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Introduction

In this course you will cover:

• The basic features of electronic suspension systems
• The function and operation of electronic suspension system
• The function and operation of tire inflation monitoring systems
• How to diagnose these systems

Upon completion of this course, you should be able to:

• Differentiate electronic suspension systems
• Compare electronic suspension systems components
• Distinguish Tire Inflation Monitoring Systems (TIMS) operation
• Interpret proper Strategy Based Diagnosis application

Test your self by matching the system on the left with the vehicle on the right:

1. ____ Selectable Ride  A. Pontiac Bonneville
2. ____ Automatic Level Control  B. Chevrolet Venture
3. ____ Air Suspension  C. Chevrolet Pickup
4. ____ Computer Command Ride  D. GMC Envoy
5. ____ Time Damping/Road Sensing Suspension  E. Corvette
6. ____ Vehicle Stability Enhancement System  F. Cadillac Seville
Course Overview:
This course contains four modules:
• Suspension Systems Overview
• Suspension Systems Component Overview
• Tire Pressure Monitoring Systems, and
• Diagnostic Exercises
Each module builds on prior modules, so they should be completed in order.
When you have finished all of the modules, you will be able to take the course test.
Section 1: Electronic Suspension Systems
Overview

Six lessons are in this module
1. Selectable Ride
2. Automatic Level Control
3. Air Suspension
4. Computer Command Ride
5. Real Time Dampening/Road Sensing Suspension
6. Vehicle Stability Enhancement System

Lesson 1: Selectable Ride

The Selectable Ride (SR) system is the least complex of all the systems we'll cover in this course.

SR allows the driver to choose between two distinct damping levels: firm and normal. It is found on Chevrolet and GMC full size trucks.

More specifically, the vehicle applications for the SR system include one-half and three-quarter ton Chevrolet and GMC trucks, with both two and four wheel drive.

Using only a switch and four electronically controlled gas charged dampers, the mode select switch, when commanded, activates the bi-state dampers at all four corners of the vehicle, allowing the driver to select vehicle ride characteristics.

The system is either energizing or de-energizing the bi-state dampers to provide a firm or normal ride.

Of the many potential system functions, Selectable Ride only uses bi-state dampers controlled by the driver. This system has no significant variations between the 1/2 and 1/3 ton applications.
Lesson 2: Automatic Level Control

The Automatic Level Control system (ALC) automatically adjusts the rear height of the vehicle in response to changes in vehicle loading and unloading.

Note that ALC is found across many of GM’s products.

ALC controls rear leveling by monitoring the rear suspension position sensor and energizing the compressor to raise the vehicle or energizing the exhaust valve to lower the vehicle.

ALC has several variations across the different platforms.

What is Automatic Level Control's main function?

________________________________________________________________________

________________________________________________________________________
Lesson 3: Air suspension

Air Suspension (AS), is a system very similar to the ALC system. Its primary functions are to:

- Keep the vehicle visually level
- Provide optimal headlight aiming, and
- Maintain optimal ride height.

AS consists of:

- An air suspension compressor assembly
- Rear air springs, and
- Air suspension sensors

AS is currently used on the 2002 model year Oldsmobile Bravada and is an option on the 2002 model year GMC Envoy.

AS maintains rear trim height within 4 mm in all loading conditions, and the leveling function will deactivate if the vehicle is overloaded.

AS also includes an accessory air inflator found in the rear cargo area.
Lesson 4: Computer Command Ride

The Computer Command Ride system (CCR) controls the firmness of the vehicle's ride by automatically controlling an actuator in each of the four struts to increase ride firmness as speed increases.

The three damping modes are:

- Comfort
- Normal, and
- Sport

Damping mode selection is controlled by the CCR Control Module according to vehicle speed conditions, vehicle accelerator input, driver select switch position, and any error conditions which may exist.

CCR is found on the 1999 and earlier model year Pontiac Bonnevilles.

In the PERFORM ride, the system will place the damping level in the Firm mode regardless of vehicle speed and accelerometer inputs.

In the TOURING ride, however, the damping level depends on vehicle speed and accelerometer inputs.

CCR's function is damping of the vehicle's ride.

Point Check: Place a check mark on the appropriate line.
There are a total of eleven lines that need to be checked.
The check marks represent a correlation between vehicles and functions

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Lesson 5: Real Time Dampening and Road Sensing Suspension

This lesson covers two systems:

- Real Time Damping (RDT), and
- The similar Road Sensing Suspension (RSS)

RDT independently controls a solenoid in each of the four shock absorbers in order to control the vehicle ride characteristics and is capable of making these changes within milliseconds.

RSS, coupled with ALC, controls damping forces in the front struts and rear shock absorbers in response to various road and driving conditions.

There are nine vehicle applications for these two systems.

RTD and RSS incorporate an electronic suspension control module, front and rear suspension position sensors, bi-state dampers, and a ride select switch. An air compressor is used on some models.

Of all the systems covered so far, these two systems have the most variations. While the systems are similar, they cannot exist on the same vehicle. Take a moment to review the chart and see which combinations exist.
Lesson 6: Vehicle Stability Enhancement System

Vehicle Stability Enhancement System (VSES) includes an additional level of vehicle control to the EBCM. VSES is also known as Stabilitrak. VSES is the interaction between the suspension system and the Anti Lock (ABS) system to provide vehicle stability enhancement during over, or under-steer conditions.

There are several vehicles that use the VSES system.

Basically, the system monitors the ABS and other inputs during vehicle turning maneuvers. These input values are compared to a lookup chart inside the Electronic Brake Control Module to determine if the vehicle is responding correctly to driver inputs.

If values do not agree, VSES activates the appropriate wheel brake or brakes via the ABS system to bring the vehicle's path closer to the driver's commanded direction.
VSES is currently found on nine vehicles. However, there are system variations that exist.

This is the end of Module 1. It contains an overview of six electronic suspension systems used by GM. The six, in order from least to most complex are:

- Selectable Ride
- Automatic Level Control
- Air Suspension
- Computer Command Ride
- Real Time Damping or Road Sensing Suspension, and
- Vehicle Stability Enhancement System

If you need to review, do so before taking the section test.
Section 1 Test

1. Which of the following is the least complex electronic suspension system?
   A. Vehicle Stability Enhancement System
   B. Air suspension
   C. Selectable Ride
   D. Automatic Level Control

2. Automatic Level Control maintains
   A. Negative rear trim height only
   B. Front trim height only
   C. Rear trim height only
   D. Positive front trim height only

3. What vehicles are equipped with Air Suspension?
   A. 2002 Bravada and option on 2002 GMC Envoy
   B. 2002 Escalade and option on 2002 Bravada
   C. 2002 Bonneville and 2002 Bravada
   D. 2002 Escalade and 2002 Bravada

4. The _____ and _____ suspension systems are found on a ___ model year Bonneville.
   A. C.C.R., V.S.E.S., 2002
   B. C.C.R., A.I.C., 1999
   C. A.L.C., V.S.E.S., 1999

5. Which of the following vehicles with Real Time Damping or Road Sensing Suspension also incorporates rear leveling functions?
   A. Bravada
   B. 1500 C Truck with ABS
   C. Corvette
   D. Tahoe
Section 2: Suspension Systems Component Overview

Lesson 1: Sensors

There are five different sensors found on the electronic suspension systems covered in module one.

Suspension Position Sensor

Depending on the vehicle you service, the Suspension Position Sensor may be called by a different name. It can be called:

• An Automatic Level Control Sensor
• An Electronic Suspension Position Sensor
• A Position Sensor, or
• An Air Suspension Sensor

Even though it has different names, its function doesn't change. The sensor is responsible for providing control module feedback regarding the relative position and movement of suspension components.

The common mounting location is between the vehicle body and the suspension control arm. This varies with the number of sensors found on the vehicle. Vehicles can have between one and four of these sensors, depending on the system you are servicing.

Always refer to service information for actual mounting locations for the vehicle you are servicing.
The sensor is found in the systems shown in the graphic.

The sensor or sensors may provide individual wheel position or axle position information to the control module.

The operation of the sensor is either an air suspension sensor two-wire type or a potentiometer three-wire type. The Air Suspension Sensor is also known as a linear hall effect sensor.

The air suspension sensor operation consists of a moveable iron core linked to the components. As the core moves, it varies the inductance of the internal sensor coil relative to suspension position.

The suspension control module energizes and de-energizes the coil approximately 20 times a second, thereby measuring sensor inductance as it relates to suspension position.

The potentiometer three-wire, requires reference and ground voltage. It produces a variable analog voltage signal.

As suspension components move up or down, they move a corresponding arm on the suspension position sensor through a ball and cup link. Suspension position sensor voltage changes relative to this movement.

The sensor receives a 5-volt reference signal from the control module. The position sensor returns a voltage signal between 0 and 5 volts depending on suspension arm position.
Some useful diagnostic tips for you to be aware of are:

- Most suspension systems using a sensor will display the actual voltage on a Tech 2.

- Some systems may require sensor learning or "reprogramming" after replacement. For instance, you would reprogram the sensor for the Tahoe or Suburban, while on a Chevrolet Venture you wouldn't have to.

- If you experience an intermittent concern with the suspension position sensor, watch the voltage of the sensor while examining the harness to detect where your drop offs occur.

- And finally, there are DTCs for this sensor, which can be found in service information.

**Check up:**

1. Which systems will have only ONE suspension position sensor?
   - A. SR
   - B. RTD
   - C. ALC
   - D. AS

2. A three-wire potentiometer-type suspension sensor requires the following circuits:
   - A. Ignition power and data
   - B. Reference ground and signal
   - C. Reference power and data
   - D. Ignition ground and signal
Steering Wheel Position Sensor

Depending on the vehicle, the Steering Wheel Position Sensor may also be called a hand-wheel position sensor.

The function of this sensor is to provide the control module with signals relating to steering wheel position, the speed and direction of hand-wheel position.

The sensor is found on most RTD and RSS applications. It's typically located at the base of the steering column. Always refer to service information for vehicle specific information.

The hand-wheel sensor produces two digital signals, Phase A and Phase B, which are used by the Electronic Brake Control Module (EBCM). These signals are produced as the steering wheel is rotated.

The sensor can also produce more than two signals. For example, on the Cadillac Escalade it produces one analog and three digital signals.
As you can see in the schematic, the analog signal is a standard power to ground circuit. The sensor uses a 5-volt signal reference. Analog signal voltage values increase or decrease, between 0-5 volts, as the steering wheel is moved left and right of center. The digital signal is also a standard power to ground circuit as shown in the schematic.

There are three possible digital signals: Phase A, Phase B and an Index pulse, which provide the suspension control module with steering wheel speed and direction. Digital signals are either high or low, 5 volts or 0 volts.

The Tech 2 provides DTC faults for this sensor. If you are working on an intermittent concern with a steering wheel position sensor, activate your Tech 2 snapshot and slowly turn the steering wheel lock to lock. After the snapshot is complete, review and plot the analog sensor voltage and see if you have any signal drop out. This drop out is a clue in diagnosing intermittent concerns.

**Check up:**

1. A hand-wheel position sensor produces ______________ signals.
   
   A. Both digital and analog
   B. Digital and PWM
   C. Only analog
   D. Only digital
Pressure Sensor

The pressure sensor's main function is to provide feedback regarding the compressor's operation to the suspension control module.

The sensor assures both that a minimum air pressure is maintained in the system and that a maximum value is not exceeded.

A pressure transducer (sensor) is typically mounted on the compressor assembly as shown in the graphic.

This sensor is typically found on systems like Air Suspension, Real Time Damping, and Road Sensing Suspension that use a compressor assembly.

Although most of these systems use a pressure sensor, the sensors are NOT interchangeable because operating ranges differ between each application. Always use the correct sensor for the application you are servicing.

The operation of the pressure sensor requires a 5-volt reference, a ground and a signal wire to provide feedback to the control module.

The voltage output on the signal wire will vary from 0-5 volts based upon pressure in the system. As you would expect, high voltage indicates high pressure and low voltage, low pressure.

As you work on this type of a sensor, it's worthy to note that the suspension control module may set various DTCs relating to the operation of the pressure sensor.

Check up:

1. The pressure sensor provides ________________ to the suspension control module.
   A. Feedback regarding compressor operation
   B. Rear air shock position information
   C. Air compressor duty cycle data
   D. Rear suspension air height position
**Lateral Accelerometer Sensor**

The lateral accelerometer sensor's main function is to provide the suspension control module with feedback regarding vehicle cornering forces. For example, when a vehicle enters a turn, the sensor provides information as to how hard the vehicle is cornering. This information is processed by the suspension control module to provide appropriate damping on the inboard and outboard dampers during cornering events.

You'll find the lateral accelerometer sensor on the more complex systems, such as RTD and RSS systems that incorporate the VSES system.

This sensor can be either a stand-alone unit or combined with the Yaw Rate Sensor.

Typically, the sensor is mounted in the passenger compartment under a front seat, center console, or package shelf.

The sensor produces a voltage signal of 0 to 5 volts as the vehicle maneuvers left or right through a curve. The signal is an input to the EBCM.

As already noted, the lateral accelerometer input to the EBCM indicates how hard the vehicle is cornering. For example, with 0 lateral acceleration, the sensor input is 2.5 volts.

Some important diagnostics tips for working on the lateral accelerometer that you should be aware of are:

- No change or they drop off, a potential concern is indicated. There are DTCs associated with lateral accelerometer circuits. Check service information for specific codes that can be set.
- Also, while driving the vehicle, voltage values should increase or decrease during cornering events. These changes indicate proper operation.
Yaw Rate Sensor

The Yaw Rate Sensor provides information to the suspension control module and the EBCM. This information is used to determine how far the vehicle has deviated from the driver's intended direction.

You'll find the yaw rate sensor on more complex systems, such as RTD or RSS that incorporate the VSES system.

This sensor, as shown, can be either a stand-alone unit or combined with the lateral accelerometer sensor.

Typically, the sensor is mounted in the passenger compartment under the front seat or center console.

In the example shown, the sensor is located on the rear package shelf.

The sensor produces a voltage signal of 0 to 5 volts as the vehicle yaw rate changes. The voltage signal is an input to the EBCM.

As already noted, the yaw rate input to the EBCM indicates the number of degrees that the vehicle deviates from its intended direction.

For example, with a 0 degree yaw rate, the sensor output is 2.5 volts. During an emergency maneuver, the signal will vary above or below 2.5 volts.

This sensor does set DTC codes. These codes can be found in service information. Some yaw rate diagnostic tips are:

- If you are working on an intermittent concern, it's a good idea to monitor the yaw rate voltage on the Tech 2 while checking the harness.
- A voltage change may indicate a wiring malfunction.

Check up:

1. Under emergency maneuvers, the yaw rate signal will:
   A. Vary above or below 2.5 volts
   B. Decrease under acceleration
   C. Increase under acceleration
   D. Activate service VSES indicator
Lesson 2: Selector switch

The Driver Select Switch is a two or three mode switch. It is part of the shift select switch and is usually located at the center console. The switch is an input to the suspension control module.

With two modes a driver can select Touring or Performance ride. These modes are also known as a soft or firm ride.

This switch is found on the Selectable Ride and the Computer Command Ride systems.

Even though the function remains the same, switch configuration will change from vehicle to vehicle. Some configurations, like the Bonneville CCR system, provide an LED indicator that shows current system mode.

The CK Selectable Ride system also uses an indicator to show which mode the driver has selected performance ride, it completes a path to ground for its related circuit on the CCR module. The CCR module monitors the switch inputs for control of the strut actuator damping modes.

The Bonneville CCR uses two momentary switches and, when depressed, ground is applied to the suspension control module. The module activates the corresponding indicator along with the damping function.

The CK switch for Selectable Ride does not provide a signal to a module but is a latched switch that directly controls the damper solenoids. When depressed, it provides and maintains power to the dampers until it is depressed again and de-energizes the solenoids.

When you are servicing this switch, remember that the suspension control module can set DTCs relating to the function of the mode select switch.

The mode select switch status is generally provided on the Tech 2. Note that on the SR system, switch functionality is not monitored, but symptom charts found in service information provide diagnostics related to switch malfunctions. Also, on some models, the Tech 2 can provide feedback relating to switch operation.

The three position switch is used only on the Corvette RTD system. It allows the driver to have three modes of operation:

- Tour
- Sport, and
- Performance
Unlike the two position switch which is a momentary latched switch, the three position switch is a rotary switch. Voltages for this switch are determined by switch position and corresponding resistors.

When servicing a three mode switch remember that the suspension control module may set DTCs if a malfunction is detected with a mode switch.

Also, using your Tech 2 data screen you can confirm proper switch operation. To do this, make sure you are connected and in the data screen, then operate the switch and monitor the corresponding feedback on the screen. Always make sure you are using the most current service information available.

Check up:

1. Which of the following will have a three-position mode switch?
   A. Bonneville with CCR
   B. Corvette with RTD
   C. C/k truck SR
   D. Escalade with RTD/VES
Lesson 3: Bi-state and Tri-state Damper

The bi-state damper is also known as a solenoid controlled damper. Bi-state dampers are found on the RTD, RSS, and SR systems.

Each of the suspension dampers used in these systems have an integral solenoid. The solenoid valve provides various amounts of damping by directing hydraulic damping fluid in the suspension shock absorber or strut.

The Pulse Width Modulation (PWM) voltage signal from the suspension control module controls the amount of current flow through each of the damper solenoids.

With a low PWM signal de-energized, more hydraulic damping fluid is allowed to bypass the main suspension damper passage, resulting in a softer damping mode.

As the PWM signal increases, or is energized, the damping mode becomes more firm.

When servicing a damper, please note that if the suspension module does not control the shock absorber solenoid, a full soft damping mode results.
In fact, in some system malfunctions, the module may command one or all of the damper solenoids to a full soft damping.

As the PWM signal increases, or is energized, the damping mode becomes more firm.

When servicing a damper, please note that if the suspension module does not control the shock absorber solenoid, a full soft damping mode results. In fact, in some system malfunctions, the module may command one or all of the damper solenoids to a full soft damping.

The main difference between a tri-state damper and a bi-state damper is that the tri-state uses an electrical actuator while the bi-state is solenoid controlled.
A tri-state (actuator controlled damper) is currently used only on the CCR system. There are three damping modes:

- Comfort
- Normal, and
- Sport

A tri-state damper has an integral electrical strut actuator that rotates a selector valve to change the flow of hydraulic damping fluid.

The CCR module controls the operation of the strut actuators to provide the three damping modes.

The strut position input provides feedback to the CCR module. The strut position input is compared to the commanded actuator position to monitor system operation.

As part of your system diagnostics, the strut actuators are cycled by grounding DLC pin three, which is the diagnostic enable.

**Check up:**

1. Solenoid controlled bi-state dampers are in _________ mode when
   
   A. Firm, shorted
   B. Firm, de-energized
   C. Soft, energized
   D. Soft, de-energized
Lesson 4: The compressor assembly

Inflator Switch:

Vehicles that have an air inflator system as part of the ALC system also have an air inflator switch.

The air inflator switch is an input to the ALC and Air Suspension system. The driver uses this switch as the control for initiating the air inflator system operation.

This switch is found on the:

- Chevrolet Venture
- GMC Envoy
- Pontiac Montana
- 1999 and earlier Bonnevilles, and the
- Oldsmobile Silhouette and Bravada

The inflator switch provides a signal to the ALC or AS module to initiate compressor activation.

With the ignition on, the driver can turn the system to ON. By doing so, the switch will command the compressor to run for up to ten minutes, giving the driver time to inflate a tire or other items requiring air.

When servicing the switch, remember there are no DTCs associated with this component.
**Inflator or Compressor Relay:**

The second component within the compressor assembly is the Inflator or Compressor Relay.

This relay is responsible for controlling the compressor motor.

The suspension control module energizes the relay to activate the compressor motor. This adjusts the rear trim height as needed.

Some vehicles also incorporate an accessory air inflator. This function is activated by a driver controlled accessory air inflator switch.

The inflator switch is an input to the suspension control module and commands the compressor to energize and the inflator solenoid valve to divert compressed air to the inflator valve.

The suspension control module controls the compressor relay for normal operation or for the accessory air inflator.

To avoid compressor overheating, the timer within the suspension control module limits the compressor run time to 10 minutes.

When you are servicing a compressor relay, you should be aware that Tech 2 data, may not be available for this relay.

However, on RTD or RSS systems with a compressor; the Tech 2 may display DTCs associated with compressor relay operation.

In these instances, the Tech 2 will display data relating to relay operation and can be used to command the relay to verify proper operation.
Compressor/Air-Dryer

The inflator switch energizes the inflator compressor relay and which in turn energizes the compressor.

The compressor is a positive displacement air pump. It can generate up to 150 lbs. of pressure per square inch.

The compressor is found on the ALC, AS, RTD, and RSS systems.

On vehicles like the Chevrolet Venture, Pontiac Montana, or Oldsmobile Silhouette, the typical pump location is a 12 volt permanent magnet motor drives the compressor. The compressor supplies compressed air to the rear air shock absorbers or struts to raise the vehicle.

When servicing the compressor you should note that improper operation of the exhaust solenoid can cause the compressor to fail. Typically, the compressor is a replace only component. Please refer to service information for the most current information for the vehicle you are working on.

Air Dryer:

Within the compressor is an air dryer. The air dryer is responsible for removing moisture from the compressor system. Improper air dryer operation can cause a premature failure in the system if an air line restriction occurs due to excessive moisture build up.

Check up:

1. The accessory air inflator switch will:
   A. Directly control the compressor motor
   B. Command suspension control module to energize the compressor
   C. Command compressor motor to adjust rear trim height only
   D. Operate compressor for 30 minutes
**Exhaust Solenoid:**

While the compressor is responsible for building pressure in the compressor system, the exhaust solenoid is responsible for relieving it. The solenoid is physically located on the compressor. The ground side switched exhaust solenoid has three main functions.

- First, it releases compressed air from the shock absorbers or air springs to lower the vehicle body.
- Secondly, it relieves compressor head pressure. By exhausting air, it prevents compressor start up against high head pressure, which can possibly cause fuse failure.

And finally, the solenoid acts as a pressure relief valve, which limits overall system pressure. When servicing an exhaust solenoid, you should be aware that on RTD or RSS systems the control module can set DTCs related to the solenoid. The special functions on the Tech 2 can be used to command the solenoid and verify its operation.

**Check up:**

1. The exhaust solenoid will:
   - A. Create compressor head pressure
   - B. Release compressor air from shock absorbers
   - C. Always be energized
   - D. Energize during accessory air inflation operation
Lesson 5: Control Module Inputs, outputs, programming

Inputs:
The suspension control module requires many inputs. These inputs are delivered to the module either directly, indirectly or through the class two serial data line.

Input signals are delivered via different paths because they are shared by different control modules. As you can see by the list on the screen, there are several input signals.
Direct inputs are received from sensors wired directly to the control module.

For example, the suspension position sensor is considered a direct input because the signal from the sensor does not go through any other module prior to the suspension control module.

Indirect inputs are provided to the suspension control module after being processed by a different control module.

An example of this is the Hand-wheel Position Sensor (HWPS). The HWPS is wired directly to the EBCM on some models.

The EBCM processes the HWPS signal and sends the hand-wheel position information on a dedicated wire to the suspension control module shown in the schematic.

Information received via a Class 2 data line is similar in nature to indirect inputs.
For example, the vehicle speed sensor (VSS) is a direct input to the PCM. The PCM processes the speed signal and sends this information via the class two line for other modules, like the EBCM. This is shown in the schematic.

Outputs:
Outputs from the control module are sent either directly or via the Class 2 data circuit.

As you can see, there are several output signals.

Direct outputs, such as the damper, are controlled through the power or ground side of the circuit.

This An example of a Class 2 serial data output is the IPC warning lamps, which are used for the suspension system.
When a failure is detected within the suspension system, the electronic suspension control module will send a Class 2 serial data message to the IPC requesting mode lamp illumination. The schematic shows this relationship. Circuit is wired directly to the suspension control module as shown by the schematic.

Check Up:

1. Control module outputs can be:
   A. Lift/Dive signal actuators and tech 2 data
   B. Actuators, dampers and mode indicators
   C. Lift/Dive signal, tech 2 data and dampers
   D. VSS, actuators and tech 2 data
Programming:

Because each vehicle has a unique set of data values, you will most likely have to perform a reprogram or relearn function to orient a new module to the vehicle. This includes the desired personalization settings of the vehicle’s owner.

Some examples of after-module replacement reprogramming are found in the RSS, RTD, and ALC systems. For example, the ALC system may have a rear integration module.

Take a look at the reprogramming procedure for a Rear Integration Module (RIM) on a 2001 Bonneville.

• After replacing the module you would perform a recalibration of the ALC.

• After connecting the Tech 2 to the data link connector, turn the ignition ON with the engine OFF.

• Under Chassis Main Menu, select Rear Integration module.

• Then select recalibration.

Follow the screen prompts to completion.

Before performing the relearn or reprogram procedure, make sure your Tech 2 has been updated with the most recent software. Also, remember to record the owner’s personalization settings, if they are available, prior to removing the original module. Refer to body control module programming or the RPO configuration in service information to record the personalization settings.
Lesson 6: Operational Examples

Automatic Level Control
When trim height falls due to vehicle loading, the ALC control module energizes the compressor relay based on data from the rear suspension position sensor.

The compressor provides additional compressed air to the air shocks and raises the rear of the vehicle accordingly.

When vehicle trim height is too high due to vehicle unloading, the ALC control module energizes the exhaust solenoid based on data from the rear suspension position sensor.

The exhaust solenoid releases compressed air until the vehicle trim height is at the desired position.

Vehicle Stability Enhancement System
While driving a vehicle not equipped with VSES, emergency maneuvers may result in a loss of vehicle control due to under or over steer conditions.

While driving a vehicle with VSES, the EBCM and Suspension Control Module constantly monitor all road and driver inputs to determine if VSES requires activation due to an emergency maneuver.

When the driver initiates an emergency maneuver and provides rapid steering input to avoid an obstacle, the EBCM and Suspension Control Module react accordingly. The EBCM commands the IPC to illuminate the VSES active indicator.

The four dampers on all corners are energized to the Firm setting. In this example, the EBCM also activates the Left Front wheel brake to help the vehicle maneuver to the left as desired by the driver.

As the driver continues to maneuver the vehicle and turns it back to the right, the EBCM and Suspension Control Module continue to react. The four dampers on all corners remain in the Firm setting.

The EBCM now activates the Right Front brakes to help the vehicle maneuver in the driver's desired direction. Once VSES activation is no longer required, the EBCM will command the IPC to de-activate the VSES active indicator and resumes normal operation by constantly monitoring all road and driver inputs.
Section 2 Test

1. The air suspension sensor's function is to provide _______ of the suspension components.
   A. Control
   B. Data
   C. Feedback
   D. Input

2. The two mode switch is an _____ to the suspension control module and is_____ by the driver.
   A. Output not, controlled
   B. Output, controlled
   C. Input not, controlled
   D. Input, controlled

3. A bi-state damper is ________ while a tri-state damper uses ____________.
   A. Solenoid controlled, an electrical actuator
   B. Electrically actuated, solenoid controlled
   C. Pulse width modulated, solenoid controlled
   D. Solenoid controlled, pulse width modulated

4. The compressor is a ________ pump and can generate up to ________ psi.
   A. Positive displacement, 150
   B. Vacuum, 150
   C. Positive displacement, 300
   D. Vacuum, 300

5. Direct inputs are:
   A. Only found in ALC and RTD systems
   B. Wired directly from sensor to control module
   C. Wired through several control modules
   D. Only found in RSS and RTD systems
Section 3: Tire Pressure Monitoring System

Lesson 1: Tire Pressure Monitoring System

TIMS can be found on several different vehicle platforms. TIMS is either an ABS or transmitter based system, depending on the application.

A TIMS system, whether ABS or transmitter based, is primarily an added safety feature for the driver.

TIMS aids driver awareness in keeping proper tire inflation by notifying the driver if a tire's pressure falls out of a predetermined range.

ABS-based TIMS is found on the Buick LeSabre, Park Avenue, and Regal.

It is also on the Chevrolet Impala and Monte Carlo, on the Oldsmobile Alero, and Aurora, and on the Pontiac Grand Am and Grand Prix.

Transmitter-based TIMS is found on the Cadillac DeVille, and Seville, as well as the Chevrolet Corvette.

In an ABS-based system the EBCM controls the function of the system by monitoring input signals from a sensor located at each wheel assembly and from a reset switch, as well as data sent via the Class 2 serial data line.

The EBCM provides output control by sending data messages to the Instrument Panel Cluster (IPC) to alert the driver of any malfunction conditions.

In a transmitter-based system, wheel speed activated sensors are internally mounted to each tire assembly.

These sensors produce a radio frequency signal related to the amount of pressure in the tire or wheel assembly.

Check up:

1. An ABS based TIMS is found on the:
   A. Regal, Seville, Bonneville
   B. Regal, Impala, Grand Am
   C. Seville, Aurora, Grand Am
   D. Corvette, Aurora, Monte Carlo
Lesson 2: TIMS System Components

This lesson has six topics.

- The first 3 topics, ABS Wheel Speed Sensors, ABS Computer, and Reset Switch examine TIMS components found on ABS systems.
- Topics 4 and 5, Tire Pressure Transmitters and Tire Pressure Receiver, cover TIMS components found on transmitter based systems.
- Topic 6, Driver Information Center and IPC, explains both ABS and transmitter based style displays.

**ABS Wheel Speed Sensors:**

There are four wheel speed sensors used in an ABS based system. Each sensor produces an AC voltage signal. The voltage signal has a frequency proportional to the speed of the wheel. These signals are inputs to the EBCM.

You will find these sensors on the Buick LeSabre, Park Avenue, and Regal, as well as on the Chevrolet Impala and Monte Carlo, the Oldsmobile Alero and Aurora, and on the Pontiac Grand Am and Grand Prix.

Wheel speed sensor voltage is produced as a toothed ring rotates past the wheel speed sensor. A tire with lower inflation has a smaller diameter and will rotate at a faster speed.

The toothed ring and the sensor are not repairable. Service of wheel speed sensors may require a replacement of a complete hub or bearing assembly.

If you are servicing a vehicle that has recently had a tire replaced, it is possible that the sensor is reporting a different value than the other three tires. If this occurs, you should ensure a proper reset of the system was performed.
Wheel speed sensors are either integral or discreet.
Integral means the sensor is an integrated part of the wheel bearing and hub assembly.
Discreet means the sensor is mounted separately from the bearing hub assembly and can be replaced as an individual component.
When servicing a sensor, remember that the EBCM monitors a sensor’s AC frequency, not its voltage. A variance in tire size will either increase or decrease measured speed.

Always ensure replacement tires are of the same brand, type and size.
The EBCM will set various DTCs for each wheel speed sensor. If it detects a fault with a wheel speed sensor, it will set a DTC, and tire pressure monitoring will be disabled.
The driver may have a flat tire but not have an illuminated low tire indicator.
Using your Tech 2, individual wheel speeds can be monitored on the data screen.

Check up:
1. Which is true about a sensor mounted separately from the bearing hub assembly?
   A. It is an integral sensor
   B. It is a discrete sensor
   C. It cannot be replaced as an individual component
   D. It is part of the axle shaft assembly
Lesson 3: ABS Computer

The Electronic Brake Control Module’s primary function is to oversee the ABS traction control operation.

A transmitter-based application may have an EBCM too, but it does not require its use for tire monitoring operations. The EBCM receives wheel speed input from each of the four wheel speed sensors. Once the vehicle travels at least eight miles, the EBCM compares input from the wheel speed sensors to determine if a low or high tire pressure condition exists.

Be careful when you rotate tires or replace tires, as wheel speed signals may change because of a change from the prior learned values.

When the EBCM determines that all tires have air pressure within 10-12 lbs per square inch psi of the other tires, it sends the IPC a data message that requests the LOW TIRE lamp to be OFF.

When the EBCM determines that at least one tire has air pressure that is 10-12 psi lower or higher than the other tires, it sends the IPC a data message that requests the LOW TIRE lamp to be ON.
In some vehicles, the EBCM stores a related DTC when this occurs.

- Before verifying correct operation for the tire inflation monitoring function, first check tire pressure.
- Check the tire inflation monitoring function, follow the service information chart for Diagnostic System Check Tire Inflation Monitoring. This checks the ability of the EBCM and the Body Control Module (BCM) to communicate with a Tech 2 and with other electronic control modules in the vehicle. You can also view any stored DTCs.
- The EBCM will request the IPC to turn ON the LOW TIRE lamp if a DTC related to tire inflation is stored.
- The chart shown was current at the time of publication. Always refer to current service information for the vehicle you are servicing.

### Check up:

1. The EBCM compares wheel speed sensor input after __________ miles.
   - A. 4
   - B. 8
   - C. 6
   - D. 10
Lesson 4: Reset Switch

Vehicles with the tire inflation monitoring function are equipped with a TIM reset switch. Typically, the switch is housed in the under-hood junction block; however, the switch's location is unique to each vehicle, so you'll need to refer to service information for its exact location.

The switch provides the Body Control Module (BCM) with a signal requesting that the EBCM begin to auto-learn the tire pressures at each of the four wheels again.

A TIMS reset is necessary when tires are rotated or one or more tires are replaced. The BCM sends data messages to the EBCM through a Class 2 data circuit.

The reset switch connects to the BCM with a signal circuit and with a ground connection through the vehicle chassis to the BCM ground circuit. Pressing the switch button causes the switch contacts to close momentarily.

You can view the signal of the reset switch with a Tech 2. During diagnosis, you can check the switch contact resistance and switch circuit voltages.

As a part of routine maintenance, the reset switch must be pressed after the tire pressures have been changed or when the tires are rotated.

If you do not perform this activity, the TIMS function may falsely detect a tire inflation fault and illuminate the LOW TIRE lamp.

Check up:

1. A TIMS reset switch is usually mounted in the ____________________.
   A. Base of the steering column
   B. Center console
   C. Under-hood junction block
   D. Glove box
Lesson 5: Tire Pressure Transmitters

The tire pressure transmitter is also called a tire pressure monitor sensor. A sensor is mounted to the tire wheel assembly in place of a traditional valve stem.

The tire pressure monitor sensor produces a radio frequency signal related to the amount of pressure in the wheel or tire assembly.

An internal battery powers the sensor. This battery typically has a life span of eight years and is not serviced separately. If a battery fails, the entire transmitter assembly must be replaced.

Each tire pressure monitor sensor has a unique identification code that allows the system to identify the specific location such as left front, right front, left rear or right rear.

As the vehicle begins to move, a roll switch in the tire pressure monitor sensor activates the sensor at 10-15 mph.

Once the sensor is activated, it sends tire pressure information within the range of 0-60 psi to the remote control door lock receiver. If the vehicle is stationary for more than one minute, the sensor will power down to minimize battery usage.

Because the tire pressure monitor sensors are integral to the tire wheel assembly, a change in tire location due to a tire rotation could result in improper reporting of tire inflation pressures.
Lesson 6: Tire Pressure Receiver

The tire pressure monitor is an operation of the remote control door lock receiver. The receiver receives input signals from the tire pressure monitor sensors.

As the collage shows, transmitter based TIMS applications are typically found on those vehicles using run flat tires.

The remote control door lock receiver processes the signals and sends the information on a Class 2 serial data line to the instrument panel cluster.

To compensate for changes in altitude, the remote control door lock receiver requests barometric pressure from the Power-train Control Module (PCM) when the ignition is first turned on.

If the receiver does not get barometric pressure information, it will substitute a default value and no altitude compensation will occur.

The receiver has self-diagnostic capabilities and will store DTCs related to system malfunctions.
Use the Tech 2 to view and clear both current and history code DTCs. On some models, you can also use the vehicle on-board diagnostics, which is accessed through the driver information center.

When replacing tires on vehicles equipped with transmitter-based systems, it is extremely important that you use the same tire model as the original.

Replacement tires that have a steel belt configuration different from the original equipment tire can cause interference with reception of the sensor signal.

Use your J41760 programming tool while watching the IPC messages to confirm transmitter operation.

One final note of caution: Any time that the remote control door lock receiver is replaced, the tire pressure monitor programming procedure must be performed.

The tire pressure monitor programming procedure allows the remote control door lock receiver to learn the unique tire pressure monitor sensor identification codes.

Always refer to service information, as shown in the graphic, for the vehicle that you are servicing.

Check up:

1. The remote control door lock receiver request barometric pressure from the _______.
   A. EBCM
   B. VCM
   C. PCM
   D. EBTCM

2. Any time that the remote control door lock receiver is replaced, the _____ procedure must be performed.
   A. tire pressure monitoring programming
   B. PCM relearn
   C. Barometric reset
   D. EBCM release
Lesson 7: Driver Information Center

There are two types of driver information center readouts found in GM vehicles.

- The instrument cluster either uses a LOW TIRE pressure indicator, or
- The IPC message center to display a CHECK TIRE PRESSURE warning to the driver

On the Buick Park Avenue, an ABS based TIMS system based vehicle, the Driver Information Center (DIC) displays TIRE PRESSURE LOW: CHECK TIRES on the instrument cluster.

Other vehicles, like the Pontiac Grand Am or Bonneville, will display an amber LOW TIRE pressure readout.

On the Chevrolet Corvette, a transmitter based TIMS system vehicle, the driver information center displays several messages.

Using the driver information center GAUGES button, the driver can display individual tire pressure information on the IPC. In addition, the IPC displays the following warning messages: HIGH or LOW TIRE PRESSURE as well as FLAT TIRE.

- When servicing the IPC or the DIC, if there are no tire pressure readings, verify that proper class two data operation exists.

Refer to service information for the vehicle you are servicing.
TIMS Operation

- ABS based operation, and
- Transmitter-based operation

2001 Buick Park Avenue ABS based TIMS Operation

With the vehicle moving, the wheel speed sensors provide an AC voltage signal to the EBCM. The voltage signal has a frequency proportional to the vehicle's speed.

After the vehicle travels at least 8 miles, the EBCM compares input data from the four wheel speed sensors.

The EBCM recognizes a low tire pressure when wheel speed indicates that one wheel has a pressure difference of at least 10-12 psi compared to the other three wheels.

Once a low tire pressure condition is recognized, the EBCM sends a message to the instrument cluster.

The instrument cluster illuminates the LOW TIRE PRESSURE indicator or displays the TIRE PRESSURE LOW: CHECK TIRES message.

The Buick, in our example, only displays the TIRE PRESSURE LOW CHECK TIRES message.

- After a repair, reset the LOW TIRE pressure indicator using the tire inflation reset switch.
- Clear the tire pressure low check tires message using the GAGES button on the IPC.

Operation Transmitter Based System

Chevrolet Corvette TIMS Operation

With the ignition on and no vehicle speed, the remote control door lock receiver requests barometric pressure information from the PCM to compensate tire pressure readings for differing altitudes.
Once the vehicle is moving and reaches speeds of 10-15 mph, the roll switch in each of the four tire pressure monitor sensors activates each sensor, allowing it to produce a radio frequency signal related to the amount of tire pressure.

The remote control door lock receiver processes the tire pressure signals it receives from the four tire pressure monitor sensors and sends the processed tire pressure information to the IPC on a Class 2 serial data line.
Based on the information received, the IPC displays the following messages from the remote control door lock receiver:

- LOW TIRE PRESSURE
- HIGH TIRE PRESSURE
- FLAT TIRE PRESSURE, or
- SERVICE TIRE WARN SYS

Or as shown by the graphic, it displays the actual tire pressures.

Each of these displays has a unique tire pressure signal range.

- The low tire display means that the signal is between 5-25 psi.
- The high tire display means that the signal is over 42 psi.
- The flat tire display means that the signal is under 5 psi.
- The service tire warn sys display means that no tire pressure signal was sent to the remote control door lock receiver from any of the sensors, or that no tire pressure messages were sent to the instrument cluster.

The IPC displays individual tire pressures when the DIC gauges button is pressed. The tire pressure monitor sensors power down if the vehicle is stationary for more than one minute.

Remember, the remote control door lock receiver stores DTCs related to tire pressure monitor system malfunctions.
Section 3 Test

1. ABS TIMS systems notify the driver when: _______________.
   A. Tire pressure falls out of a predetermined range
   B. Tire pressure is normal
   C. A tire rotation occurs
   D. An ABS event occurs

2. A tire with a _____ inflation has a ______ diameter and rotates at a ______ speed.
   A. Lower, smaller, faster
   B. Higher, smaller, slower
   C. Higher, larger, faster
   D. Lower, larger, slower

3. The tire pressure monitor sensor produces a ________.
   A. Digital signal
   B. Class two signal
   C. Radio frequency signal
   D. Pulse width modulation signal

4. When replacing tires on vehicles equipped with transmitter based systems, you should use __.
   A. The exact same tire model as original
   B. Only radial configured tires for better transmitter operation
   C. Any tire model the customer request
   D. Only steel belted tires for better transmitter operation

5. Wheel speed sensors produce __________.
   A. A pulse width modulated signal
   B. A phase B signal
   C. An analog signal
   D. An AC voltage signal
Section 4: Diagnostic Exercises

Strategy Based Diagnostics (SBD) provides an organized thought process and guidance as you create a plan of action for each specific diagnostic situation. By following a similar plan for each diagnostic situation, you will achieve maximum efficiency at vehicle diagnosis and repair.

Although each SBD step is numbered, you are not required to use every step to successfully diagnose a customer concern. The two exercise simulations in this module represent a possible path for diagnosis and repair. They are not intended to be the only way to diagnose Module 4 has two diagnostic lessons in it. There is no module test.

Lesson 1: Suspension Based Diagnostics

You have been given a work order and the keys to a 2001 Tahoe.

- Take a moment to review these options.
- Please note that not all of them will be used at this time.
- Begin the exercise by determining the first three steps you’d make.
- Write your answers below.

Options:
- a. Grab Tech 2
- b. Check SI 2000
- c. Call TAC
- d. Replace parts
- e. Read Work Order
- f. Grab a snack

Correct Order:
1. ______
2. ______
3. ______
As you approach the vehicle, you notice that it is sitting normally. It is not leaning to the left or right, and there are no fluids puddling under the truck.

- Take a moment to read your choices.
- Given these options, write below in the order you think is correct.

**Options:**

a. Drive vehicle  

b. Check DTC’s  

c. Start vehicle  

d. Visual preliminary checks related to Work Order

**Correct Order:**

1. ________  

2. ________  

3. ________  

4. ________
As directed by service information, you are conducting a road-test. Using your Tech 2 in snapshot mode, you take some different screen shots.

- Review each type of road test, and watch the data on your Tech 2 screen.
- Pay attention to any variations in the sensor voltages.

So far we have verified the customer concern, performed our quick checks and we're in the process of completing the diagnostic system checks.

- Based on the choices given, write your answers below in the best possible order.

**Options:**

a. Finish diagnostic circuit Check
b. Replace R/F sensor
c. Perform DTC chart for code C0620
d. Check Bulletins/PI

**Correct Order:**

1. _______
2. _______
3. _______
We didn't find any bulletins per our check.
At this time you've completed the diagnostic system check, which led you to the DTC chart.
The chart shown is an overview of the circuit malfunction criteria.
Take a moment to review the rest of the chart before answering the question.

**DTC Chart**

**Conditions for running the DTC**
- Under normal driving conditions
- Vehicle speed greater than 0 Km/h (0 mph)

**Conditions for setting the code**
- The ESC module senses a position sensor signal voltage below 0.5 volts or above 4.5 volts.
- No bulletins found

**Question:**
Based on this chart, did we encounter circuit failure during the road trip?
Yes  No

The preliminary checks in the diagnostic chart are listed here for your review.
In our example, you already know that the signal voltage was outside the normal parameters, which should raise a flag in your diagnostics.

**Diagnostic Aids**

**Important:**
Before proceeding with the diagnosis do a visual inspection of the mechanical aspects of the suspension position sensor and its components. Ensure the suspension position sensor and the suspension position link is not bent, disconnected, or insulation on wires are not rubbed through or damaged in any way.

**Question:**
Following the DTC info, we'll do preliminary checks looking for:
- Pinched, chafed, or rubbed through wires
- Suspension position sensor link not bent
- Suspension position sensor link not disconnected
• Move the wiring harness in each of the three sections.
• While you do this, watch your Tech 2 screen and see if there are any voltage variances.
• After you find the voltage variance, move on.

<table>
<thead>
<tr>
<th>DATA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspension Control Select</td>
<td>2.0 Volts</td>
</tr>
<tr>
<td>Steering Position PWM</td>
<td>0.16 ms</td>
</tr>
<tr>
<td>Chassis Pitch Input Cha</td>
<td>No Cha</td>
</tr>
<tr>
<td>Chassis Pitch Input Sta</td>
<td>Inactive</td>
</tr>
<tr>
<td>Right Front Position Sen</td>
<td>0.00 Volts</td>
</tr>
<tr>
<td>Left Front Position Sen</td>
<td>2.52 Volts</td>
</tr>
<tr>
<td>Right Rear Position Sen</td>
<td>2.31 Volts</td>
</tr>
<tr>
<td>Left Rear Position Sen</td>
<td>2.31 Volts</td>
</tr>
<tr>
<td>Left Front Shock Level</td>
<td>0%</td>
</tr>
<tr>
<td>Suspension Control Select Sw</td>
<td>3 / 14</td>
</tr>
</tbody>
</table>

Test showed a variance in voltage on the right front sensor while moving the wires.

What is your best choice for repairing this type of malfunction?

Write your answer: _______________________________

Upon closer visual inspection, you find damaged wires. What is your best choice for repairing this type of malfunction?

a. replace the connector pigtail
b. replace the entire harness
c. splice and repair damaged wires

You have now completed the repair. But before you move on to the next job, you have a few tasks to complete.

• Write items on the lines below in the order you'd perform them.

   Answers:
   
   1. ______________________ a. Road test to confirm fix
   2. ______________________ b. Cashier returns keys to customer
   3. ______________________ c. Turn in paperwork
   4. ______________________ d. Confirm fix on hoist

   The best way to verify the repair is to take the vehicle out for another road test.

   Remember, a good rule of thumb is that any concern needing to be road tested to duplicate the condition, needs to be road tested to verify the repair.
Lesson 2: TIMS Based Diagnostics

You've been given a work order and the keys to a 2001 Monte Carlo.

- Take a moment to read the work order and your options. Note that not all of the options are used at this time.
- Given these options, begin the exercise by determining the first three steps you'd perform. Write your answers below.

Options:

a. Grab Tech 2/Tire pressure gauge
b. Check SI 2000
c. Call TAC
d. Replace parts

Correct Order:
1. _______
2. _______
3. _______

As you approach the vehicle, you notice that the left rear tire is new.

- Take a moment to review your choices.
- Given these options, write your answers below in the order you think is correct.

Options:

A. Check Tire pressures
B. Check DTC’s
C. Start Vehicle
D. Visual preliminary checks related to Work Order

Correct Order:
1. _______
2. _______
3. _______
4. _______
Continue your diagnosis by placing your next steps in the order that you’d perform them.

Always refer to current service information when servicing a vehicle. The service information for this exercise was accurate at the time of course publication.

Options:  

a. Finish diagnostic system check  
b. Check bulletins/PI  
c. Perform DTC chart - C1245

Correct Order:

1. _______
2. _______
3. _______

Use Service Information to print out all information related to the DTC chart.

• Be sure to read all of the DTC chart, as there will be questions relating to it on the next screen.

DTC C1245

Circuit Description
The tire pressure monitor (TPM) system, also known as, the tire inflation monitor (TIM) system uses the electronic brake control module (EBCM), wheel speed sensors, class 2 serial data messages, and instrument cluster in order to perform the system functions.

The EBCM contains the software to perform the system monitoring functions. The EBCM uses wheel speed data obtained from the wheel speed sensors to detect relative pressure differences. Any ABS/TCS system activity causes the EBCM to temporarily suspend the tire inflation monitor system functions.

Conditions for Running the DTC
The vehicle speed is between 24-145 km/h (15-90 mph).

Conditions for Setting the DTC
One of the following conditions occur:

• The EBCM detects a tire pressure difference of 69 kPa (10 psi).
• The EBCM sets a DTC C1254.
• Loss of battery positive voltage (B+) at the EBCM.
• A battery disconnect or a low battery voltage condition.

Actions Taken When the DTC Sets
The IPC/DIC displays the tire pressure indicator warning message.

Conditions for Clearing the DTC

• The condition for the DTC is no longer present (the DTC is not current) and you performed the tire inflation monitoring reset function.
• The condition for the DTC is no longer present (the DTC is not current) and you used the scan tool Clear DTC function.
• The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.
Diagnostic Aids
Any of the following conditions can cause this DTC.
- One or more of the vehicle's tires is under inflated
- One or more of the vehicle's tires is over inflated
- The tire pressures have been altered without resetting the TIM
- The tires have been rotated or changed without resetting the TIM
- The tires are different in size than the original equipment manufacturer's
- Rough or slippery road conditions (dirt, gravel, wet, snow, or ice)
- The tires are out of balance
- Loss of battery positive voltage (B+) at the EBCM
- A battery disconnect or a low battery voltage condition
- Water intrusion into a wheel speed sensor connector (test connectors using J 42675 Flat Wire Probe Adaptor Kit to avoid connector damage)
- A suspension condition (i.e. the vehicle is out of alignment)

Test Description
The number below refers to the step number on the diagnostic table.

5. This step inspects the tires for proper tire pressures.

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Did you perform the TPM Diagnostic System Check?</td>
<td>Go to Step 2</td>
<td>Go to Diagnostic System Check - Tire Pressure Monitoring</td>
</tr>
<tr>
<td>2</td>
<td>1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. With a scan tool, monitor the DTC Information for DTC C1245 in the DRP/ABS/TCS/TIM/VSES (if equipped) Diagnostic Trouble Codes (DTCs). Does the scan tool indicate that DTC C1245 is current?</td>
<td>Go to Step 3</td>
<td>Go to Diagnostic Aids</td>
</tr>
<tr>
<td>3</td>
<td>Since most occurrences of this DTC are caused by low tire pressure, review the TPM system with the customer to verify the conditions under which the DTC set. Did tire inflation cause this DTC to set?</td>
<td>Go to Step 5</td>
<td>Go to Step 4</td>
</tr>
<tr>
<td>4</td>
<td>1. Perform the tire inflation monitoring reset. Refer to Tire Pressure Monitor Reset Procedure. 2. Use the scan tool in order to clear the DTCs. 3. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text. Does the DTC reset as a current DTC?</td>
<td>Go to Diagnostic Aids</td>
<td>System OK</td>
</tr>
<tr>
<td>5</td>
<td>Inspect the tire pressures and adjust if needed. Perform the tire inflation monitoring reset if tire pressures were adjusted. Refer to Tire Pressure Monitor Reset Procedure. Did you complete the repair?</td>
<td>System OK</td>
<td>--</td>
</tr>
</tbody>
</table>
These four questions are related to the chart you just reviewed.

- For each question, check on the appropriate response to enter your answer.

Answers:

1. Do the tire pressures that you measured in prior steps reflect a failure condition as labeled in “Conditions” for setting the DTC?
   Yes No

2. Were any of the conditions listed in the Diagnostic Aids present on the vehicle?
   Yes No

3. By completing Step 4 of the chart, have you repaired or diagnosed the concern?
   Repaired Diagnosed

4. Is the vehicle now ready to be returned to the customer?
   Yes No

This question may appear obvious on the surface, but it is important for you to verify your repair.

Service information states that storing the code requires driving the vehicle above fifteen miles per hour. By driving the vehicle you ensure that the criteria for running the code have been met.

As a reminder, any condition that requires vehicle speed to set a concern will also need to be driven to verify the repair. This will help you fix it right the first time and avoid a potential come back.

In order to verify the repair, you should ________________.

a. Road test the vehicle
b. Road test the vehicle
c. Road test the vehicle
d. All of the above

This completes the diagnostic scenario.
Summary

In order to fix it right the first time, you need to follow a logical order, which strategy based diagnostics provides.

1. Follow a logical order – SBD
2. Use your resources
3. Verify concern is gone – Road Test

Use resources like service information, and always verify your repair.
Course Test

1. The Selectable Ride system uses _________________.
   A. One switch and four electronically controlled bi-state dampers
   B. Two switches and four electronically controlled bi-state dampers
   C. One switch and four electronically controlled tri-state dampers
   D. One switch and two rear electronically controlled bi-state dampers

2. VSES is the interaction between the_____ system and the_____ system to provide vehicle stability enhancement.
   A. Suspension, ABS
   B. Steering, ABS
   C. Power-train control, steering
   D. Power-train control, suspension

3. The lateral accelerometer sensor can be combined with the _____________.
   A. Handwheel position sensor
   B. MAP sensor
   C. Mode switch select
   D. Yaw rate sensor

4. The integral ___________ strut actuator rotates the selector valve inside a tri-state damper.
   A. Hydraulic
   B. Mechanical
   C. Gas assisted
   D. Electrical

5. Accessory air inflator operation is limited to ________ minutes.
   A. 14
   B. 10
   C. 8
   D. 12
6. The compressor provides compressed air to the ____________?
   A. Rear shocks or struts
   B. Solenoid controlled damper only
   C. Front shocks or struts
   D. Accessory air inflator only

7. All of the following are ways inputs are delivered to the suspension control module except:
   A. Ground path communications
   B. Indirectly
   C. Class two serial data
   D. Directly

8. When trim height falls due to vehicle loading, the ALC control module energizes the ____.
   A. Compressor relay
   B. Rear trim height actuator
   C. Rear suspension position sensor
   D. Air compressor clutch

9. VSES uses the____ and ___ control module to constantly monitor all road and driver inputs.
   A. BCM, damper
   B. EBCM, suspension
   C. EBCTM, steering
   D. PCM, handwheel position

10. In an ABS based Tire Inflation Monitoring System the __________ monitors inputs and sends serial data messages to the __________ to alert the driver.
    A. Suspension control module, IPC
    B. EBCM, IPC
    C. Tire inflation control module, heads up display
    D. EBCM, radio
11. Tire pressure monitor sensor information is transmitted to the _________.
   A. Electronic Brake Control Module
   B. Remote Control Doorlock Receiver
   C. Roll switch
   D. Powertrain Control Module

12. On a transmitter based TIMS application, which of the following messages are displayed on the DIC in addition to actual tire pressure?
   A. Underinflated and flat tire
   B. Low tire pressure and underinflated only
   C. High tire pressure and underinflated only
   D. High or low tire pressure and flat tire

13. In a transmitter based TIMS application, the roll switch is activated by vehicle speeds _________ 10 mph, which activates the _________.
   A. Under, pressure monitor sensors
   B. Over, pressure monitor sensors
   C. Under, remote control doorlock receiver
   D. Over, remote control doorlock receiver

14. Which of the following must be completed prior to performing a DTC diagnostic chart?
   A. Clear all DTC’s with tech 2
   B. Call TAC for assistance
   C. Verify cause isolation
   D. Diagnostic system check

15. After repairing any tire inflation monitoring system concern, which of the following must be completed to verify repair?
   A. Call TAC for assistance
   B. Refer to diagnostic aids in service information
   C. Perform road test
   D. Check for updated bulletins/PIs
Glossary

AIR ASSISTED DAMPER: A damper that incorporates an air bellows assembly that when pressurized with compressed air provides additional vehicle support to maintain proper vehicle leveling.

AIR SPRINGS: A air bellows assembly that by itself when pressurized with compressed air provides complete support for that segment of the vehicle in place of a traditional coil or leaf spring.

BI-STATE: A component that operates in two distinctly different states. For example, a bi-state damper has two distinctly different states of damping, ie soft an CONTROL MODULE: A self-contained electrical component designed as a single replaceable unit and consists of like or unlike parts including solid state components. It is designed for rapid replacement and must have a specific integral electrical function.

DAMPER: A suspension component that provides suspension movement damping. Also known as a shock absorber or strut.

DAMPING: The function of controlling and smoothing out sudden or abrupt movements or shocks to a component.

DISCRETE: The type of wheel speed sensors where the sensor and reluctor wheel are serviced separately.

DIVE: When the front of a vehicle drops suddenly due to rapid brake application or abrupt steering maneuvers.

DROP-OUT: When the signal from a sensor or other component intermittently falls to zero or close to zero volts indicating a malfunction.

GAS CHARGED DAMPER: A damper that incorporates a nitrogen gas charge that assists the vehicle's springs to support the vehicle mass.

INTEGRAL: The type of wheel speed sensors where the sensor and reluctor wheel are serviced as one assembly.

LATCHED: A type of switch that when depressed changes state to either on or off and remains that way until it is depressed again.

LED: Light Emitting Diode

MOMENTARY: A type of switch that when depressed changes state to either on or off and remains that way only as long as it remains depressed.

PITCH: A vehicle movement where the vehicle rolls from side to side during sudden or aggressive cornering maneuvers

PRESSURE TRANSDUCER: A component that produces a signal based on pressure at a location - e.g., Manifold Absolute Pressure sensor (MAP).

PWM: Pulse Width Modulation

RELUCTOR: A toothed iron ring that passes near a Vehicle Speed Sensor or a Wheel Speed Sensor to produce a signal relating to a rotating component
**ROTARY SWITCH**: A type of switch that is not depressed to activate or deactivate a component but is rotated instead to one of two or more positions.

**SR**: Selectable Ride

**SENSOR**: A device giving a signal for detection or measurement of a physical property. It is an "information" pick-up device that for a varying input will respond with a varying output.

**SOLENOID**: An electrical device consisting of a coil which produces a magnetic field and a plunger which is pulled to a central position in the coil when the coil is energized. A solenoid may be used as an actuator in a valve or switch.

**SWITCH**: A device which completes, interrupts, or changes the connections in one or more electrical circuits by manual or mechanical actuation, or as a result of changes in ambient temperature or pressure.

**TIMS**: Tire Inflation Monitoring System or Tire Inflation Monitoring Systems

**TRANSDUCTER**: A device that receives energy from one system and retransmits (transfers) it, often in a different form, to another system. For example, the cruise control transducer converts a vehicle speed signal to a modulated vacuum output to control a servo.

**TRIM HEIGHT**: A measurement on a vehicle that corresponds to the height of a vehicle and how high or low it sits from a desired position.

**TRI-STATE**: A component that operates in three distinctly different states. For example, a tri-state damper is a damper that has three distinct states of damping - i.e., touring, sport and performance.