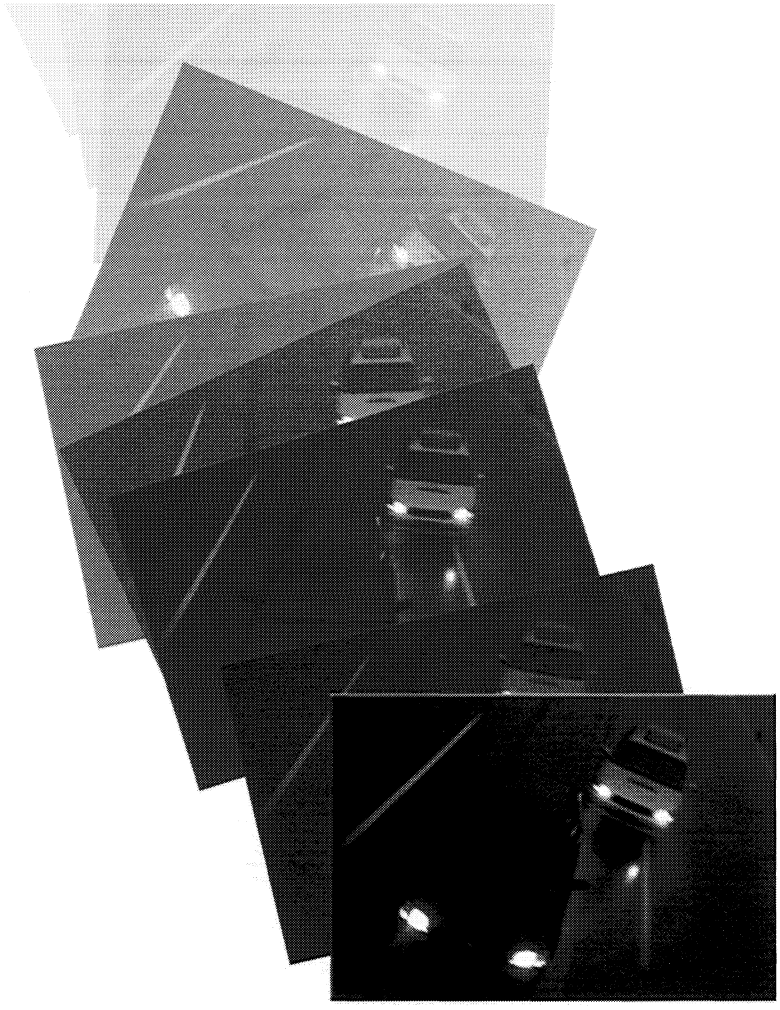
SUBARU®

Vehicle Dynamics Control

(VDC)



Video Reference Booklet

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VEHICLE DYNAMICS CONTROL (VDC)

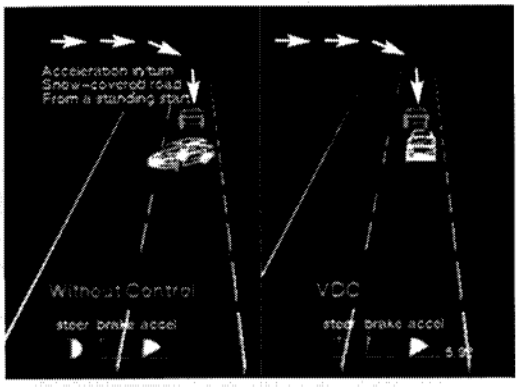
CONTENTS

INTRODUCTION

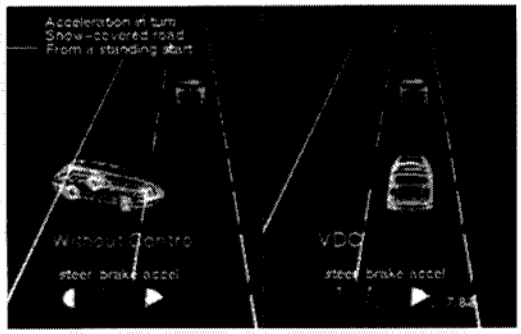
This Subaru Video Reference Booklet covers Vehicle Dynamics Control (VDC). VDC provides a high level of stable handling, thanks to All-Wheel Drive (AWD) automatic transmission with variable torque distribution.

It is a powerful active safety mechanism that allows the driver to maintain control of the vehicle if it starts to fishtail.

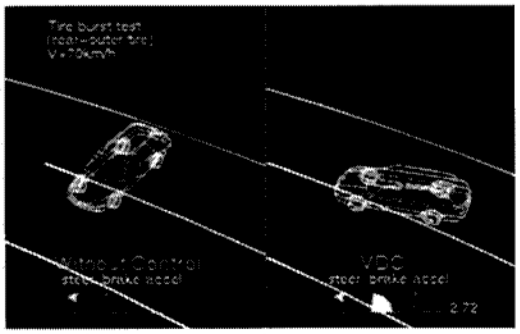
This Video Reference Booklet will cover what the VDC system is, the difference in handling stability between a vehicle with VDC and a vehicle without, how the VDC system works, how the brake control system works, and inspection and maintenance.



Acceleration in Turn, Snow-Covered Road, from Standing Start



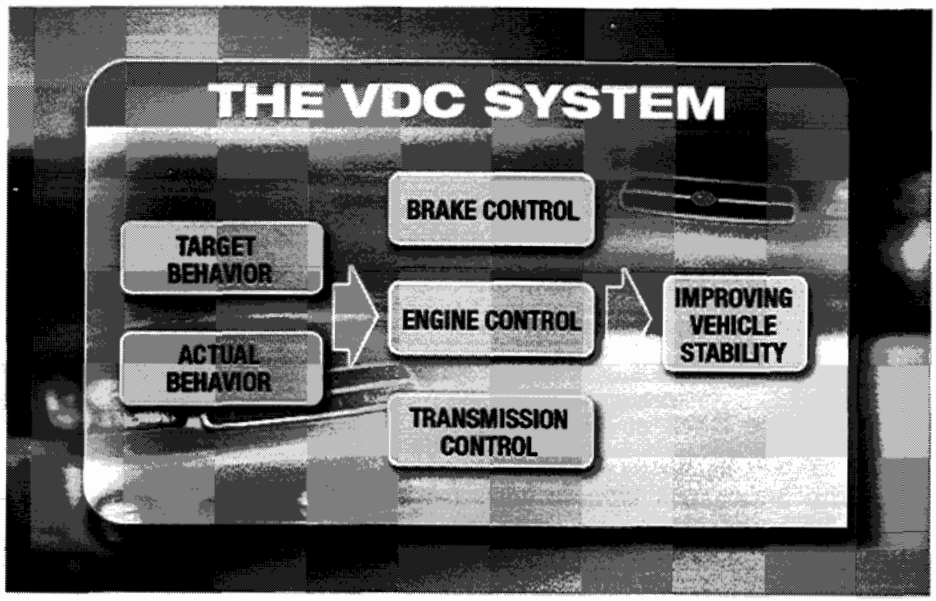
Acceleration in Turn, Snow-Covered Road, from Standing Start



Tire-Burst Test

VEHICLE DYNAMICS CONTROL (VDC)

WHAT THE VDC SYSTEM IS



VDC System Operation

Running, stopping and turning are the most important performance factors for a motor vehicle. Until now, the AWD and Traction Control System (TCS) have controlled functions related to running, while the Antilock Brake System (ABS) has controlled the braking functions.

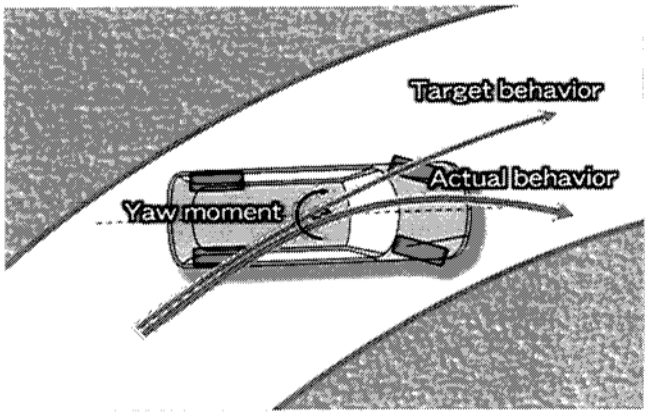
Now the VDC system adds new features and functions that use TCS and ABS to provide automatic assistance when turning. The VDC system constantly monitors the difference between the intentions of the driver and the actual behavior of the vehicle.

Brake control by the ABS, engine control by the ECM, and transfer control by the Transmission Control Module (TCM) are used to independently adjust the braking force and driving force of each wheel. The VDC system corrects for excessive understeering and oversteering, which results in improved running stability.

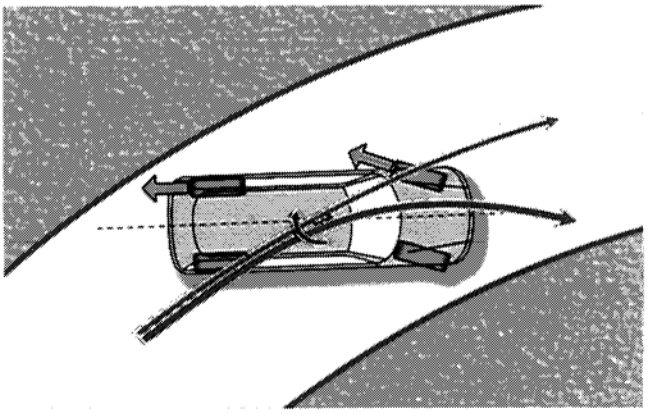
A VDC indicator light flashes when the VDC system is operating to alert the driver to extreme driving conditions.

VDC System In-Operation Indicator

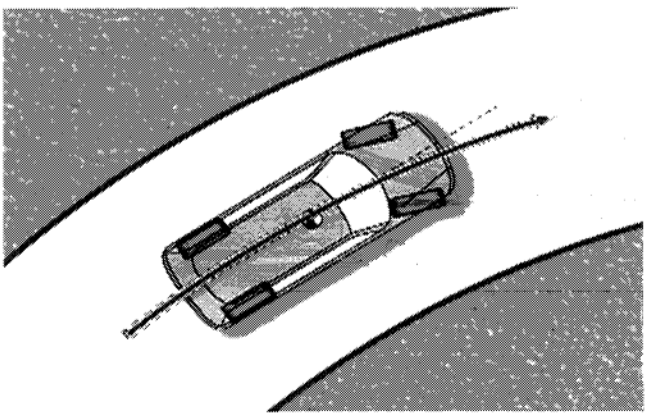
The VDC system uses the brake system as a major means of control. When the vehicle goes into excessive oversteering, the VDC system applies braking force to the outer front and rear wheels. This reduces the yaw moment and brings the vehicle closer to the driver's intended path. (Yaw is rotation of the vehicle around a vertical axis.)



Oversteer



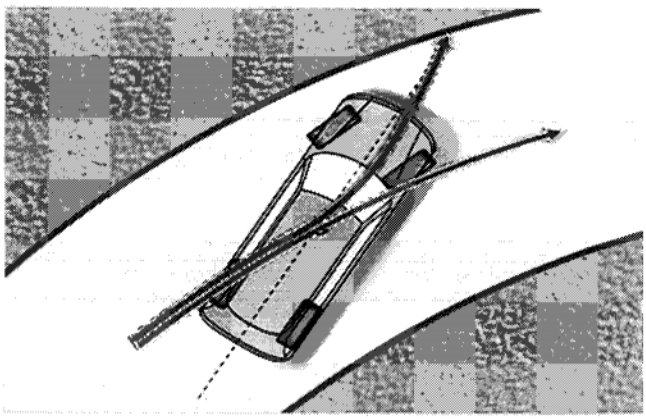
VDC Correction for Oversteer



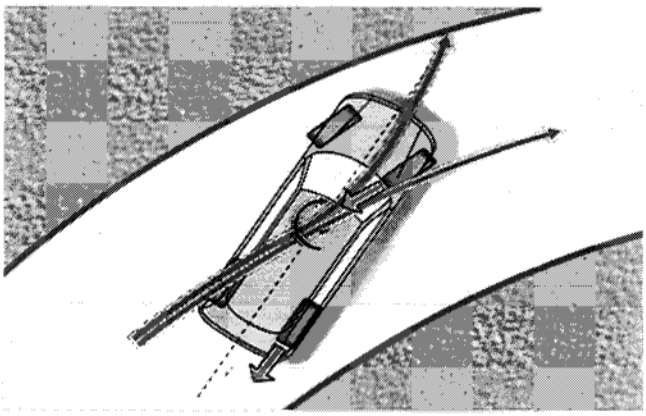
Results of VDC Correction

When the vehicle goes into excessive understeering, the VDC system applies braking force to the inner front and rear wheels. This increases the yaw moment and brings the vehicle closer to the driver's intended path.

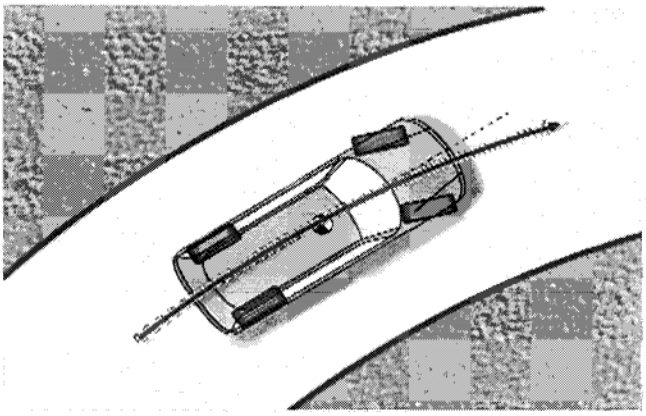
In addition, fuel is cut to reduce engine power while these operations are being performed, and torque distribution to the front and rear wheels is optimized. All of this means that the VDC system controls the yaw in order to stabilize vehicle behavior.



Understeer



VDC Correction for Understeer



Results of VDC Correction

DIFFERENCE IN HANDLING STABILITY: VDC VS. NO VDC

There is a significant difference in handling stability between a vehicle that has VDC and one that does not.

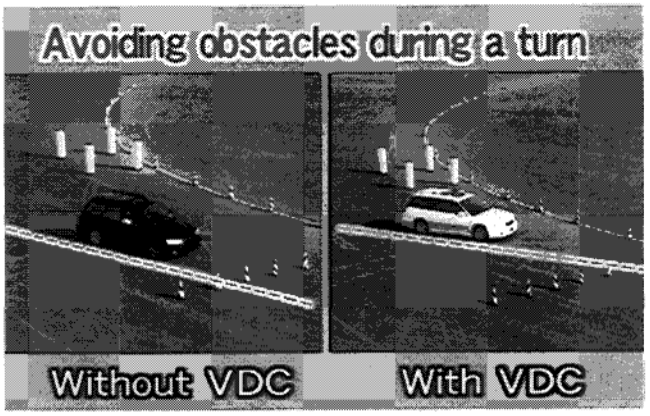
In a slalom test on a low-friction road surface, a vehicle without VDC might have trouble negotiating the obstacles, whereas a comparable vehicle with VDC would tend not to have trouble.

In a test that involves maneuvering to avoid obstacles during turns, a vehicle without VDC might have trouble avoiding the obstacles, whereas a comparable vehicle with VDC would tend not to.

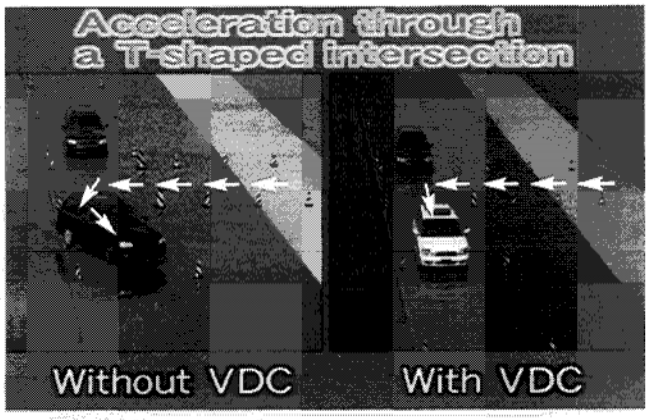
In a test simulating acceleration through a T-shaped intersection on a very slippery road surface, a vehicle without VDC might have trouble accelerating smoothly, whereas a comparable vehicle with VDC would tend not to.

In a test where a vehicle is traveling on a slippery road and another vehicle or other object suddenly appears from the side, a vehicle without VDC might have trouble avoiding the object, whereas a comparable vehicle with VDC would tend not to.

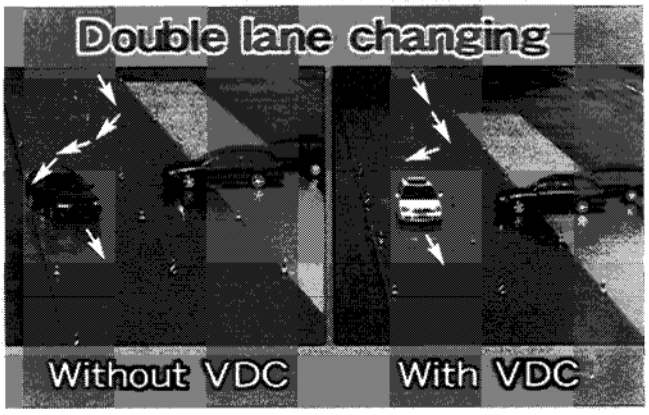
The ability of the VDC system to instantly adjust to road conditions makes it a valuable tool that helps drivers avoid accidents.



Avoiding Obstacles During a Turn



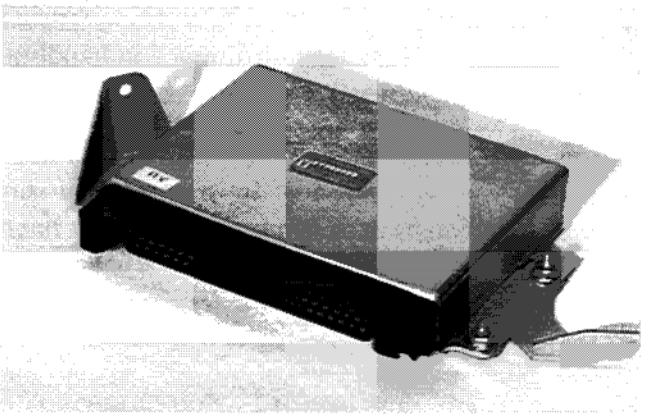
Acceleration Through a T-Shaped Intersection



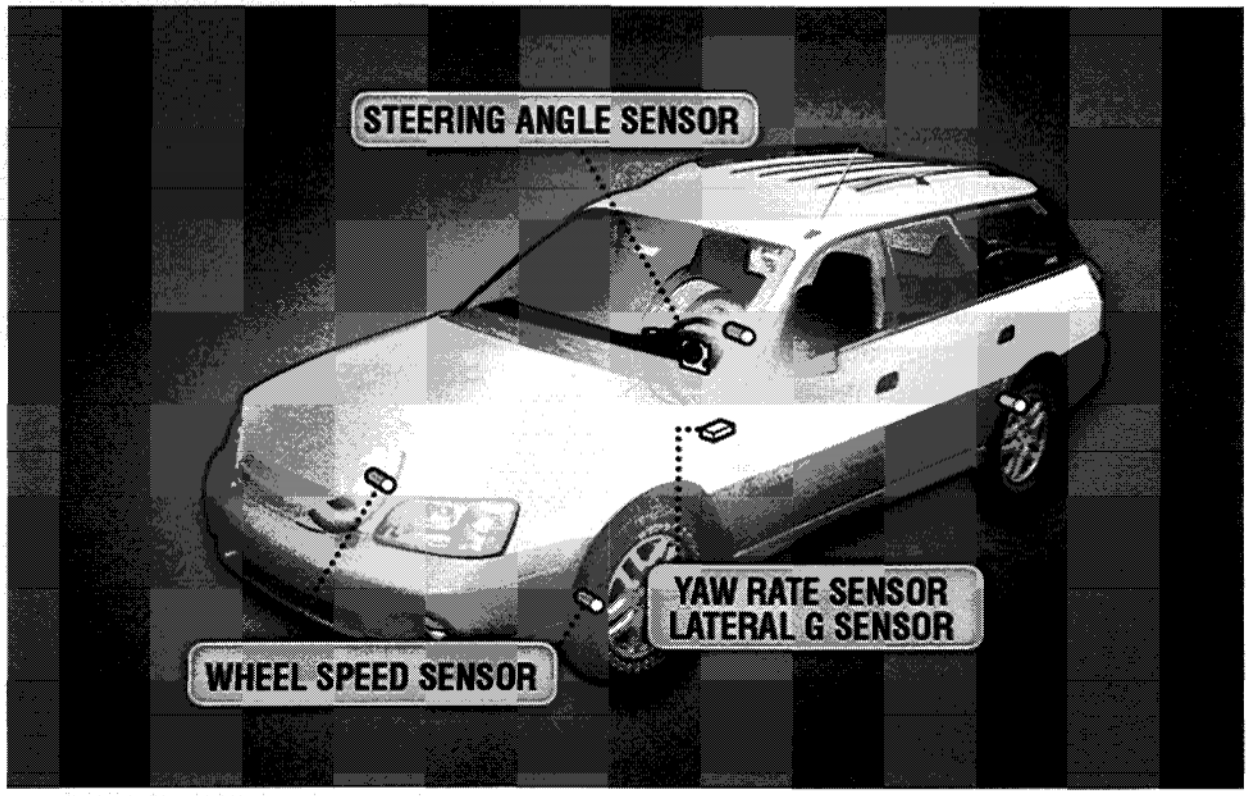
Double Lane Changing

HOW THE VDC SYSTEM WORKS

The VDC system sends data, picked up by various sensors, to the VDC Control Module, which analyzes and evaluates it. The VDC Control Module then issues commands that control braking, the engine, and transfer components.

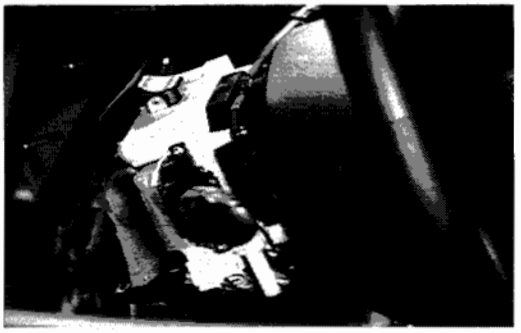


VDC Control Module

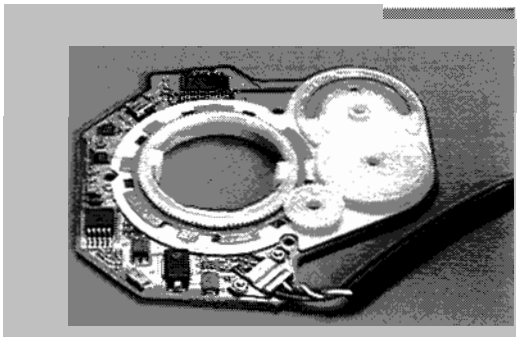


VDC Sensors

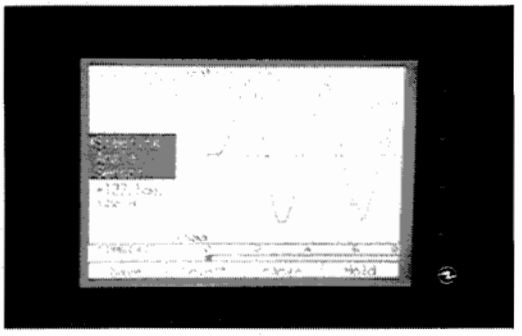
Steering Angle Sensor. The steering angle sensor detects the driver's intended path. It consists of a hall element, magnet, slip disc, and gears. Instead of detecting steering wheel movement, this sensor detects the positive or negative value of the steering wheel position from a neutral position of zero degrees. This makes it possible to obtain higher-precision measurement of steering wheel position. It measures the steering wheel position and reports it as an angle up to 360 degrees with an accuracy of 2.5 degrees. The measurement range is 720 degrees.



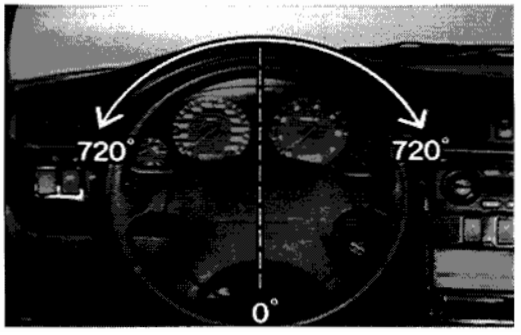
Steering Angle Sensor



Steering Angle Sensor



New Select Monitor (NSM) Display of Steering Angle Sensor Signal



Steering Angle Sensor Range

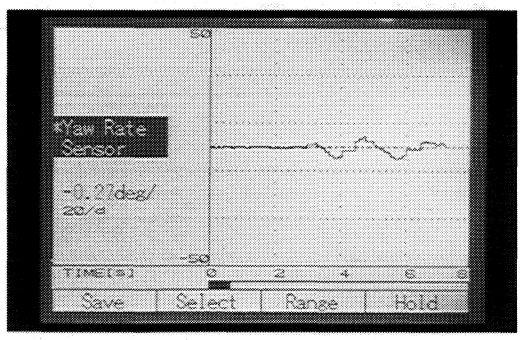
Yaw-Rate Sensor. In the console there is a combination yaw-rate sensor and lateral G-sensor. The yaw-rate sensor detects the rotary speed of vehicle yaw. Rotation of the vehicle on its yaw axis causes the sensor to generate voltage, which is used to determine the yaw-rate.

Lateral G-Sensor. A lateral G-sensor, which is integral with the yaw sensor, detects changes in vehicle forces from side to side.

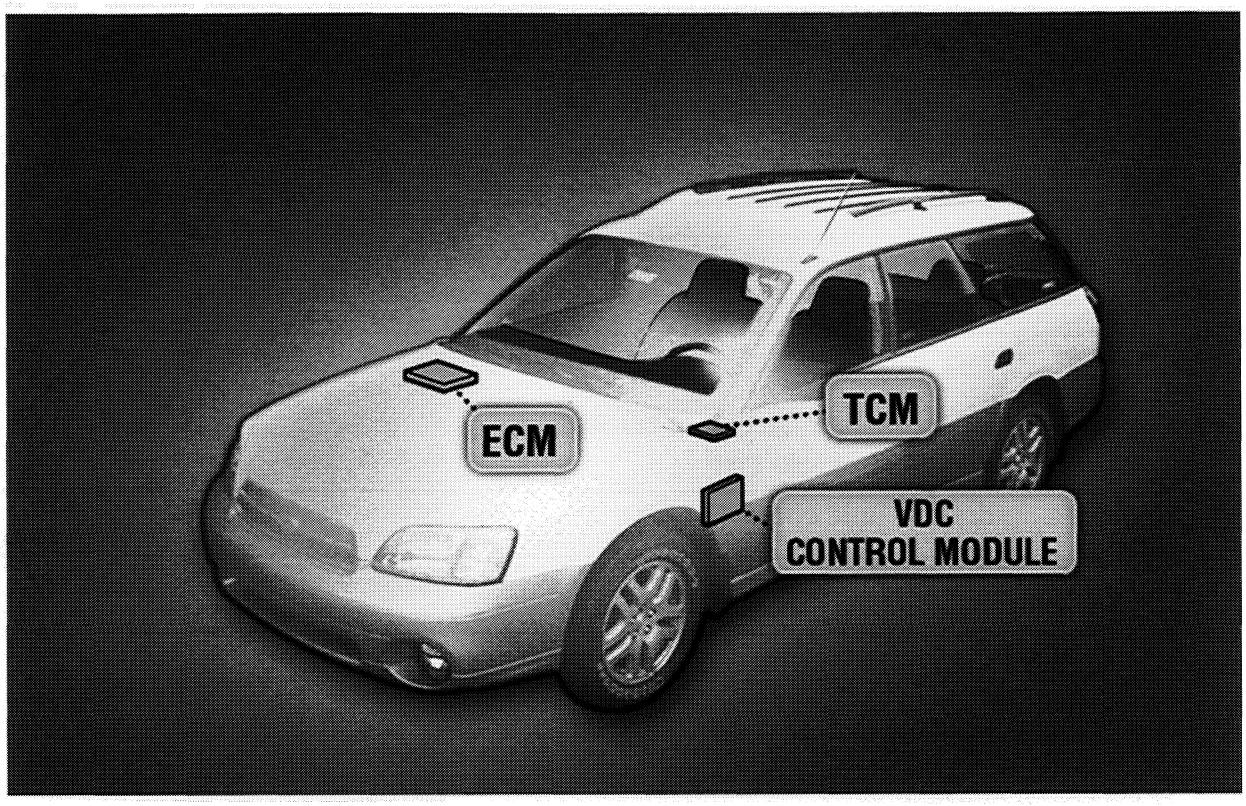
Wheel Speed Sensors. Wheel speed sensors detect wheel speeds.

These sensors constantly send data that provide a clear picture of the vehicle's current running status.

Yaw Rate and Lateral G Sensor



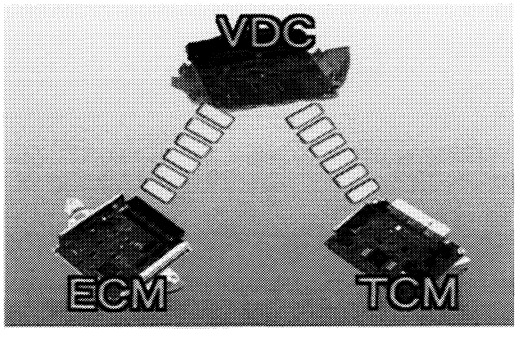
New Select Monitor Display of Yaw Rate Sensor signal



Control Modules

VDC Control Module. Several components analyze and evaluate the data. The VDC Control Module houses a computer that analyzes the data sent from the sensors and instantly makes adjustments that keep the vehicle running on line. It is truly the "brains" of the VDC system.

TCM and ECM. The TCM and ECM are important partners of the VDC control module. The VDC control module exchanges data with the TCM and ECM. The TCM keeps distribution of the drive force optimized for current running conditions, while the ECM controls engine output.

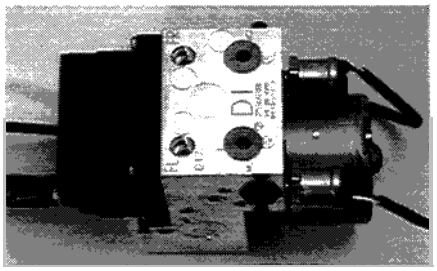


Data Exchange Among Modules

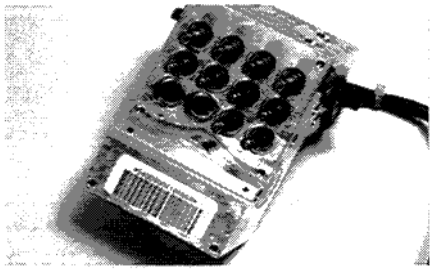
BRAKE CONTROL SYSTEM

Location of VDC Hydraulic Unit

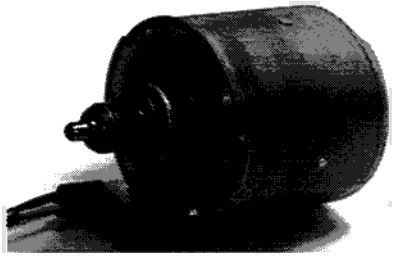
The VDC hydraulic unit controls brake fluid pressure. It adds two solenoid valves to the ABS hydraulic unit for cornering control. The VDC hydraulic unit consists of: solenoid valves that switch between the pressurization, hold, and depressurization modes; a motor that generates brake fluid pressure; and pressure sensors to detect changes in brake pressure.



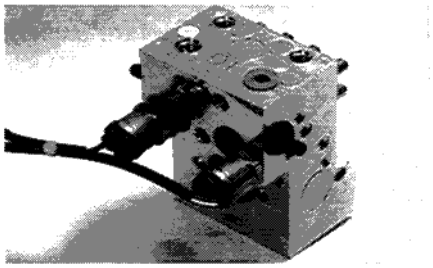
VDC Hydraulic Unit



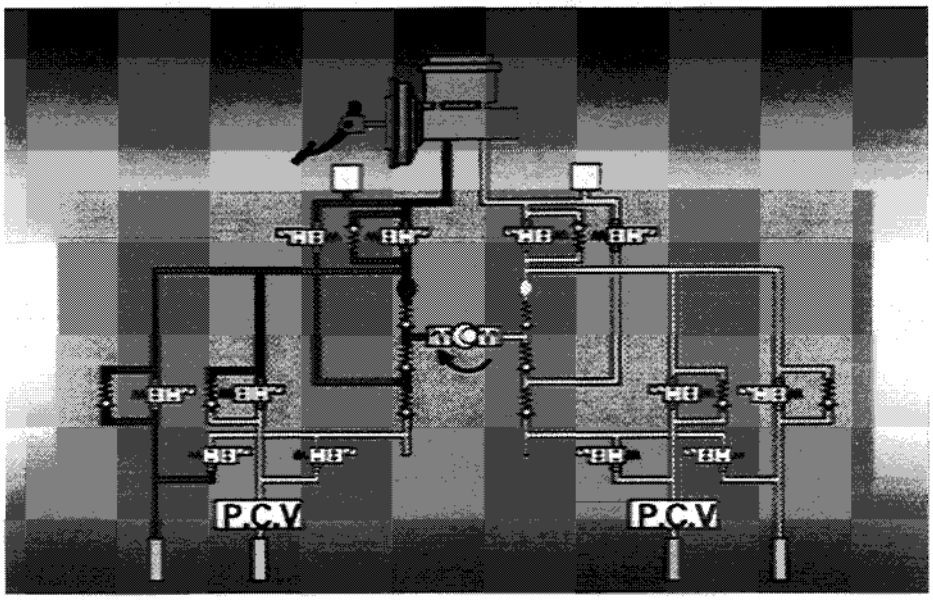
Solenoids in VDC Hydraulic Unit



VDC Hydraulic Unit Motor

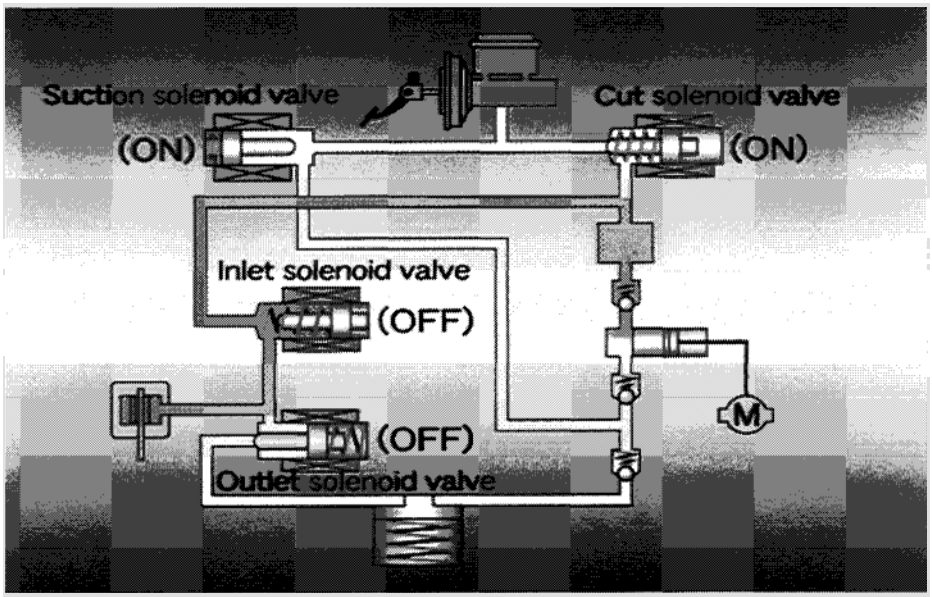


Pressure Sensors in VDC Hydraulic Unit

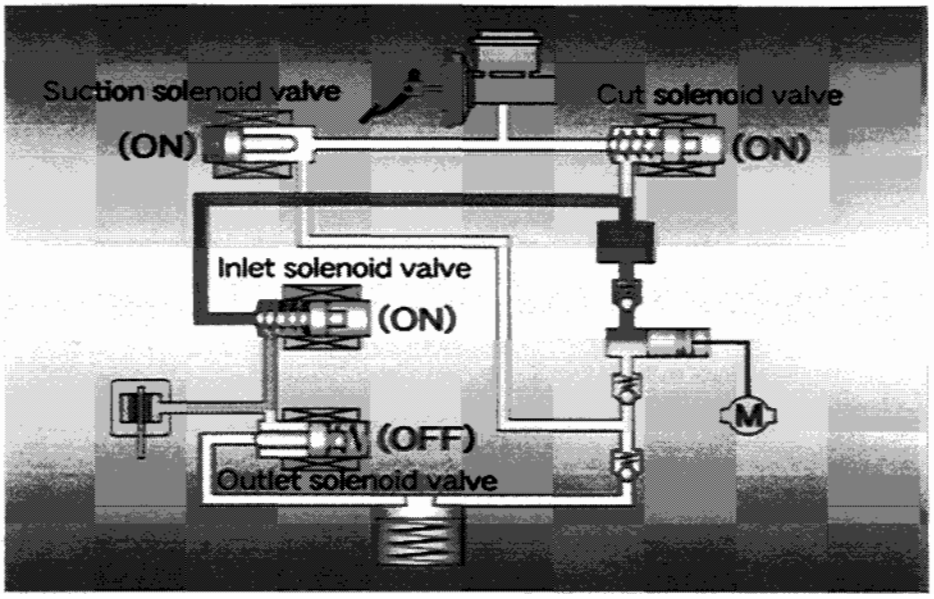


Hydraulic Circuit for One Wheel

Here's how brake fluid pressure control switches among the three modes in the hydraulic circuit for an individual wheel. First, in the "pressurization" mode, the suction solenoid valve and the cut solenoid valve turn On, and the motor operates to generate fluid pressure.



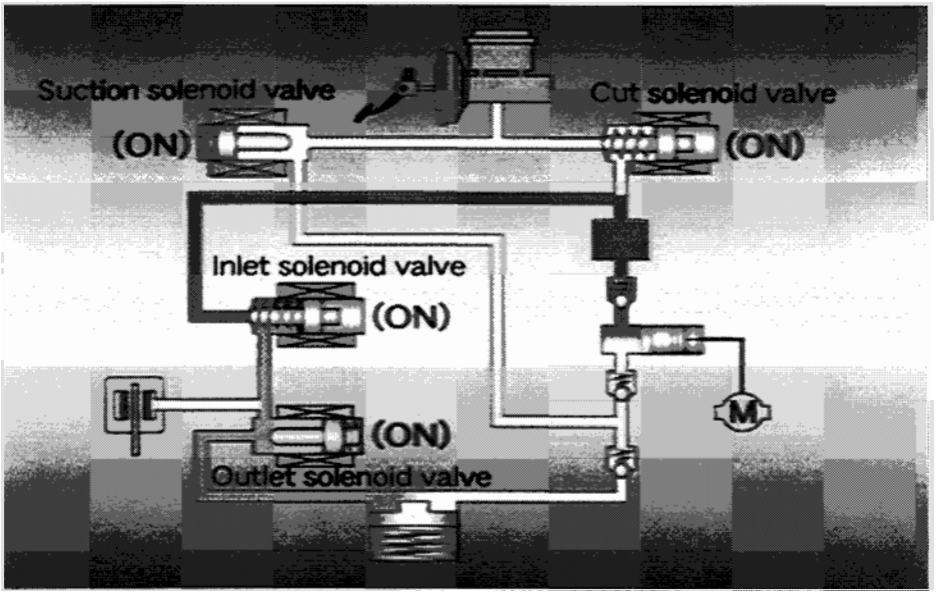
Pressurization Mode



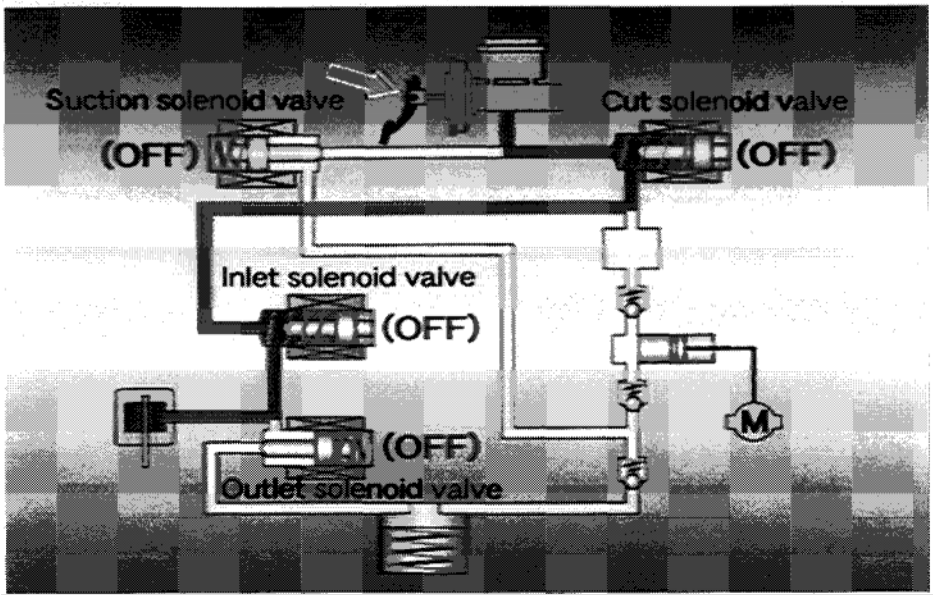
Hold Mode

In the "hold" mode, the inlet solenoid valve is On, which maintains fluid pressure at the most appropriate level.

In the "depressurization" mode, the outlet solenoid valve turns On, which releases fluid pressure from the wheel cylinder, releasing the brake. Brake fluid is returned to the master cylinder by the pump.



Depressurization Mode

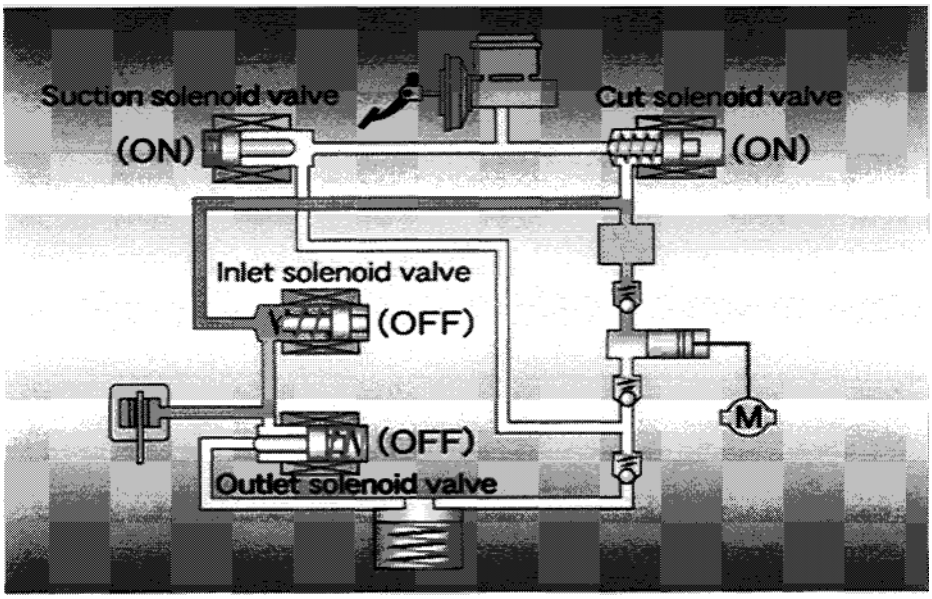


ABS Operation – Pressure Supplied by Master Cylinder

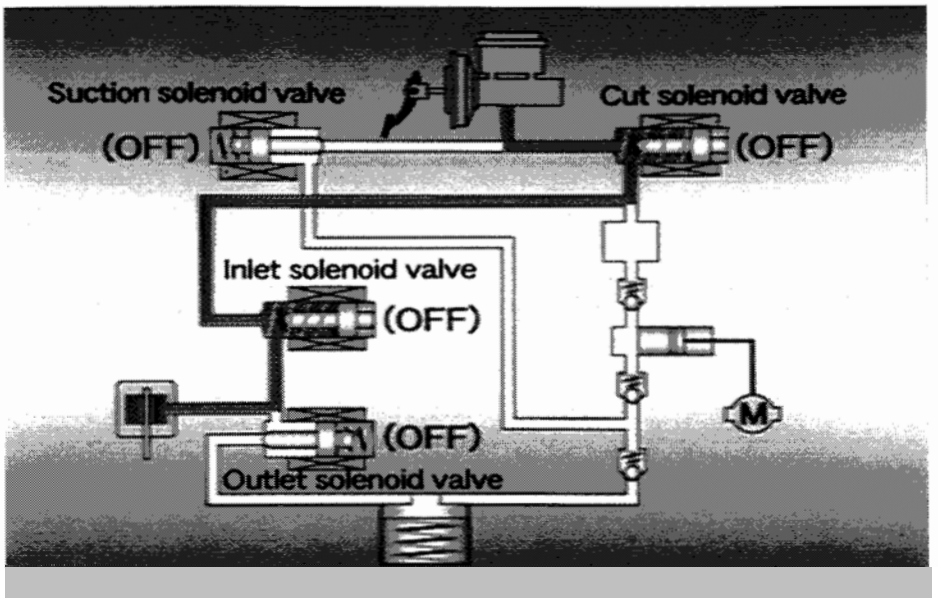
These processes are continually repeated to perform VDC brake fluid pressure control.

The source of brake fluid pressure for ABS system operation is the master cylinder.

The pressure source for VDC system operation is the pump.



VDC System Operation – Pressure Supplied by VDC Pump



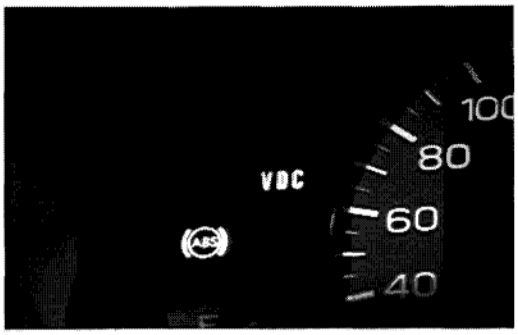
Fail-Safe Mode

The system is designed with a fail-safe function that turns Off all solenoid valves when any trouble occurs in the VDC system, which switches over to a conventional brake hydraulic system.

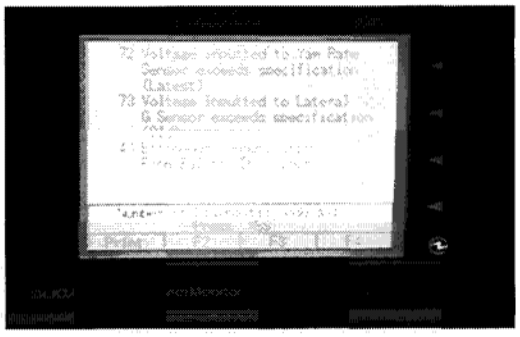
INSPECTION AND MAINTENANCE

Malfunction of the system is indicated by a VDC warning light, an ABS warning light, and the instrument panel. Only the VDC warning light turns on if the VDC system malfunctions without affecting ABS function.

The VDC control module has a self-diagnostic function that stores the latest three trouble codes related to malfunction. These trouble codes can be viewed using the New Select Monitor.



VDC and ABS Warning Lights

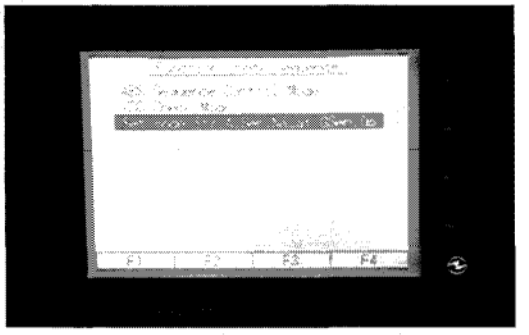


VDC Diagnostic Trouble Code Display on NSM

After performing maintenance on any of the following items, be sure you always properly reset the steering angle sensor and lateral G-sensor:

- VDC control module
- Steering angle sensor
- Yaw sensor
- Lateral G-sensor
- Steering system components
- Tires
- Wheel alignment

Always be sure you turn off the VDC system before performing any service work that involves lifting all four wheels from the ground and running the engine in gear. To turn off the VDC system, install a fuse into the VDC off holder inside the fuse box.



NSM Menu: Set Mode for Steering Angle Sensor and Lateral G Sensor Selected

Installing Fuse in VDC-Off Holder in Underhood Fuse Box (to Turn Off VDC System)

CONCLUSION

Vehicle Dynamics Control is a stability control system that is a direct result of Subaru's commitment to active safety. The Vehicle Dynamics Control system enhances performance of the AWD system and helps drivers maintain control of their vehicles, even before they realize they have lost it.

VEHICLE DYNAMICS CONTROL (VDC)

Mark your answers to the following questions and retain this booklet for future use.

Name _____

Dealer _____ **Dealer Code** _____

1. Which of the following systems is used by the Vehicle Dynamics Control (VDC) system to independently adjust the braking force and driving force of each wheel during turns?
   a. Antilock Brake System (ABS).
   b. Transmission Control Module (TCM).
   c. ECM.
   d. All of the above.
2. When a vehicle equipped with VDC goes into excessive oversteering, the VDC system applies braking force to . . .
   a. The inner front wheel.
   b. The outer wheels.
   c. The inner rear wheel.
   d. The outer rear wheel.
3. Yaw is . . .
   a. Rotation of the vehicle around a longitudinal axis.
   b. Rotation of the vehicle around a lateral axis.
   c. Rotation of the vehicle around a vertical axis.
   d. The opposite of dive.
4. When a vehicle equipped with VDC goes into excessive understeering the VDC system applies braking force to . . .
   a. The inner front wheel.
   b. The outer front wheel.
   c. The inner wheels.
   d. The outer rear wheel.
5. During correction for an oversteering or understeering situation, the VDC system . . .
   a. Cuts fuel.
   b. Optimizes torque distribution between the front and rear wheels.
   c. Applies braking force to one of the wheels.
   d. All of the above.
6. Sensors used by the VDC include:
   a. Steering angle sensor.
   b. Yaw-rate sensor.
   c. Lateral G-sensor.
   d. All of the above.
7. The steering angle sensor detects movement of the steering wheel.
   a. True.
   b. False.
8. The range of the steering angle sensor is . . .
   a. 180°
   b. 360°
   c. 540°
   d. 720°
9. If the VDC malfunctions without affecting ABS operation, . . .
   a. The VDC light turns on.
   b. The ABS light turns on.
   c. The VDC and ABS lights turn on.
   d. The VDC alarm chimes.
10. What should you do before performing any service work that involves lifting all four wheels of a vehicle equipped with VDC off the ground and running the engine in gear?
    a. Reset the steering angle sensor.
    b. Reset the lateral G-sensor.
    c. Turn off the VDC system.
    d. None of the above.