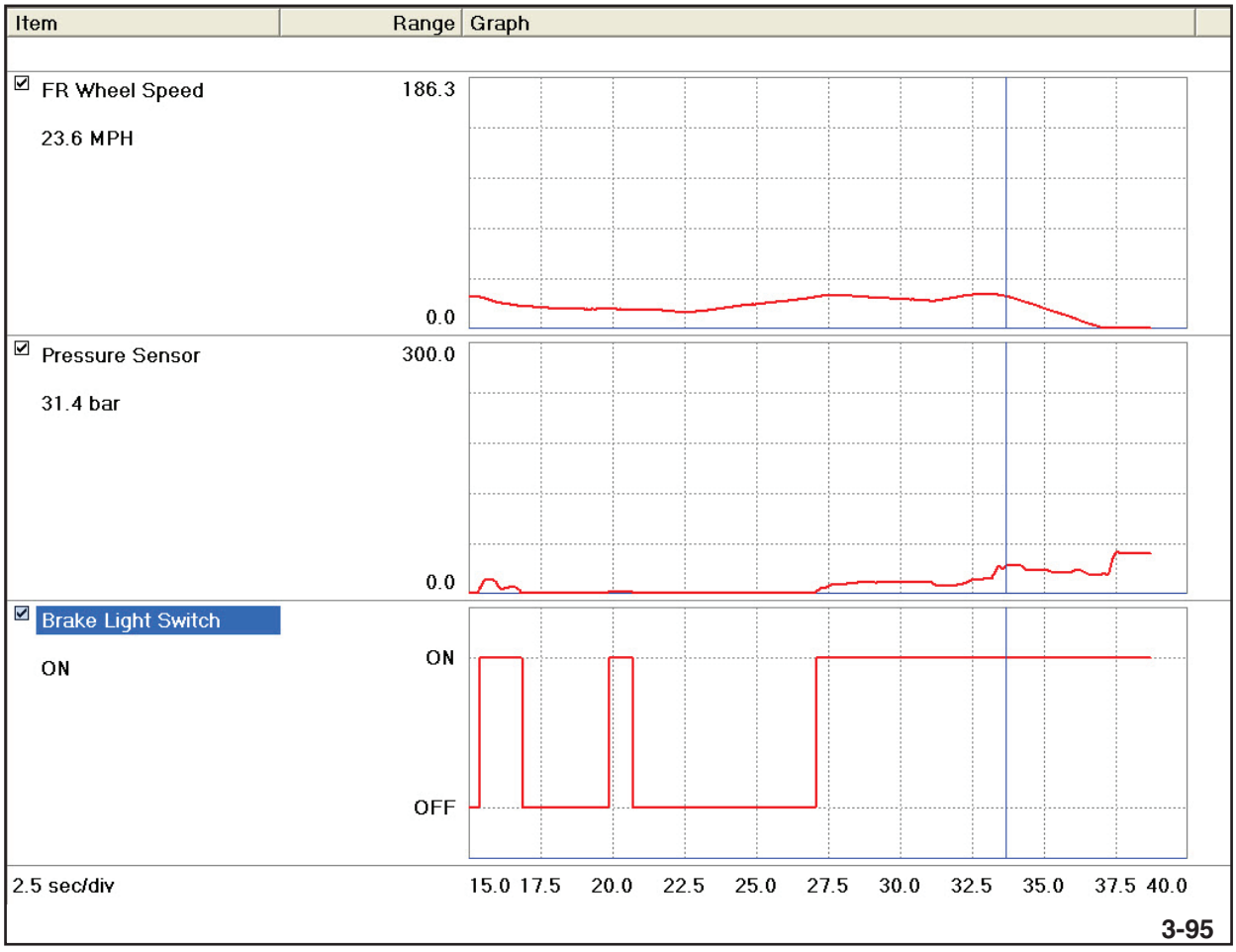
Introduced with some 2012 Models, the Brake Override System (BOS) is designed to prevent unintentional vehicle acceleration. The system monitors the simultaneous application of both the Brake Pedal and accelerator pedal by the driver.

The BOS activates when the brake is depressed and accelerator pedal is applied from 80 to 100 percent of operation. Engine operation is reduced by closing the Throttle Plate and the physical driver application of the Accelerator Pedal has no effect on engine speed.

Note: The vehicle must be moving for the system to operate. The brake override system will not operate below 6 MPH.

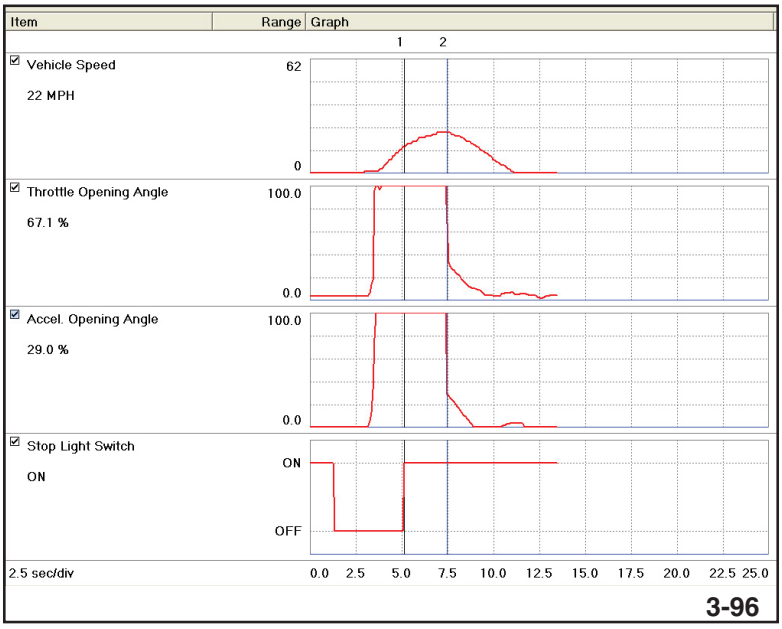
Two levels of recognition are programmed into the BOS. Each level is recognized by the system utilizing Hydraulic Pressure Sensor output from the HCU.

Light brake application with Accelerator Pedal Sensor output greater than 80% requires approximately 30 bar to activate.



Light Brake HCU

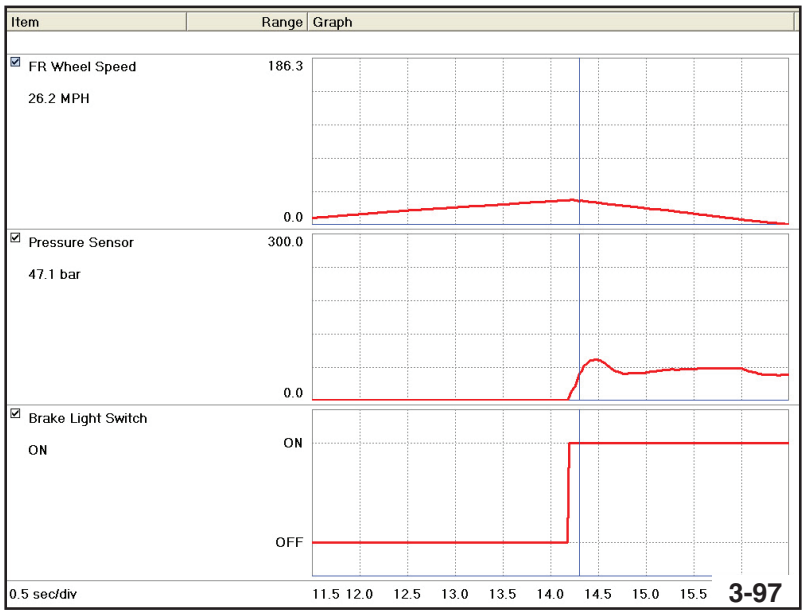
The activation time is delayed slightly to allow the driver time to release the Brake Pedal. If the Brake Pedal remains depressed, the Engine ECM removes the Accelerator Pedal Input and Throttle opening Duty Ratio in a stepped logic. The BOS will remain active until the accelerator pedal is fully released.



Light Brake ECM

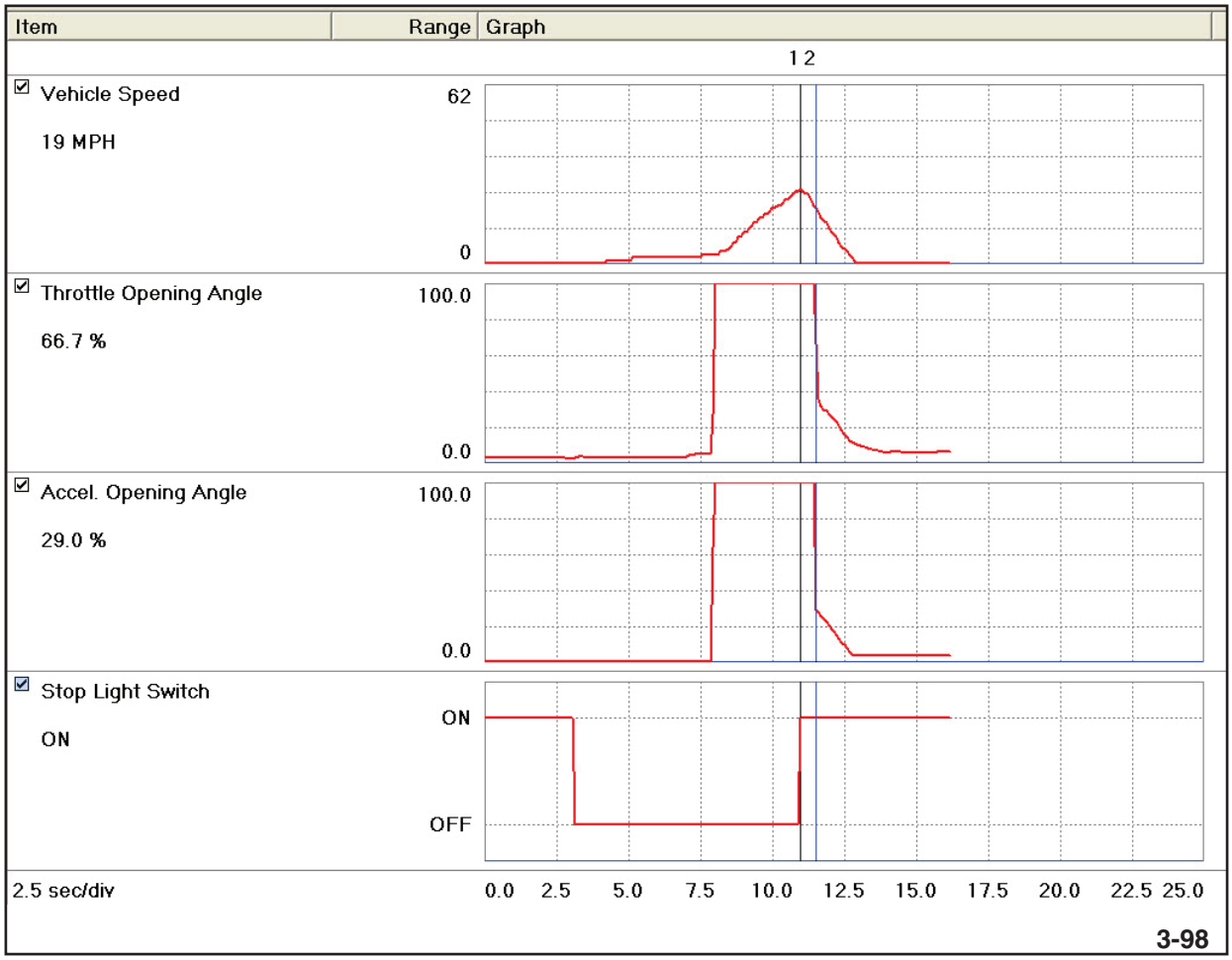
Note: Failure to release the accelerator pedal after the vehicle speed is 0 MPH will result in limited accelerator pedal control (driver could press the accelerator to the floor but the response from the throttle is very low, resulting in minimum acceleration).

Heavy brake application with Accelerator Pedal Sensor output greater than 80% requires approximately 45 bar to activate.



Heavy Brake HCU

The BOS activates immediately. If the Brake Pedal remains depressed, the Engine ECM removes the Accelerator Pedal Input and Throttle opening Duty Ratio in a stepped logic. The BOS will remain active until the accelerator pedal is fully released.



Heavy Brake ECM

Note: Failure to release the accelerator pedal after the vehicle speed is 0 MPH will result in limited accelerator pedal control (driver could press the accelerator to the floor but the response from the throttle is very low, resulting in minimum acceleration).

Note: Each level of BOS operation shows the accelerator opening angle according to a predetermined value. During the actual drive cycle for capturing the data shown, the accelerator pedal angle was 100%.

Diagnostics

Self-Diagnostics

The VDC system has extensive self-diagnostic capabilities. When the ignition switch is turned from OFF to ON, the VDCCM performs an electrical self-check and illuminates the VDC, ABS, Hill Holder, and/or other related warning lights on the combination meter. If there are no electrical problems, the warning lights should turn OFF after approximately 2 seconds.

Note: During this self-test a slight shock in the brake pedal may be felt and audible noise may be heard from the Motor Pump actuation. This does not indicate an abnormal condition.

Combination Meter Warning Lamps

Item	Value	Unit
☑ ABS Warning Lamp	OFF	
☑ VDC Warning Lamp	OFF	

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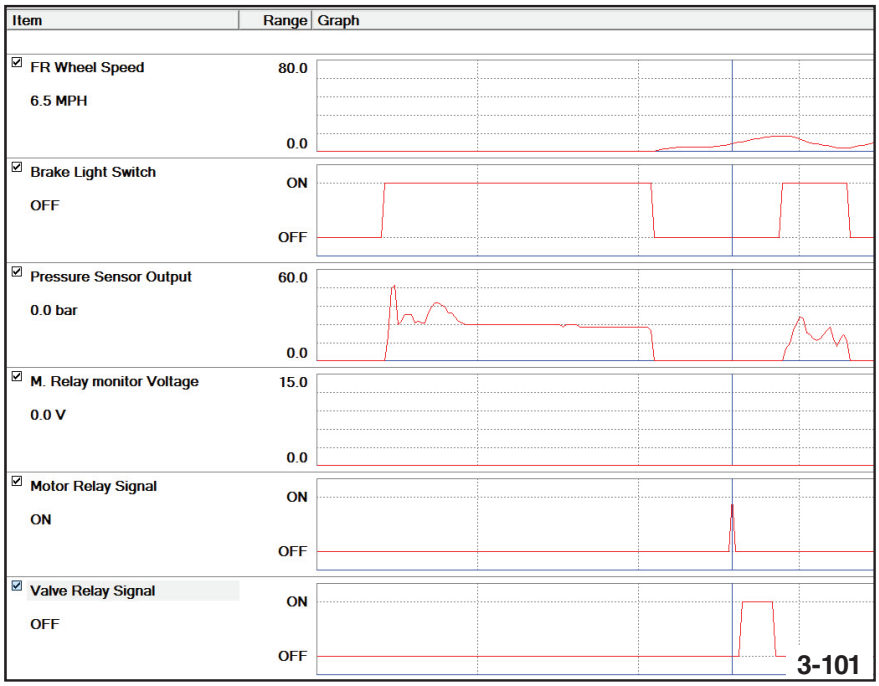
SSM Warning Lamp PIDS

The VDCCM performs a second check when the vehicle speed reaches approximately 3 -6 MPH (if the brake has not been applied) or approximately 8 MPH (if the brake has been applied). During this self-check the VDCCM briefly operates the Motor Pump.

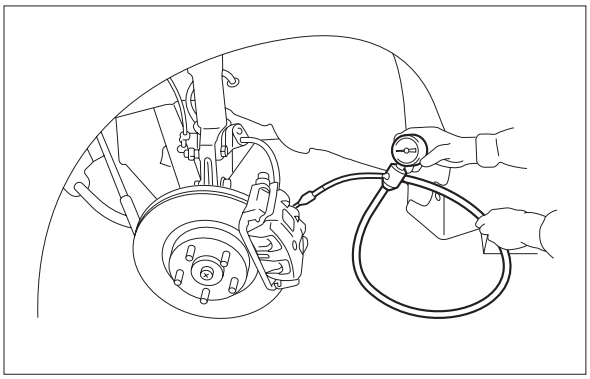


System Self-Test

Mechanical Diagnostics

The hydraulic functions of the VDC system may be inspected with the aid of a brake hydraulic pressure gauge.

Warning: The VDC system can generate high pressures. Therefore, only use a gauge exclusively designed for brake fluid measurement. Gauges from other vehicle systems may introduce fluid cross-contamination resulting in brake system malfunctions.



Inspection conditions	Front wheel	Rear wheel
Initial value	3,500 kPa (36 kgf/cm^2, 511 psi)	3,500 kPa (36 kgf/cm^2, 511 psi)
When depressurized	500 kPa (5 kgf/cm^2, 73 psi) or less	500 kPa (5 kgf/cm^2, 73 psi) or less
When pressurized	3,500 kPa (36 kgf/cm^2, 511 psi) or more	3,500 kPa (36 kgf/cm^2, 511 psi) or more

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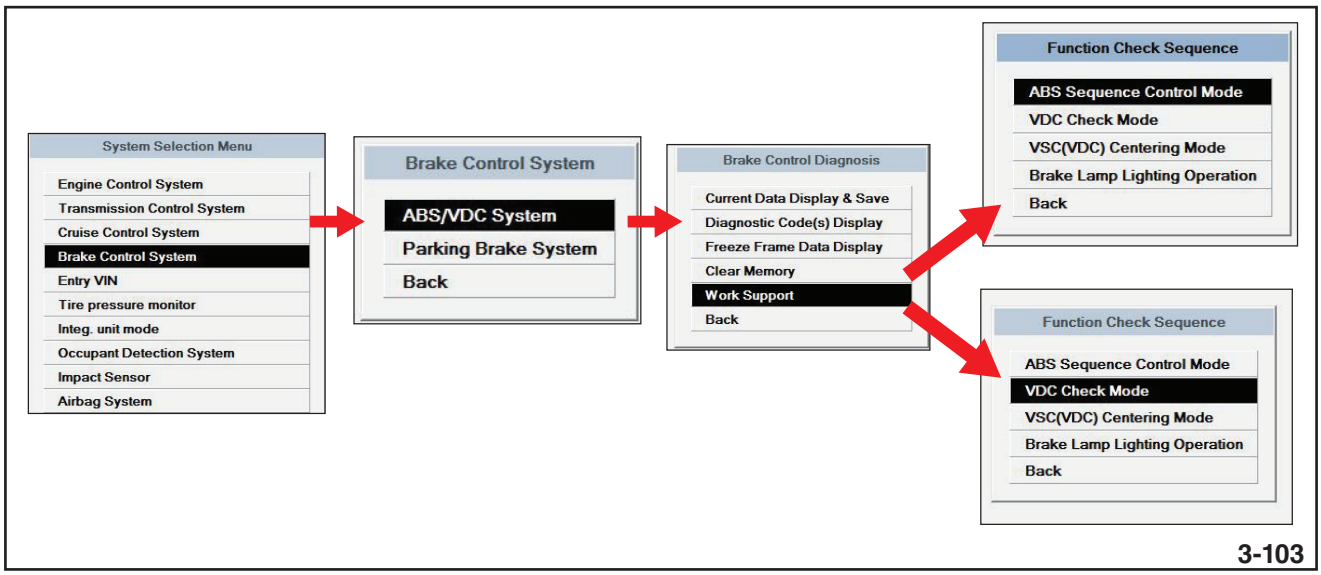
Hydraulic Pressure Gauge

Once the brake hydraulic pressure gauge has been fitted, both ABS and VDC inspection procedures can be performed using the SSM.



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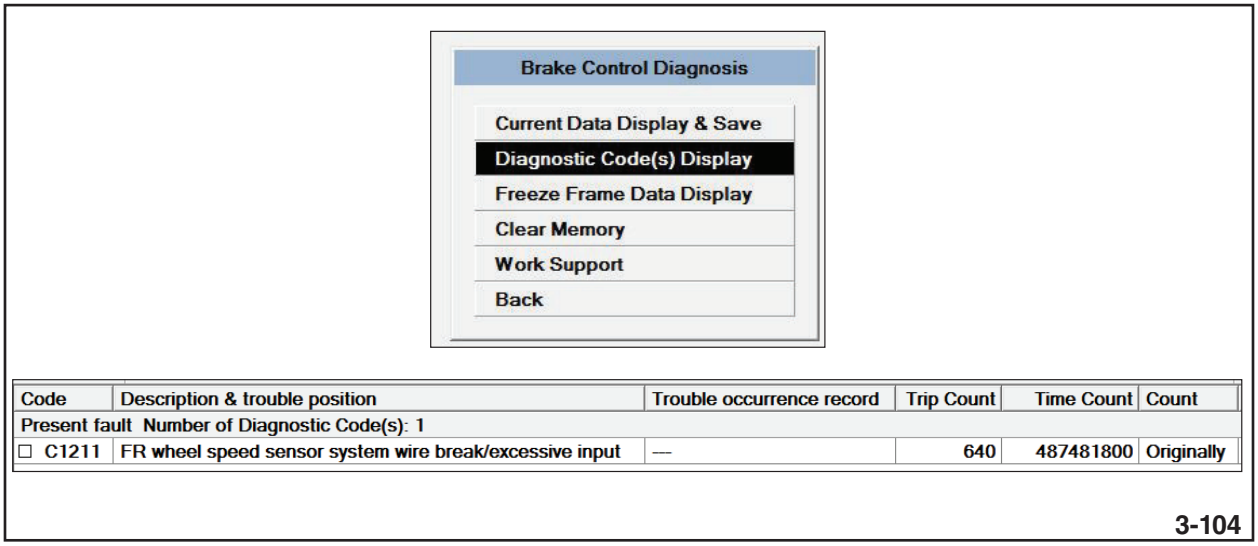
ABS and VDC Work Support

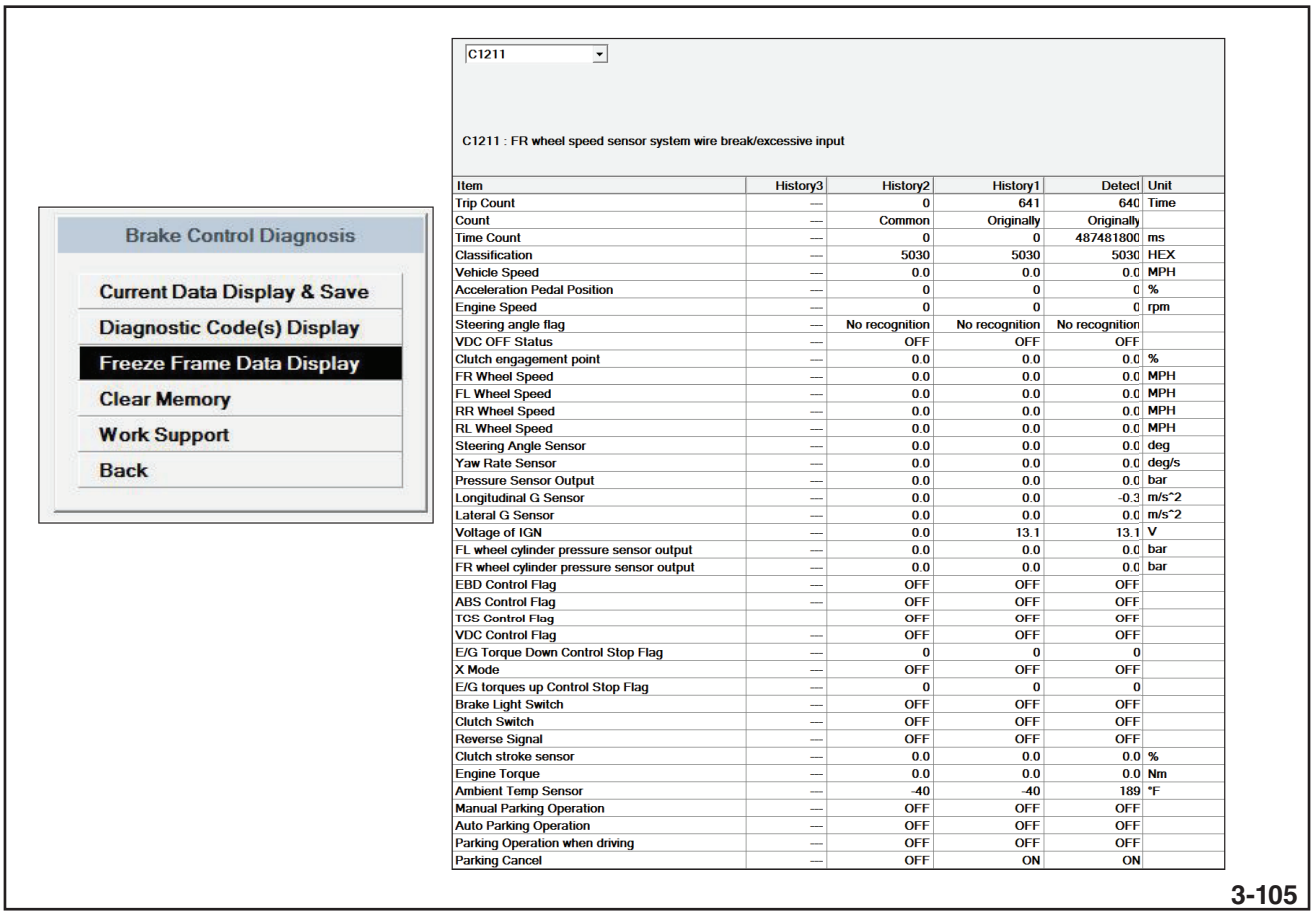
Diagnostics with the Subaru Select Monitor (SSM)

The SSM provides comprehensive Diagnostic Trouble Codes (DTCs) that are associated with the VDC system. Refer to STIS for specific diagnostic procedures for each DTC.



Diagnostic Trouble Code Display

The Freeze Frame display provides critical information about the vehicle's condition at the time the DTC was generated.



Freeze Frame Data Display

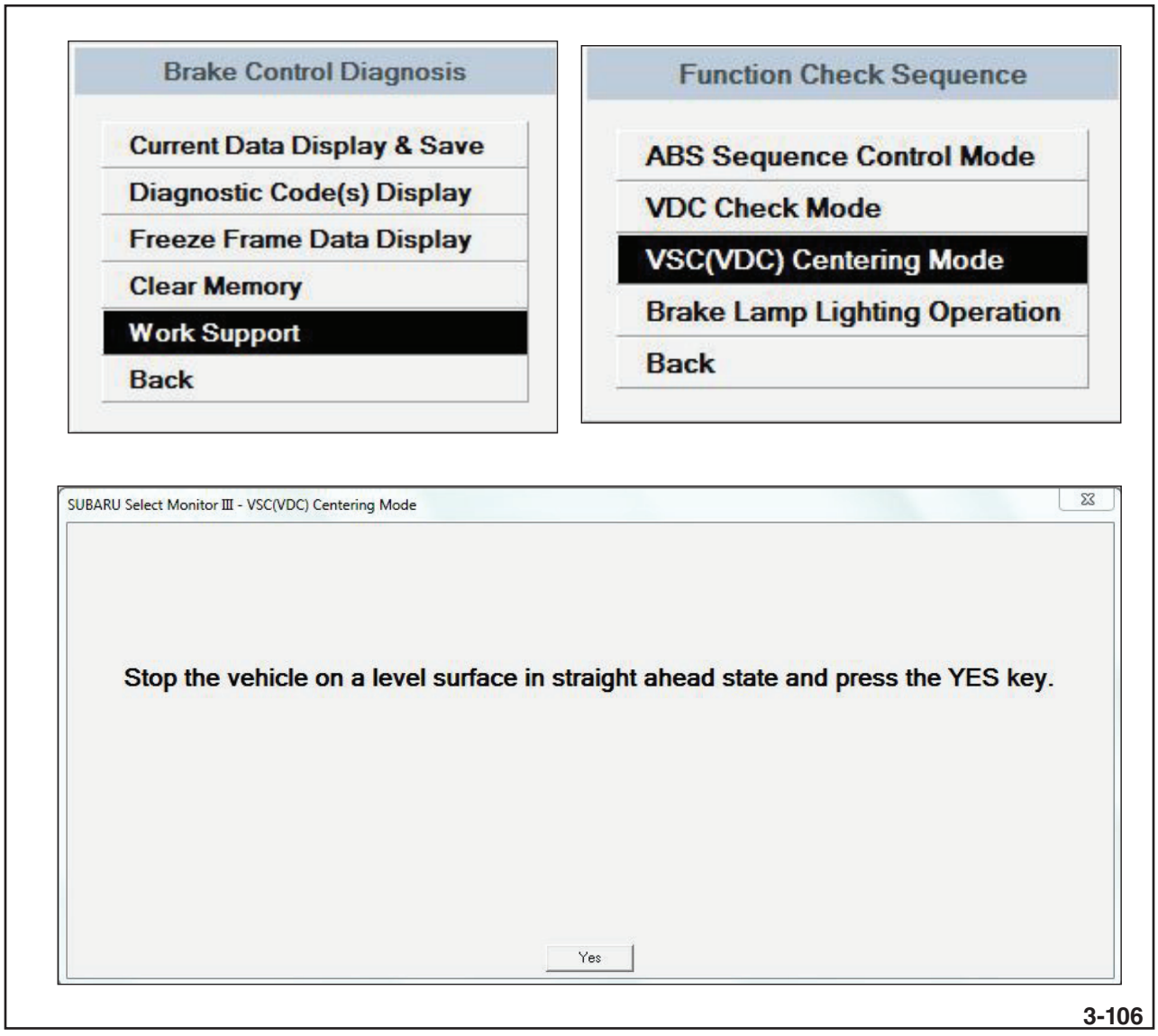
Service

Vehicle Dynamics Control (VDC/VSC) Centering Mode

After installing, replacing, or adjusting the following components, it is necessary to perform the VSC(VDC) Centering Mode. This mode is performed by placing the vehicle on a level surface with the steering wheel in the straight ahead position.

- Steering Angle Sensor
- Steering Wheel
- Suspension Components
- Wheel Alignment
- VDCCM & H/U
- VDCCM & H/U Bracket

After the VSC (VDC) Centering Mode has been completed, test drive the vehicle for at least 10 minutes to ensure there are no system malfunctions.

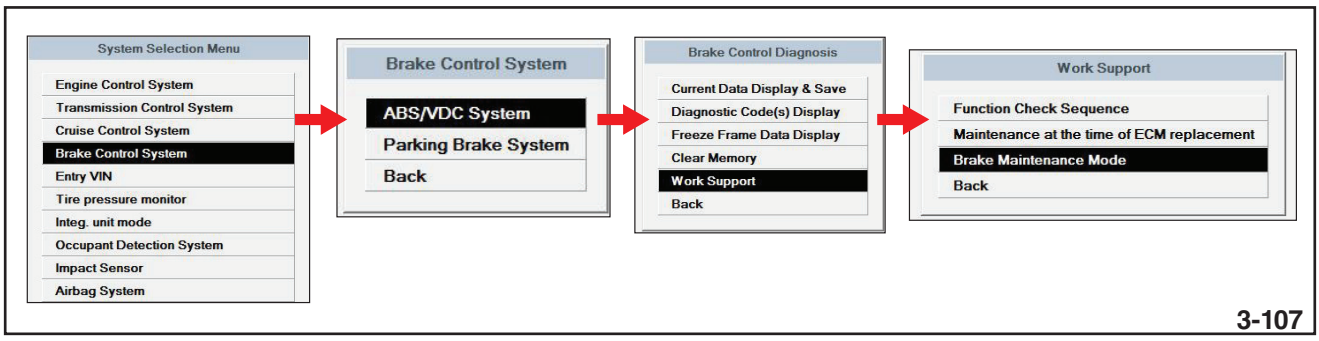


VSC (VDC) Centering Mode

VDCCM Parameter Information

The VDCCM contains “parameter” information that identifies vehicle specific information such as model and grade (trim) level. Whenever the VDCCM is replaced, the Parameter information must be read, written, selected, and/or confirmed. There are 4 SSM functions related to the VDCCM Parameter;

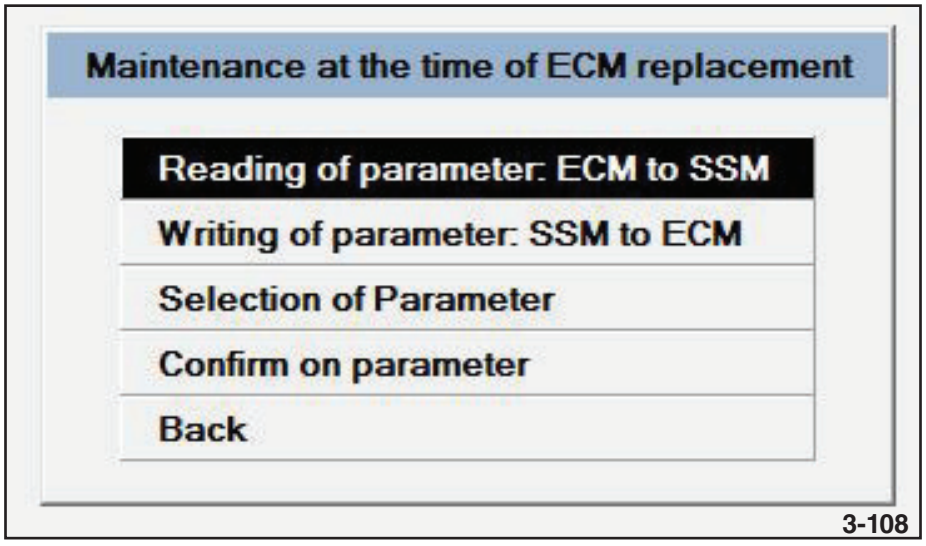
- Reading of Parameter (ECM to SSM)
- Writing of Parameter (SSM to ECM)
- Selection of Parameter
- Confirm on Parameter



VDCCM Parameter-SSM Menus

Reading of Parameter

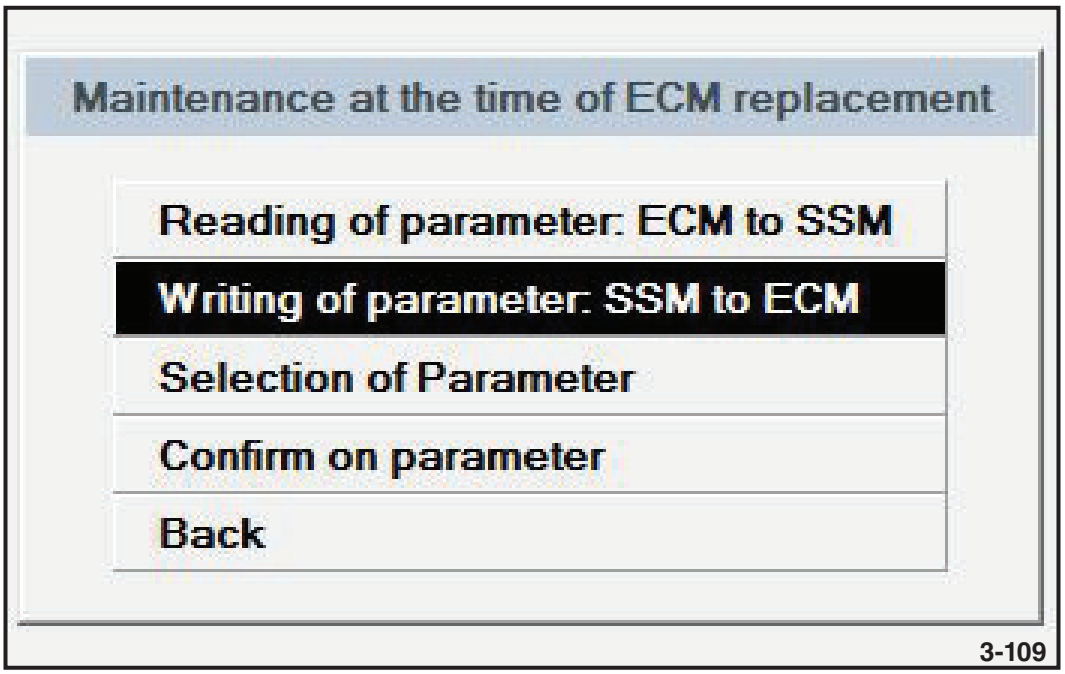
Reading the parameter allows the user to retrieve the current parameter stored in the VDCCM and save it as a file to their local PC.



Reading of Parameter

Writing of Parameter

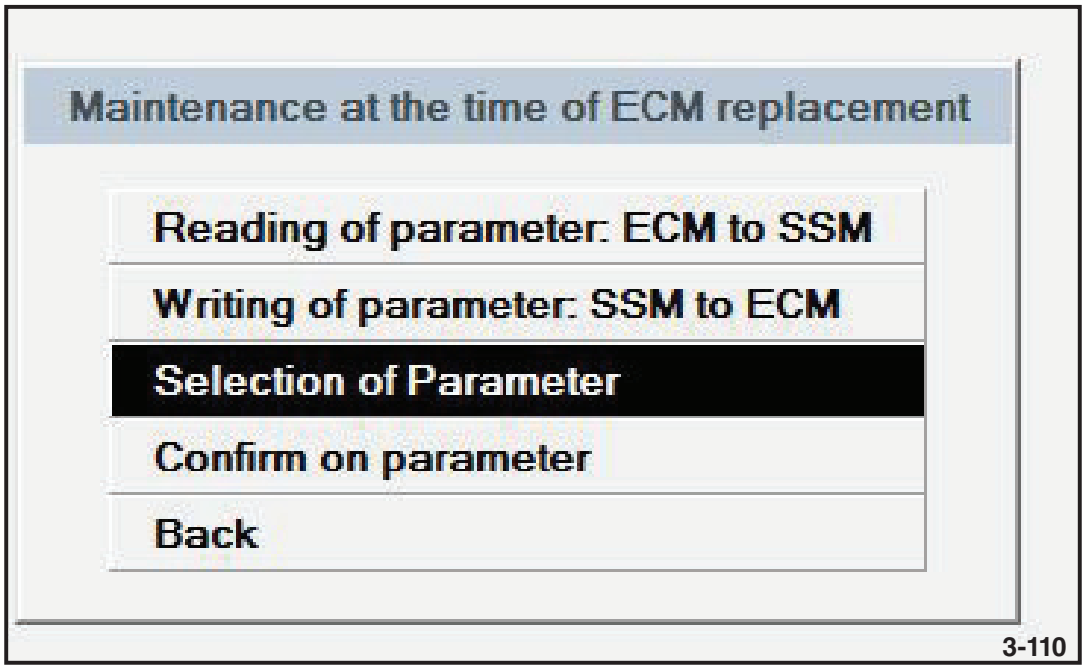
Once the Parameter has been saved to the local PC, it can be written to the new VDCCM using the Writing of Parameter function.



Writing of Parameter

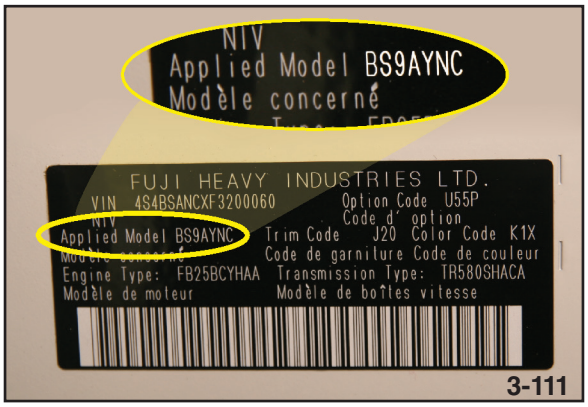
Selection of Parameter

The Selection of Parameter function requires the user to manually enter the Applied Model code for the vehicle being serviced.



Selection of Parameter

Applied model and option codes can be found on the “Model Number Plate” located on the inside of the front passenger door frame.



Model Number Plate

Digits	Code	Meaning	Details
1	B	Series	LEGACY
2	N	Body type	N: Sedan S: OUTBACK
3	9	Total engine displacement Drive system	9: 2.5 L AWD F: 3.6 L AWD
4	A	Model year	A: 2015MY
5	Y	Destination	Y: U.S.A., Canada
6	2	Grade	2: 2.5 i 4: 2.5 i Premium 5: 2.5 i Premium EyeSight 8: 2.5 i Limited 9: 2.5 i Limited EyeSight A: 3.6 R B: 3.6 R Premium D: 3.6 R Limited E: 3.6 R Limited EyeSight G: OUTBACK 2.5 i H: OUTBACK 2.5 i Premium J: OUTBACK 2.5 i Premium EyeSight M: OUTBACK 2.5 i Limited N: OUTBACK 2.5 i Limited EyeSight R: OUTBACK 3.6 R T: OUTBACK 3.6 R Premium V: OUTBACK 3.6 R Limited W: OUTBACK 3.6 R Limited EyeSight
7	A	Fuel feed system transmission	A: DOHC MFI 6MT C: DOHC MFI CVT

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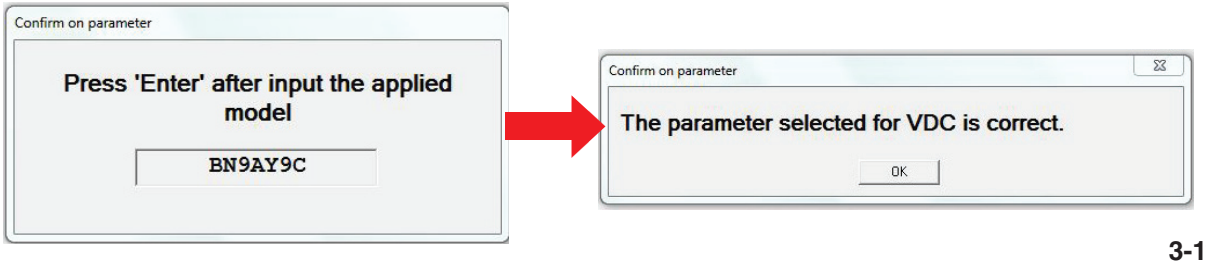
Applied Model Chart - STIS

Confirm on Parameter

The Confirm on Parameter function allows the user to verify the currently written parameter information in the VDCCM. This is accomplished by entering the Applied Model number from the Model Number Plate. The SSM will display the result of the parameter check.



Confirm on Parameter

NOTES:

EyeSight®

Introduction

Introduced with 2013 Legacy and Outback models, EyeSight® is a driver assist system that uses a wide range of functions provide safer, more comfortable driving and to reduce driver fatigue. EyeSight® uses two Stereo Cameras to identify vehicles, pedestrians, obstacles, traffic lanes and other items in front of the vehicle. Under the ideal circumstances, the system can apply the brakes or decrease the throttle to reduce the severity, or help avoid a collision. However, EyeSight® is not a replacement for attentive driving. EyeSight® has a limit to its recognition of dangerous situations and it cannot avoid all collisions in all conditions. The EyeSight® system's performance is heavily dependent on several factors including (but not limited to);

- **Driving conditions:** Driving in low visibility conditions such as low light, fog, heavy rain, or with a dirty windscreen may affect the proper operation of the EyeSight® system
- **Tire condition:** Correct specification, balanced, and evenly worn
- **Road conditions:** If the road is slippery the vehicle may not be able to avoid a collision even if the Pre-Collision Brake system is active. Some elements of the EyeSight® system may not work well or at all on sharply winding roads, roads with poorly marked lane markings or roads with steep gradients.

EyeSight® Equipped Vehicle

Driver Assist Functions

The EyeSight® System provides the following driver assist functions:

1. **Adaptive Cruise Control (ACC)**
   Adaptive Cruise Control combines the benefits of Cruise Control with active monitoring of the road ahead by EyeSight®, and it issues warnings and activates automatic braking when needed. Adaptive Cruise Control can regulate vehicle speed in order to keep a safe following distance from the car ahead.
   a. **Stay-Stopped**
      The Stay-Stopped function works in conjunction with Adaptive Cruise Control to keep the vehicle stopped when the vehicle in front has also come to a complete stop.
   b. **Conventional Cruise Control**
      Conventional Cruise Control drives the vehicle at a constant speed and does not adjust speed based on a lead vehicle. This mode can also be used when the Stereo Cameras are not activated (malfunction). To use this function, it is necessary to switch from Adaptive Cruise Control.
   c. **Lead Vehicle Start Alert**
      Lead Vehicle Start Alert notifies the driver when the vehicle in front has started moving but the EyeSight® vehicle has not.
2. **Pre-Collision Braking (PCB)**
   Pre-Collision Braking can recognize an impending collision originating in front of the EyeSight® vehicle, alert the driver, reduce engine torque, and automatically apply the brakes to help avoid a collision or minimize the impact.
   a. **Pre-Collision Steering Assist (Beginning with 2015MY Vehicles)**
      Pre Collision Steering Assist alters the logic of the VDC system to increase the driver's ability to avoid a possible collision.
   b. **Pre-Collision Throttle Management**
      Pre-Collision Throttle Management is designed to help prevent drivers from accelerating into a stopped vehicle or other obstacle in front of them. It warns the driver and reduces engine power until the brakes are applied to avoid an impact.
   c. **Pre-Collision Brake Assist**
      Pre-Collision Braking Assist is activated when the system determines that there is a high risk of collision with an obstacle and provides additional brake fluid pressure to assist the driver
3. **Lane Departure Warning (LDW)**
   Lane Departure Warning alerts drivers when they unintentionally move out of their travel lane. It takes no corrective vehicle action other than issuing visual and audible warnings.
   a. **Lane Sway Warning**
      Lane Sway Warning detects unusual back and forth vehicle movement within the driver's lane of travel that is usually indicative of a fatigue.
4. **Lane Keep Assist (LKA) (Beginning with 2017MY Vehicles)**
   Lane Keep Assist (LKA) system provides a physical input to the Electronic Power Steering (EPS) system to assist in keeping the vehicle in the current lane of travel if it is likely to depart.

5. **High Beam Assist (HBA) (Beginning with 2017MY Vehicles)**
   High Beam Assist increases the use of the vehicle's High Beam headlights to improve low ambient light visibility by automatically switching the headlight mode.

Caution: It is the responsibility of drivers to operate their vehicles safely at all times. Drivers should always remain alert and should never become complacent while operating their vehicles because of the presence of EyeSight®. EyeSight® is never a substitute for active driver involvement and it may not operate optimally under all driving conditions. Always refer to the appropriate Owner's Manual for complete warnings and cautions. All vehicles with EyeSight® contain a separate EyeSight® Owner's Manual with a full listing of functions and warnings.

System Versions

The EyeSight® system is available in multiple versions depending on the model type. Version 2 and Version 3 are the only systems that currently exist in the North American market. While there are differences in hardware, performance, and operation, both systems provide the same basic driver assist features.

	13MY	14MY	15MY	16MY	17MY
Legacy/Outback	Version 2	Version 2	Version 3	Version 3	Version 3
Forester	N/A	Version 2	Version 2	Version 2	Version 3
Impreza/Crosstrek	N/A	N/A	Version 3	Version 3	Version 3

Performance Area	EyeSight® (Version 2)	EyeSight® (Version 3)	Enhancement results
Forward Distance Range	262 ft (80 m)	Increased appx. 40%	Increased detection distance
Horizontal Range	25°	Increased appx. 40%	Increased horizontal detection
Camera Recognition	Monochrome	Color	Brake Lamp Recognition
Image Processing engine	Base	New	Increased durability to environment (Ex. Sunlight)

System Construction

The EyeSight® system contains the following unique components;

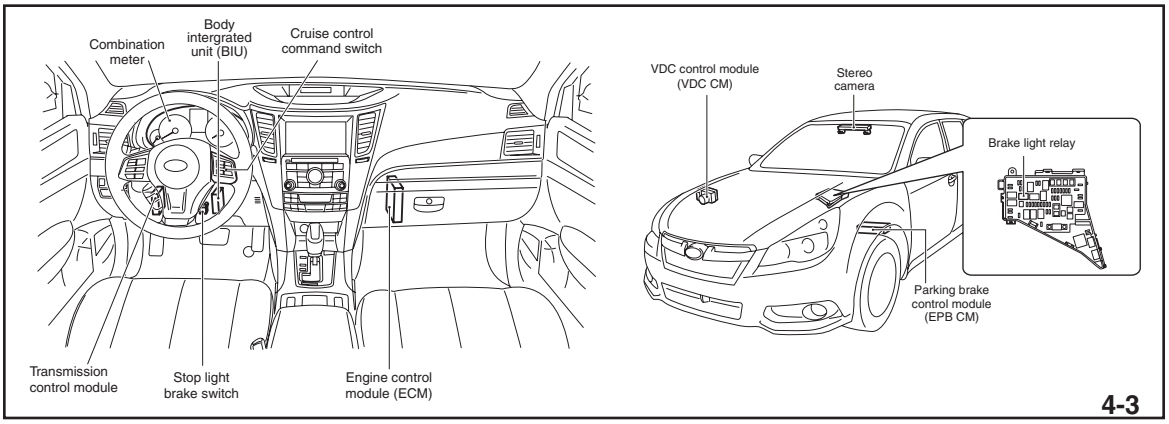
Stereo Camera Assembly

Brake Lamp Relay

Steering Wheel Switches

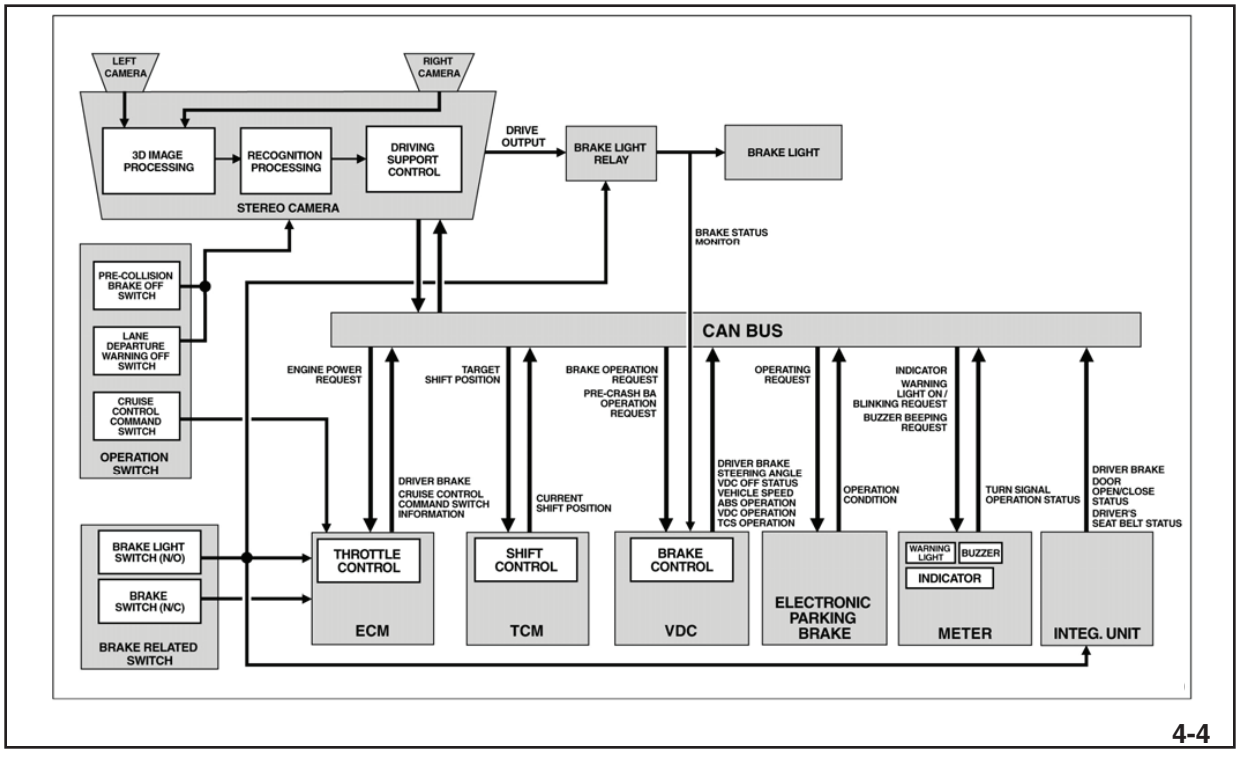
Pre-Collision Brake OFF switch

Lane Departure Warning OFF switch



System Component Locations

As images are processed by the Stereo Camera assembly, commands are transmitted via high-speed CAN to numerous control modules including the Engine Control Module (ECM), Transmission Control Module (TCM), and Vehicle Dynamics Control Module (VDCCM).



CAN System Configuration

Driver Interfaces

Steering Wheel Switches

The EyeSight® system features steering wheel mounted control buttons to adjust Adaptive Cruise Control and customizing functions through the Multi-Function Display (MFD) if equipped.

INFO/SET switch

Use the arrows above and below to set or view information on various functions in the multi information display.

Cruise Control switch

Press to turn Adaptive Cruise Control on or off.

RES/+ switch

Press to resume set speed or to increase set speed while in either Adaptive or Conventional Cruise Control.

SET/- switch

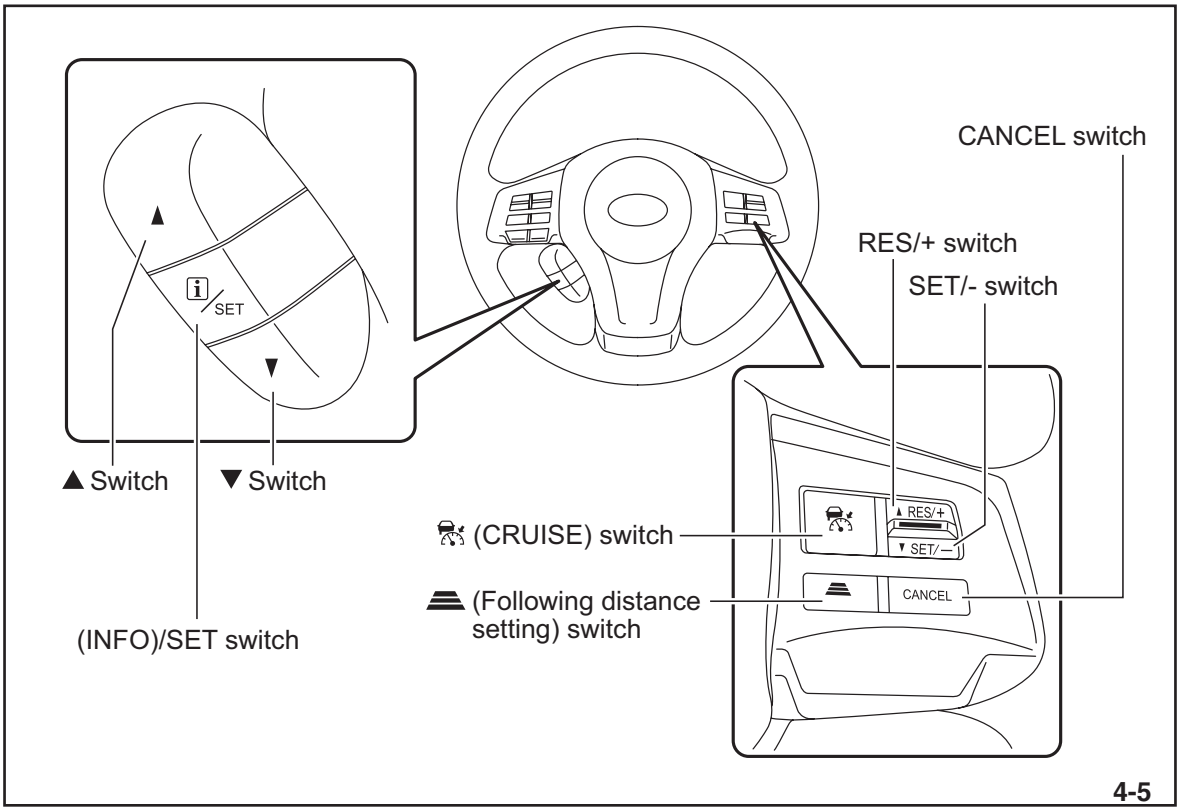
Press to set the current speed or to reduce set speed while in either Adaptive or Conventional Cruise Control.

CANCEL switch

Press to cancel the Cruise Control.

Following Distance Setting switch

Press to change the following distance setting while using Adaptive Cruise Control. Press and hold to turn off Adaptive Cruise Control and to switch to Conventional Cruise Control.



Steering Wheel Controls

The EyeSight® system contains two switches to control the ON and OFF functions of the Pre-Collision Braking and Lane Departure Warning systems. Depending on the model, these switches may be located on the Stereo Camera cover or the left driver's console.

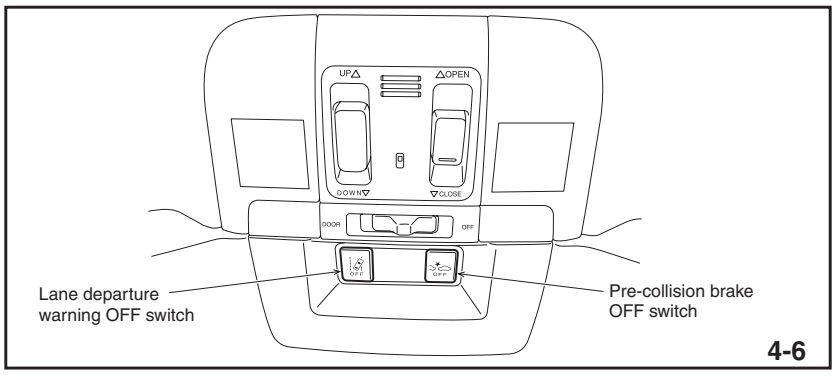
Pre-Collision Brake OFF Switch

Press and hold the Pre-Collision Brake OFF switch to turn off the Pre-Collision Braking System and the Pre-Collision Throttle Management. When these systems are off, the indicator light on the instrument panel illuminates. Press and hold the button again to turn the systems back on. In the following situations, turn off the Pre-Collision Braking System otherwise the Pre-Collision Braking System may activate unexpectedly.

- When the vehicle is being towed
- When loading the vehicle onto a carrier
- When a chassis dynamometer, free-rollers or similar equipment is used
- When a mechanic lifts up the vehicle, starts the engine and spins the wheels freely
- When passing hanging banners, flags or branches, or when thick/tall vegetation is contacting the vehicle
- When using a drive-through car wash

Lane Departure Warning OFF Switch

Press and hold the Lane Departure warning OFF switch to turn off the Lane Departure Warning and the Lane Sway Warning functions. When these functions are off, the indicator light on the instrument panel illuminates. Press and hold the button again to turn the functions back on.



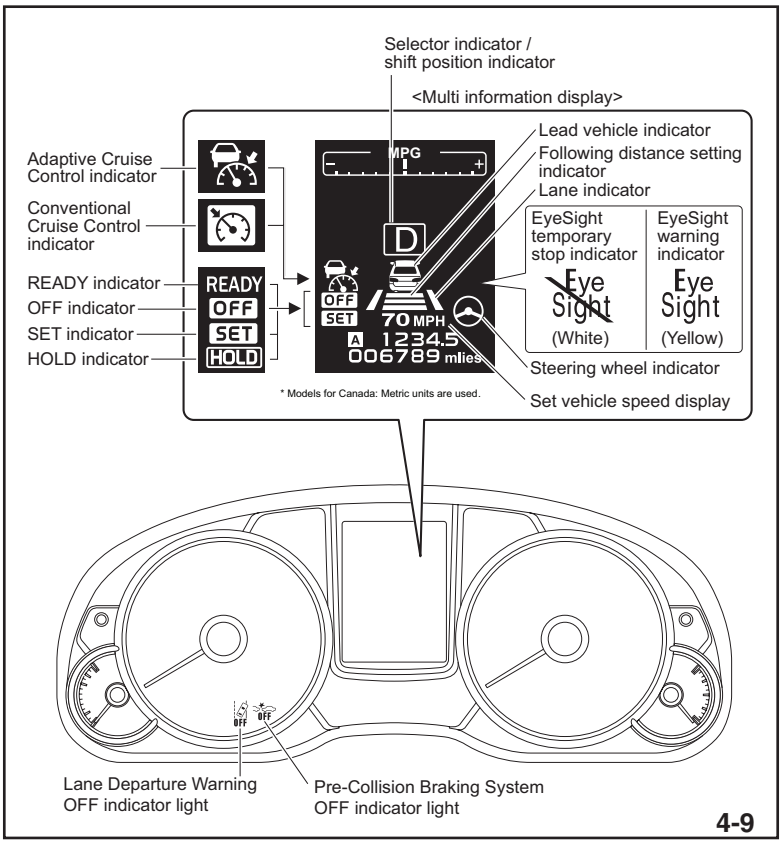
Camera Mounted Switches

EyeSight® OFF Buttons

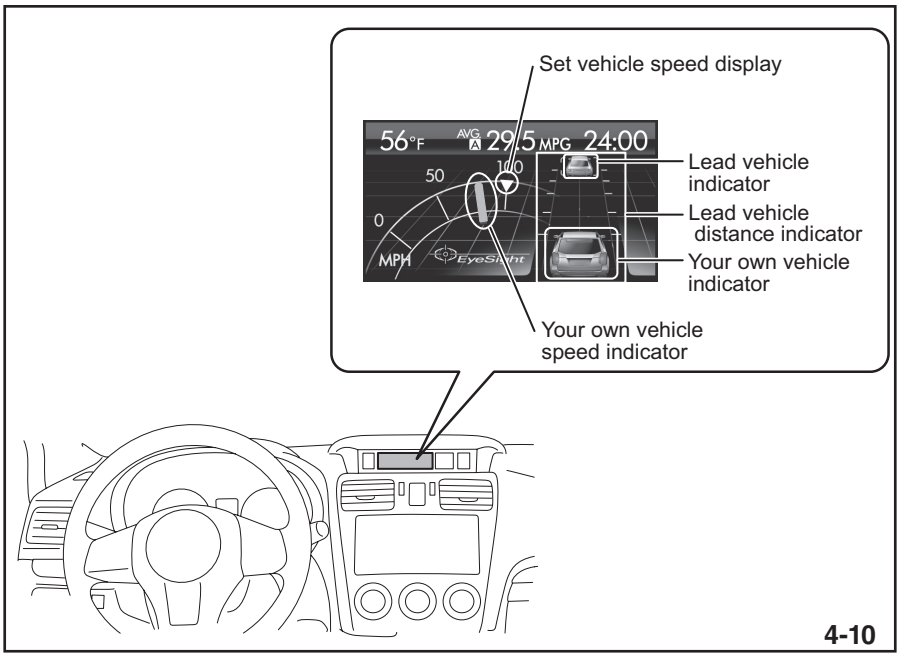
LDW and PCB OFF Switches

Combination Meter/ Multi-Function Display (MFD)

The Combination Meter and Multi-Function Display are used to communicate various warnings and information to the driver. Specific icons and warning messages vary slightly by make and model.



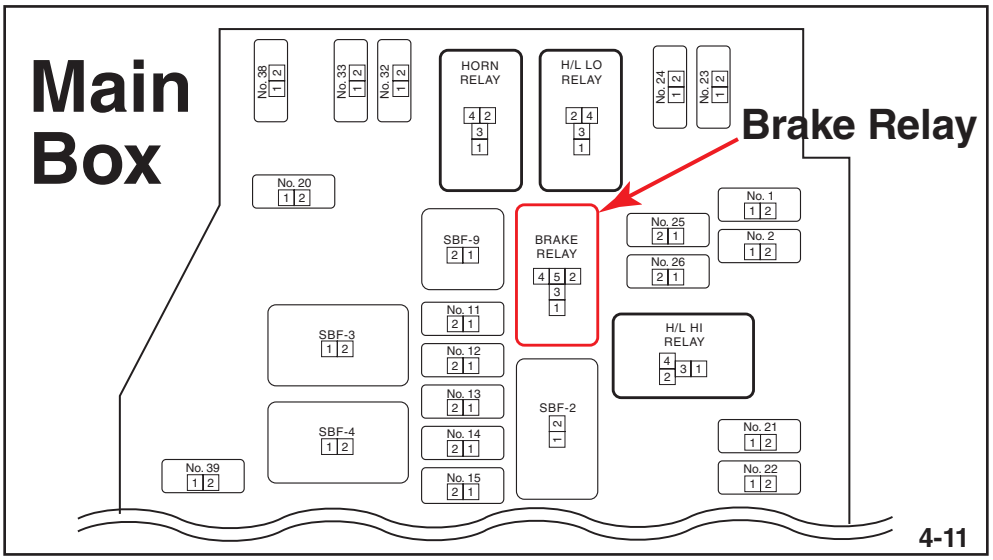
Combination Meter Display



Multi-Function Display

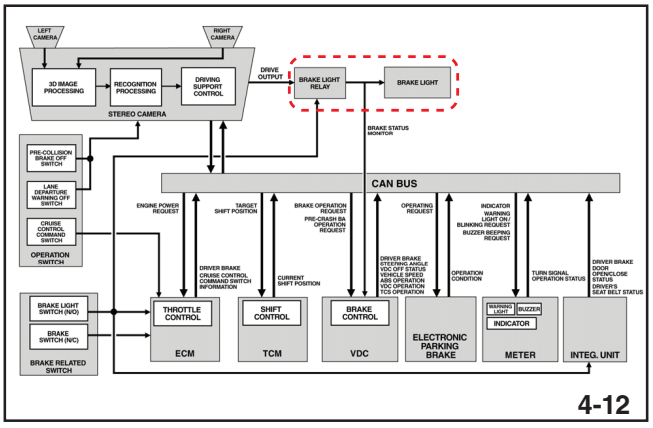
Brake Lamp Relay

The EyeSight® system has the ability control the operation of the brake lights (stop lights) during braking operations. To accomplish this a Brake Lamp relay, controlled by commands from the EyeSight® system, is located in the Main Box.

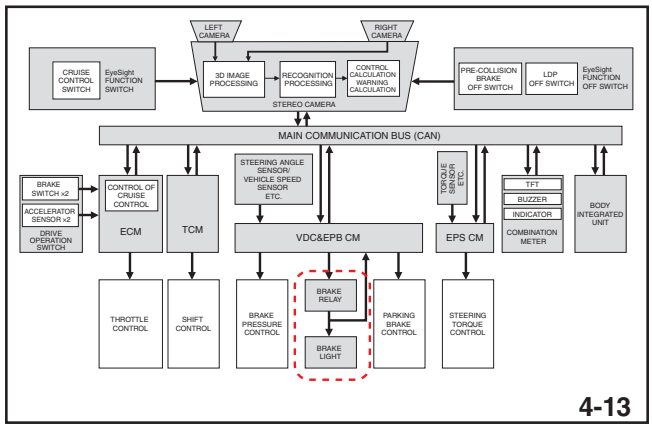


Brake Lamp Relay

Depending on the model, the operation of the Brake Lamp relay may be controlled by the Stereo Camera assembly or the VDCCM via CAN communication.



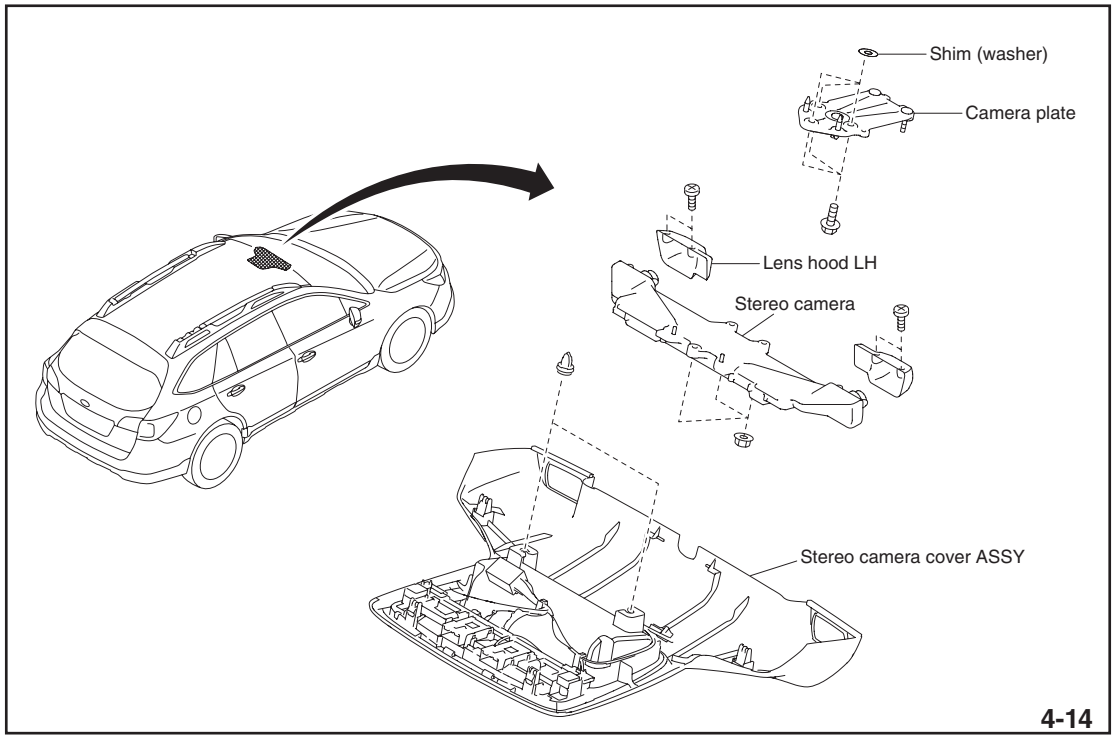
Brake Light Relay – Eyesight® CM Controlled



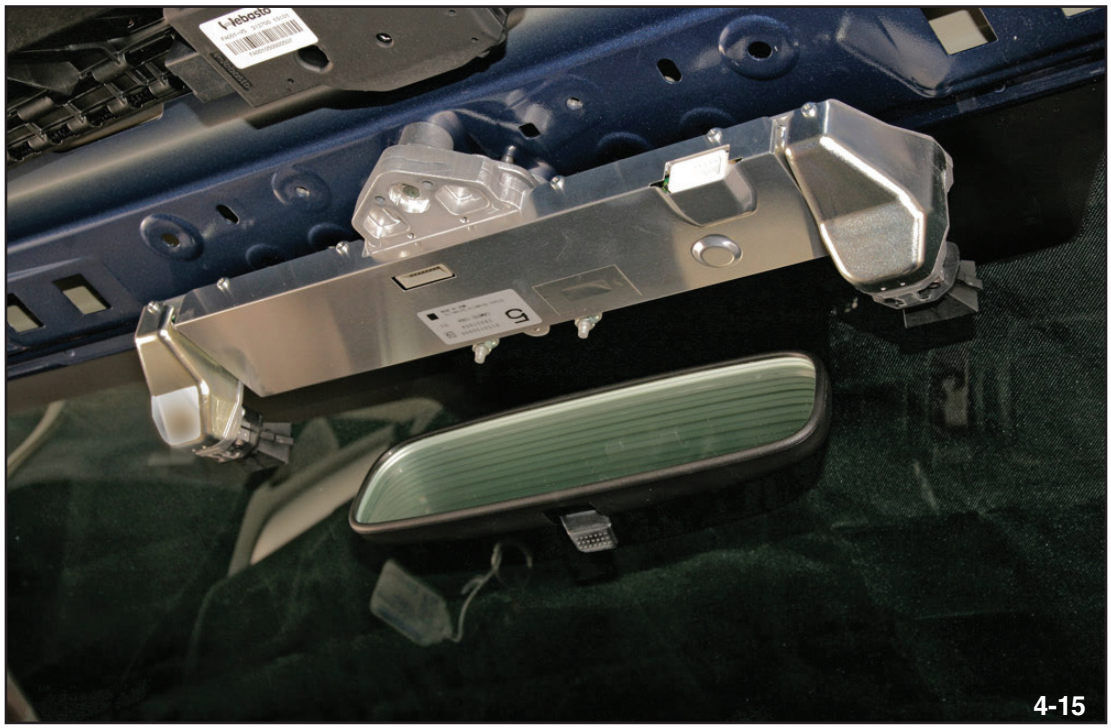
Brake Light Relay – VDCCM Controlled

Stereo Camera Assembly

The primary component of the EyeSight® system is the Stereo Camera assembly. The Stereo Camera assembly is securely mounted to the roof structure of the vehicle behind the windshield. All EyeSight® commands, functions, and image processing are performed by the Main Board located inside the Stereo Camera assembly.

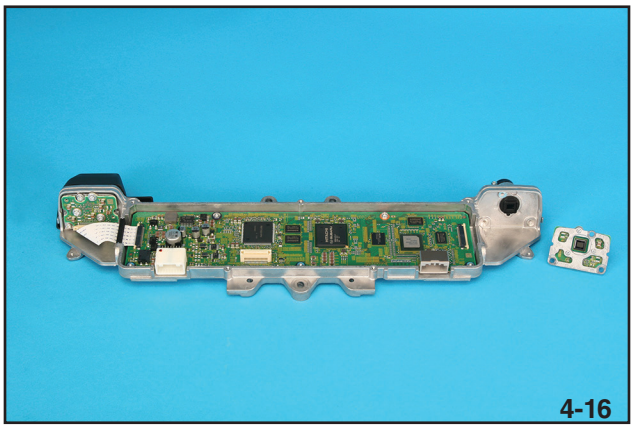


Stereo Camera Assembly – Line Art

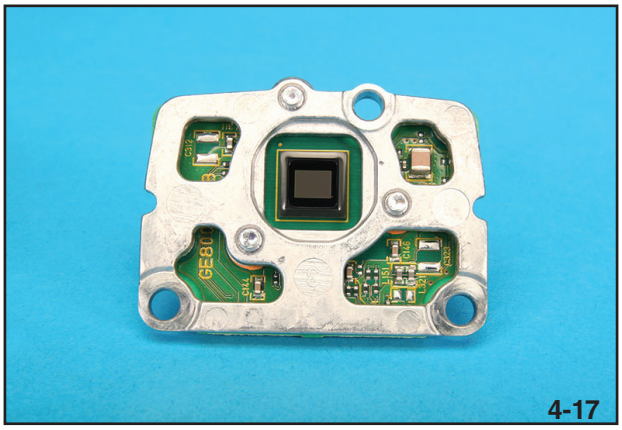


Stereo Camera – Trim Removed

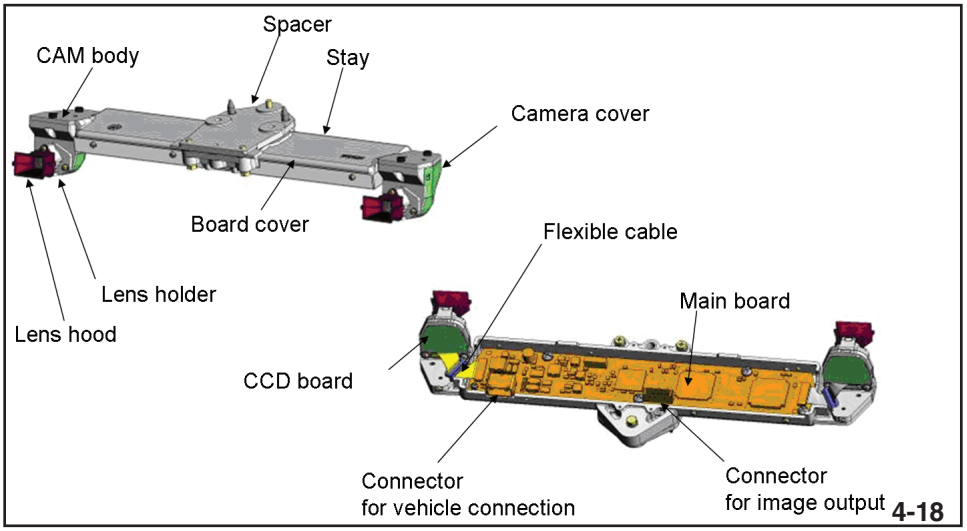
The Stereo Cameral assembly contains a pair of CCD (charge-coupled device) cameras that capture images of objects in front of the vehicle. The Cameras view through lenses that are protected by lens hoods. Care must be taken when handling the Stereo Camera assembly as to not soil the lenses or lens hoods.



Stereo Camera – Cover Removed

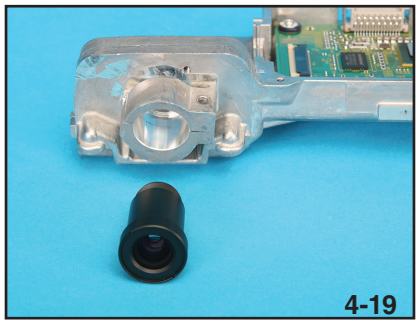


Single CCD Camera



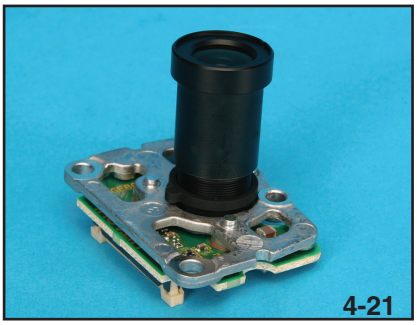
Stereo Camera Construction

Each CCD camera views through a non-serviceable lens fitted into the frame of the camera assembly. A rubber seal is fitted between each lens and camera to protect against contamination.



Stereo Camera Lens Removed

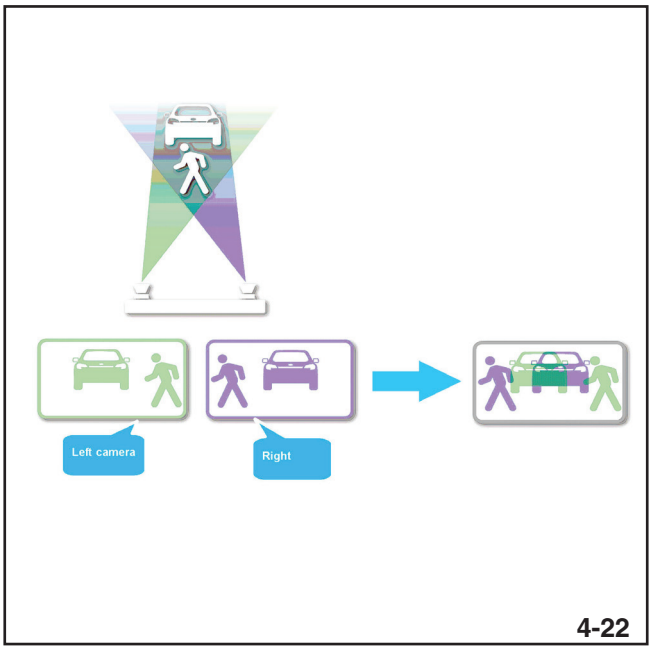
CCD Camera, Lens, and Seal



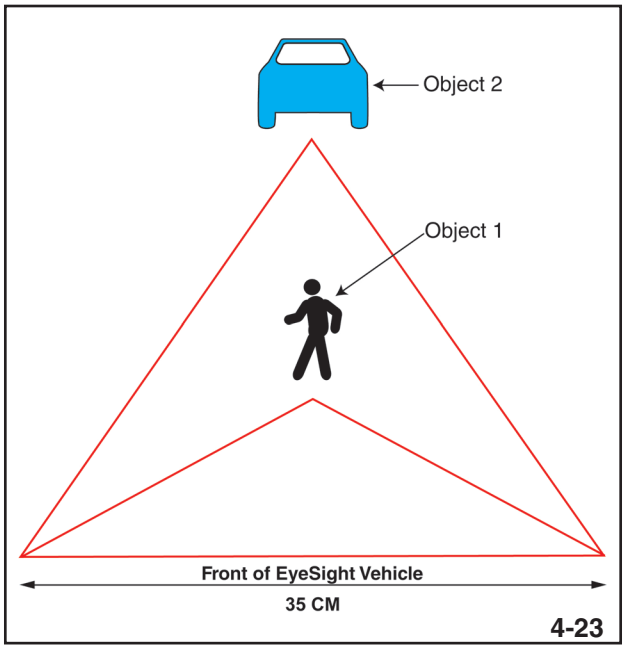
CCD Camera, Lens, and Seal

Camera Characteristics

During operation the Stereo Cameras produce simultaneous left and right images. When the two images are superimposed, a deviation is present due to the difference in the individual cameras line of sight. This deviation becomes smaller or larger depending on the distance of the captured object. This phenomenon is referred to as the parallax of an image. The EyeSight® system uses the image parallax to triangulate the relative distance of the object. Since the distance is constantly calculated by the EyeSight® system, changes in vehicular distance and speed can readily utilized for the various EyeSight® functions.

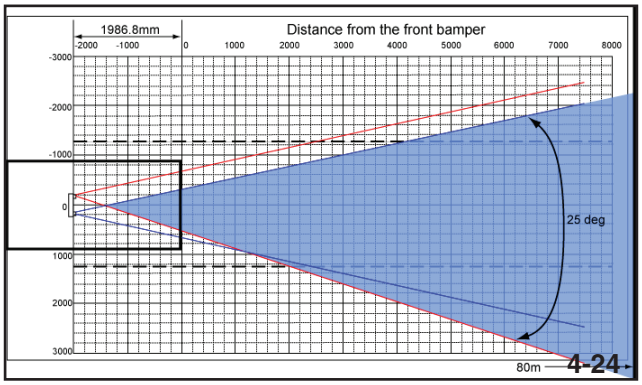


Parallax

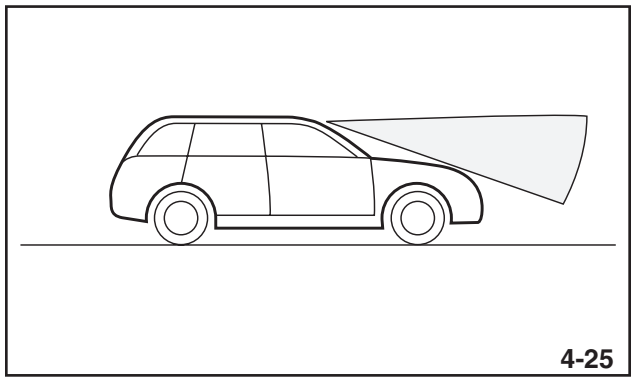


Object Triangulation

The Version 2 EyeSight® system has an operating range of approximately 80 m in a 25° field of view from the front bumper. Detection by the EyeSight® system is limited to objects that are within the range of the Stereo Cameras' field of vision. After an object enters the range of the cameras' field of vision, it may take some time for the system to detect it as a controllable target and warn the driver. This is critical when considering EyeSight's ability to react to crossing pedestrians and vehicles that cut into the current lane of travel.

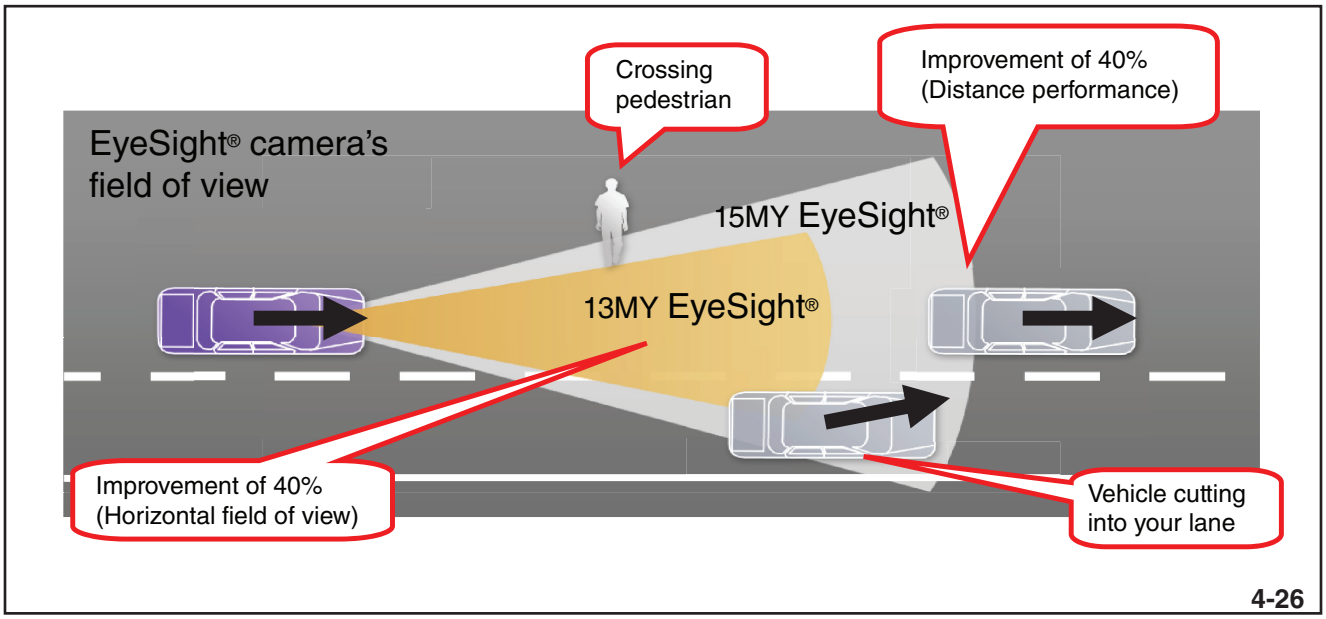


Eyesight® Horizontal Field of view



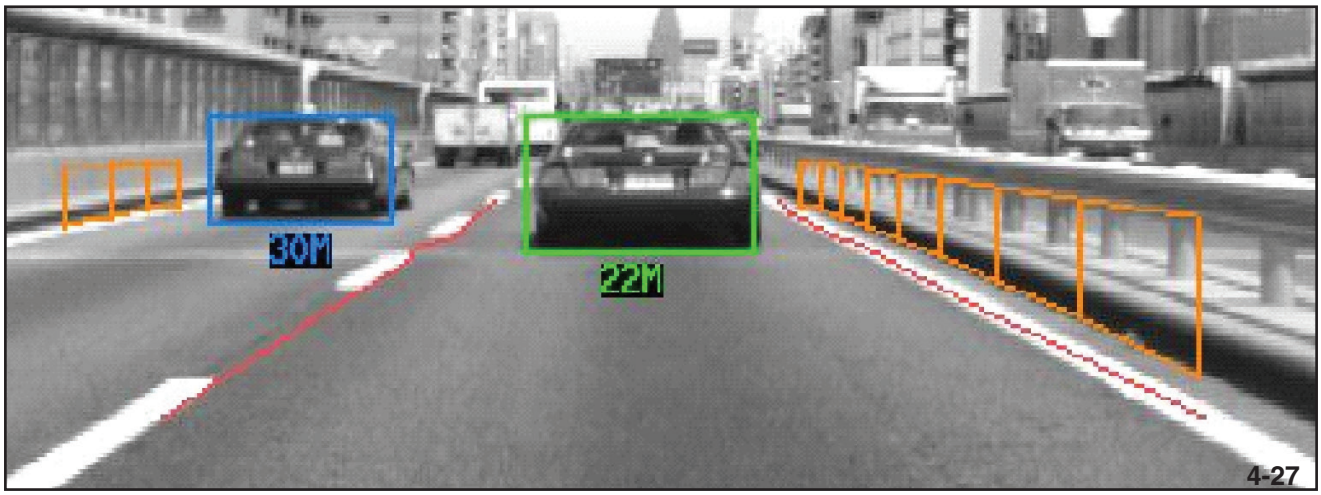
Eyesight® Vertical Field of view

The Version 3 EyeSight® system features approximately 40% improvement to both the forward distance range and horizontal range of the Stereo Cameras.

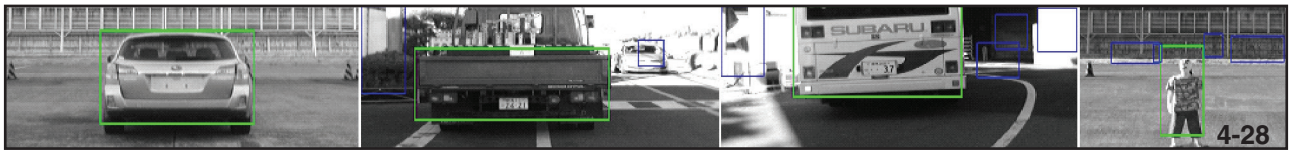


Eyesight® Field of View Comparison

The Stereo Cameras are constantly processing objects, measuring distances, and calculating closing rates. Version 2 systems perceive images using monochromatic (grey scale) processing.

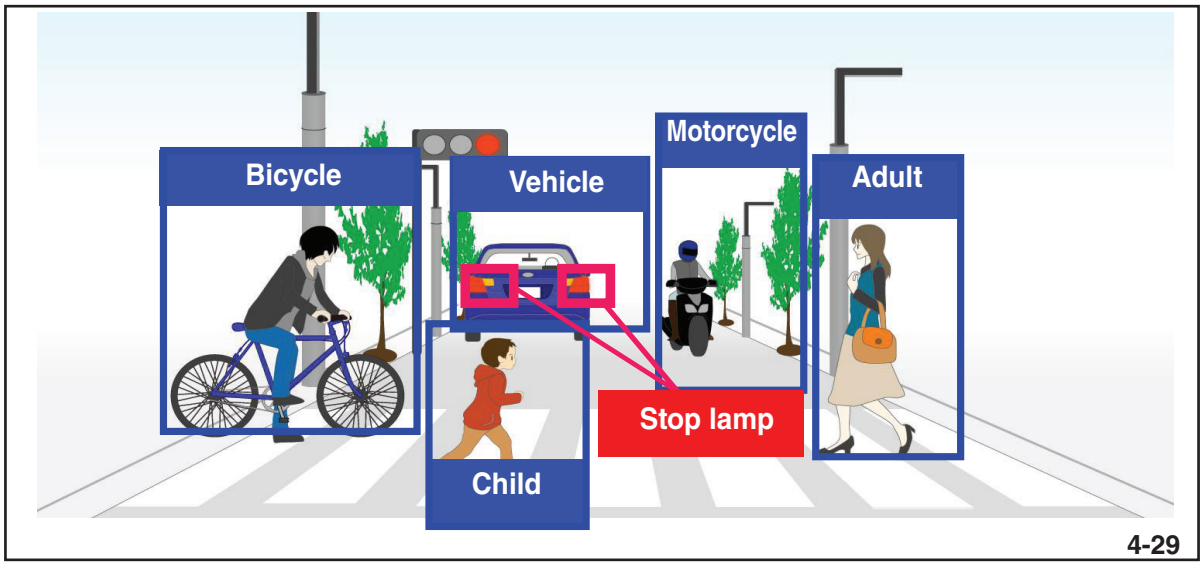


Stereo Camera's View



Version 3 Object Detection

Version 3 systems are enhanced to capture images using color recognition. This allows the EyeSight® system to identify brake lamps from vehicles ahead.



Version 3 Object Detection

The characteristics of the Stereo Cameras are similar to those of human eyes. Consequently, conditions that are difficult for the driver to see have the same effect on the Stereo Cameras and make it difficult for the system to detect vehicles, obstacles, and traffic lanes. Conditions that may affect operation of the EyeSight® system include, but are not limited to:

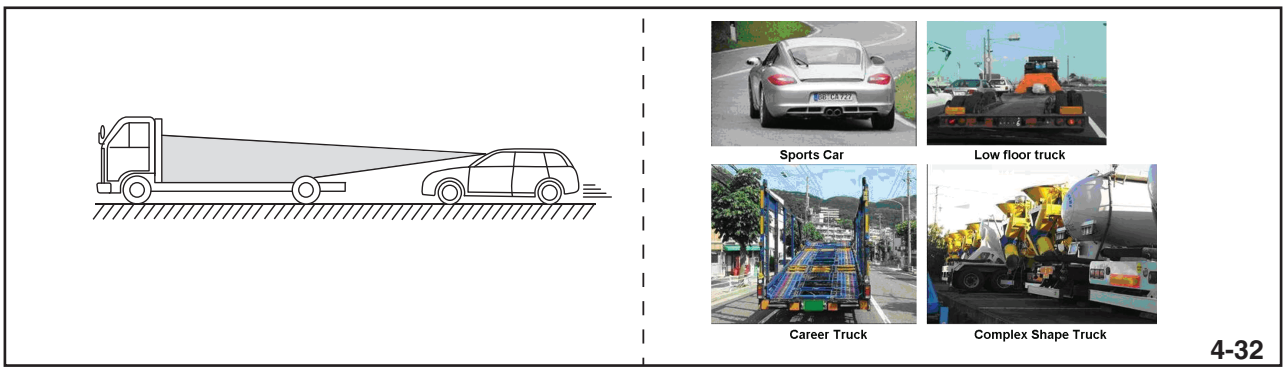
Sun glare, inclement weather, dirty windshield, cracked windshield, oil film, and/or reflections.
Objects with Low-contrast, regularly spaced patterns, no pattern, horizontal lines, backlit objects, very small objects (less than 3 feet tall), or nonstandard shaped vehicles, such as cement mixers or car-carrier trucks.
Non-approved aftermarket vehicle accessories, such as hood protectors, and water repellent glass coatings.

Backlight *Small Objects* *Low Light*

Windshield Obstructions

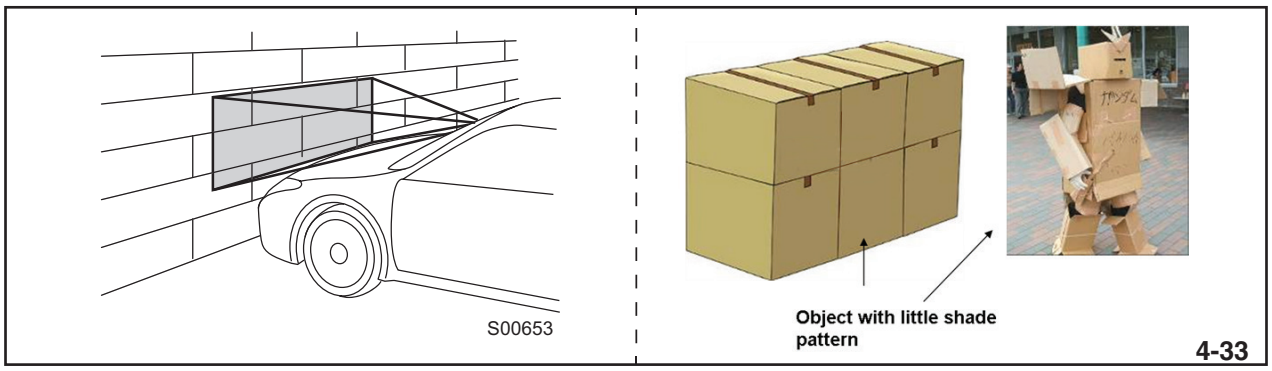
When the rear aspect of the vehicle in front is low, small or irregular the system may recognize another part of the vehicle as its rear and will determine operation from that:

When there is an empty truck or trailer with no rear and/or side panels on the cargo bed
With vehicles that have cargo protruding from their back ends
With non-standard shaped vehicles (vehicle transporters or vehicles with a sidecar fitted, etc.) - When the height of the vehicle is low, etc.



Irregular Objects

Objects with little pattern or low contrast may be difficult for EyeSight® to detect since accurate depth perception (parallax) cannot be established. Some examples of these include a fence, garage door, wall, or object with a uniform pattern (a striped pattern or brick pattern, etc.).



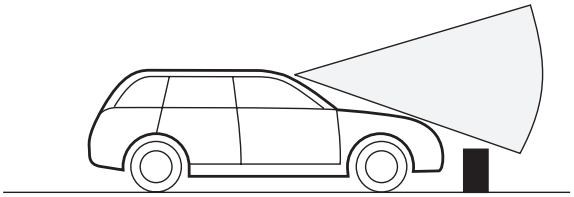
Low Contrast Objects

The EyeSight® system's Pre-Collision Braking function also identifies pedestrians as potential obstacles. Depending on the conditions, there may be cases when the system cannot detect a pedestrian. In the following conditions, there is a possibility that the system may not be able to detect a pedestrian or similar object.

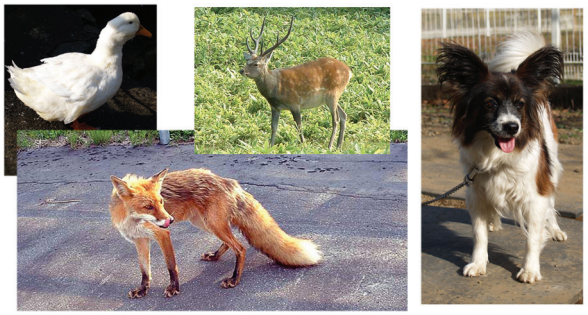
- When pedestrians are walking in a group
- When a pedestrian is next to a wall or other obstacle
- When a pedestrian is using an umbrella
- When a pedestrian is wearing clothes that are a similar color to the surrounding environment
- When a pedestrian is carrying bulky luggage
- When a pedestrian is bent over, crouching down or lying down
- When a pedestrian is in a dark location
- When a pedestrian suddenly crosses in front of you from the side or suddenly runs in front of you

Pedestrians

Objects that are small or in difficult to view areas such as in front of the bumper may not be detected.



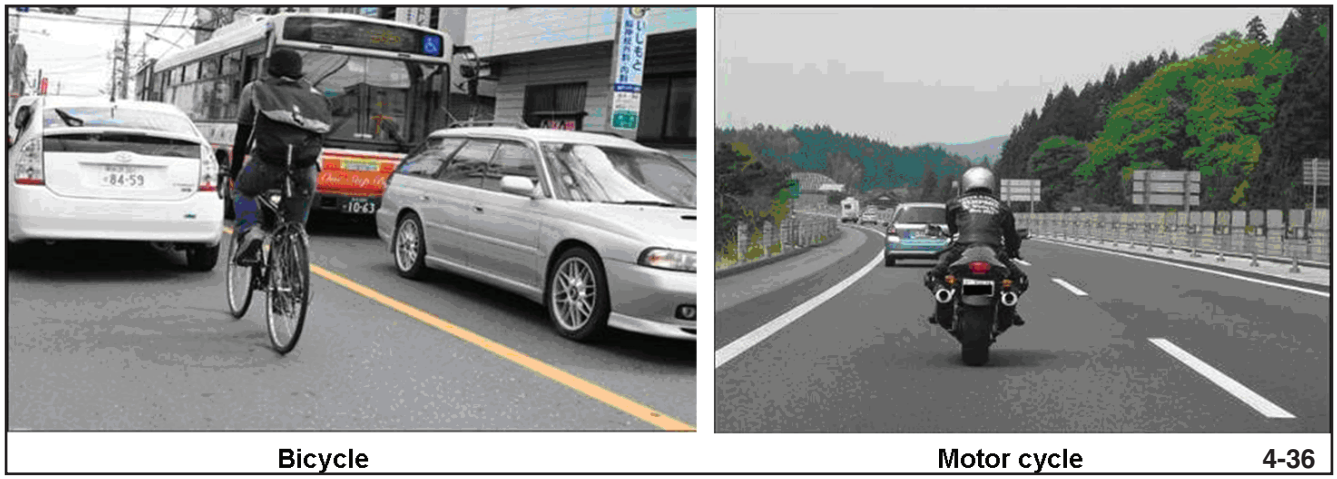
Low objects surrounding the vehicle cannot be detected.



4-35

Small Objects

- Other conditions that may be difficult for EyeSight® to interpret are;
- The vehicle in front suddenly swerves, accelerates, or decelerates
- A vehicle, motorcycle, bicycle, or pedestrian suddenly cuts in from the side or suddenly runs in front of you
- You suddenly change lanes and your vehicle is immediately behind an obstacle
- There is a vehicle, motorcycle, bicycle, or pedestrian in a location close to the front bumper
- The speed difference between your vehicle and an obstacle is 4 MPH (5 km/h) or less
- Driving on sharp curves, steep uphill grades, or steep downhill grades
- Driving on a bumpy or unpaved road
- Changes in brightness such as at a tunnel entrance or exit



Bicycles/Motorcycle

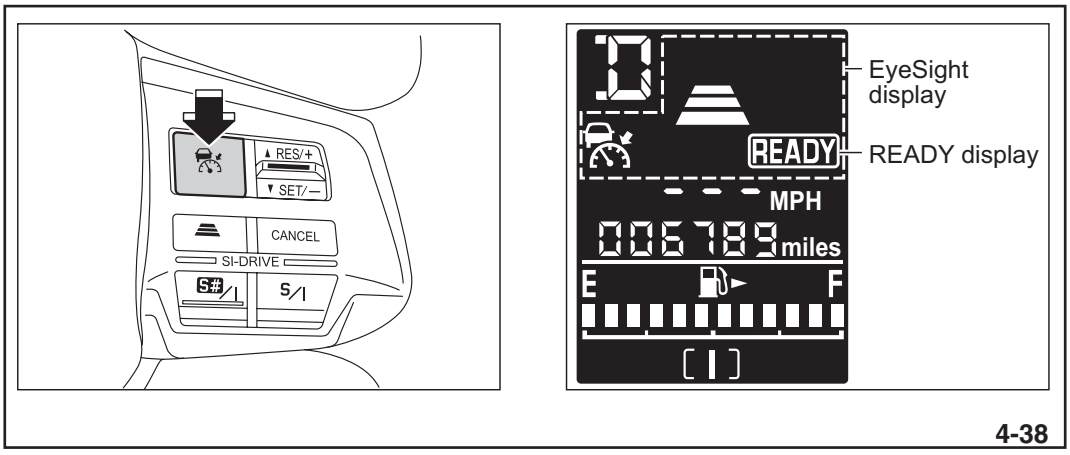
Difficult Environmental Conditions

Driver Assist Functions

Adaptive Cruise Control

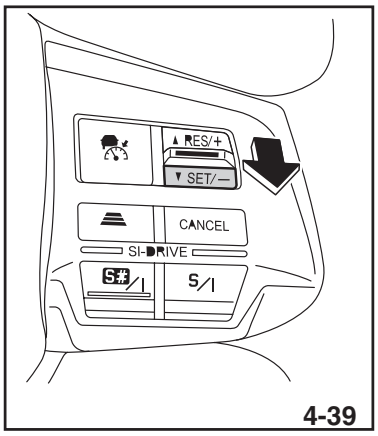
When driving on a highway or freeway, Adaptive Cruise Control allows the vehicle to follow a vehicle directly ahead while maintaining an appropriate distance without operation of the brake or accelerator pedal. Adaptive Cruise Control is set to standby status by pressing the steering wheel mounted cruise control switch. Once depressed, an Adaptive Cruise Control icon and READY icon will appear on the Combination Meter or MFD.

Note: The vehicle must be traveling at a minimum of 25 MPH for the system to be READY.

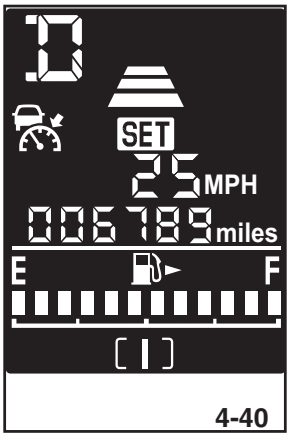


Adaptive Cruise Control – Ready

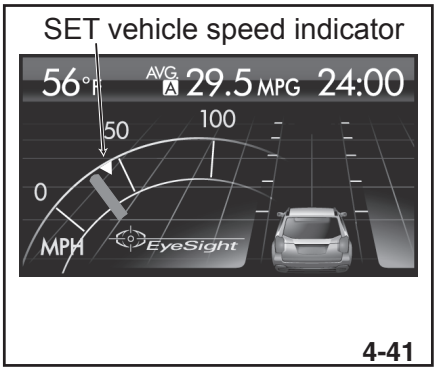
The system is engaged by depressing the steering wheel mounted SET/- switch. Once SET, the vehicle will begin cruising and the Set Speed indicator will be displayed. Each press of the SET/- or RES/+ will change the vehicle target speed by 5 MPH. Pressing and holding either switch will change the target speed by 1 MPH



Set- Switch

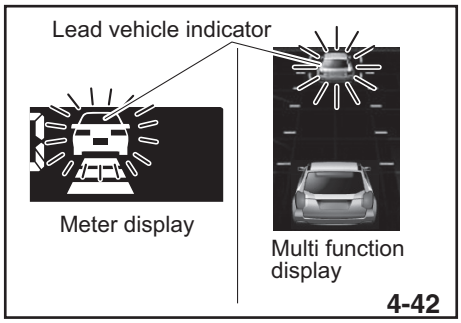


Set Vehicle Speed Indicator (Combination Meter)

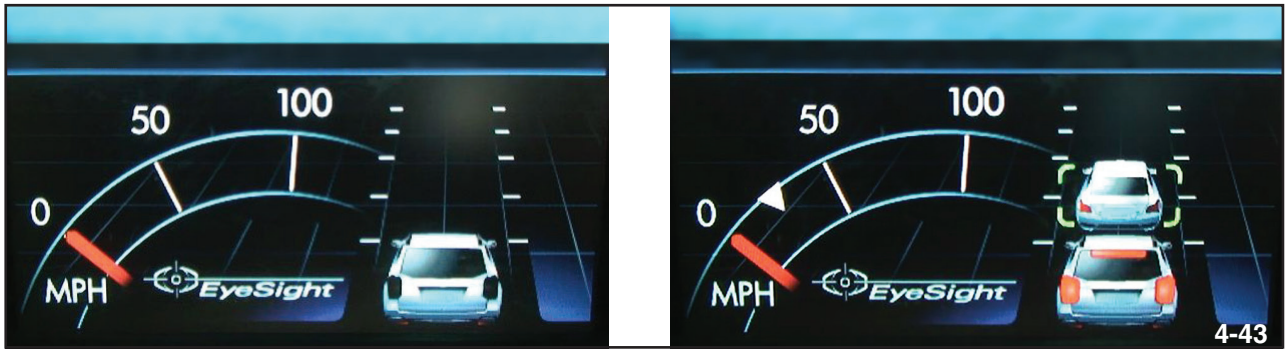


Set Vehicle Speed Indicator MFD)

When the system detects a lead vehicle, an indicator will be displayed on the combination meter or MFD and an audible beep will be heard. The system will use driver set vehicle speed as the maximum speed to follow the preceding vehicle. If the vehicle moves from the lane ahead or travels too far away, the lead vehicle indicator will turn off and the vehicle will accelerate to the preset vehicle speed automatically.

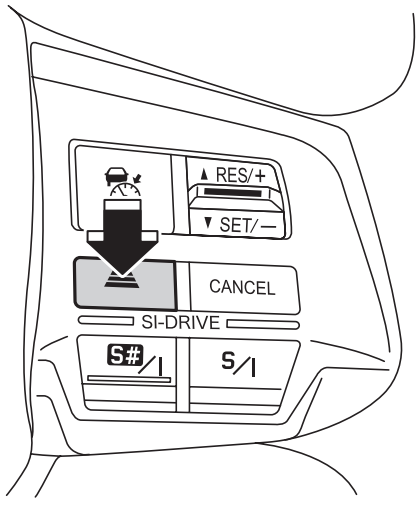


Lead Vehicle Indicator – Comparison



Lead Vehicle Indicator (MFD)

The following distance from the lead vehicle can be adjusted using the steering wheel mounted distance setting switch. Actual following distance is varied and relative to the traveling speeds of both vehicles.



NOTE

The following distance changes according to the vehicle speed and is further the faster that the vehicle is traveling at.

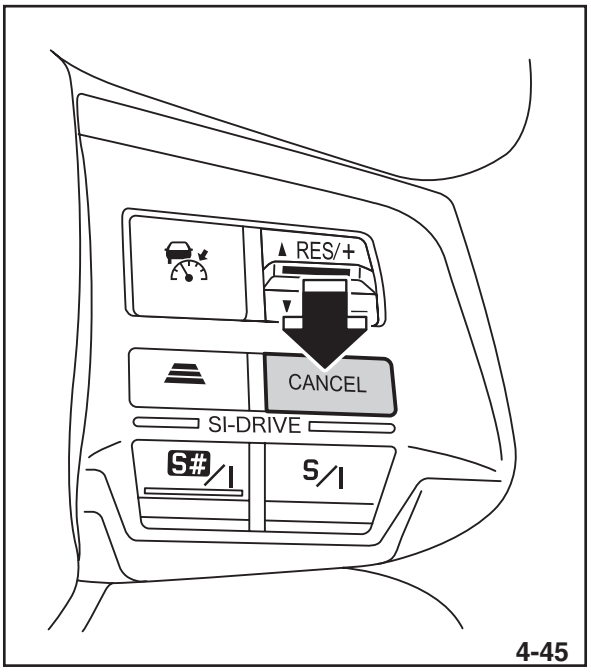
<Approximate guide to following distances>

Following distance indicator	When you vehicle speed is 25 MPH (40 km/h)	When you vehicle speed is 60 MPH (100 km/h)
	Approx. 95 ft (30 m)	Approx. 190 ft (60 m)
	Approx. 80 ft (25 m)	Approx. 160 ft (50 m)
	Approx. 65 ft (20 m)	Approx. 130 ft (40 m)
	Approx. 50 ft (15 m)	Approx. 100 ft (30 m)

4-44

Following Distance Guidelines

Adaptive Cruise Control can be canceled by pressing the Steering Wheel mounted CANCEL switch, the Cruise Control switch, or depressing the brake pedal.



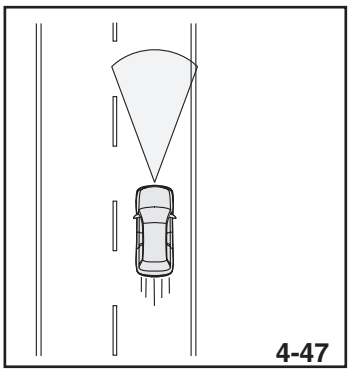
Cruise Control Cancel Switch

Some models feature redesigned steering wheel switches for Adaptive Cruise Control functions. A new Following Distance switch has been incorporated. The RES/+ and SET/- function have been redesigned with a seesaw 4-step type switch. Each direction has a deep and shallow step. A shallow step will increase or decrease speed 1 mph. A deep step will increase or decrease speed 5 mph.

Redesigned Adaptive Cruise Control Switches

No Vehicle Detected

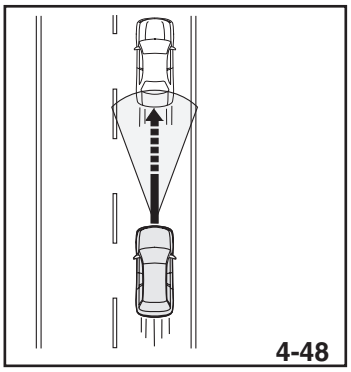
When no vehicle in front is detected, the EyeSight® vehicle drives constantly at the set target vehicle speed between approximately 25 MPH (40 km/h) and 90 MPH (145 km/h).



No Vehicle Detected

Lead Vehicle Detected

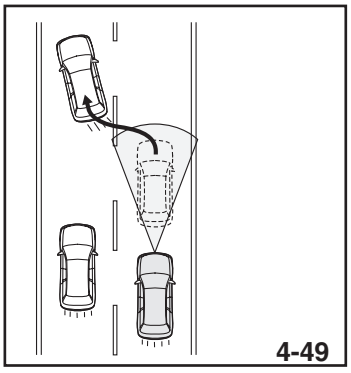
A vehicle in front is detected (lead vehicle), the EyeSight® vehicle tracks the lead vehicle in front, and will maintain the chosen following distance, up to the set target vehicle speed - between 25 MPH (40 km/h) and 90 MPH (145 km/h).



Lead Vehicle Detected

Lead Vehicle Departure

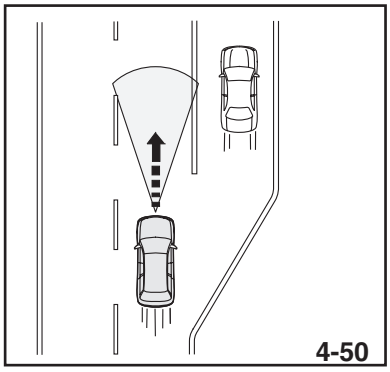
If a lead vehicle is no longer detected in front of the EyeSight® vehicle a single beep will be heard and the lead vehicle indicator will disappear to alert the driver. This may occur if the lead vehicle departs the lane of travel of the distance becomes too great.



Lead Vehicle Departure

Acceleration - Resume

If the vehicle in front is no longer detected under conditions other than the previous ones, the EyeSight® vehicle gradually accelerates back to the set target vehicle speed and will drive at that constant speed. If a vehicle in front is detected while accelerating to the set target vehicle speed, vehicle tracking will begin again.



Vehicle Acceleration

Beginning with 2017MY Impreza models, the driver can customize “Cruise Control Acceleration Characteristics” to better match their driving style and the prevailing conditions. These settings can be found through the Multi-Information Display (MID) settings menus.

Multi – Information Display

MID – EyeSight® Menu

The Cruise Control Acceleration Characteristics can be adjusted to one of four levels to allow the driver to better match the surrounding environment.

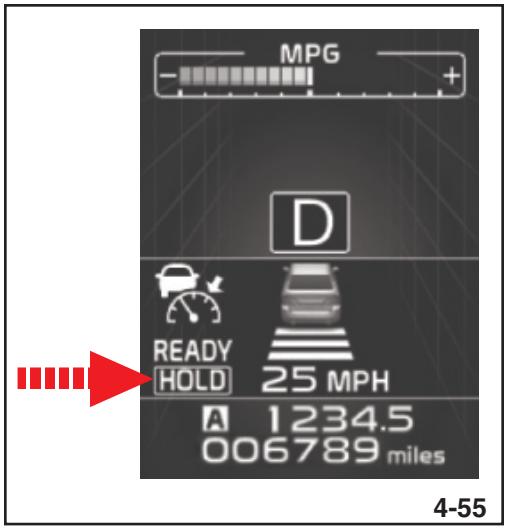
Acceleration Characteristics

Lv. 1 Eco

Level	Description	Maximum Acceleration (Relative)
Lv. 1	Eco	Approximately 60%
Lv. 2	Comfort	Approximately 80%
Lv. 3	Standard (Default)	Approximately 100%
Lv. 4	Dynamic	Approximately 120%

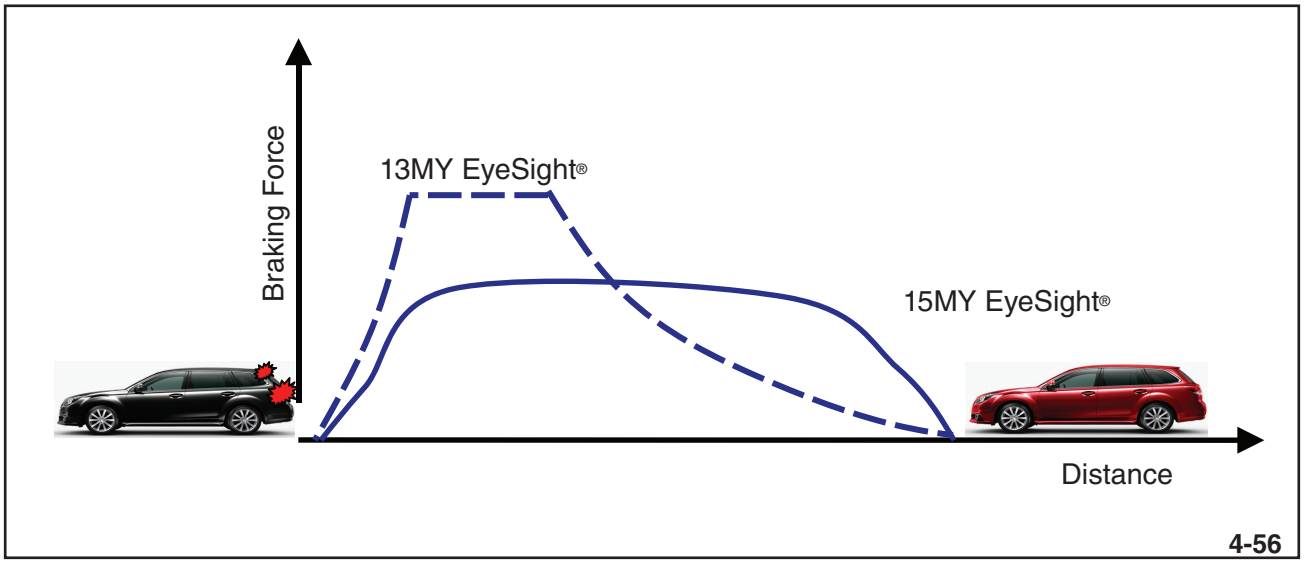
Stay-Stopped

If the vehicle in front comes to a stop while utilizing Adaptive Cruise Control, the EyeSight® vehicle also will also come to a stop and will stay stopped until further action is taken. When the EyeSight® vehicle comes to a stop after the vehicle in front has stopped, Adaptive Cruise Control is paused, the stay-stopped function is engaged, and the "HOLD" indicator illuminated. Stay-stop is disengaged by pressing the RES/+ switch or depressing the accelerator pedal. Models that utilize an Electronic Parking Brake (EPB) will apply the EPB during stay-stopped status. Vehicles that do not utilize an EPB will use the VDC system to hold the vehicle briefly and then release the brakes.



Stay-Stopped (HOLD) Indicator

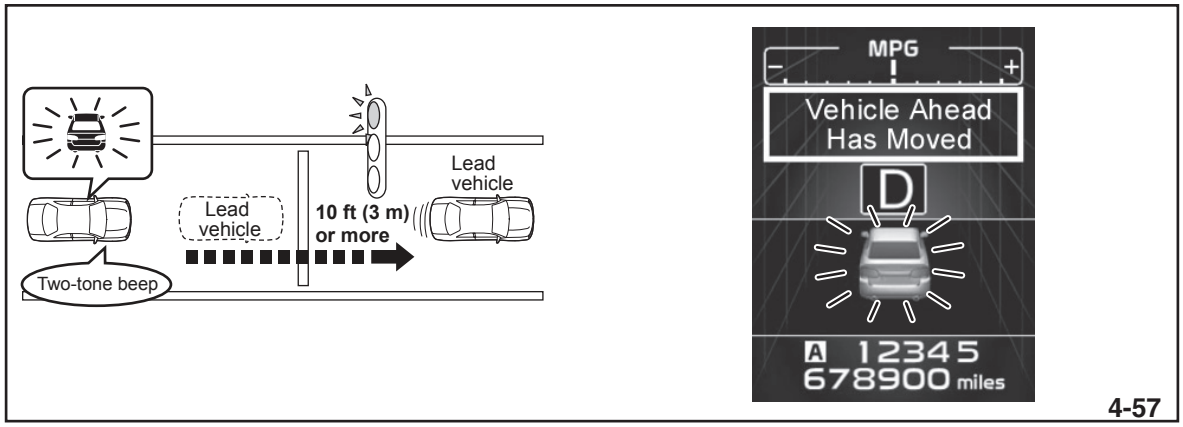
Version 3 EyeSight® vehicles have improved braking logic when functioning with Adaptive Cruise Control. The Version 3 system's improved distance and ability to detect brake lights provides a more natural deceleration/braking feeling.



Adaptive Cruise Control - Braking Comparison

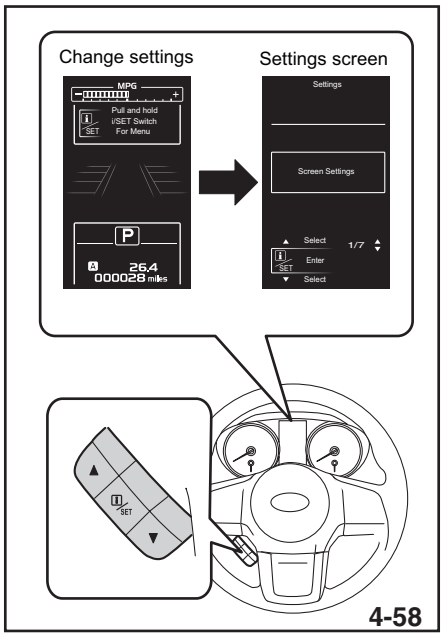
Lead Vehicle Start Alert

Lead Vehicle Start Alert functions when the EyeSight® vehicle remains stopped while the vehicle in front has started to move forward approximately 10 ft (3 m) or more. The driver is alerted by means of a two-tone audible beep and flashing lead vehicle indicator on the multi information display. This function only activates when the select lever is in the Drive, Manual, or Reverse gear position.

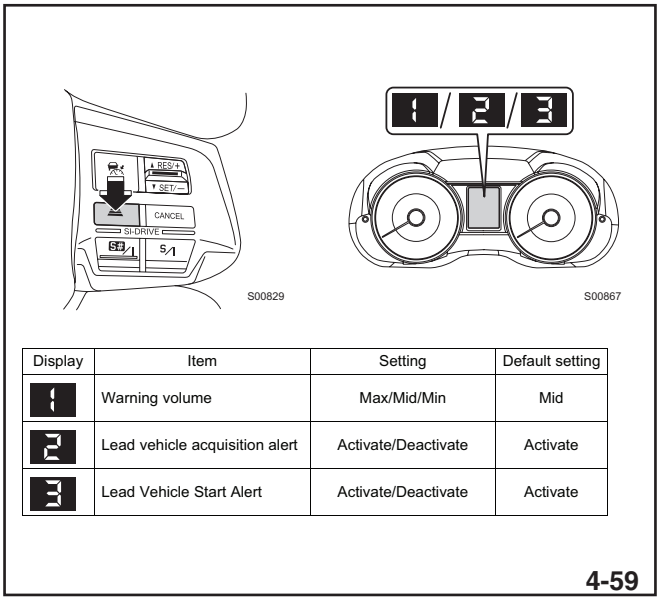


Lead Vehicle Start Alert

Lead Vehicle Start Alert can be turned ON and OFF using the driver's customizing functions or steering wheel mounted switches.



Lead Vehicle Start Alert – Customization 1



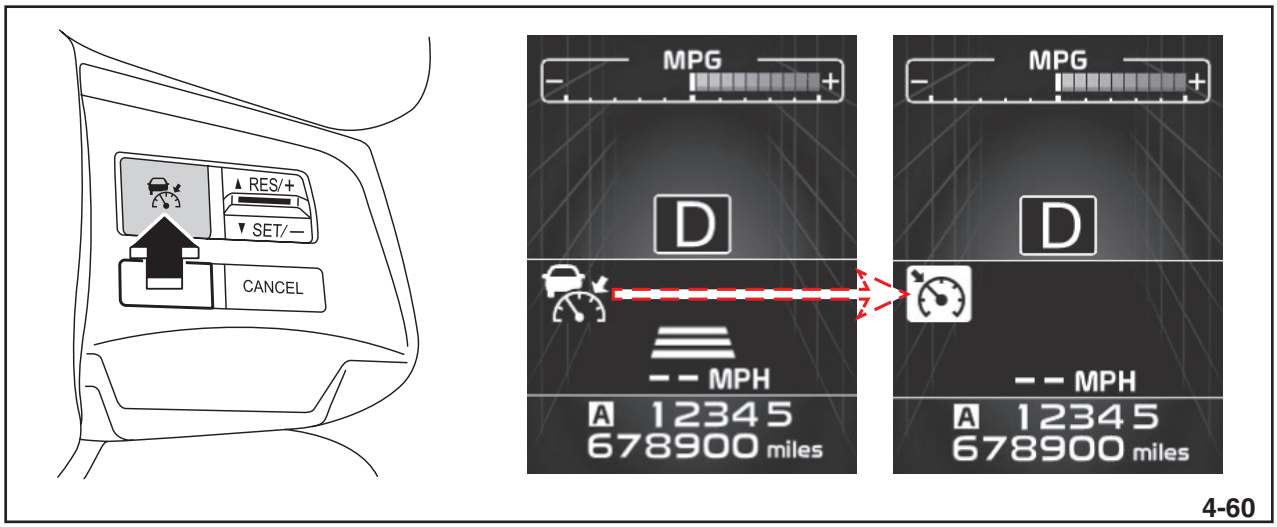
Display	Item	Setting	Default setting
1	Warning volume	Max/Mid/Min	Mid
2	Lead vehicle acquisition alert	Activate/Deactivate	Activate
3	Lead Vehicle Start Alert	Activate/Deactivate	Activate

Lead Vehicle Start Alert – Customization 2

Conventional Cruise Control

Depending on the model, Conventional Cruise Control can be enabled by depressing and holding either the Adaptive Cruise Control switch or Following Distance (combination of both on certain models) switch for approximately 2 seconds. When the system is transitioned, the icon on the trip meter will change to conventional cruise control symbol.

Note: Always consult the appropriate EyeSight® Service Manual for specific details on transitioning to Conventional Cruise Control.



Conventional Cruise Control Transition

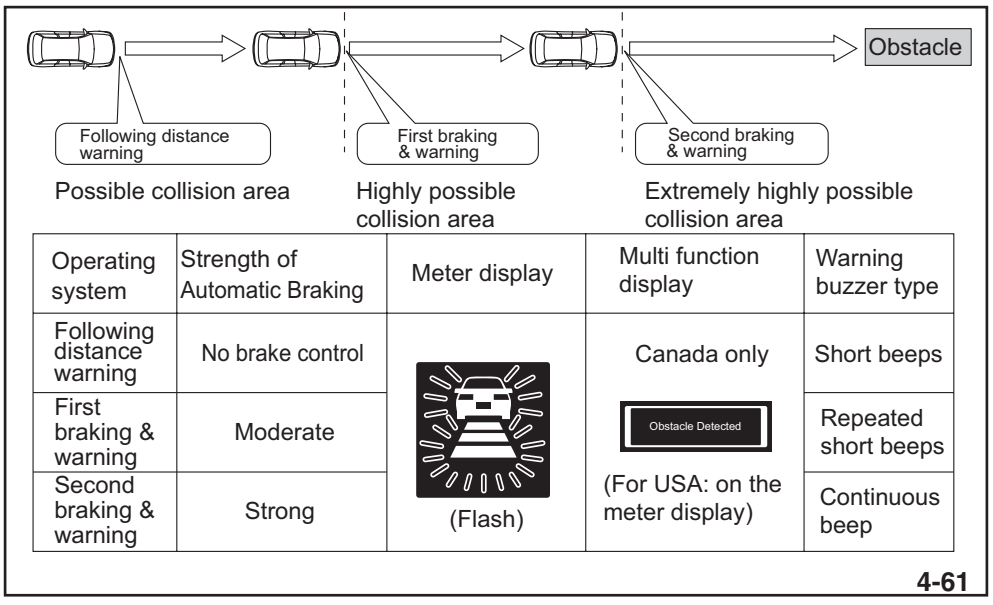
Pre-Collision Braking

Pre-Collision Braking calculates probability of collision based on the distance to the obstacle ahead, overlap rate, steering angle, and relative speed calculated by the Stereo Cameras in order to warn the driver of a collision and control braking effort. EyeSight® initiated pre-collision braking operates within the range of approximately 1 to 100 MPH (1 to 160 km/h).

Note: If the driver depresses the brake pedal or turns the steering wheel, the system may determine that evasive action is being taken by the driver. As a result, Pre-Collision Braking control may not activate to allow full control for the driver.

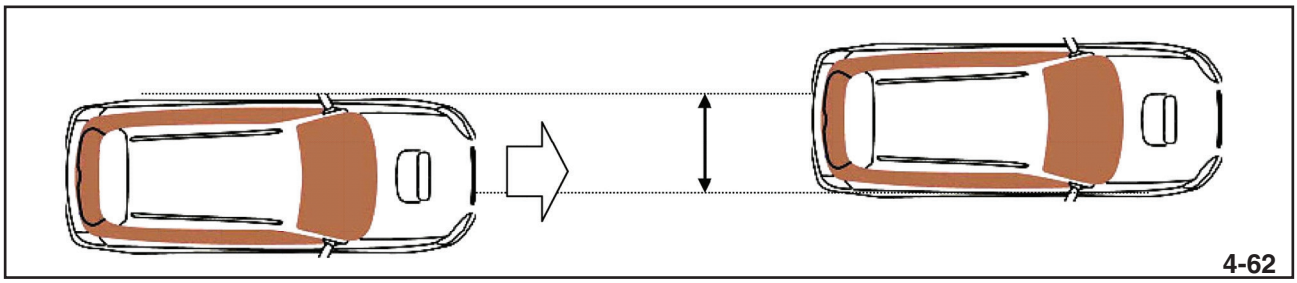
The Pre-Collision Braking System operates in three stages.

1. **Following Distance Warning:** When the system determines that there is a risk of collision, repeated short beeps can be heard and the indicators on the combination meter and the multi-function display illuminate to warn the driver. The Following Distance Warning operates when Adaptive Cruise Control is not set. When the driver depresses the brake pedal to decelerate and achieves a suitable following distance, the warning is canceled.
2. **First Braking and Warning:** When the system determines that there is a high risk of collision with an obstacle in front, repeated short beeps can be heard and the indicators on the combination meter and the multi-function display illuminate to warn the driver. Additionally, moderate braking control is activated via command to the VDCCM. If the system determines that the amount of evasive action (braking, steering, etc.) taken by the driver has reduced the risk of collision, braking activation is canceled.
3. **Second Braking and Warning:** If the system then determines that the risk of collision is extremely high, the audible beeps change to a continuous tone and stronger braking control is activated. If, despite any evasive action taken by the driver, the system subsequently determines that a collision is unavoidable, braking control is continued. When the vehicle stops, a buzzer sounds three short beeps and a single long beep. The automatic braking function is cancelled approximately 2 seconds after the vehicle stops and the vehicle starts creeping forward gradually.



Pre-Collision Braking Stages

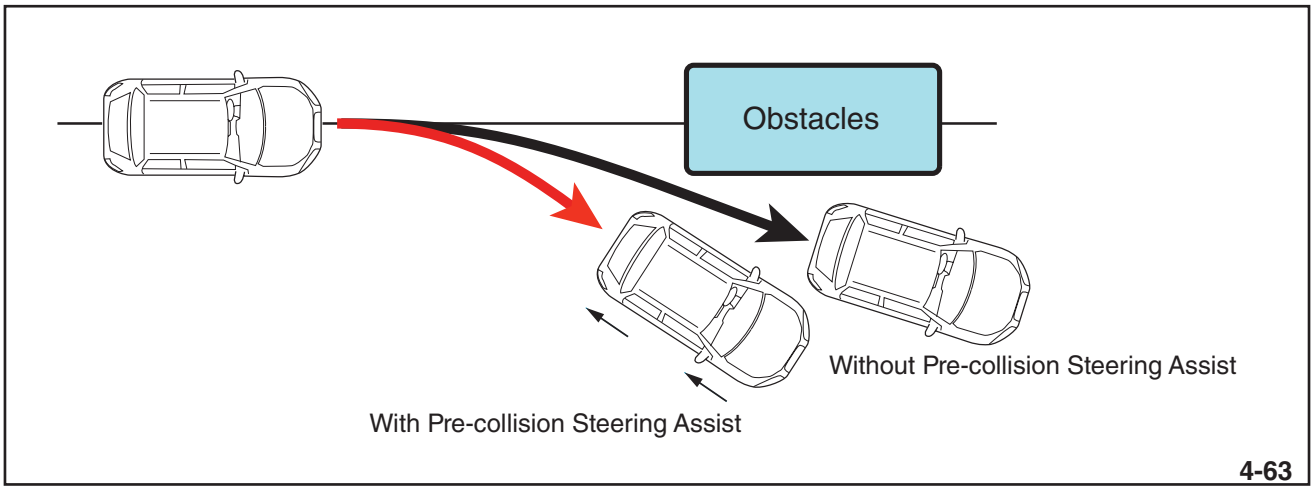
The Pre-Collision Braking function is adjusted according to the offset of the obstacle in front. When the overlap of the EyeSight® vehicle and the obstacle is small, the possibility that a collision can be avoided by steering operation is higher. As a result, the Pre-Collision Braking functions are delayed



Intervention Timing and Overlap Rate

Pre-Collision Steering Assist (Beginning with 2015MY Legacy/Outback)

Pre-collision Steering Assist alters the characteristics of the VDC system, increasing the vehicle yaw rate to improve the driver's ability to avoid a collision. This function aids in obstacle avoidance during overlap conditions.



Pre-collision Steering Assist

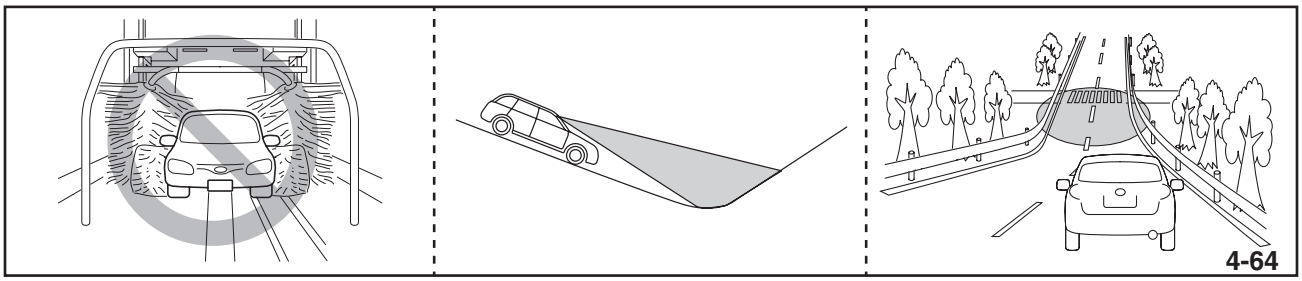
Pre-Collision Brake Assist

Pre-Collision Brake Assist is activated if the system determines that the driver is performing emergency braking and commands assistance from the VDCCM&H/U motor pump. Pre-Collision Braking Assist does not operate when the vehicle speed is approximately 7 MPH (10 km/h) or less or 100 MPH (160 km/h) or more.

Recommended OFF Conditions

The Pre-Collision Braking System may unexpectedly activate in the following (but not limited to) situations. Therefore, it is recommended to turn off the Pre-Collision Braking system by pressing the camera cover or console mounted Pre-Collision Brake OFF switch.

- The vehicle is being towed
- Loading the vehicle onto a carrier
- A chassis dynamometer, free-rollers or similar equipment is used
- A Technician lifts up the vehicle, starts the engine and spins the wheels freely
- Passing hanging banners, flags or branches, or when thick/tall vegetation is contacting the vehicle
- Using a drive-through car wash
- Passing through an automatic gate (opening and/or shutting)
- Driving close to the vehicle in front
- Driving in a location where the grade of the road changes rapidly



Pre-Collision Braking – Recommended OFF Conditions

Pre-Collision Throttle Management

Pre-Collision Throttle Management operates when an obstacle is detected in front of the vehicle, and the driver attempts to accelerate at an unsafe rate. If the obstacle in front is stopped or is travelling very slowly, and the system determines that the accelerator pedal has been depressed more than the necessary amount (by mistake or another reason), engine output is restricted, repeated short beeps can be heard, and the leading vehicle indicator/ following distance setting indicator on the combination meter flashes. The vehicle will move ahead gradually in order to give the driver additional time to react to the obstacle or brake. The permissible throttle opening is determined based on the relative speed and the distance between the vehicle and the obstacle. In case that the vehicle is at a standstill and 1 m (39 inches) in front of a wall, the permissible throttle opening will become 5-10%. During the pre-collision throttle management operation, if the accelerator pedal is kept depressed, the throttle valve opens gradually. This function operates when the select lever is in the Drive or Manual gear positions. Pre-Collision Throttle Management can be disabled by pressing the Pre-Collision Brake OFF switch for 2 seconds or longer.

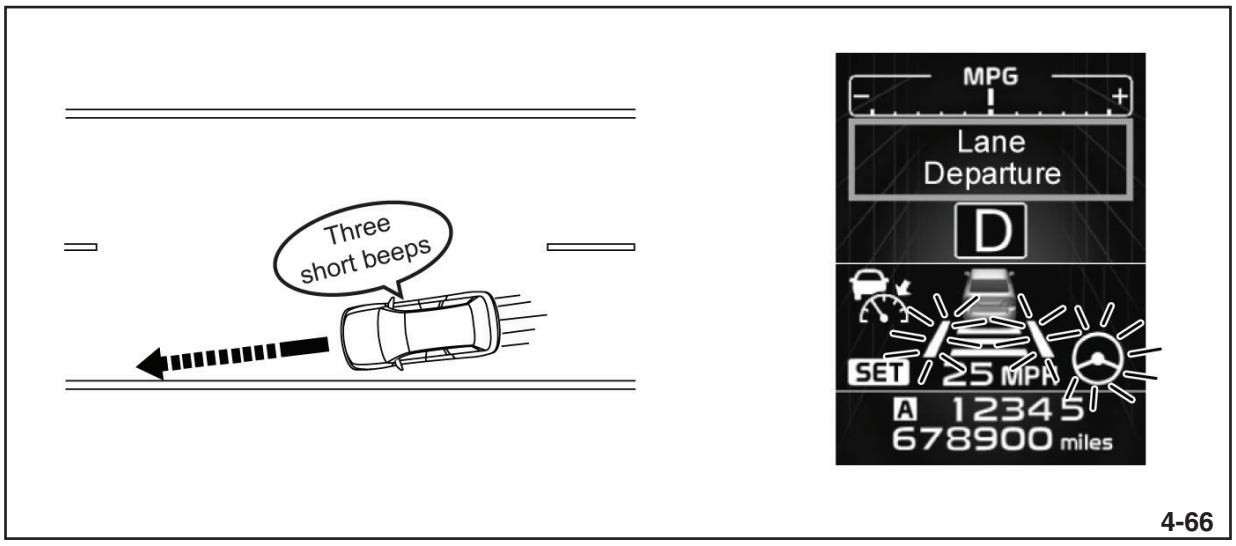
Per-collision Throttle Management

Conditions in which the pre-collision throttle management may not correctly operate:

- Target object status is not foreseen
- Obstacle is too far away from the vehicle or displaced
- Obstacle is short or small in size
- Vehicle or pedestrian cuts in from outside visible area
- Recognition condition is not good
- Immediately after turning
- Direct sunshine
- Dirty front windshield
- Window washer is used
- Out of headlight illumination range
- Sharp curve
- Fence

Lane Departure Warning (LDW)

Lane Departure Warning operates when the vehicle is likely to depart the traffic lane. The EyeSight® system monitors the lane markings on the road and determines if the vehicle is drifting from the current lane of travel. When the lane departure warning activates, 3 or 6 (depending on model) short audible beeps can be heard, the steering wheel indicator flashes, and the right/left lane indicators flash on the combination meter.



Lane Departure Warning

Conditions when Lane Departure Warning may not operate or may excessively operate:

- Vehicle speed is approximately 32 MPH (50 km/h) or less.
- For approximately 7 seconds after the Lane Departure Warning activates once
- The steering wheel is turned significantly in either direction
- The brake pedal is depressed or immediately after it is depressed
- The accelerator pedal is almost fully depressed and the vehicle is accelerating or immediately after accelerating
- Following distance behind a vehicle in front is short
- The turn signal is operating and for approximately 7 seconds after the turn signal lever has returned to its original position
- The vehicle has not returned to the inside of the lane after the Lane Departure Warning has activated
- The lane is narrow
- When it is difficult for the camera to detect lane markings:
  - There are no lane markings (white lines, etc.) or they are very worn
  - It is difficult to detect lane markings as they are similar in color to the road surface
  - The lane markings are narrow
- When the lead vehicle has taken measures to avoid an obstacle and following this you have performed steering operations

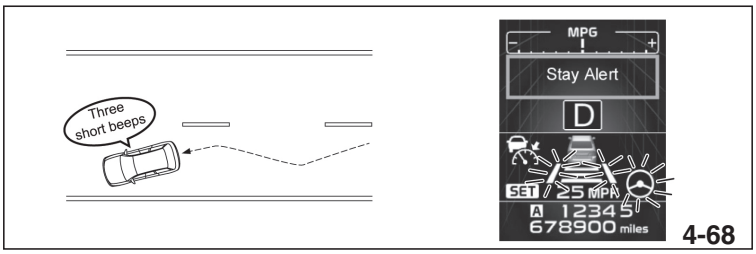
The following situations may cause incorrect lane detection and faulty Lane Departure Warnings to occur. Therefore, is it recommended to turn OFF the Lane Departure Warning system by pressing the Lane Departure Warning OFF switch.

- Tire tracks on a wet road or snow-covered road
- Boundaries between snow and asphalt, marks from road repair, etc.
- Double lane lines, etc.
- Shadows of guardrails, etc.

Snowy Roads

Lane Sway Warning

Lane Sway Warning detects wandering or drifting within the lane, and warns the driver. When the lane sway warning activates, 3 or 6 (depending on the model) short audible beeps can be heard, the steering wheel indicator flashes, the right/left lane indicators flash on the combination meter, and a “Stay Alert” message is displayed. Wandering detection is based on several minutes of driving data and will not be detected immediately when it occurs. In addition, the warning may continue for some time even after wandering stops. The Lane Sway Warning System may also issue a warning when the driver is tired, not concentrating on the road, or otherwise not paying adequate attention to driving. This system activates only when the vehicle speed is approximately 60 km/h (37 mph) or more.



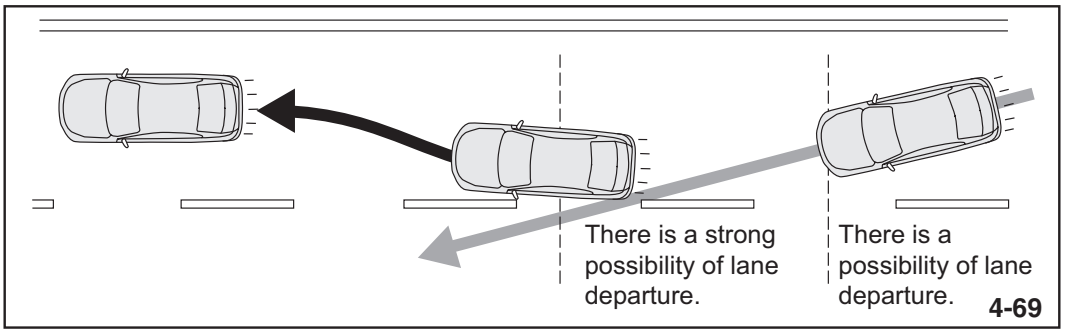
Lane Sway Warning

The lane sway warning is not active in the following conditions:

Disarmed condition	Description
Brake operation	When the driver applies brake
Driving direction	While the vehicle is backing up
Vehicle speed	While driving in low speed
Steering operation	When the steering angle exceed a certain angle
Turn signal	While the turn signal is turned on
The vehicle in front	While the vehicle is approaching to the vehicle in front
Road condition	While driving near a pedestrian crossing

Lane Keep Assist (LKA)

Beginning with some 2017 MY vehicles, Lane Keep Assist (LKA) is a new feature for the existing EyeSight® system. LKA provides lane departure prevention by using the EyeSight® cameras to identify lane markings and requesting steering movement from Electronic Power Steering (EPS) system to assist in keeping the vehicle in the current lane of travel if it is likely to depart. The LKA system predicts if the vehicle will depart from the lane and therefore operates at an earlier timing than the Lane Departure Warning (LDW) of the EyeSight® system.



Lane Keep Assist (LKA) Function

The LKA system is enabled by depressing the steering wheel mounted LKA switch. The system will default to an OFF status at each ignition cycle meaning the driver must enable the system each time the vehicle is started. When the steering wheel switch is depressed, the Lane Keep Assist Indicator on the multi information display will illuminate white. This means the system is in a “standby” mode.

LKA — Steering Wheel Switch

Lane Keep Assist Indicator (White)

The LKA system goes into a standby (ready) status when the following conditions have been met:

- Vehicle speed is between 40mph (65km/h) and 90mph (145km/h)
- The system is detecting lane markings
- The driver is holding the steering wheel
- Driving on a straight road or gentle curve
- Driving near the center of the lane
- Lane width is approximately 10-15ft (3m-4m)

In order for the LKA system to provide lane departure functions, the EyeSight® system must be able to learn the lane markings on the current road surface. As the lane marking are identified, the left and right “Lane Indicators” will illuminate on the multi information display accordingly.

Caution: If the “Lane Indicators” are not illuminated then lane departure prevention functions will not operate. However, LKA will function on one side only if that indicator is illuminated.

Left Lane Indicator

Right Lane Indicator

Both Lane Indicator

When the LKA system is providing lane departure prevention, the Lane Keep Assist Indicator will change from white to green. When the LKA system is no longer providing lane departure prevention, the indicator will return to white.

Lane Keep Assist Indicator (Green)

If the system does not detect steering operation by the driver for a certain period of time, the "Keep Hands On Steering Wheel" message may appear on the multi-information display. This message will continue to appear until the system detects steering input. If the system still cannot detect steering input, then lane departure prevention functions may be automatically canceled.

"Keep Hands On Steering Wheel" message

Under certain conditions, the LKA system may be canceled. When this occurs, an audible beep will sound and the white lane indicators will turn off. Situations that may cause cancel conditions include:

- When the system cannot detect the lane markins
- The windshield wiper operates at a high speed
- The vehicle speed is less than approximately 37 MPH (60 km/h) or is more than approximately 93 MPH (150 km/h)
- The ABS, the Vehicle Dynamics Control or the Traction Control System operates
- Either the driver's door, the front passenger's door or the rear door is open
- The seatbelt of driver's seat is unfastened
- The electronic parking brake is applied (The electric parking brake indicator light illuminates or blinks)
- The select lever is shifted to a position other than D or M position
- The system could not detect the steering operation by the driver When the system determines that the steering assistance is difficult to continue due to the road condition
- When the EyeSight® system is temporarily stopped or has a malfunction

Note: Other conditions may exist. Always consult the Owner's Manual for the appropriate year and model.

High Beam Assist (HBA)

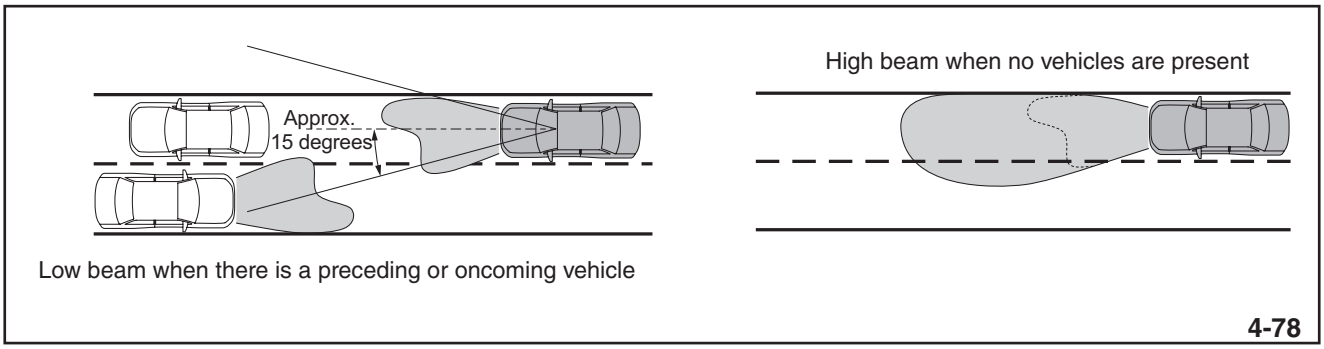
Optionally available with some 2017MY Subaru vehicles, the High Beam Assist (HBA) system is designed to increase the use of the vehicle's High Beam headlights to improve low ambient light visibility. This is accomplished by automatically switching the headlights between high and low beam according to the conditions in front of the vehicle. The HBA system provides the following benefits to the driver:

- Reduced operation of the headlight switch
- Prevents driver from forgetting to turn off the high beams
- Improves EyeSight® recognition during nighttime driving

2017MY Headlights

Caution: Do not overestimate the capacity of the high beam assist function. The driver always has the responsibility to understand the surrounding situation, to drive safely, and to change the headlight mode manually if necessary.

Based on the preceding (in front of the vehicle) conditions, the system will toggle the low and high beam headlights to maximize visibility while reducing distraction to other objects in front of the vehicle. The system detects light sources in a 30° (approximate) range in front of the vehicle. The range of detection is limited to the input method of the system and any environmental conditions that may exist.



HBA System Operation

When any of the following conditions are met, the headlight will change to high beam:

- When the vehicle speed increases to or above 20 mph (32 km/h)
- There is no preceding or oncoming vehicle
- The forward area of the vehicle is dark
- The road does not have a sharp curve

When any of the following conditions are met, the headlight will change to low beam:

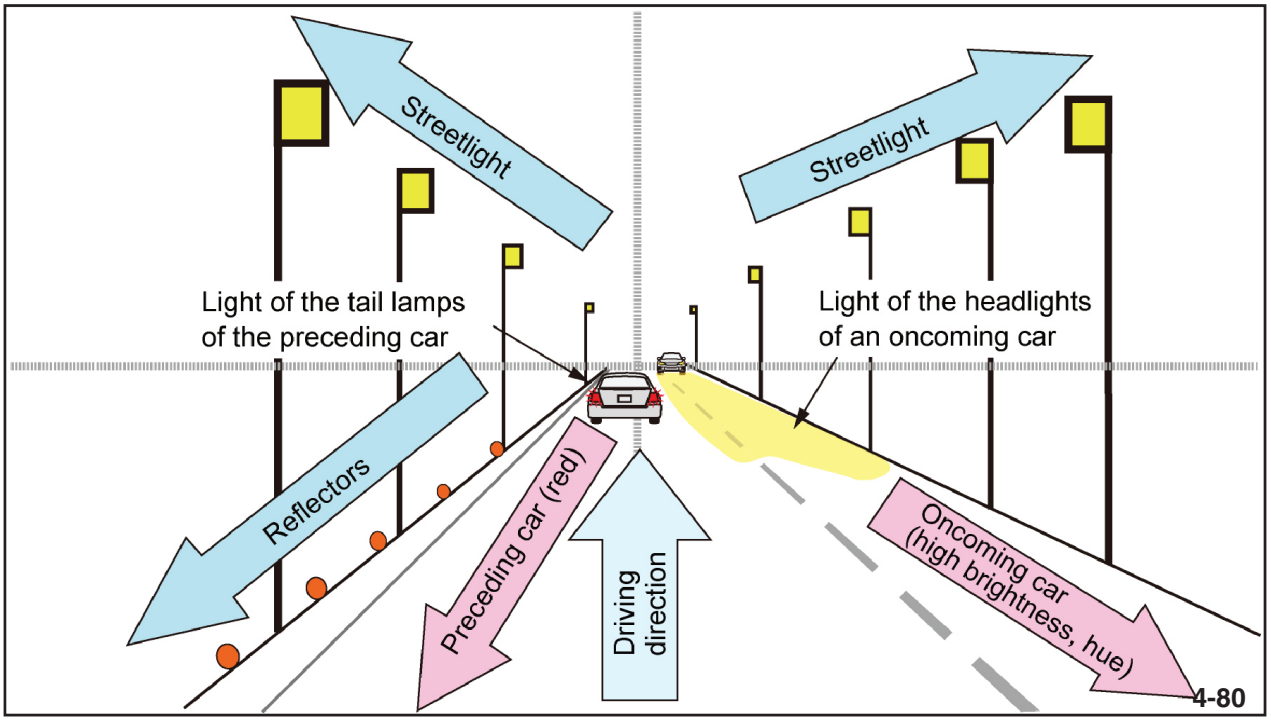
- When the vehicle speed decreases to or below 10 mph (16 km/h)
- When the forward area of the vehicle is bright
- When there is a preceding or oncoming vehicle
- When the EyeSight® system is malfunctioning or is temporarily stopped

The HBA system uses the EyeSight® (Ver. 3) system's stereo cameras to identify driving conditions such as oncoming vehicles and road curvature. However, light source identification may be derived from one of two potential sources depending on the model. On some models, the EyeSight® stereo cameras are used whereas other models utilize a dedicated Monocular camera mounted to the rear view mirror.

Model	Model Year	Driving Condition Detection	Light Source Detection
Legacy/Outback	2017	EyeSight® Stereo Camera	Monocular Camera
Forester	2017	EyeSight® Stereo Camera	EyeSight® Stereo Camera
Impreza	2017	EyeSight® Stereo Camera	EyeSight® Stereo Camera
WRX	2017	Not Available	Not Available

EyeSight® Stereo Cameras and Monocular Camera

Regardless of the input method, the HBA system will monitor the light source of objects in front of the vehicle such as the headlamps of oncoming vehicles, tail/brake lamps of preceding vehicles, street lights, and reflectors.



HBA Recognition Theory (Right hand drive image)

Caution: The High Beam Assist function recognizes surrounding objects based on the brightness of illumination in front of the vehicle. Therefore, the headlight mode may not match the driver's sense in the following conditions (including, but not limited to):

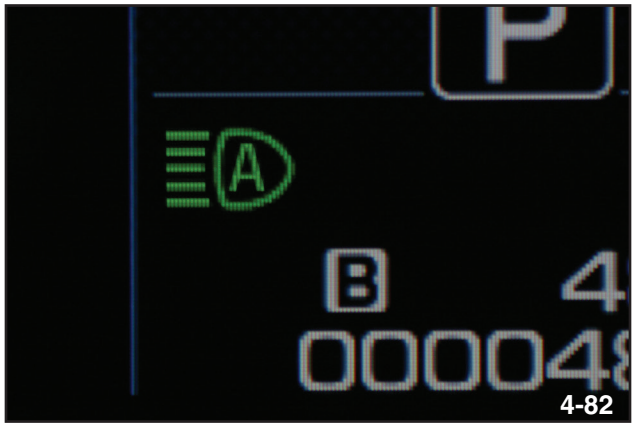
- In bad weather (fog, snow, sand, storm, heavy rain, etc.)
- If there is light similar to headlights or tail lights in the surrounding area
- When an oncoming vehicle or vehicle ahead is driven without its headlights or tail lights
- There are objects that reflect light strongly, such as a road sign or a mirror
- Driving on a road with many ups and downs or uneven surfaces

* **For a full listing of HBA warnings and cautions, consult the applicable Owner's Manual and/or Service Manual.**

To enable the HBA system, the driver must select the "AUTO" position on the Light Control Switch and push the Turn Signal Lever forward to the "High Beam" position. When these two selections are made, a green "High Beam Assist Indicator" will be displayed on the combination meter.

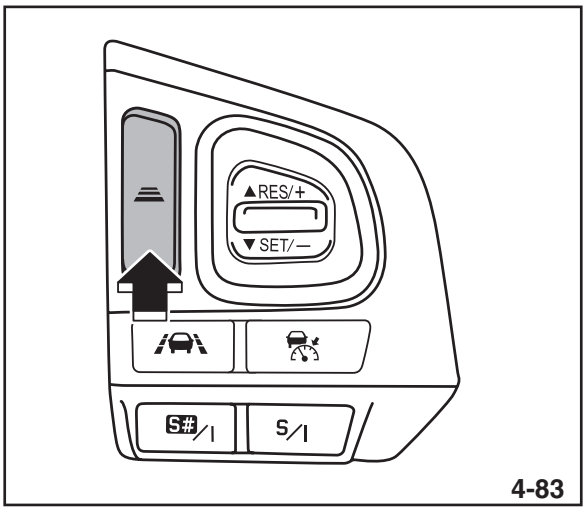
Note: The HBA function will not begin until the low beams are turned on as judged by the auto headlight system (light sensor).

Turn Signal Lever — AUTO Position

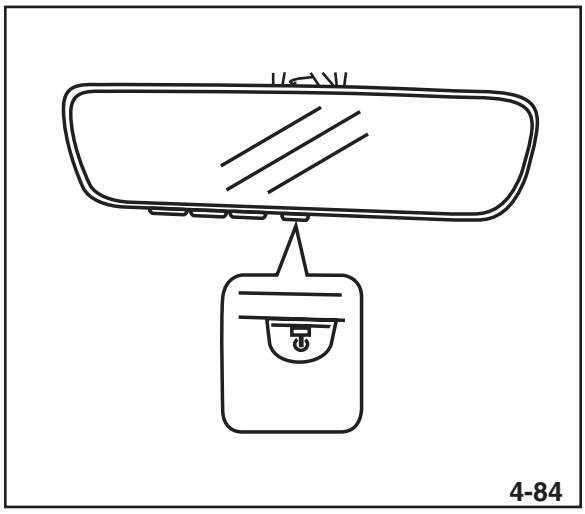


High Beam Assist Indicator

The sensitivity of the HBA system can be temporarily lowered by the user based on the systems performance in certain environments. Depending on the model, this may be accomplished through the use of the steering wheel mounted "Following Distance" switch or rear view mirror "Automatic Dimming ON/OFF" button. Consult the appropriate Owner's Manual for specific directions.



Following Distance Switch



Automatic Dimming ON/OFF Button

Note: The sensitivity of the high beam assist function returns to normal level the next time the ignition switch is turned to the "LOCK"/ "OFF" position and the engine is restarted.

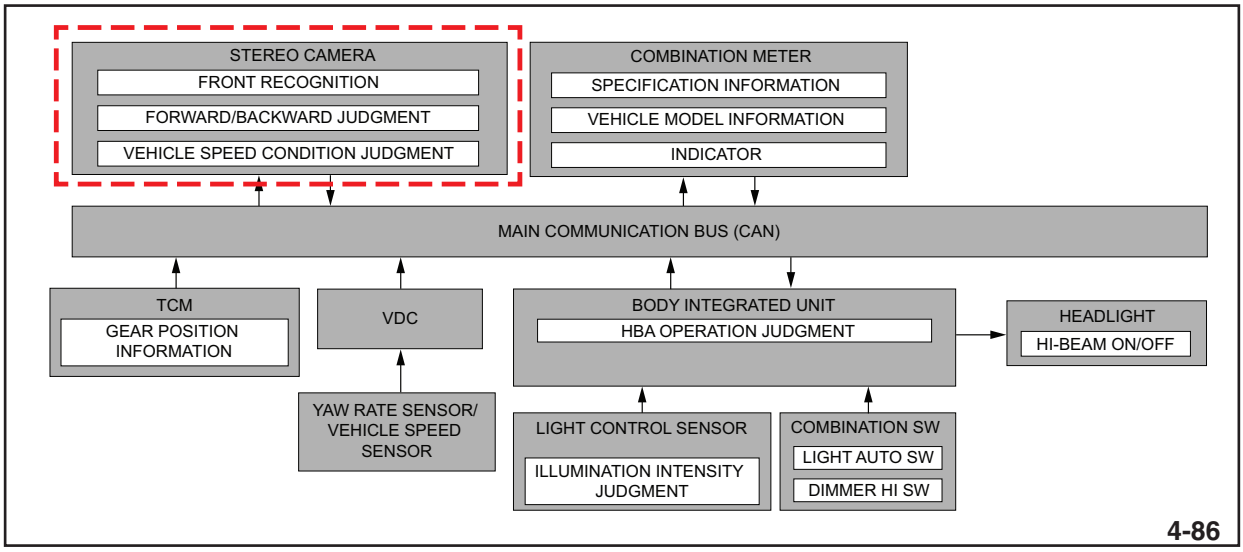
HBA Variations

Currently, there are two types of HBA input methods. However, both systems feature the same basic functionality:

- EyeSight® stereo cameras for light source detection
- Monocular camera for light source detection

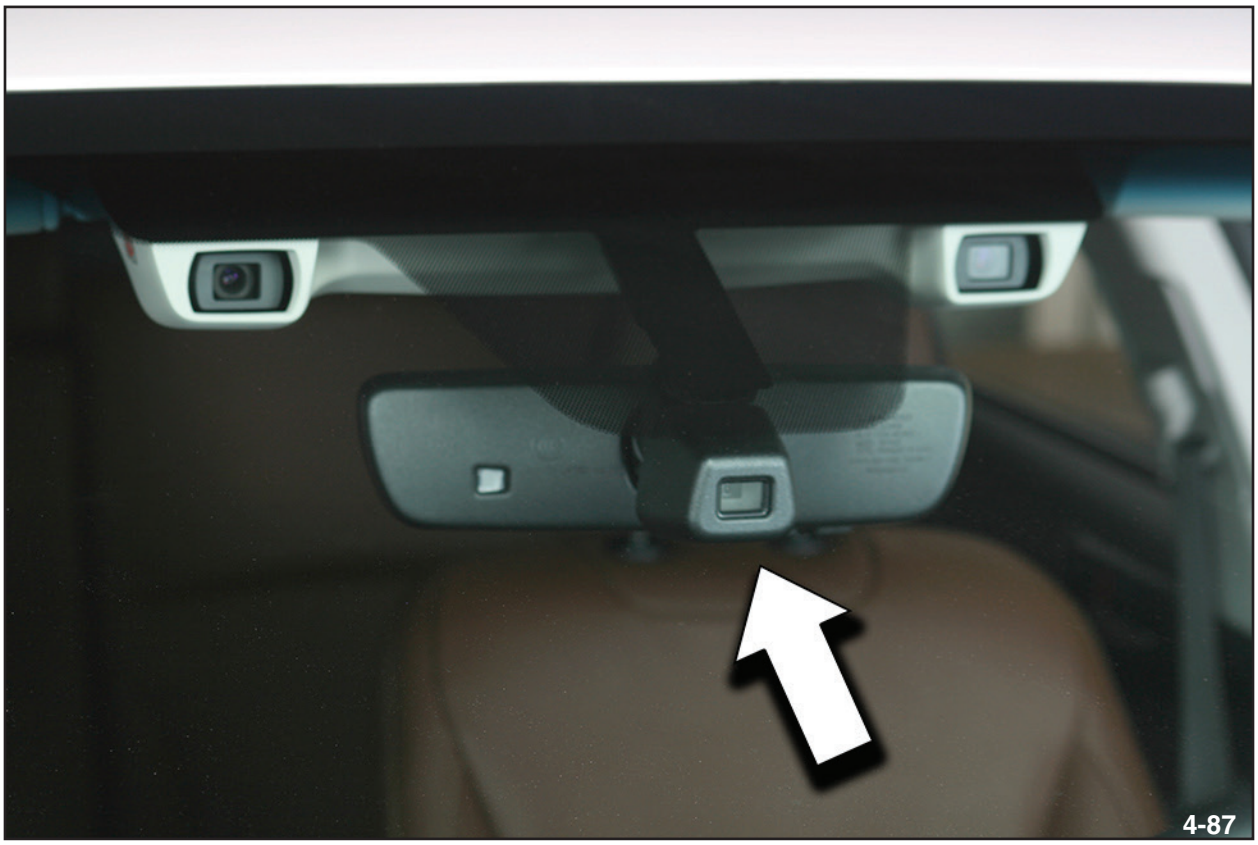
2017MY Forester uses the EyeSight® (Ver. 3) stereo camera as the primary input for HBA judgements. On these vehicles, the EyeSight® system uses the vehicle's CAN network to transmit and receive any and all necessary information to allow for HBA function.

EyeSight® Stereo Cameras

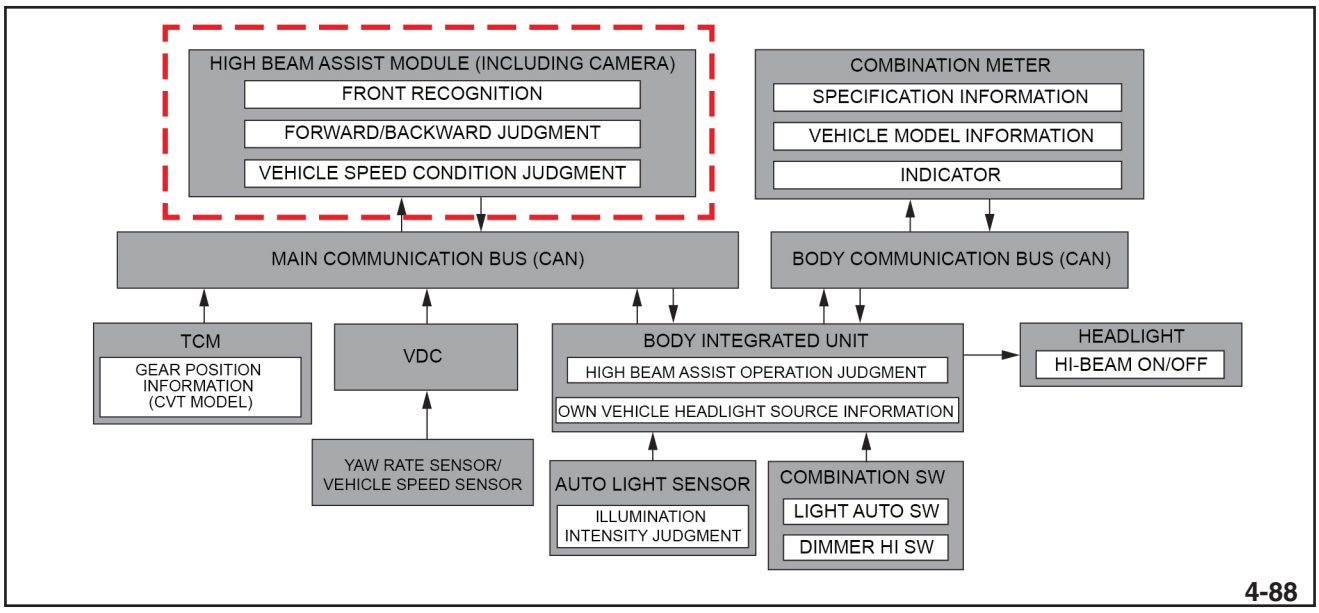


HBA System Architecture - EyeSight®

2017 Legacy and Outback models utilize a dedicated Monocular (single) camera mounted to the rear view mirror. The Monocular Camera also serves as the High Beam Assist Module.



Monocular Camera

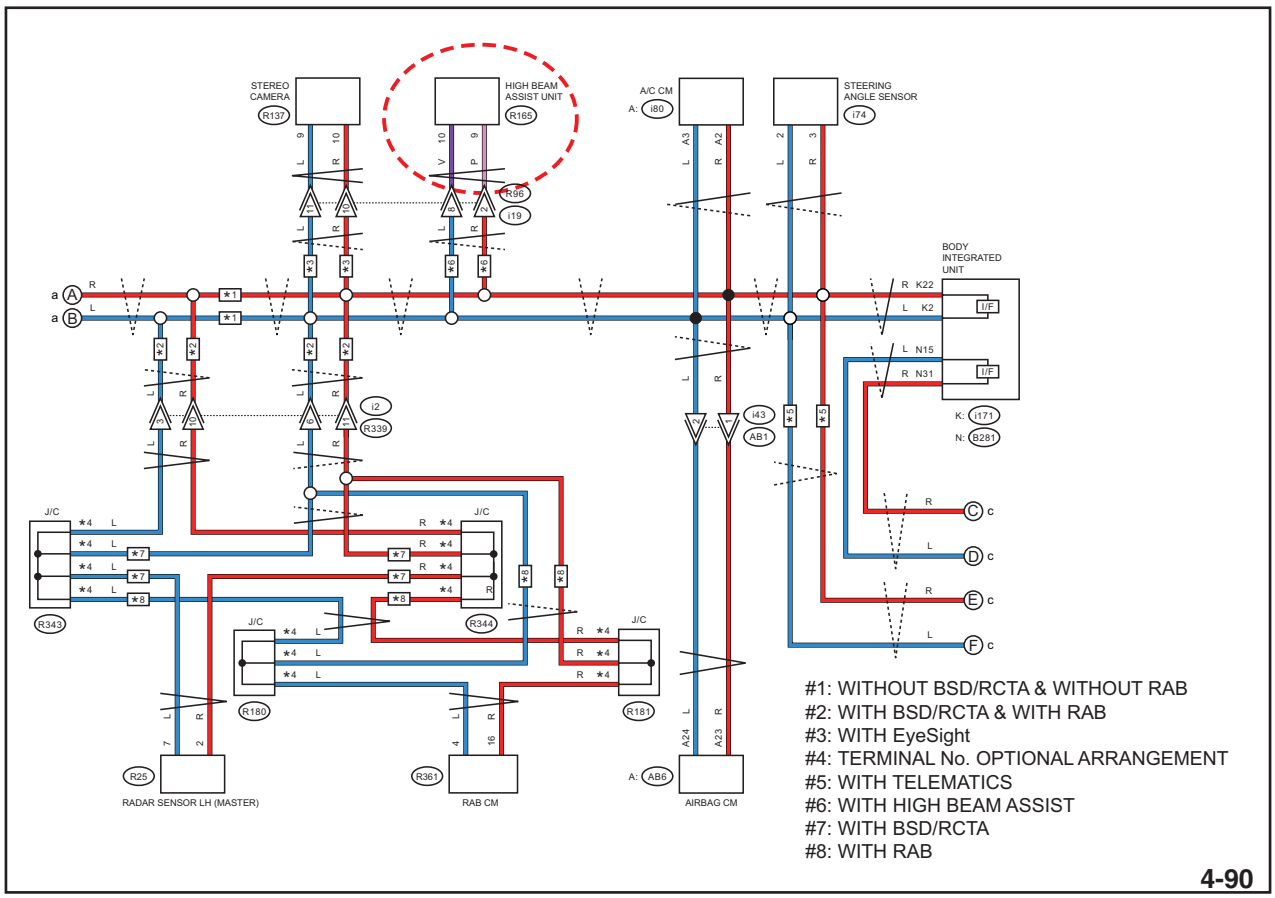


HBA System Architecture — Monocular

Rear view mirrors that utilize the monocular camera also feature a front light sensor to measure the ambient source in the forward direction.

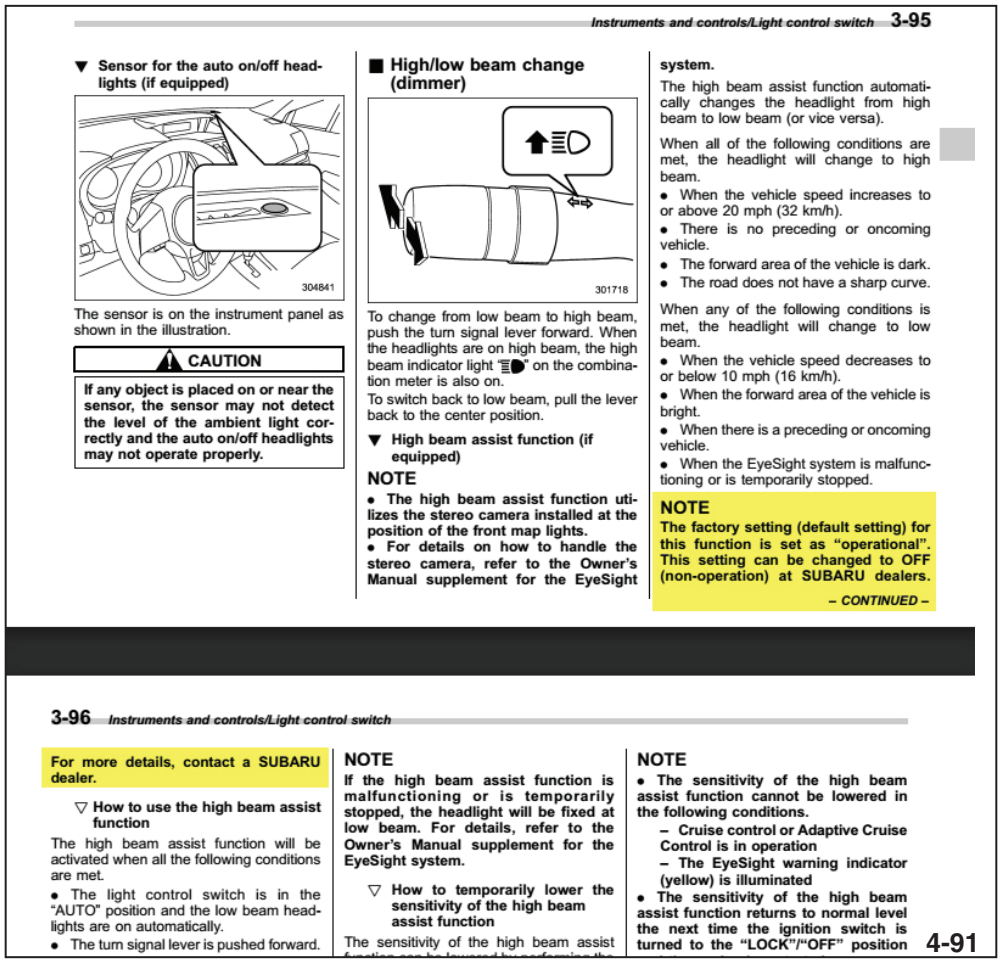
Front Light Sensor

The HBA Unit/Monocular Camera is directly connected to the vehicle's Main CAN network to transmit and receive necessary information for HBA function. Direct control of the headlights is controlled by the Body Integrated Unit (BIU)



CAN Construction — Monocular

On certain models, the HBA system may be disabled based on customer request as outlined in the Owner's Manual.



Instruments and controls/Light control switch 3-95

▼ Sensor for the auto on/off headlights (if equipped)

304841

The sensor is on the instrument panel as shown in the illustration.

CAUTION

If any object is placed on or near the sensor, the sensor may not detect the level of the ambient light correctly and the auto on/off headlights may not operate properly.

■ High/low beam change (dimmer)

301718

To change from low beam to high beam, push the turn signal lever forward. When the headlights are on high beam, the high beam indicator light on the combination meter is also on.

To switch back to low beam, pull the lever back to the center position.

▼ High beam assist function (if equipped)

NOTE

- **The high beam assist function utilizes the stereo camera installed at the position of the front map lights.**
- **For details on how to handle the stereo camera, refer to the Owner's Manual supplement for the EyeSight system.**

The high beam assist function automatically changes the headlight from high beam to low beam (or vice versa).

When all of the following conditions are met, the headlight will change to high beam.

- When the vehicle speed increases to or above 20 mph (32 km/h).
- There is no preceding or oncoming vehicle.
- The forward area of the vehicle is dark.
- The road does not have a sharp curve.

When any of the following conditions is met, the headlight will change to low beam.

- When the vehicle speed decreases to or below 10 mph (16 km/h).
- When the forward area of the vehicle is bright.
- When there is a preceding or oncoming vehicle.
- When the EyeSight system is malfunctioning or is temporarily stopped.

NOTE

The factory setting (default setting) for this function is set as "operational". This setting can be changed to OFF (non-operation) at SUBARU dealers.

– CONTINUED –

3-96 Instruments and controls/Light control switch

For more details, contact a SUBARU dealer.

▽ How to use the high beam assist function

The high beam assist function will be activated when all the following conditions are met.

- The light control switch is in the "AUTO" position and the low beam headlights are on automatically.
- The turn signal lever is pushed forward.

NOTE

If the high beam assist function is malfunctioning or is temporarily stopped, the headlight will be fixed at low beam. For details, refer to the Owner's Manual supplement for the EyeSight system.

▽ How to temporarily lower the sensitivity of the high beam assist function

The sensitivity of the high beam assist

NOTE

- **The sensitivity of the high beam assist function cannot be lowered in the following conditions.**
  - **– Cruise control or Adaptive Cruise Control is in operation**
  - **– The EyeSight warning indicator (yellow) is illuminated**
- **The sensitivity of the high beam assist function returns to normal level the next time the ignition switch is turned to the "LOCK"/"OFF" position**

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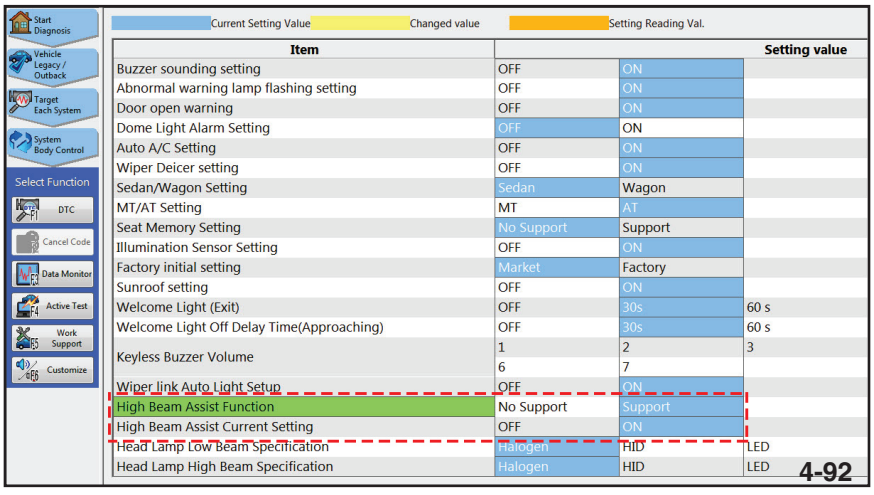
2017MY Owner's Manual — HBA Operational Setting

Fulfillment of this request is accomplished by accessing the function setting in the Body Control menu on the Subaru Select Monitor.



Start Diagnosis
Vehicle Legacy / Outback
Target Each System
System Body Control
Select Function
DTC
Cancel Code
Data Monitor
Active Test
Work Support
Customize

Current Setting Value | Changed value | Setting Reading Val.

Item			Setting value
Buzzer sounding setting	OFF	ON	
Abnormal warning lamp flashing setting	OFF	ON	
Door open warning	OFF	ON	
Dome Light Alarm Setting	OFF	ON	
Auto A/C Setting	OFF	ON	
Wiper Deicer setting	OFF	ON	
Sedan/Wagon Setting	Sedan	Wagon	
MT/AT Setting	MT	AT	
Seat Memory Setting	No Support	Support	
Illumination Sensor Setting	OFF	ON	
Factory initial setting	Market	Factory	
Sunroof setting	OFF	ON	
Welcome Light (Exit)	OFF	30s	60 s
Welcome Light Off Delay Time(Approaching)	OFF	30s	60 s
Keyless Buzzer Volume	1	2	3
	6	7	
Wiper link Auto Light Setup	OFF	ON	
High Beam Assist Function	No Support	Support	
High Beam Assist Current Setting	OFF	ON	
Head Lamp Low Beam Specification	Halogen	HID	LED
Head Lamp High Beam Specification	Halogen	HID	LED

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Body Control Customizing — Monocular

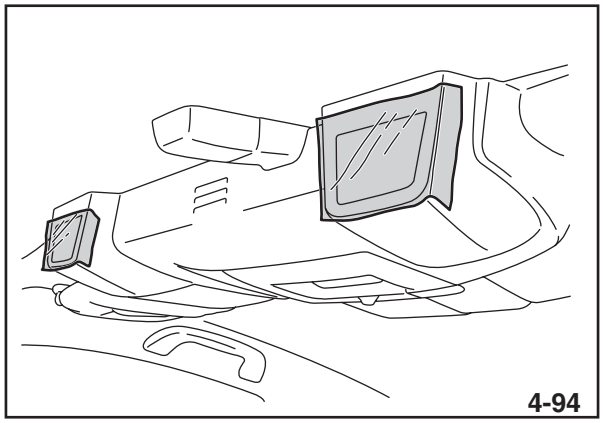
Service and Diagnostics

Stereo Camera Care and Handling

The Stereo Camera lenses are precision components and require great care in handling. When the system detects that the Stereo Camera lenses are dirty, EyeSight® functions will be prohibited. Always observe the following precautions when handling them:

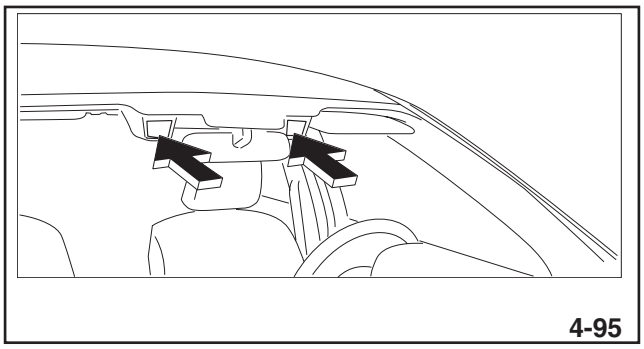
- Do not touch or try to clean the EyeSight® camera lenses inside the vehicle. Extra precaution should be used when cleaning the inside of the windshield. Over-spray from cleaners may impair or even damage the camera lenses.
- Do not remove or disassemble the stereo cameras or lenses.
- Do not change the positions where the Stereo Cameras are installed or modify any of the surrounding structures.
- Do not install any interior rearview mirror other than a genuine SUBARU rearview mirror (such as a wide-type mirror). Also, use the rearview mirror so it does not obstruct the Stereo Camera assembly. Failure to do so may affect the field of vision and could prevent the EyeSight® system from functioning properly.

Stereo Camera Warning Label

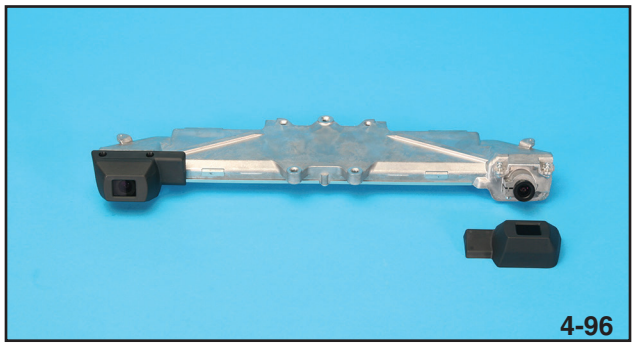


Use of Protection

The Stereo Camera lens hoods can be inspected for contamination through the windshield glass. Thin and uniform accumulation of dust, dirt, or tobacco stains resulting from normal use should not cause issues. Do not attempt to clean or service in these cases. In the event a Stereo Camera lens hood becomes contaminated, it is possible to replace the hoods separately from the camera assembly. Once the lens hoods have been replaced, the Camera Adjustment, Inspection procedure must be performed.



Lens Hood Inspection



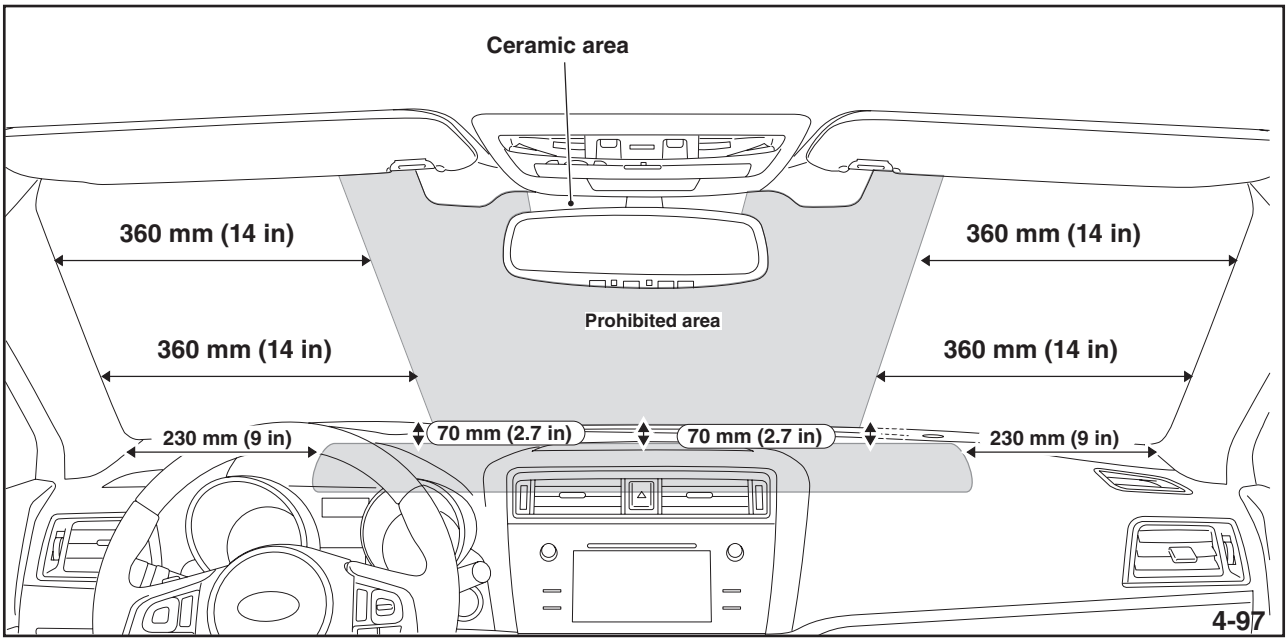
Lens Hood Removed

Windshield Care

In order for the EyeSight® system to function properly, the windshield must be free from damage, unauthorized accessories, or exceptional debris. The windshield also contains "prohibited" areas in which no obstructions or damage can be present.

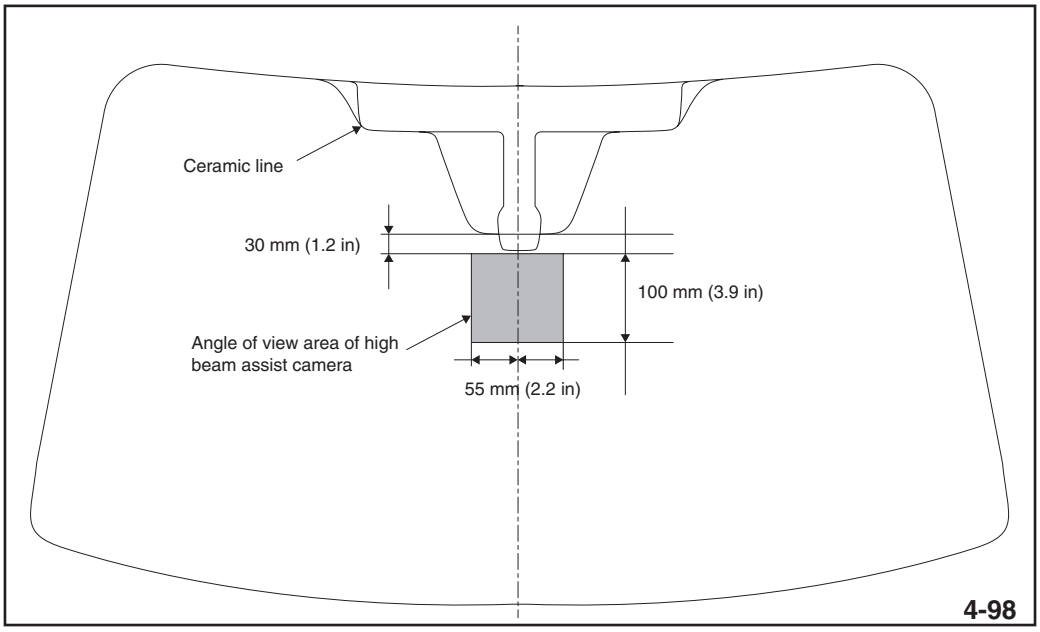
Note: EyeSight® models use a Subaru genuine windshield glass specifically designed for the EyeSight® system. If windshield glass other than the specifically designed EyeSight® glass is used, the visibility of the Stereo Camera may be distorted and may prevent the correct measurement of objects. If the windshield is replaced, the Camera Adjustment, Inspection procedure must be performed.

- Other factors affecting EyeSight® operation include;
- No oil film, dirt, scratches or fogging that obstructs the forward visibility of the Stereo Camera can be present.
- Do not stick or attach any aftermarket accessories in the prohibited area. Even outside the prohibited area, it is possible that abnormal operation may occur due to the reflection of light or the reflection on the glass. If this happens, it may be necessary to change the adhering position or installation position of the accessory.



Windshield Areas

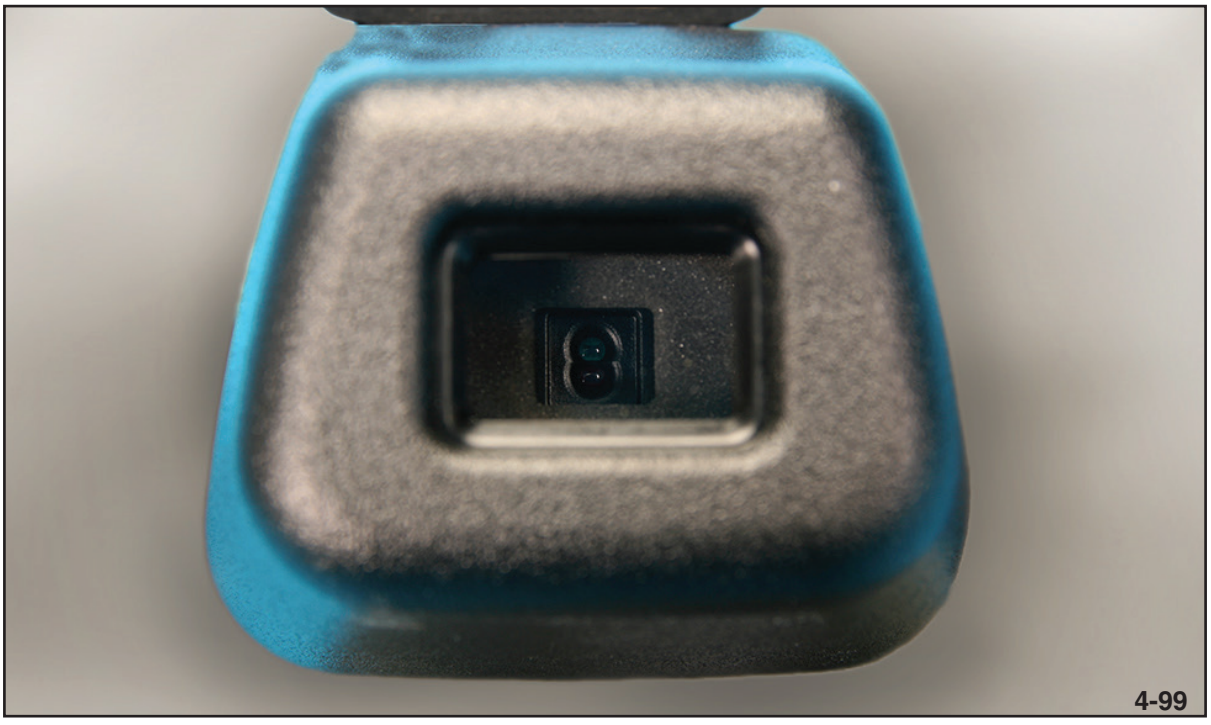
Models that utilize a Monocular Camera (High Beam Assist (HBA)) have an additional “prohibited area” in the front windshield. This area must be free of oil film, dirt, fogging or any other obstructions in order for the HBA system to function properly.



Monocular Camera Prohibited Area

The monocular camera should have the lens surface inspected for contamination such as cleaner residue or fingerprints.

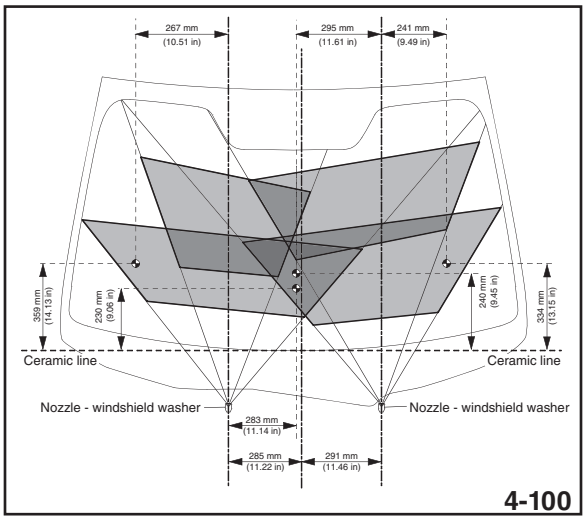
Note: If the Monocular camera is touched it is possible to clean the lens using a soft cloth.



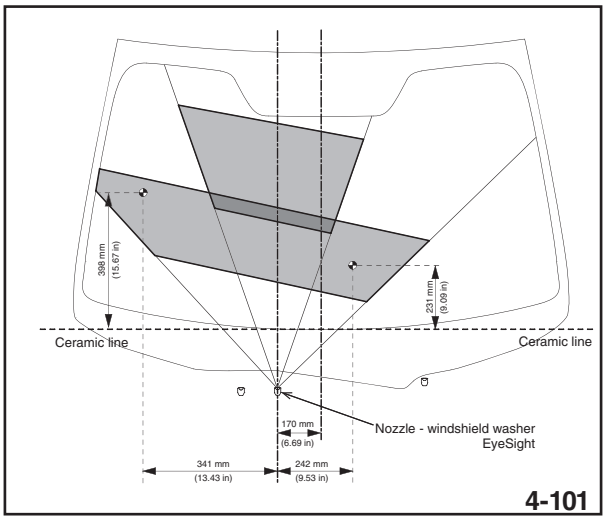
Monocular Camera and Lens

Some EyeSight® vehicles contain an additional front windshield washer nozzle to aid in removing debris from the Stereo Camera's field of view. Always ensure adjustment of the nozzle is correct.

Note: Only Subaru genuine wiper blades should be used. Use of other than genuine parts may affect the recognition of the Stereo Camera. If the wiper blades produce streaking, they should be replaced as soon as possible.



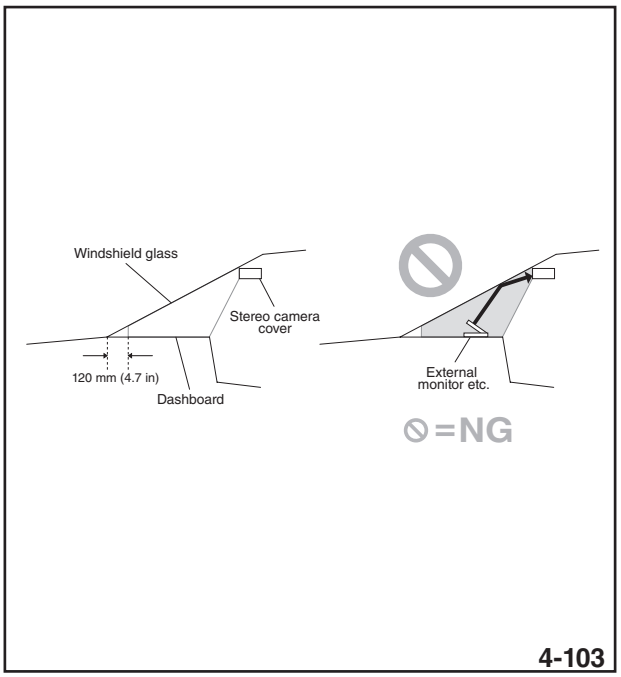
Normal Washer Nozzle Spray Area



Dedicated EyeSight® Washer Nozzle Spray Area

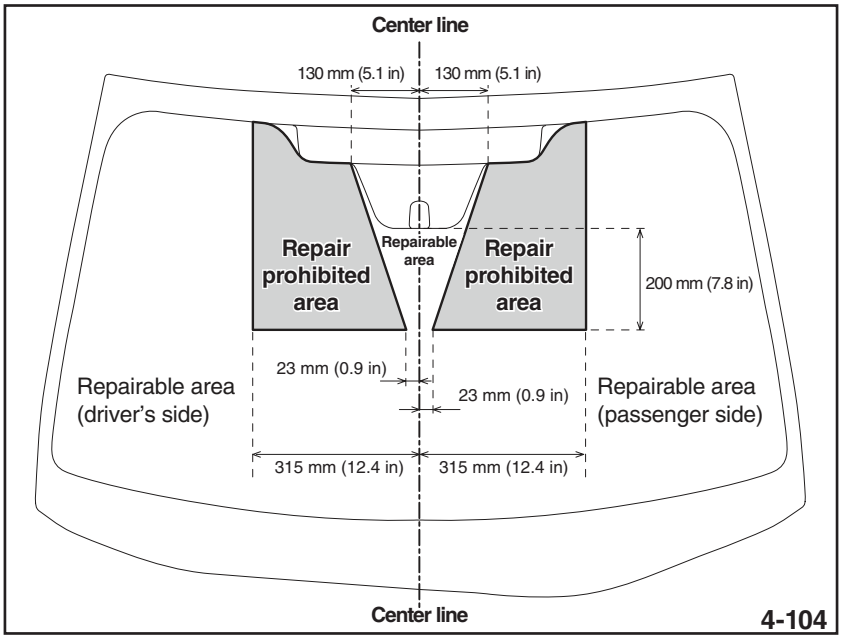
Placement of GPS navigation units, ETC (Electronic Toll Collection) or other accessories on the dashboard may be reflected on the windshield glass, affecting the recognition of the Stereo Camera.

Windshield Reflection



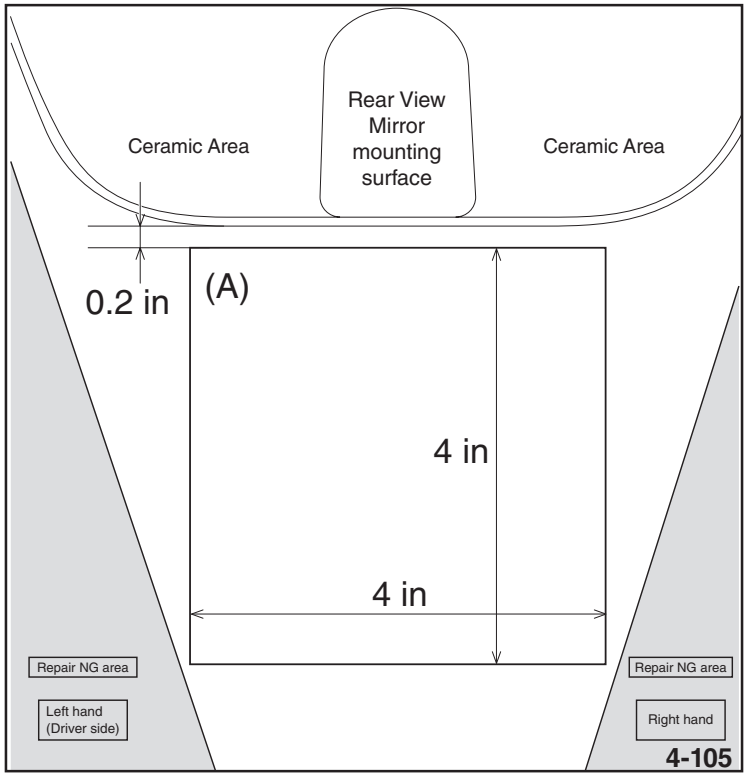
Prohibited Object Areas

It is permissible to repair minor damage to the windshield in the “repairable” areas (C and D) as shown in the diagram below. However, if any damage is found in the prohibited areas, the windshield must be replaced.



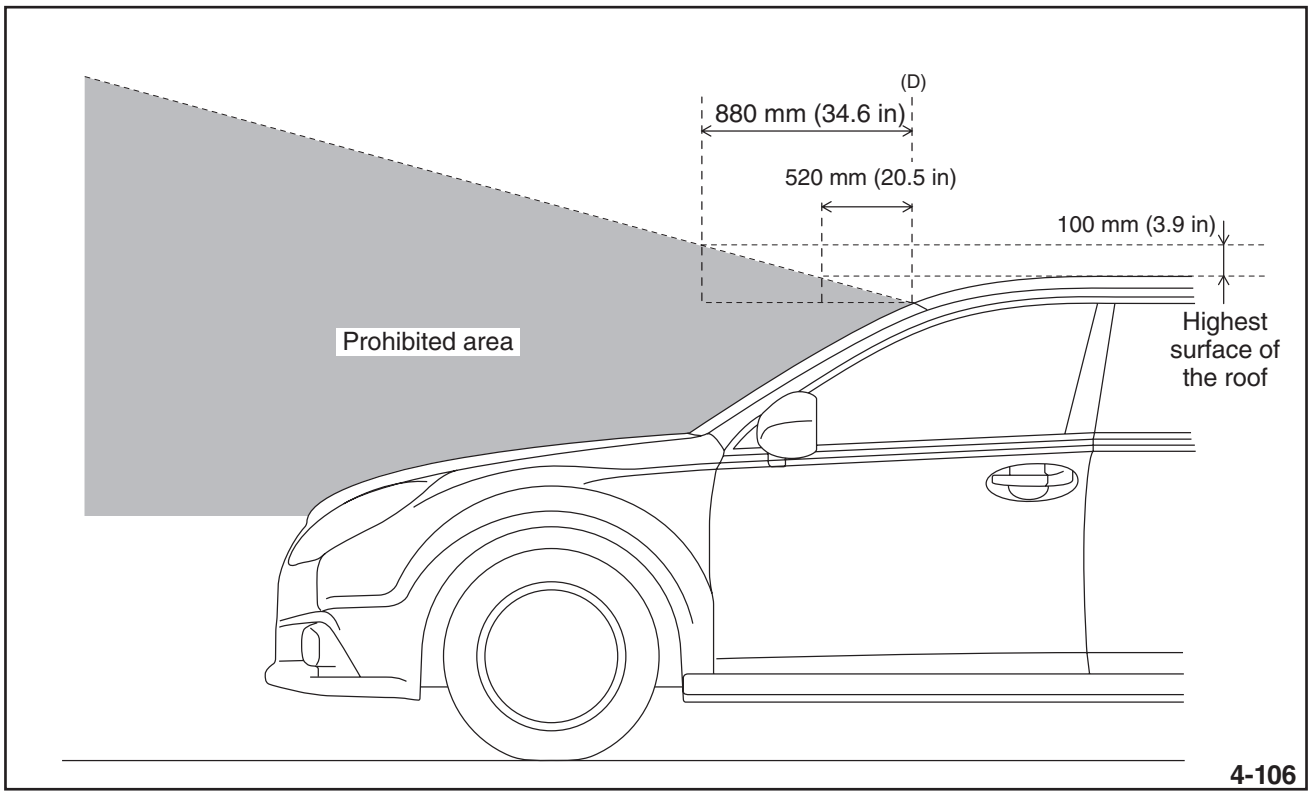
Windshield Repair Areas

ETC (Electronic Toll Collection) devices may only be installed in the specified area and can be no thicker than 1.5 inches. Scale templates and instructions for defining the permissible area can be found on STIS.



ETC Mounting Area

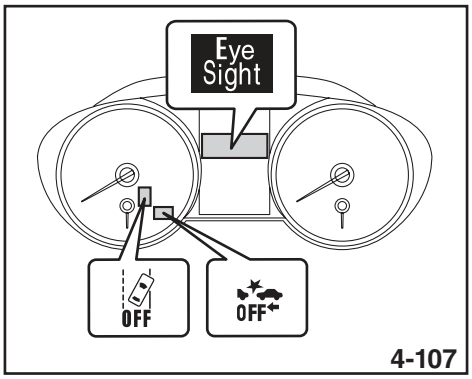
Installation of roof mounted accessories/cargo must be installed with consideration to avoid the Stereo Camera field of view.



Roof Accessory/Cargo Prohibited Area

Eyesight (General)

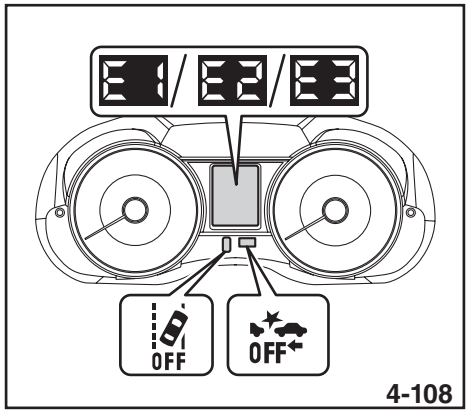
If a malfunction is detected in the EyeSight® system, indicators in the Combination Meter and the Multi-Function Display (MFD) are generated to inform the driver.



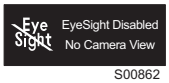
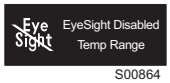
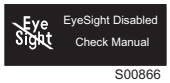
Combination Meter – Malfunction Display

Displayed screen	Cause	Action
EyeSight Off Check Manual S00699	An EyeSight malfunction or position/angle misalignment of stereo cameras has occurred.	Inspection and adjustment is necessary. Contact your SUBARU dealer.
EyeSight Disabled No Camera View S00700	It is difficult for the stereo cameras to detect objects in front • The front windshield is dirty or fogged up • Poor weather conditions • Strong light from the front	• Clean the front windshield. • In bad weather or if there is strong light from the front, the EyeSight system will restart once you have driven your vehicle for a period of time and the conditions affecting the system have improved. If the system does not restart, even after the conditions have improved and a period of time has elapsed, contact your SUBARU dealer for an inspection.
EyeSight Disabled Temp Range S00701	In low or high temperatures	The system will restart once the temperature is within the operational range of the EyeSight system. If the system does not restart, even when the temperature inside the vehicle is normal, contact your SUBARU dealer for an inspection.
EyeSight Disabled Check Manual S00694	• When the EyeSight system is starting • When the system has determined that the vehicle is extremely inclined • When the pre-collision secondary braking has operated 3 times after the engine was started • When the engine is stopped	The system will restart once the cause has been eliminated. At this time, it may take some time for the system to restart. If the system does not restart, even after the conditions have improved and a period of time has elapsed, contact your SUBARU dealer for an inspection.

Some models display error codes in the form of “E” messages on the Combination Meter.

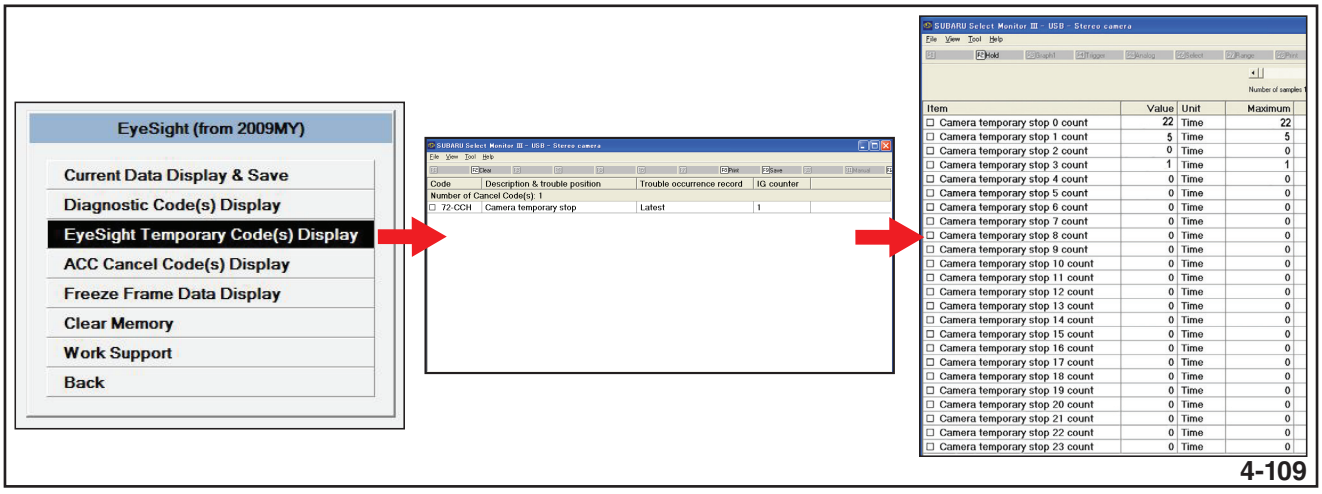


Combination Meter –“E”Code Display

Display	Cause	Action
<Meter display>  S00861 <Multi function display>  S00862	It is difficult for the stereo cameras to detect objects in front • The front windshield is dirty or fogged up • Poor weather conditions • Strong light from the front • Extremely hot or cold temperatures	• Clean the front windshield. • In bad weather or if there is strong light from the front, the EyeSight system will restart once you have driven your vehicle for a period of time and the conditions affecting the system have improved. Also, as the “E1” screen will be displayed after the “E2” screen, once operation of the cameras is stable, the system will restart. In either case, it may take some time for the system to restart. If the system does not restart, even after the conditions have improved and a period of time has elapsed, contact your SUBARU dealer for an inspection.
<Meter display>  S00863 <Multi function display>  S00864	In low or high temperatures	The system will restart once the temperature is within the operational range of the EyeSight system. If the system does not restart, even when the temperature inside the vehicle is normal, contact your SUBARU dealer for an inspection.
<Meter display>  S00865 <Multi function display>  S00866	• When the EyeSight system is starting • When the system has determined that the vehicle is extremely inclined • When the pre-collision secondary braking has operated 3 times after the engine was started • When the engine stops (except for the stop due to the start stop function).	The system will restart once the cause has been eliminated. At this time, it may take some time for the system to restart. If the system does not restart, even after the conditions have improved and a period of time has elapsed, contact your SUBARU dealer for an inspection.

Temporary Stop (Cancel Codes)

Temporary Stop conditions are generated as a result of environmental influences to the EyeSight® system. Generally, these include Stereo Camera view obstructions, strong sunlight, heavy rain, etc. In these circumstances the driver is alerted to the Temporary Stop by the Combination Meter and/or MFD. Simultaneously, the EyeSight® system will generate and store Cancel Codes, DTCs, and Temporary Stop Count(s). This information can be retrieved using the Subaru Select Monitor (SSM).



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Temporary Code Display (SSM)

There are up to 32 unique (depending on the Version) Temporary Stop condition (pause or cancel) codes that the EyeSight® system may identify. These codes can be helpful when addressing intermittent customer concerns. A full list of can be found on STIS.

Subaru Select Monitor display items	Main causes	Possible conditions for temporary stop (including events occurring less frequently)	Cancel code/ DTC	Meter display
Camera temporary stop 0 count	Backlight of the sunlight	Backlight, dirty window glass, fogged window glass, frost on the window glass, oil film on the window glass, raindrop adhering to the window glass, fingerprint adhering to the lens, deteriorated wiper, front of the camera is blocked by hand, object on the dashboard reflected against the windshield glass, bad weather (heavy rain, snowstorm, dense fog), unpatterned wall, fence, wall with vertical stripe, water drop raised by preceding vehicle, steep slope, banner, grass, preceding vehicle with large uneven surface (trailer, etc.), preceding vehicle driving in the night without illuminating the tail light	72-CC	E1
Camera temporary stop 1 count Camera temporary stop 2 count	Dirty window glass, fogged window glass, frost on the window glass, oil film on the window glass, raindrop adhering to the window glass, fingerprint adhering to the lens, object on the dashboard reflected against the windshield glass, bad weather (heavy rain, snowstorm), water drop raised by preceding vehicle			
Camera temporary stop 3 count	Fogged window glass, frost on the window glass	Backlight, dirty window glass, fogged window glass, frost on the window glass, oil film on the window glass, raindrop adhering to the window glass, fingerprint adhering to the lens, deteriorated wiper, front of the camera is blocked by hand, object on the dashboard reflected against the windshield glass, bad weather (heavy rain, snowstorm, dense fog), water drop raised by preceding vehicle, very dark and no obstacle around the vehicle, unpatterned wall, blanket of snow around the vehicle and no obstacle is found		
Camera temporary stop 4 count	Front of the camera is blocked by hand.	Backlight, dirty window glass, fogged window glass, frost on the window glass, oil film on the window glass, raindrop adhering to the window glass, fingerprint adhering to the lens, deteriorated wiper, front of the camera is blocked by hand, object on the dashboard reflected against the windshield glass, bad weather (heavy rain, snowstorm, dense fog), banner, grass, etc.		

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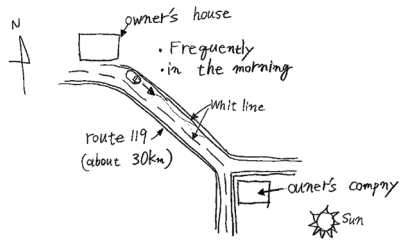
Temporary Stop Conditions (STIS)

Diagnosing customer concerns involving Temporary Stop conditions should be supplemented with the “Check List for Interview” found on STIS. Identifying the environmental conditions at the time of the Temporary Stop can aid in isolating the root cause as well as educating the customer on the operation of the EyeSight® system.

Writer/ Inspector	Writer's name	User	
	Inspector's Name	Dealer	
Vehicle information	Car accessory equipment condition	Car accessory is installed to the windshield glass.	No/Yes Position:)
		Other	No/Yes (Accessory's name:)
	Is there any modification for the following items?	Suspension?	Not changed/Changed (Specifically:)
		Headlight?	Not changed/Changed (Specifically:)
		Tire size?	Not changed/Changed (Specifically:)
		Front wiper?	Not changed/Changed (Specifically:)
	Is there any modification for the following items?	Is there any scratch or damage on the windshield glass?	No/Yes (Specifically:)
		Are antennas, etc. attached on the prohibited area?	No/Yes (Specifically:)
		Is wide mirror or accessory attached?	No/Yes (Specifically:)
	How is the condition around camera?	Is there any scratch or damage on the windshield glass?	No/Yes (Specifically:)
		Are antennas, etc. attached on the prohibited area?	No/Yes (Specifically:)
		Is wide mirror or accessory attached?	No/Yes (Specifically:)
	How is the surface condition of the windshield glass?	Presence of oil film, fogging, dirt and/or glass coating	No/Yes (Specifically:)
	How is the condition of the dashboard?	Is there anything that can be easily reflected against the windshield glass on the dashboard?	No/Yes (Specifically:)
	How is the deterioration of the wiper?	Does any streak or uneven wiping area remain in front of the camera?	No/Yes (Specifically:)
	How is the condition of the tire?	Is there any wear? Is there any excessive wear difference?	No/Yes (Specifically:)
		Is the air pressure proper?	No/Yes (Specifically:)
	How is the condition of the camera lens filter?	Is there finger print adhesion or cracks on the lens filter?	No/Yes (Specifically:)
Description of malfunction	What kind of malfunction has been detected?	Failure/temporary stop/faulty operation of adaptive cruise control/ faulty operation of pre-collision brake/other faulty operations	
	What kind of DTC and/or cancel code is displayed?	Customer does not remember	
	How is the meter display?	EyeSight warning light	Off/On/Blink
		Pre-collision brake OFF indicator light	Off/On
		Lane departure warning OFF indicator light	Off/On

Occurrence conditions	Occurrence date	11-11-2011	Occurrence location	From owners home to work
	Vehicle speed at occurrence	Approx. km/h 0~60	Occurrence timing	During driving/during stopping/continues after engine has started
	Road type	Express way/ limited highway/main highway/ general road	Weather	Fine/cloudy/rainy/snowy/other
	Road condition 1	Dry/slippery (Rainy • compacted snow • icy road)	Ambient temperature	Approx. °C 0~+15
	Road condition 2	Asphalt/gravel/ ground and sand/other	Position of solar radiation	Described in the detailed chart when the weather is fine.
	Road shape	Uphill/downhill/bank/ roll/uneven surface FLAT	Time elapsed after engine start	Immediately after engine start/ within 5 minutes after engine start/more than 5 minutes after engine start
	Wiper operation status	OFF/INT/LO/ HI/AUTO	Light on status	Off/LO On/HI On
	Vehicle weight	Number of passengers: ( ) Did the vehicle carry heavy load? (No/Yes (Approx. kg)		

Detailed chart (Refer to the example of description.



In case of malfunction caused by temporary stop or faulty operation, draw a chart so that the following conditions can be recognized referring to the example of description. (Images taken by digital camera can be used.)

- Road shape (straight, curve, tunnel, number of lane, etc.)
- Road grade and it's change
- Presence of white line, guardrails and/or side wall (degree of clarity)
- Position of the sun
- Presence and shape of preceding vehicle, oncoming vehicle, vehicle running on the next lane or pedestrian
- Presence and shape of surrounding building or structure
- Traveled course of owner's vehicle and preceding vehicle

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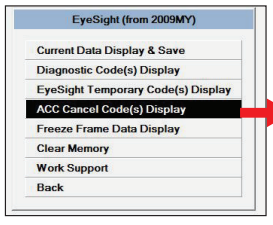
Check List for Interview

Adaptive Cruise Control (ACC) Cancel Codes

Adaptive Cruise Control (ACC) may generate cancel codes in response to conditions that may inhibit the functions of the ACC system. Depending on the EyeSight® version.



Code	Cancel Reason of ACC Cruise Control	Trip Count
Num of ACC Cancel Code(s): 2 Curr. IG ON Count 207		
☐ 1D	Common:Cruise SW OFF	80
☐ 09	Common:Brake Pedal Depressed	32

ACC cancel code	Item	Contents of diagnosis
02	ACC Mode:Maintaining Standstill Position	Displayed when the cruise control is cancelled after the own vehicle stops following the preceding vehicle.
04	ACC Mode:Stereo Camera Temporary	Displayed when the cruise control is canceled by the EyeSight temporarily stop while driving in the adaptive cruise mode.
08	Common:Vehicle Speed Sensor Abnormal	Displayed when the cruise control is canceled due to a wheel speed sensor malfunction.
09	Common:Depress The Brake Pedal	Displayed when the cruise control is canceled by the brake operation of the driver.
0A	Common:Pre-Collision Braking	Displayed when the cruise control is canceled because the pre-collision brake function is activated.
0B	Common:AT Manual Mode	Displayed when the cruise control is canceled because the AT manual mode is selected or paddle operation is performed.
0C	Common:VDC SW OFF	Displayed when the VDC function is turned OFF by the VDC OFF switch and the cruise control is canceled.
0D	Common:Any Doors is Opened	Displayed when the cruise control is canceled because either of the driver's door, passenger's door, or rear doors is opened.
0E	Common:Unfastened The Driver's Seatbelt	Displayed when the cruise control is canceled because the driver's seat belt is unfastened.
0F	Common:EPB Activation	Displayed when the cruise control is canceled because the EPB is activated.
10	Common:EPB Special Mode	Displayed when the cruise control is canceled by an irregular operation of a driver, which repeats activation/deactivation of the EPB.
12	Common:AT Gear Range	Displayed in the following situations: The driver performed the SET or RES operation to drive the vehicle either in the adaptive cr uise mode or in the constant speed mode, but that operation was not accepted because it was done immediately after shifting into D range.
13	Common:Steep Sloping Road	Displayed when the road surface was judged to be too steep and therefore the cruise control is canceled.
14	Common:ABS Activation	Displayed when the cruise control is canceled because the ABS is activated.
15	Common:Steering Angle Excessive	Displayed when the cruise control is canceled because the steering wheel is fully turned.
16	ACC Mode:Vehicle Stop Judge	Displayed when the cruise control is cancelled after the own vehicle stops following the preceding vehicle while driving in the adaptive cruise control mode.
17	Common:Parking Brake Activation	Displayed when the cruise control is canc elled because the parking brake is applied.

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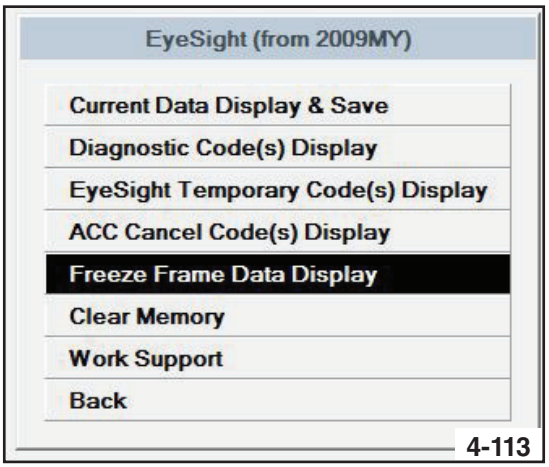
Adaptive Cruise Control – Cancel Codes

Diagnostic Trouble Codes and Freeze Frame Data

Diagnostic Trouble Codes (DTCs) derived from system malfunctions should always be supported with Freeze Frame Data (FFD). FFD provides relevant information leading up to and at the time the DTC was set.



Freeze Frame Data-SSMIII Menu

C1211

C1211 : FR wheel speed sensor system wire break/excessive input

Item	History3	History2	History1	Detect	Unit
Trip Count	---	0	641	640	Time
Count	---	Common	Originally	Originally	
Time Count	---	0	0	487481800	ms
Classification	---	5030	5030	5030	HEX
Vehicle Speed	---	0.0	0.0	0.0	MPH
Acceleration Pedal Position	---	0	0	0	%
Engine Speed	---	0	0	0	rpm
Steering angle flag	---	No recognition	No recognition	No recognition	
VDC OFF Status	---	OFF	OFF	OFF	
Clutch engagement point	---	0.0	0.0	0.0	%
FR Wheel Speed	---	0.0	0.0	0.0	MPH
FL Wheel Speed	---	0.0	0.0	0.0	MPH
RR Wheel Speed	---	0.0	0.0	0.0	MPH
RL Wheel Speed	---	0.0	0.0	0.0	MPH
Steering Angle Sensor	---	0.0	0.0	0.0	deg
Yaw Rate Sensor	---	0.0	0.0	0.0	deg/s
Pressure Sensor Output	---	0.0	0.0	0.0	bar
Longitudinal G Sensor	---	0.0	0.0	-0.3	m/s^2
Lateral G Sensor	---	0.0	0.0	0.0	m/s^2
Voltage of IGN	---	0.0	13.1	13.1	V
FL wheel cylinder pressure sensor output	---	0.0	0.0	0.0	bar
FR wheel cylinder pressure sensor output	---	0.0	0.0	0.0	bar
EBD Control Flag	---	OFF	OFF	OFF	
ABS Control Flag	---	OFF	OFF	OFF	
TCS Control Flag	---	OFF	OFF	OFF	
VDC Control Flag	---	OFF	OFF	OFF	
E/G Torque Down Control Stop Flag	---	0	0	0	
X Mode	---	OFF	OFF	OFF	
E/G torques up Control Stop Flag	---	0	0	0	
Brake Light Switch	---	OFF	OFF	OFF	
Clutch Switch	---	OFF	OFF	OFF	
Reverse Signal	---	OFF	OFF	OFF	
Clutch stroke sensor	---	0.0	0.0	0.0	%
Engine Torque	---	0.0	0.0	0.0	Nm
Ambient Temp Sensor	---	-40	-40	189	°F
Manual Parking Operation	---	OFF	OFF	OFF	
Auto Parking Operation	---	OFF	OFF	OFF	
Parking Operation when driving	---	OFF	OFF	OFF	
Parking Cancel	---	OFF	ON	ON	

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Freeze Frame Data Display

Lane Keep Assist (LKA)

Diagnosis of the LKA system should begin by completing the “CHECK LIST (ACTIVE LANE KEEP)”. Completing the check list may identify any potential external factors that may affect the operation of the LKA system. This check list can be found in the “Diagnostics with Phenomenon” section of the Service Manual.

10.CHECK LIST (ACTIVE LANE KEEP)

		Item name	Yes/No	
1	Check that the current status applies to the condition that use of lane keeping is not desired.			
	1	An object was placed on the dashboard.	Yes	No
	2	Tire pressure is not correct.	Yes	No
	3	The vehicle is equipped with the temporary spare tire.	Yes	No
	4	The vehicle is equipped with worn tire or tires with excessive wear difference.	Yes	No
	5	The vehicle is equipped with the tires out of specification.	Yes	No
	6	The flat tire is repaired using the temporary repair kit.	Yes	No
	7	The suspension (including STI parts) has been modified.	Yes	No
	8	Wheel balance is abnormal (balance weight falls off, slides off, etc.).	Yes	No
	9	Wheel alignment is out of the specified value.	Yes	No
	10	The steering wheel has been replaced with a non-genuine part.	Yes	No
	11	The steering wheel is off-center.	Yes	No
	12	The lighting devices, such as headlights and fog lights, have been modified.	Yes	No
	13	An abnormal vibration can be felt on the steering wheel.	Yes	No
	14	The steering wheel operation is heavier than usual.	Yes	No
	15	An error occurs, for example, no display appears in the combination meter or no alarm sounds.	Yes	No
	16	The headlight cannot illuminate the road surface sufficiently because the headlight is dirty, attached with ice, snow or mud, or the optical axis is deviated.	Yes	No
	17	The driving status of own vehicle was unstable due to an accident or failure.	Yes	No
	18	The vehicle carried heavy load.	Yes	No
	19	Passenger capacity was exceeded.	Yes	No
	20	The vehicle towed another vehicle.	Yes	No
	21	The vehicle drove on a general road (other than limited highways).	Yes	No
	22	The vehicle drove on a road with sharp curves, such as an urban highway.	Yes	No
	23	The vehicle drove on a slippery road such as icy roads or snow-covered roads.	Yes	No
	24	The vehicle drove on a lane restricted road or a temporary road due to road construction.	Yes	No
	25	The vehicle drove on a road where obsolete white lines did not disappear completely.	Yes	No
	26	On the road surface there were some snow, puddles, snow melting agent, cracks, road repair traces, obsolete white lines.	Yes	No
	27	The vehicle entered the interchange, service area, parking area, junction or tollgate.	Yes	No
	28	The vehicle drove on a road where the surrounding brightness (such as inlet and outlet of a tunnel) suddenly changed.	Yes	No
	29	The vehicle drove on a road where there was some water or sandy dust raised by a preceding vehicle or oncoming vehicle, or sand or smoke blown in the wind, or moisture in front of own vehicle.	Yes	No
	30	The windshield glass was covered with fog, snow, dirt, frost or sandy dust.	Yes	No
	31	The raindrops, water drops or dirt on the windshield glass were not wiped off sufficiently.	Yes	No
	32	Canoes etc. loaded on the roof block the visibility of the stereo camera.	Yes	No
	33	The vehicle drove immediately after the stereo camera was replaced or adjusted.	Yes	No

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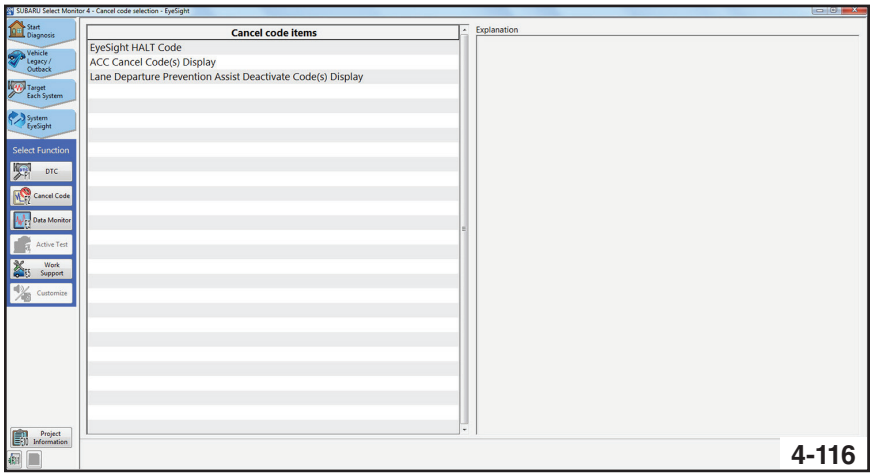
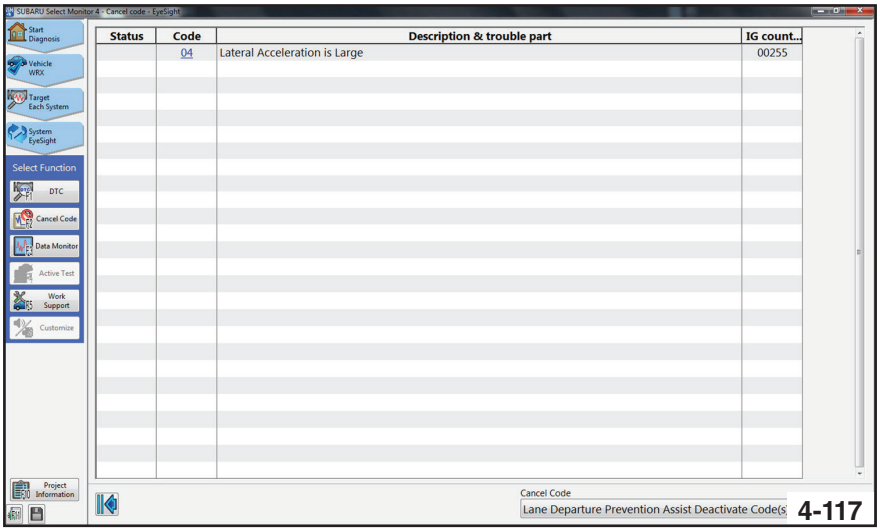
Checklist (Active Lane Keep)

Up to 8 Cancel Codes related to the LKA system may be stored. In the event more than 8 codes are stored, the oldest code will be deleted to store the latest.



SMM — EyeSight® System Cancel Codes



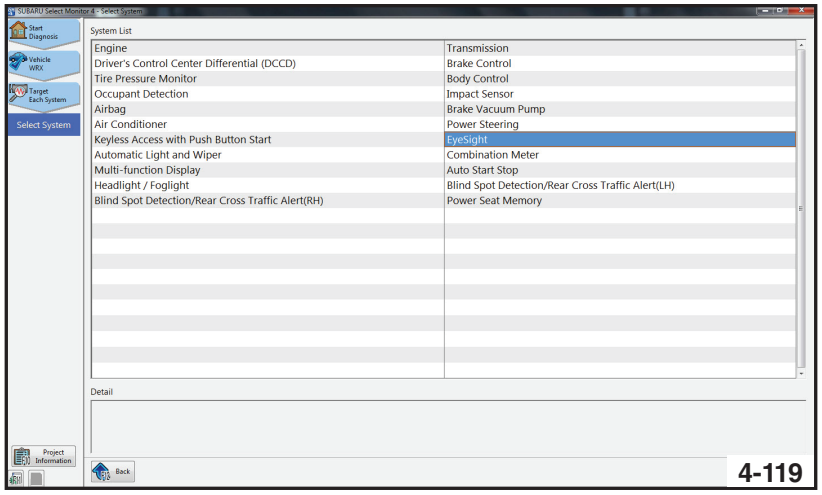
SSM — LKA Cancel Codes

Code	Item	Contents of diagnosis
02	Judging Steering Wheel Not Held	Detected when steering wheel operation by the driver is not detected for a predetermined time (approx. 17 seconds).
04	Lateral Acceleration is Large	Detected when control output value exceeds the controllable range by a driving operation such as rounding a curve at high speed or making a sharp turn.
0C	Lane Recognition Prohibition(Environmental Factor)	Detected when a driving lane width is narrowed.
11	Steering Angle Learning Value Out of Range	• Detected when there is an excessive deviation in the wheel alignment. • May also be detected when the center point of steering angle sensor deviates.
18	Out of Control Return Possibility Range	Detected when lane departure prevension control continues for a predetermined time.
26	Real Yaw Rate Excessive	Detected when actual yaw rate exceeds the maximum value of target yaw rate by a specified amount.
28	Wiper Hi Speed	Detected when wiper Hi operation is activated.
37	Yaw Rate Sensor Abnormal(Control)	Detected when the difference between actual yaw rate and expected yaw rate becomes the specified value or more. **4-118**

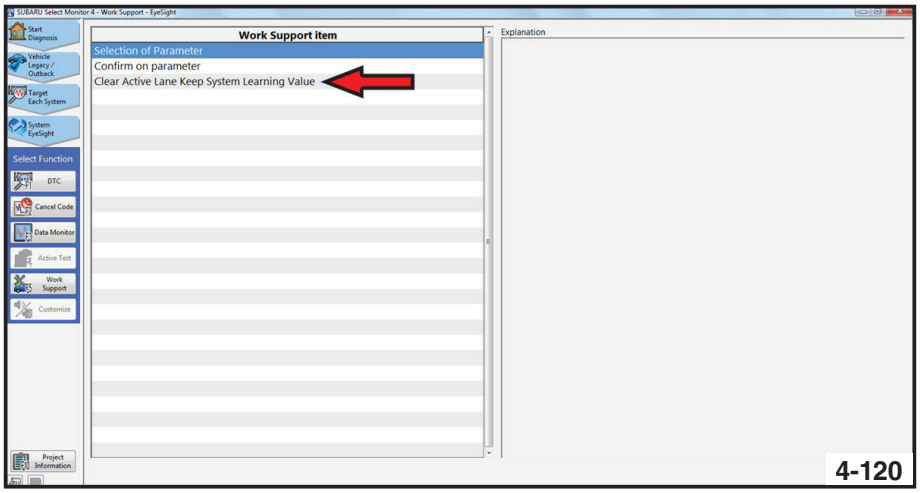
Service Manual — LKA Cancel Codes

LKA Learning Value

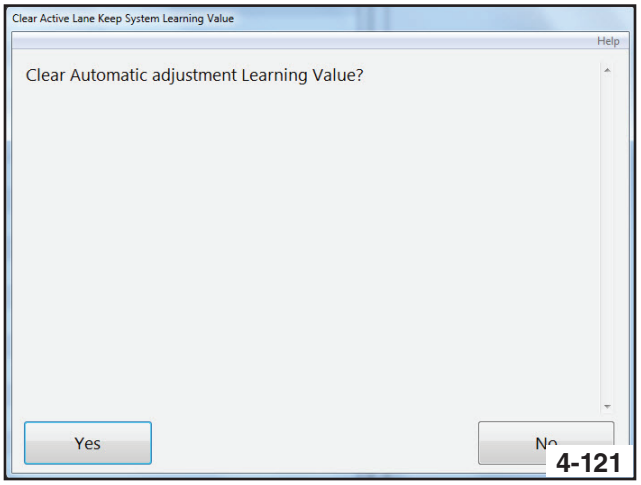
When suspension parts are replaced or a wheel alignment is performed, the “Clear Active Lane Keep System Learning Value” function should be executed.



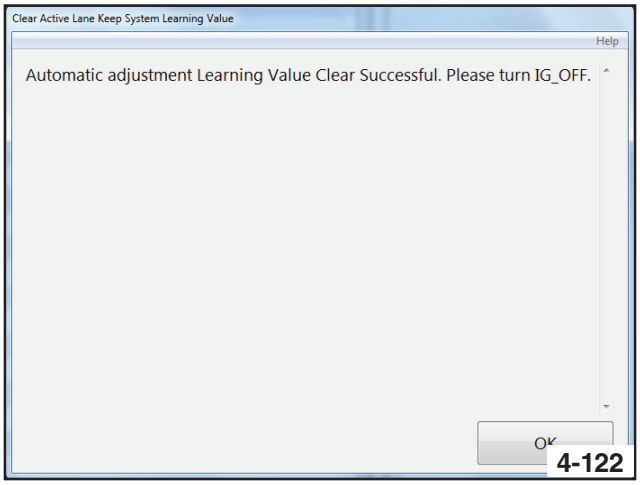
SSM — Target Each System



SSM — EyeSight® Utilities



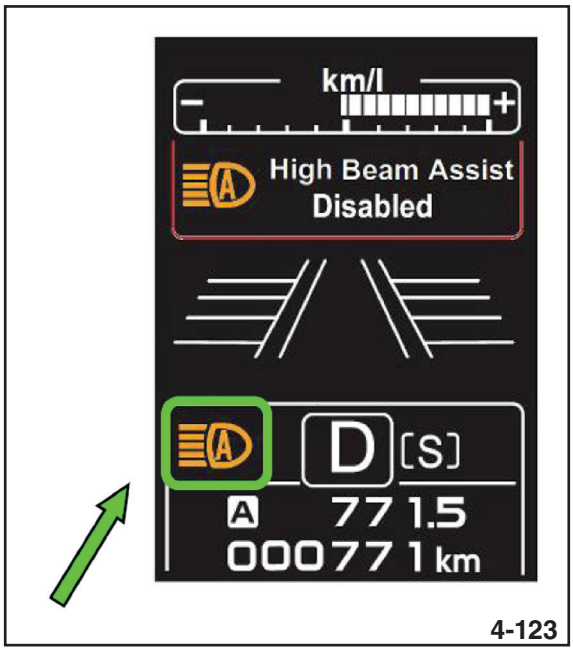
SSM — Clear Learning Value 1



SSM — Clear Learning Value 2

High Beam Assist (HBA)

A “yellow” High Beam Assist warning indicator may be displayed on the Combination Meter Multi Information Display (MID) if a malfunction is present in the system (Monocular camera vehicles).



HBA Malfunction Indicator

Basic diagnosis of the HBA system should always begin with the completion of the Check List for Interview found in the Service Manual.

High Beam Assist Check List for Interview		Date of Vehicle Bring-in Year Month Day	
Customer's name		Registration No.	Initial year of registration Year Month Date
		Vehicle model	Frame number
Interviewer	Inspector	Engine type	Odometer reading
Customer specified content			
Date and time when the symptom occurred	Year Month Date Approximate time		
Frequency of symptom occurrence	Always occurs Sometimes occurs (times per day/ times per month)		
Conditions upon symptom occurrence	Weather	• Fine • Cloudy • Rainy • Snowy• Foggy • Other ( )	
	Temperature	°C (°F) — °C (°F)	
	Vehicle speed	km/h (MPH) to km/h (MPH)	
	Road condition	• Dry • Wet • Accumulated snow • Unpaved road • Bumps (uneven) Other ( )	
	Road conditions	Own vehicle	• Straight • Gentle right-hand curve • Gentle left-hand curve • Sharp right-hand curve • Sharp left-hand curve • Uphill • Downhill • Intersection • Top of the hill • Other ( )
		Oncoming vehicle * Relative position from user's viewpoint	• No oncoming vehicle • Straight • Gentle right-hand curve • Gentle left-hand curve • Sharp right-hand curve • Sharp left-hand curve • Uphill • Downhill • Intersection • Top of the hill • Other ( )
		Headlight of oncoming vehicle * When the type is unknown, indicate the color.	• HID/LED (white) • Halogen • Only one side was lit • Other ( )

Conditions upon symptom occurrence	Road conditions	Preceding vehicle	• No preceding vehicle • Straight • Gentle right-hand curve • Gentle left-hand curve • Sharp right-hand curve • Sharp left-hand curve • Uphill • Downhill • Intersection • Top of the hill • Other ( )
		Number of street light ahead	• 0 • 1 • 2 • 3 • 4 • 5 • More ( )
		Reflection board/Signs	• 0 • 1 • 2 • 3 • 4 • 5 • More ( )
			• Red • White • Blue • Other ( )
	Vehicle status	Number of passengers: , (Front seats: /Rear seats:)	
		Cargo room load capacity	
		Tire inflation pressure (when vehicle was brought in) • Front wheel kPa (psi) • Rear wheel kPa (psi)	
	Driving duration and distance with the described load condition	• Distance km (mile) • Time minutes	
	Driving environment before symptom occurrence (Approximately 10 minutes before the occurrence)	• Inner city (surroundings are bright by street lights) • Suburbs (surroundings are relatively dark due to sparse street lights)	
Accessory installation condition			
Diagnostic code			
Other NOTE: • Describe things that were noticed, if any. • Attach illustration or photo of the road ahead of the vehicle at the time of the symptom occurrence.			

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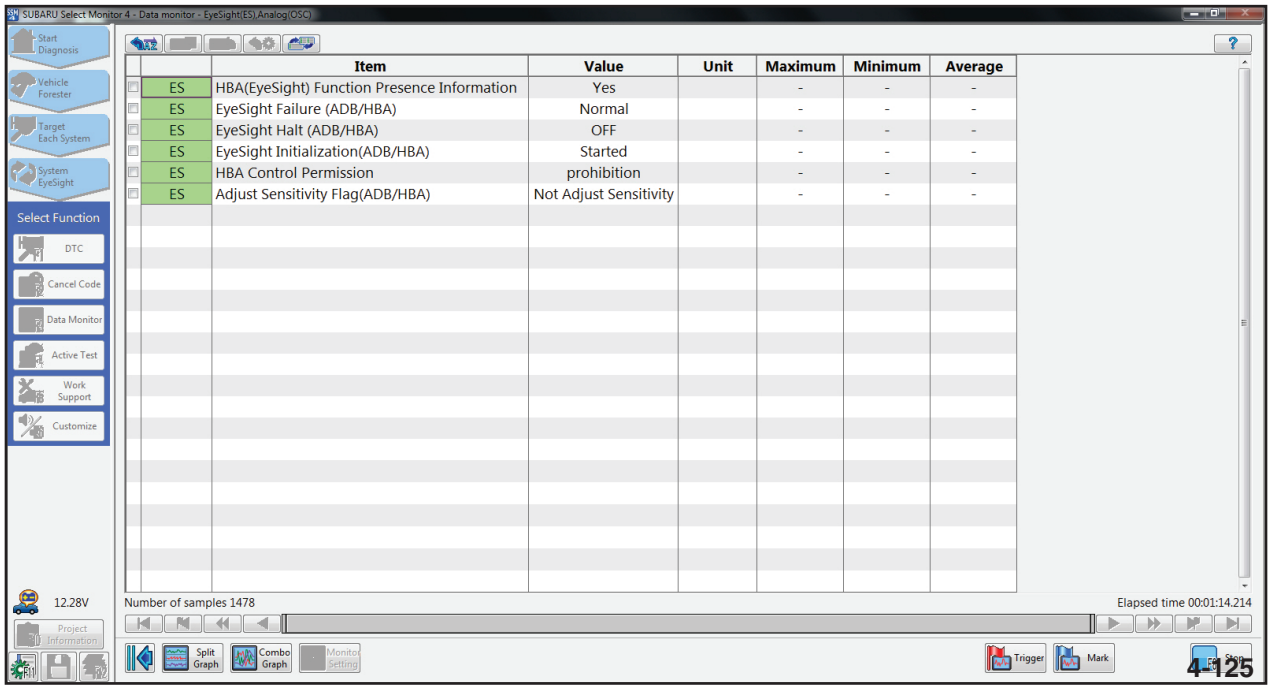
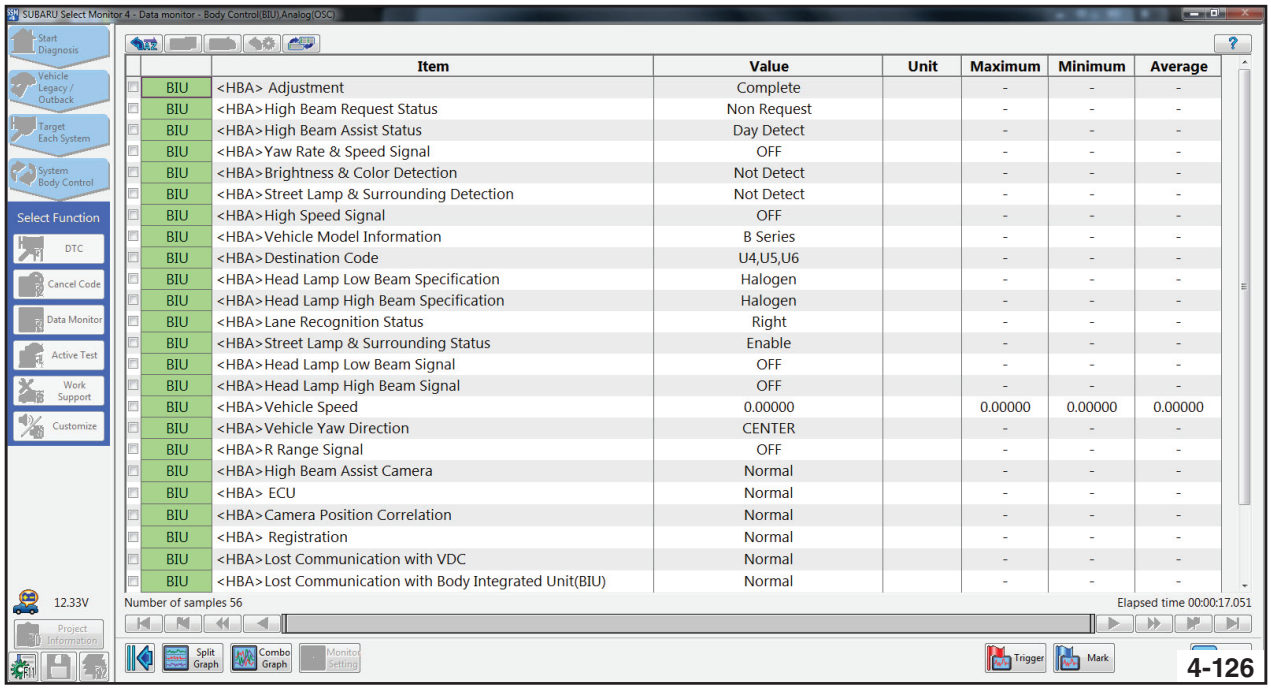
HBA Check List for Interview

Data related to the HBA system's inputs and outputs can be found under the EyeSight® system Data Monitor information.



HBA Data Monitor — EyeSight®

Models that use a Monocular camera contain HBA related data within the Body Control system menu of the SSM.



HBA "Data Monitor — Monocular

Note: Both HBA systems are equipped with a self-adjusting function. As a result, no aiming is required during removal or replacement.

EyeSight® based systems do not contain any unique HBA DTCs since the system contains no unique components. However, monocular camera systems contain approximately eleven unique DTCs due to the additional complexity.

DTC	Item	Note
B2680	HIGH BEAM ASSIST SENSOR	<Ref. to BC(diag)-60, DTC B2680 HIGH BEAM ASSIST SENSOR, Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
B2681	HIGH BEAM ASSIST CONTROL MODULE	<Ref. to BC(diag)-62, DTC B2681 HIGH BEAM ASSIST CONTROL MODULE, Diagnostic Procedure with diagnostic Trouble Code (DTC).>
B2682	HIGH BEAM ASSIST UNIT FIELD OF VIEW	<Ref. to BC(diag)-65, DTC B2683 VEHICLE SPECIFICATION INFORMATION REGISTRATION, Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
U111F	<HBA>LOST COMMUNICATION WITH BODY CONTROL MODULE	<Ref. to BC(diag)-75, DTC U111F <HBA>LOST COMMUNICATION WITH VEHICLE DYNAMICS CONTROL MODULE, Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
U1145	<HBA>LOST COMMUNICATION WITH BODY CONTROL MODULE	<Ref. to BC(diag)-75, DTC U1145 <HBA>LOST COMMUNICATION WITH BODY CONTROL MODULE. Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
U115A	<HBA>LOST COMMUNICATION WITH INSTRUMENT PANEL CLUSTER (IPC) CONTROL MODULE	<Ref. to BC(diag)-76, DTC U115A <HBA>LOST COMMUNICATION INSTRUMENT PANEL CLUSTER (IPC) CONTROL MODULE, Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
U123C	LOST COMMUNICATION WITH HIGH BEAM ASSIST CONTROL MODULE	<Ref. to BC(diag)-76, DTC U123C LOST COMMUNICATION WITH HIGH BEAM ASSIST CONTROL MODULE, Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
U141A	<HBA>INVALID DATA RECEIVED FROM INSTRUMENT PANEL CLUSTER (IPC) CONTROL MODULE	<Ref. to BC(diag)-76, DTC U141A <HBA>INVALID DATA RECEIVED FROM VEHICLE DYNAMICS CONTROL MODULE, Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
U142A	<HBA>INVALID DATA RECEIVED FROM INSTRUMENT PANEL CLUSTER (IPC) CONTROL MODULE	<Ref. to BC(diag)-76, DTC U142A <HBA>INVALID DATA RECEIVED FROM INSTRUMENT PANEL CLUSTER (IPC) CONTROL MODULE, Diagnostic Procedure with Diagnostic Trouble Code (DTC).>
U1446	<HBA>INVALID DATA RECEIVED FROM BODY CONTROL MODULE	<Ref. to BC(diag)-76, DTC U1446 <HBA>INVALID DATA RECEIVED FROM INSTRUMENT PANEL CLUSTER (IPC) CONTROL MODULE, Diagnostic Trouble Code (DTC).>
U153D	INVALID DATA RECEIVED FROM HIGH BEAM ASSIST CONTROL MODULE,	<Ref. to BC(diag)-76, DTC U153D INVALID DATA RECEIVED FROM HIGH BEAM ASSIST CONTROL MODULE, Diagnostic Procedure with Diagnostic trouble Code (DTC).> **4-127**

HBA DTCs — Monocular

Stereo Camera Adjustment and Inspection

Camera Adjustment

Whenever removed or replaced, the Stereo Camera must be adjusted/calibrated to correct errors which exist in manufacturing tolerances in the body shell or in the Stereo Camera assembly. The lateral and longitudinal optical axis and measuring distance to an object are compensated in the Camera Adjustment procedure.

Camera Inspection

The Stereo Camera can be inspected for accuracy without making adjustments to the optical axis. This is useful in identifying Stereo Cameras that have skewed by impact or damage, contaminated, or improperly installed. By performing the Camera inspection, malfunctions or damages of the Stereo Camera, for example finger print on the lenses, can be detected.

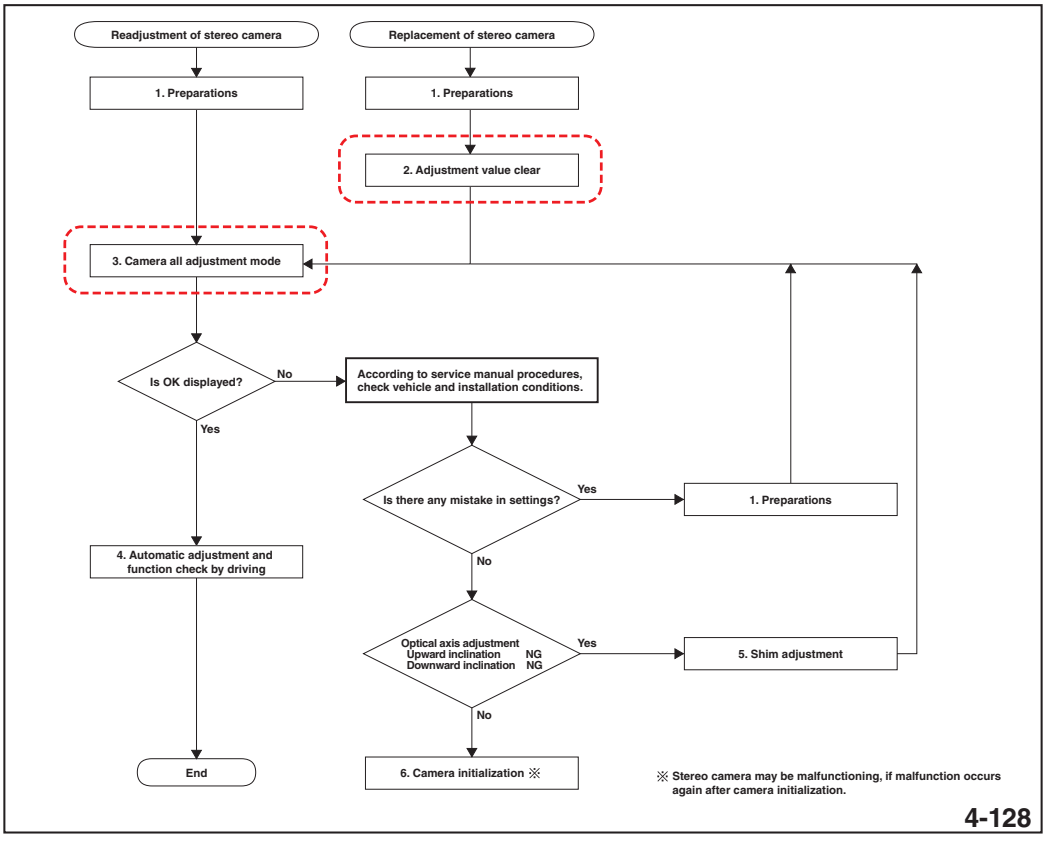
Note: When a new Stereo Camera is installed on a vehicle, the EyeSight® warning lamp stays on and the following DTCs may be generated:

- B28AF: Camera Adjustment and Inspection has not been completed
- B28A0: Vehicle model judgment abnormal.

After the camera adjustment and inspection are completed successfully, those DTCs will be cleared.

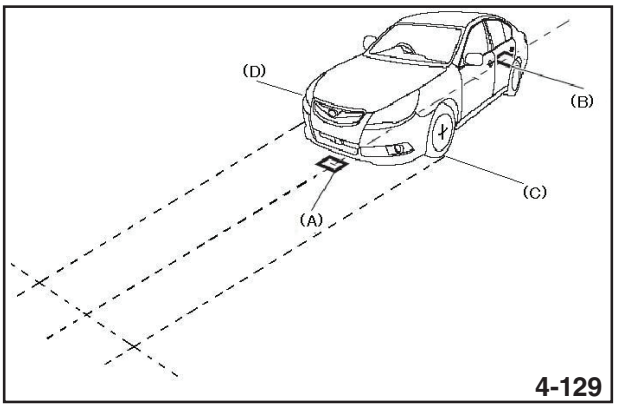
Preparations

The first step in preparing the EyeSight® system for either a Camera Adjustment or Camera Inspection is to perform the “Preparations” Step.



Camera Adjustment, Inspection Flow Chart

The “Preparation” step requires the placement of a SST Random Chart at a specific height and distance so that it is centered and square in relation to the vehicle. Height and distance of the SST varies by make and model and there are 2 SST random charts available for the Version 2 and Version 3 EyeSight® systems. The SST Random Charts are not interchangeable between the Version 2 and Version 3 systems.



Preparation Measurements

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST87599YC001	87599YC001 (Newly adopted tool)	RANDOM CHART	Used for adjusting stereo camera.
		Version 2	
 ST87599VA000	87599VA000 (Newly adopted tool)	RANDOM CHART	Used for adjusting stereo camera.
		Version 3	

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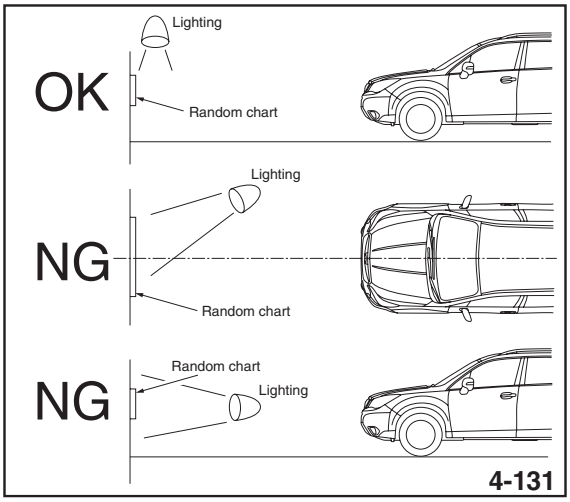
SST Random Charts (Version 2 & Version 3)

Notes: Before beginning Preparations, the following must be verified;

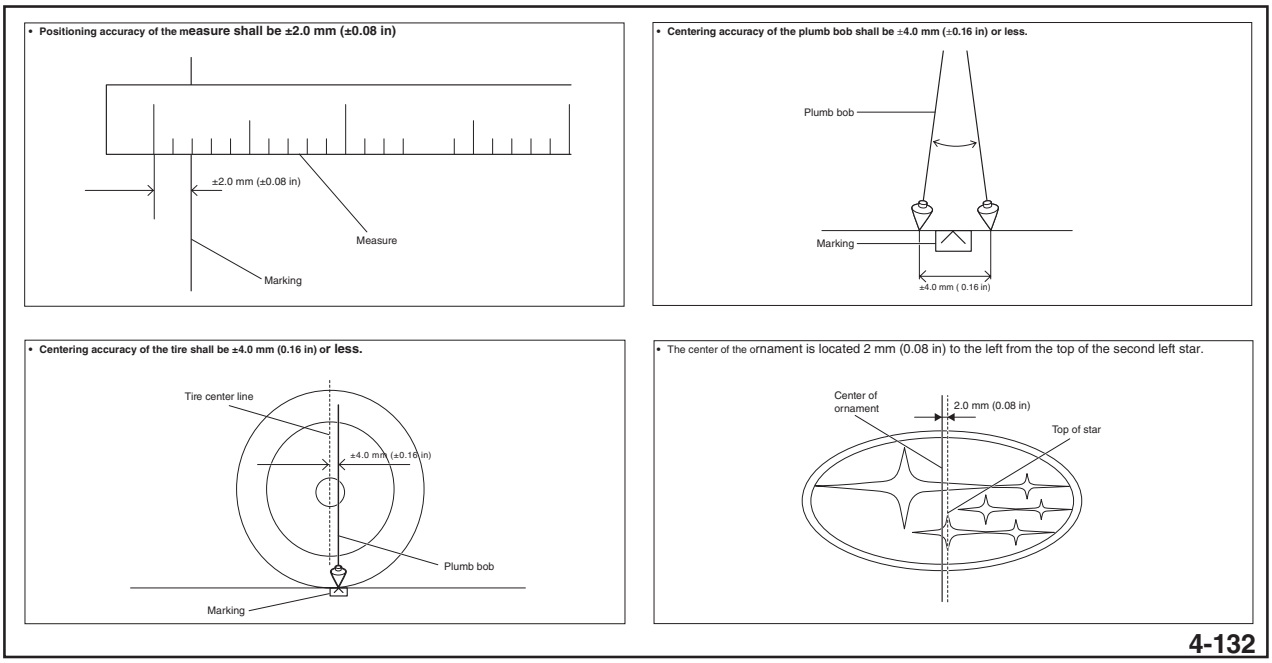
- Headlights are OFF
- Vehicle is parked on a level surface*
  - Surfaces must be level. Currently, no tolerance is specified
- Inflation pressure of tires is correct
- Vehicle does not have luggage or loads in the trunk/cargo area
- The front wheels are directed to the straight ahead position, when the steering wheel is set to the center position
- The area is well lit

Light sources must be illuminated from the top of the random chart area. Abnormal light sources may cause reflections on the SST Random Chart. Performing the Inspection and Adjusting Procedures outside is not recommended due to the inconsistency of light from the sun.



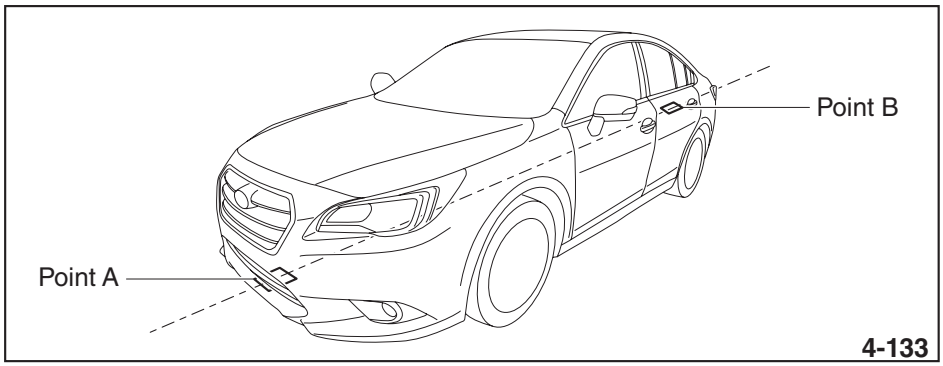
Lighting Source Considerations

Setting the height and distance of the SST Random Chart requires the use of plumb bobs, strings, tape, and tape measures. Each measurement requires great care and attention to ensure accuracy.

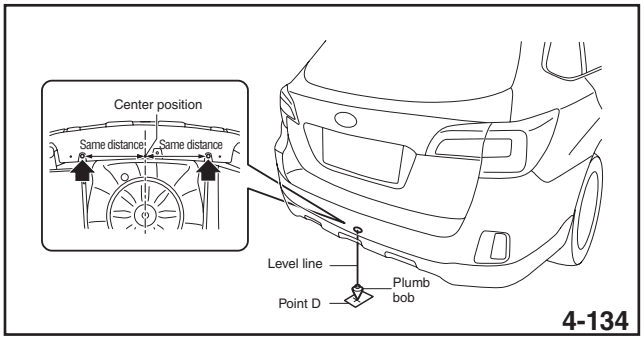


Measuring Accuracy

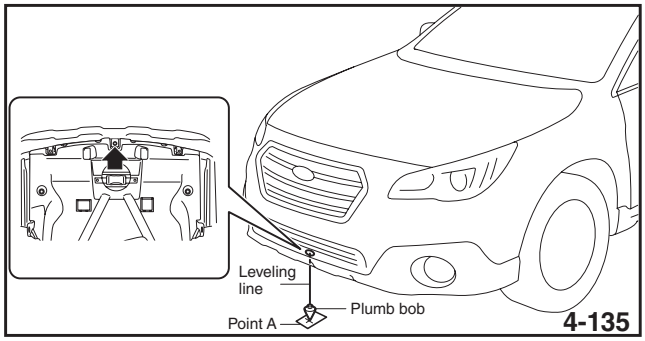
The first series of measurements are designed to establish the centerline of the vehicle. Measurements are obtained from specific points on the front and rear of the vehicle.



Vehicle Center Line

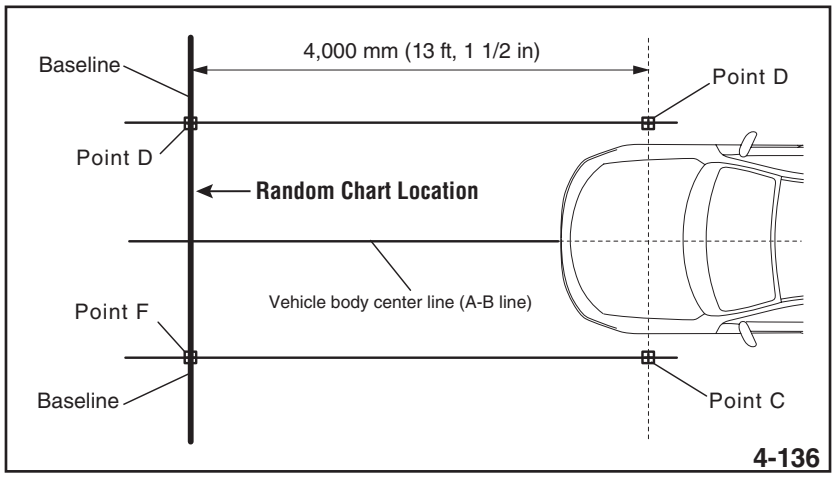


Point B Measurement



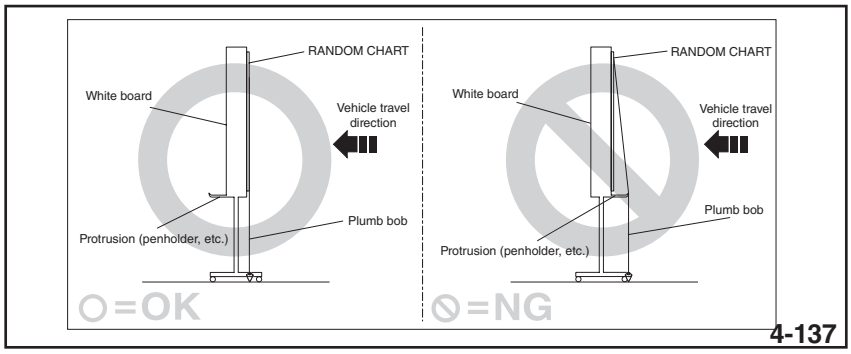
Point A Measurement

The second series of measurements are designed to place the vehicle squarely in relation to the SST Random Chart mounting surface. The preferred mounting surface is mobile white board or similar flat/mobile surface. However, a wall may be used as a mounting surface for the Random Chart.

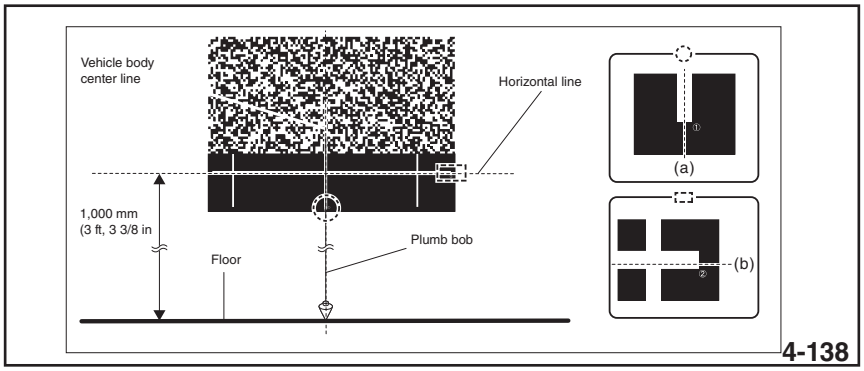


Base Line Measurement

Completing the measurements has produced a “base line” that is square, centered, and a specific distance from the front wheels of the vehicle. At this point the SST Random Chart can be prepared. The Random Chart contains markings on the lower portion to align it with the “base line” and properly set the height. If a mobile white board is used, it is critical that the plumb bobs be allowed to freely hang from the Random Chart to the floor without any obstructions such as penholders.



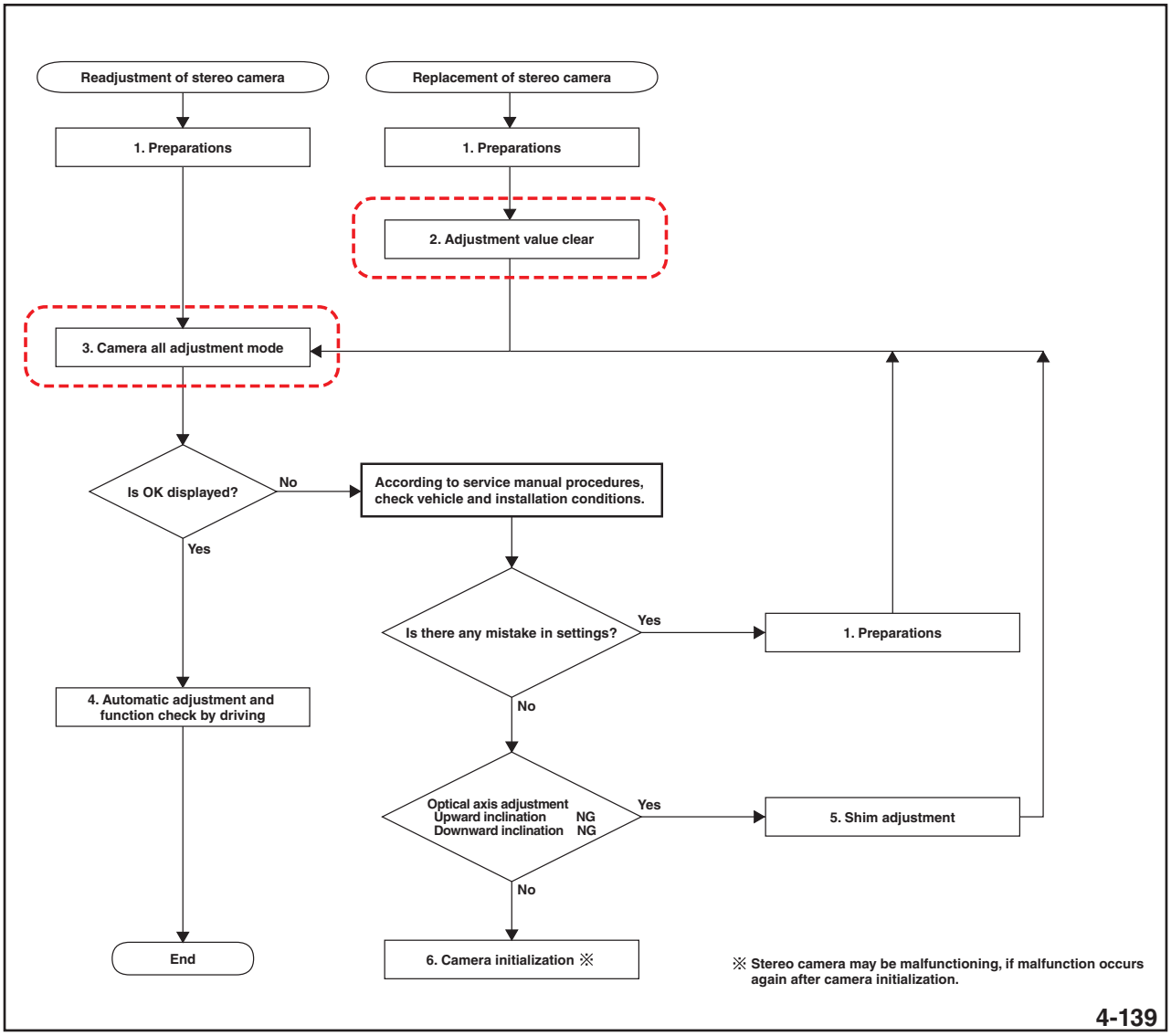
SST Random Chart Mounting



SST Random Chart Preparation

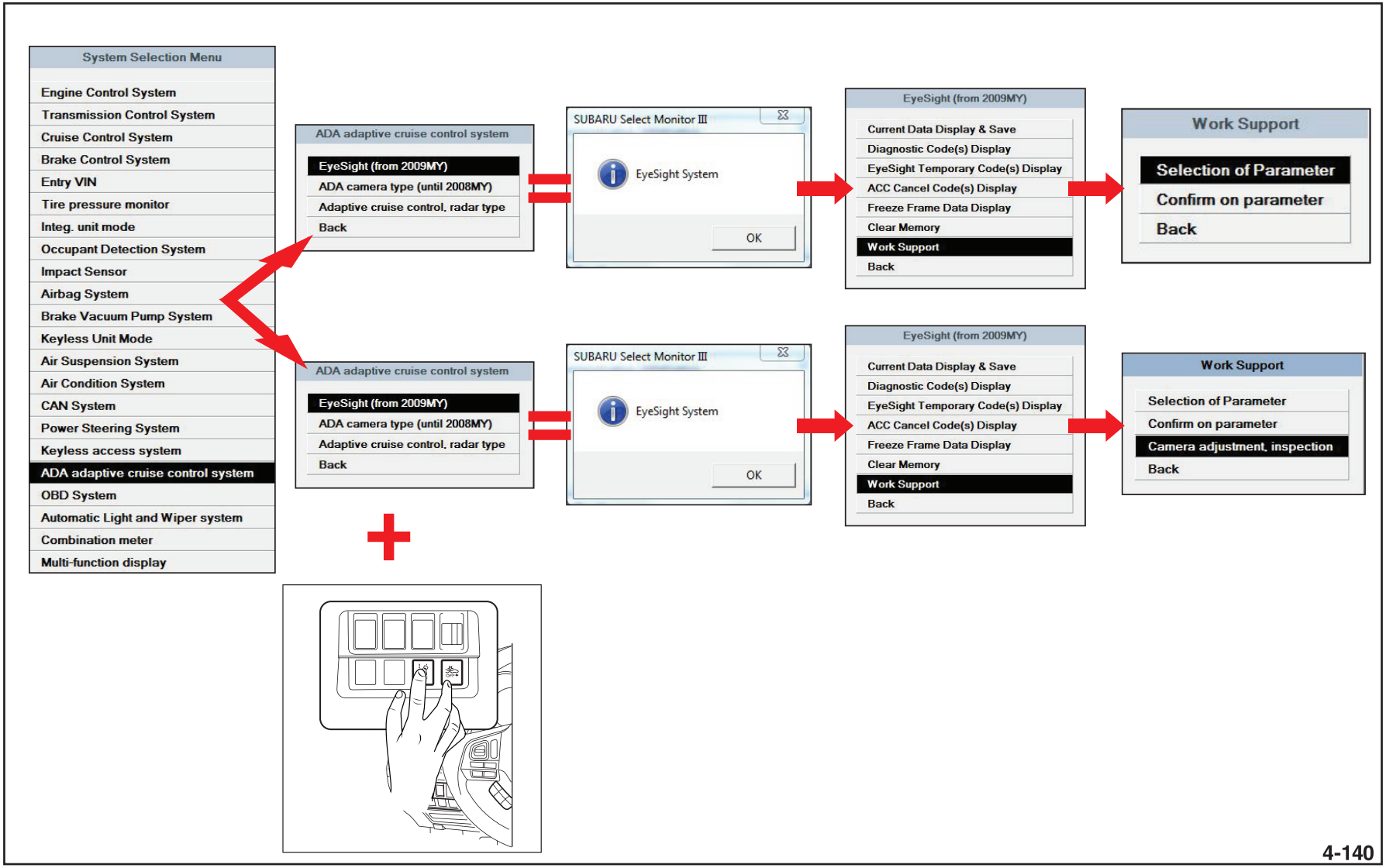
Subaru Select Monitor Work Support

Once preparations have been completed, the Subaru Select Monitor (SSM) is used to perform the Work Support functions of the EyeSight system.



Preparations Complete

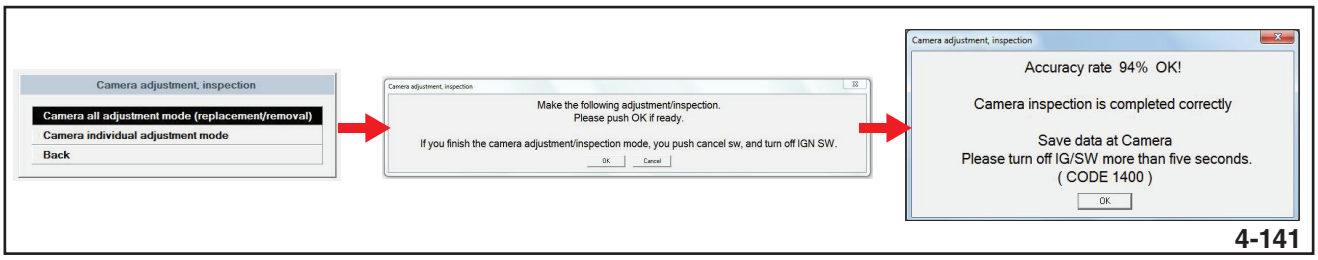
To access the Camera Adjustment, Inspection menu on the SSM, both the Pre-Collision Brake OFF and Lane Departure Warning OFF switches must be depressed as the “EyeSight (from 2009MY) menu option is selected. This is designed to prevent unwanted access to the Camera Adjustment functions.



Camera Adjustment – SSM Menus

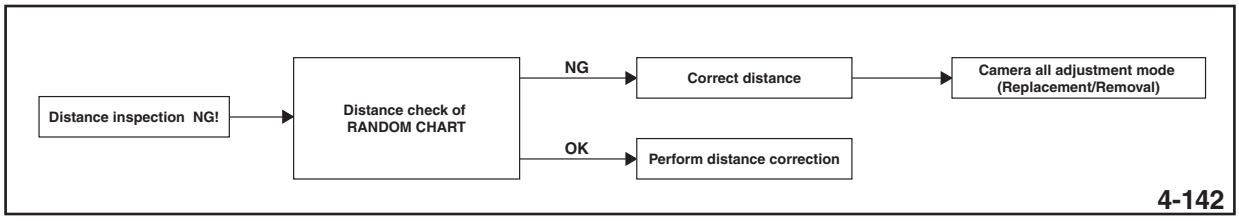
Camera All Adjustment Mode

The Camera All Adjustment Mode (replacement/removal) is the primary SSM function that is used if the Stereo Camera assembly has been removed, replaced, or disturbed for any reason.



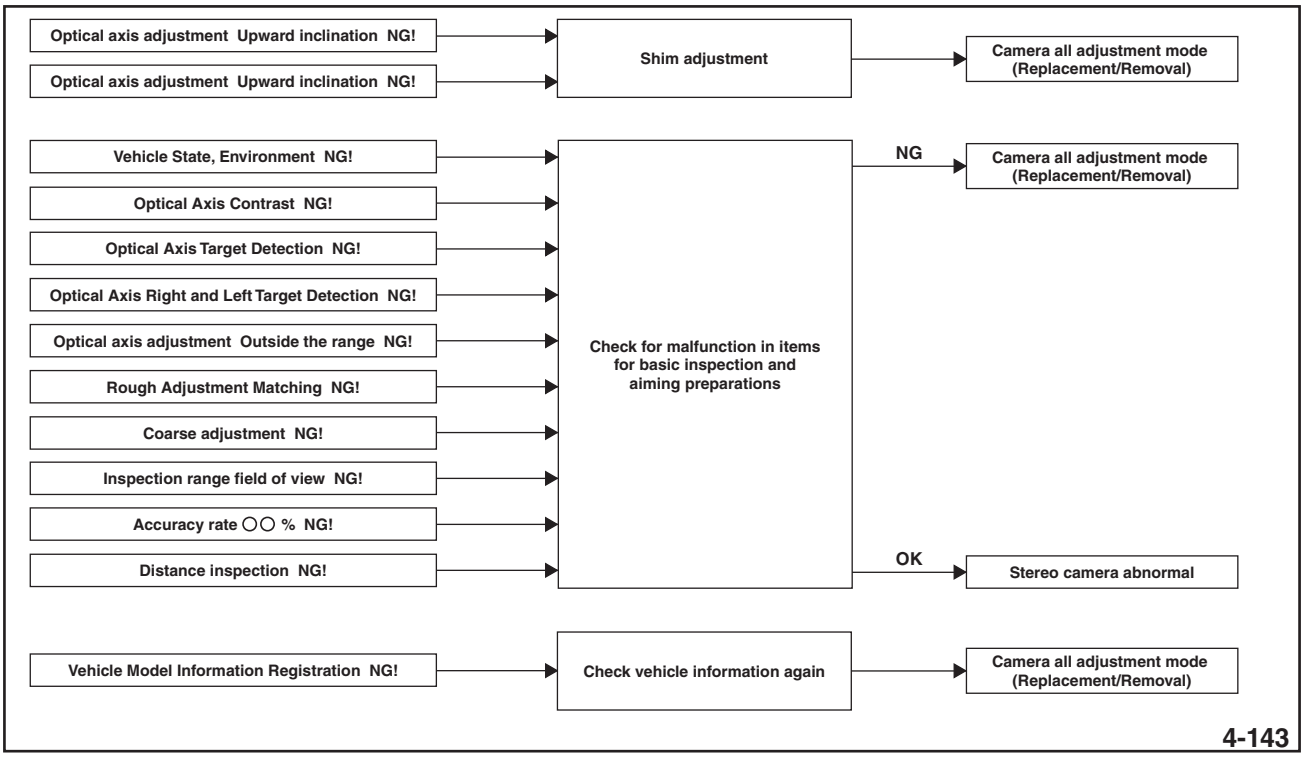
All Adjustment Mode (Replacement/Removal)

If a “Distance Inspection NG!” message is displayed, it is likely that the preparation was performed incorrectly. Confirm all preparation measurements and reattempt the procedure.



“Distance Inspection NG!” Flow Chart

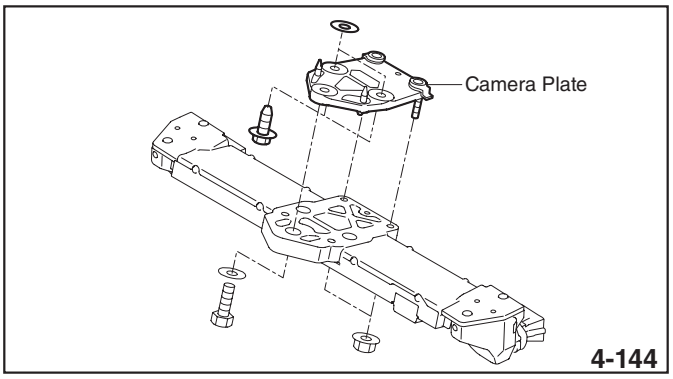
If a “ - - NG!” accuracy rate is displayed, numerous issues may be present Refer to the Service Manual inspection flow chart for corrective actions.



“— NG!”Accuracy Rate Flow Chart

If the “Optical Axis Adjustment, Upward or Downward Inclination NG!” messages are displayed, it may be necessary to add a shim (washer) between the vehicle body and camera plate. Only one shim part number is available to achieve adjustment in either the upward or downward directions. Inserting the shim into the front side of the camera assembly makes the camera angle downward. Inserting the shim into the rear side of the camera assembly makes the camera angle upward.

Note: Always verify a level floor was used during preparations before installing a shim. In many cases, an improperly prepared Random Chart height may erroneously generate an Optical Axis Adjustment message.



Stereo Camera Mounting

Once the Camera All Adjustment Mode (replacement/removal) has been completed it is necessary to drive the vehicle to perform an Automatic Adjustment and Function Check. The vehicle must be driven on a straight road with white lines on both sides at a speed of 40 km/h (25 MPH) or more for at least five minutes, while maintaining distance from the preceding vehicle 40 m (132 ft) or more. The Automatic Adjustment and Function Check is complete when the “Automatic Adjustment Status” PID on the SSM reaches a “0F” or “1F” status.

Note: For new vehicles “00” may be displayed. However, it is not necessary to test-drive the vehicle before delivery because high-accuracy aiming is performed at the factory.

Item	Value	Unit
☑ Automatic Adjustment Status	00	

Item	Value	Unit
☑ Automatic Adjustment Status	1F	

4-145

Automatic Adjustment Status

Monitoring the “Lane Recognition Status” PID on the SSM may aid in minimizing the required time to reach an acceptable Automatic Adjustment Status. A value of “00” indicates no lanes are detected by the EyeSight system.

Note: Lane Recognition Status values vary by model. Consult STIS for the correct values.

Item	Value	Unit	
☑ Lane Recognition Status	00		4-146

Lane Recognition Status

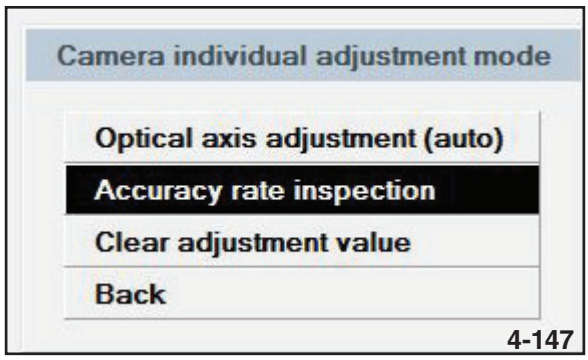
Camera Individual Adjustment Mode

Three additional functions exist under the “Camera Individual Adjustment Mode” menu:

Optical Axis Adjustment (Auto) – No field functionality

Accuracy Rate Inspection – Measures current accuracy rate (requires preparation). If the measured distances are correct at more than 70% of the divided sections, the EyeSight® system judges that the system has no trouble.

Clear Adjustment Value – Clears adjustment setting



Camera Individual Adjustment Mode – SSM Menu

NOTES:

Reverse Automatic Braking (RAB)

Introduction

Optionally available with some 2017 MY Subaru vehicles, the Reverse Automatic Braking (RAB) system is a driver assist system designed to help avoid collisions or reduce collision damage when reversing the vehicle. If a wall or other obstacle is detected in the reversing direction, the system will notify the driver with progressive audible warnings, reduce engine power, and activate the vehicle's brakes automatically.

Reverse Automatic Braking (RAB) - Sonar Sensors

WARNINGS:

- Reverse Automatic Braking is not a system intended to replace the driver's responsibility to check surrounding areas for vehicles, obstacles or to avoid a collision.
- The driver is responsible for driving safely. Always be sure to check the surroundings visually when reversing the vehicle.
- Since the system operation has various limitations, the warning sound or automatic braking may be delayed or may not operate at all even when an obstacle is present in the reversing direction.
- The system is not designed to detect people (including children), animals or other moving objects.
- Depending on the vehicle condition or the surrounding environment, the sonar sensor's ability to detect objects may become unstable.

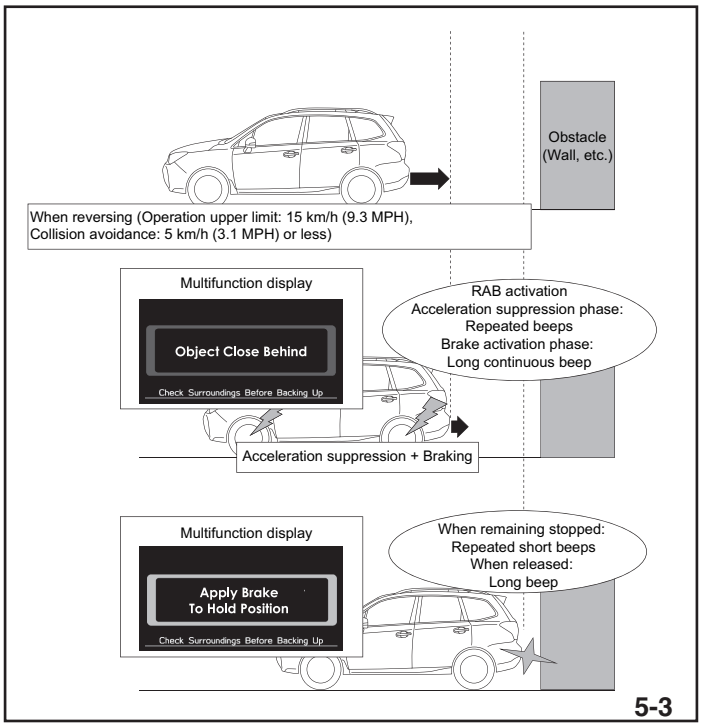
* For a full listing of RAB warnings and cautions, consult the applicable Owner's Manual and/or Service Manual.

System Operation

The Reverse Automatic Braking (RAB) system detects and measures the distance of objects from the vehicle using ultrasonic sonar sensors installed in the rear bumper area. When the system determines there is a moderate possibility of a collision, it will provide progressive audible alerts to the driver through the Combination Meter speaker. When the system determines there is a high possibility of a collision, it will reduce engine power and carry out braking control to reduce any potential damage caused by hitting the object.

When engine power suppression control or brake control is being carried out, a warning screen is shown on the Multi-Function Display (MFD) and an alarm sound is emitted to inform the driver that the system control has been activated.

Note: After automatic braking control, if no operations are performed by the driver for 120 seconds, the Electronic Parking Brake (EPB) will be applied (EPB equipped vehicles only).

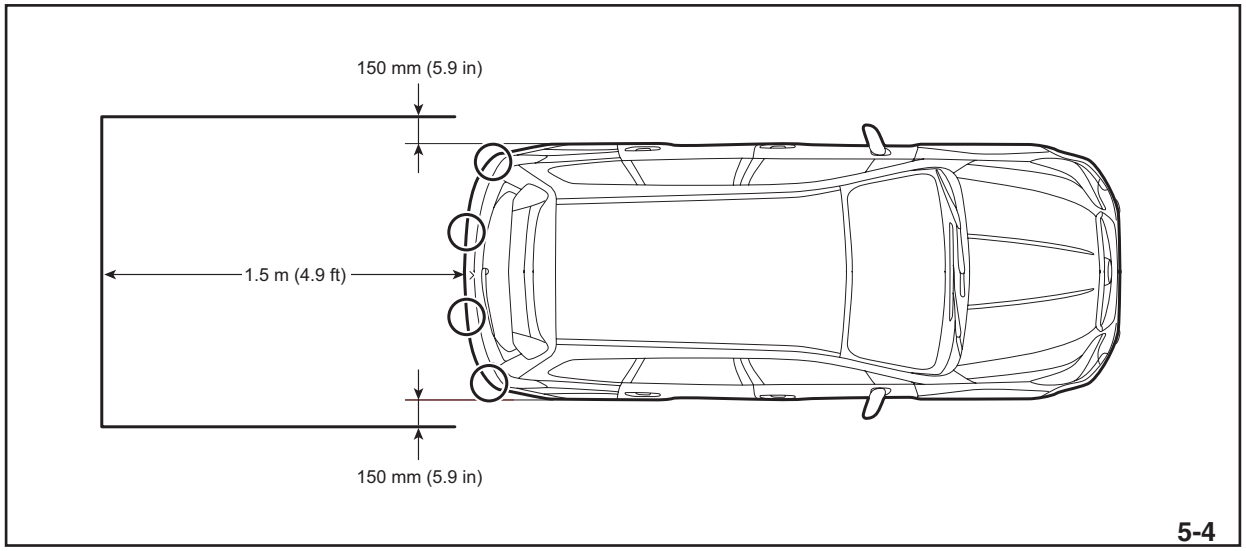


RAB Phases of Operation

Operating Conditions	Cancel Conditions
• RAB activation ON • Parking brake OFF • The select lever is in the “R” position. • The vehicle is reversing at approximately 1.5 to 15 km/h (1 to 9 mph). • The obstacle is approximately 0.5 m (1.64 ft.) or further from the bumper when the select lever is shifted to the “R” position.	• The driver depresses the brake pedal when the vehicle remains at a complete stop. • The driver depresses the accelerator pedal when the vehicle remains at a complete stop. • Obstacles are unable to be detected. • The driver strongly depresses the accelerator pedal during acceleration suppression. • The select lever is shifted to any position other than “R”.

The RAB system utilizes four bumper-mounted sonar sensors that provide a maximum detecting range of approximately 4.9ft (1.5m) from the rear of the vehicle and approximately 5.9in (150mm) outside the vehicle width.

Caution: The sensors cannot detect objects that are moving and/or too close to the rear bumper (Appx. 20in (50cm)).

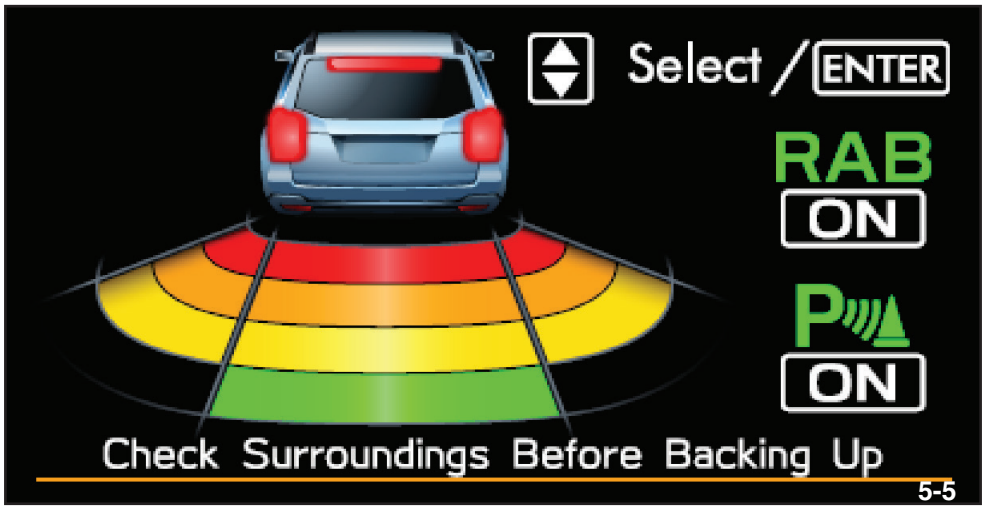


Sonar Sensor Detecting Range

Caution: In the following cases, the system may not be able to properly detect an obstacle:

- A sticker, paint, or a chemical is applied to the rear bumper near the sonar sensor
- The rear bumper is modified
- The rear bumper has been removed and reattached incorrectly
- The ground clearance is changed due to the vehicle's loading condition or modification
- Ice, snow or mud is adhered to the rear bumper near the sonar sensor
- The rear bumper is exposed to strong impact, or the rear bumper is deformed

When the shifter lever is placed in the “R” position, a visual representation of the detecting range is displayed on the Multi-Function Display (MFD), if equipped. Each of the four colored blocks represents a specified range from the detected object. As the vehicle becomes closer to objects in the reversing direction, the colored blocks will illuminate to indicate the proximity of the object and relative location behind the vehicle.



RAB Detection Area Display

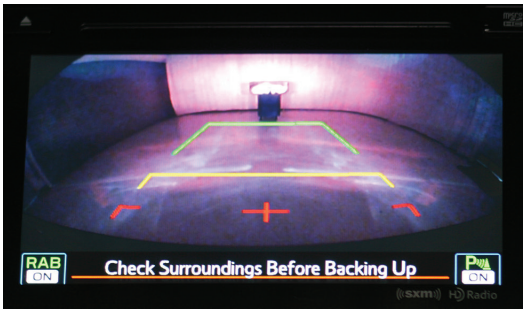
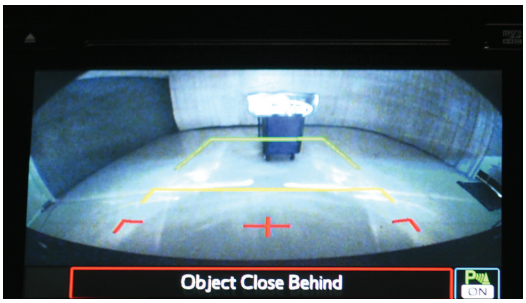
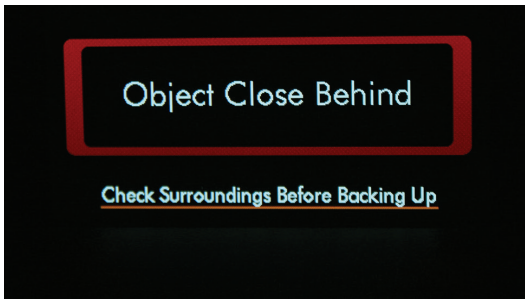
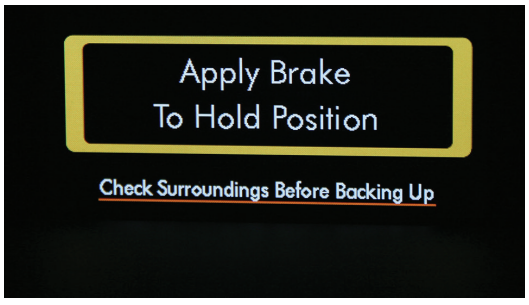
Alarm pattern	Range of detected object	Distance indicator	Warning sounds
Long proximity warning (Obstacle detect warning)	35 inches (90cm) or more	Green	No warning sound
Medium proximity warning (First braking and warning -yellow)	28 to 35 inches (70 to 90cm)	Yellow + Green	Short beeps
Short proximity warning (First braking and warning - orange)	20 to 28 inches (50 to 70cm)	Orange + Yellow + Green	Rapid short beeps
Closest proximity warning (Second braking and warning)	20 inches (50cm) or less	Red + Orange + Yellow + Green	Continuous beep
* Range of detection may vary depending on the environmental condition. 5-6			

Guideline of Detecting Range

Note: The following types of obstacles (including, but not limited to) may not be detected:

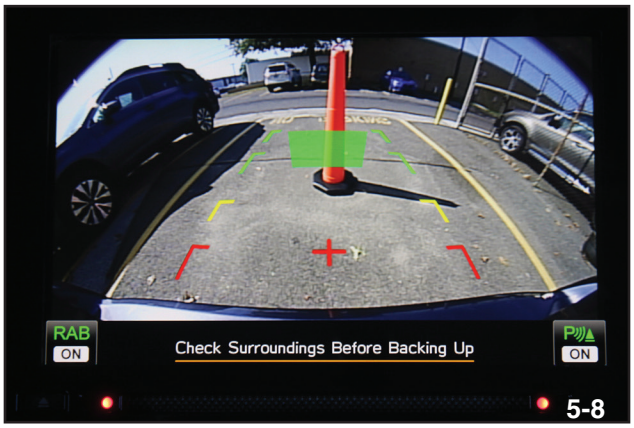
- Sharp objects, thin poles, fences, thin objects such as ropes.
- Objects with particular surface conditions.
- Objects that are poor at reflecting sound waves such as people, cotton, or snow.
- Objects such as walls orientated at an angle to the vehicle
- Objects that have a low height.

As the vehicle approaches an obstacle the warning messages are displayed on the Navigation screen or MFD. The visual warnings are supplemented by progressive audible warnings from the Combination Meter speaker. Visual warning messages differ depending on the model as shown below:

	Vehicle without MFD	Models with MFD
1st Stage		
2nd Stage		
3rd Stage		
4th Stage		
		5-7

Stages

Beginning with 2017MY Impreza models, reverse display is enhanced are displayed with color coordinated boxes indicating their distance from the rear of the vehicle.



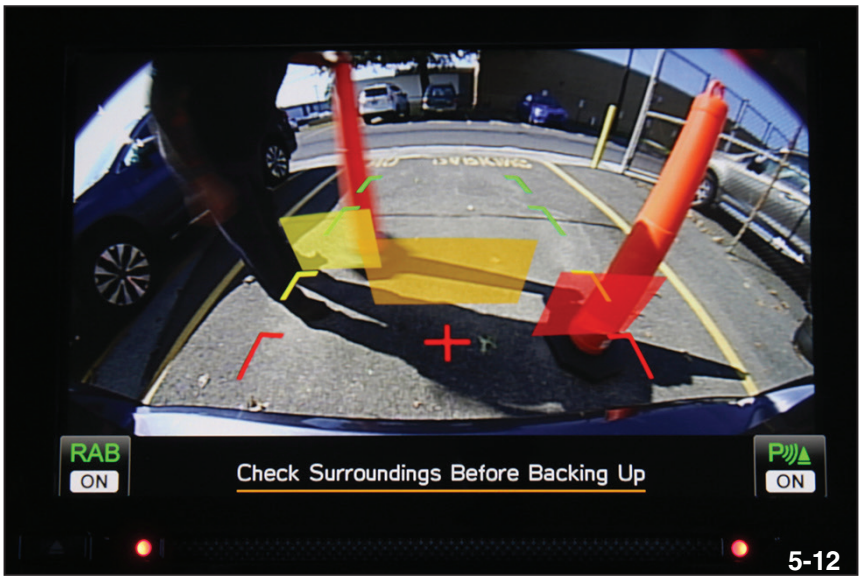
RAB Warning – Green

RAB Warning – Yellow

RAB Warning – Orange

RAB Warning – Red

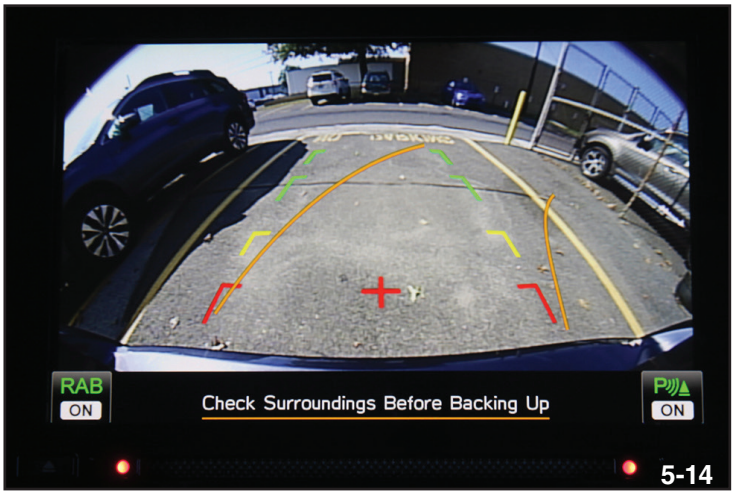
The system also detects and displays multiple objects in multiple areas behind the vehicle.



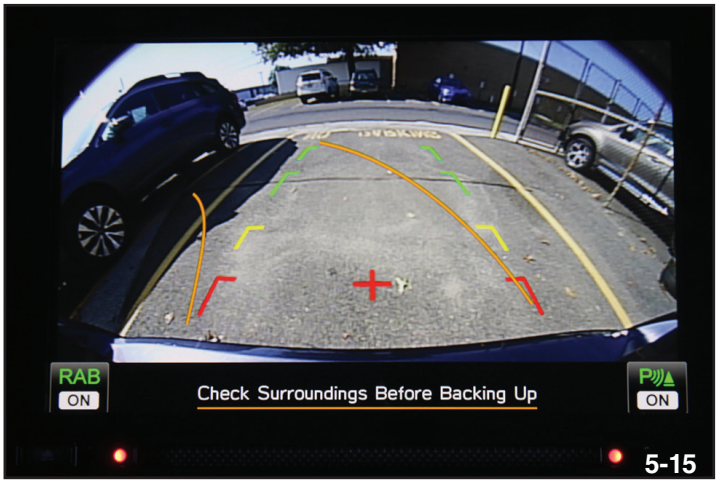
RAB Warning – Multiple Objects

When reversing the vehicle, new guidance lines are displayed when the steering wheel is turned.

Reverse – Straight



Reverse – Left



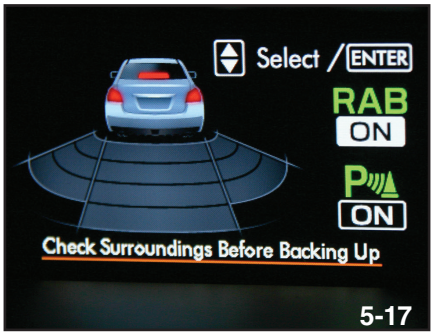
Reverse – Right

When the shifter lever is in the “R” position, the MFD or Navigation will display driver selectable options to temporally disable the automatic braking and audible warning functions. Control of these selections varies depending on the model equipment.

Note: Both functions are restored to the default “ON” setting the next time the shifter lever is placed in the “R” position.

Vehicles that are equipped with an MFD utilize the MFD control button to toggle the RAB functions ON and OFF. Selections made can be seen on the MFD screen.

MFD Control Button



RAB Functions-Enabled

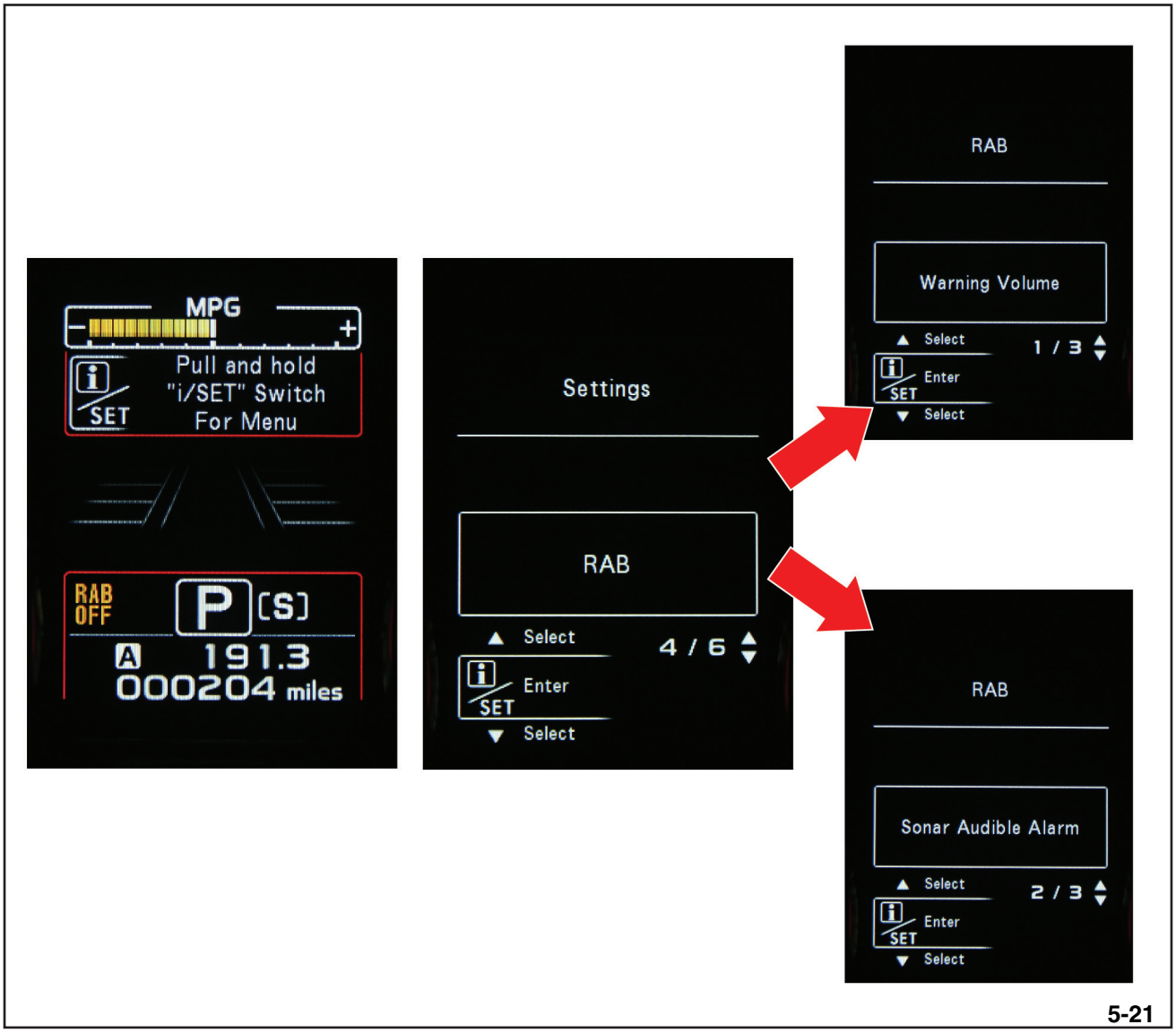
RAB Functions-Disabled

Vehicles that are not equipped with an MFD utilize the navigation screen to toggle the RAB functions ON and OFF. Selections are made by a “long press” of the touch screen button.

RAB Functions-Enabled

RAB Functions-Disabled

The driver can customize Warning Volume and Sonar Audible Alarm ON/OFF settings through the Multi-Information Display (MID) located in the center of the Combination Meter. These selections can be toggled by using the steering wheel mounted controls.

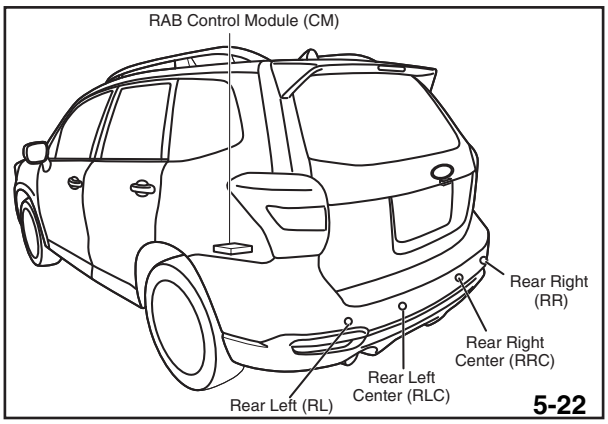


RAB Customization

RAB (Models with EyeSight® system)	Setting	Options	Default
	Warning Volume	Max/Mid/Min	Mid
	Sonar Audible Alarm	On or Off	On

System Construction

The RAB system is comprised of a Control Module (RAB CM), four (4) Sonar Sensors, four (4) Sensor Holders/Bezels, and a Sensor Harness.

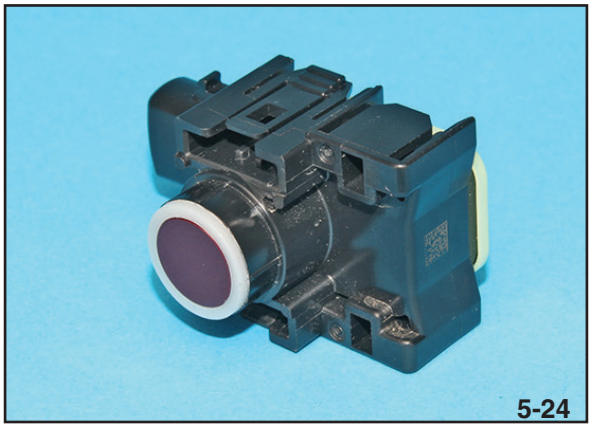


RAB System Overview

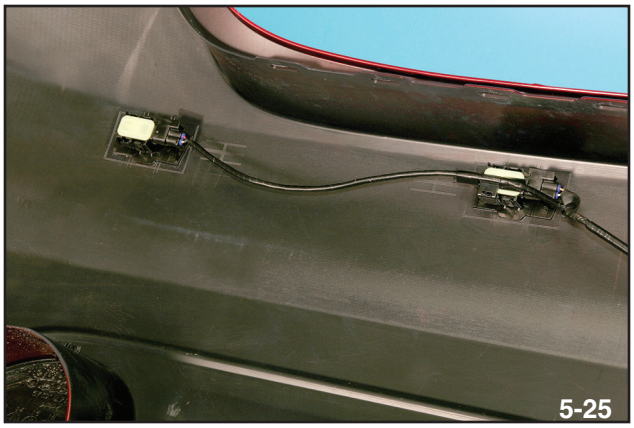
Sonar Sensor Mounting

Each sensor functions as a speaker and microphone that transmits and receives ultrasonic sound waves. As these waves reflect off objects in the projected area, integrated circuits (IC) in each sensor calculate the distance between the obstacle and the vehicle. The results of these calculations are sent to the RAB CM to determine the correct level of driver warning and/or intervention.

Note: On some models, the Sonar Sensors are painted to match the body color. In those instances, replacement sensors are ordered pre-painted to match the vehicle.



Sonar Sensor - 1



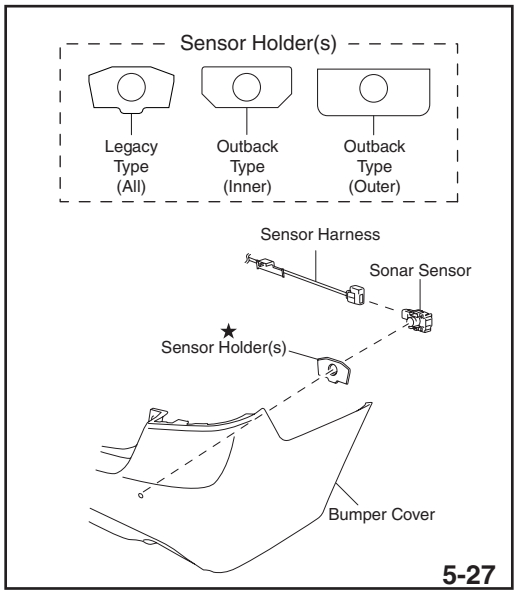
Sonar Sensor - 2

☐	RAB	RR Sonar Detection Distance	32	cm	218	0	94
☐	RAB	RRC Sonar Detection Distance	0	cm	144	0	5
☐	RAB	RL Sonar Detection Distance	132	cm	138	0	16
☐	RAB	RLC Sonar Detection Distance	0	cm	0	0	0

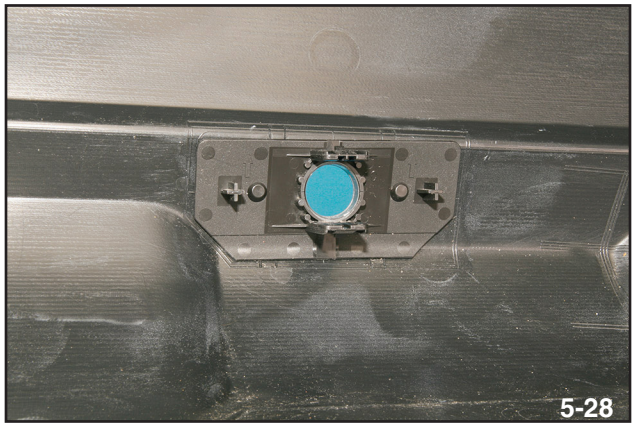
5-26

Sonar Sensor - SSM Data

Each Sonar Sensor is attached to the bumper by a flush mount Sensor Holder or a Sensor Bezel. Holders and bezels may be serviced separately from the bumper cover or sonar sensors and do not come pre-installed in replacement bumper covers. Flush mount style holders are a one-time use part due to a pre-installed adhesive material. Additionally, some models utilize different holders/bezels for the inner and outer mounting points.

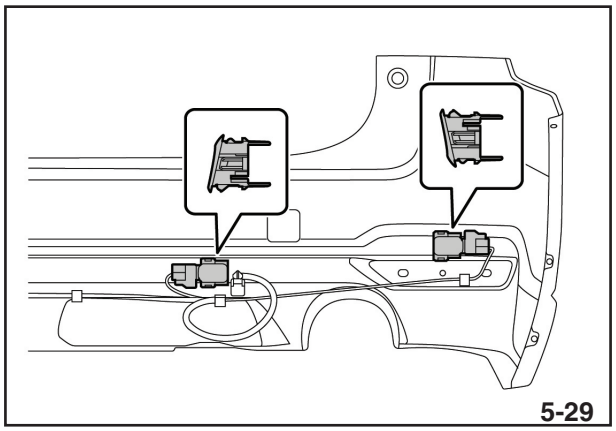


Flush Mount Sensor Holder

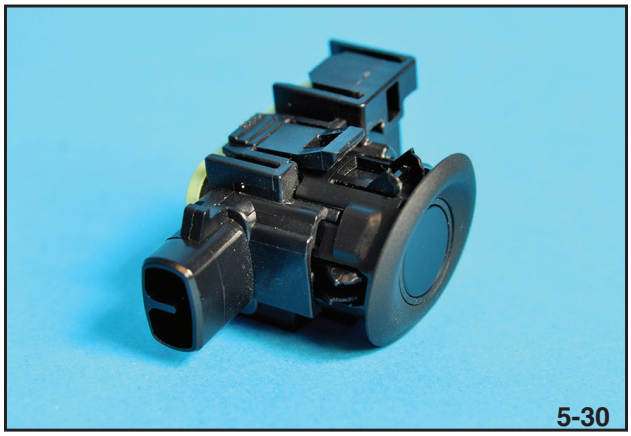


Flush Mount Sensor Holder

Vehicles that utilize Bezels retain the Sonar Sensor to the bumper cover via locking tabs. Use care when removing the bezels or sensors as to not damage the lock clips.

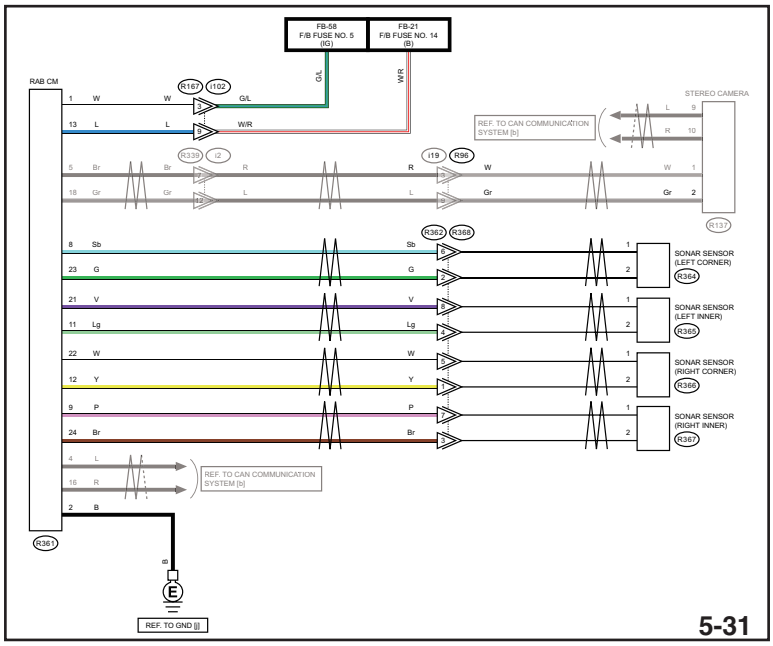


Bezel Style Sensor Holder

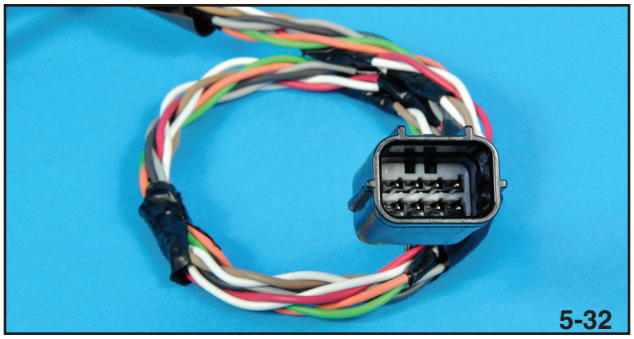


Bezel Style Sensor Holder

The sonar sensors are independently connected directly to the RAB CM through a dedicated harness.

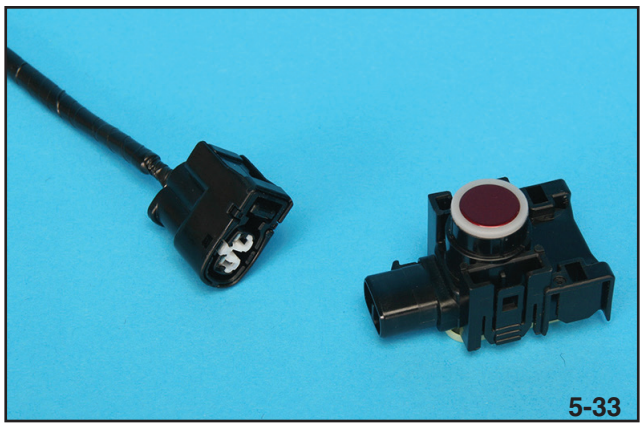


Sonar Sensor Harness(s)

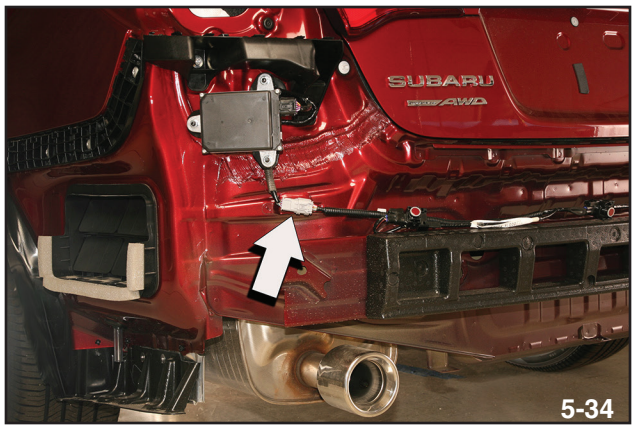


Sonar Sensor Harness Connector

The sensor harness attaches to each of the 4 harnesses along the inside of the bumper and connects through the rear body panel before traveling to the RAB CM.

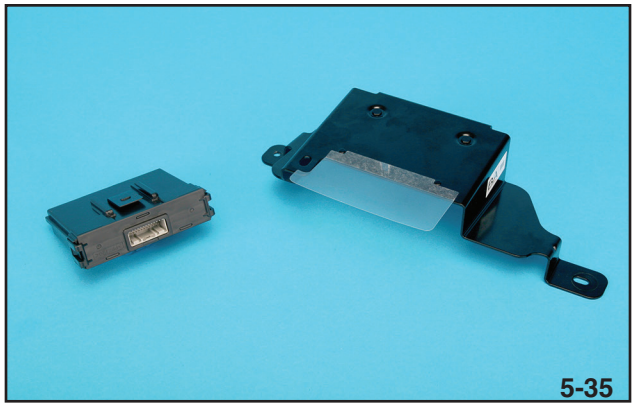


Sonar Sensor Harness and Sensor



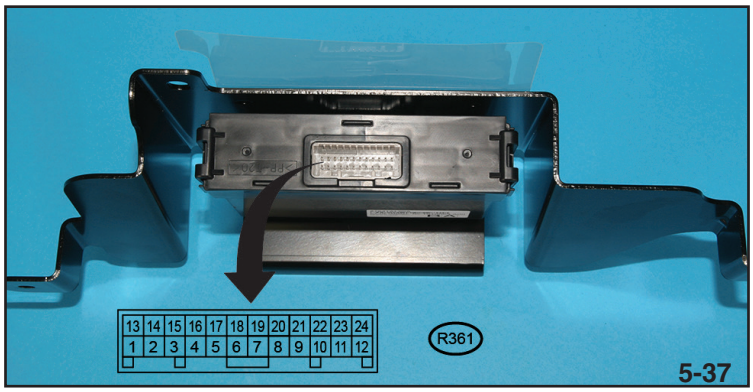
Sonar Sensor Harness-Body Connection

The RAB CM can be found in different locations depending on the model. In this example (Legacy/Outback/WRX), the control module is located under the Driver's seat whereas in a Forester model, the module is located under the rear cargo tray.



RAB Control Module (CM)

RAB CM Mounting-Legacy/Outback



RAB CM

Terminal No.	Content	Measuring condition	Standard
(R361) No. 1 ⟷ Chassis ground	Ignition power supply	Ignition switch ON	Battery voltage
(R361) No. 2 ⟷ Chassis ground	Ground	Always	1 Ω or less
(R361) No. 3	Not used	—	—
(R361) No. 4	Main CAN-L	—	—
(R361) No. 5	Local CAN-H (stereo camera communication line)	—	—
(R361) No. 6	Not used	—	—
(R361) No. 7	Not used	—	—
(R361) No. 8	Sonar sensor communication line (left corner -)	—	—
(R361) No. 9	Sonar sensor communication line (right inner -)	—	—
(R361) No. 10	Not used	—	—
(R361) No. 11	Sonar sensor communication line (left inner +)	—	—
(R361) No. 12	Sonar sensor communication line (right corner +)	—	—
(R361) No. 13	Battery power supply	Always	Battery voltage
(R361) No. 14	Not used	—	—
(R361) No. 15	Not used	—	—
(R361) No. 16	Main CAN-H	—	—
(R361) No. 17	Not used	—	—
(R361) No. 18	Local CAN-L (stereo camera communication line)	—	—
(R361) No. 19	Not used	—	—
(R361) No. 20	Not used	—	—
(R361) No. 21	Sonar sensor communication line (left inner -)	—	—
(R361) No. 22	Sonar sensor communication line (right corner -)	—	—
(R361) No. 23	Sonar sensor communication line (left corner +)	—	—
(R361) No. 24	Sonar sensor communication line (right inner +)	—	—

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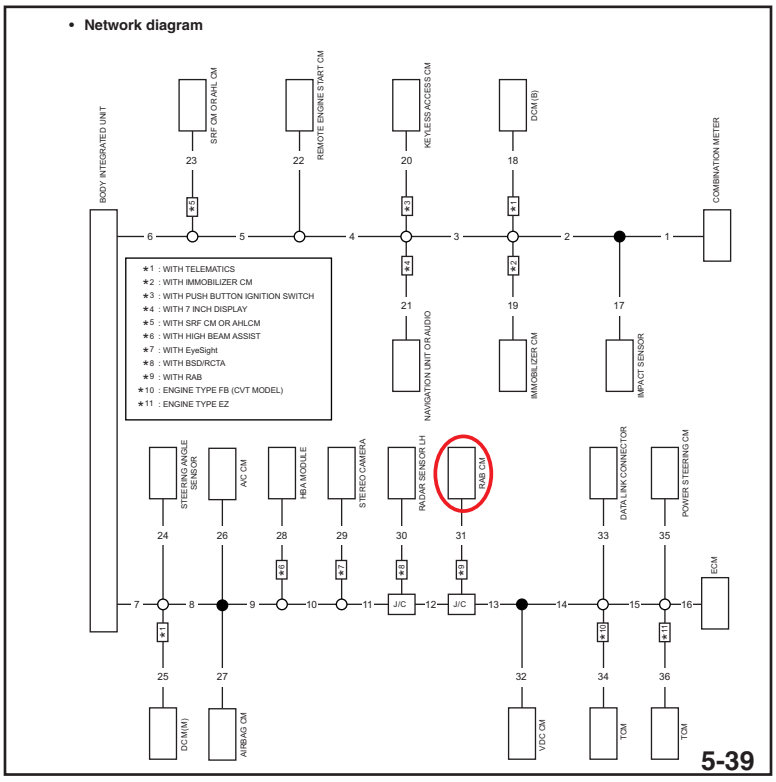
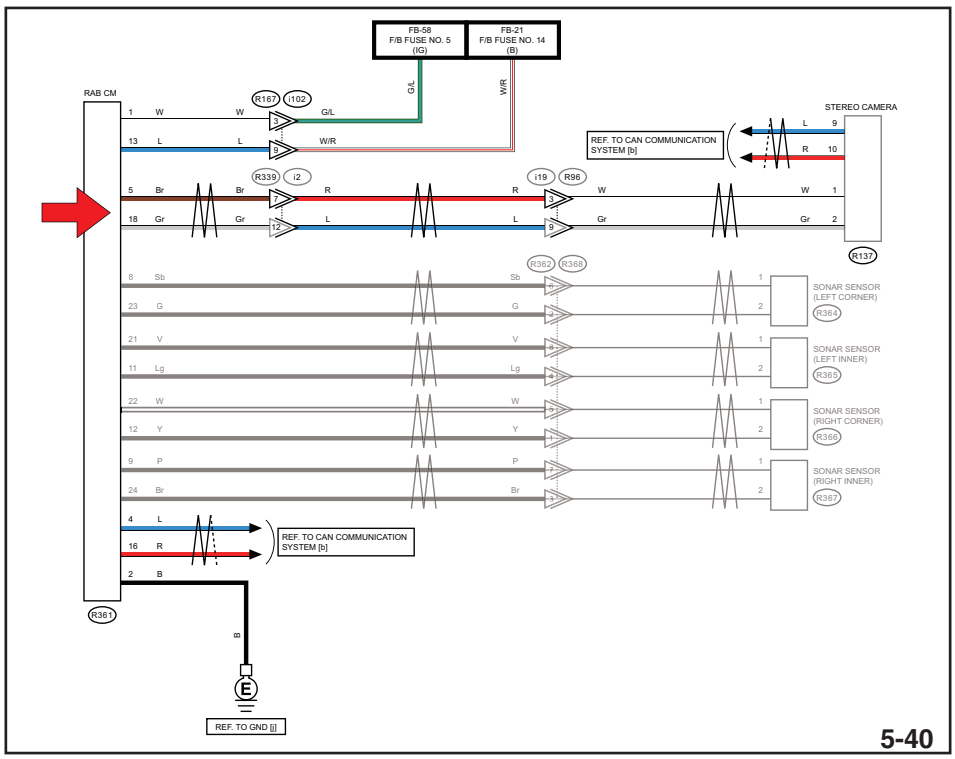
RAB CM I/O

The RAB CM is connected to the Vehicle's Main CAN network.



Main CAN Network

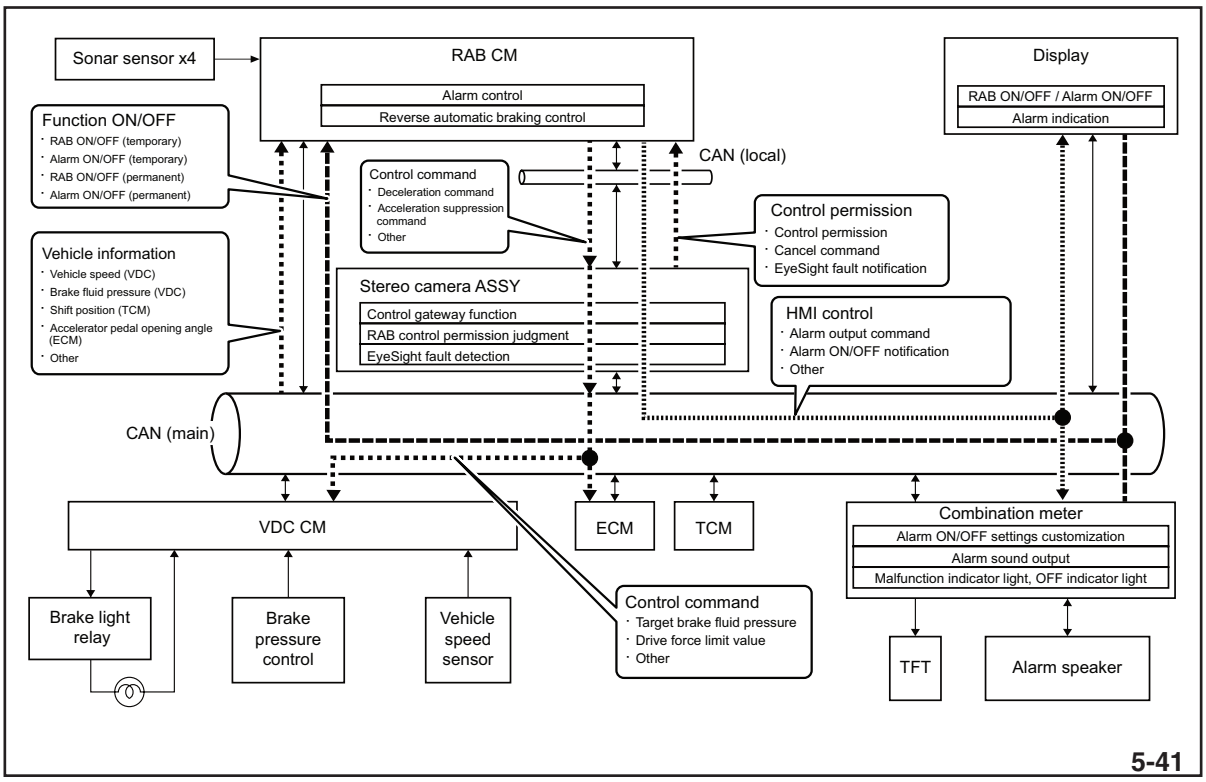
Additionally, the RAB CM directly communicates with the EyeSight (Stereo Camera) control module via a private CAN network.



RAB — EyeSight CAN Network

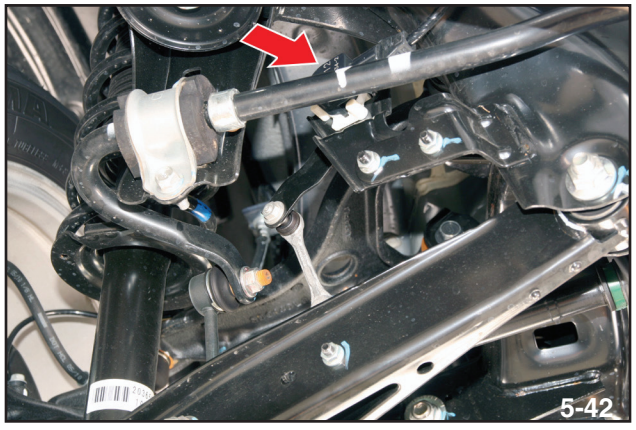
Integration with the vehicle's Main CAN allows the RAB system to receive basic vehicle information such as wheel speed, brake fluid pressure, shifter position and accelerator angle to calculate the appropriate RAB actions. Additionally, the RAB system is able to coordinate with the human-machine interface (HMI) functions such as MFD and Combination Meter display/ control.

RAB requests for engine, transmission, and braking control are processed though the EyeSight Stereo Camera (Via private CAN) which outputs commands to the Engine Control Unit (ECU), Transmission Control Module (TCM), and Vehicle Dynamics Control Control Module (VDC CM).



RAB > EyeSight CAN Network

All models with RAB, regardless of headlight option (Halogen/HID/LED), contain a vehicle height sensor located in the rear suspension. This input is used to detect cargo area loading to more accurately judge RAB functions.



Rear Height Sensor

Inspection

Pre-Delivery Inspection

During a Pre-Delivery Inspection (PDI), the RAB system should be inspected for normal operation and proper appearance.

56. Blind Spot Detection / Rear Cross Traffic Alert (BSD/RCTA)	1. Press the BSD/RCTA OFF switch several times to check that the system is activated and deactivated correctly. 2. Check the rear bumper around the sensor for dirt, scratch, affixed stickers and poor paint coating.
57. Reverse Automatic Braking (RAB)	1. Check that the RAB system is activated and deactivated correctly. 2. Check the sonar sensor installed on the rear bumper for parts missing, dirt, scratch, foreign objects, etc.
58. Diagnostic trouble code (DTC) check	Check that the diagnostic trouble code (DTC) is not detected.

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PDI Inspection

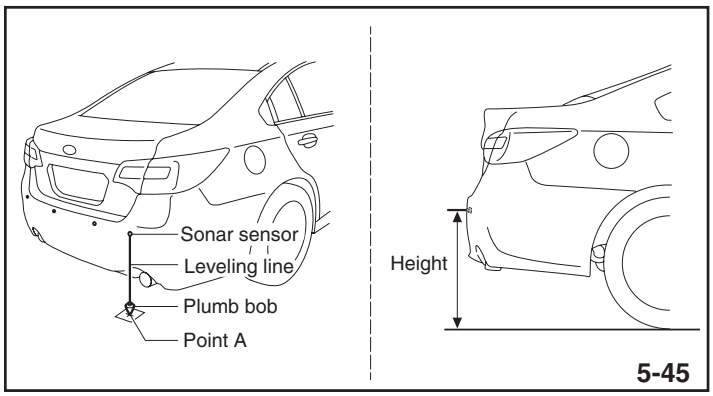
Example RAB PDI Inspection procedure:

1) Check that the RAB system is activated and deactivated correctly.
   (1) Start the engine and let idle for 6 seconds or more, and then shift the select lever to “R” range.
   (2) Check that “RAB” and “RAB OFF” turn off in the Combination Meter.
   (3) Check that the RAB warning is displayed on the rearview camera screen of the navigation system and “RAB” and “P ” indicators illuminate in green.
   (4) Select “RAB” displayed on the screen, and check that “RAB OFF” is displayed in the Combination Meter when “RAB OFF/ON” is switched and “RAB OFF” is conducted.
   (5) Select “P” displayed on the screen, and check that “P OFF/ON” can be switched.
2) Check the sonar sensor installed on the rear bumper for parts missing, dirt, scratch, foreign objects, etc.
   a. The sensor surface must not stick out or sink in at 0.5 mm or more from the rear bumper surface.
   b. If the sensor surface largely sinks in, the sensor may not be engaged in the holder behind the bumper. In this case, check the installation condition of the sensor after removing the bumper.
   c. Make sure that there are no foreign objects (tape, stickers, dust or dirt) on the sonar sensor surface. If there is a layer of foreign objects on the sensor surface, remove it completely so that no residue remains.

Sensor Depth Inspection

Basic Inspection

During basic diagnostics, the height and installation angle of each Sonar Sensor should be inspected. These inspections may identify potential issues such as impact damage or improper installation.



Sensor Height Inspection

Height Inspection — Preparation Tools

1) Before performing measurement, check the following items:
   - **a. The vehicle is parked on a level surface.**
   - **b. The inflation pressure of tires is correct.**
   - **c. The vehicle does not have load.**
   - d. Check the area around the sensor and rear bumper for any scratches or other type of deformation
2) Prepare a plumb bob, tape measure, packing tape, and marker.
3) Measure installation height of the sonar sensor.
   a. Suspend the plumb bob with leveling line from the sensor, and mark the position where the plumb bob touches the ground. (Point A)

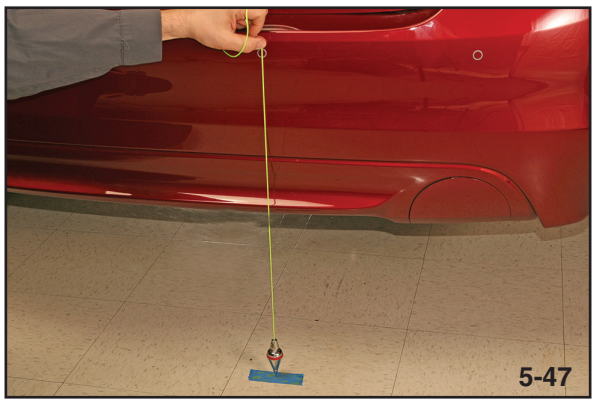
Note: Stick the packing tape etc. on the floor, then make a marking on the tape.

   b. Measure the height from the sensor to the marked Point A.

4) Confirm that sensor installation height is within the acceptable limit.

Specification:

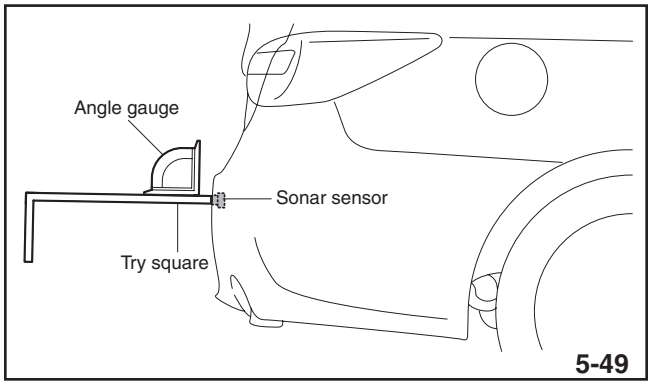
Sedan model: 590 — 620 mm (23.23 — 24.41 in)
OUTBACK model: 475 — 505 mm (18.7 — 19.88 in)



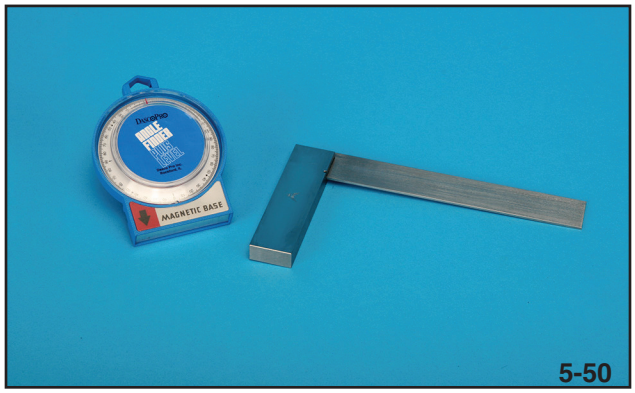
Plumb Bob (Point A)

Height Measurement

5) Using an angle gauge and try square, measure the installation angle as shown in the figure.



Sensor Angle Inspection



Angle Inspection Preparation Tools

6) Use the measurement tools while placing them perpendicular to the sonar sensor.

7) Confirm that sensor installation angle is within the acceptable limit.

Specification:

Sedan model: 2° — 6°

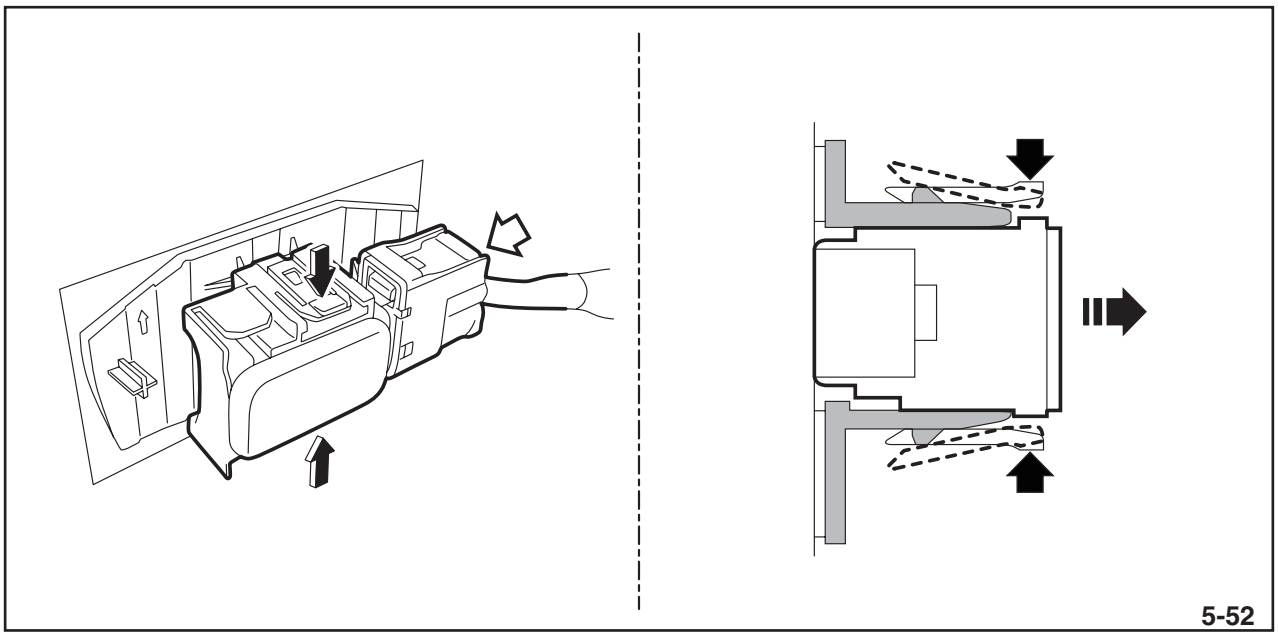
OUTBACK model: 6° — 10°

Angle Measurement

Service

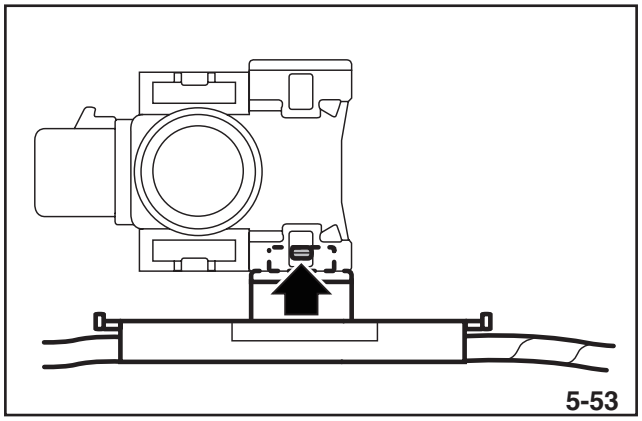
Removal of a sonar sensor is accomplished by depressing the lock tabs on the top and bottom of the assembly in order to release the claws. Care should be taken so as to not damage the lock release tabs on the Sensor Holder/bezel or harness connector.

Caution: Always disconnect the ground cable from the battery before attempting service on the RAB system.

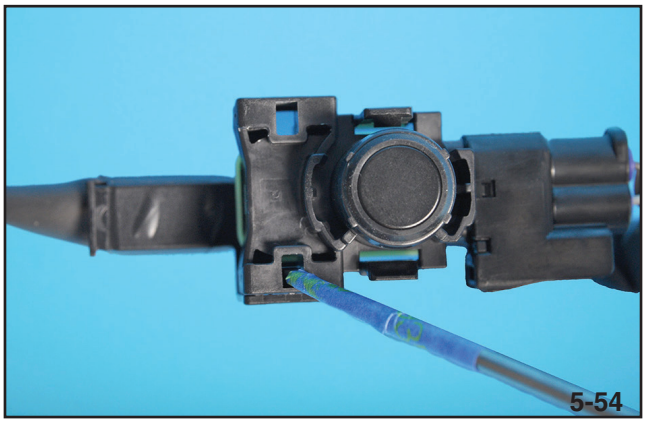


Sonar Sensor Removal

When removing the harness cord from the sensor assembly, use a flat tip screwdriver wrapped with a protective covering such as tape. Failing to do so may cause cosmetic damage to the sensor body.



Harness Cord connection



Harness Cord Removal

If the bumper is damaged or has been replaced it may be necessary to fit new Sensor Holders or bezels to the rear bumper. Flush mount style Sensor Holders are one-time use and cannot be transferred to new or replacement bumpers.

To ensure consistent centering during installation, vehicles that utilize flush mount Sensor Holders require a new SST (Sonar Tool 87692VA000). These tools are provided as a Retailer essential tool and are included with the purchase of new flush mount Sensor Holder sets for applicable vehicles.

ILLUSTRATION	TOOL NUMBER	DESCRIPTION	REMARKS
 ST87692VA000	87692VA000 (Newly adopted tool)	SONAR TOOL	Used for installing the holder - sonar.

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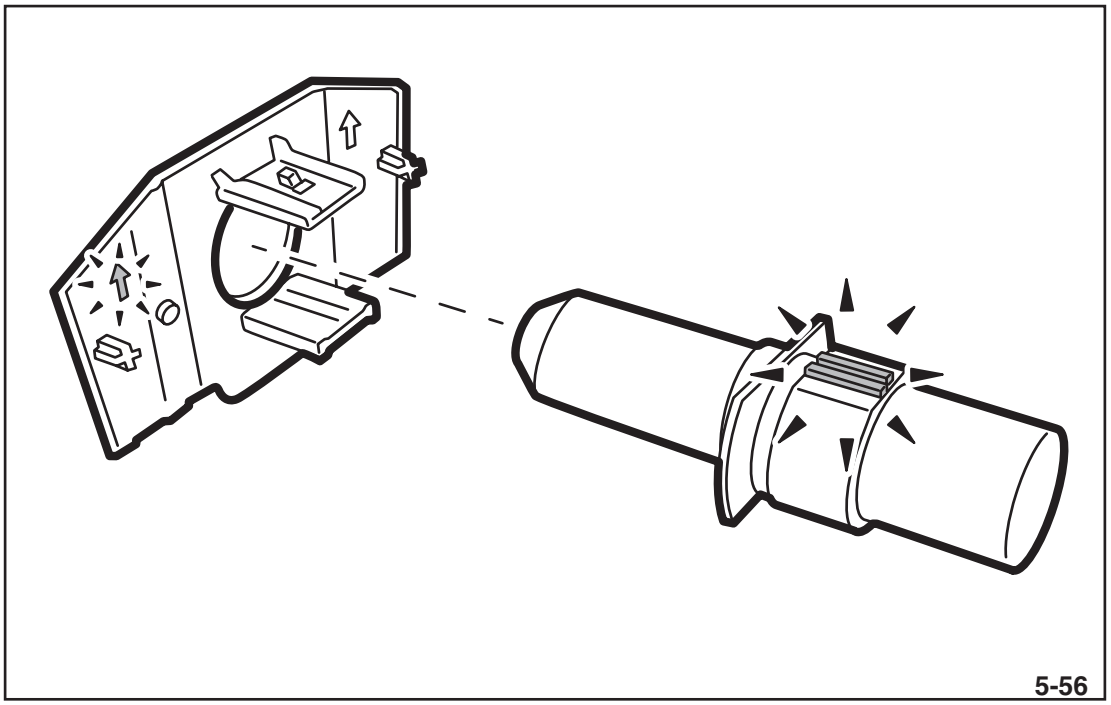
Sonar Tool — 87692VA000

The SST is fitted through the Sensor Holder with the two slots oriented on the top side. The raised edges of the SST should fit flush against the Sensor Holder. Ensure the lock tabs are fully seated before proceeding.



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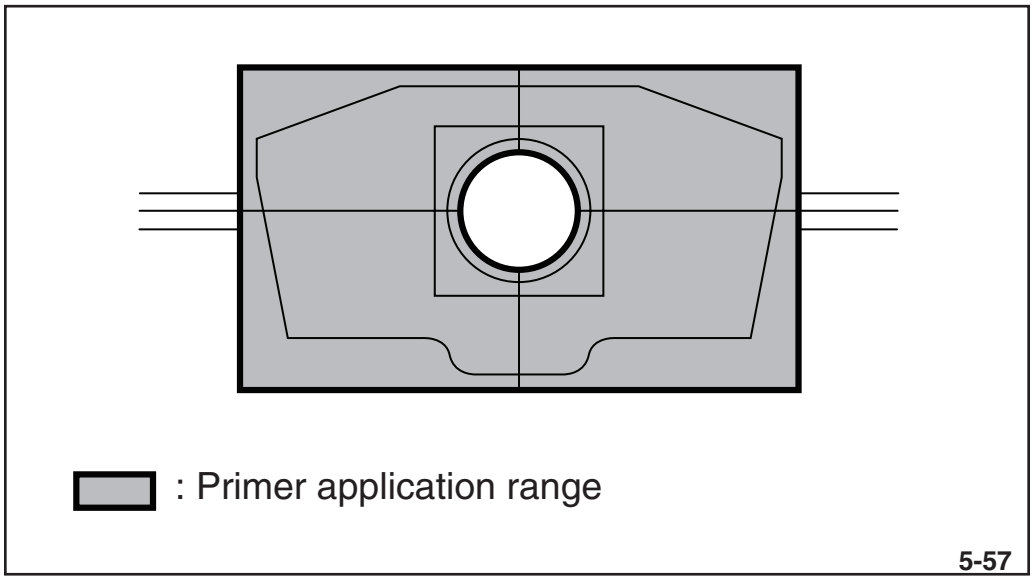
Sonar Tool Orientation

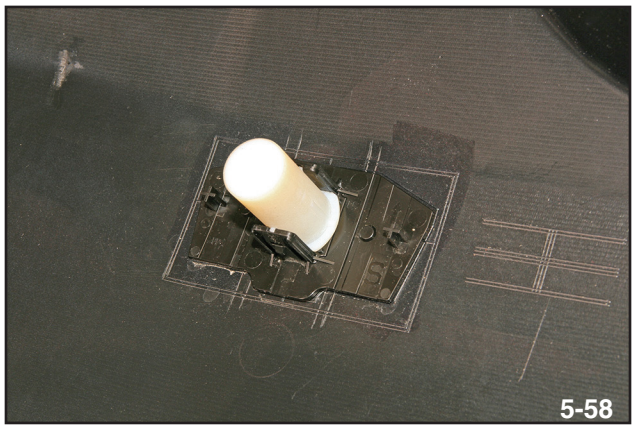
Prior to installing the Sensor Holder, it is necessary to thoroughly clean and oil, dirt or contamination around the Sensor Holder installation area and apply an adhesion promoter such as 3M K-540NT or an equivalent.

Note: Do not remove the protective adhesive backing until this step has been completed.



Preparation Area

After the surface has been thoroughly cleaned and the adhesion promoter applied, the Sensor Holder should be fitted to the rear of the bumper cover with the aid of the SST. Once aligned, the Sensor Holder should be firmly depressed to ensure adhesion of the two components.

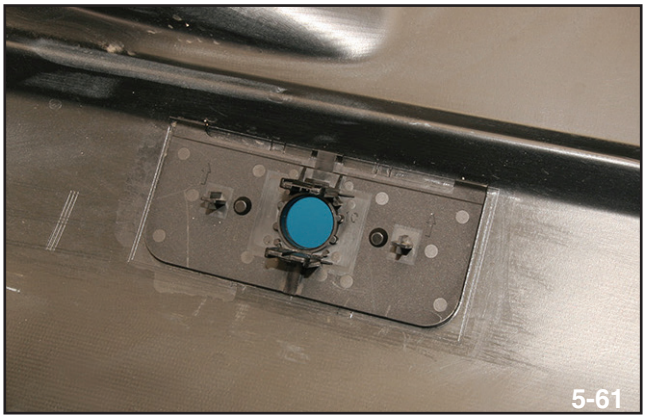


Sonar Tool Installed (rear)

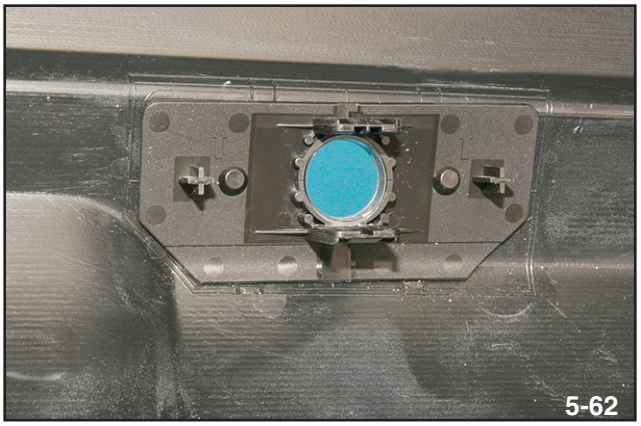
Sonar Tool Installed (front)

Some models (such as Outback), utilize two (2) different types of Sensor Holders to accommodate the bumper cover shape.

Outback Sensor Holders

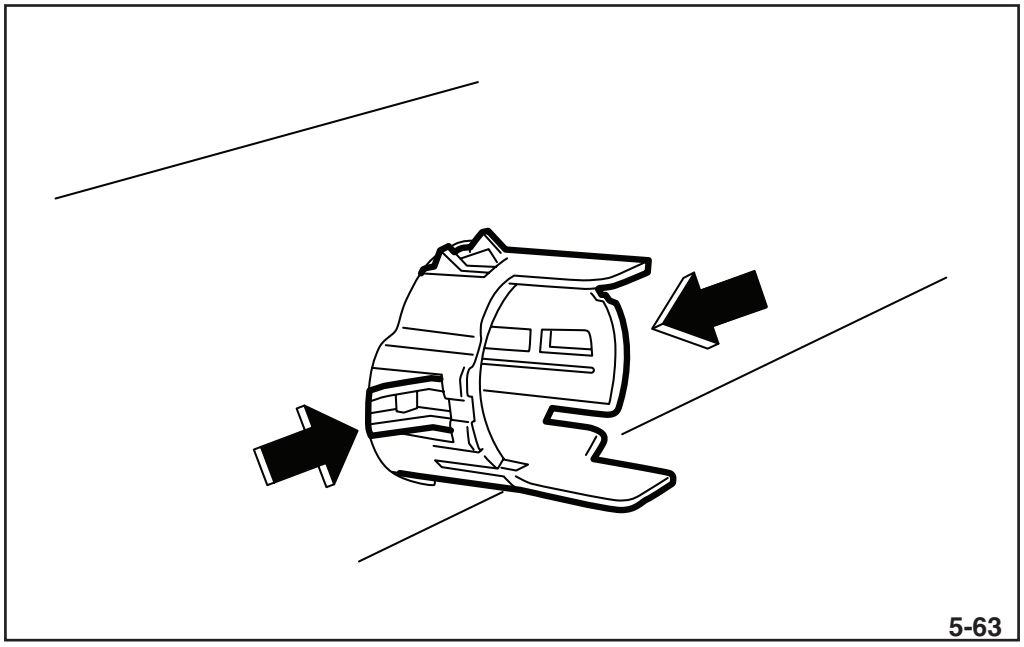


Outback Sensor Holder — Outer

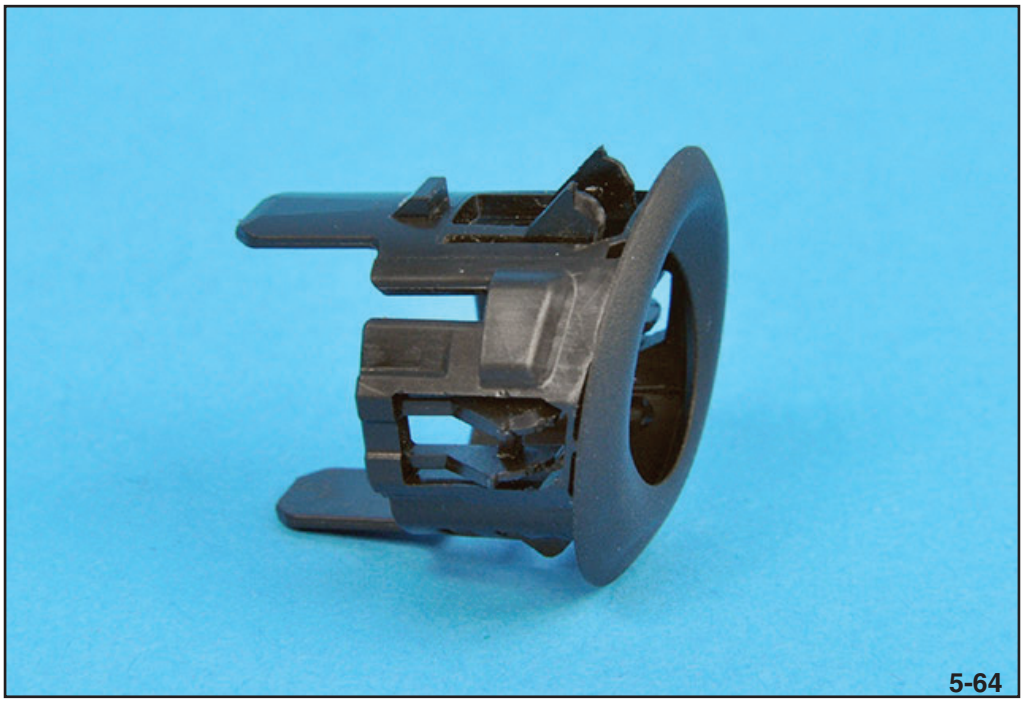


Outback Sensor Holder — Inner

Vehicles that use bezels are serviced by depressing the tabs located inside the bumper cover. There are four lock release tabs located around the bezel. Take care during removal not to damage the tabs.



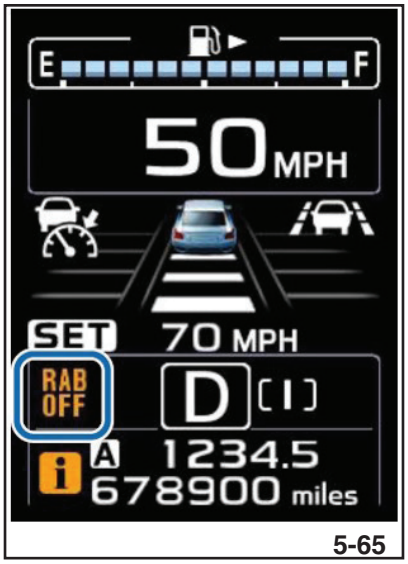
Bezel Type Sensor Holder — Lock Tabs



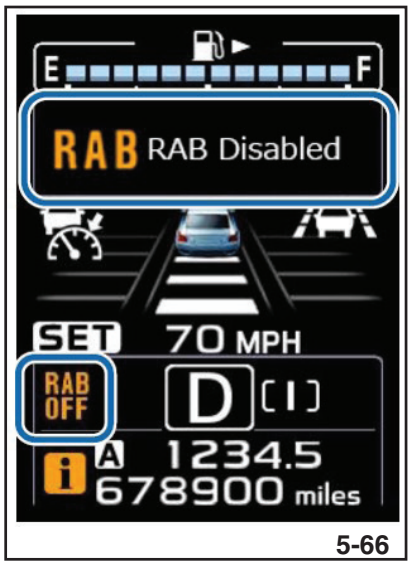
Bezel Type Sensor Holder — Removed

Diagnostics

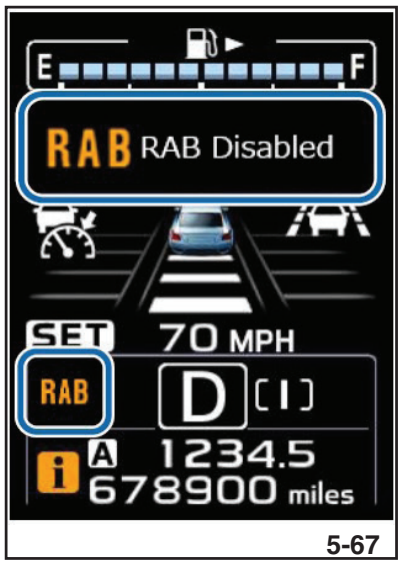
The Multi-Information Display (MID) will display warning messages related to the RAB system status. These messages may indicate the system is “OFF”, “Temporarily Stopped”, or in a state of “Failure”.



RAB Disabled (Driver)



RAB Temporary Stop



RAB Malfunction

The basic diagnosis of the RAB system should always begin with the completion of the Check List for Interview found in the Service Manual.

Reverse Automatic Braking Check List for Interview		Received Year Month Date	
Customer's name		Registration No.	Initial year of registration Year Month Date
		Vehicle model	Frame number
Interviewer	Inspector	Engine type	Odometer reading
Customer specified content • • •			
Date and time when the trouble occurred		Frequency of trouble occurrence	Always occurs
			Sometimes occurs (times per day, times per month)
Location where the trouble occurred		Weather	❑ Fine❑ Cloudy❑ Rainy❑ Snowy❑ Others
		Temperature	°C (°F) — °C (°F)
Road conditions			
Road condition			
Condition of warning light	❑ On❑ Off❑ Blink		
Accessory installation condition			
Diagnostic code			
Time stamp			
Control module item number/ver			
Condition of trouble occurrence (How the trouble occurs)			
Vehicle bring-in history information			

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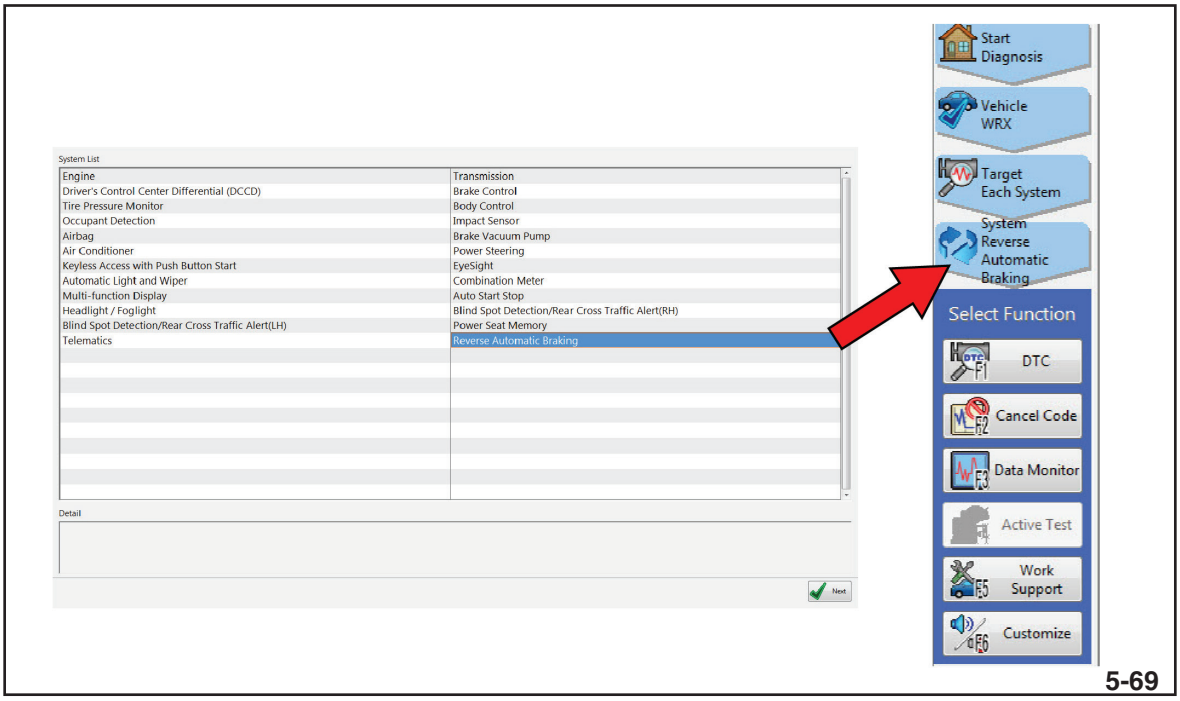
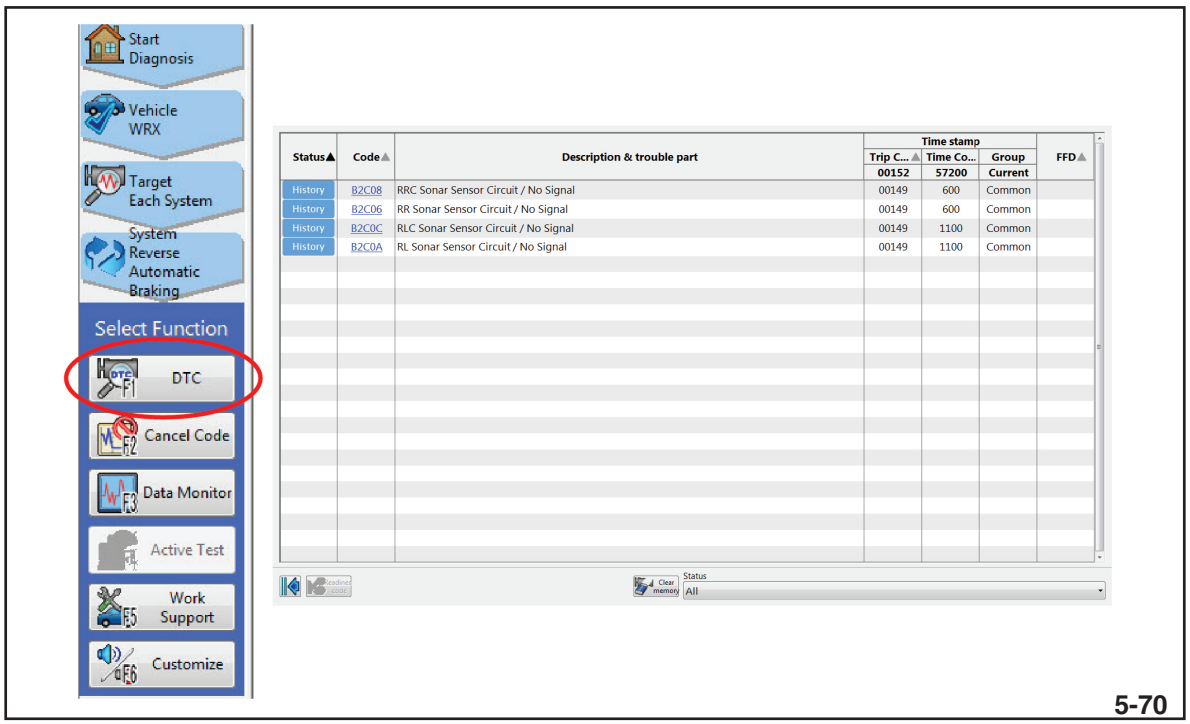
Check List for Interview

The Subaru Select Monitor contains a new menu heading for the “Reverse Automatic Braking” system that features DTC, Cancel Code, Data Monitor, Work Support, and Customizing functions.



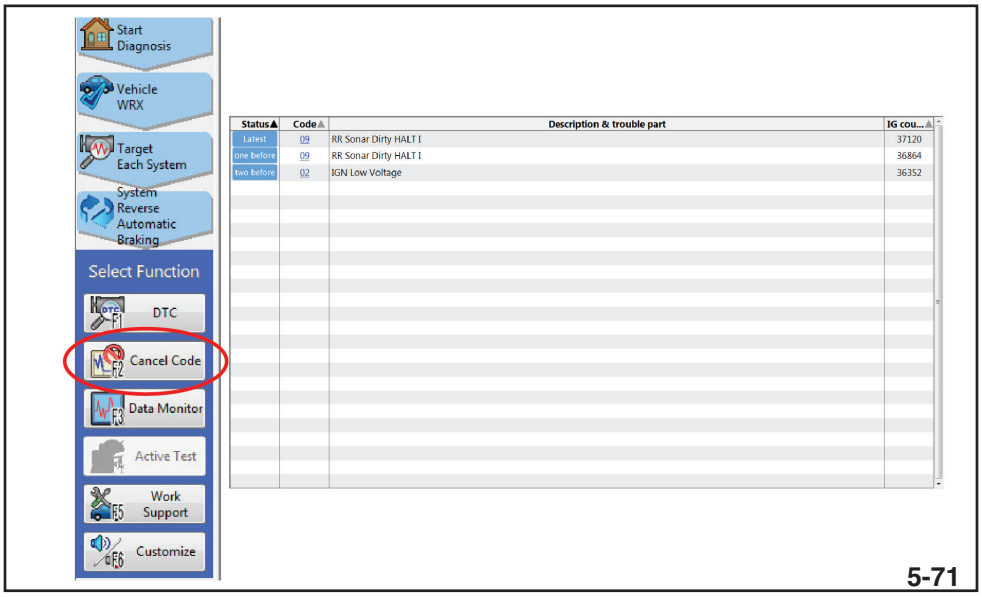
SSM — RAB Main Menu

The RAB system features comprehensive diagnostics that include over 30 unique diagnostic trouble codes (DTCs). DTCs can be retrieved from the “DTC” function selection under the Reverse Automatic Braking heading in the SSM.



SSM — RAB DTC Display

Similar to EyeSight and Blind Spot Detection & Rear Cross Traffic Alert (BSD/RCTA) systems, the RAB system features cancel codes that may assist in phenomena diagnosis. Only the three (3) most recent Cancel Codes will be stored in memory. After the stored Cancel Codes exceed three, the oldest code will be deleted.



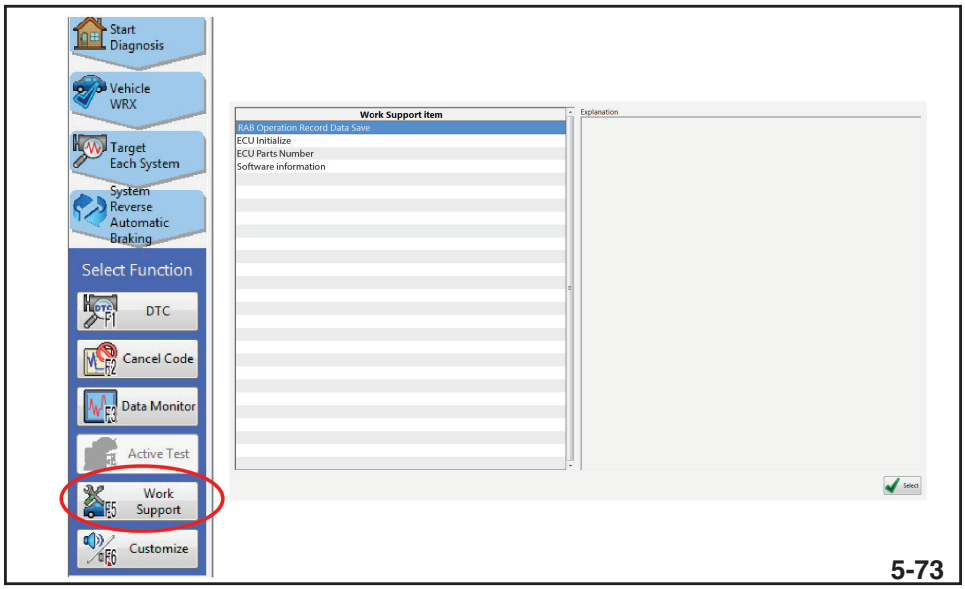
SSM — RAB Cancel code Menu

A listing of the individual cancel codes and their likely causes can be found in the Diagnostic section of the appropriate service manual.

Code	Description & Trouble Position	Content
0X01	+B Low Voltage	The battery power supply of RAB CM is reduced.
0X02	IGN Low Voltage	The ignition power supply of RAB CM is reduced.
0X03	RRC Sonar Noise	Sonar sensor (right inner) signal is interfered due to noise.
0X04	RLC Sonar Noise	Sonar sensor (left inner) signal is interfered due to noise.
0X05	RR Sonar Noise	Sonar sensor (right corner) signal is interfered due to noise.
0X06	RL Sonar Noise	Sonar sensor (left corner) signal is interfered due to noise.
0X07	RRC Sonar Dirty HALT I	Substance adhered to the sonar sensor (right inner).
0X08	RLC Sonar Dirty HALT I	Substance adhered to the sonar sensor (left inner).
0X09	RR Sonar Dirty HALT I	Substance adhered to the sonar sensor (right corner).
0X0A	RL Sonar Dirty HALT I	Substance adhered to the sonar sensor (left corner).
0X0B	RRC Sonar Dirty HALT II	Substance adhered to the sonar sensor (right inner).
0X0C	RLC Sonar Dirty HALT II	Substance adhered to the sonar sensor (left inner).
0X0D	RR Sonar Dirty HALT II	Substance adhered to the sonar sensor (right corner).
0X0E	RL Sonar Dirty HALT II	Substance adhered to the sonar sensor (left corner).
0X0F	RRC Sonar Mount Error	Substance adhered to the sonar sensor (right inner).
0X10	RLC Sonar Mount Error	Substance adhered to the sonar sensor (left inner).
0X11	Detect Low Level of Vehicle Height	The vehicle was tilted (ex. the rear of the vehicle was lowered) due to overload. (OUTBACK model only)
		5-72

RAB Cancel Codes

The Work Support menu features the ability to export saved RAB data, initialize the RAB CM, and identify basic part number and software version information.

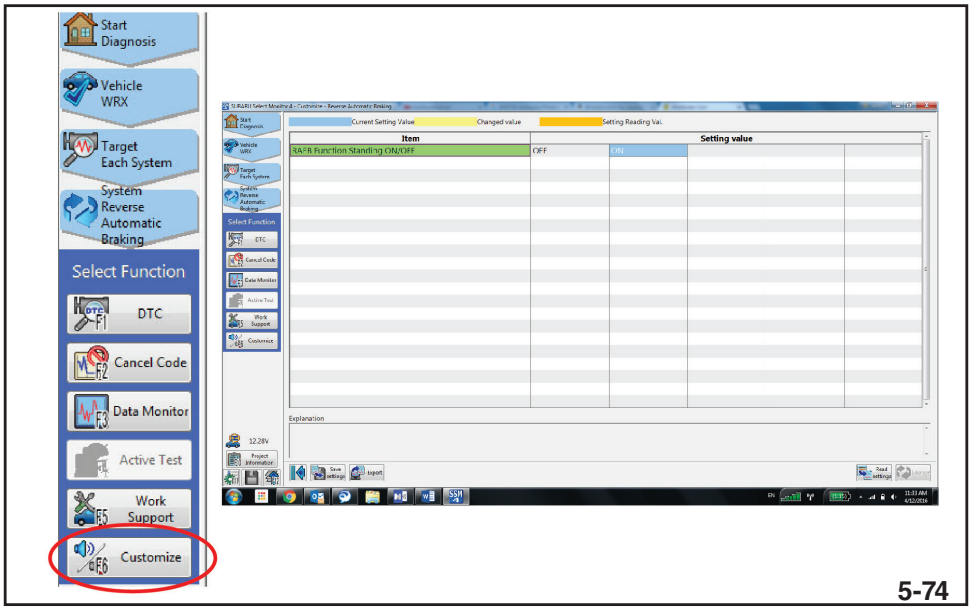


SSM— RAB Work Support

RAB Operation Record Data Save	Exports a .bin (binary) log file of RAB operation. *For Engineering use only
ECU Initialize	Reset the RAB CM to the factory settings
ECU Parts Number Display	RAB CM part number is displayed
Software Information Display	RAB CM software version is displayed

The Customizing menu contains the “RAEB Function Standing ON/OFF” function.

CAUTION: Setting this value to “OFF” will disable all RAB system functions.



SSM — RAB Function Standing Setting

NOTES:

Blind Spot Detection (BSD) / Rear Cross Traffic Alert (RCTA)

Introduced on some 2015 Legacy and Outback models, the Blind Spot Detection (BSD)/ Rear Cross Traffic Alert (RCTA) system offers three functions. Blind Spot Detection detects vehicles on either side of the vehicle, in the driver's blind spots. Lane Change Assist detects fast-approaching vehicles in adjacent lanes, and Rear Cross Traffic Alert detects vehicles approaching from a perpendicular direction while reversing, such as from a driveway. LED indicators on the side mirrors alert the driver. Rear Cross Traffic Alert uses an indicator in the rear view camera display.

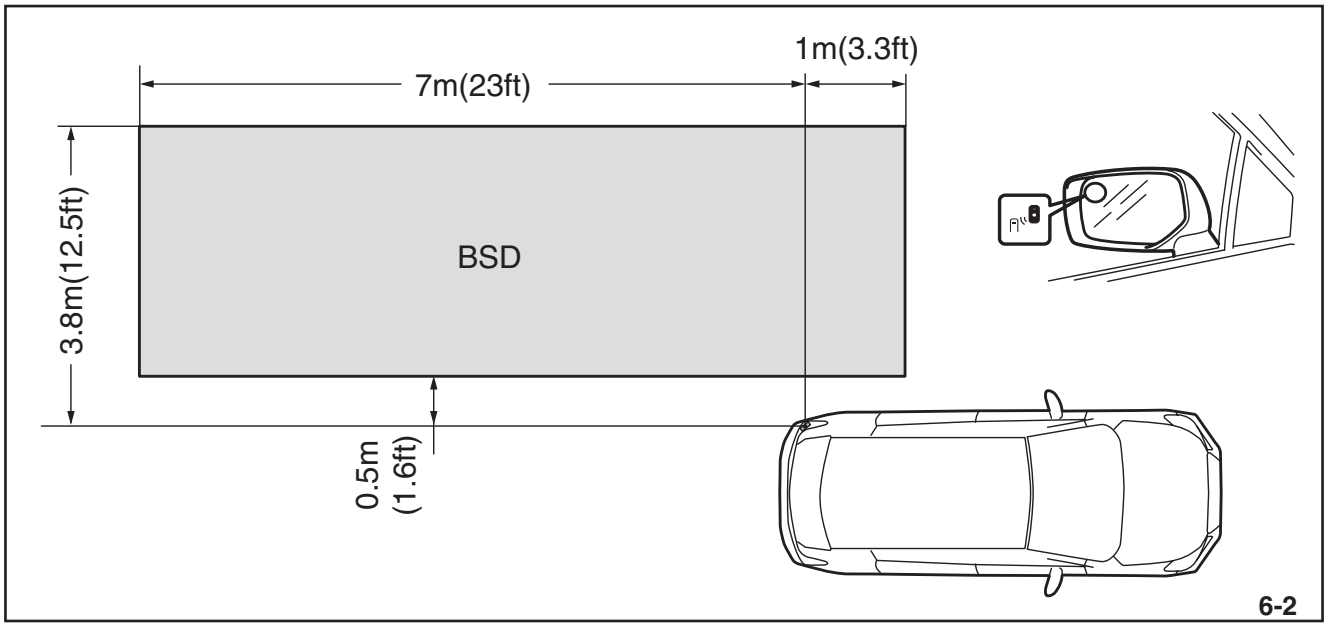
Note: Beginning with all 2016MY vehicles, the "Subaru Rear Vehicle Detection (SRVD) system" name has been changed to "Blind Spot Detection (BSD) / Rear Cross Traffic Alert (RCTA) System". System functions have remained the same despite the name change.

Basic Operation

Blind Spot Detection (BSD)

Blind Spot Detection (BSD) notifies the driver of vehicles traveling at a similar rate of speed in neighboring lanes behind the C or D pillars by illuminating an LED indicator in the side mirror. The detection area for BSD is approximately 23 ft from the rear bumper cover.

Note: If the driver attempts to change lanes by enabling the turn signal while a vehicle is in the vehicle's blind spot, a flashing LED indicator in the side mirror will alert the driver to the potential hazard.

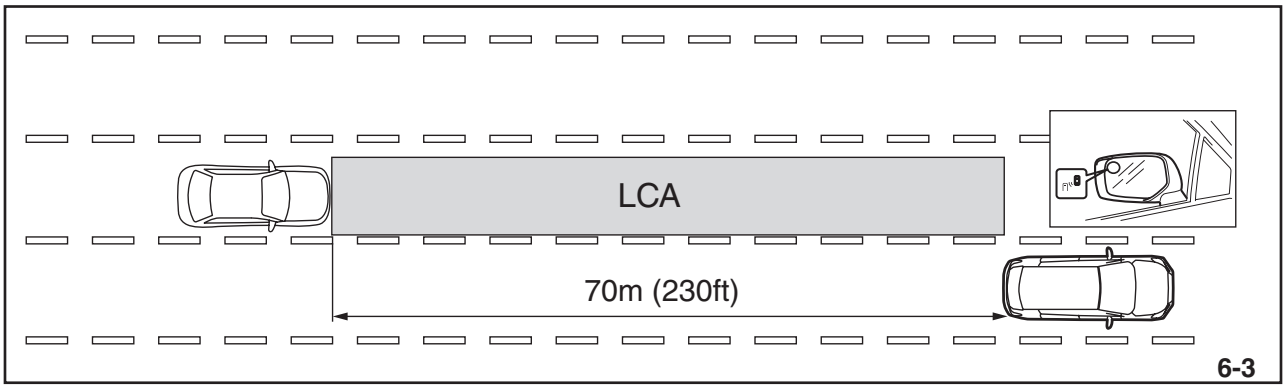


BSD Detection Area

Lane Change Assist (LCA)

Lane Change Assist (LCA) notifies the driver of fast-approaching vehicles in neighboring lanes by illuminating the LED indicator in the side mirror. The detection area for LCA is approximately 230 ft from the rear bumper cover and is based on “Time to Collision” (TTC) calculations.

Note: If the driver attempts to change lanes by enabling the turn signal while a vehicle is approaching at a higher speed, a flashing LED indicator in the side mirror will alert the driver to the potential hazard.



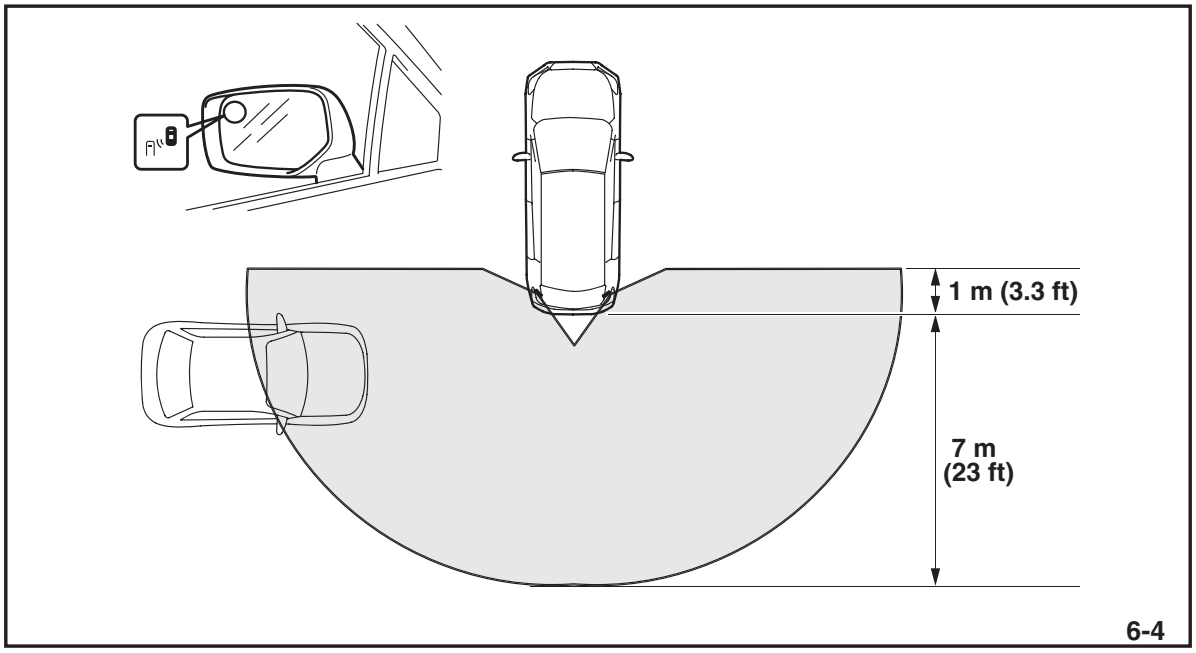
LCA Detection Area

Visual alerts are issued for any vehicle with a Time to Collision (TTC) of approximately 4.5 seconds. Large variations in relative speed difference will result in more advanced notice from the LCA system. See chart below for estimates of relative speed differences versus distance of TTC warning.

Relative Vehicle Speed Difference	Inter-vehicular Distance
6.2 mph (10km/h)	**Within 41 ft** (12.5 m)
12.4 mph (20km/h)	**Within 82 ft** (25 m)
18.6 mph (30km/h)	**Within 139 ft** (42.5 m)
24.9 mph (40km/h)	**Within 164 ft** (50 m)

Rear Cross Traffic Alert (RCTA)

Rear Cross Traffic Alert (RCTA) detects vehicles approaching from a perpendicular direction while in reverse. A flashing LED indicator in the side mirror, a pattern of audible tones, and a flashing indicator in the rear view camera display alert the driver of potential hazards with a Time to Collision (TTC) of approximately 3.5 seconds.



RCTA Detection Area

See chart below for estimates of relative speed differences versus distance of TTC warning.

Relative Vehicle Speed Difference	Inter-vehicular Distance
6.2 mph (10 km/h)	**Within 31 ft** (9.7 m)
12.4 mph (20 km/h)	**Within 63 ft** (19.4 m)
18.6 mph (30 km/h)	**Within 95 ft** (29.1 m)

Operating Conditions

The BSD/RCTA system functions will operate when all the following conditions are met:

- The ignition switch is in the “ON” position
- The BSD/RCTA warning indicator and BSD/RCTA OFF indicator are turned off
- The vehicle is driving at speeds above 10 mph (15 km/h) (Except when reversing)
- The shift lever is in the “R” position (when reversing)

Driver Interface

Approach indicator lights

Side mirror LED indicators promote awareness without interrupting the driver's line of sight. These indicators may illuminate or flash during BSD, LCA, and RCTA operations.

Side Mirror LED OFF

Side Mirror LED ON

Beginning with 2017MY Impreza models, new BSD/RCTA approach indicator lights have been incorporated in the side mirrors to improve visibility. The functionality and circuit configuration remains unchanged from the previous indicator.

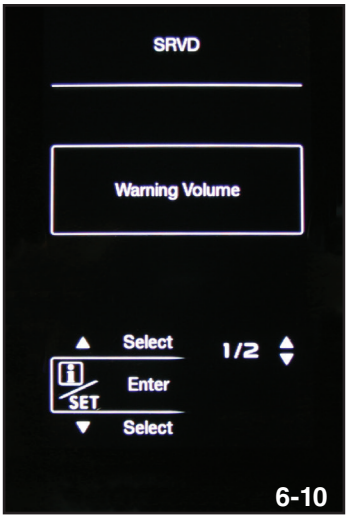
Approach Indicator — OFF

Approach Indicator — ON

Approach Warning Buzzer

An audible warning buzzer can be heard from the Combination Meter during Rear Cross Traffic Alert (RCTA) functions. This volume can be customized through the Combination Meter.

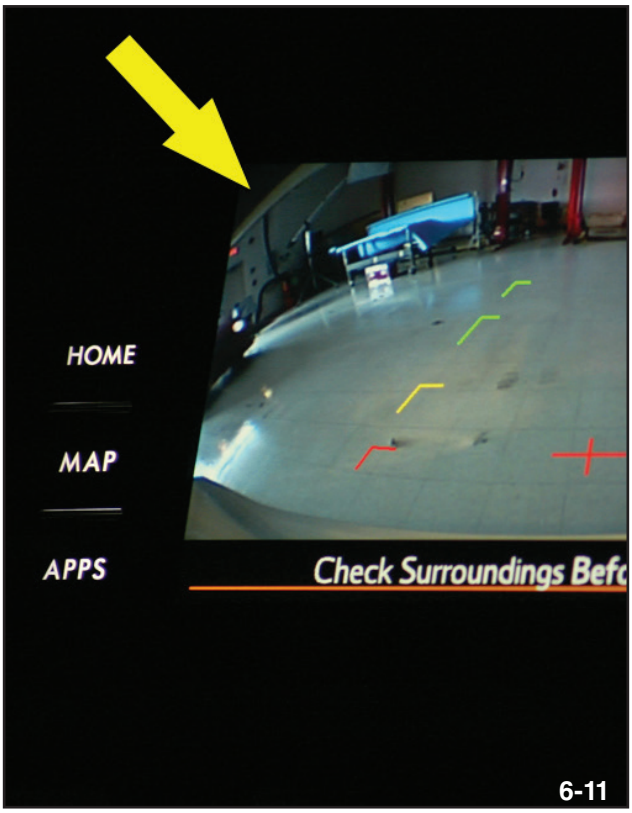
BSD/RCTA Settings



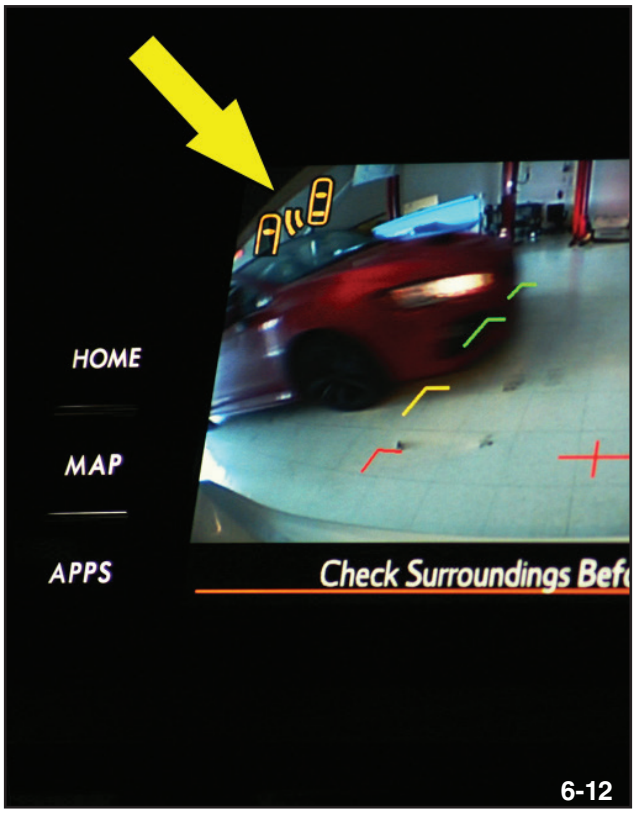
BSD/RCTA Warning Volume

Rear View Camera Indicator

RCTA uses the rear view camera to display alerts on the upper corner of the corresponding side from which a vehicle is detected.



Rear Camera Alert OFF



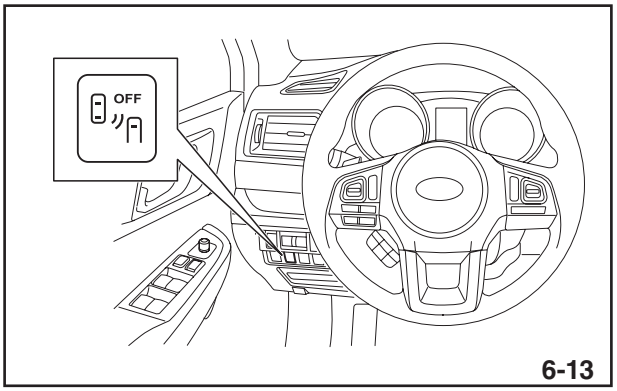
Rear Camera Alert ON

BSD/RCTA "OFF" Switch

A console mounted BSD/RCTA "OFF" switch functions to disable the BSD/RCTA system.

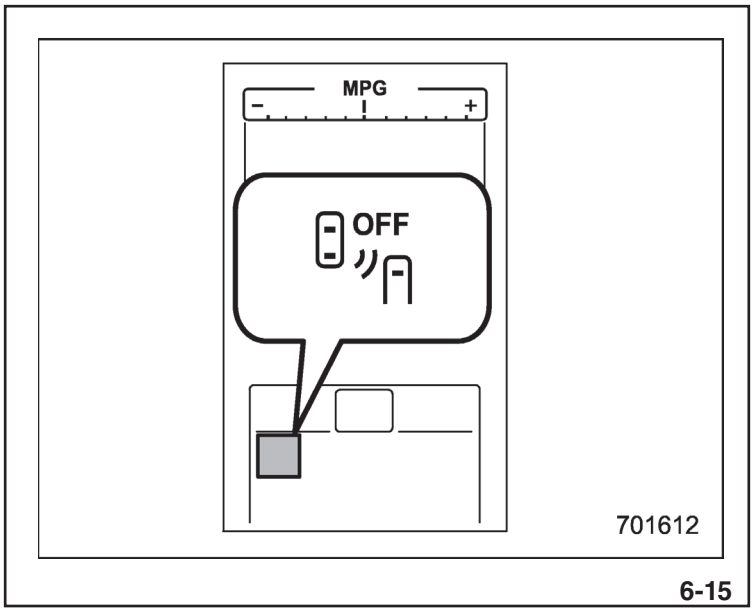
In the following cases, press the BSD/RCTA "OFF" switch to deactivate the system:

1. When towing a trailer.
2. When a bicycle carrier or other item is fitted to the rear of the vehicle.



BSD/RCTA OFF Switch Placement

BSD/RCTA OFF Switch



BSD/RCTA OFF Indicator

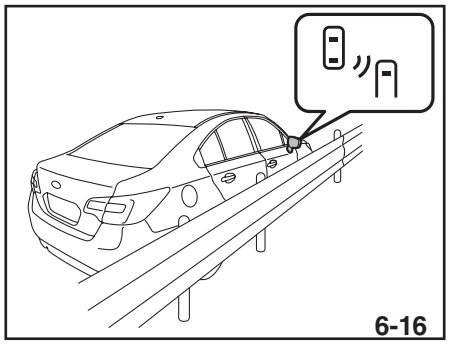
Rear Radar Characteristics

The BSD/RCTA system will not operate in the following situations:

- The BSD/RCTA OFF indicator is illuminated
- The vehicle speed is below 10 mph (15 km/h) even when the BSD/RCTA OFF indicator is not illuminated (Except when reversing)

The following may cause the BSD/RCTA system indicators to illuminate:

- Driving close to solid objects such as guardrails, tunnels, and sidewalls
- Turning at an intersection in an urban area
- A building or wall exists in the reversing direction
- On a road with extremely narrow lanes, the system may detect vehicles driving in a lane next to the neighboring lane



Driving to close to Guard Rail

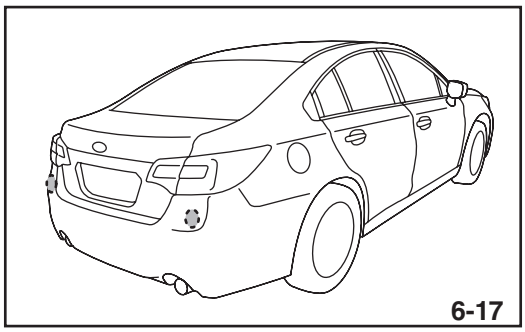
The Radar sensors may not detect or may have difficulty detecting the following vehicles or objects:

- Small motorcycles, bicycles, pedestrians, and stationary objects on the road or road side
- Vehicles with body shapes that do not reflect radar (vehicles with low body height such as a trailer with no cargo and sports cars)
- Vehicles that are not approaching your vehicle even though they are in the detection area either on a neighboring lane to the rear or beside your vehicle when reversing (The system determines the presence of approaching vehicles based on the data detected by the radar sensors)
- Vehicles traveling at significantly different speeds
- Vehicles driving in parallel at almost the same speed as your vehicle for a prolonged period of time
- Oncoming vehicles
- Vehicles in a lane beyond the neighboring lane
- Vehicles traveling at a significantly lower speed that you are trying to overtake

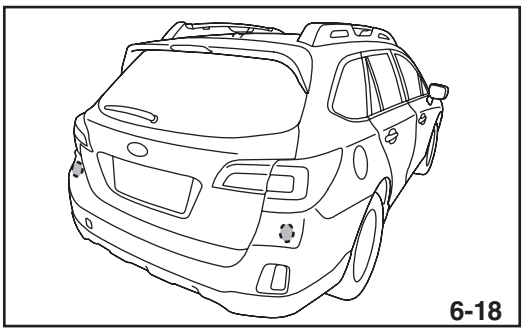
Caution: The driver is responsible for driving safely. Always be sure to check the surroundings with your eyes when changing lanes or reversing the vehicle. This system is designed to assist the driver by monitoring the rear and side areas of the vehicle during lane change and reversing. However, you cannot rely on this system alone in assuring safety during a lane change or reversing. Over-confidence in this system could result in an accident and lead to serious injury or death. Since the system operation has various limitations, the flashing or illumination of the BSD/RCTA approach indicator light may be delayed or it may not operate at all even when a vehicle is present in a neighboring lane or approaching from either side.

System Construction

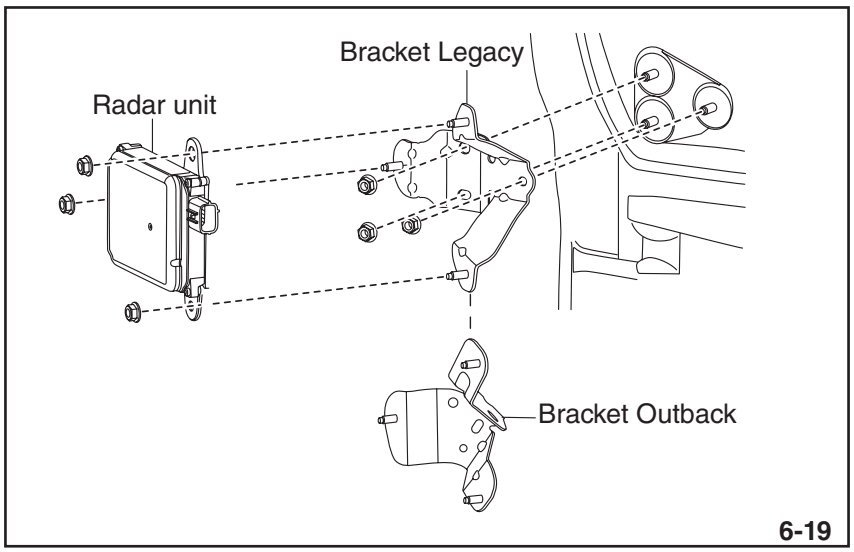
The BSD/RCTA system consists of two rear Radar units symmetrically fitted behind the bumper cover under the rear tail lights.



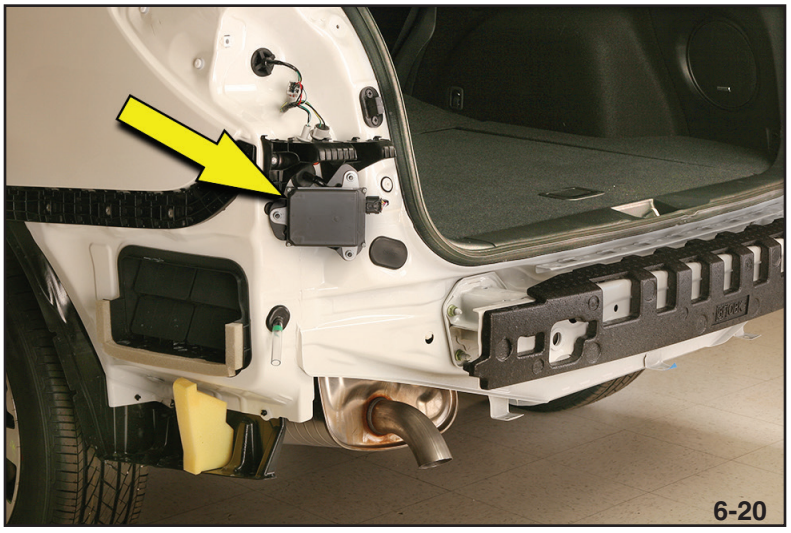
Radar Units (Legacy)



Radar Units (Outback)



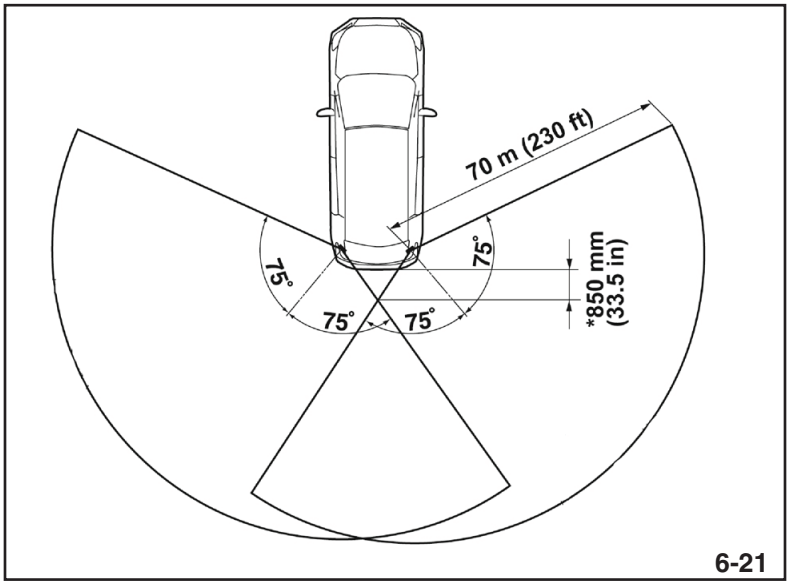
Radar Unit Mounting



LH Radar Unit (Outback)

The Subaru Rear Vehicle Detection system is classified as a Short Range Radar system. Each of the two Radar units contains a Radio Frequency (RF) antenna that emits electromagnetic radiation in the 24 GHz frequency range. At a distance of 20cm from the sensor, the radiated power is 0.0027 mW/cm2. This is well below the human exposure protection limit of 1.0 mW/cm2.

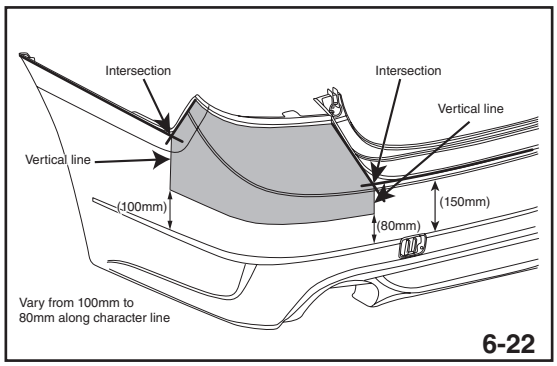
The detectable angle from the center of each RF antenna is 75° or 150° total with a range of approximately 230ft (70m). Regardless if the system is using BSD, LCA, and RCTA, the RF antennas are always monitoring a 150° angle with a range of 230ft. What differentiates BSD, LCA, and RCTA is the logic used to estimate relative speed difference versus distance of Time to Collision (TTC) warning.



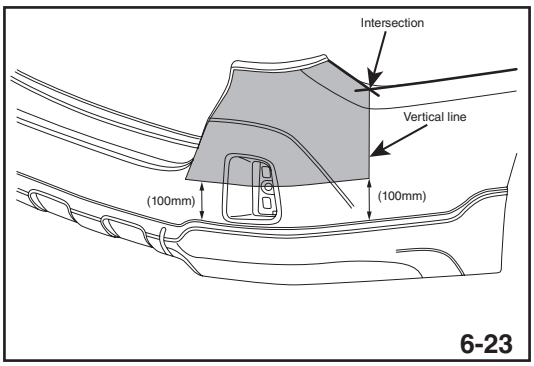
BSD/RCTA Detection Area

To ensure correct operation of the BSD/RCTA system, observe the following precautions:

1. Always keep the bumper surface near the radar sensor clean
2. Do not affix any stickers of other items on the bumper surface near the radar sensors
3. Do not modify the bumper near the radar sensors
4. Do not paint the bumper near the radar sensors
5. Do not expose the bumper near the radar sensors to strong impacts. If a sensor becomes misaligned, a system malfunction may occur, including the inability to detect vehicles entering the detection areas

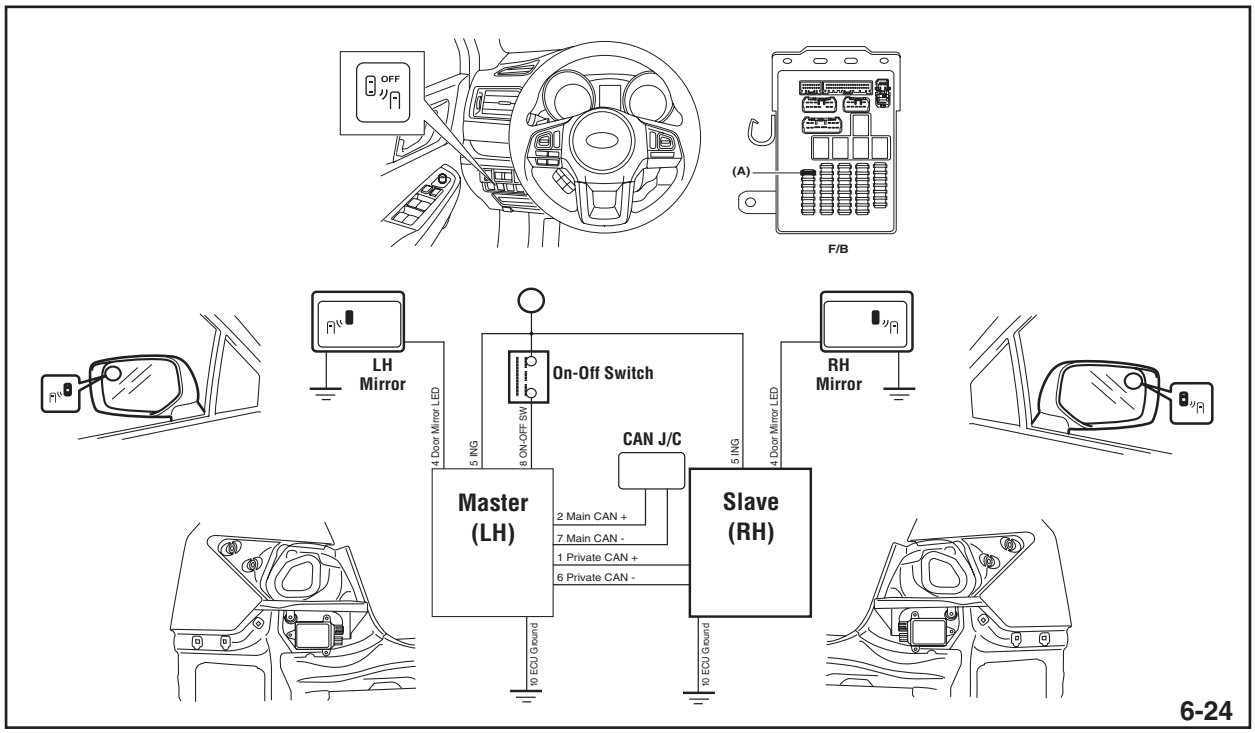


Bumper Prohibited Areas Legacy



Bumper Prohibited Areas Outback

Each Radar unit contains an internal control unit that processes information from the RF antenna and controls alert decisions. The left and right rear Radar units are distinguished as Master (LH) and Slave (RH). The Master and Slave Radar units are connected to each other via a private CAN network where alert decisions are determined. The Master (LH) Radar unit communicates with the Main CAN for necessary vehicle information and receives a direct input from the console mounted BSD/RCTA “OFF” switch. Each Radar unit has direct control over its respective side mirror LED indicator.



BSD/RCTA System Overview

Item	Value	Unit
Trip Count	262	Time
Count	Common	
Time Count	251700	ms
SRVD System fail flag	Normal	
SRVD System HALT flag	Normal	
SRVD System ON-OFF flag	ON	
LH-Side Target detection flag	Un-detect	
LH-Side BSD caution 1st flag	OFF	
LH-Side LCA caution 1st flag	OFF	
LH-Side RCTA caution flag	OFF	
LH-Side Radar Voltage value	12.3	V
LH-Side Temperature value	82	°F

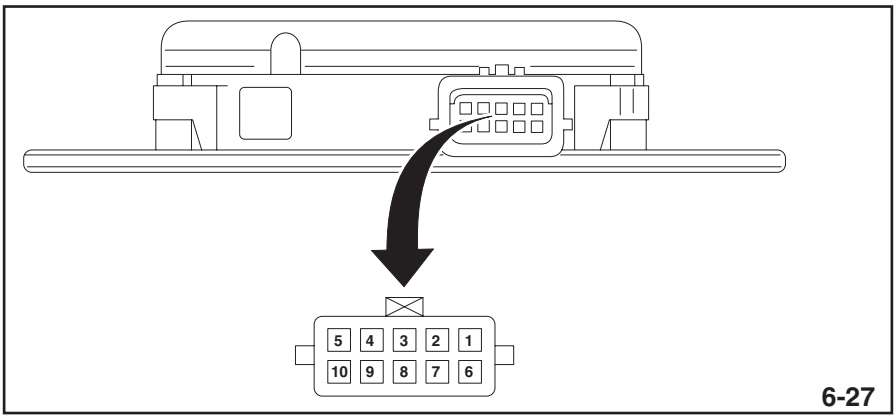
6-25

BSD/RCTA LH (Master) Data

Item	Value	Unit
Trip Count	262	Time
Count	Common	
Time Count	269800	ms
SRVD System fail flag	Normal	
SRVD System HALT flag	Normal	
SRVD System ON-OFF flag	ON	
RH-Side Target detection flag	Un-detect	
RH-Side BSD caution 1st flag	OFF	
RH-Side LCA caution 1st flag	OFF	
RH-Side RCTA caution flag	OFF	
RH-Side Radar Voltage value	12.4	V
RH-Side Temperature value	84	°F

6-26

BSD/RCTA RH (Slave) Data



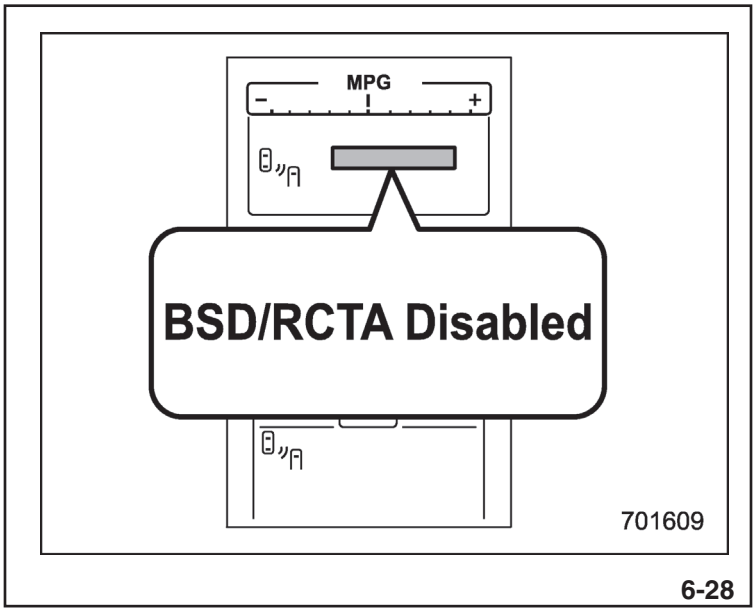
Radar Unit Connector

Terminal No.	Contents		Measuring condition	Standard
	Radar LH (master)	Radar RH (slave)		
1 ←→ Chassis ground	Private CAN H	Private CAN H	Always	1 MΩ or more
2 ←→ Chassis ground	Master CAN H	—	Always	1 MΩ or more
3 ←→ Chassis ground	—	—	—	—
4 ←→ Chassis ground	Left mirror LED output	Right mirror LED output	When Ignition key Inserted	Pulse generation
5 ←→ Chassis ground	Ignition power supply	Ignition power supply	Ignition switch OFF → ON	Less than 1 V →9
6 ←→ Chassis ground	Private CAN L	Private CAN L	Always	1 MΩ or more
7 ←→ Chassis ground	Master CAN L	—	Always	1 MΩ or more
8 ←→ Chassis ground	Subaru Rear Vehicle Detection OFF switch	—	• Ignition switch ON • Subaru Rear Vehicle Detection switch OFF → ON	Less than 1 V → 9 — 16 V
9 ←→ Chassis ground	—	—	—	—
10 ←→ Chassis ground	GND	GND	Always	Less than 1 Ω

Service and Diagnostics

Temporary Stop

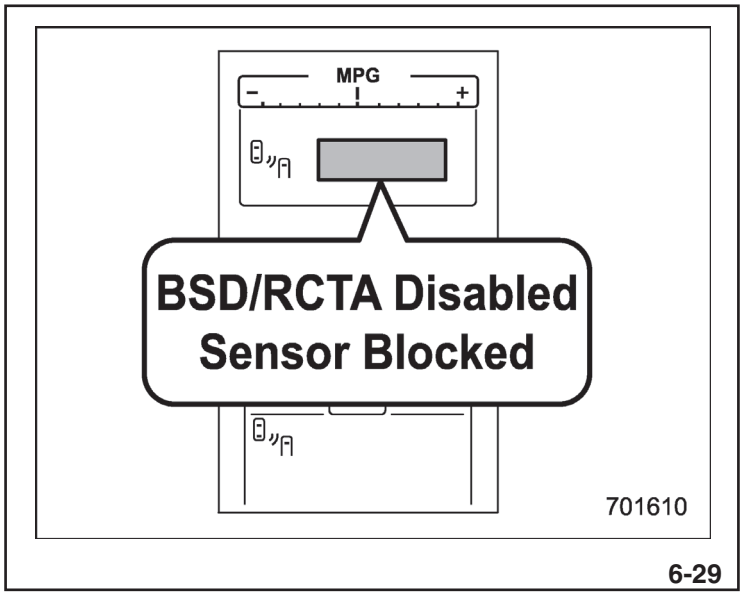
The “BSD/RCTA Disabled” message is displayed when the system experiences a “temporary stop” condition such as extremely high or low temperatures or when abnormal voltage exists. Once these conditions are corrected, the system will recover from the temporary stop condition and the indicator will turn off.



BSD/RCTA Temporary Stop Indicator

Sensor Blocked

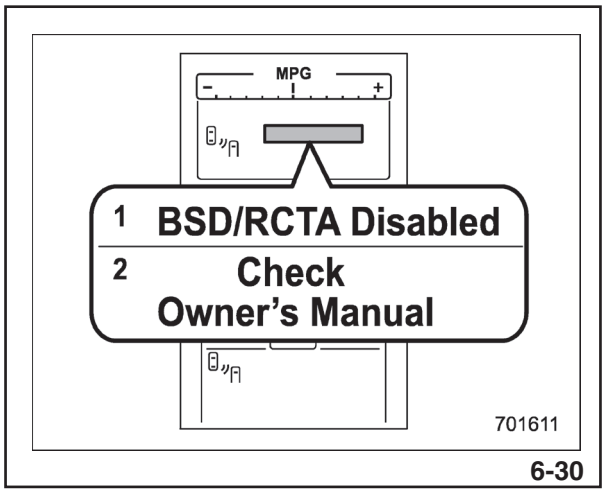
The “BSD/RCTA Disabled Sensor Blocked” message is displayed when the detectability of the radar sensor is reduced. Once the condition is corrected, the system will recover from the temporary stop condition and the indicator will turn off.



BSD/RCTA Sensor Blocked Indicator

System Malfunction

If the BSD/RCTA system experiences a general malfunction, such as circuit or communication failures, the BSD/RCTA indicator and “Check Owner’s Manual” will be displayed on the Combination Meter. The Owner’s Manual will direct the driver to contact their Subaru Retailer.



BSD/RCTA Malfunction Indicator

The BSD/RCTA system features conventional diagnostics with DTC, FFD, and normal sampling data through the Subaru Select Monitor (SSM).

Note: Refer to the appropriate Service Manual for a complete listing of Diagnostic Trouble Codes (DTCs)

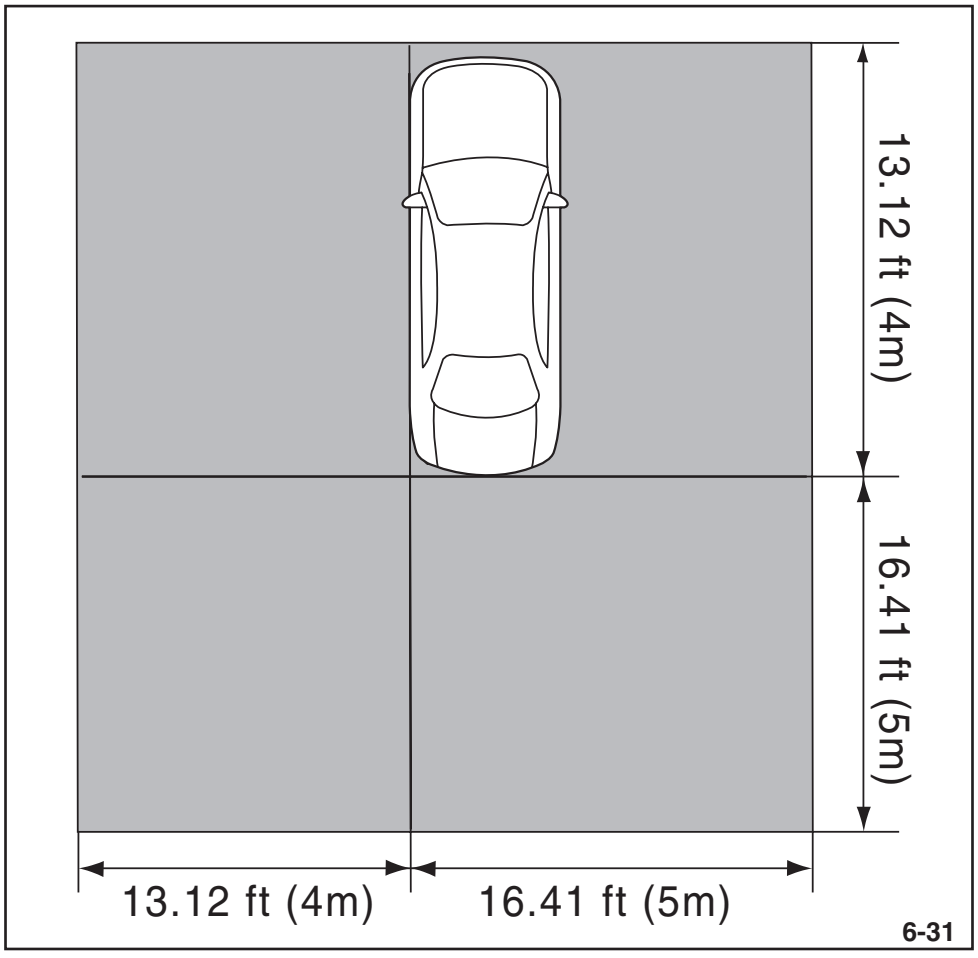
DTC	SSM Indication	Detection Condition	Resetting Condition
B2304	RADAR ASSY B&&S ON-OFF switch adhesion	This failure occurs if the harness from the rear side radar through the door mirror to ground short-circuits to ground.	When the ignition is set to ON, the switch should operate normally.
B2311	RADAR ASSY B&&S TCM fail detection	This failure occurs if the system breaks down due to a failed rear side radar caused by a failure in the TCM.	When the ignition is set to ON, the TCM should operate normally.
B2313	RADAR ASSY B&&S VDC fail detection	This failure occurs if the system breaks down due to a failed rear side radar caused by a failure in the VDC.	When the ignition is set to ON, the VDC should operate normally.
B2320	RADAR ASSY B&&S Low Voltage (less than 9V)	This failure occurs if the voltage applied to the rear side radar stays at 9 V or lower for about 5 sec.	When the power supply becomes higher than 9 V, the triggered indication is reset.
B2321	RADAR ASSY B&&S High Voltage (more than 16V)	This failure occurs if the voltage applied to the rear side radar stays at 16 V or higher for about 5 sec.	When the power supply becomes lower than 16 V, the triggered indication is reset.
B2327	RADAR ASSY B&&S internal failure (internal electric circuit)	This failure occurs if the rear side radar internal failure is detected.	When this failure occurs, basically replace the radar with a new one.
B2328	RADAR ASSY B&&S internal failure (RADAR misalignment)	This failure occurs if eccentricity is detected in the rear side radar axis.	Adjust the axis of the radar.
B2329	RADAR ASSY B&&S uncompleted RADAR alignment	This failure occurs if the axis adjustment by the SSM in the rear side radar has failed.	Adjust the axis of the radar.
B2340	RADAR ASSY B&&S high ambient temperature (more than 85°C)	This failure occurs if the temperature inside the rear side radar moves out of working temperature range.	When the internal temperature returns within the working temperature range, the triggered indication is reset.
B2341	RADAR ASSY B&&S degradation of detecting performance	This failure occurs if radar irradiation is blocked or radar reflection cannot be received.	When the radar properly irradiates or re-ceives the reflected signal, the triggered indication is reset.
B2350	RADAR ASSY B&&S Communica-tion error between Master and Slave	This failure occurs if there is any trouble between the Master and Slave in the rear side radar.	When the ignition is set to ON and the private CAN operates normally, the triggered indication is reset.

Radar Axis Alignment

Alignment of the Radar Axis is performed after removal/installation or replacement of a BSD/RCTA Radar unit. This includes body repairs or the replacement of a mounting bracket.

Note: This procedure outlines the Radar Axis Alignment for the Master (LH) Radar unit. Alignment of the Slave (RH) Radar unit is accomplished with the same procedure on the opposite side of the vehicle.

Secure an open and level area with 13.12 ft (4m) from the rear and side of the vehicle.

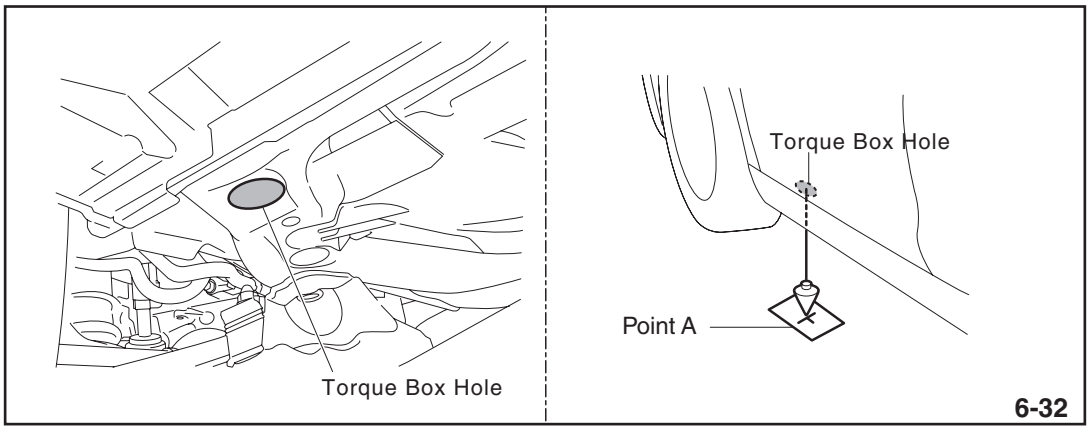


Radar Axis Alignment Area

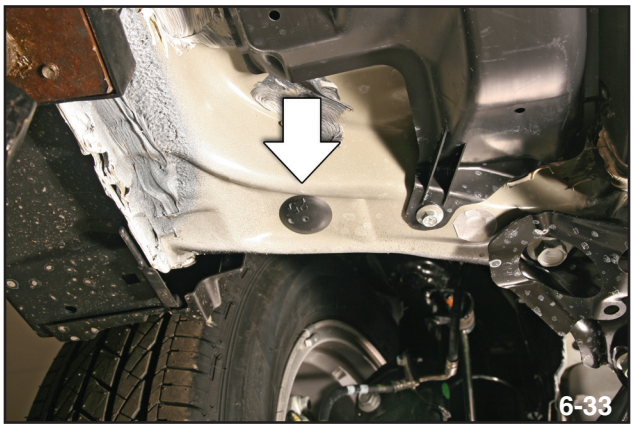
Caution: No large metallic objects (other than SST Radar Reflector) or persons can be present in the Radar Axis Alignment area during the procedure.

Point A

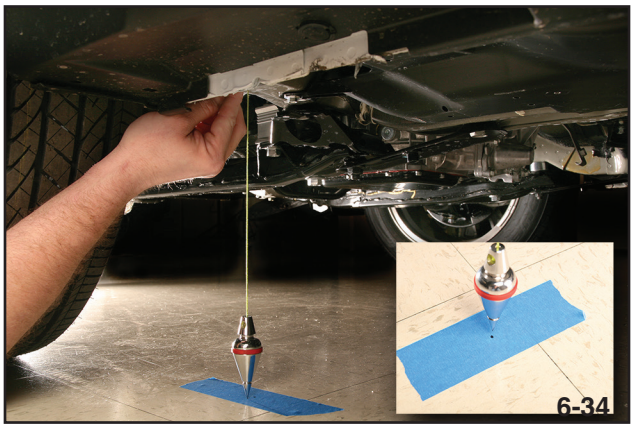
Suspend a line with a plumb bob from the center of the rubber cap located in driver's side torque box gauge hole, and mark Point A on the floor with tape.



Point A Set-up (Artwork)



LH Torque Box Hole

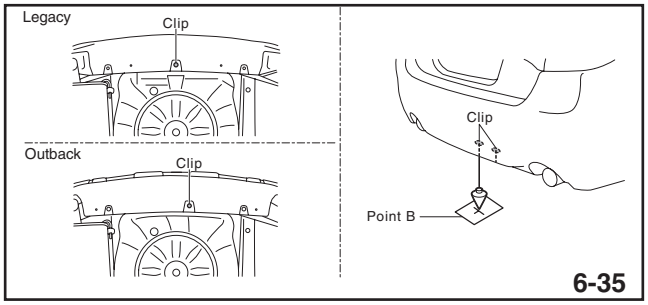


Point A

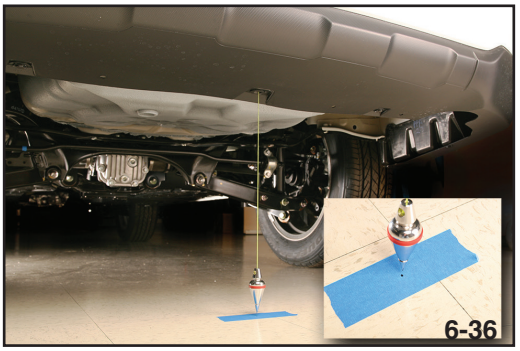
Point B

Suspend a line with plumb bob from the center of the vehicle rear, and mark the center point on the floor with tape.

1. Remove the clip located in the vehicle center at the rear bumper.
2. Thread a line with plum bob into the hole
3. Mark Point B on the floor with tape.

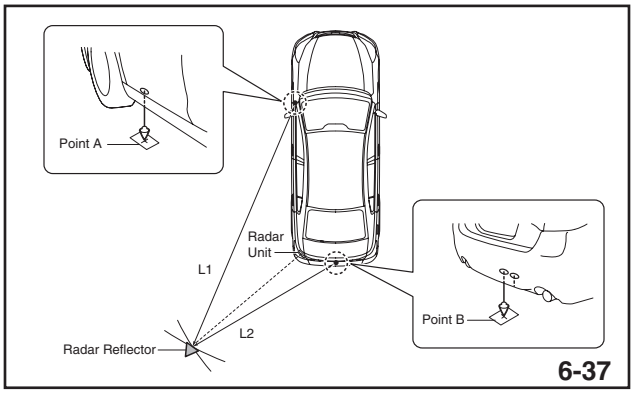


Point B Set-up (Artwork)

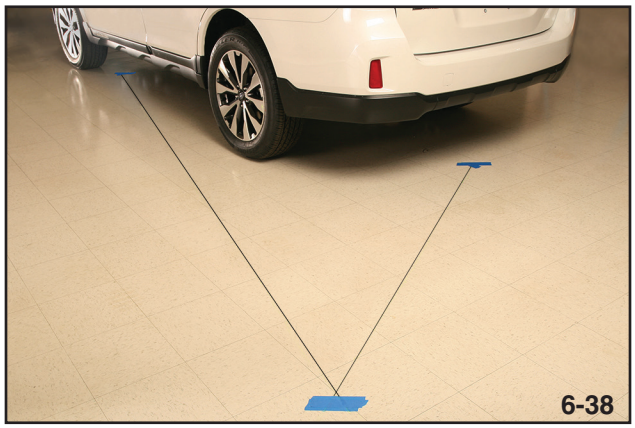


Point B

4. Using a strong string or soft tape measure, locate the point at which L1 and L2 intersect based on the corresponding body style.



Alignment Preparation (Artwork)



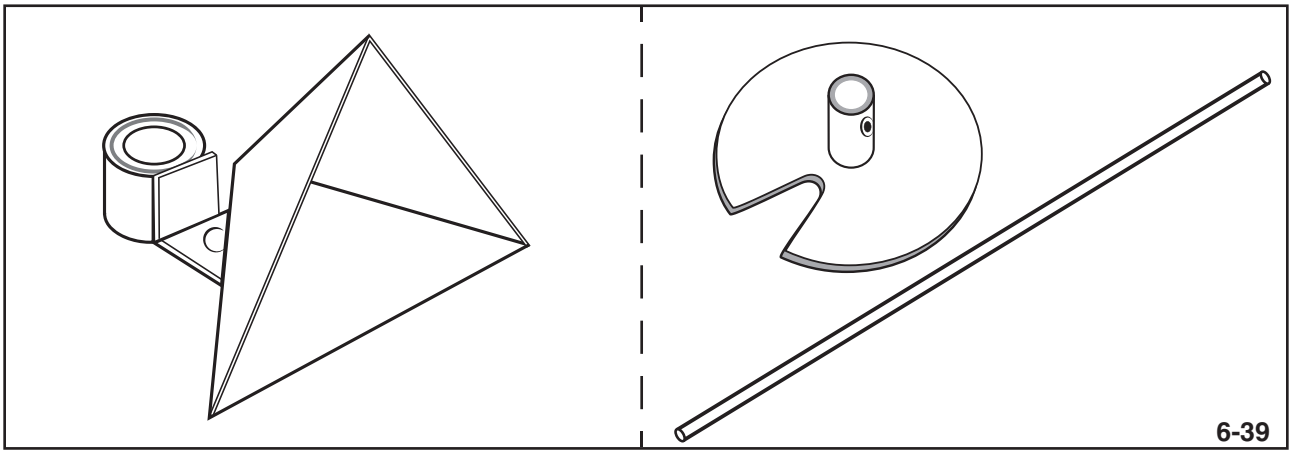
Alignment Preparation

	Sedan		Outback			
			Left		Right	
	L1	L2	L1	L2	L1	L2
Length	4,420 mm	2,025 mm	4,430 mm	2,100 mm	4,430 mm	2,005 mm
	(174.02 in)	(79.72 in)	(174.41 in)	(82.68 in)	(174.41 in)	(78.94 in)

Note: Point B on Outback models is offset from the center of the vehicle. Therefore, a different length for L2 is used from side to side.

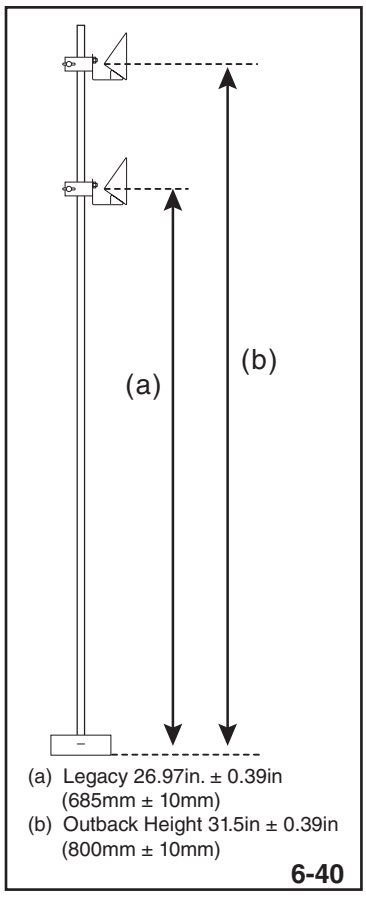
Radar Reflector and Stand

5. Prepare SSTs J-51658 (Radar Reflector) and J-51662 (Stand).

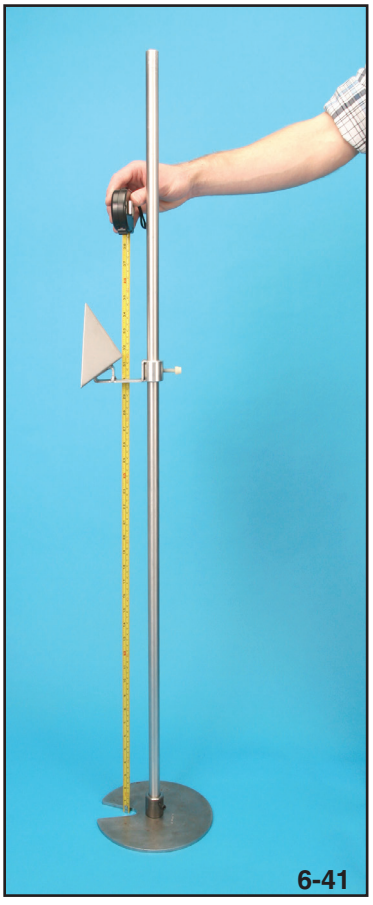


Radar Reflector and Stand

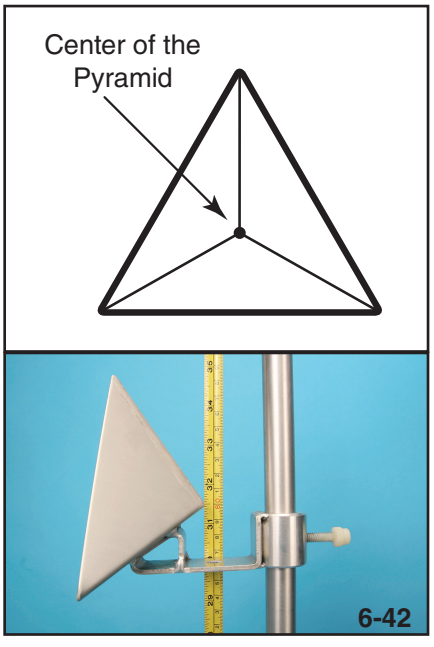
6. Using the stand, set the Height of the Radar Reflector to the corresponding vehicle body style.



Radar Reflector Different Heights (Artwork)

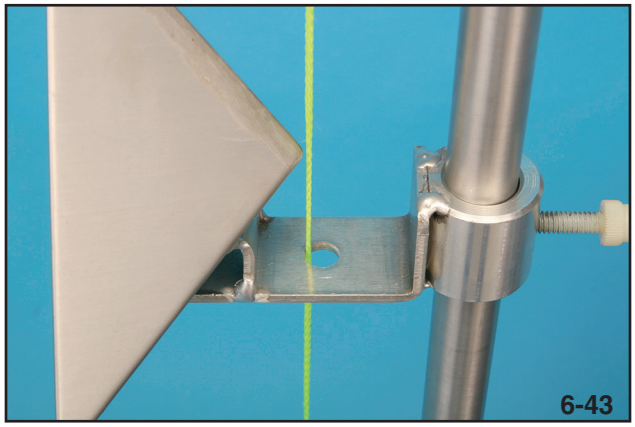


Radar Reflector and Stand

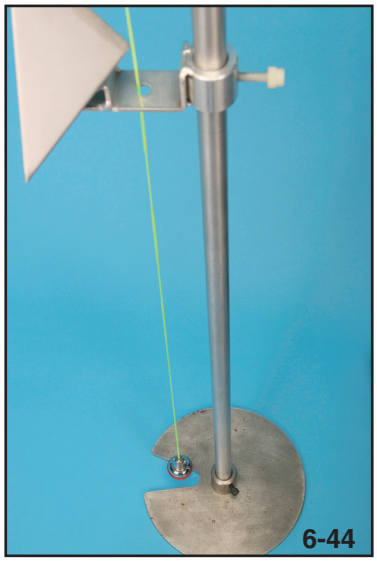


Radar Reflector Height

7. Suspend a line with plumb bob to align the rear of the Radar Reflector pyramid with the convergence point established by L1 and L2.

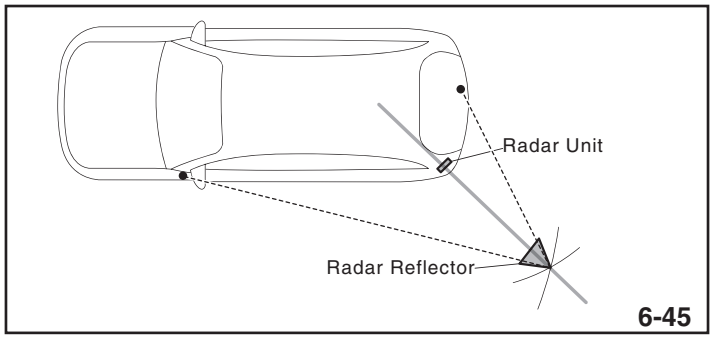


Radar Reflector Pyramid



Radar Reflector and Stand

8. Without disturbing the alignment of the Radar Reflector, carefully aim the center of the pyramid at the Radar unit location. A slight amount of angular error is allowed.



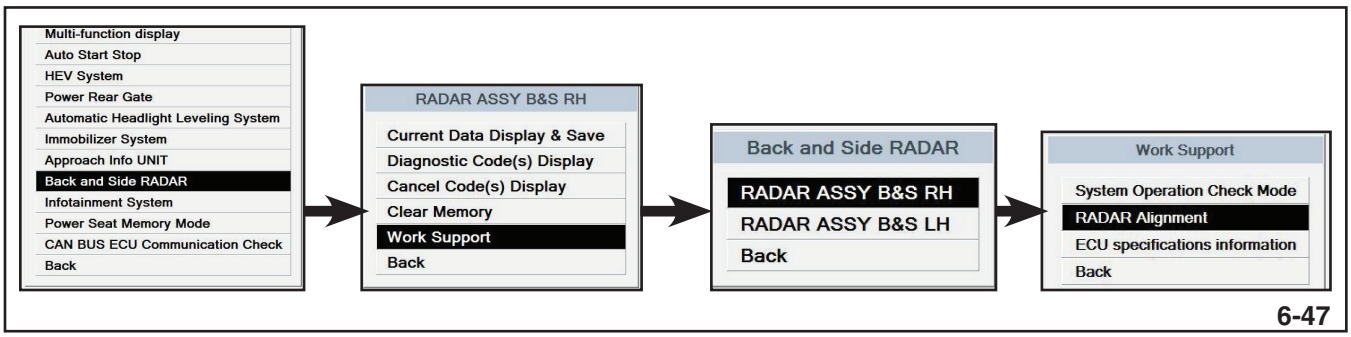
Radar Reflector Aiming Angle

Aiming Radar Reflector

Subaru Select Monitor (SSM) Work Support

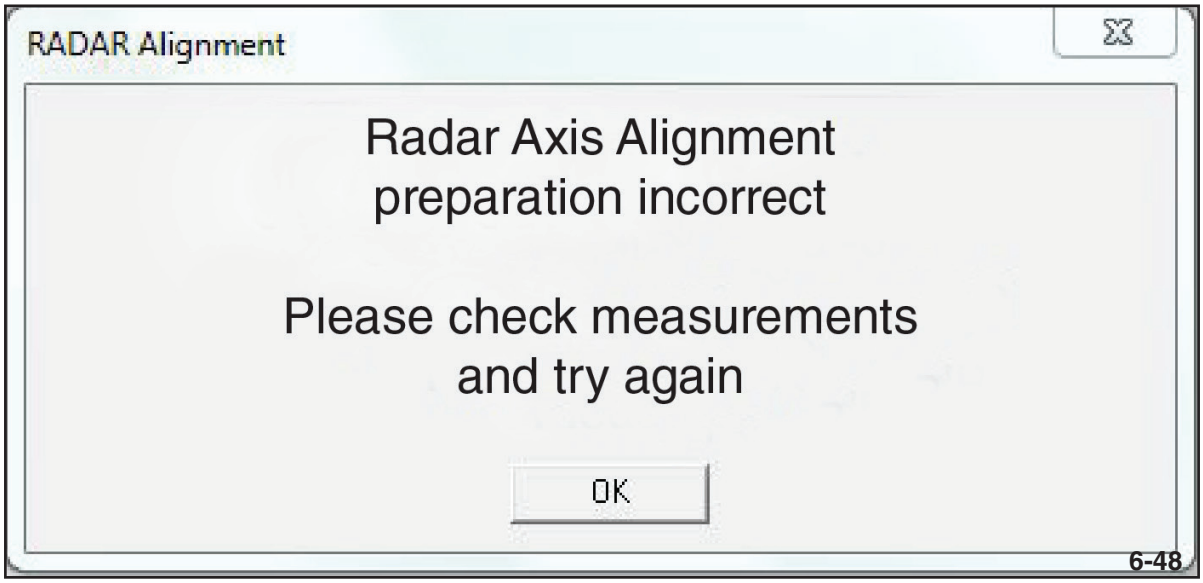
Once preparations are complete, the Radar Axis Alignment is executed using the Subaru Select Monitor (SSM).

Note: Turn the Ignition switch to the ON position. Wait for 10 Seconds



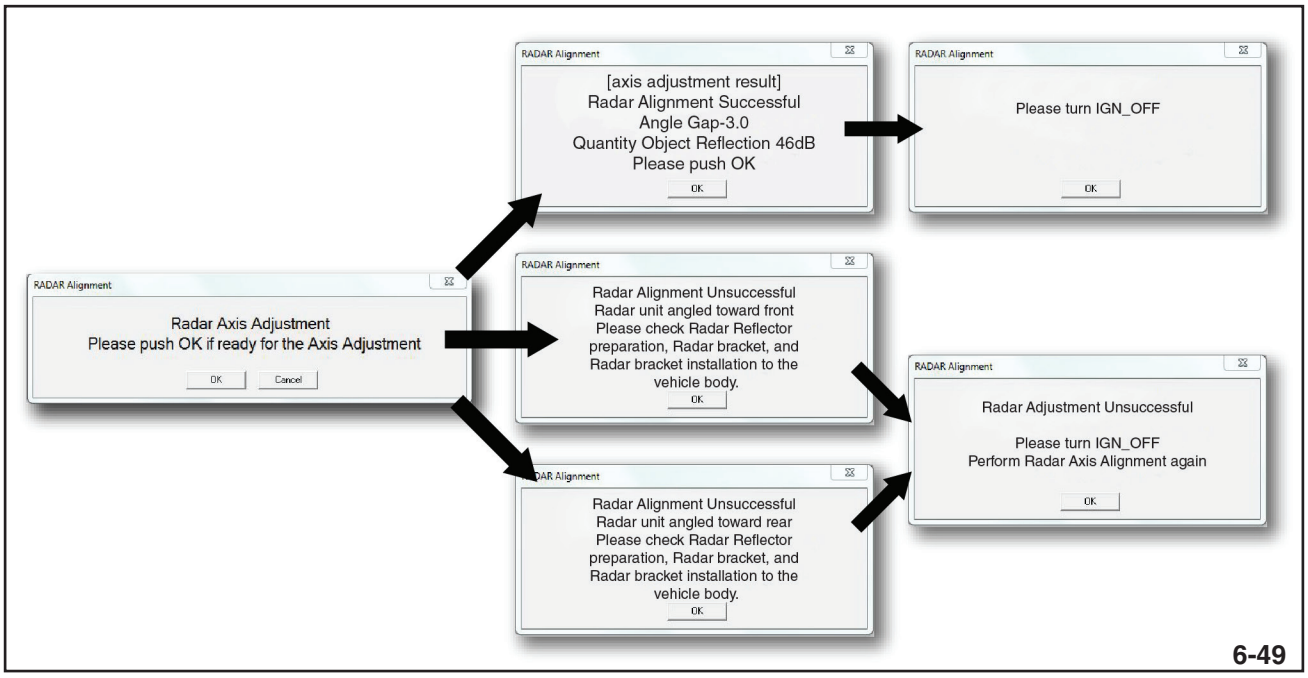
SSMIII Work Support

If preparations were incorrect, then the system will display a similar message. Ensure Point A, Point B, and Radar Reflector positioning are correct as indicated in the appropriate service manual.



Radar Axis Alignment

After executing the Radar Axis Alignment, the system will determine the success of the alignment. If the result is “Successful” then repairs should be verified by test drive.

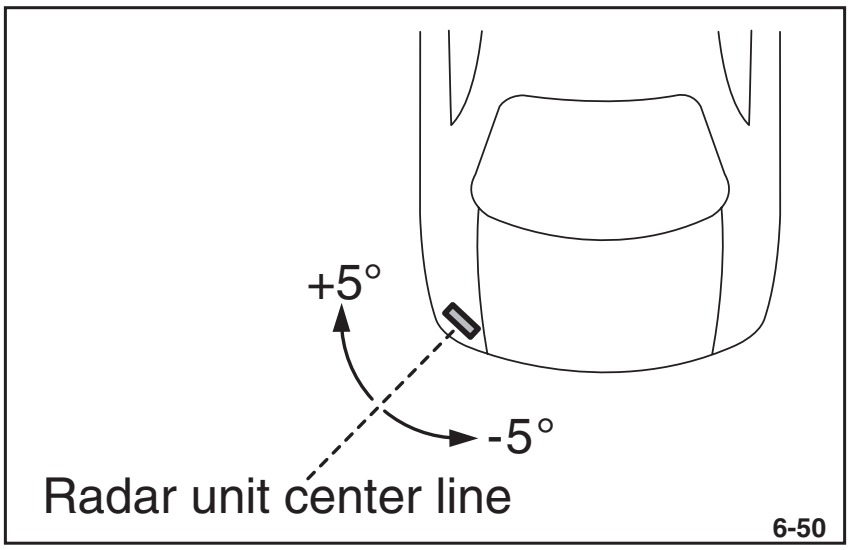


Radar Alignment SSMIII Messages

Note: “Quantity of Object Reflection (dB)” is a value to express radar signal strength and is used for research purposes only. This information is not provided for technician diagnostics.

If the result of the Axis Alignment is out of the permissive range, it is possible that the reflector position may be incorrect or the Radar unit bracket/mounting location may be deformed.

The maximum allowable misalignment of the Radar unit is ±5°. If this value is greater than ±5° then bent or damaged components exist.



Radar Alignment

NOTES:

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