SUBARU

QUALITY DRIVEN® SERVICE

CERTIFIED SUBARU TECHNICIAN

Technicians Reference Booklet

Brake System

Module 501

AUTOMOTIVE Youth Educational Systems YES

November 2006

MSA5P0170C

Technical Training

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This book is revised with material from New Model Update 913 thru 916.

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Table of Contents

Introduction

This Technicians Reference Booklet introduces the brake systems used on Subaru vehicles. It covers the component operation, troubleshooting, diagnosis, and service precautions and procedures. This information is presented with special emphasis on procedures, tools and materials unique to the Legacy, Forester and Impreza vehicles. Subaru-specific servicing procedures and precautions are also included in this booklet.

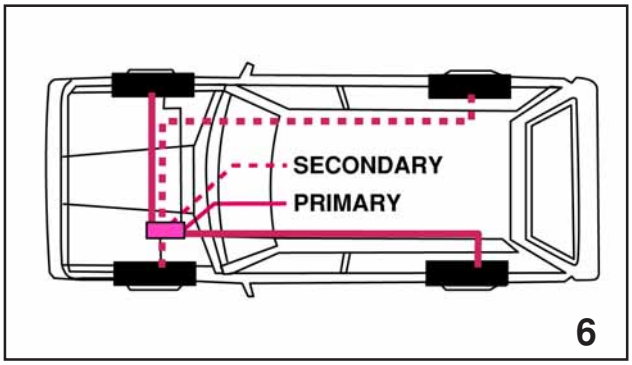
The text and illustrations are derived from and follow the classroom lectures and slide presentations. They are intended to supplement and reinforce classroom instruction and to serve as a home-study reference source. Lists of applicable Service Bulletins, important notes and cautions, and Special Tools are included within this booklet. Pages for noting additional Diagnostic Tips and Notes are also provided.

Technicians Worksheets are to be completed during the hands-on lab work segments of the Brake System Module.

Always refer to the appropriate model year Subaru Service Manual and the Applicable service bulletins for all specifications and detailed service procedures.

General Overview

SUBARU Brake Systems Overview



Dual Diagonal Brake System

All Subaru vehicles are equipped with a dual diagonal brake system. A master cylinder feeds a crisscross hydraulic circuit consisting of a primary circuit and a secondary circuit. Braking force is transmitted to the right front and the left rear brakes by the primary system. Braking force is delivered to the left front and the right rear brakes by the secondary system. This safety feature not only provides even braking, but also provides balanced braking in the event of failure of one of the circuits.

Disc Brake Overview

Disc brakes are self adjusting and feature a single or dual piston in a free floating caliper design or as in some later models, fixed calipers. The type of caliper used depends on model type and trim level.

Front Disc Brake

Front disc brakes feature a ventilated disc which has high heat dissipation and superb braking stability. Due to the nature of their design, disc brakes quickly restore the original braking performance when wet.

Rear Disc Brake

Rear disc brakes features are similar in a solid rotor design brake mechanism.

All current Subaru vehicles equipped with a rear drum brake system will be of the self adjusting type.

Front Disc Brakes

Most disc brakes on Subaru vehicles feature self-adjusting, single piston or dual piston, free-floating calipers that slide on pins. The calipers are designed to provide easy access to the pads. The pads are equipped with wear indicators that begin to squeal when the pad wears to a specific minimum pad thickness. Ventilated front rotors keep the brakes cooler. Solid rotors are used with rear brakes.

When the brake pedal is depressed and hydraulic pressure is supplied to the caliper, the piston slides through a flexible square-cut seal to push against the inside pad, and the caliper body is pulled against the outer pad. As the pad wears, the piston slides farther through the seal to take up the slack.

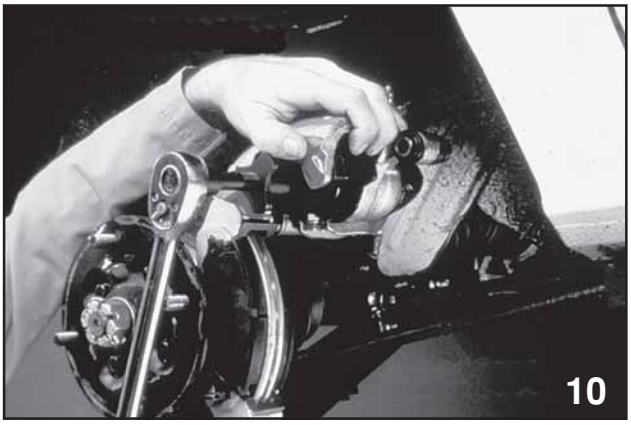
When the brake pedal is released, the piston is pulled away from the pad by the force of the seal returning to its normal square shape.

Pad Replacement Procedures

When replacing disc brake pads, follow the steps listed below. Always replace the pads in sets of four. Remember that the brakes are free-floating; guide pins and the sliding surfaces of the pad and clips must be properly lubricated, and sufficient clearance must exist between the top pad and the holder.

1) Remove the lock pins and raise the caliper
2) Remove the pads
3) Loosen the bleeder screw and push the piston in the cylinder
4) Install new pads
5) Reinstall the caliper and the brake cable

NOTE: IF THE PAD FITS TIGHTLY IN THE PAD HOLDER, RAPID PAD WEAR CAN OCCUR.



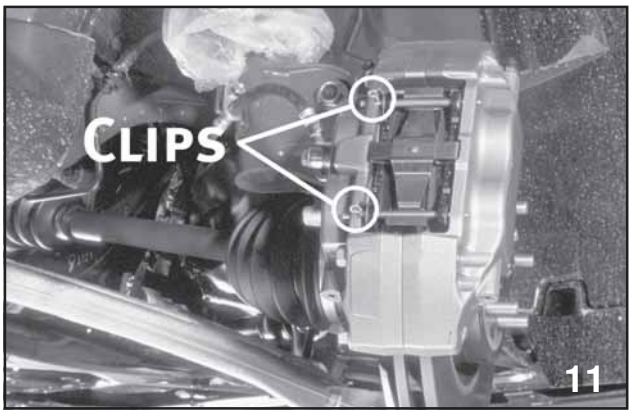
Depressing Caliper Piston (Older)

Because the new pads will be thicker than the old ones being replaced, the caliper piston needs to be retracted in the caliper body. Before pushing the piston back into the caliper, loosen the bleeder screw. After the pads are replaced and the brake calipers are reassembled, depress the brake pedal several times to take up the slack between the caliper piston and the brake pad before test-driving the vehicle.

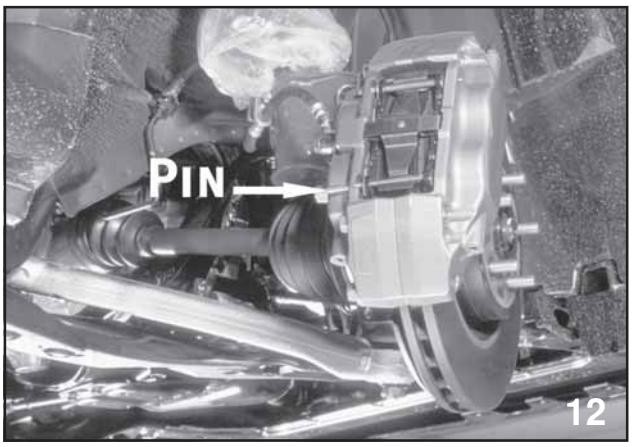
Beginning with the 2004 WRX STi, some Brake Systems will have fixed calipers and pads. These high performance brakes apply direct braking force from both sides of the brake caliper. Each side of the brake caliper is provided a brake fluid bleeder. Follow the directions provided in the appropriate service manual to bleed the air from the brake system when ever service work to the hydraulics is performed.

NOTE: NEVER SEPARATE THE BRAKE CALIPER HALVES

The front is equipped with Brembo 4 piston calipers. The front brake rotor is 12.6 in diameter with a minimum thickness of 28mm.



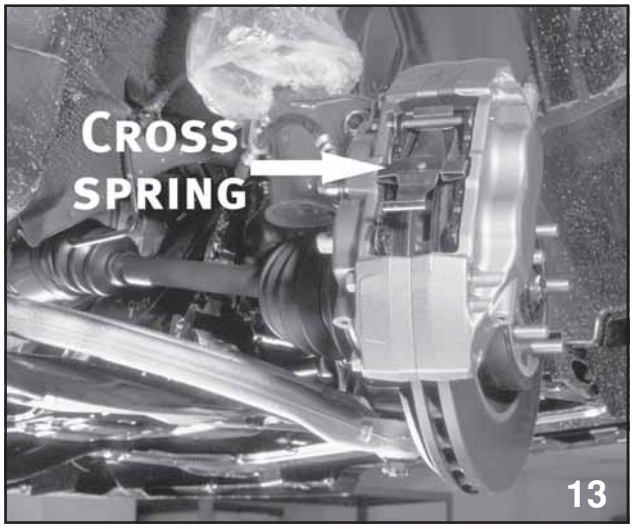
Front Caliper (Clips)



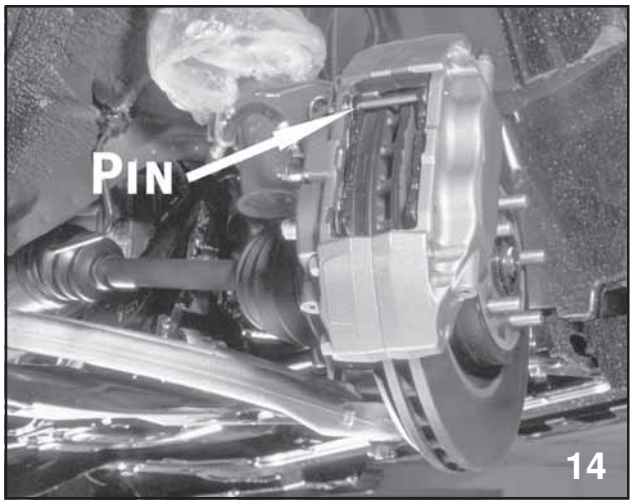
Front Caliper Lower (Pin)

Replacing the break pads is accomplished by first removing the clips from end of the pad pins.

Remove the lower pad pin.



Front Caliper (Cross Spring)



Front Caliper Upper (Pin)

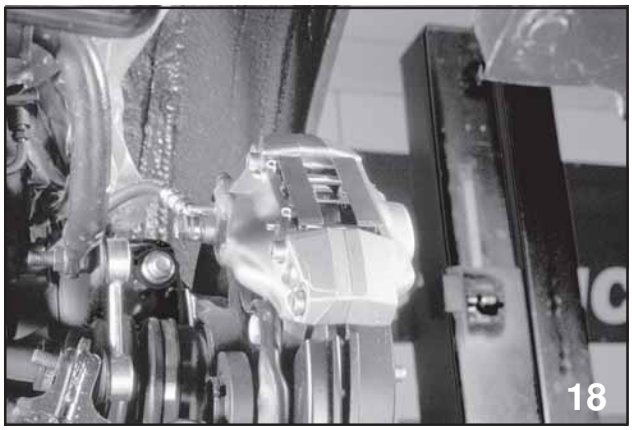
Next remove the cross spring. Then remove the upper pad pin.

Pads Slightly Out

Pads Gone

Pull the pads out slightly and use the pads to push the pistons back inside the caliper.

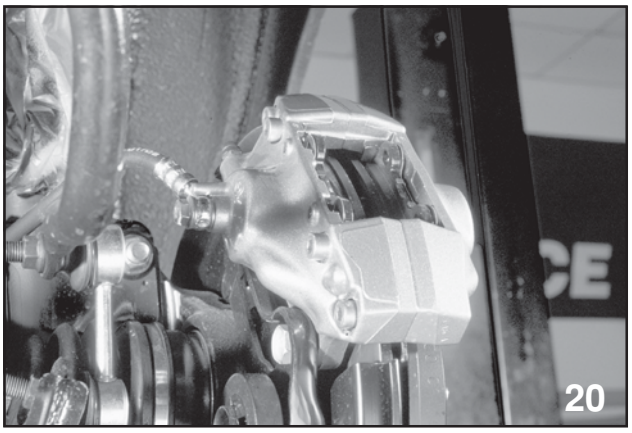
Rear Rotor and Caliper



Rear Caliper

The rear of the vehicle is equipped with Brembo 2 piston calipers. The rear brake rotor is 12.3 in diameter with a minimum thickness of 18mm.

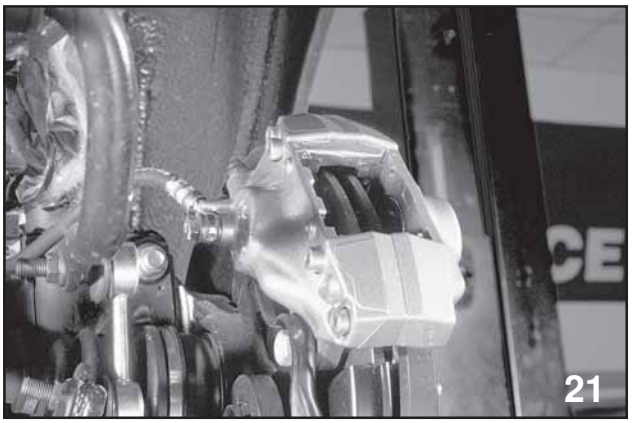
Pin Nearly Out



Pins and Cross Spring Removed

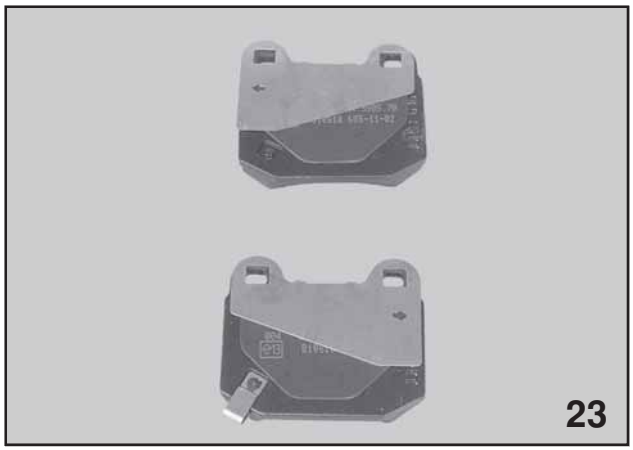
Remove the clips and pad pins, followed by the cross spring .

Pull the pads out slightly and use the pads to push the pistons back inside the caliper.



Pads Removed

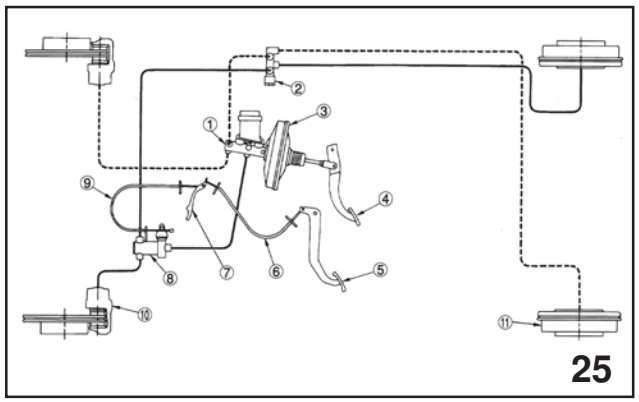
Front Pads



Rear Pads

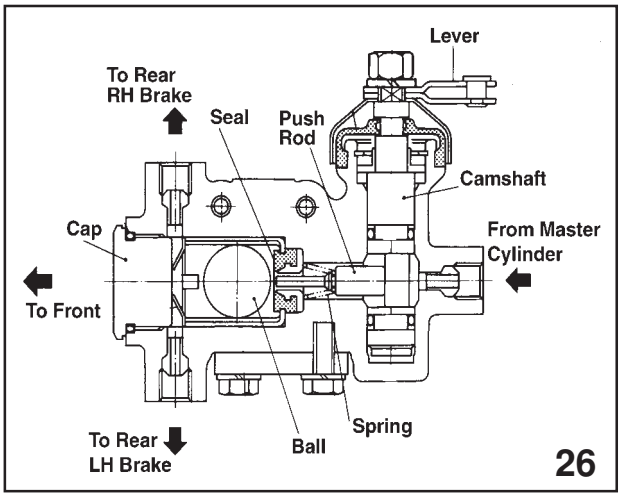
Arrows point in the direction of forward rotation.

Hill Holder™ System



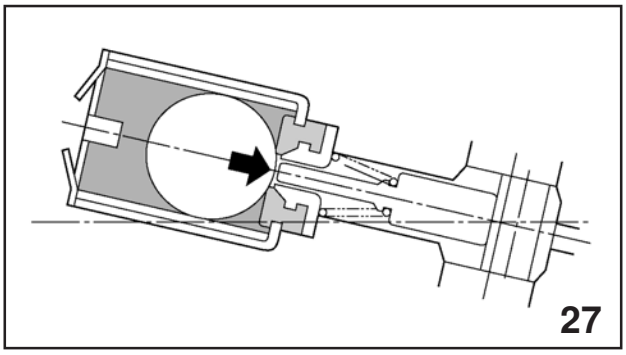
Hill-Holder™ System

Subaru brake systems also incorporate a unique Hill-Holder (TM) system. It is standard equipment on all 1990 to 1994 Legacy vehicles and some later Legacy and Impreza vehicles. The system prevents rollback when the vehicle is starting on an uphill grade. The heart of the Hill-Holder (TM) system is the pressure hold valve (PHV). Connected in series with the primary circuit, it works in conjunction with the clutch pedal via a linking device to hold pressure in the primary hydraulic brake circuit.

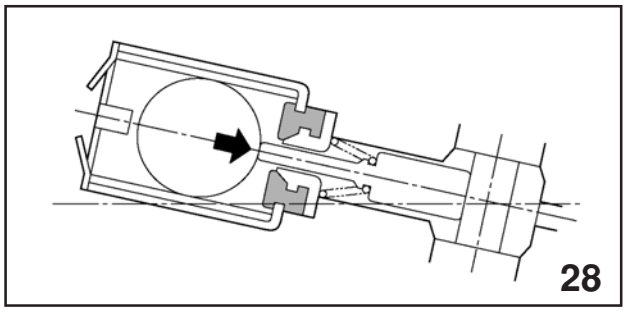


Pressure Hold Valve

When the vehicle comes to a stop on an uphill grade greater than or equal to 3 degrees, a push rod inside the PHV retracts when the clutch is depressed. This permits a ball in the PHV to roll backwards to seal hydraulic pressure in the primary circuit. When the brake pedal is released, the pressure trapped in the primary circuit by the ball holds the vehicle stationary. When the clutch pedal is released, the push rod extends once more to unseat the ball and release the hydraulic pressure.



Clutch Pedal In (Artwork)



Clutch Pedal Out (Artwork)

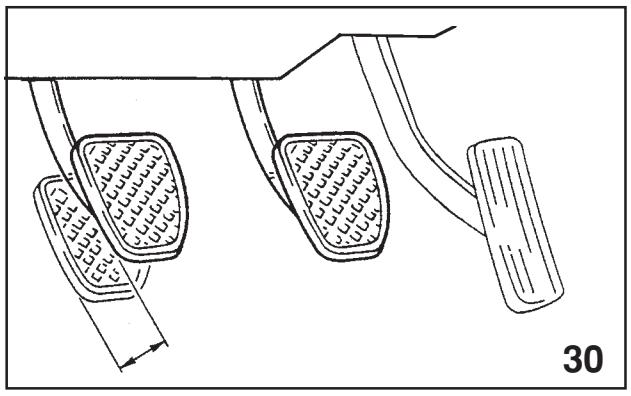
NOTE: THE PHV IS NON-SERVICEABLE AND MUST BE REPLACED AS A UNIT.

Hydraulic Servicing Precautions

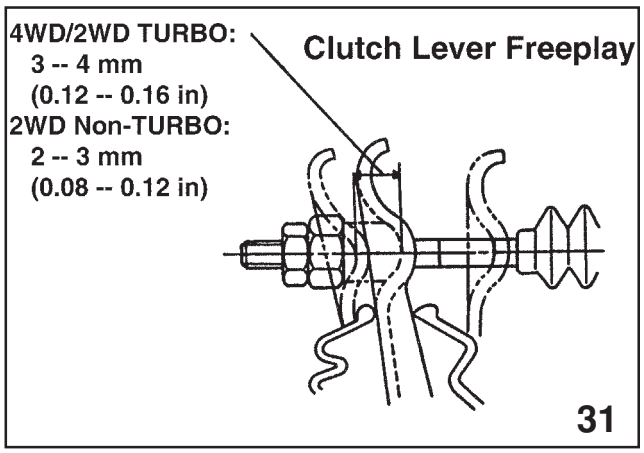
When servicing any of the hydraulic components, follow these precautions carefully.

1) Use DOT 3 or DOT 4 brake fluid.
2) Clean internal brake components with alcohol. External brake components may be cleaned with brake clean type solvents.
3) Use specified lubricants.
4) Do not hone aluminum cylinders.
5) Do not use silicone type brake fluids

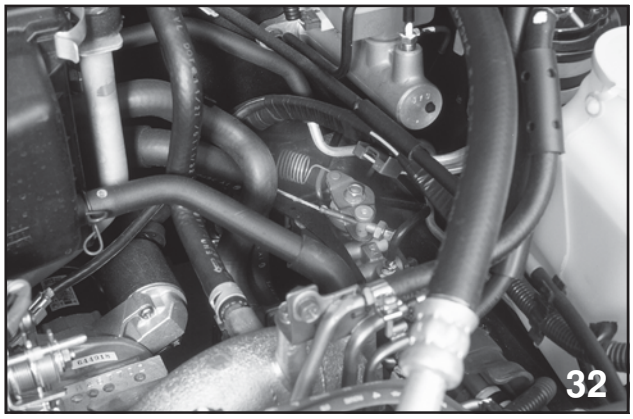
Clutch Pedal



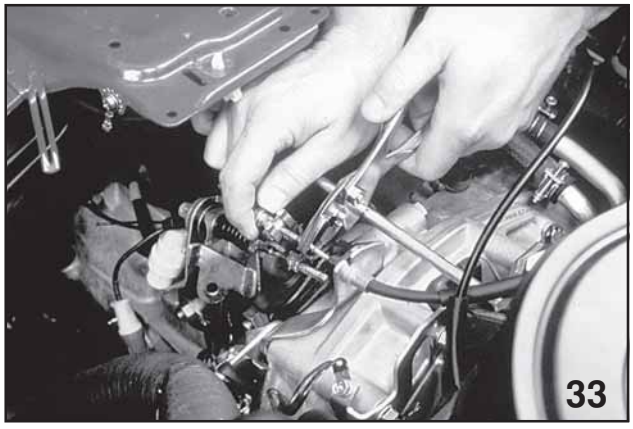
Clutch Pedal Free Pay



Clutch Lever Free Play



PHV



Adjusting PHV

Check the operation of the Hill-Holder (TM) system at every maintenance interval by road-testing the vehicle. If the system does not function properly, first verify the clutch pedal free play. Check it at either the pedal or the lever and adjust as necessary. If the vehicle will not hold on an incline of 3 degrees or greater, tighten the adjusting nut of the pressure hold valve cable until proper operation is achieved. If the brakes release late, loosen the adjusting nut on the PHV.

NOTE: CONFIRM PROPER OPERATION BY ROAD-TESTING THE VEHICLE.

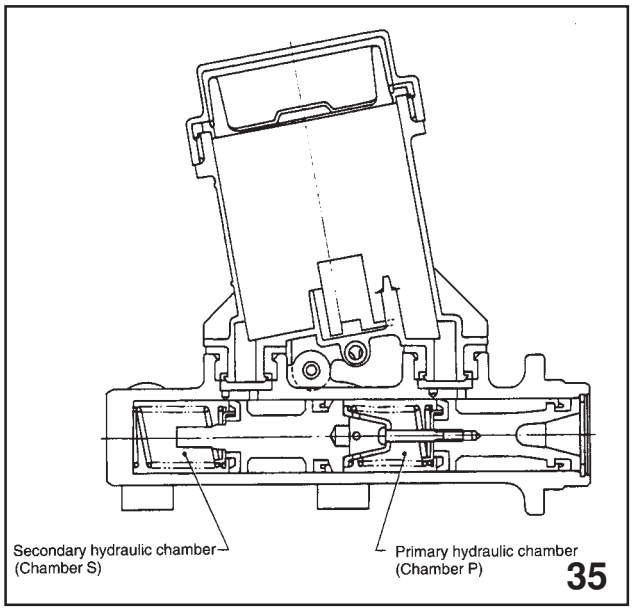
The PHV can also be adjusted to operate on very small inclines. Install a shim (P/N: 725807000) between the frame and the support to raise the front of the PHV.

NOTE: ONLY ONE SHIM IS ALLOWED.

The 2003 Forester 5 speed manual transmission model is equipped with a hill holder. The hill holder operates the same as earlier versions except the Secondary Brake Circuit is utilized to maintain braking action.

Master Cylinder

A sealed reservoir tank has been adopted to extend the service life of the brake fluid.

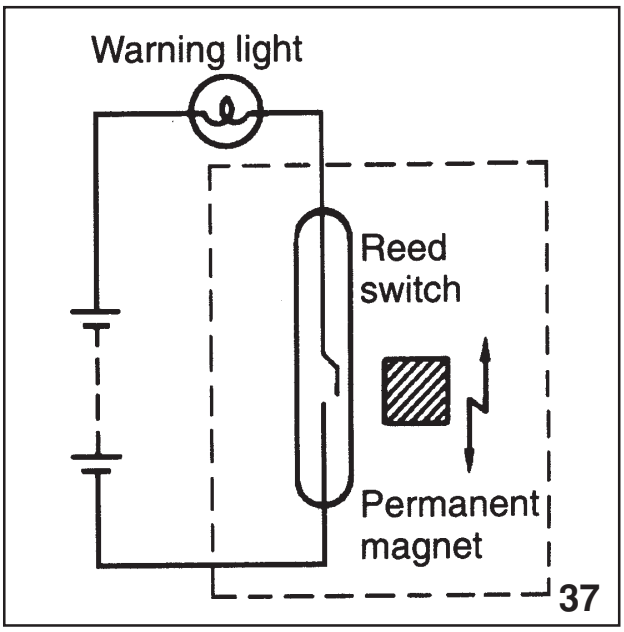


Master Cylinder Cross-Section

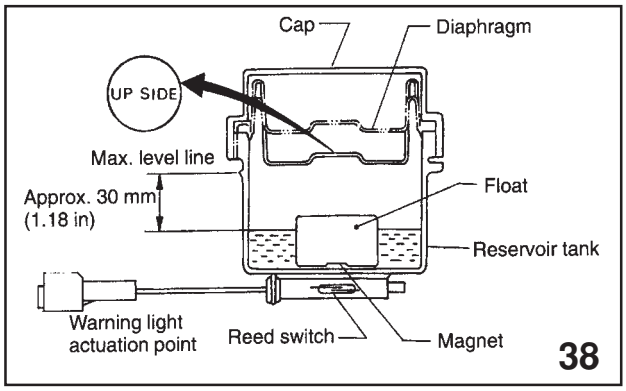
The master cylinder used in all current Subaru vehicles is divided into two chambers: Primary hydraulic chamber (Chamber P) and Secondary hydraulic Chamber (Chamber S).

Master Cylinder

The primary chamber supplies working pressure to the right-front and left-rear hydraulic circuits while the secondary chamber supplies working pressure to the left-front and right-rear hydraulic circuit. In the event of a hydraulic circuit failure, the vehicle will still maintain some braking performance.



Reed Switch Schematic



Reed Switch Construction

Brake Fluid Indicator

Components consist of a reed switch which mounts below the brake fluid reservoir and a permanent magnet housed in a float inside the brake fluid reservoir. When activated, the reed switch completes a ground circuit to turn on the brake warning lamp in the combination meter. Under normal conditions, the float remains above the reed switch, and the magnetic force from the permanent magnet in the float is unable to activate it. As the brake fluid drops, and falls below a specified level, the reed switch will be activated by the permanent magnet, completing the circuit to ground. The brake warning light may light intermittently if the vehicle tilts or swings excessively.

NOTE: WHEN THE BRAKE WARNING LIGHT ILLUMINATES:

1) The daytime running lights will not function. (If vehicle is equipped).
2) The Traction Control System will not operate.
3) On Impreza WRX STi, the DCCD will see a “Hand brake applied” signal

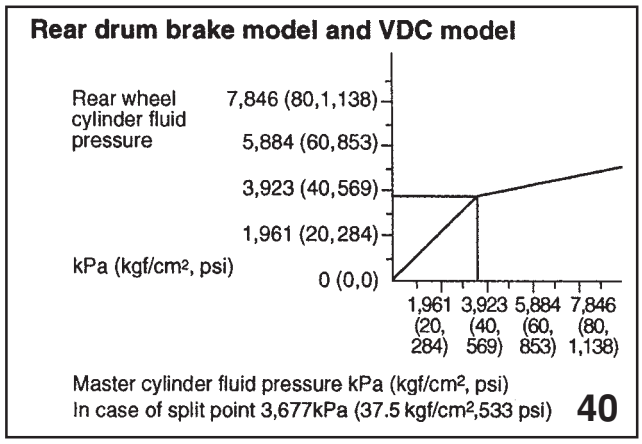
Typical Proportioning Valve

Typical Proportioning Valve

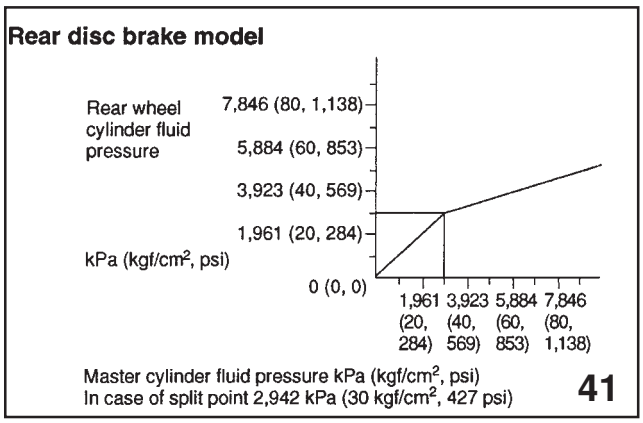
Another hydraulic component in Subaru brake systems is the proportioning valve.

The job of the proportioning valve is to reduce the possibility of rear wheel lockup. It does this by controlling the brake fluid pressure available to the rear wheel cylinders. When the pressure in the master cylinder reaches a predetermined point, called the split point, the proportioning valve limits the pressure between the master cylinder and the rear wheel cylinders. If either the primary or the secondary circuit fails, the proportioning valve will no longer control pressure to the rear wheels. The pressure in the operative circuit will remain equal to the pressure in the master cylinder.

NOTE: SPLIT POINTS MAY VARY DEPENDING ON VEHICLE TYPE AND MODEL YEAR. ALWAYS REFER TO THE APPROPRIATE MY SERVICE MANUAL FOR THE CORRECT SPLIT POINT SPECIFICATIONS.



2001 Legacy Rear Drum Brake and VDC Model

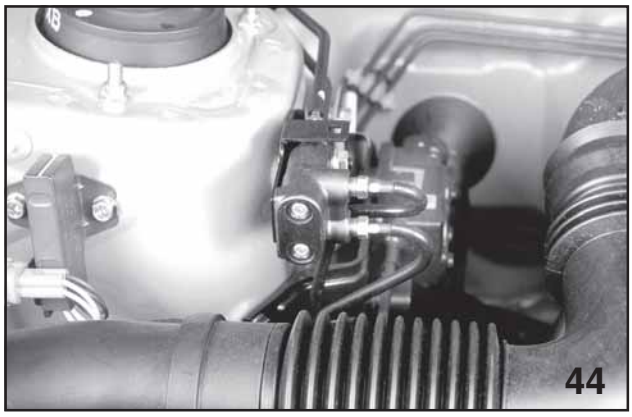


2001 Legacy Rear Disc Brake Model

Electronic Brake Distribution

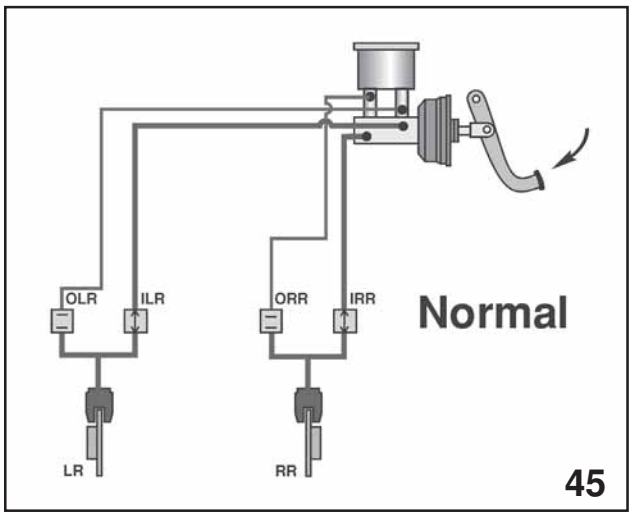
Beginning with some 2004 models, an EBD valve was used to replace the proportioning valve.

HCU

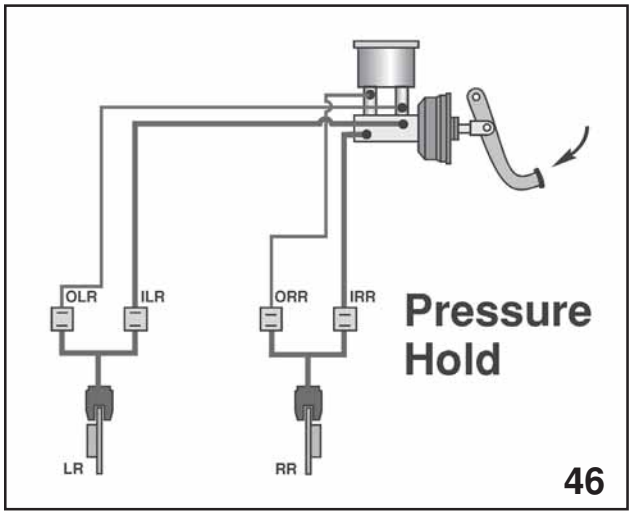


Proportioning Valve Location

This new system controls the brake fluid pressure to the rear wheels by taking advantage of existing ABS 5.3i components. This process eliminates the mechanical proportioning valve.

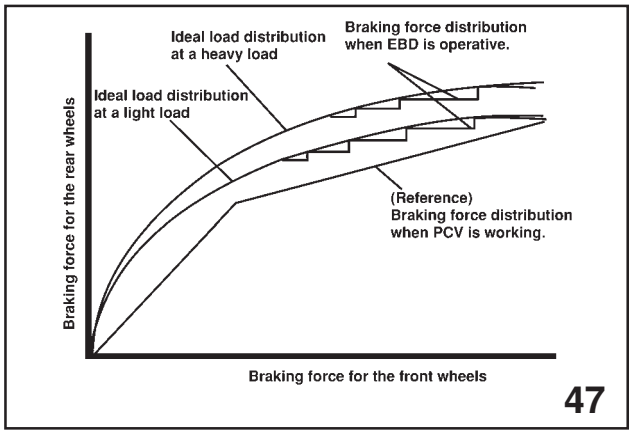


Normal (Artwork)

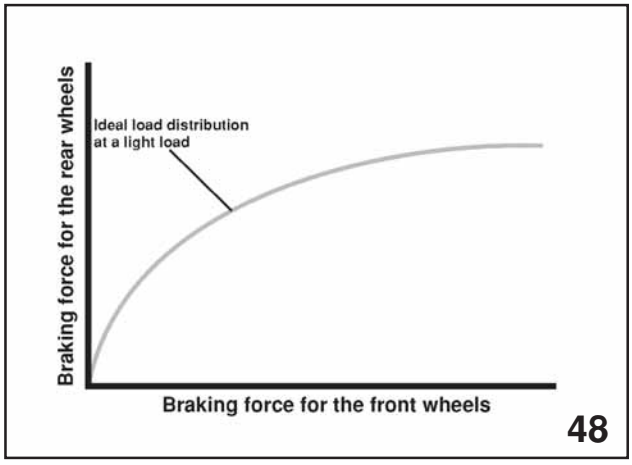


Pressure Hold (Artwork)

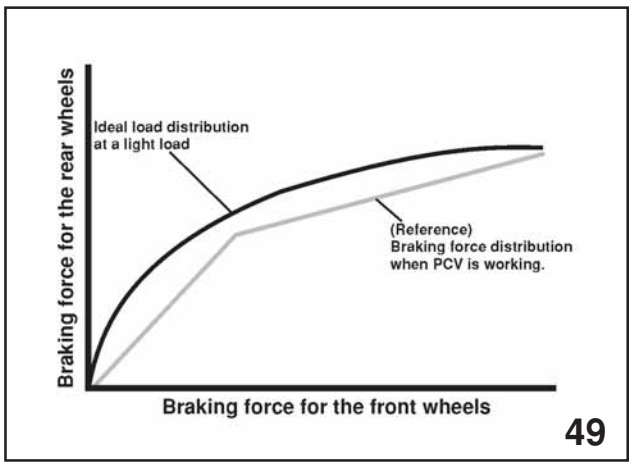
The hydraulic control unit will activate the inlet solenoid valves to achieve pressure hold controlling the pressure to the rear wheels.



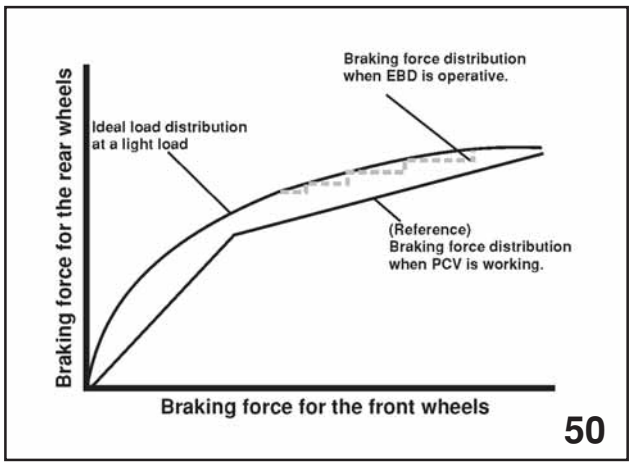
Big Graph (Artwork)



Ideal (Artwork)



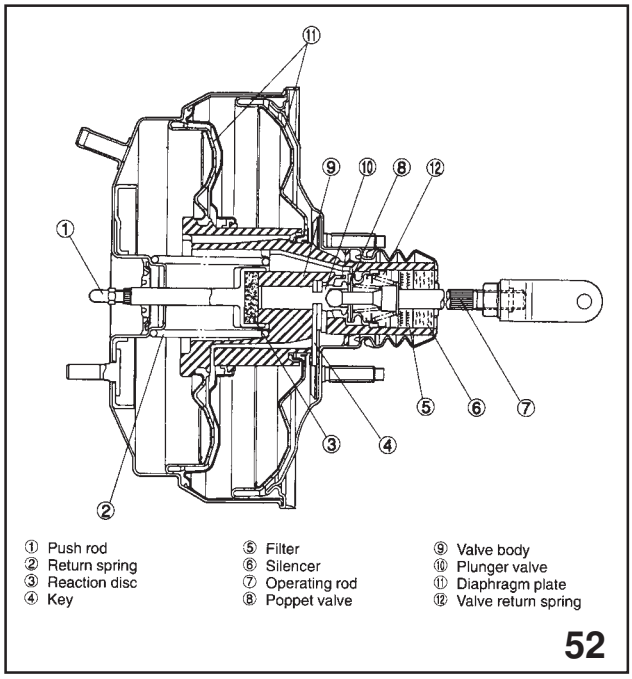
PCV Operation



EBD

The control unit built inside the HCU monitors the wheel speed of the front and rear wheels to decide how much braking force is generated from the rear wheels. The wheel speed difference between the front and rear on a vehicle with a light cargo load generates a higher wheel speed difference and results in lower braking force from the rear wheels. Heavier cargo loads in the rear generate lower speed differences between the front and rear and can receive higher brake fluid pressure.

Brake Booster

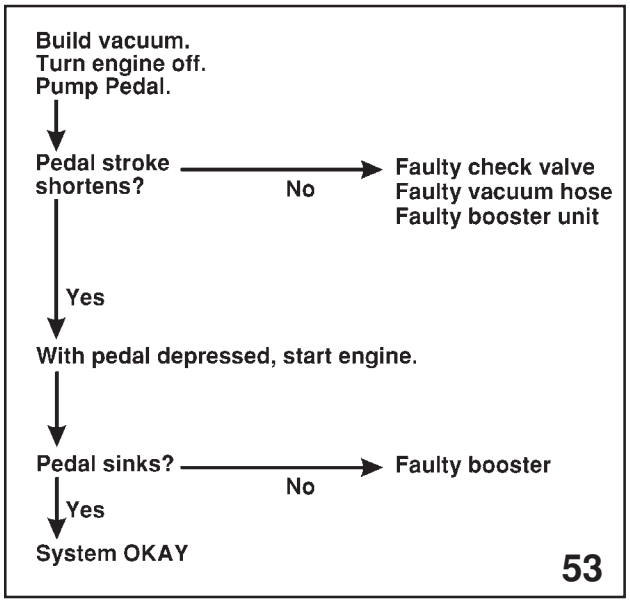


Brake Booster

The brake booster, which is attached to the master cylinder, provides vacuum assist to the brake pedal. Manifold vacuum provides the negative pressure to one side of a diaphragm that is connected to the brake pedal linkage. Atmospheric pressure then assists in pedal application. A check valve in the vacuum line traps the vacuum in the booster unit. This ensures booster operation even when manifold vacuum is low.

NOTE: THE BRAKE BOOSTER IS NON-SERVICEABLE AND MUST BE REPLACED AS A UNIT. THE CHECK VALVE MAY BE REPLACED SEPARATELY.

Check the booster operation by following the steps listed below:



Booster Check

Disc Brake Inspections

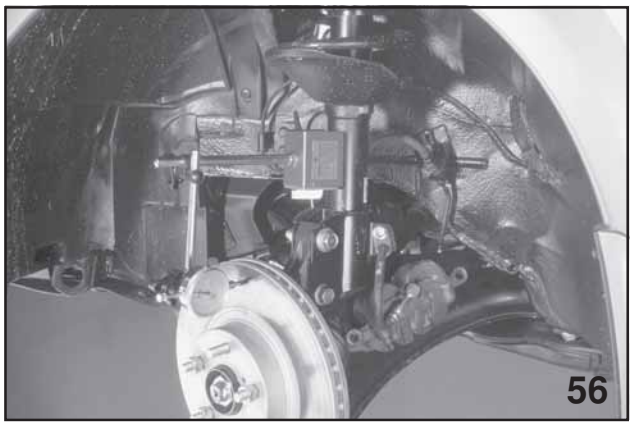
Measuring Rotor Thickness

When servicing disc brakes, always make the following inspections: Measure the pad thickness, rotor thickness, rotor runout, and rotor parallelism.

Parallelism

thickest rotor measurement – thinnest rotor measurement ≤ .0008

A visual inspection will probably suffice for determining the remaining pad thickness, but rotor thickness should be measured near the center of the rotor with a micrometer. Specifications for rotor thickness may vary from year to year, so consult the appropriate service manual for proper specifications.



Measuring Rotor Runout

Rotor runout should be measured within 0.20 inches (5mm) of the outer edge of the rotor.

Consult the Subaru Service Manual on STIS for the acceptable runout limit. If runout is not within the acceptable limit, machine the rotor within specifications if possible. Do not machine a rotor to less than the minimum thickness stamped on the rotor. Rotor parallelism must be measured at three or more places. If your measurements vary more than .0008 inch, machine or replace the rotor.

Rotor Resurfacing

If you find it necessary to service vehicle rotors, Subaru recommends on-the-car rotor resurfacing equipment.

Rotor Resurfacing

Due to the nature of brake system design, resurfacing rotors with off-the-car type brake lathes often results with customers returning to with complaints of brake vibration and judder. Resurfacing rotors on-the-car can minimize comebacks because the rotor and hub are serviced as an assembly. In this manner, stacked tolerances that may have occurred with time can be compensated for. If you a resurfacing a Subaru with a trapped rotor, on-the-car service will save the time and expense of wheel bearing replacement. Subaru has tested and recommended a rotor matching system by PROCUT. Rotor matching refers to servicing the rotor and hub as an assembly. The PROCUT PFM 900 offers quick and accurate setup while proving optimum rotor finish for brake pad break-in.

Rotor Resurfacing Notes:

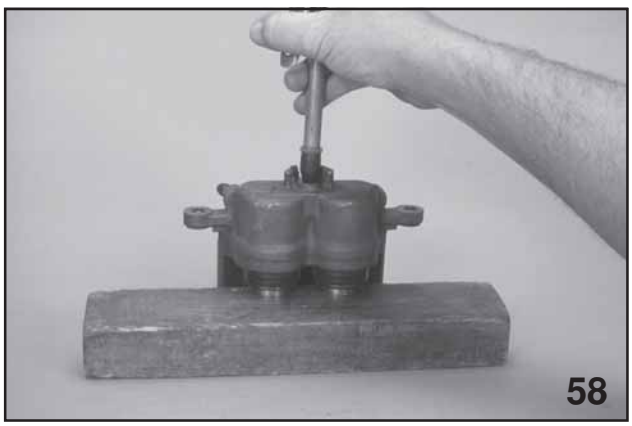
1. Remove rotor and remove any corrosion on the inner and outer hat surfaces. (Only on non-trapped design).
2. Remove any corrosion on the hub surface that mates with the rotor.
3. If the rotor must be removed after resurfacing, mark the rotor and hub so that their relative positions remain unchanged after installation.
4. Remove all metal chips from ABS wheel speed sensors and tone wheels.
5. When reinstalling wheels, use a torque wrench to tighten wheel nuts to proper specifications.

Caliper Overhaul

Whenever the brake system is inspected, the inspection should include checking the condition of the calipers. Calipers in need of repair can cause numerous brake problem including pulling to one side, reduced pad life, ABS not operating at optimum performance, and loss of brake fluid.

If the calipers are determined to be the cause of the problem, a caliper overhaul would then be necessary.

Caliper overhaul includes replacement of seals, dust boots, and rubber components of the slide mechanism. Caliper bores with minor corrosion may be cleaned up with a caliper hone. Deep pitting will require replacement of the caliper housing.



Piston Removal

Caliper Disassembled

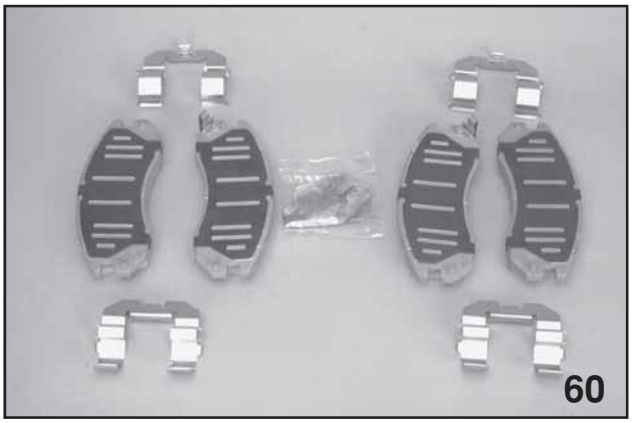
NOTE: THE FOLLOWING PRECAUTIONS WHEN OVERHAULING DISC BRAKES ON A SUBARU VEHICLE:

1) Use compressed air to gradually force the piston out of the cylinder.
2) To avoid injury, keep your fingers away from the piston when forcing it out of the cylinder.
3) Avoid scratching the cylinder wall or the piston.

AFTER DISASSEMBLING THE CALIPER, MAKE THE FOLLOWING INSPECTIONS:

1) Check the caliper body for damage.
2) Check the piston for wear and damage.
3) Upon reassembly, use only specified greases and compounds.
4) Bleed the brake system after servicing.

NOTE: USE ONLY DOT 3 OR DOT 4 BRAKE FLUIDS.

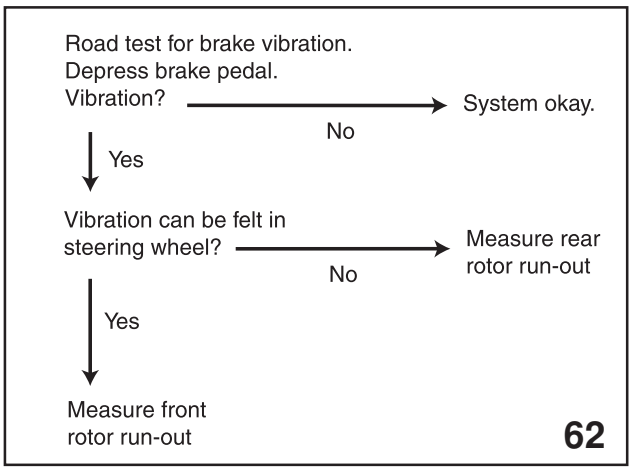


Front Caliper Lubrication Points

Pads Assembled

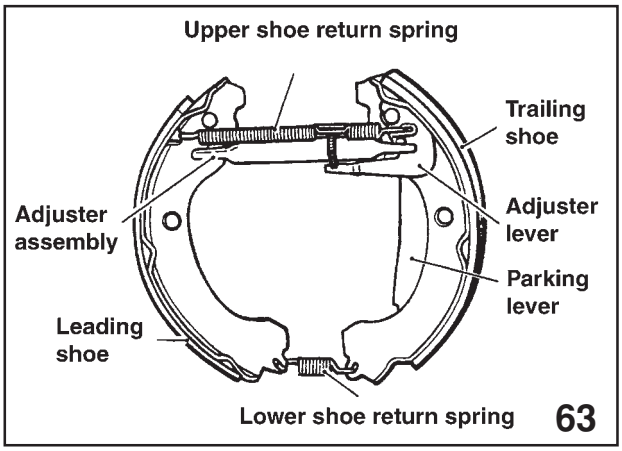
Brake System Inspection

To determine whether the source of a brake vibration is in the front brakes or in the rear brakes, road-test the vehicle. Follow the steps listed below:



Locating Brake Vibration Source

Rear Drum Brakes

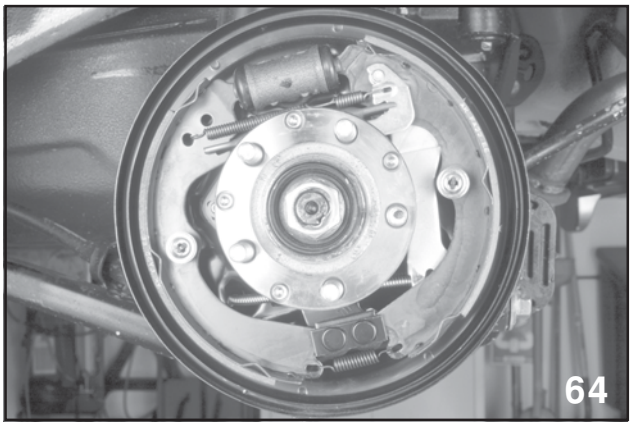


Self-Adjuster Operation (Brakes Applied)

Subaru vehicles equipped with rear drum brakes will be of the self-adjusting type. When the drum brake is activated, the self-adjuster lever travel increases. When the brake shoes are contacting, the self-adjusting lever rotates the adjuster assembly's screw to lengthen the whole assembly. This maintains clearance between the shoes and the drum to a specified value.

NOTE: THE SELF-ADJUSTING MECHANISM OPERATES EACH TIME THE BRAKE PEDAL IS DEPRESSED. THE SCREW ROTATES ONLY WHEN CLEARANCE IS EXCESSIVE.

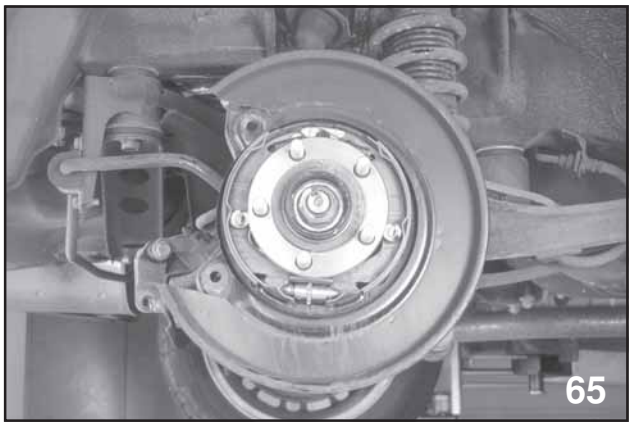
NOTE: ALWAYS RELEASE THE SELF-ADJUSTING MECHANISM BEFORE REMOVING THE DRUM.



Drum Brake Lubrication Points

When servicing rear drum brakes, follow these precautions:

1) Pull the drum if necessary.
2) Replace large and small springs in their proper positions (large spring on top, small spring on bottom).
3) Apply specified grease to lubrication points on the backing plate.
4) Apply specified grease to the contact surface of the self-adjuster and shoe and to the inside wheel cylinder boot.
5) If the wheel cylinder is scratched, replace it. Wheel cylinders cannot be honed.
6) Wheel cylinder piston seats are not replaceable separately. The seals are available with replacement pistons only.
7) Measure the drum diameter. Note that specifications may change from year to year. Consult the appropriate service manual for specifications.
8) If drums are unevenly worn, resurface them on a brake lathe.
9) Replace the cotter pins, lock tabs, or stake nuts with new ones.



Legacy Parking Brake System

The Legacy, Forester, and Impreza use a rear drum type parking brake system. The drums are located in the rear disc rotors. The mechanically operated parking brake engages the shoes against the drums. When the parking brake lever is released, the shoe return spring disengages the shoes from the drum.

Parking Brake Servicing Procedures

Refer to the appropriate Subaru service manual for detailed servicing procedures.

NOTE: EACH BRAKE SHOE PARKING BRAKE LEVER MUST MOVE SMOOTHLY. DO NOT CONFUSE LEFT AND RIGHT PARKING BRAKE LEVERS AND STRUTS.

Test drive the vehicle to confirm proper operation of the brake system and also to "break-in" the parking brake linings. Maintain 15 to 20 MPH and lightly pull on the parking brake lever and release. Repeat at least five times.

CAUTION: DO NOT "LOCKUP" THE REAR WHEELS, ALWAYS PULL THE LEVER SLOWLY. DO NOT PERFORM THIS OPERATION ON PUBLIC ROADS.

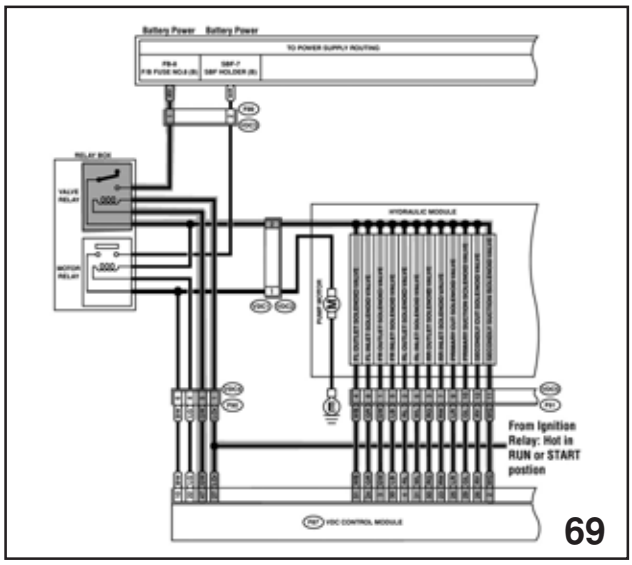
Check the parking brake for the proper adjustment. Always use the appropriate service manual for exact specifications. The first step is to adjust the clearance between the shoes and drum by rotating the star-wheel located on the parking brake assembly. Then, pull up on the parking brake lever and count the number of notches until resistance is felt. If the count is out of specs, adjust the length of the parking brake cable with the adjusting nut located on the parking brake lever.

General ABS Operation

The purpose of ABS is to allow the driver to maintain directional control over the vehicle during extreme braking conditions. This is accomplished by using a Hydraulic Control Unit, Anti-lock Brake System Control Module, G-Sensor and wheel speed sensors to determine impending wheel lockup. If wheel lockup is detected, hydraulic pressure to the affected wheel is modulated until wheel slip is controlled.

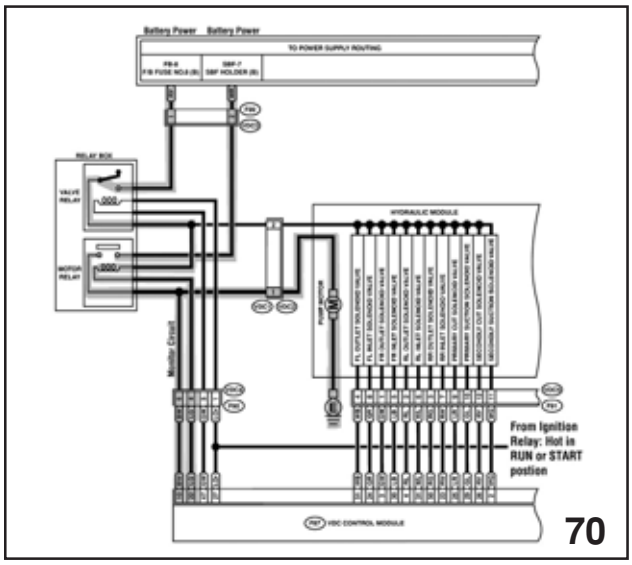
Hydraulic Control Unit

The HCU contains an electrically controlled motor plunger/pump. Depending on the ABS model, Subaru HCU's will have three, four, eight, or ten electrical solenoids to help control brake application when ABS is active. To activate a solenoid, it must receive battery voltage and a ground signal. The solenoids receive battery voltage from a valve relay. The valve relay is energized by the HCU. The HCU energizes the valve relay at vehicle start up and remains energized unless the ABSCM detects a problem in ABS circuitry. Upon seeing a fault, the ABSCM de-energizes the valve relay interrupting the power supply to the solenoids in the HCU. Under normal driving conditions, the valve relay remains energized at all times. You can see this information displayed on your Select Monitor. (Only on ABS systems that are Select Monitor compatible).



Valve Relay Circuit

The solenoids receive their ground signal directly from the ABSCM. In actual operation, the solenoid receives constant power and the ABSCM activates a solenoid by providing a path to ground.

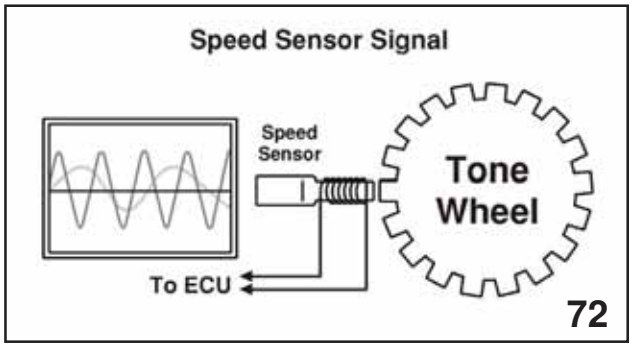


Motor Relay Circuit

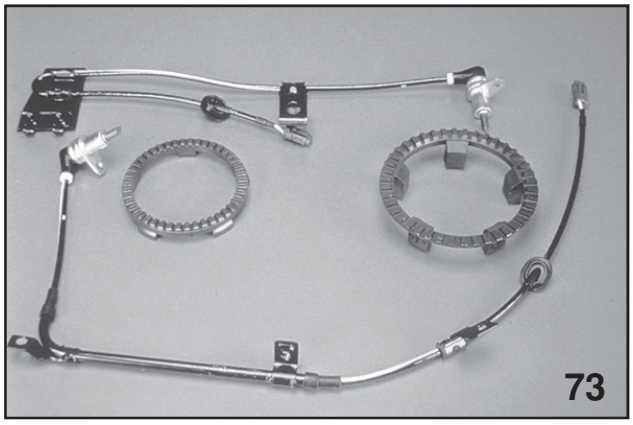
The HCU's on Subaru ABS systems contain a pump motor which operates a hydraulic pump inside the HCU. The pump motor has a constant ground and receives power from a motor relay. The motor relay is energized by the ABSCM. The only time the ABSCM will energize the motor relay is when ABS is controlling the braking action of the vehicle and during a self-check during initial vehicle start and drive. This can be observed on your Select Monitor. (Only on ABS systems that are Select Monitor compatible)

Wheel Speed Sensors/ Tone Wheel

The wheel speed sensor is constructed by coiling fine copper wire around a permanent magnet. A notched tone wheel is attached to each axle or hub and acts as a reluctor which modulates the magnetic field of the speed sensor. The voltage and frequency signals correspond the speed the individual wheels.



Speed Sensor Operation



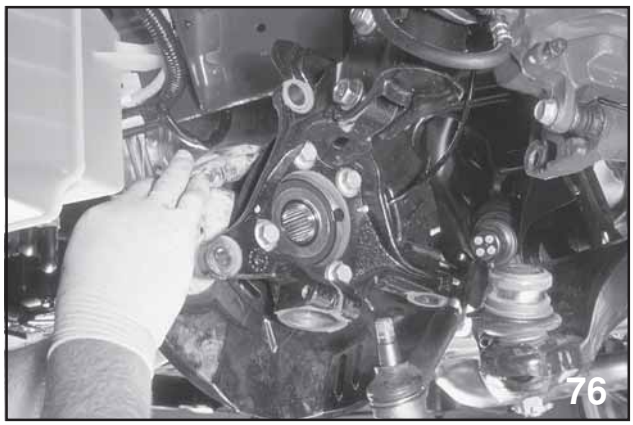
Speed Sensor Components

THE REAR WHEEL BEARING HAS BEEN DESIGNED TO BE REPLACED IN ONE UNIT AND SHARES THE SAME SHAPE AS THE FRONT WHEEL BEARING.

Encoder Ring

For 2005 the tone wheel on some models for the ABS and VDC has been removed from the axles and has been replaced with an encoder ring that is fixed to the wheel bearing.

Axle

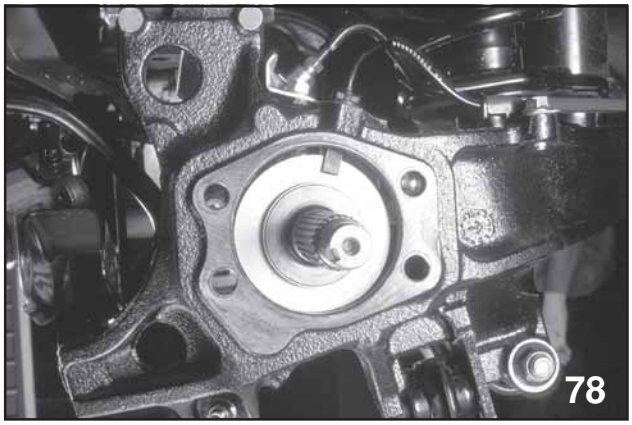


Speed Sensor

The speed sensor has been designed to work with the encoder ring and mounts through the wheel bearing housing. This change has been adopted for all wheels.

Wheel Bearing Hub Bench

The encoder ring is adhered to the wheel bearing outer shell and is not serviceable. Small magnetic strips are incorporated to the encoder ring to provide the pulses to the speed sensor as the wheel rotates.



Rear Axle and Housing

NOTE: SUBARU RECOMMENDS THAT THE BRAKE SYSTEMS BE FLUSHED AT 30,000 MILE INTERVALS. THIS INSURES THAT BRAKE FLUID THAT HAS DETERIORATED WITH TIME IS REMOVED FROM THE SYSTEM AND REPLACED WITH FRESH FLUID. THIS WILL HELP IN MAINTAINING GOOD PERFORMANCE FROM THE BRAKE SYSTEM.

ABS Quick Tips

Bosch Nippon ABS-2SL

- No long term memory
- Electrical faults indicated by ABS warning lamp
- Does not communicate with Select Monitor.
- Only stores 1 trouble code at a time.
- Special bleeding procedure.
- Select Low Control.
- Codes retrieved through cutout in rug underneath passenger seat.

Nippon ABS-2E

- Long term memory
- Electrical faults indicated by ABS warning lamp
- Does not communicate with Select Monitor
- Stores up to three trouble codes.
- Special bleeding procedure.
- Select Low Control
- Codes retrieved by grounding diagnostic terminal and observing ABS warning lamp.
- Sequence control

Teves Mark IV

- Combines ABS and TCS
- Long term memory
- Electrical faults indicated by ABS or TCS warning lamp
- Communicates with SMI or SMII
- Special bleeding procedure
- Select Low Control
- Codes retrieved by grounding diagnostic terminal and Observing TCS warning lamp or by using SMI or SMII.
- Separate ABS and TCS sequence control procedures.

ABS 5.3

- Electrical faults indicated by ABS warning lamp.
- Long term memory
- Stores up to three trouble codes
- Special bleeding procedure
- Communicates with SMI or SMII
- Select Low Control
- Codes retrieved by grounding diagnostic terminal and Observing ABS warning lamp or by using SMI or SMII
- Sequence control

ABS 5.3i

- Electrical faults indicated by ABS warning lamp
- Long term memory
- Stores up to three trouble codes
- Special bleeding procedure
- Communicates with SMII
- Select Low Control
- Codes retrieved by grounding diagnostic terminal and Observing ABS warning lamp or by using SMII or SMIII
- Sequence control
- Stores up to three trouble codes.
- Special bleeding procedure.
- Select Low Control
- Codes retrieved by grounding diagnostic terminal and observing ABS warning lamp.
- Sequence control

VDC

- Electrical faults indicated by ABS or VDC warning lamp.
- Long term memory
- Stores up to three trouble codes
- Special bleeding procedure
- Communicates with SMII or SMIII
- Select Low Control
- Separate ABS and VDS sequence control procedures
- Special procedure to calibrate steering sensor and G Sensor

Super Sports ABS

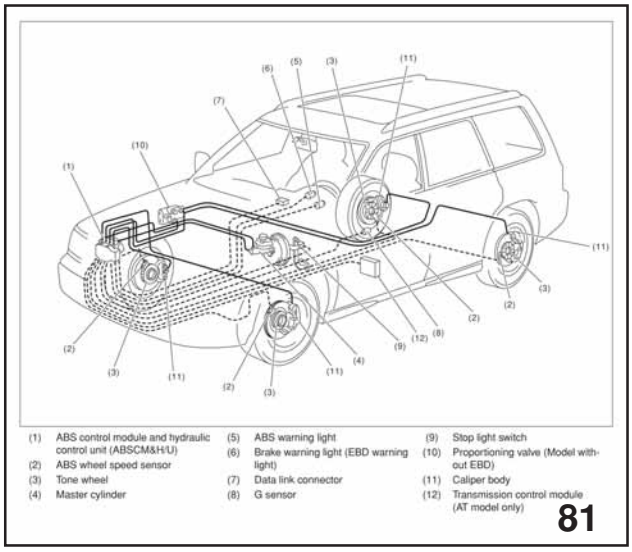
- Electrical faults indicated by ABS warning lamp
- Long term memory
- Stores up to three trouble codes
- Special bleeding procedure
- Communicates with SMII or SMIII
- Codes retrieved by grounding diagnostic terminal and Observing ABS warning lamp or by using SMII
- Sequence control

ABS 5.3 & 5.3i Overview

The ABS 5.3 is a four-sensor, four-channel system. It controls the front wheels independently during ABS braking. It controls the rear wheels as a pair, as appropriate for whichever of the two wheels is turning more slowly.

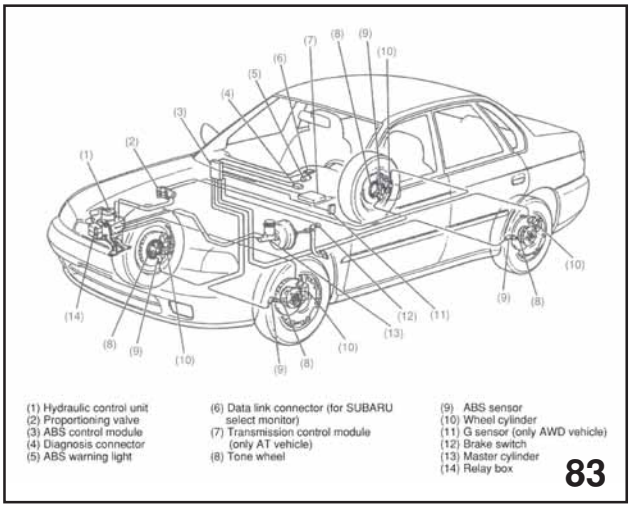
The ABS 5.3 system has improved self-diagnostics and trouble code memory, and it can communicate with OBD-II testers, such as the New Select Monitor.

It was introduced in 1996 on Legacy vehicles equipped with ABS. More recently, an updated system, the ABS 5.3i, has been introduced. The 5.3i is used on the 1998 Forester, late 1997 Legacy, and late 1997 Impreza vehicles equipped with ABS.



ABS 5.3i System

Differences Between the 5.3 and the 5.3i



ABS 5.3 System

Although the ABS 5.3 and 5.3i systems are similar in most ways, there are a few important differences.

On the ABS 5.3, the ABS control unit is located behind and to the right of the glove box. With the 5.3i, the ABS control unit is mounted on the Hydraulic Control Unit (HCU).

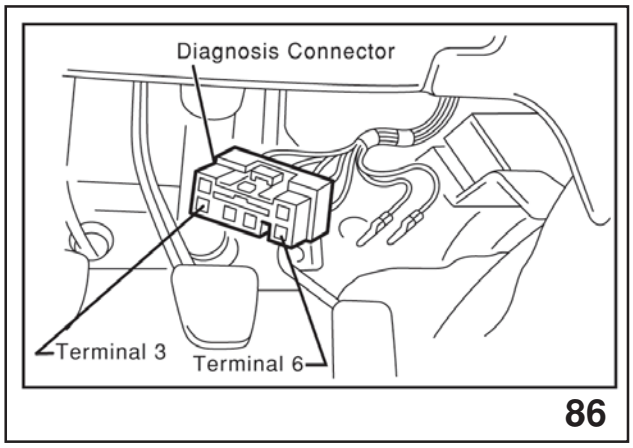
The Select Monitor can communicate only with the ABS 5.3. The Select Monitor III can communicate with both the 5.3 and 5.3i, using the appropriate cartridges.

Select Monitors

Component Locations

Most of the ABS 5.3 and 5.3i components are located in the engine compartment. The HCU is located under the hood at the front right corner. It contains the solenoid valves used to control hydraulic pressure to the wheels during ABS braking, as well as the motor pump assembly and the relays. In the 5.3i version, the ABS control unit is mounted on the HCU, instead of behind the glove box.

For both models, the G sensor is located under the center console. It senses acceleration and deceleration, so that the ABS control unit can compare the actual speed of the vehicle with the speed reported by the wheel speed sensors.



Diagnosis Connector

The diagnosis connector is located above the accelerator pedal. It can be used to manually read and clear trouble codes.

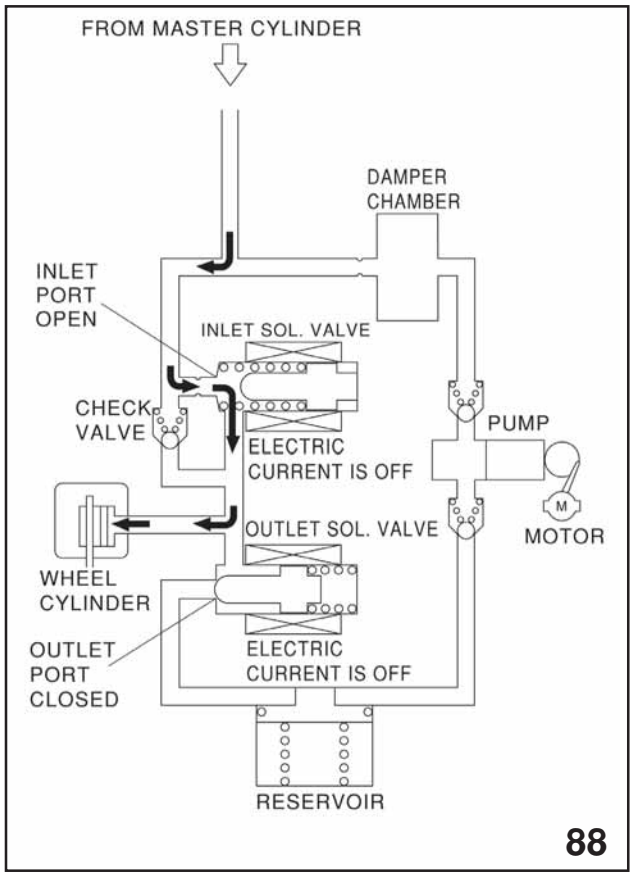
The Data Link Connector (DLC) is located under the dash panel on the driver's side. It allows the New Select Monitor to communicate with several of the vehicle's systems, including the ABS.

At each wheel, there's a speed sensor and a tone wheel. The tone wheel provides a magnetic pulse to the wheel speed sensor, which the ABS control unit uses to determine the speed of rotation of the wheel.

Operation

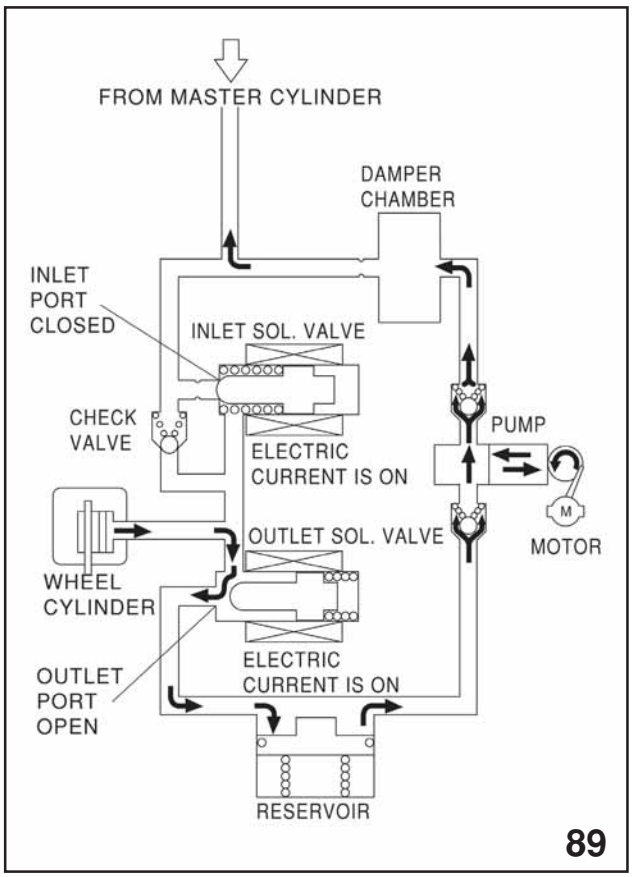
Hydraulic fluid is directed from the master cylinder to the brake calipers at each wheel, where the HCU controls brake fluid flow by means of eight solenoid valves. There is an inlet valve and an outlet valve for each wheel. During normal braking, the inlet valve is open and the outlet valve is closed.

There are three ABS modes: Pressure Decrease, Pressure hold, and Pressure Increase. When the ABS control unit senses that one or more of the wheels is starting to lock up, it activates the ABS system and controls braking for the affected wheel, in these ABS modes. It also activates the motor-pump assembly.



Hydraulic System – Normal Braking

Pressure Decrease

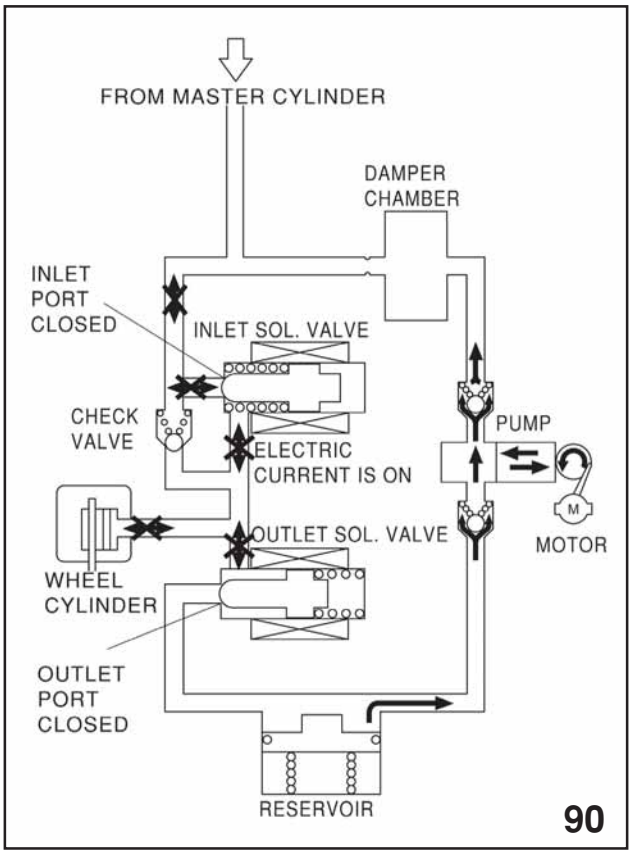


Hydraulic System – Pressure Decrease

In the Pressure Decrease mode, the HCU closes the inlet solenoid valve, shutting off pressure from the master cylinder to the brake caliper at the affected wheel. At the same time it opens the outlet solenoid valve, releasing brake fluid pressure from the caliper, reducing braking at the wheel.

Pressure Hold

In the Pressure Hold mode, the HCU closes the inlet and outlet solenoid valves for the affected wheel. The solenoids hold the pressure in the caliper constant. The HCU uses Pressure Hold when wheel speed is optimal.

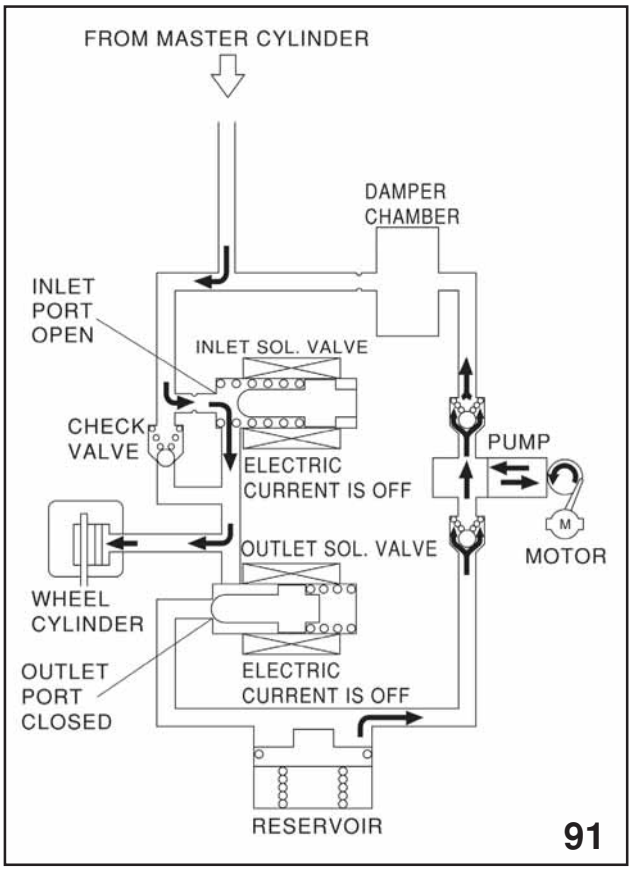


Hydraulic System – Pressure Hold

Pressure Increase

In the Pressure Increase mode, the HCU opens the inlet solenoid valve and closes the outlet valve. The motor-pump assembly assists the master cylinder in applying brake fluid pressure to the caliper of the affected wheel.

For more detailed information on how the ABS 5.3 system operates, see the Service Manual, Part M, “Mechanism and Function,” Section 4-4.



Hydraulic System – Pressure Increase

Diagnostics

The ABS 5.3 system has extensive self-diagnostic capabilities. When the ignition switch is turned from “Off” to “On,” the ABS system performs an electrical self-check and illuminates the ABS warning light for 1 ½ seconds. If there are no electrical problems, the system then turns the light off.

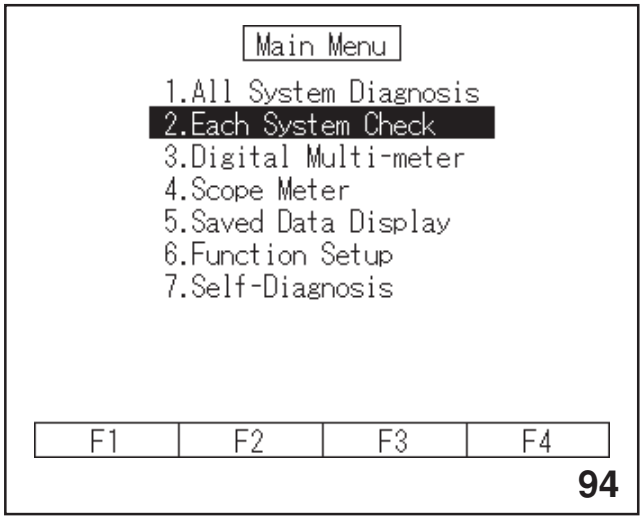
ABS Warning Light

The ABS 5.3 system performs a second check when vehicle speed reaches 3 m.p.h. (if the brake has not been applied) or 8 m.p.h. (if the brake has been applied). During this second self-check, the ABS system operates its motor pump for 0.2 second and exercises.

If the ABS control unit does not detect any problems it keeps the ABS warning light off. If the control unit does find a problem, it turns the ABS warning light on and stores one or more trouble codes. The ABS system then remains passive even if a wheel begins to lock up.

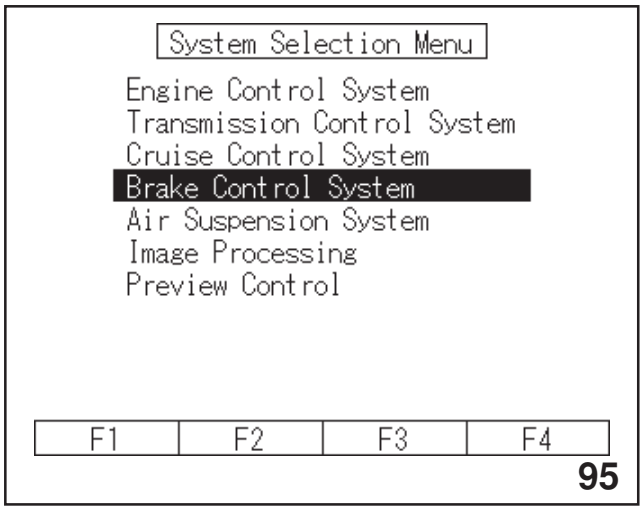
If the problem involves one of the wheel speed sensors, with the ABS 5.3i, the system waits until the next ignition cycle before turning the ABS warning light on. If, at the next ignition cycle, the ABS system sees the same wheel speed sensor problem again, it turns on the ABS warning light and the system stays passive.

Otherwise, the ABS system assumes there is no problem.



New Select Monitor – “Each System Check” Selected

If a vehicle with an ABS 5.3 or 5.3i system has an ABS warning light that stays on, you can use the New Select Monitor to read its trouble codes. Simply plug in the New Select Monitor, turn the ignition switch to “On,” and select “Each System Check” from the main menu.

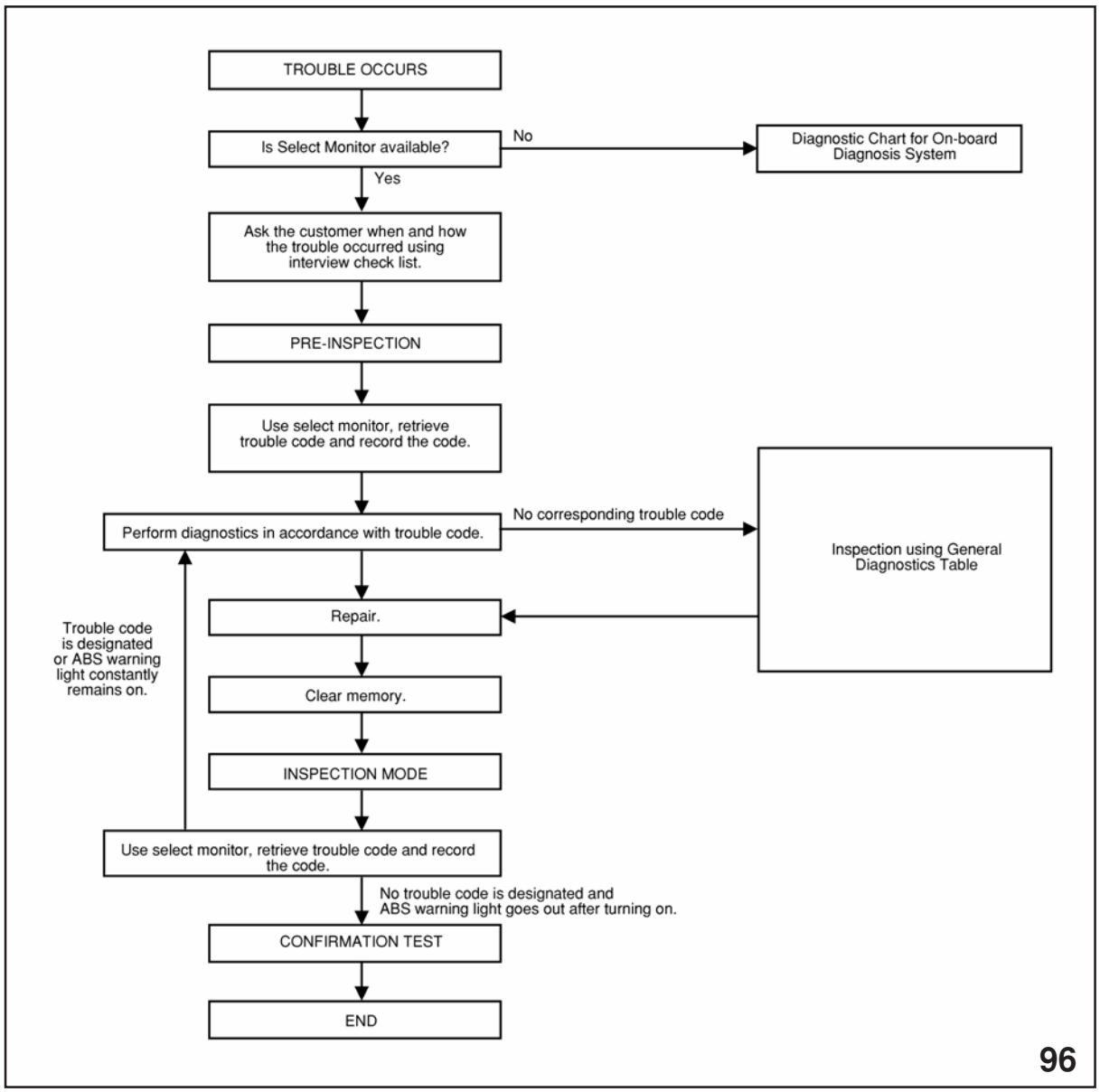


New Select Monitor – “ABS/TCS” Selected

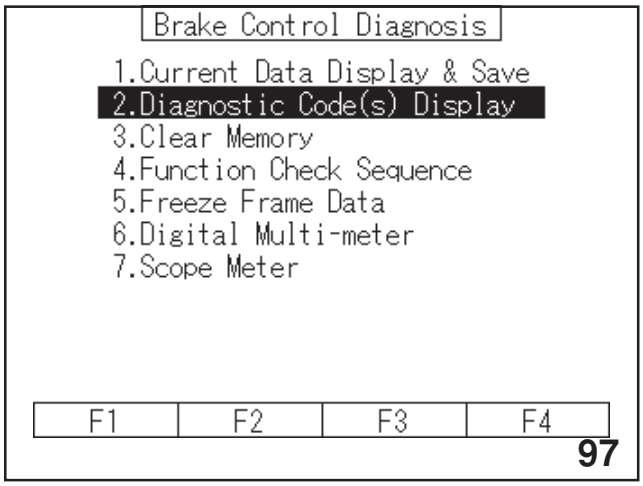
Next, select "ABS/TCS."

The New Select Monitor will display the trouble codes stored in the ABS memory, beginning with the most recent. Be sure to write down any trouble codes you find.

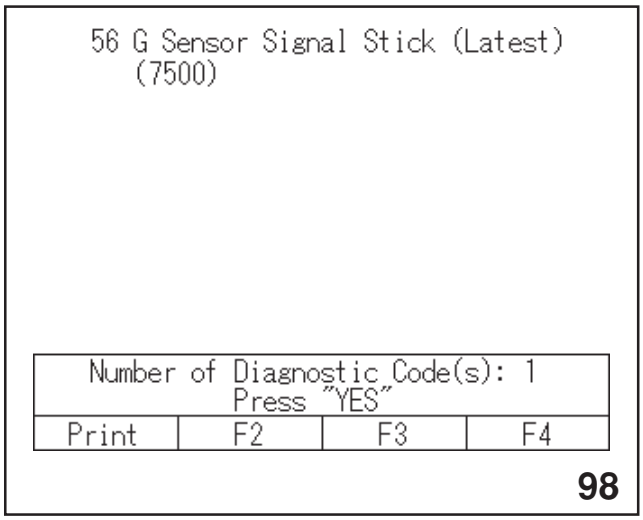
For every trouble code, the Service Manual provides a step-by-step troubleshooting procedure.



Typical Troubleshooting Procedure



New Select Monitor – "Diagnostic Code(s) Display" Selected

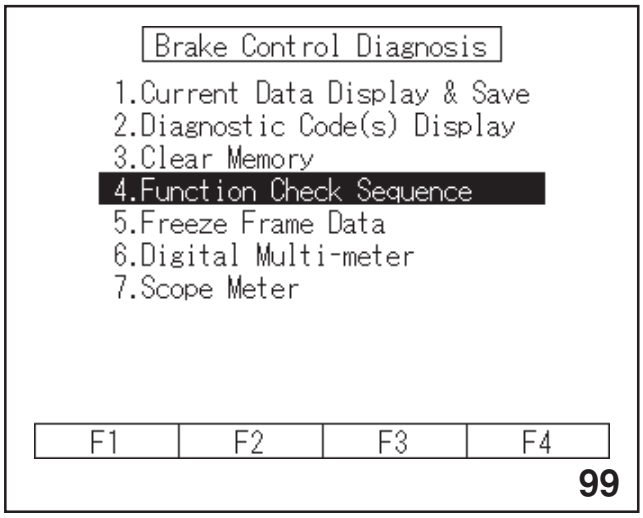


New Select Monitor – ABS Trouble Code Displayed

Sequence Control

With an ABS system, once you have bled the brakes in the conventional way, you have to activate Sequence Control to push air out of the HCU into the brake lines. Otherwise, air trapped in the HCU will get into the lines and the customer may return complaining that the brakes have become "spongy." During Sequence Control, the HCU turns on the motor-pump assembly and commands Pressure Increase for each caliper.

Using the New Select Monitor, command Sequence Control, as follows. At the "ABS Diagnosis" menu, select "4. Function Check Sequence" and follow the directions displayed on the New Select Monitor's screen. You must command Sequence Control twice, in order to ensure that you have expelled all air from the HCU. Then bleed the brakes again, the conventional way, to remove any air pushed out of the HCU into the brake lines.



New Select Monitor-"Function Check Sequence" Selected

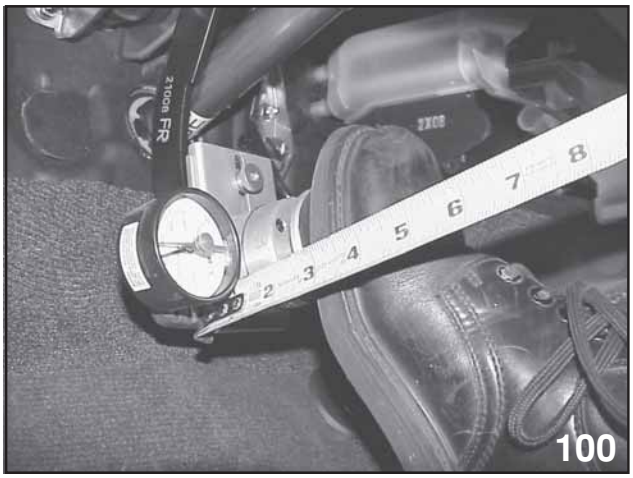
Checking the Pedal Stroke

Now, check the pedal stroke. With the engine idling, depress the brake pedal with the brake pedal effort gauge, at 110 lb. of force, and measure the distance between the brake pedal and the steering wheel.

Release the brake pedal and measure it again. For a vehicle with ABS, brake pedal travel should not exceed 3 ¾ in. (95 mm). If the travel is more than that, there may still be some air inside the HCU. Perform the brake bleeding procedure again, using Sequence Control and conventional bleeding.

Always remember to verify specifications in the appropriate service manual.

EXAMPLE: THE PEDAL STROKE FOR THE 06' TRIBECA IS 4.5 INCHES



Using the Brake Pedal Effort Gauge to Measure Travel

When bleeding is complete, add brake fluid to the required level indicated on the brake fluid reservoir by the line labeled “MAX.”

Finally, road-test the vehicle at a low speed and apply the brakes hard, two or three times, to ensure that they work properly.

Commanding Sequence Control without the Select Monitor

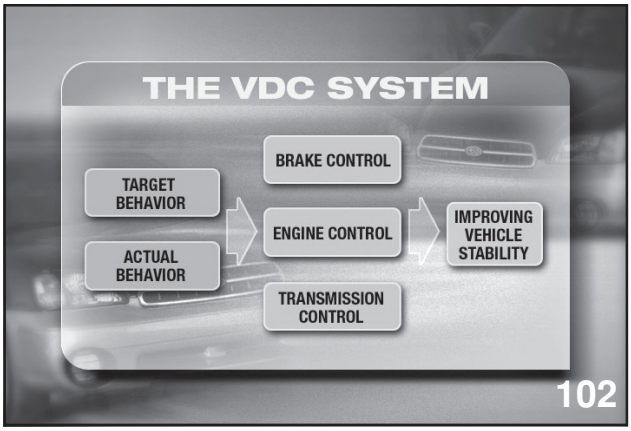
You can also command Sequence Control without the Select Monitor. To do this, with the ignition switch “Off,” ground terminals 3 to 6 of the diagnosis connector, using the connector’s grounding wires.

Turn the ignition switch “On” and within a half second after the ABS warning light goes off, depress the brake pedal and hold it. The ABS will go into Sequence Control and purge air from the HCU.

Conclusion

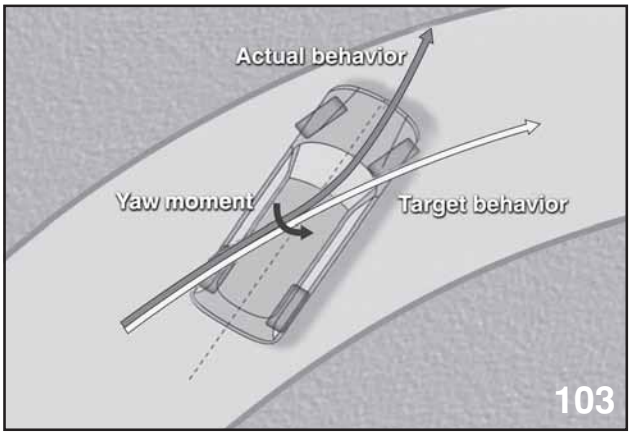
Effective diagnosis requires a logical, step-by-step approach. Be sure to use the appropriate Service Manual, the New Select Monitor, and this video Reference Booklet to look for trouble codes, perform diagnosis, and bleed air from the system. That way, you should have no trouble with the ABS 5.3.

Vehicle Dynamic Control (VDC)



VDC Logic

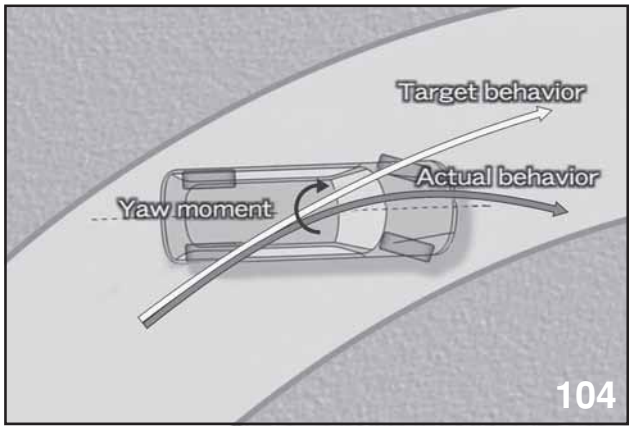
Vehicle Dynamic Control or VDC combines Anti-lock Brakes, Traction Control and new vehicle stability logic. The VDC system is designed to keep the vehicle behavior in the driver’s expectations when the actual vehicle behavior may divert from what is expected.



Understeer

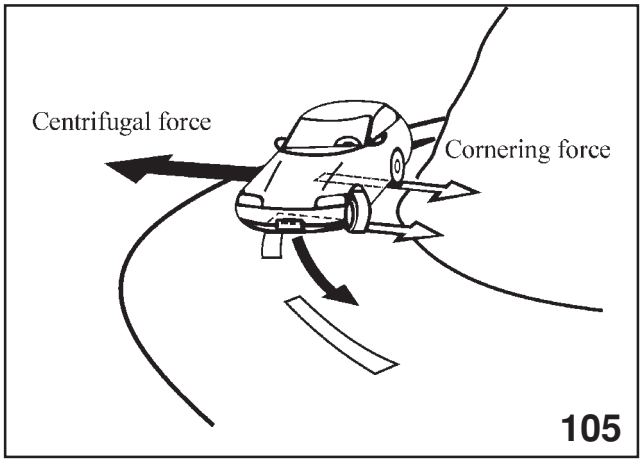
VDC operation comes into use during periods of driving when understeer or oversteer conditions are encountered. Four wheel TCS and ABS functions become active any time the VDC CM determines they are needed.

Understeer is the result of a movement of the vehicle where the driver's intent is to make a change in direction and while the steering wheel is turned the vehicles direction changes little or not at all. This is due to the front wheels slipping across the road surface.



Oversteer

Oversteer is the result of a movement where the driver's intent is to make a change in direction. While the vehicle is doing so, the amount of change is too great. This is due to the rear wheels slipping across the road surface.



Cornering Force

Slip occurs whenever a vehicles' cornering force is less than its centrifugal force. The cornering force is a combination of vehicle weight, tire quality, design, and the road surface.

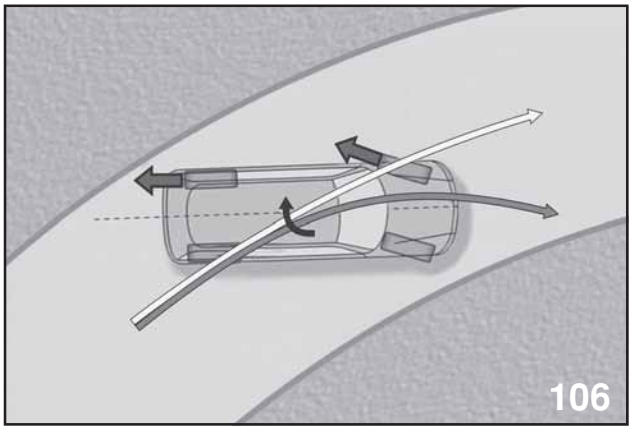
There are two ways to control slip: Produce a force or yaw moment of the reverse direction in the case of oversteering or produce a yaw moment of the same direction as the turning direction in the case of understeering.

These two slip controls can be utilized by three systems acting independently or together.

They are:

- Brake control by utilizing the hydraulic control unit
- Engine torque control with the ECM
- Torque distribution control for the front and rear wheels working with the TCM.

Oversteering and understeering can occur with the accelerator depressed, brake pedal depressed or with no pedal depressed. In each case, the response from the VDC CM is customized to the driving conditions of the vehicle and the resulting vehicle response.



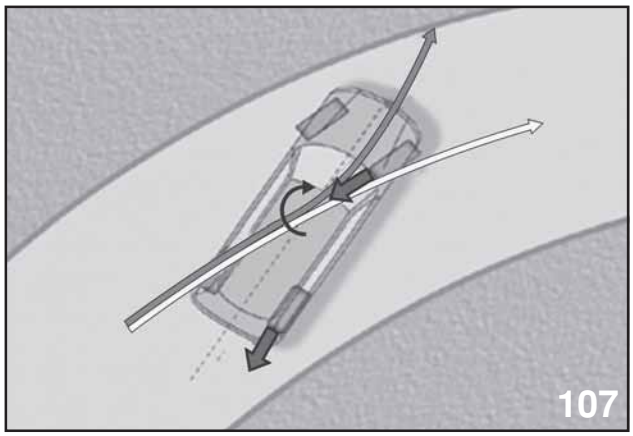
Oversteer While Accelerating

Oversteering while depressing the accelerator pedal

Correction required: Stop the rear wheels from slipping outward, and maintain the front of the vehicle towards the intended path.

Actions taken:

1. Apply strong brake force to the front outer wheel.
2. Apply weak brake force to the rear outer wheel.
3. Increase the transfer clutch engagement.
4. Decrease engine torque by fuel cut.



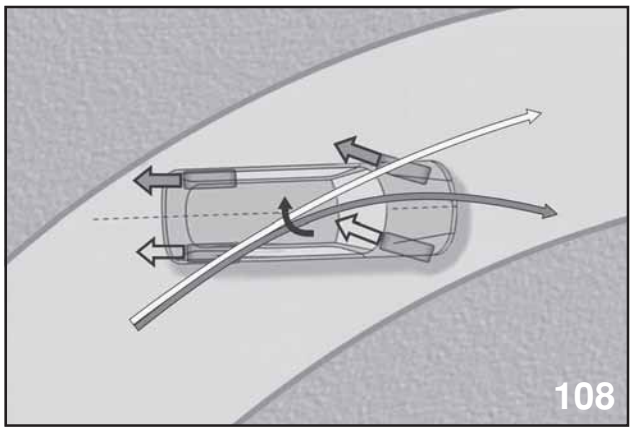
Understeer While Accelerating

Understeering while depressing the accelerator pedal.

Correction required: Stop the front wheels from slipping outward and return the front of the vehicle to the intended path.

Actions taken:

1. Apply weak brake force to the front inner wheel.
2. Apply strong brake force to the rear inner wheel.
3. Release the connection of the transfer to increase driving force distribution ratio to the rear wheels.
4. Decrease engine torque by fuel cut.



Oversteer While Braking

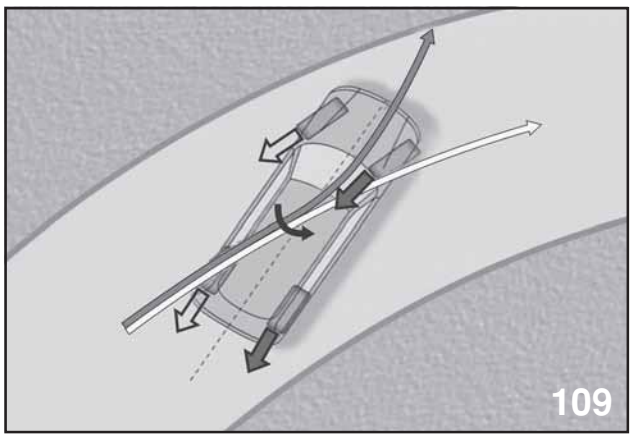
Oversteering while applying the brake.

Correction required: This is the same situation as the ABS system operating and understeering condition is needed.

Actions taken:

1. Loosen the brake for the front inner wheel.
2. Loosen the brake for the rear inner wheel.

If the braking force applied by the driver is insufficient, VDC operates creating hydraulic pressure by the pump to increase the braking force on the front outer wheel.



Understeer While Braking

Understeering while applying the brake.

Correction needed: This is the same as the ABS system operating and oversteering condition is needed.

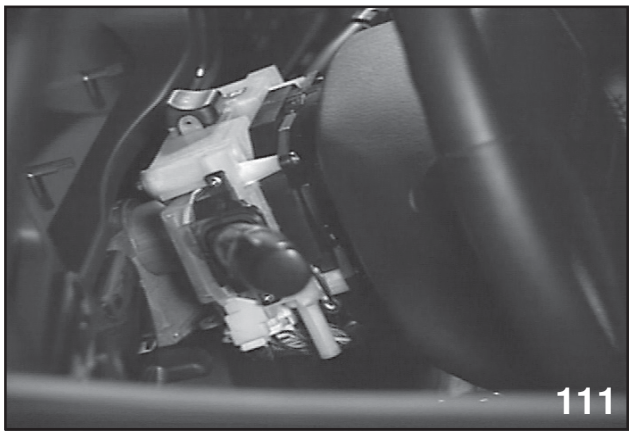
Actions taken:

1. Loosen the brake for the front outer wheel.
2. Loosen the brake for the rear outer wheel.

If the braking force supplied by a driver is insufficient, VDC operates creating hydraulic pressure by the pump, to increase the braking force on the rear inner wheel.

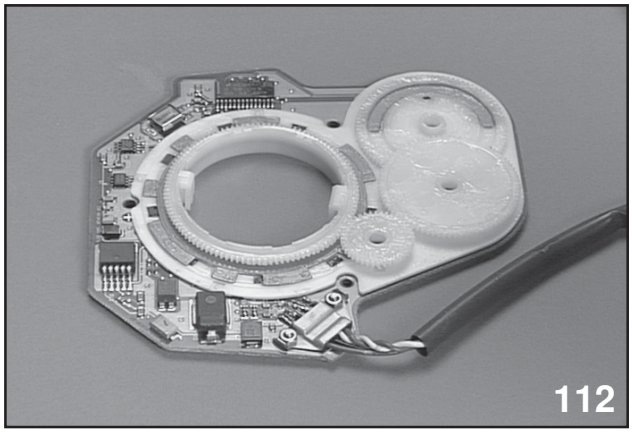
Sensors

Steering Position Sensor



Steering Position Sensor

This sensor is located under the steering wheel and is indexed with it to create signals as the steering wheel is turned.

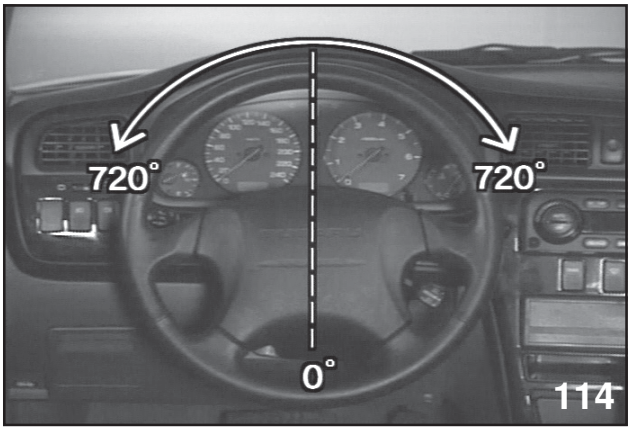


Steering Position Sensor Construction

The internal make up of the sensor consists of two sensing elements.

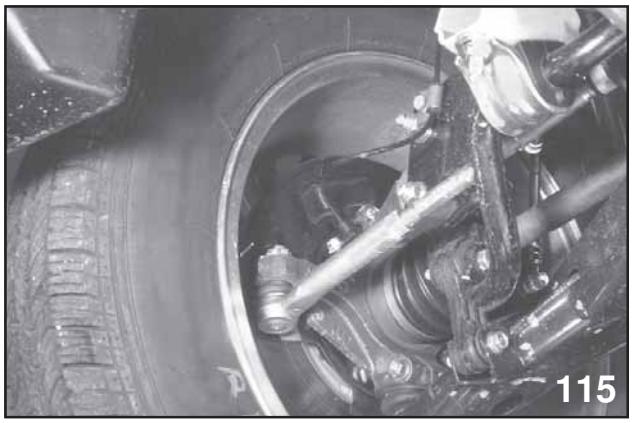
Steering Position Sensor Waveform

The first is made of a large reluctor with nine hall elements. The positioning of the reluctor over the hall elements creates signals that are sent to the VDC CM control unit that when combined with the second sensing element communicate the position of the front wheels. The output of the steering wheel position is displayed in 2.5-degree increments. The full range of steering wheel detection is 720 degrees.



Degrees of Turn

360 degrees to the right which shows up as positive and 360 degrees to the left shows up as negative. The movement of the second sensing element tells the control unit to go negative or positive and communicates the number of steering wheel revolutions.

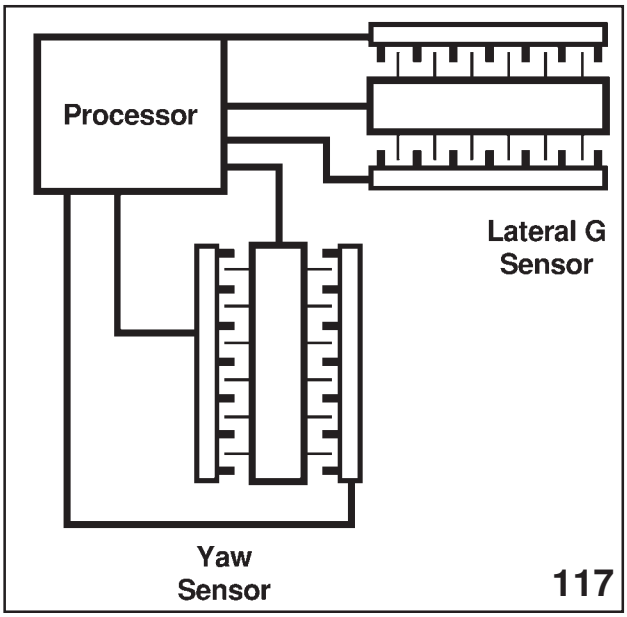


Wheel Speed Sensor

Wheel Speed Sensor-Detects wheel speed by each wheel.

Yaw Sensor

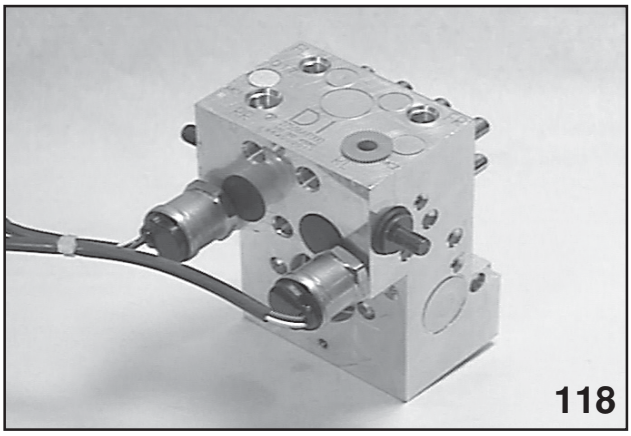
Yaw Rate Sensor- Detects the rotating velocity of the vehicle body during turning.



Yaw Sensor (Artwork)

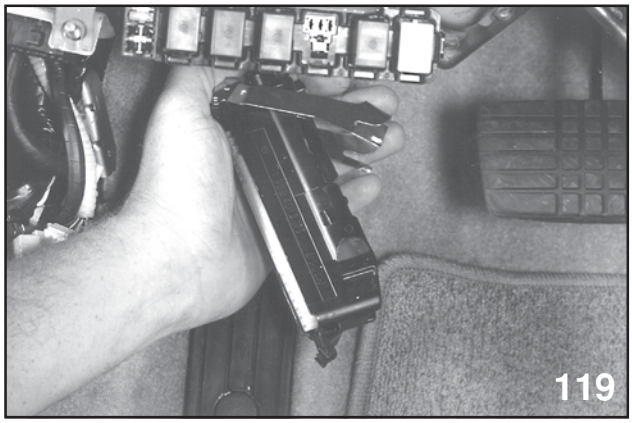
Lateral G Sensor- measures the centrifugal force exerted on the vehicle.

These two sensors are housed in a single unit and is located in the center console near the hand brake.



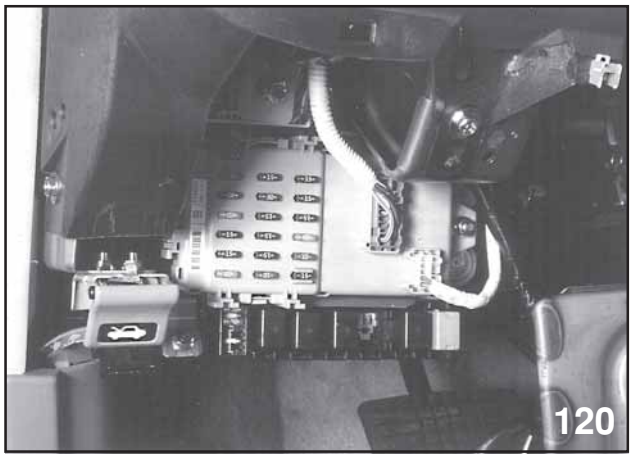
Hydraulic Control Unit

Brake pressure Sensor- Measures the estimated braking force applied to each wheel applied by the driver.



VDC CM Connector

Input signals from the VDC CM determines the calculated driving force applied to the wheels.

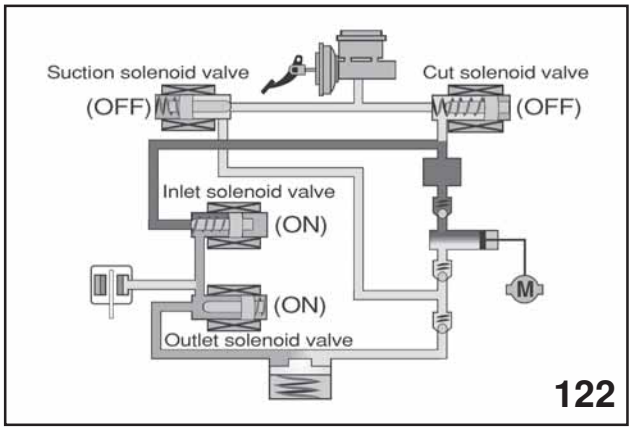


VDC CM Location

Signals from the TCM- Using front to rear split information combined with VDC CM information determines the driving force of the engine or braking applied to the wheels.

Hydraulic Operation during ABS and or VDC Operation when the brake pedal is depressed

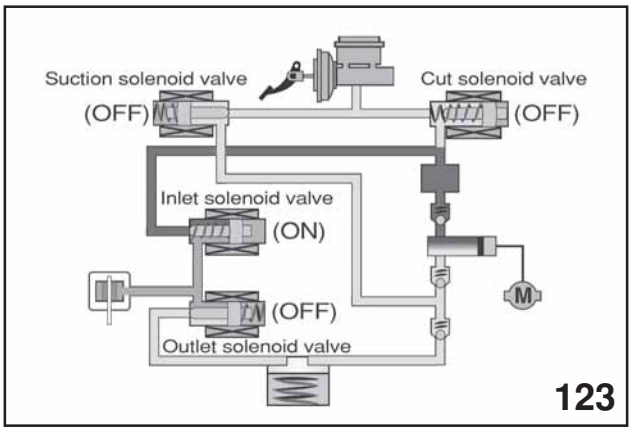
Pressure Reducing Mode



Pressure Reducing Mode

When the wheels are about to lock due to the braking action, instructions are issued from the control module and power is supplied to the EV and AV solenoid valves. The EV valve closes, cutting off the master cylinder pressure and wheel cylinder pressure. The AV valve opens reducing the wheel cylinder pressure and power is simultaneously supplied to the motor at this time. The brake fluid temporarily is collected in the reservoir and is sucked out by the self sucking pump, passed through the damper chamber, where pulsations are absorbed and is then returned to the master cylinder side. In this way; a pressure-reducing control is performed with the fluid pressure in the wheel cylinder side being completely separated from that in the master cylinder.

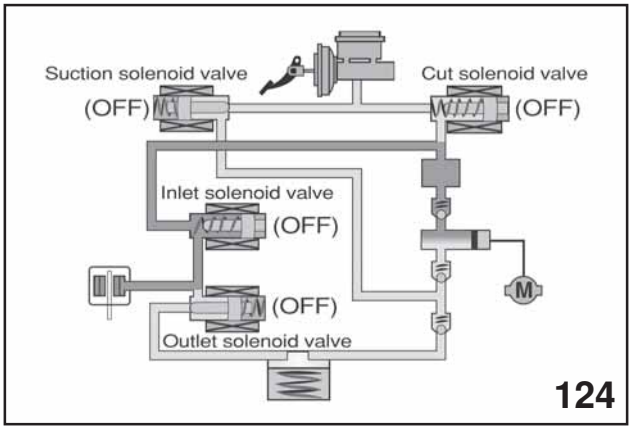
Pressure Holding Mode



Pressure Holding Mode

When the optimum wheel cylinder fluid pressure is obtained, power is supplied to the solenoid valve (EV valve) according to VDC CM instructions. The valve closes, cutting off the master cylinder pressure and the wheel cylinder side.

Pressure Increasing Mode

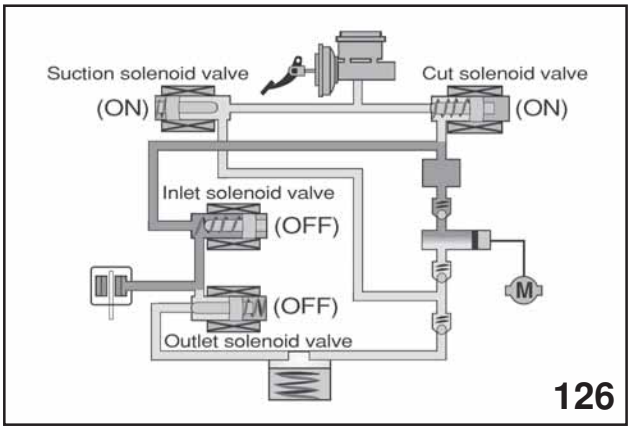


Pressure Increasing Mode

When the wheel cylinder pressure needs to be increased, power to the solenoid valves are turned off according to VDC CM instructions, resulting in normal braking conditions. Pressure is then applied by the master cylinder.

TCS Operation and or VDC operation when the brake pedal is released

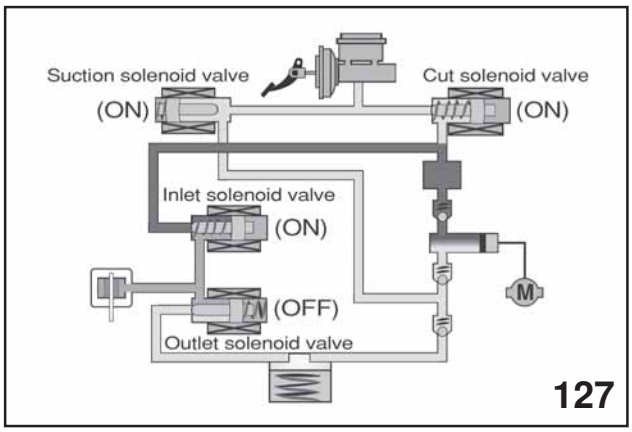
Pressure Increase Mode



Pressure Increasing Mode

When the wheels slip while driving, or slip occurs while the vehicle is turning, instructions are issued by the VDC CM and the VDC/TCS control is initiated. Power is supplied to the USV and HSV valves. The USV valve closes and the HSV valve opens at the same time. Power is also supplied to the motor, and the brake fluid in the master cylinder reservoir is sucked through the HSV valve by the self sucking pump, passing through the EV valve and pressurizing the wheel cylinder side.

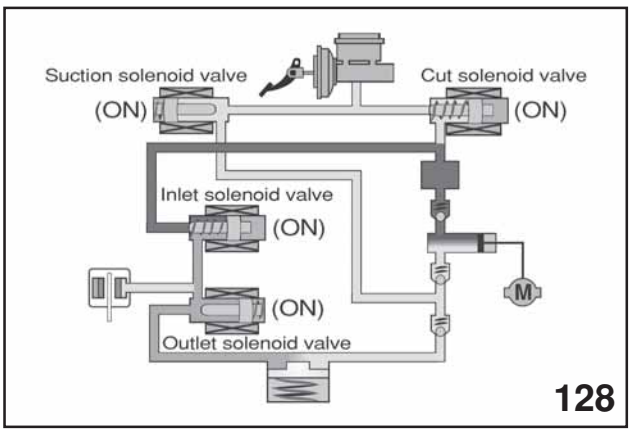
Pressure Holding Mode



Pressure Holding Mode

When the optimum wheel cylinder fluid pressure is obtained, power is supplied to the EV valve according to VDC CM instructions. The USV valve, HSV valve and motor power supply conditions are not changed. The EV valve is closed, cutting off the brake fluid pressurized by the self -sucking pump. The brake fluid pressurized by the self-sucking pump is then passed through the USV relief valve and returned to the master cylinder.

Pressure Reducing Mode



Pressure Reducing Mode

When the wheel cylinder fluid pressure must be reduced, power is supplied to the EV valve and AV valve according to VDC CM instructions. The USV valve, HSV valve and motor power supply conditions are not changed. The EV valve is closed and the AV is opened. The wheel cylinder fluid pressure is discharged to the master cylinder side through the reservoir and HSV valve, reducing the pressure on the wheel cylinder side. The brake fluid pressurized by the self-sucking pump is passed through the USV relief valve and returned to the master cylinder.

VDC light operation

During the light check cycle all lights will illuminate for a short time.

- VDC Operation (Car with tire tracks)
- VDC
- VDC OFF
- ABS

During VDC operation the VDC Operation light (car with tire tracks) will blink.

During TCS operation the VDC Operation light (car with tire tracks) will be on solid.

A malfunction with the VDC system will illuminate just the VDC light.

A malfunction with the ABS will illuminate the ABS and VDC light.

A malfunction with the ECM or TCM will illuminate the VDC Off light.

A fuse placed in the VDC slot in the fuse box will illuminate the VDC Off light.

VDC Diagnostics

VDC diagnostics begin with verifying the complaint and doing a thorough visual inspection. The following steps should help you diagnose most complaints that did not cause an ABS or VDC warning light to illuminate. This can also help you in cases that no trouble code was stored in the memory of control unit.

1. Check battery voltage to insure battery is fully charged
2. Inspect tires for proper sizing. Ideally, all four tires should be of the same make, model, and size
3. Check air pressure in all four tires and set to specifications.
4. Check all four wheels for excessive brake drag. This could indicate sticky pistons or caliper slides.
5. Inspect all hydraulic lines for leaks and make needed repairs.
6. Inspect wheel bearings for excessive play and make needed repairs.
7. Top off brake fluid level if necessary.
8. Perform ABS and VDC sequence control procedures and compare your results to specifications in service manual.

Access Trouble Codes

Trouble codes can be accessed with your NSM or by using the diagnostic connector located under the dash to the right of the steering wheel.

NOTE: THE SELECT MONITOR IS THE PREFERRED METHOD FOR ACCESSING TROUBLE CODES AND INITIATING OTHER SERVICE PROCEDURES. MORE INFORMATION ON USING THE DIAGNOSTIC CONNECTOR CAN BE FOUND IN THE BRAKES SECTION OF THE SERVICE MANUAL.

If codes are stored, trouble shoot according to the diagnostic charts in the service manual. Remember that freeze frame information will be stored for the first trouble code the ABSCM detected. Freeze frame information can help reproduce the driving conditions under which the fault was detected. This can also be used to verify that a repair has been successfully completed.

Perform the inspection mode.

Verify that no additional trouble codes have been stored.

Sequence Control

On Subaru vehicles equipped with VDC, there is a procedure called sequence control that can be performed. Sequence control has two basic functions. The first is to allow the technician to check the mechanical condition of the pump and solenoids inside the ABS/VDC hydraulic control unit. The second function is to help purge air from ABS/VDC hydraulic control unit during a brake bleeding procedure.

There are two sequence control procedures that can be used on VDC equipped vehicles. The first procedure allows you to check the ABS side of the system while the second procedure allows you to check the VDC side of the system. Both sequence control procedures can be accomplished with the NSM.

Below you will find specs for a *2001 Outback Wagon* as an example:

ABS SEQUENCE CONTROL

	FRONT WHEEL	REAR WHEEL
Initial value	3,432 kPa (35 kg/cm2, 498 psi)	3,432 kPa (35 kg/cm2, 498 psi)
When decompressed	490 kPa (5 kg/cm2, 71 psi) or less	490 kPa (5 kg/cm2, 71 psi) or less
When compressed	3,432 kPa (35 kg/cm2, 498 psi) or more	3,432 kPa (35 kg/cm2, 498 psi) or more

VDC SEQUENCE CONTROL

	FRONT WHEEL	REAR WHEEL
When compressed	2,942 kPa (30 kg/cm2, 427 psi) or more	1,961 kPa (20 kg/cm2, 284 psi) or more
When decompressed	490 kPa (5 kg/cm2, 71 psi) or less	490 kPa (5 kg/cm2, 71 psi) or less

Calibration of Steering Sensor and Lateral G Sensor

The VDC system incorporates a steering sensor and yaw rate sensor as part of the input system into VDC CM. The yaw rate sensor also has a lateral G sensor built into it. Always conduct a steering angle sensor and lateral G sensor calibration procedure whenever you have removed or installed the following items.

1. VDC control module
2. Steering angle sensor
3. Yaw rate and lateral G sensor
4. Steering wheel parts (Including airbag)
5. Suspension parts
6. Adjustment of wheel alignment

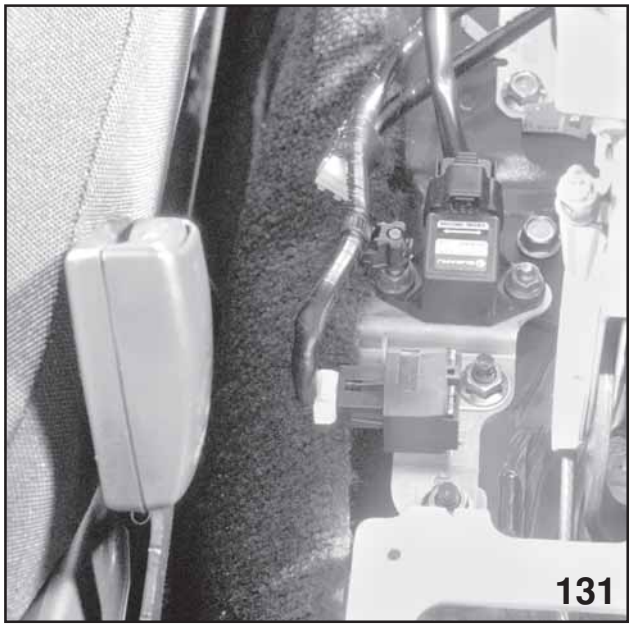
The calibration procedure can be accomplished with the NSM.

NOTE: BEFORE PERFORMING THE CALIBRATION PROCEDURE, MAKE SURE THE VEHICLE IS ON A LEVEL SURFACE AND THAT IT HAS BEEN DRIVEN AND STOPPED WHILE GOING IN THE STRAIGHT AHEAD POSITION. THIS IS TO INSURE THAT THE CALIBRATION PROCEDURE IS ACCURATELY PERFORMED.

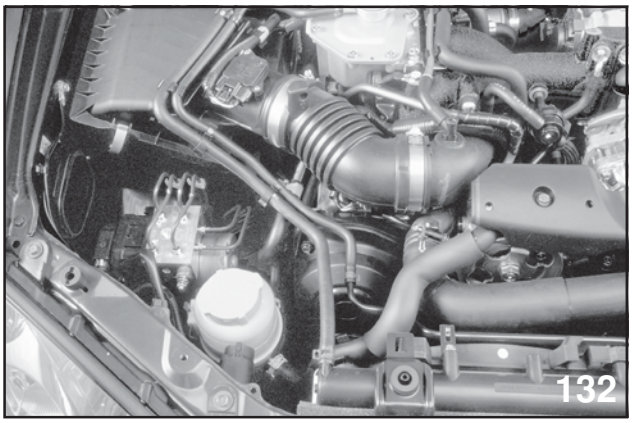
2004 Super Sports ABS

The 2004 WRX STi is equipped with Super Sports ABS. This system incorporates the proportioning control of Electronic Brake Distribution (EBD) and Anti Lock Brakes (ABS) with new logic that allows current ABS components to perform new tasks. EBD controls the brake fluid pressure to the rear wheels by using wheel speed differences between the front and rear wheels. The Super Sports ABS logic assists with providing enhanced cornering control while the brake is being applied. Previous model years' ABS was designed with Select Low Control, this would control both rear wheels at the same time any time either rear wheel began to lock up. Super Sports ABS will, under the right conditions, individually control the rear wheels. This allows the brake force to the rear wheel on the outside of the turn to continue braking while the inside wheel receives anti lock control.

* Other components include wheel speed sensors, brake switch, refer to the appropriate service manual for system layout.



G Sensors



Hydraulic Control Unit (HCU)

Subaru B9 Tribeca Brakes

Pedals

The front brakes are identical to the 2005 Legacy, while the rear brake assembly has increased in size.

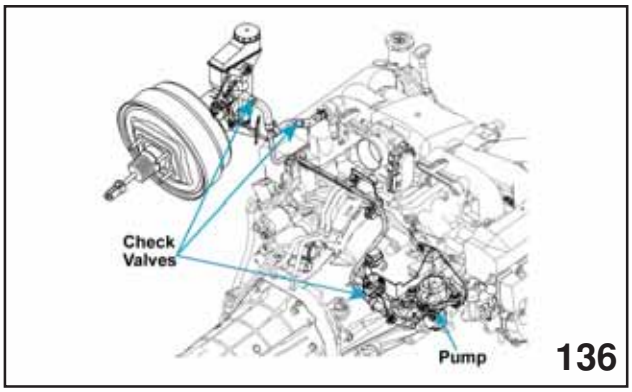
- The rear brake rotor has a larger diameter (320mm against 294mm of '05 Legacy)

A foot operated parking brake is utilized on the Subaru B9 Tribeca. The cable for the parking brake is adjusted at the pedal assembly.

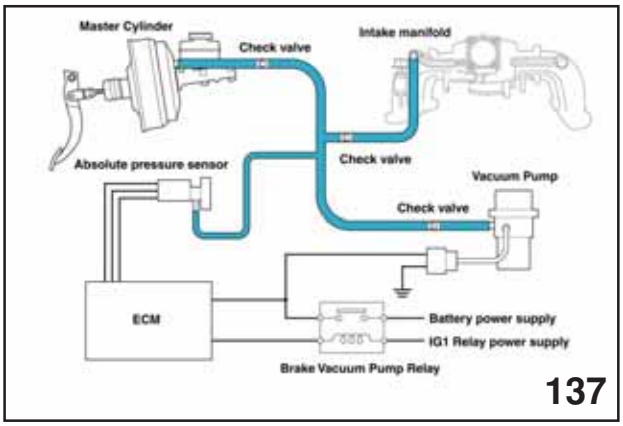
Rear Rotor

Adjustment to the parking brake clearance is adjusted through the access in the outside of the rear rotors.

Brake Vacuum Pump



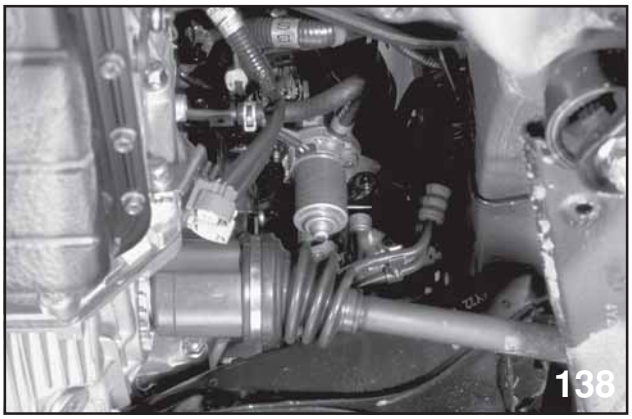
Brake Vacuum Pump (Artwork)



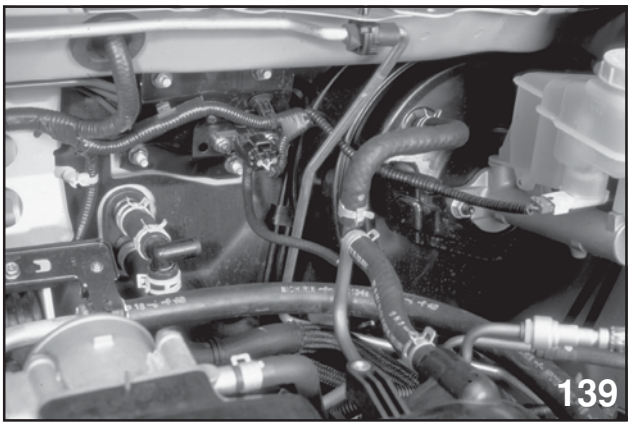
System (Artwork)

The Subaru B9 Tribeca is equipped with an electric vacuum pump that is used to supplement engine manifold vacuum during braking in low manifold vacuum conditions.

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.



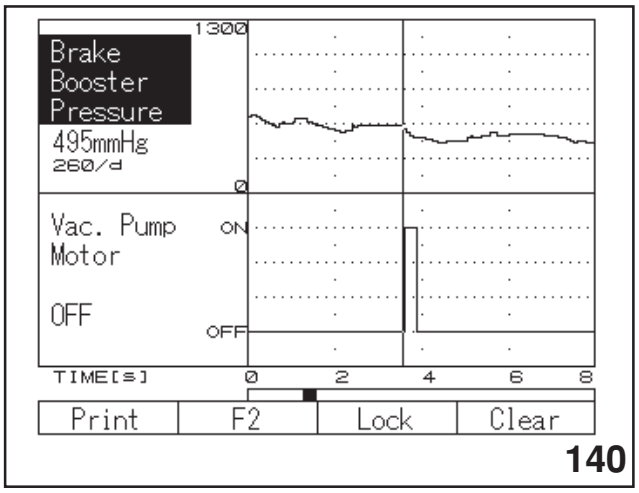
Pump Location



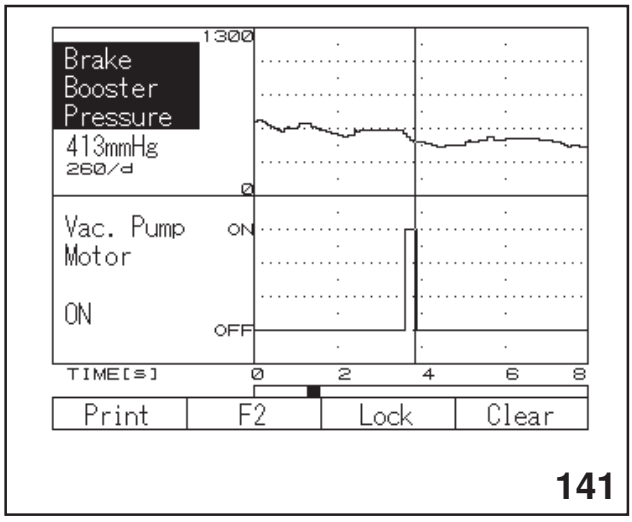
Booster and Sensor

The Electric vacuum pump is located on the lower right side of the engine and must be removed before access to the engine/bell housing/transmission bolts can be obtained.

The brake booster has been enlarged for more power (9in+10in tandem, against 8in+9in tandem of '05 Legacy).



Brake booster pressure value activating electric vacuum pump motor



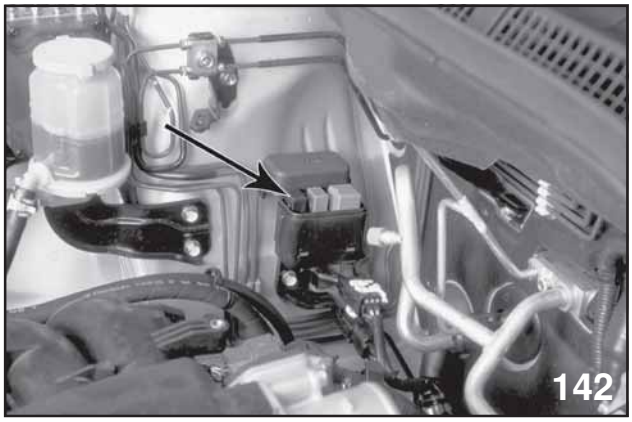
Brake booster pressure value deactivating electric vacuum pump motor

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

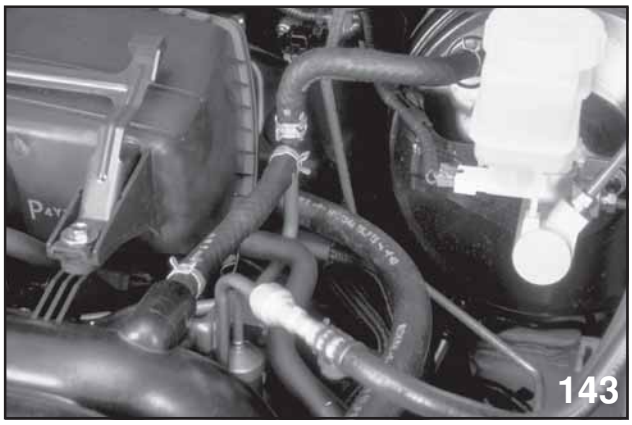
The first situation is created as the vehicle is moving slowly and the brake has been applied and released several times in a short time period. This will increase the pressure in the brake booster supply line to, for example, 468 to 538 mmHg. (As determined by the absolute pressure sensor).

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.

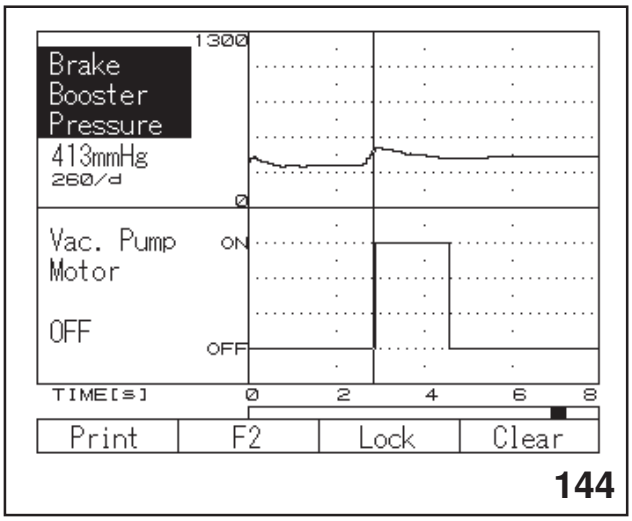
The vacuum pump will decrease the pressure in the booster vacuum supply hose. A check valve located near the intake manifold and the vacuum pump isolates the negative pressure, ensuring the negative pressure is directed only to the brake booster. The vacuum pump will continue to operate until the difference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



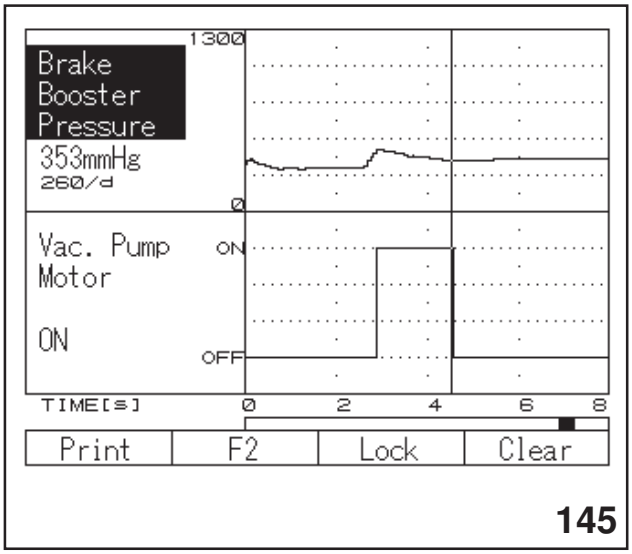
Relays



Piping



Pump activation > 80 km/h



Pump deactivation > 80km/h

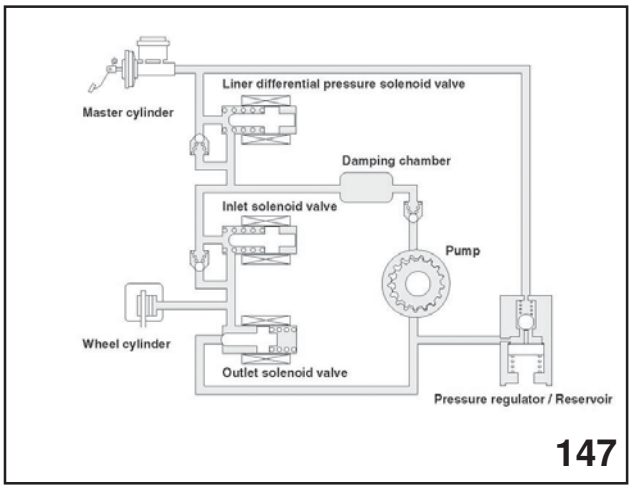
The second situation occurs only above vehicle speeds greater than 49 m.p.h. (80 km/h). A difference of 355 to 365 mmHg or less between atmospheric pressure and brake booster pressure activates the vacuum pump (for example 413 mmHg booster pressure and 758 mmHg atmospheric pressure). The pump will continue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

The select monitor is equipped with a new menu item, Brake Vacuum Pump System. When selected, the select monitor will allow viewing of the data from atmospheric pressure, brake booster pressure, test mode signal, vacuum pump relay and vacuum pump motor.

Subaru B9 Tribeca Vehicle Dynamics Control (VDC brakes)

Normal braking

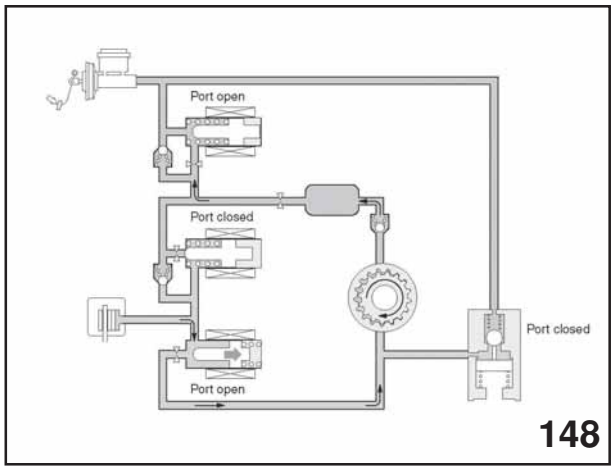


Normal Braking

During normal braking the linear differential pressure solenoid valve is open. Pressure from the master cylinder is routed to the inlet solenoid valve and the brake caliper, applying the brake. The outlet solenoid is closed, maintaining the brake force from the driver. The pressure at the check valve near the linear differential control solenoid and the Inlet solenoid valve is equal on both sides so the spring tension, in the check valves, maintains the valve in the closed position.

Pressure is also routed to the dampening chamber and adds to the closing force created by the spring in the check valve.

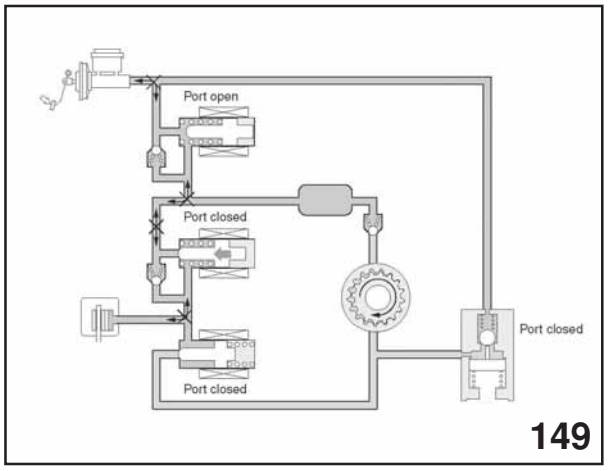
ABS decrease



ABS Decrease

During ABS decrease the inlet solenoid valve closes and the outlet solenoid opens, decreasing the braking force at the caliper. The pump activates and moves the brake fluid into the dampening chamber and back to master cylinder.

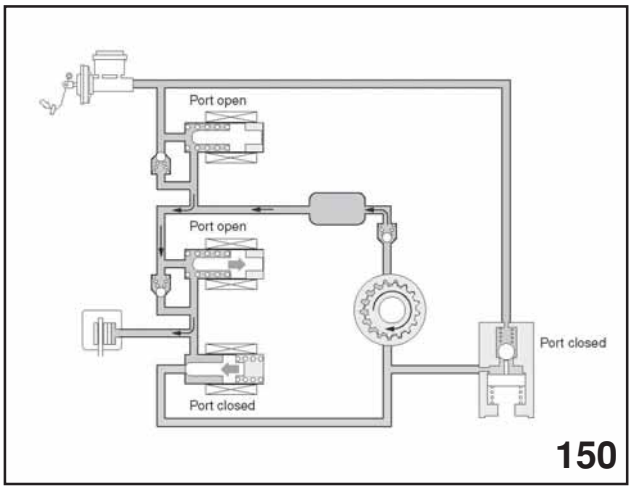
ABS pressure hold



ABS Pressure Hold

During ABS pressure hold the inlet and outlet solenoid valves are closed, maintaining the existing pressure at the brake caliper.

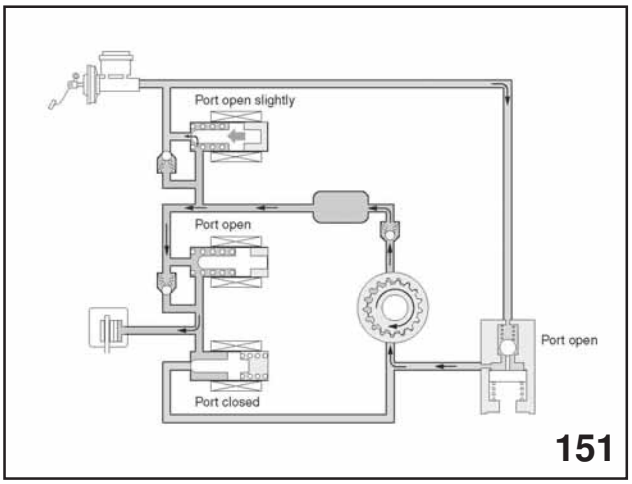
ABS increase



ABS Increase

During ABS increase the solenoid valves are positioned as they are during normal braking and the pump is operating. Pressure from the master cylinder applies the braking force and the pump is in operation, in preparation for ABS pressure decrease if necessary.

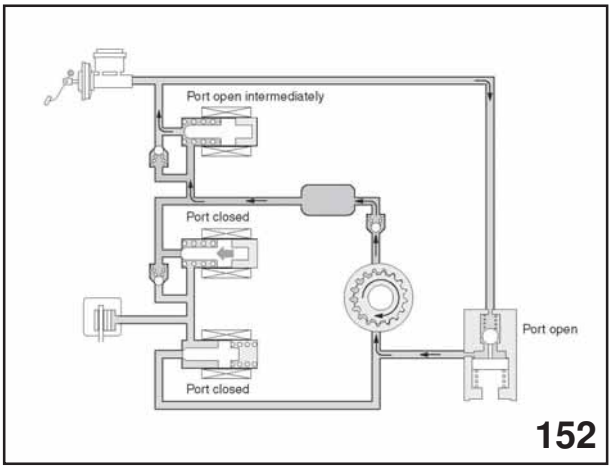
VDC pressure rise



VDC Pressure Rise

During VDC pressure rise the linear differential control solenoid receives a duty ratio, controlling the amount of brake force created between the pump and the brake caliper. During the VDC pressure rise the inlet solenoid valve is open and the outlet duty solenoid is closed.

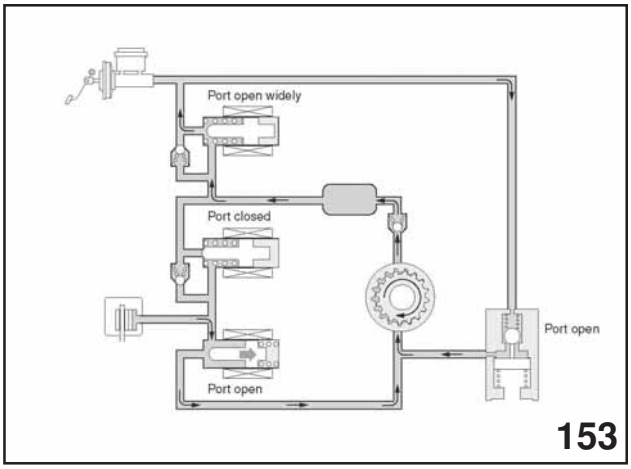
VDC pressure hold



VDC Pressure Hold

During VDC pressure hold the inlet and outlet solenoid valves are both closed, maintaining the existing braking force at the brake caliper. The liner differential control solenoid is opened and the pump will continue to operate, circulating the brake fluid in preparation of VDC pressure rise if needed.

VDC pressure decrease



VDC Pressure Decrease

During VDC pressure decrease the inlet control solenoid is closed and outlet duty solenoid is open, decreasing the brake pressure at the brake caliper. The linear differential duty solenoid is open and the pump is operating.

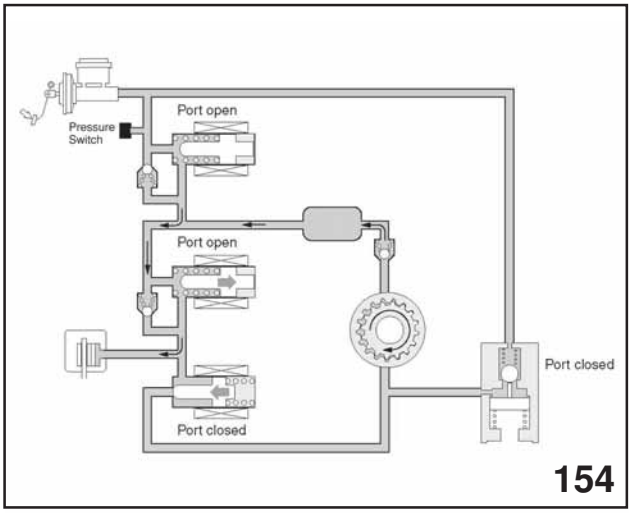
Control logic, HCU/ECM, and system diagnosis are similar to current VDC systems.

Brake Assist 2007

Brake Assist is a system designed to recognize emergency braking operation and automatically enhance braking effort. Brake assist improves vehicle and occupant safety by reducing stopping distances.

A pressure switch mounted on the Hydraulic Control Unit (HCU) monitors the pressure increase from the master cylinder as the brakes are applied. When the pressure increases faster than normal, Brake Assist activates. The driver may feel a slight pulsation in the brake pedal as the hydraulic brake pressure applies maximum braking. (Pressure increase compared to time)

Releasing the brake pedal deactivates Brake Assist. (Brake switch and pressure switch input to HCU)



2007 Pressure Switch

2007 Legacy

The 2007 Legacy and Outback models are described from pages 53 to 78. Please review the material on these pages to become familiar with the systems equipped on each model. In cases where the systems are shared with the Subaru B-9 Tribeca, refer to the Subaru B-9 Tribeca chapter in the beginning of this reference booklet.

VDC System

The VDC system of the 2007 Legacy is very similar to past model years with the exception of the Hydraulic Control Unit (HCU). This year the HCU is designed to operate more than one type of vehicle. Upon installation, a new HCU must be initialized (*Selection of Parameter) to the vehicle in which it is installed. This process is accomplished with the SMIII using the procedure outline below. This information can also be found in the help section of the SMIII.

The SMIII is also used to confirm that a HCU has been previously initialized correctly to a vehicle (Confirm on Parameter). This would be performed during diagnosis when the operation of the HCU is in question.

*Selection of parameter is the process of selecting the operating parameters of the vehicle to the HCU.

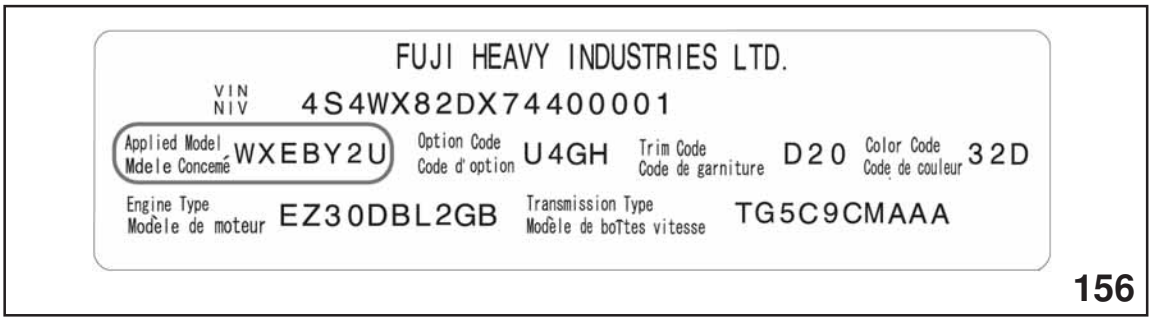
Selection of Parameter

This function is used to select/register parameters when the VDC control module has been replaced with a normal spare part.

NOTE: ALWAYS EXECUTE "CLEAR MEMORY" AFTER OPERATING THIS FUNCTION.

THIS FUNCTION CANNOT BE USED WITH A CONTROL MODULE THAT IS NOT A NORMAL SPARE PART.

TO CONFIRM THE APPLIED MODEL, REFER TO THE "MODEL NO. PLATE" AFFIXED TO THE VEHICLE. THE LOCATION OF THE MODEL NO. PLATE IS SHOWN IN THE *SERVICE MANUAL.



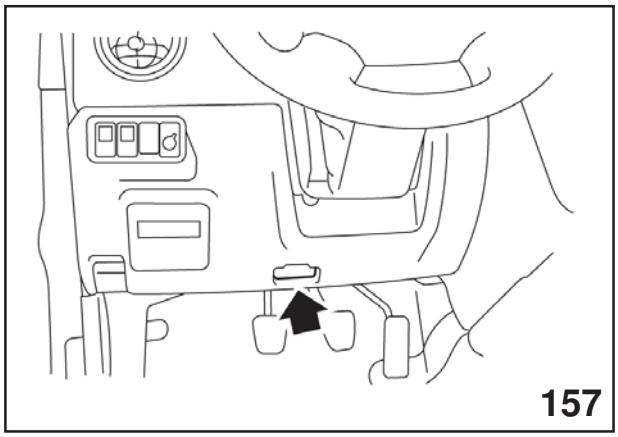
Model No. Plate

Registration Procedure

1. Prepare the SDI, diagnosis cable, USB cable, and a PC with the PC application installed.
2. Use the diagnosis cable to connect the SDI to the data link connector of the vehicle.

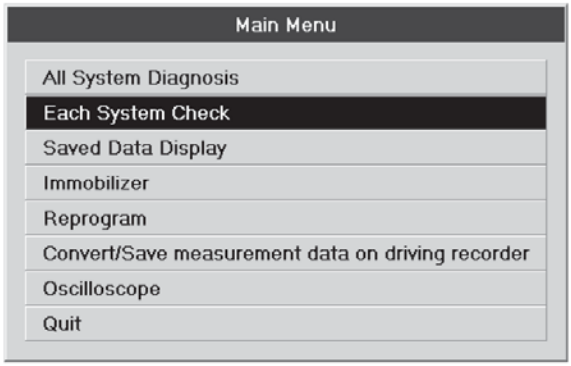
NOTE: SDI POWER WILL TURN ON AUTOMATICALLY WHEN THE DIAGNOSIS CABLE IS CONNECTED TO THE VEHICLE. IF THE PWR LED OF THE SDI DOES NOT LIGHT, TURN ON THE VEHICLE'S IGNITION SWITCH OR START THE ENGINE, AND THEN PRESS THE SDI [PWR] KEY AND CHECK AGAIN TO SEE IF THE PWR LED OF THE SDI LIGHTS.

NOTE: SELECTION AND CONFIRMATION OF PARAMETER ONLY APPLIES TO VEHICLES EQUIPPED WITH VEHICLE DYNAMIC CONTROL (VDC).


157

SDI Location

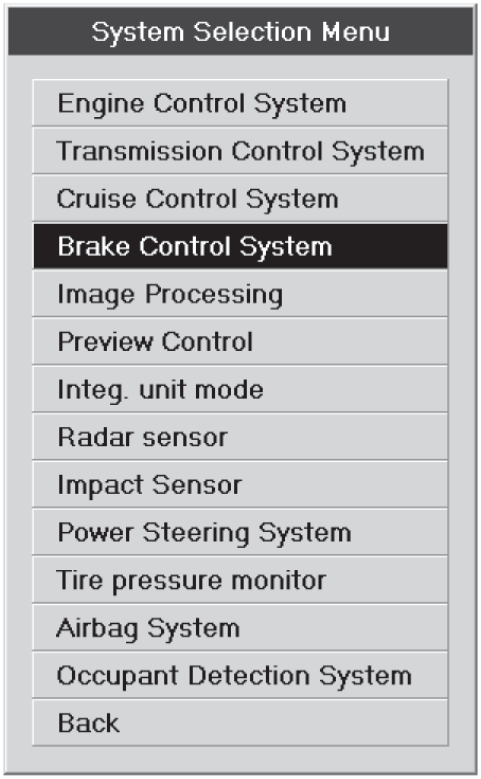
3. Use the USB cable to connect the SDI to the PC.
4. Turn on the vehicle's ignition switch.
5. Double-click the SSMIII icon on the PC screen to start up the application.
6. On the Main Menu that appears on the display, select [Each System Check] and then press the Enter key or left-click with the mouse.



158

Main Menu

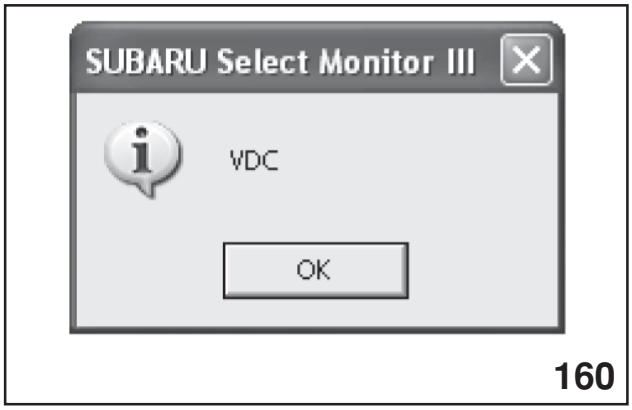
7. On the System Selection Menu, select [Brake Control System] and then press the Enter key or left-click with the mouse.



159

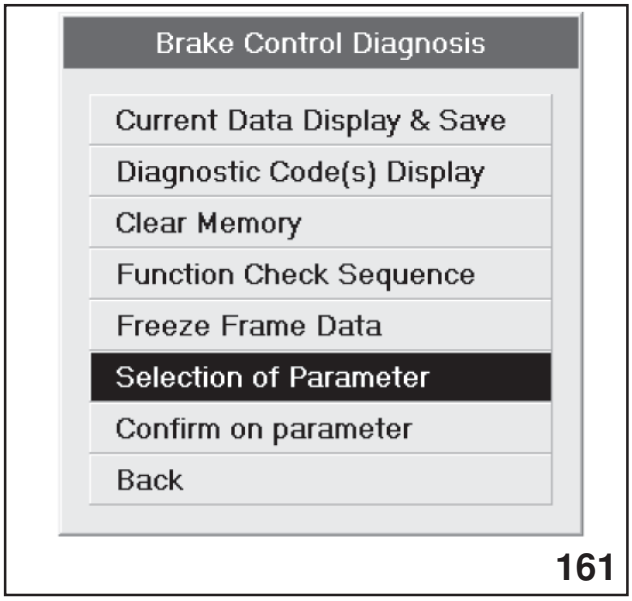
System Selection Menu

8. This displays a compliance verification message for the system being diagnosed. Click the [OK] button.



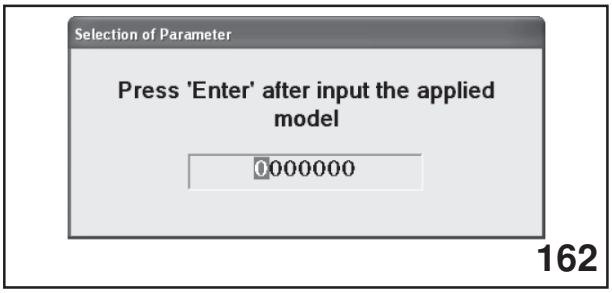
Subaru Select Monitor III

9. From the list of fault diagnosis, select [Selection of Parameter] and then press the Enter key or left-click with the mouse.



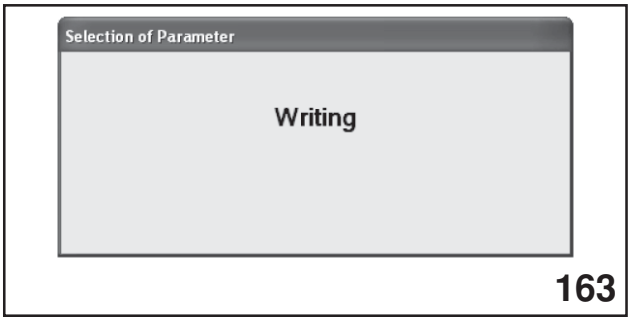
Brake Control Diagnosis

10. Input the applied model and press the Enter key.



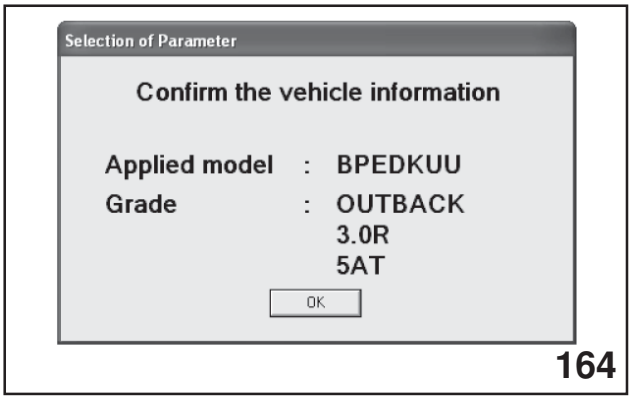
Selection of Parameter
Applied Model

11. Stand by as the message below will appear on the screen.



Selection of Parameter
Writing

12. The vehicle information check screen will be displayed. Make sure that the applied model and grade shown on the screen are correct and then click the [OK] button.



Selection of Parameter
Confirm the Vehicle Information

NOTE: IF THE APPLIED MODEL AND GRADE ARE DIFFERENT THAN THOSE OF THE VEHICLE, EXECUTE THE REGISTRATION PROCEDURE AGAIN AFTER CLICKING THE [OK] BUTTON.

Confirm on Parameter

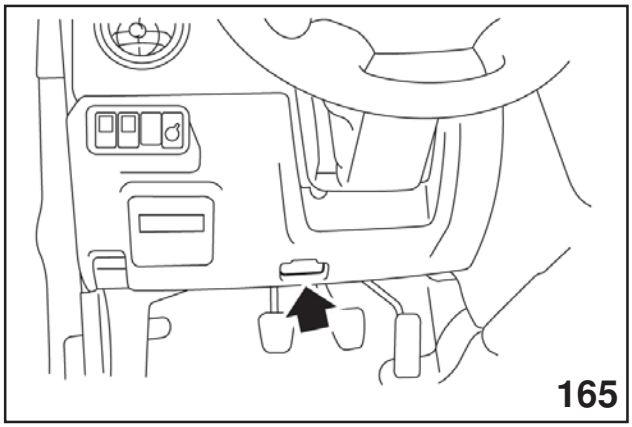
This function allows you to confirm the parameters registered in the VDC control module.

NOTE: THIS FUNCTION CAN BE USED EVEN IF THE VDC CONTROL MODULE IS NOT A NORMAL SPARE PART.

Confirm Procedure

1. Prepare the SDI, diagnosis cable, USB cable, and a PC with the PC application installed.
2. Use the diagnosis cable to connect the SDI to the data link connector of the vehicle.

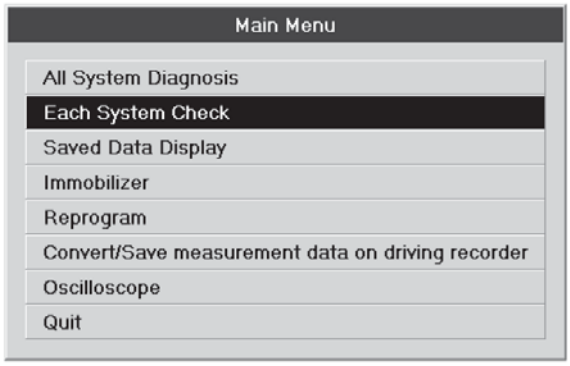
NOTE: SDI POWER WILL TURN ON AUTOMATICALLY WHEN THE DIAGNOSIS CABLE IS CONNECTED TO THE VEHICLE. IF THE POWER OF THE SDI DOES NOT LIGHT, TURN ON THE VEHICLE'S IGNITION SWITCH OR START THE ENGINE, AND THEN PRESS THE SDI [PWR] KEY AND CHECK AGAIN TO SEE IF THE PWR LED OF THE SDI LIGHTS.



165

SDI Location (Connect USB cable)

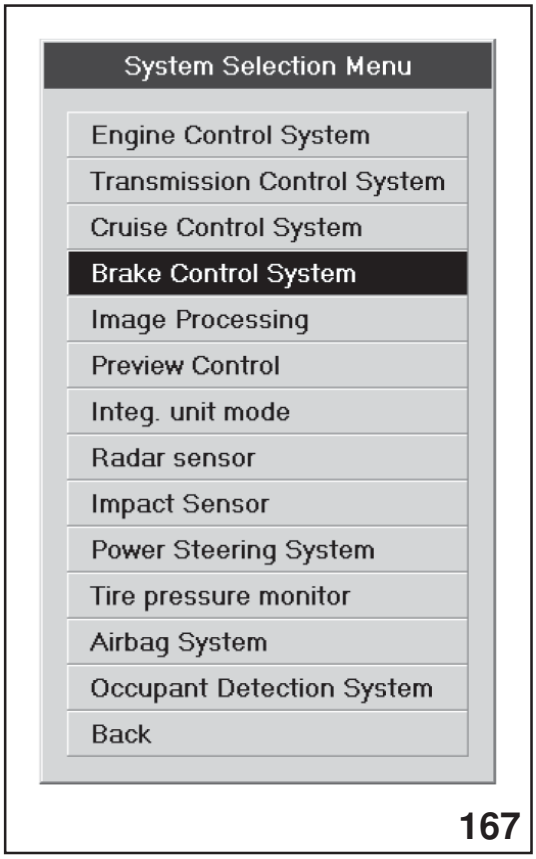
3. Use the USB cable to connect the SDI to the PC.
4. Turn on the vehicle's ignition switch.
5. Double-click the SSMIII icon on the PC screen to start up the application.
6. On the Main Menu that appears on the display, select [Each System Check] and then press the Enter key or left-click with the mouse.



166

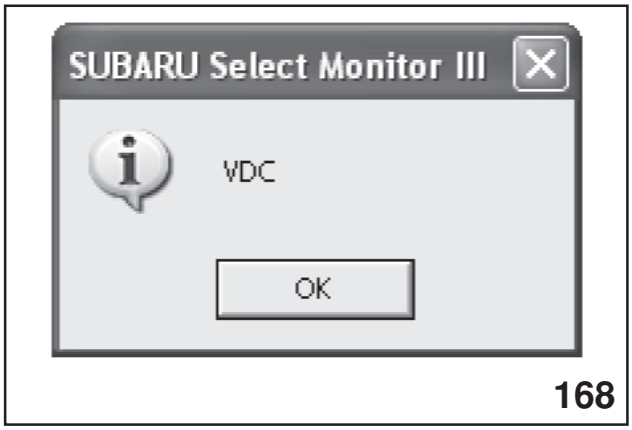
Main Menu

7. On the System Selection Menu, select [Brake Control System] and then press the Enter key or left-click with the mouse.



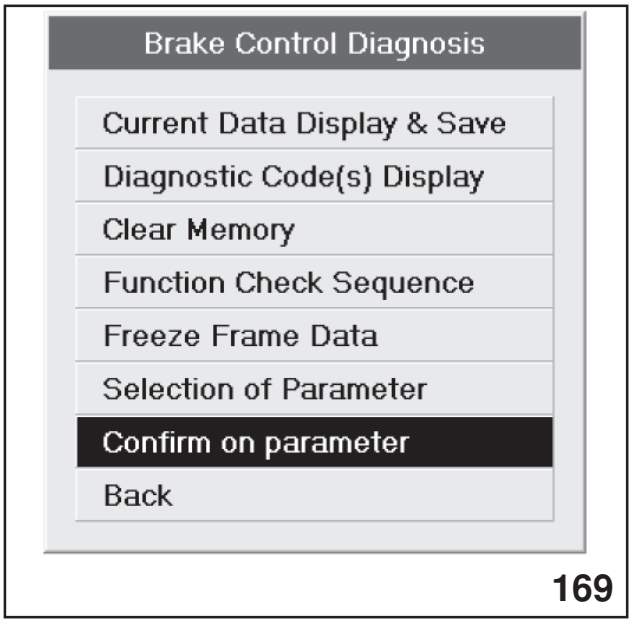
System Selection Menu

8. This displays a compliance verification message for the system being diagnosed. Click the [OK] button.



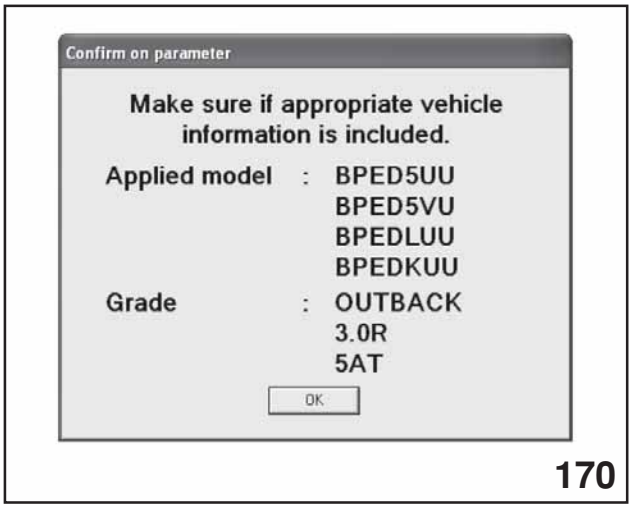
Subaru Select Monitor III

9. From the list of fault diagnosis, select [Confirm on Parameter] and then press the Enter key or left click with the mouse.



Brake Control Diagnosis

10. The parameter confirm screen will be displayed. Make sure the “Applied model” and “Grade” of the pertinent vehicle are displayed, and then click the [OK] button.



Confirm on Parameter

Slide Sequence

Slide No.	Description	Page No.
1	Title Slide (Fuel Injection and Engine Management)	
2	Created By	
3	Teaching Aids	
4	Title Slide (Introduction)	7
5	Title Slide (General Overview)	7
6	Dual Diagonal Brake System	7
7	Front disk Brake	8
8	Rear Disc Brake	8
9	Front Disc Brake	8
10	Depressing Caliper Piston (Older)	9
11	Front Caliper (Clips)	9
12	Front Caliper Lower (Pin)	9
13	Front Caliper (Cross Spring)	10
14	Front Caliper Upper (Pin)	10
15	Pads Slightly Out	10
16	pads Gone	10
17	Rear Rotor and Caliper	10
18	Rear Caliper	10
19	Pin Nearly Out	11
20	Pins and Cross Spring Removed	11
21	Pads Removed	11
22	Front Pads	11
23	Rear Pads	11
24	Title Slides (Hill-Holder™ System)	12
25	Hill-Holder™ System	12
26	Pressure Hold Valve	12
27	Clutch Pedal In (Artwork)	12
28	Clutch Pedal Out (Artwork)	12
29	Clutch Pedal	13
30	Clutch Pedal Free Play	13
31	Clutch Lever Free Play	13
32	PHV	13
33	Adjusting PHV	13
34	Title Slide (Master Cylinder)	14
35	Master Cylinder Cross-Section	14
36	Master Cylinder	14
37	Reed Switch Schematic	15
38	Reed Switch Construction	15
39	Typical Proportioning Valve	15
40	2001 Legacy Rear Drum Brake and VDC Model	16
41	2001 Legacy Rear Disc Brake Model	16
42	Electronic Brake Distribution	16
43	HCU	16
44	Proportioning Valve Location	16
45	Normal (Artwork)	17
46	Pressure Hold (Artwork)	17
47	Big Graph	17
48	Ideal (Artwork)	17
49	PCV Operation	17
50	EBD	18
51	Title Slide (Brake Booster)	18

Slide Sequence

Slide Sequence

Slide Sequence

Tools and Equipment

Special Tools

Tool Number	Description

State I/M Program Advisories Bulletins

No.	Date	Title	Subject
WXT-77	02/29/00	2000MY vehicles	Master Cylinder Bore Size
11-67-02	02/21/02	All 1999 Forester & Impreza, 1999 2.2L non Cal. sped	Air Flow Meter Sensing Unit Availability

Service Bulletins

No.	Date	Title	Subject
06-29-00	05/10/00	All 2000 Models	Low Brake Pedal Perception
06-32-03	11/01/03	All models; All Years	Brake Vibration Diagnostics and Revised Flat Rate Time

Tech TIPS

Date	Subject


CERTIFIED
SUBARU
TECHNICIAN


AUTOMOTIVE
Youth
Educational
Systems
YES
PROUD PARTNER