Damage Analysis of Advanced Automotive Systems (DAM07e)

Textbook

I-CAR®

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DAM07-STMAN1-E

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Contents

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Module 1 - Driving Assist Safety Systems

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Blind Spot Detection Systems

The learning objectives for this module include identifying and understanding operations of:

- blind spot detection systems.
- cross traffic alert systems.
- parking assist.
- lane departure warning.
- attention assist.
- adaptive cruise control.
- pre-collision systems.
- Volvo City Safety.

Advancements in vehicle technologies are evident by looking at the instrument panels and center consoles on newer vehicles, such as on this Lexus LS 460.

Advancements in technology have impacted all areas of our lives. Nowhere is this more evident than in the vehicles we drive. Computer advancements have provided:

- collision warning systems.
- better safety systems.
- more comfort and convenience options.

This has increased the challenges of writing an accurate estimate. This course is designed to help an estimator identify vehicle options, provide an overview of how the options work, list the parts that make up the system, and identify potential damage analysis issues.

Understanding the operation of these systems benefits more than just insurance appraisers. In-shop estimators, repair technicians, and managers can all benefit from understanding advanced systems operation. Even if the repair is not being conducted at the repair facility, it is important to know how body repairs / structural repairs can affect advanced vehicle system operation.

Scan tools are generally required for performing diagnostics on advanced vehicle systems.

Due to the complexity of these systems, the trouble code provides the best direction for repairing electronic problems. Therefore, notice that throughout the course, many of the diagnostic recommendations require a scan tool to retrieve diagnostic trouble codes (DTCs). Depending on how the repair facility is equipped, this may require subletting a specific repair to a dealership or a properly equipped mechanical repair facility.

Even the most minor collisions can cause problems, typically through sensor misalignment. With more computerized systems, more sensors are attached to the vehicle to monitor driving conditions. Therefore, it is important to know what is behind each panel.

Also, test drives are more important now than in the past as they are used for diagnosis, troubleshooting, and helping avoid issues when the vehicle is released to the customer.

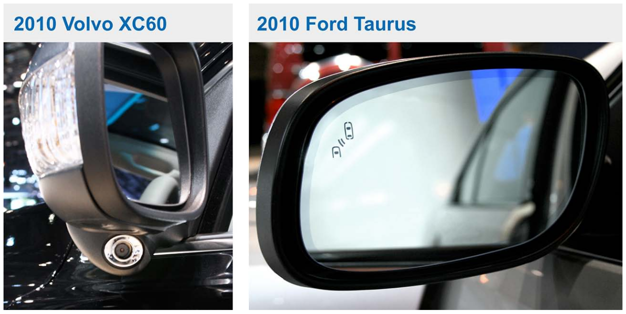
Owner's manuals are recommended for determining specific vehicle options.

To determine if a vehicle is equipped with a specific feature:

- enter the VIN into an estimating system or call a dealership, if practical.
- reference the owner's manual.
- use aftermarket publications. Hunter makes a specific manual that lists possible options on a vehicle.
- look at the vehicle instrument panel, driver information center, switches on the door trim and center console, etc. Check instrument panel indicator lamps by turning the ignition to RUN and seeing which dash lamps turn on during the bulb check. With the exception of the bulb being burned out, if a feature does not light up it is likely that the vehicle is not equipped with the option. Depending on the vehicle, system operation and warnings may be indicated as a text message in a driver information center.

Many times options are available in packages from the vehicle maker. Being familiar with what packages are available for specific vehicles can provide a good indication of what other options are available.

Also, some systems have a direct relationship with others. For example, if a vehicle is equipped with a blind spot assist system, there is a good chance it might also have the cross traffic alert system.



The blind spot detection system on this 2010 Volvo XC60 uses door mirror cameras to detect approaching vehicles (left). The blind spot detection system on the Ford Taurus has an indicator lamp in the door mirror (right).

Many vehicles are now equipped with systems that detect vehicles approaching from behind in an adjacent lane. These systems are typically called blind spot detection systems. The blind spot detection system:

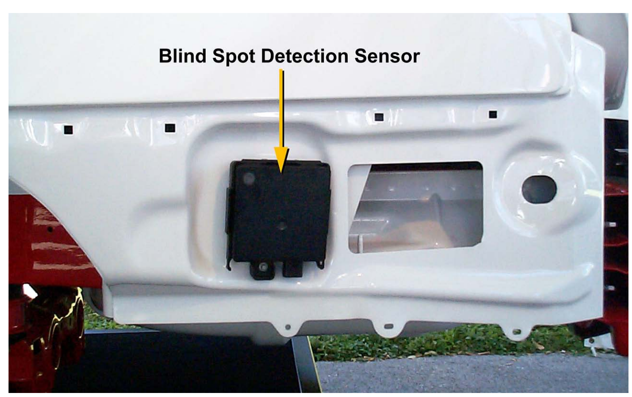
- engages when the turn signal is activated and signals the driver when a vehicle is approaching.
- generally uses radar to gauge distance of approaching vehicles. The Volvo system uses a camera in the door mirrors to watch for approaching vehicles. However, the 2013 Volvo S60 / V60 / XC60 now use radar sensors to monitor blind spots.
- is designed to ignore stationary objects.

Regardless of the name, the functionality is similar between the systems.

The radar sensor for most blind spot detection systems is based on existing technology. For example, Valeo Raytheon had designed a system for the military called advanced phased array radar technology that was used to guide missiles to their target. This system was miniaturized and equipped with reduced power requirements. The system is designed to track approaching vehicles by determining distance and closing rate.

Other systems may be based on Doppler radar technology. This type of radar, most commonly associated with weather radar, is designed to detect moving targets while ignoring the stationary targets.

Refer to "Video: Blind Spot Detection System Demonstration" in the presentation. This video shows how a blind spot detection system operates.



The blind spot detection system on this Ford Fusion has a sensor located behind the rear bumper cover.

A blind spot detection system with radar sensors operates by:

- having the sensors detect vehicles approaching from the rear.
- using a mathematical model to calculate when an approaching vehicle enters and leaves the blind spot area. The computer software calculates when, in what manner, and in which situations a warning should be issued.
- applying voltage to the indicator lamp located in the door mirror, lighting the warning indicator.

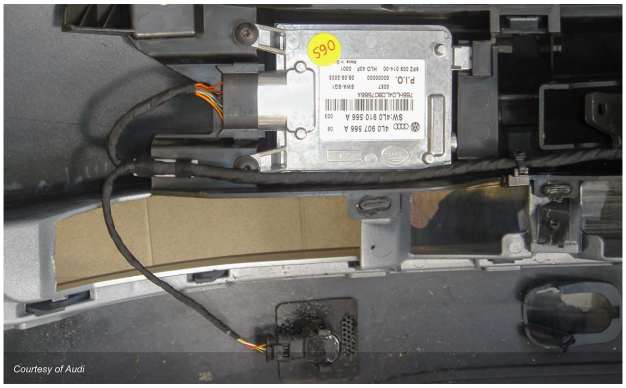
The range varies according to the vehicle maker. For example:

- on Ford vehicles, the range of the sensors extend rearward from the door mirrors to about 10 feet beyond the rear bumper.
- on General Motors vehicles, the range of the sensors extends rearward from the door mirrors to about 11 feet beyond the rear bumper.
- on Volvo vehicles that use a camera-based system, the cameras can detect objects up to 31 feet rearward from their location on the door mirrors.

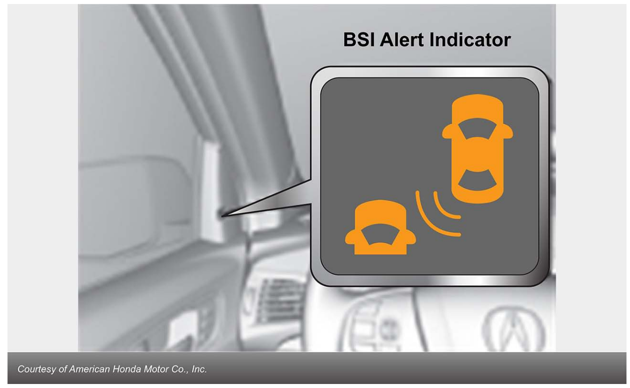
This type of icon on the door mirrors is an indication that the vehicle is equipped with a blind spot detection system.

To determine if a vehicle is equipped with this option:

- check the door mirrors. The mirrors are equipped with an LED that lights when the approaching vehicle comes into the blind spot. On some vehicles, such as the Ford Fusion, both of these LEDs light when the vehicle is started.
- some vehicles may provide an icon on the driver information center or instrument cluster.
- some vehicles have a switch to turn the system on or off. On the 2014 Toyota Highlander, the blind spot detection system must be turned on by the driver. The button is located on the left side of the steering wheel and is identified by the letters BSM.



This is a blind spot detection sensor on an Audi Q7.



The indicator lamp turns on or flashes when a vehicle is in the blind spot area.

Primary blind spot detection system parts include:

- sensors, which are generally located behind the rear bumper cover, one on each side.
- cameras. Some Volvo vehicles have cameras placed beneath the door mirrors that detect approaching traffic.
- the steering wheel (on some systems). Depending on the vehicle maker, some systems vibrate the steering wheel when vehicles are in the blind spot and the blinker is activated.
- door modules / control module.
- door mirrors.

Blind spot detection systems that use the radar sensors:

- have an indicator lamp on the door mirror that alerts the driver to the proximity of the approaching vehicle. For example, on Audi models, the indicator light on the door mirror glows continuously when a vehicle is approaching. When the approaching vehicle is in the critical area, the indicator lamp flashes.
- may have a warning chime and a message in the instrument panel cluster to indicate an approaching vehicle. On Toyota vehicles, the indicator lamp flashes and a warning chimes if a vehicle is detected in the blind spot area when the turn signal for that side of the vehicle is turned on.
- may allow the brightness of the indicator lamp to be adjusted to compensate for peripheral perception deterioration, a common condition that occurs as people age.

Mud buildup on the rear bumper cover can interfere with a blind spot detection system.

Problems that are not related to mechanical damage and can be fixed and / or diagnosed simply include:

- dirt or debris over the sensor area. Dirt, snow, mud, and other miscellaneous debris can build up over the sensor preventing an accurate reading.
- severe weather, such as rain or snow, which may affect the operation and cause occasional missed alerts. The number of missed alerts will increase with increased rainfall or road spray.
- when the vehicle is towing a trailer, or has an object such as a bicycle rack attached to the rear of the vehicle, the system will not properly operate.

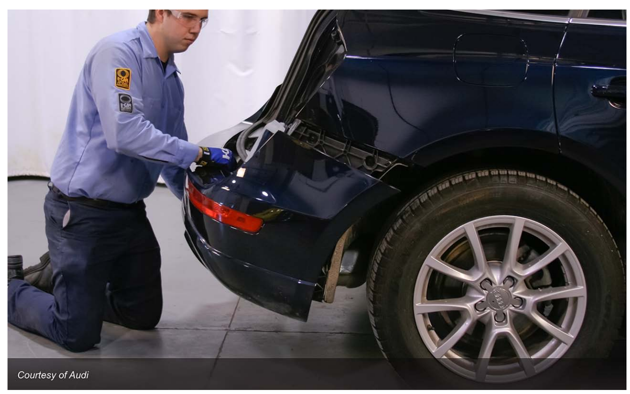
Other conditions that may cause the system to not operate properly include:

- when several vehicles accelerate from a standing start with a vehicle alongside.
- a vehicle moves from two lanes over to the adjacent lane.
- the rate of speed of the approaching vehicle is too fast.

On the Toyota system, the system is engaged only if the:

- blind spot detection system is switched on.
- road speed is above 10 mph.

For Ford and Cadillac, when the vehicle is started, the exterior mirror LEDs briefly light to indicate that the system is operating and there are no faults. If a fault is present, the LEDs remain lit and a message may appear on the instrument cluster stating “Blind Spot System Fault,” “Blind Spot Not Available,” “Blocked Sensor,” etc.



Part removal may be required to determine if a sensor has collision damage.

When performing damage analysis, check for a damaged:

- bumper bracket and / or bumper beam. Bent or collapsed bumper parts can affect sensor positioning

and alignment. This will cause improper readings by the sensors.
- bumper cover. Even in light impacts, a sensor can be damaged.
- door mirror.

With some systems, such as those used on General Motors vehicles, the sensors are identical and may be swapped from one side of the vehicle to the other when troubleshooting potential problems, however, sensors should not be swapped from one vehicle to another.

An improperly operating blind spot system may display a message on the vehicle message center.

Beyond physical damage, a scan tool will be required to assess a malfunctioning blind spot detection system for proper diagnostics and trouble code retrieval. This may require subletting the diagnostic operation, or purchasing the required equipment.

Vehicle maker-specific scan tools may be required to calibrate the system after repairs.

If the blind spot detection system sensors have been replaced, calibration is generally required using vehicle-specific diagnostic equipment. Calibration may also be required after rear bumper cover removal or replacement of the control modules. Calibration of the sensors is particularly vital since the measurements taken from these points determine if a signal should be sent indicating an approaching vehicle. The calibration essentially informs the computer of the sensor's exact position so that the proper calculation can be made. Sensors may not be identical on the left and right sides of the vehicle.

On the 2014 Toyota Highlander, the blind spot detection sensor must be calibrated if it is replaced. Calibration requires the use of a scan tool.

2014 Honda Accord

The camera on the right door mirror (left) turns on when the right turn signal is on or when the button (right) is pushed.

Video captured from the right side door mirror is shown on the center display.

An alternative to a conventional blind spot detection system is Honda's LaneWatch. On this system, only the blind spot on the right side of the vehicle is monitored. The LaneWatch system:

- uses a video camera located on the right door mirror. The camera monitors the blind spot on the right side of the vehicle. This provides a view of vehicles, bicycles, or pedestrians that are not normally visible in the passenger side door mirror. The viewing range can extend to one or two lanes on the right side of the vehicle and up to 50 yards behind the vehicle.
- automatically turns on with the right turn signal. It can also be turned on by pressing the button located on the end of the turn signal lever.
- displays video captured from the side camera on the center display.

2014 Honda Accord Hybrid

The camera must be aimed if it is removed or replaced.

The LaneWatch camera must be aimed if the camera is removed or replaced, the door mirror is removed or replaced, the door panel is removed or replaced, or if body repairs are made to the door panel. The aiming procedure requires special tools, which include an aiming stand and an aiming marker. It is important to follow the target setup instructions in the service information precisely to ensure the camera is aimed properly. After the target is properly set up, the aiming procedure is initialized through a diagnosis menu on the vehicle display. Steps for accessing the diagnostic menu may vary depending on the trim level of the vehicle.

An overview of the camera aiming procedure is available on the Honda service information website.

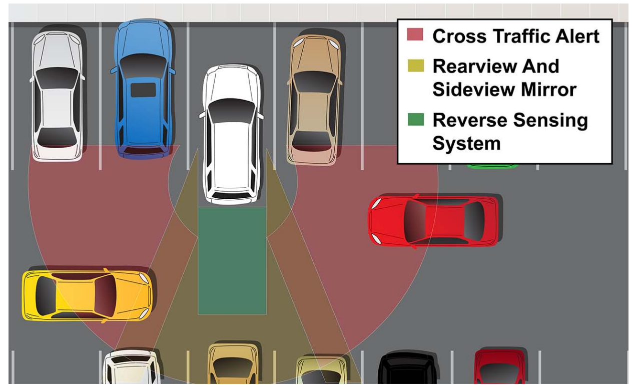
Cross Traffic Alert Systems

Cross traffic alert systems may use the same indicator lamps in the door mirror as the blind spot detection system.

Some vehicles are equipped with a feature called a cross traffic alert system. This particular system:

- is designed to assist a driver with oncoming traffic when backing out of a parking stall.
- warns of an approaching vehicle with:
    - an audible alert from the parking aid speaker.
    - a visual alert on the right or left door mirror.
    - a message on the instrument panel cluster that states either "Vehicle Coming From Right" or "Vehicle Coming From Left."

The system may detect vehicles approaching from up to 45 feet away. However, this distance may vary depending on the system.



The cross traffic alert system is designed to detect vehicles approaching at 90° angles.

The cross traffic alert system:

- uses many of the same parts as a blind spot detection system, such as sensors located behind the rear bumper cover.
- radar detects an approaching vehicle.
- sensors work at a 90° angle.
- works for straight and angled parking.
- only operates in reverse.

Some cross traffic alert systems can be turned on or off with an ON / OFF function in the message center.

Refer to "Video: Cross Traffic Alert Demonstration" in the presentation. This video shows how a cross traffic alert system operates.

2015 Kia K900

It is important to check the rear bumper for damage as this may be an indication of potential sensor damage.

Because the system uses the same parts as the blind spot detection system, damage to the rear bumper or rear portion of the quarter panel can cause damage to the system. Additionally, the repair considerations are similar to the blind spot detection system. If a fault is detected on the instrument panel cluster, a scan tool is recommended for troubleshooting the problem.

Similar to the blind spot detection system, items that can cause non-detection include:

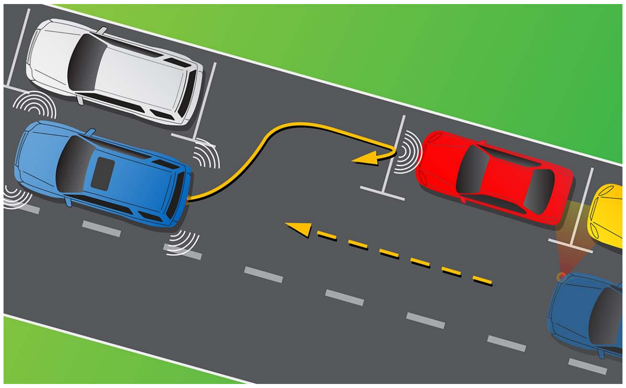
- mud or debris buildup on the rear bumper cover.
- the quarter panel being obstructed.
- collision damage to the rear bumper cover and quarter panels.

Parking Assist

This monitor is providing instructions for using the hands-free parking assist feature on a Lexus.

There are two types of parking assist. These include:

- assist only, where the system provides visual and / or audio feedback to help determine the distance to obstacles.
- hands-free parallel parking assist.



The parking assist feature is designed to provide audible cues with regard to distance between objects and bumpers.

The parking assist system is designed to:

- calculate the distance to an object in the rear of the vehicle and provide audible and / or visual signals to the driver while parking and working the vehicle in reverse. Some systems engage when it detects an object 8 feet behind the vehicle.
- work at low speeds, typically less than 5 - 11 mph.
- may calculate how close an object is to the front of the vehicle. The Mercedes-Benz Parktronic system monitors the front and rear of the vehicle if the vehicle is in REVERSE, and will only monitor the front of the vehicle if the vehicle is in DRIVE.

Some systems do not detect objects below the bumper as well as people or pets.

The system can be turned on or off manually using a switch on the instrument panel.

2010 Ford Fusion (Left), 2014 Nissan Rogue (Right)

The parking assist camera may be attached to the rear closure panel, such as a deck lid (left) or hatch (right).

Some systems are equipped with a camera in the rear or front to get a visual of the area around the vehicle. The camera:

- mounts on the spoiler, deck lid, or hatch, etc.
- is activated when the vehicle is shifted into reverse, giving the driver a clear view behind the vehicle.
- provides a video image that is generally displayed on the navigation screen. On the 2012 Ford F-150, the image is displayed on the rearview mirror.

The U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA) issued a final rule requiring rear visibility technology in all new vehicles under 10,000 pounds by May 2018. This new rule is designed to significantly reduce the risk of fatalities and serious injuries caused by backover accidents.

The 2009 - 2014 Lexus LX has a camera in the front grille that is used for parking and seeing around blind spots when pulling into traffic and vision is blocked by a wall or vegetation. There is also a camera in the passenger side door mirror that provides a visual for curbside parking.

Refer to "Video: Parking Assist Operation" in the presentation. This video shows the parking assist system on the 2010 Ford Fusion Hybrid.

Parking aid sensors may be located on the rear bumper cover.

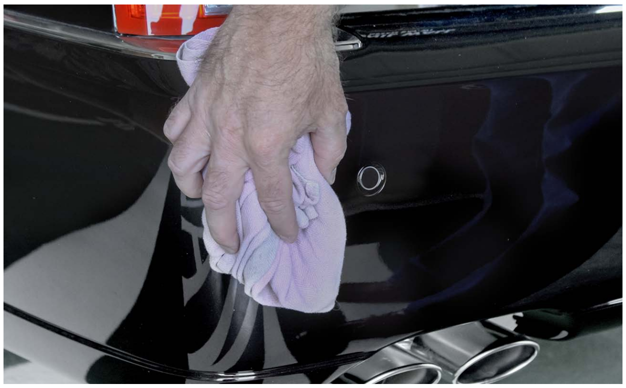
Parking aid sensors may be located on the front bumper cover.

Parts that make up the parking assist feature include:

- parking aid sensors - bumper covers.
- parking aid module - location varies.
- parking aid speaker (if equipped).
- display (if video-equipped).

The arrow is pointing to the switch for the parking assist system.

Parking assist has progressed to the point where almost all vehicle makers offer this feature as an option or a standard feature on their new models. To determine if a vehicle is equipped with parking assist, check for signature round sensors in the bumper cover. A button or switch on the instrument panel may also indicate that the vehicle is equipped with a parking assist system.



Making sure the sensors are clean is important when troubleshooting the parking assist feature.

To determine if there are problems with the parking assist feature, check for warnings indicated on the message center. Quick troubleshooting suggestions include making sure the parking:

- brake is released and the sensors are clear of debris.
- assist system is not turned off manually.

If the issue is not related to an obstructed sensor or the switch, the system may have detected a malfunction, which may require the use of a scan tool for further diagnosis.

Parking assist sensors should be checked for damage, even after a minor collision.

When analyzing damage to the parking assist parts, note that sensors:

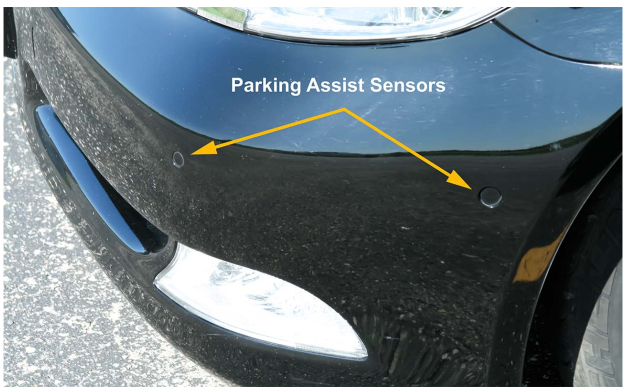
- and control modules cannot be adjusted or repaired.
- are generally identical in construction, so there is no specific sensor for each position in the bumper.

The sensors on the rear and front bumper can typically be refinished. However, excessive coats of refinish can hinder sensor performance.

When using the hands-free parallel parking assist system, the display screen provides specific instructions for proper use.

Some systems have been designed to automatically parallel park the vehicle into an open parking stall. The driver only needs to confirm the desired parking space and apply the brakes when required to control speed. The vehicle handles the proper steering.

The Toyota / Lexus system is called the Advanced Parking Guidance System and it assists the driver during parking and parallel parking by displaying an image of the area behind the vehicle and controlling the steering wheel when the vehicle is in reverse.



The parking assist sensors are used by the system to judge the distance to other vehicles.

To make calculations and estimates, the parking assist electronic control unit (ECU) uses signals from the:

- steering angle sensor.
- power steering ECU.
- skid control ECU.
- engine control module (ECM).
- parking assist sensors.

These results are used to make various guidelines, which are combined together with video from the television camera, and output to the multi-display.

The camera and sensors are integral parts of the hands-free parallel parking assist system.

Parts of the hands-free parallel parking assist system include a:

- camera, which may be mounted on the deck lid or tailgate to transmit the rearview of the vehicle to the parking assist ECU.
- parking assist ECU, which receives vehicle condition signals from various ECUs, and makes an electronic frame to verify the parking location based on calculations. The system combines the frame with video from the television camera and outputs the video with frame to the multi-display.
- multi-display, which receives video signals containing a composite of the rearview and the frame signals from the parking assist ECU, and displays them on the panel.
- steering angle sensor, which detects the angle of the steering wheel and sends the signal to the parking assist ECU.

- skid control ECU, which sends stop switch, parking switch, vehicle speed, driving distance, and other vehicle condition signals to the parking assist ECU.
- park / neutral position switch.
- display and navigation, which uses the yaw rate detected by the gyro sensor that is built into the navigation ECU to transmit the movement of the vehicle to the parking assist ECU.
- parking assist sensors.

A scan tool is used to diagnose the parking assist system.

If the parking assist system detects a malfunction:

- a DTC will be stored.
- the object alarm module may send a message to the instrument panel cluster to display the SERVICE PARK ASSIST message on the driver information center.
- a chime may sound.

The specific warning may vary depending on the vehicle maker.

Depending on the size of the equipped tires (for example, the tire size may affect the rotation of the tire in relation to the steering wheel) and the vehicle angle (for example, the vehicle angle is too small), the parking position may deviate or the vehicle may not be straight.

Test drives are often used to calibrate specific sensors.

If a fuse or the battery is disconnected, the system may need to be initialized. For example, on the Lexus system, if the battery is removed and reinstalled, the rearview monitor will be operational, but cannot assist backup parking operation because the center position recognized by the steering angle sensor may not be initialized.

When replacing the parking assist ECU, it is required to initialize the television camera and calibrate the steering angle and height control sensors.

Lane Departure Warning

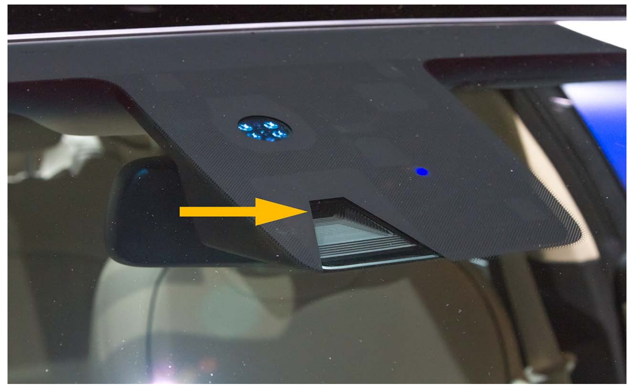
Lane departure warning systems are designed to warn the driver if the vehicle starts to drift out of the chosen lane.

The lane departure warning assist system:

- helps the driver keep the vehicle in the chosen lane.
- warns the driver that the vehicle is drifting out of the lane. Warnings may be audio, visual, or a vibration of the steering wheel.
- may only provide a warning. However, some systems also use the brakes to provide countersteering force to help keep the vehicle in the lane.
- operates at a speed of 35 mph or above, depending on the vehicle maker, and requires lane markers.

The warning system is not activated if the turn signal is engaged before changing lanes. If the system is activated, the warning ends when:

- the driver steers back into the lane.
- a lane change is completed.
- the vehicle drives on the line for longer than 2.5 seconds.
- the brake pedal is pressed.



The lane departure warning system sensor is a camera attached to the windshield next to the rearview mirror.

The lane departure sensor is a camera, which:

- is behind the windshield near the interior rearview mirror. Both the camera and computer are housed in the camera control unit above or within the interior rearview mirror unit.
- looks out at the road ahead and monitors lane markings.

On the 2012 BMW 5 Series, the windshield is integrated with a heater for the camera. The windshield must be replaced if the heater is defective.

The lane departure warning system requires that the vehicle be on for the system to capture the images required by the control module for evaluation.

The lane departure warning system:

- turns on when the ignition is switched on.
- submits the camera image, and other vehicle data to be evaluated, to a control module.
- uses the control module to determine the position of the vehicle in relation to the lane markings on the road.
- has the control module send a message to the instrument cluster, vibrates the steering wheel to warn the driver, or provides an audio signal.

The system operates in the following modes:

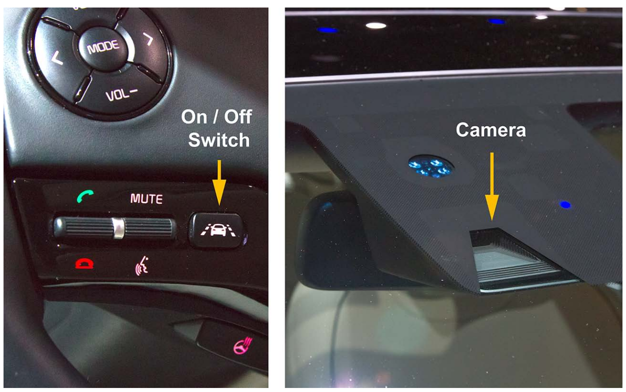
- Ready to assist
- Disabled, where the driver switches the system off
- Not Ready To Assist, where the system is active but not ready to assist because:
  - vehicle speed is below a certain speed, generally 35 - 42 mph
  - the system cannot detect lane markings
  - the windshield in front of the camera has debris that is preventing the camera from detecting the lane markings

On the 2014 Chevrolet Malibu, when the system is operating properly, a green lane departure indicator will illuminate on the instrument panel cluster. The indicator will flash red and three chimes will sound through the radio when the vehicle unintentionally leaves the lane. If the system is switched on, but not ready to provide warnings, the Not Ready To Assist or Lane Departure Warning Unavailable message may display on the information center. This could be due to either insufficient speed, poor lane markings, or the camera is blocked in some way (fog, snow, dirt).

This vehicle has a lane departure warning indicator lamp on the instrument panel.

To determine if a vehicle has a lane departure warning system:

- check for a camera contained in the rearview mirror area. Make sure not to confuse a rain sensor for a camera.
- look for the presence of an on / off button on the steering wheel or instrument panel.
- check for an indicator lamp on the instrument cluster. The BMW system will also display a lane departure system icon in the head-up display.



The on / off switch and camera are primary parts of the lane departure warning system.

Primary parts of the lane departure warning system may include:

- a camera.
- a control module.
- a lane departure warning on / off switch.
- a vibrator motor (if equipped).
- the instrument panel cluster.
- the radio, for warning notification.

Road construction (top) or poor road markings (bottom) will prevent proper operation of the lane departure warning system.

The lane departure warning system may not accurately detect:

- temporary markings along construction sites that would confuse the system.
- worn and faded road markings.
- road markings covered by snow or ice.
- road markings on roads with sharp bends.
- road markings under very poor weather conditions.

These are non-mechanical issues that can cause the lane departure warning system to seem not to be operating properly.

A warning in the vehicle message center states that the system is not functioning properly.

Damage to the system may be indicated by:

- a system malfunction message in the driver information center.
- cracks in the windshield that obstruct the camera lens.
- damage to the roof panel near the windshield above the camera.

A scan tool will be required to diagnose any electronic issues with the lane departure warning system.

Similar to other systems, improper vehicle alignment can cause problems with the system. For example, dog tracking may cause the camera to point away from the center of the lane, resulting in improper reading of the lane markers.

Test drives are often used to calibrate the lane departure warning system after repair or part replacement.

When the camera or windshield is removed / replaced / installed, the camera must be aimed after installation. To calibrate the camera:

- specific calibration procedures may be provided in the vehicle service information.
- determine the exact installation position of the camera and its installation angle.

A calibration test drive may be required after installation. The calibration takes place while driving. The system scans the camera image for all straight edges and from the orientation determines the viewing angle of the camera. The test drive may take a couple minutes. In poor weather conditions, it may take longer.

On a 2014 Chevrolet Malibu, calibration is necessary when the camera module is replaced. Calibration is not necessary when only replacing the windshield and / or the original camera is reinstalled properly. To calibrate the camera:

1. Select the Frontview Camera Learn in the scan tool.
2. Operate the vehicle in the following conditions until the amber indicator turns off:
   - Clean windshield
   - Avoid lane changes
   - Maintain vehicle speeds between 35 - 56 mph
   - Ensure the road contains visible references (well-defined lane markings, curbs, etc.)

2010 Toyota Prius

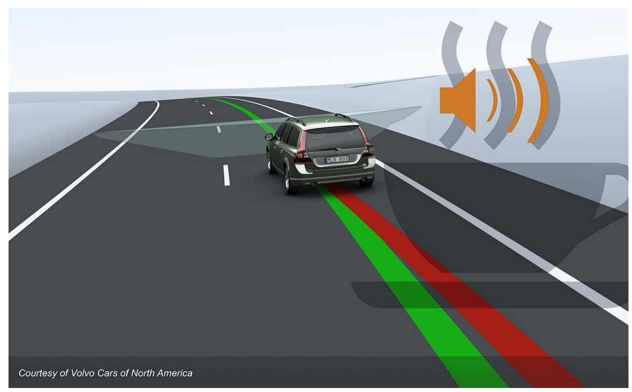
Some option packages for the 2010 Toyota Prius feature Toyota's version of the lane departure warning system.

The Toyota Lane-Keeping Assist feature:

- debuted on the 2010 Toyota Prius and is also an option on other Toyota / Lexus vehicles.
- integrates multiple systems. For example, it incorporates parts from the dynamic radar cruise control system and electric power steering.
- provides an audible alert and a light countersteering force to help the driver stop the vehicle from leaving its lane. This is a unique feature since most systems do not apply a countersteering force. This system only works when the adaptive cruise control is enabled.

Other vehicle makers have since included a similar feature (providing a limited amount of countersteering force) with their LDW systems. Examples include the 2015 Cadillac ATS and 2014 Lincoln MKS.

Attention Assist



Some attention assist systems provide an audible warning when it is determined that driver attentiveness is fading.

Similar to the lane departure warning system is the attention assist feature. This feature:

- monitors the driver attentiveness.
- at the beginning of a trip, uses sensor technology to create an overall driver profile. This behavior pattern is continuously compared with real-time data from the sensors throughout the journey.

- uses a camera to monitor the movement between lane markers and assesses whether the vehicle is being driven in a controlled way.
- uses the sensor information to determine the exact time when a break should be taken and provides an audible and / or visual warning.
- may be called "drowsy driver", "attention assist", or "driver alert control."

The message displayed in the driver information center is recommending that it is time for the driver to take a break.

With the Mercedes-Benz system, an audible alert is given to the driver and a message on the instrument cluster displays to recommend the driver stop for a break when concentration has been detected to drop below a certain level. The system may also display bars on the instrument cluster to indicate the driver's concentration level, with five bars being the highest level of concentration.

The attention assist system uses the same camera as the lane departure warning system.

Many of the same parts used for the lane departure warning system are used for the attention assist system. These include:

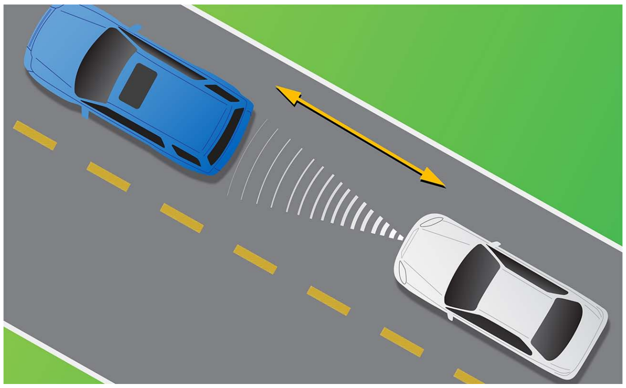
- a forward sensing camera.
- a driver information control module.
- a forward sensing control module.
- an infotainment module (silences sound system to provide audible warning).
- a driver information center.

Problems with the attention assist feature are similar to that of the lane departure warning system, as problems may occur from:

- weather and road conditions.
- physical damage to the windshield or camera housing. Cracks in the windshield can obstruct the camera's vision. For mechanical issues, a scan tool will be required to diagnose the attention assist system. Similar to the lane departure warning system, calibration of the attention assist

system is required when some of the parts are replaced, such as the camera and windshield.

Adaptive Cruise Control



Adaptive cruise control uses a radar or laser system to maintain a set distance from the vehicle ahead.

Adaptive cruise control (ACC) is:

- an extension of conventional cruise control systems.
- used to automatically maintain a set distance from a vehicle ahead. For example, if the vehicle ahead slows, the ACC system will slow the vehicle in order to maintain the specified distance.
- not a collision warning or avoidance system, but parts of the ACC system may be integrated into collision avoidance systems.
- designed to assist the driver and is not a fully independent driving system. As with conventional cruise control systems, manual inputs from the driver, both to the accelerator and brake, take priority over the ACC system.
- designed to enhance driver convenience, since accelerating and braking operations occur without driver intervention.

The ACC sensor may be located on or behind the grille (left). Controls for the ACC are located on the steering wheel (right).

ACC works with either laser- or radar-based sensors. Both types of ACC sensors operate by projecting a beam forward to detect a vehicle ahead. The set distance (timed in seconds) is the desired distance between the ACC vehicle and the forward vehicle. When a forward vehicle is detected, automatic acceleration and braking operations maintain the set distance.

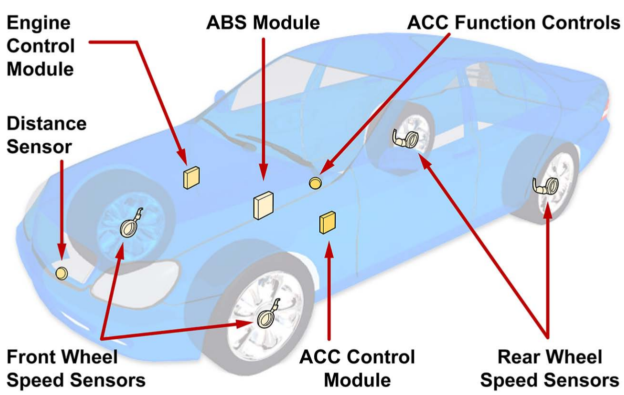
A control unit compares the actual vehicle speed and the desired set speed. If there is a difference between these two values, a signal is sent to a throttle position actuator to adjust the throttle position to bring the vehicle to the set speed.

Depending on vehicle make and model, throttle position is achieved using vacuum-powered or electronically controlled actuators.

ACC systems provide various vehicle-to-vehicle distance options, which allow a setting appropriate to traffic conditions, such as:

- short distance.
- medium distance.
- long distance.

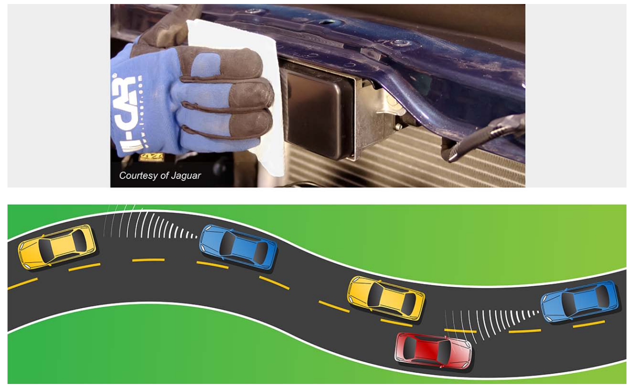
The set speed is the desired maximum speed to be regulated by the ACC system on an open road. If no forward vehicle is detected, the set speed is regulated.



These parts are common to the ACC system.

Parts for the ACC system include:

- a distance sensor (either a radar or laser sensor depending on the vehicle maker) attached to the front of the vehicle to detect the presence of a vehicle ahead and the clearance between the ACC vehicle and the forward vehicle. Some sensor locations include under or behind the front bumper or behind the grille.
- control modules. These include a module specific to ACC in addition to ABS and engine control.
- ACC function controls.
- wheel speed sensors.



Dirty sensors or curvy roads can prevent proper operation of an ACC system.

Certain conditions may prevent the ACC from engaging. These conditions include, but may not be limited to:

- a damaged or misaligned sensor. This is the most common problem.
- sensor obstruction from paint, stickers, a vehicle front protector, excessive mud, snow, etc.
- bad weather conditions, which may limit the effectiveness of a laser-based distance sensor.
- vehicle speed too high or too low.
- heavy cargo causing the front of the ACC vehicle to rise.
- the rear of the forward vehicle being extremely dirty, or having no reflectors.
- curved road, which prevents the system from contacting a preceding target.

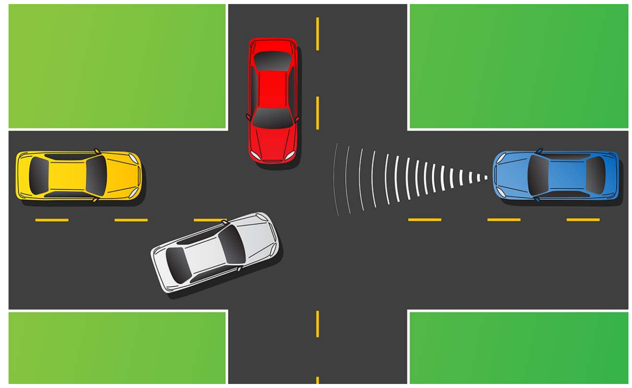
This is an ACC sensor alignment tool for Toyota / Lexus vehicles.

During replacement of the distance sensor, the:

- ACC system must be calibrated using the scan tool.
- new unit must be properly aligned. Horizontal misalignment may result in the erroneous detection of a vehicle in an adjacent lane. It can also set a DTC.
- a special aiming tool may be required.

Similar to other systems, improper vehicle alignment can also cause problems with the system. If the vehicle is unable to track the vehicle ahead due to an excessive thrust angle issue, the system will not work properly.

Pre-Collision Systems



Pre-collision systems are designed to detect situations in which a collision may be imminent.

A pre-collision system:

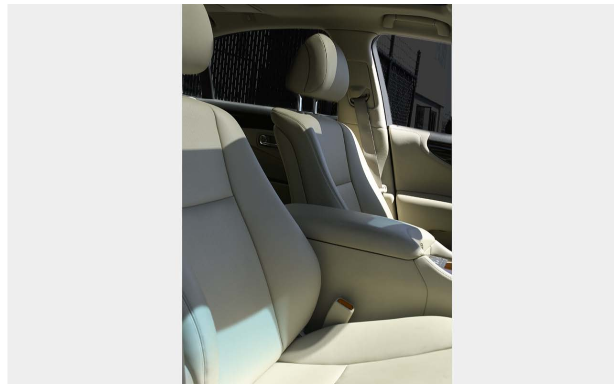
- is designed to predict a collision.
- helps prevent the collision from happening or minimize severity.
- can be used to detect front and rear collisions.
- uses forward-object detection along with additional information such as vehicle speed to predict an imminent collision.

A properly operating system is designed to determine if the distance between vehicles is at a dangerous level and if a collision is about to happen. The system will forewarn the driver of a possible collision to prompt the driver to take preventive action. The driver is alerted to an imminent collision through audible, visual, or physical alerts, or a combination of these.

Pre-collision systems are designed to tighten seat belts and pre-load the brake system when a collision looks imminent.

In addition to warning the driver, the vehicle may prep other areas of the vehicle for impact or aid in collision avoidance. For example, a pre-collision system may:

- provide brake assist by automatically adjusting the brakes to provide full stopping force as soon as the driver steps on the pedal. Depending on the system, this may be done by increasing the brake pressure and / or moving the brake pads closer to the discs.
- provide automatic braking if the driver does not act when a collision is considered imminent.
- adjust the driver and front passenger seat belt tensioners (reduce slack) to reduce occupant movement.

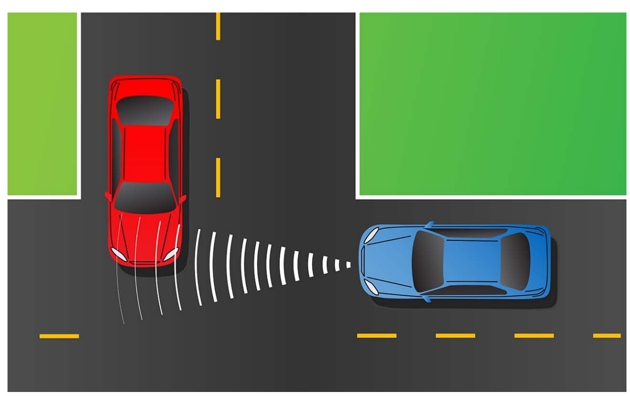


Some systems are designed to reposition the seat back and head restraint.

Other tasks that may be performed by pre-collision systems include:

- adjusting seats into crash safety position and / or adjusting the seat contour.
- closing sunroof and / or side windows.
- raising head restraints.
- adjusting damping action of shock absorbers to help keep the vehicle level.

If a collision does not take place, some systems, such as the seat belts and brakes, return to their normal state.



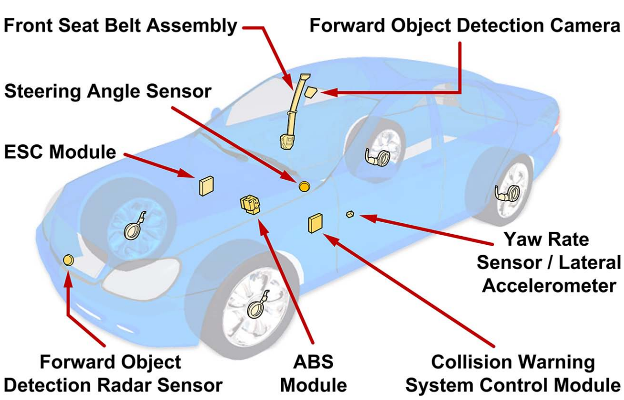
Pre-collision systems may use a radar sensor to detect vehicles in front or behind.

The pre-collision system:

- is dependent on system options.
- uses radar sensors to detect vehicles in front and behind.
- control module calculates speed, object position, and vehicle tracking.

On a 2008 - 2014 Lexus LS 600h, detecting vehicles and obstacles in front of the vehicle is determined from information provided by the front millimeter wave radar sensor and an object recognition camera. The object recognition camera consists of two side-by- side cameras located in the center front area of the headliner. The millimeter wave radar sensor is also used by the adaptive cruise control system.

On Volvo vehicles equipped with the Collision Warning with Auto Braking, both a radar sensor and a camera are used to detect forward vehicles. One advantage of the camera is the possibility of detecting stationary vehicles and warning the driver while maintaining a low false-alarm level.



These parts are common to the pre-collision system.

Pre-collision system parts may include:

- the ABS control module.
- a forward object detection radar sensor.
- a forward object detection camera.
- a collision warning system control module.
- the engine control module.
- the wheel speed sensors.
- the steering wheel angle sensor.
- the yaw rate and deceleration sensor.

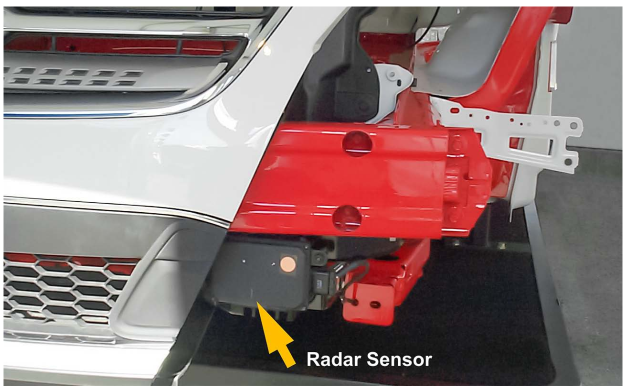
The pre-collision sensor on this vehicle is located behind the front grille, and is susceptible to light or moderate collision damage.

Correct alignment of a forward object detection sensor is critical for proper system operation. Misalignment may result in incorrect object detection. Situations that result in an out-of-alignment condition may include tampering, damage to the sensor and / or mounting brackets, or normal wear.

Collision warning systems provide malfunctioning indicator lamps in the event an error is detected in the system. The light or message is displayed on the instrument panel or message center, sometimes combined with an audible warning. This will engage from bad weather, sensor malfunction, or control module malfunction.

Doing a complete inspection may also require checking for diagnostic trouble codes.

2010 Ford Taurus



Replacement of this radar sensor requires system initialization.

Radar replacement requires specific adjustment of the radar sensor beam axis. Correct alignment of sensors is necessary to ensure the proper operation of the system. Calibration may be required following a collision if there is damage in the area of a sensor or if a sensor is replaced. A scan tool may be required to erase DTCs following successful calibration of a sensor.

The vehicle should be properly aligned before calibrating the adaptive cruise control. If the vehicle is dog tracking down a road, the sensor may not pick up the vehicle ahead.

An example of what is required for calibration includes:

- a bright, well-lighted area with no wind present.
- a level surface free of obstacles extending 5 feet or more in front of the vehicle.
- no reflective materials within 10 feet or more in front of the vehicle.
- no black and white patterned objects in front of the vehicle.
- that all fluid-filled systems are at specified levels.
- a full fuel tank.
- the spare tire in the vehicle, and all tires, including the spare, adjusted to specified pressure.
- all standard tools in the vehicle.
- no person and no extra loads in the vehicle.
- clean glass in front of the camera, and if necessary, the object recognition camera sensor lens. If the lens is dirty, apply a small amount of lens cleaner to a clean, soft cloth and clean the lens.
- the suspension system and wheel alignments properly adjusted.

Collision Mitigation Systems

Two cameras straddling the rearview mirror keep an eye to the front with Subaru's Eyesight Driver Assistance system.

Collision mitigation systems:

- provide automatic braking if the driver does not act when a collision is considered imminent.
- are offered by several vehicle makers. Examples include the Mercedes-Benz Distronic Plus system, Subaru Eyesight Driver Assistance, and Volvo City Safety.
- may use sensors or cameras from other driver assistance systems, such as adaptive cruise control, lane departure warning, or parking assist. For example, the Subaru Eyesight Driver Assistance system combines adaptive cruise control, pre-collision braking, lane departure, and sway warning into one system. The system also uses two forward-facing cameras mounted to the upper console.

The City Safety system monitors the closing distance with the preceding vehicle and will apply the brakes to avoid a collision.

City Safety is a collision avoidance system available from Volvo that can assist the driver in avoiding or reducing the effects of low-speed impacts that are common in city traffic.

With the Volvo City Safety system, if the vehicle is about to drive into the vehicle in front and the driver does not respond by properly braking, the system calculates speed and distance and automatically applies the brakes to avoid a collision. This feature became standard on all Volvo vehicles, starting with the 2010 XC60.

Refer to "Video: Volvo City Safety Operation" in the presentation. This video *shows how City Safety is designed to avoid low-speed collisions.*

The City Safety system requires a specific minimum and maximum speed for operation.

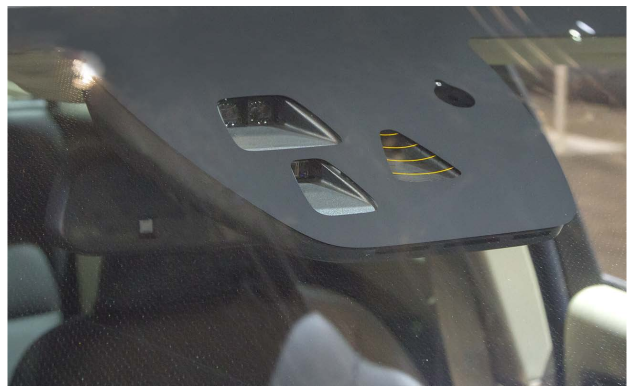
To operate the City Safety feature the:

- system auto-starts with each ignition cycle.
- vehicle speed must be no more than18 mph.
- vehicle speed must be no less than 2 mph.

This system can help prevent a collision if the difference in speed between the Volvo vehicle and the vehicle ahead is less than 9 mph. If the difference in speed is greater, a collision cannot be avoided, but the speed at which the collision occurs can be reduced. The driver must apply the vehicle brakes for full braking effect.

The system does not override the driver. The feature will not engage when the driver actively steers the vehicle or applies the brakes, even if a collision cannot be avoided. Volvo states that this is done to give the driver's action highest priority.

The driver has the option to manually deactivate the system after the vehicle is started, but it will engage the next time the vehicle is started. This means that the system will not react when approaching another vehicle at very low speeds commonly associated with parking the vehicle.



The City Safety system uses a laser sensor module that is mounted next to the rearview mirror.

City Safety system parts include a:

- laser sensor module, mounted next to the rearview mirror.
- closing velocity (control) module, located behind a panel by the pedal assembly.

The closing velocity module uses lasers to detect whether the vehicle is on a collision course with a vehicle ahead. The closing velocity module can request different functions based on the situation, such as:

- preloading the brake system.
- automatic braking.
- torque-limiting the engine.
- brake assistance.

The sensor in the closing velocity module transmits the infrared laser light from three “lobes” (left, right, and center). If there is a vehicle ahead, the light is reflected and registered by the three photo diodes. The control module measures the time it takes for the light to go from the sensor, reflect off the vehicle ahead, and return to the diodes. The time is used with the vehicle speed to calculate closing speed and distance with the vehicle ahead.

When diagnosing City Safety, the laser sensor may be hindered by:

- weather-related conditions, such as heavy rain, snow, or fog.
- dirt or ice on the windshield in front of the sensor.

If there is a problem with the City Safety system, a text message appears in the driver information module indicating a fault. Specific system malfunctions are indicated by a stored DTC.

2014 Volvo S80

The windshield for a vehicle equipped with City Safety must be replaced with the same type of windshield.

When replacing parts of the City Safety system, the:

- windshield must be replaced with the same type of windshield to avoid signal degradation.
- closing velocity module replacement requires downloading software to the module.

Module Wrap Up

Topics discussed in this module included:

- blind spot detection systems.
- cross traffic alert systems.
- parking assist.
- lane departure warning.
- attention assist.
- adaptive cruise control.
- pre-collision systems.
- Volvo City Safety.

Module 2 - Vision Assist And Advanced Restraints Systems

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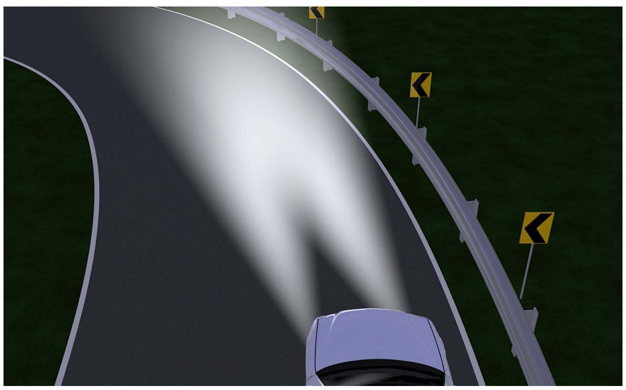
Adaptive Front Lighting

The learning objectives for this module include identifying and understanding operations of:

- adaptive front lighting.
- high beam assist.
- night view assist.
- active head restraints.
- knee airbags.



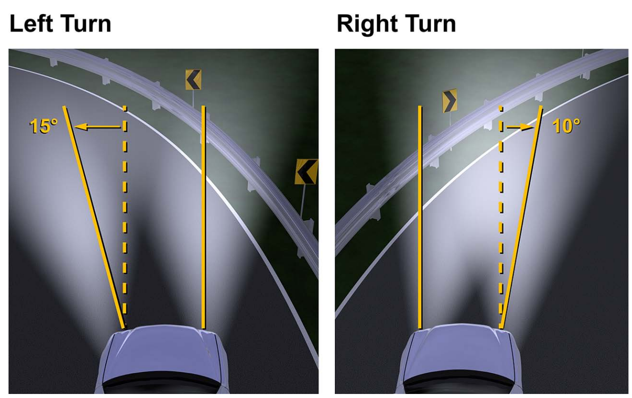
One of the functions of the adaptive front lighting system is to rotate the headlamps in the direction that the vehicle is turning.

Adaptive front lighting was developed to create better visibility while cornering by turning the headlamps in the direction of the turn. This system also:

- automatically levels the low beam headlamps (up / down) to compensate for varying vehicle loads, in addition to quick starts and sudden stops.
- has a fail-safe feature that in case of communication error, the system returns the headlamps to the straight-ahead position.

Some vehicles may be equipped with only the auto-leveling feature, while some contain both the auto leveling and cornering feature.

Refer to "Video: Adaptive Front Lighting" in the presentation. This video shows how adaptive front lighting operates.



The rotation of the right and left headlamp assemblies may differ depending on the vehicle system.

The headlamp swivel assembly control module drives the headlamp swivel actuator and moves the headlamp to the left and right operational limit. Then it returns to the proper position. On some systems, the right and left headlamps do not rotate simultaneously. The headlamp swivel actuator responds as follows while turning:

- Right turn - 0° fixed on the left side, 0° - 10° to right
- Left turn - 0° to 15° to left, 0° fixed on the right

The amount of headlamp movement is dependent on steering wheel rotation. Some systems, such as Volvo and Ford, have their motorized lamps turn up to 15° in either direction when driving.

On the Cadillac systems, the headlamp control module controls the left headlamp movement by 15° to the left and 5° to the right, and the right headlamp movement by 5° to the left and 15° to the right.

The adaptive front lighting system is designed to work when:

- the engine is running.
- the steering angle is 7.5° or more.
- vehicle speed is 6 mph or more.
- the system is turned on.

The rotation of the headlamp is controlled by the steering wheel angle sensor.

For the system to work, the:

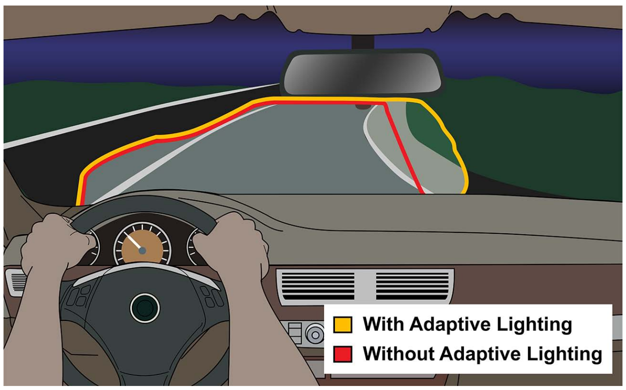
- headlamp control module receives information from a variety of sources such as the:
  - engine control module (ECM).
  - transmission control module (TCM).
  - electronic brake control module (EBCM).
  - body control module (BCM).
  - steering wheel angle sensor.
  - headlamp switch status.
  - transmission gear selection.
  - speed sensor.

- headlamp control module calculates the headlamp angle and sends commands to the left and right headlamp actuators.
- direction the headlamps move is controlled by the steering wheel angle sensor.
- headlamp actuators drive the headlamps to the position commanded by the headlamp control module.

For the automatic vertical alignment of the headlamp system to function, the:

- leveling sensors send an output to the headlamp leveling controllers as the vehicle suspension compresses and rebounds.
- controllers calculate the difference in vehicle pitch and send a command to the high-intensity discharge (HID) ballast.

- HID ballast drives the headlamp leveling actuators to the position commanded by the controllers. The headlamp leveling system also monitors the performance of the HID bulb and ballast.



The adaptive front lighting system provides more lighting in the direction of the turn.

The adaptive front lighting generally does not operate with the transmission in reverse or at vehicle speeds less than 2 mph. This may vary by vehicle maker. Movement of the headlamps may be restricted at low vehicle speeds and full movement of the lamps may not be allowed until vehicle speed is greater than about 30 mph.

On the 2013 Cadillac ATS, the following conditions must be met before the adaptive front lighting system will operate:

- Headlamp switch in the AUTO position and high or low beam headlamps being active
- Steering angle position being received from the control module
- Vehicle speed being received from the control module
- Transmission gear position being received from the transmission control module

The adaptive front lighting system includes an on / off switch.

Adaptive front lighting parts include:

- swiveling and leveling actuators.
- sensors such as:
    - steering wheel angle sensor.
    - vehicle speed sensor.
    - vehicle height sensor. The height sensor linkage is installed on the front and rear axle.
- control modules.

The adaptive front lighting system control module is located behind the instrument panel on the 2010 - 2013 Hyundai Genesis. This requires instrument panel removal if it must be replaced. The swiveling actuator is located beneath the headlamp and the leveling actuator is located next to the headlamp.

2013 BMW 74

The headlamp assembly should be checked for proper operation following any front end collision.

When checking for damage to adaptive front lighting systems, check for:

- physical damage to the headlamp assembly.
- damaged sensors.
- damaged motors.

An initialization procedure may be required when parts are replaced.

The headlamp control module monitors the headlamp actuator motor control circuits for proper circuit continuity and for shorts to ground or proper voltage. If a malfunction is detected, a DTC will be stored in memory and the driver will be notified with a message displayed on the driver information center (DIC). If a fault is detected, the system will default to setting the headlamps to a straight-ahead position.

High Beam Assist

The high beam assist sensor is used to turn the high beams on and off.

The automatic high beam assist is used to turn:

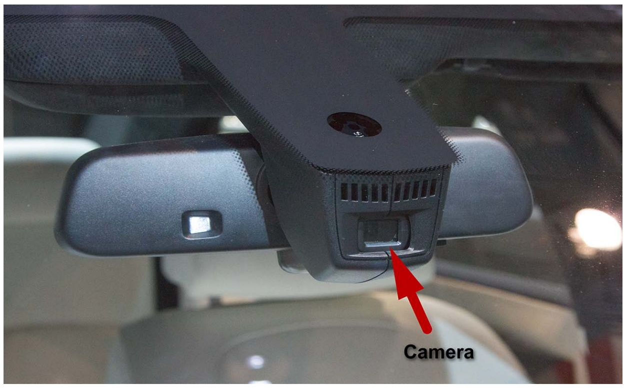
- off the vehicle high beams with oncoming traffic.
- off the vehicle high beams when approaching a vehicle from the rear.
- on the vehicle high beams after the vehicle has been passed.

On the General Motors IntelliBeam system, the high beams will only activate when driving over 25 mph. The high beam headlamps will remain on, under the automatic control of IntelliBeam, until any of the following situations occur:

- The system detects approaching vehicle headlamps
- The system detects a preceding vehicle tail lamps
- The outside light is bright enough that the high beam headlamps are not required
- The vehicle speed drops below 13 mph

- The headlamp stalk is moved forward to the high beam position

The high beam headlamps may need to be manually disabled or canceled by turning the low beam headlamps on, if any of the above conditions exist.



The camera for the high beam assist system on this vehicle is mounted by the interior rearview mirror.

High beam assist systems use a forward-facing camera that detects light color, intensity, and movement. The camera is typically located near the interior rearview mirror.

The ECU may be located beneath the instrument panel.

The high beam assist on most vehicles requires a test drive for proper initialization.

If an electrical problem is detected by the control units, a DTC is stored.

The only way to properly test the General Motors IntelliBeam system is at night when the vehicle is moving. This is due to the system using a digital light sensor on the back of the rearview mirror. This means that covering the sensors on the mirror during daylight conditions will not work.

An initialization procedure may be required after part replacement.

Night View Assist

Night view assist provides a video display of objects, people, and animals that may not otherwise be visible in the dark.

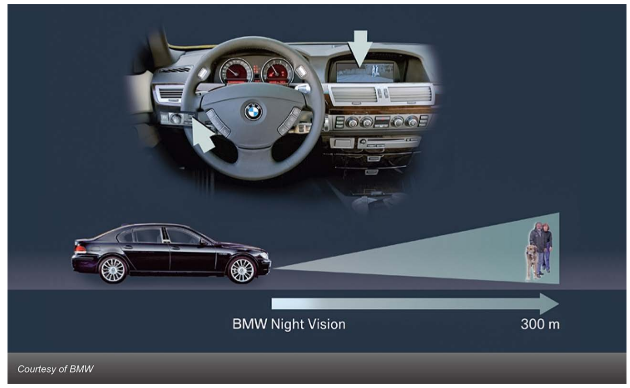
Night view assist uses infrared technology to help detect objects in the dark. Night view assist systems:

- may use far-infrared technology, which detects heat emitted from objects. This type of technology may be referred to as thermal imaging.
- may use near-infrared technology, Night vision enhancement systems

that use this technology require special infrared "floodlamps" to project infrared light onto the surrounding area. The projected light is similar to what is used for many household remote controls. This type of system is available on the 2014 Lexus LS460.
- are activated when low beam headlamps are on.
- may detect objects a set distance ahead in darkness. One system can detect objects nearly 500 feet in front of the vehicle.
- when activated, display the images on a black-and-white screen in the instrument cluster.

The Night Vision 2 system on the BMW 7 Series provides the driver with a black-and-white image of the driving environment ahead of the vehicle in the control display or central information display. This system:

- uses far-infrared technology without active infrared illumination. It essentially converts thermal radiation into electronic signals. The sensor elements alter the resistance in proportion to the temperature. The higher the temperature, the higher the signal, creating a whiter pixel.
- shows objects ahead in varying degrees of brightness depending on the temperature of these objects.
- provides a warning in the head-up display and the central information display.
- has a heater element on the inside of the protective window to prevent the camera lens from misting over or freezing up.



Night view assist system parts include on / off buttons and a display panel. These systems are designed to see several hundred feet ahead of the vehicle.

For the night view assist system to be active:

- the sensor detects proper lighting conditions.
- the ON button is pressed.
- speed parameters must be met. For example, the Lexus system cannot activate the system if vehicle speed is below 9 mph.

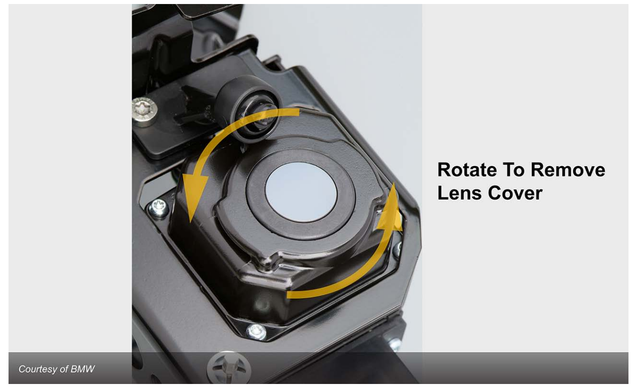
Other parameters include the:

- system can be restricted by environmental conditions such as heavy rain and snow or extreme temperatures.
- daytime running lights must be switched off.

The camera is one of the primary parts of the BMW Night View system.

Night view assist system parts may include:

- the night vision camera. The night vision camera may be mounted on or behind the grille, or located inside the passenger compartment near the windshield.
- IR floodlamps located near the headlamps. These are normal halogen bulbs, equivalent to ordinary high-beam headlamps, but use filters to prevent visible light rays from passing through. IR floodlamps are only used for near-infrared night vision systems, such as on the 2013 Lexus LS460.
- a control module beneath the instrument cluster.
- a video switch on the instrument panel.
- a washer jet for the camera lens.
- a sensor system.



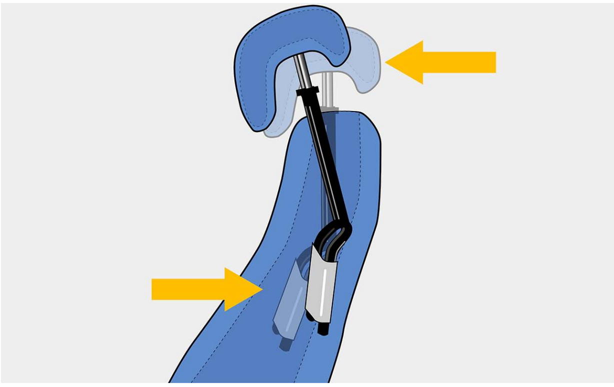
This particular camera has a removable lens cover that can be replaced if damaged.

When checking the night view assist system for damage:

- note that the camera on some systems is located on or behind the grille. This area is subject to damage.
- note that IR floodlamps may be mounted to the bumper cover. There are no specific aiming procedures for IR floodlamps, but deformed bumpers should be repaired or replaced to ensure that they are pointed in the proper direction.
- there may be a protective cover over the camera lens that can be replaced. This particular feature is available on the BMW 7 Series.
- camera replacement or alignment may require a vehicle maker-specific scan tool.
- system defects are displayed on the message center.

Camera replacement on the BMW system requires the camera software be initialized.

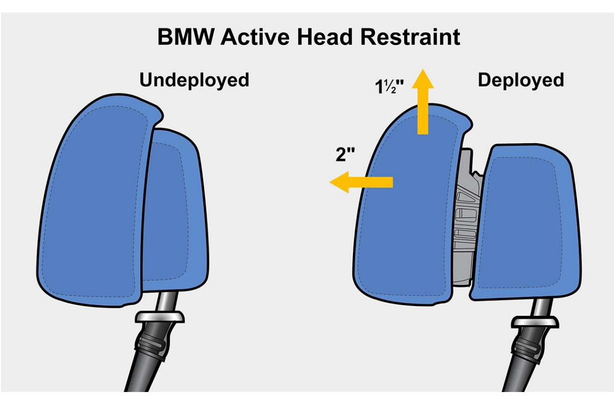
Active Head Restraints



Active head restraints are designed to provide whiplash protection in the event of a rear collision.

Active head restraints:

- reposition the headrest in the event of a rear collision to provide optimum protection against whiplash.
- move the headrest up and forward. Some systems are built into the backrest and headrest, while others are completely enclosed in the headrest.
- are either electronic or mechanical.



Electronic active head restraints may be deployed using a pyrotechnic charge such as used on this BMW system.

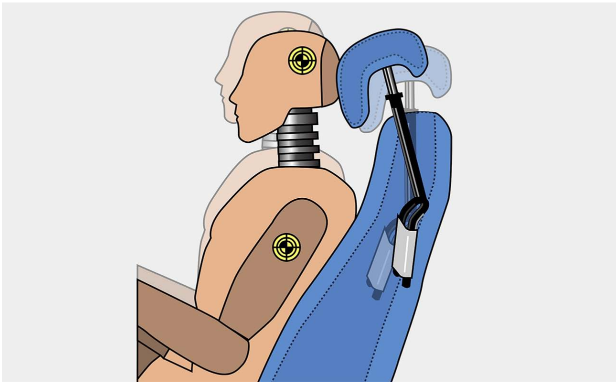
With an electronic active head restraint system, in the event of a rear impact, the front section of the head restraint, driven by a spring, is moved towards the front by up to 2" within a very short space of time, even before the head is jerked backwards due to the impact.

The crash safety module is responsible for deploying the active head restraint by igniting the head restraint pyro-actuator squib. The actuator releases the head restraint spring force by activating the release plate. The head restraint drive springs can only reset once the pyro-actuator has been replaced.

This type of system:

- is activated by sensors and a crash detection module where the crash safety module ignites the head restraint actuator squib.
- has most replacement parts located within the seat and seatback.

BMW is an example of a vehicle maker that uses an electronic head restraint system with a pyro-actuator.



Many active head restraints use a mechanical-type system that automatically resets after the collision.

With a mechanical system, the active headrests move up and forward almost instantly in the event of a rear collision when the force of the occupant body is applied to the seatback.

The active headrests, such as Toyota's, consist of a:

- lower unit.
- cable.
- upper unit.

For this system to operate, the:

1. lower unit built into the seatback is pressed by the occupant's lumbar as the occupant's body slides down during a rear-end collision.
2. cable is pulled and the headrest is moved up and forward by the upper unit, reducing the distance between the occupant's head and the headrest.

There is no post-collision repair for this type of system. After the collision, the system returns to normal operating condition provided there is no physical damage to the seat.

This Hyundai active head restraint must be reset following a collision, but the unit can be used multiple times.

Some systems require the system to be reset once it has been deployed. For example, the Hyundai system can be reset by hand. With this system, the:

1. head restraint is removed from the vehicle and positioned on a flat surface with the head support facing down.
2. locking springs on the left and right side are unlocked by pushing inward while applying downward force on the headrest backside.
3. backside is pushed until a click is heard, indicating that the active headrest is back in position.

On the BMW system that uses a pyro-actuator, the drive springs can only be reset if the pyro-actuator has been replaced.

Knee Airbags

Knee airbags are designed to restrict body movement in the event of a frontal collision.

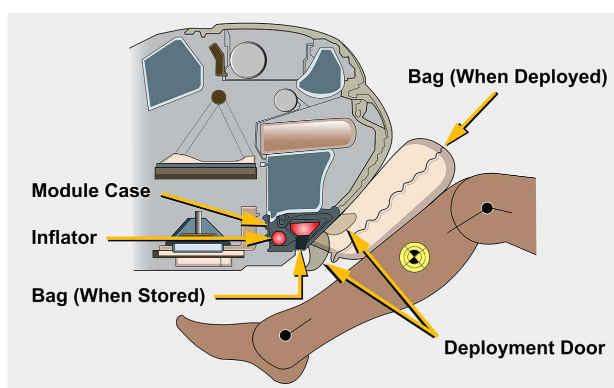
Knee airbag systems:

- may be used for the driver and the front passenger seats. Some systems may only be on the driver side such as the 2010 - 2014 Toyota Highlander.
- deploy simultaneously with the front airbags in a frontal collision.
- are designed to restrict the occupant's lower body movement, thus enhancing the protection provided by the seat belts and front airbags.
- provide support to protect the knees.

Knee airbags are located beneath the steering column (left). Some systems also have a knee airbag located near the passenger side footwell trim (right).

The knee airbag:

- is designed as a single-stage airbag with inflator assembly. The airbag is triggered in the event of a collision of sufficient severity.
- is triggered by the airbag sensor.
- on the driver side is located below the steering column in the footwell trim and on the passenger side in the footwell trim.
- may deploy even if the seat belt is not worn.
- may have a higher deployment threshold if a seat belt is worn.



These are common parts of a knee airbag system.

The driver and passenger knee airbag modules must be replaced following deployment in addition to other parts that must be replaced following airbag module deployment, such as front airbag sensors. Follow the information listed in the I-CAR Airbag Parts Replacement Recommendations listed at www.i-car.com. This information is also found at the vehicle maker's service information websites.

Module Wrap Up

Topics discussed in this module included:

- adaptive front lighting.
- high beam assist.
- night view assist.
- active head restraints.
- knee airbags.

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Module 3 - Convenience Systems

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Keyless Entry Systems

The learning objectives for this module include identifying and understanding operations of:

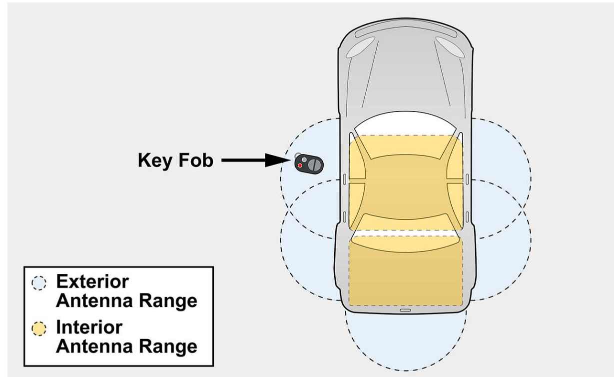
- keyless entry systems.
- theft deterrence systems.
- rain sensing wipers.
- climate-controlled seats.

Key fobs used today are considered either passive or active.

Keyless entry can be divided into two categories, active and passive.

Active keyless entry is the traditional keyless entry where a key fob is pressed to unlock the doors, trunk, or to start the engine.

Passive keyless, which is becoming more popular, allows vehicle entry without pushing buttons on a key fob. Simply carrying a pass key will unlock the door and start the engine with a push button. This system may also be part of the vehicle push-button starting system.

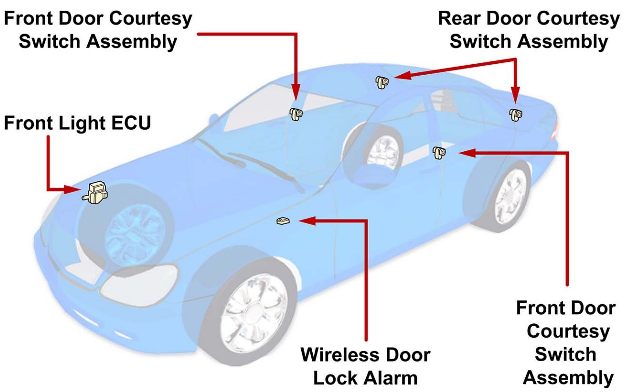


A passive key fob does not require a button to be pushed on the key fob to enter the vehicle.

A passive keyless entry system:

- uses multiple low frequency antennas to receive signals from a keyless entry transmitter.
- transmitter must be within range of the antennas.
- operates when a door handle or deck lid is opened. The antennas send out a signal verifying the transmitter is within range.

The doors unlock when a front outside door handle is gripped. If the driver door is gripped, only the driver door will unlock. If the passenger door is gripped, all doors unlock. All doors lock when the lock sensor on a front outside door handle is touched or if the back door lock switch is pushed.



These are common parts of a passive keyless entry system.

Parts of a passive keyless entry system include:

- keyless entry transmitters.
- antennas (located throughout the interior to cover the entire vehicle).
- an exterior antenna.
- control modules.
- exterior lighting (if equipped).

Diagnosing problems with a passive keyless entry system may require retrieval of DTCs.

When analyzing damage to the passive keyless entry system:

- verify that the keyless entry system works.
- non-operation requires a symptoms table for diagnosis.

Repair may require a:

- scan tool.
- calibration.

Key parts susceptible to collision damage include the:

- electronic control module.
- junction box.
- wireless door lock buzzer.
- door and handles.

All of the electrical parts are generally located under the hood on the driver side by the strut tower. However, the system is tied into the power door locks, switches, exterior and interior electrical key oscillators (which receives request signals from the certification ECU and creates an actuation area around the doors or the vehicle interior), etc. These, too, can become damaged in a collision and typically require a scan tool and service information to diagnose malfunctioning parts.

The key fob must be inside the vehicle in order to use the push-button start feature.

Vehicles with passive keyless entry may be equipped with a push-button start feature. In order to use the push-button start, the:

- key must be in the vehicle.
- brake pedal is depressed.

The vehicle power management receives a signal from the control module that the proper key is in the vehicle and the engine starts.

Some push-button start problems are indicated by a flashing LED lamp on the button.

If there are problems with the push-button start feature:

- a malfunction code may be stored in the power management control module.
- an indicator lamp on the start button flashes when a fault is detected, if equipped.

This is the MyKey key that is used by Ford to provide restricted driving.

Ford has introduced a concept called MyKey. MyKey was introduced on the 2009 Focus, but is now standard on many Ford / Lincoln models. MyKey:

- is a separate ignition key that is given to a family teenager or fleet operator. The key has a built-in microchip that gives special instructions to the vehicle.
- can be switched to limit the top speed of the vehicle.
- limits the audio volume of the sound system to 44% of the maximum.
- encourages seat belt use with a chiming pattern and muting of the sound system.

- includes additional features such as an earlier low-fuel warning and speed alert chime.

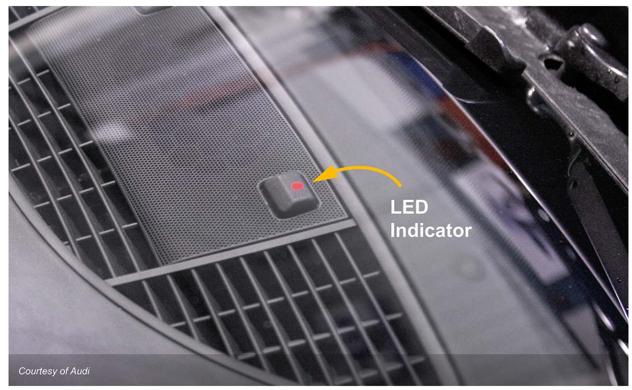
Another system by General Motors operates key comfort features. The 2010 - 2014 Chevrolet Equinox is equipped with a Smart Remote Starting system that also activates the HVAC system and optional heated seats depending on the outside temperature.

Theft Deterence

The General Motors telematics system is used to help recover stolen vehicles.

The typical theft deterrent system is designed to sound an alarm and / or flash the exterior lights during forced entry. These theft deterrent systems have been improved over the years to include more advanced electronics to detect intrusion and limit theft. Some advances include:

- General Motor's telematics subscription service, which has a Stolen Vehicle Slowdown feature that allows OnStar to slow down, stop, and recover stolen vehicles that might be involved in high-speed chases. This feature is in addition to OnStar's feature that uses GPS technology to locate lost or stolen vehicles.
- a listening device that detects the sound of glass breaking, and trips an alarm if the sound is heard.
- engine immobilizers, for when anything other than the proper key is used to start the vehicle.



Most theft deterrence systems are equipped with an LED indicator to show that the alarm system has been activated.

The theft deterrence system operates:

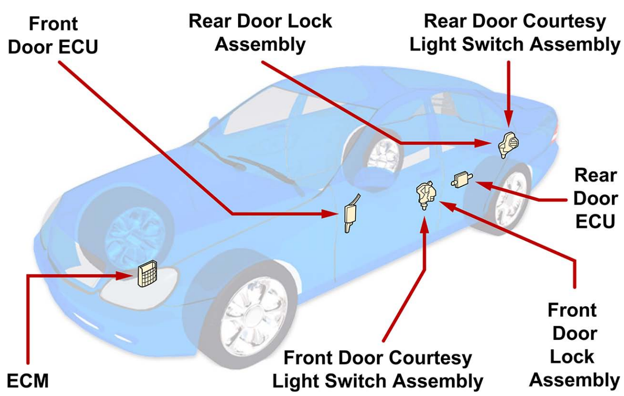
- when the doors are locked, either manually or remotely.
- by monitoring movement, noise, latches, and / or vehicle movement.
- by setting off an alarm when specific criteria are met.

On the Volvo system, the switches are checked three times per second to make sure switches are closed. Volvo also has a:

- movement sensor that detects movement inside the vehicle.

This particular system requires windows to be closed for proper operation.

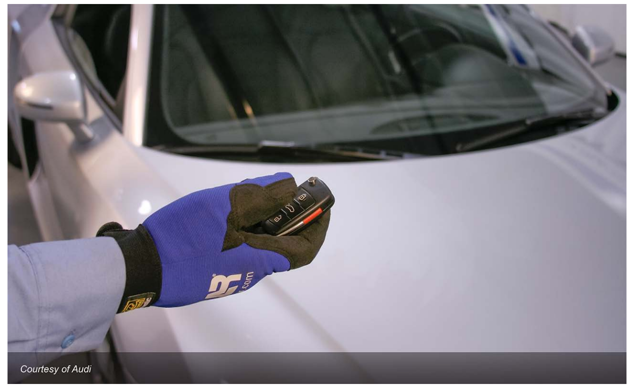
- heartbeat sensor. The heartbeat sensor is used to detect the presence of someone inside the vehicle, with an indicator on the key fob.



These are common parts of a theft deterrent system.

Parts that make up a theft deterrent system include:

- door lock control system parts.
- a control module.
- a security horn. On the Volvo, this may be powered independently of the battery.
- a security indicator lamp.
- door, hood, trunk ajar switches.
- a glass breakage sensor, if equipped. If so, there will also be a glass breakage sensor ECU.



Check for proper operation of the theft deterrent system following any collision.

Common faults may include the:

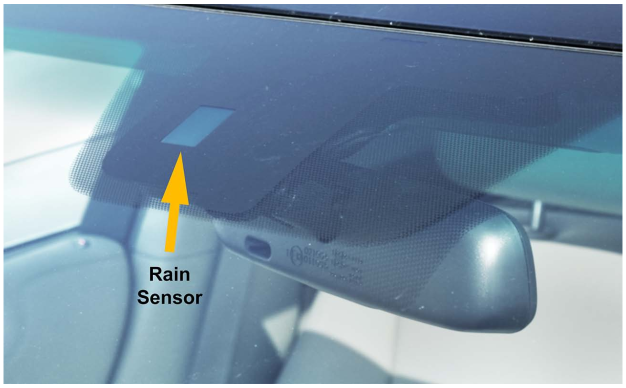
- system not arming.
- alarm not sounding and / or proper lights not flashing.
- system arming when doors / lids are open.

The theft deterrent control module on this Audi R8 is being inspected.

During damage analysis, note that:

- horns are most susceptible to damage.
- most theft deterrent system parts are integrated with other systems.

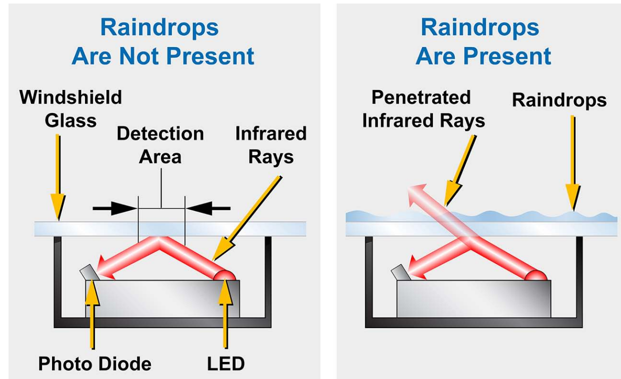
Rain Sensing Wipers



The rain sensor is typically mounted to the windshield next to the rearview mirror.

A popular option, especially in rainy areas, is rain sensing wipers. Rain sensing wipers are designed to detect moisture on the windshield and auto-start the wipers when on.

Contrary to the name, it is not the wipers that sense rain on the windshield but an infrared sensor module. The sensor module is mounted on the interior side of the windshield, in a housing either next to, or part of, the base of the rearview mirror. The module connector is also usually in the same housing.



The rain sensing wiper system detects moisture when the infrared rays of the sensor are deflected by moisture droplets on the windshield.

With rain sensing wiper systems:

- the system is set to the desired sensitivity.
- when the sensor module detects moisture on the windshield, a signal is sent to the wiper motor module to automatically start the wipers. The wipers also automatically stop when the rain stops.
- the wiper switch usually has to be in one of the on settings, or an automatic setting, to allow the automatic function to work.

The switch must be turned on for the rain sensing wiper system to activate.

Parts included in the rain sensing wiper assembly include the:

- wiper assembly (blades, linkage, etc.).
- wiper motor.
- rain sensor.
- junction boxes.
- wiper motor module.

A squirt bottle can be used to test the system.

The presence of a housing next to the rearview mirror with an electrical connection, or a flat sensor pressed against the glass on the front side of the mirror, are indications that the vehicle is equipped with a rain sensor.

When checking for damage, look for damage to the:

- windshield. Cracks or breaks in the windshield near the sensor module would affect its operation.
- housing and the electrical connection.

Initial troubleshooting described by some vehicle makers is as simple as applying water to the windshield. Volvo, for example, says to apply water out of a spray bottle three times and see if the wipers start.

During part replacement:

- a special windshield is generally not required.
- calibration of the system is generally not required.
- the sensor is generally adhered with special tape that is supplied with the part.

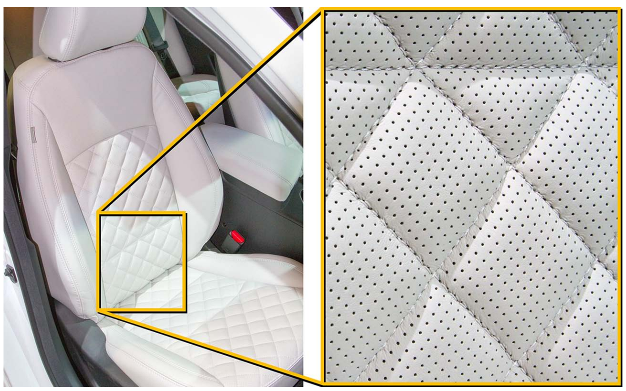
Climate-Controlled Seats

Climate-controlled seats can be heated or cooled.

Advancements in seat technology are mostly designed to increase comfort and reduce driver fatigue. One such technology is climate-controlled seats. Climate-controlled seats:

- provide heat and ventilation.
- may be tied into the HVAC system.
- cannot heat and cool at the same time.

2014 Kia Optima



This closeup of the seat shows ventilation holes.

Heated and cooled seat operation include:

- switches located on the instrument panel, center console, or door panels.
- seat temperature monitored by the seat module.

The 2009 - 2014 Lexus RX 350 has a climate control seat system that uses seat heaters to provide heat and ventilation (blower units) to provide cooling. The cooling system uses interior ambient air, rather than air from the A/C unit. Similarly, the heat function does not use heated air.

The climate-controlled seat system seat heaters have adjustable temperature areas and fixed temperature areas. Adjustable temperature areas are used for the shoulder and lumbar areas and the area of the thighs and knees that easily become cold.

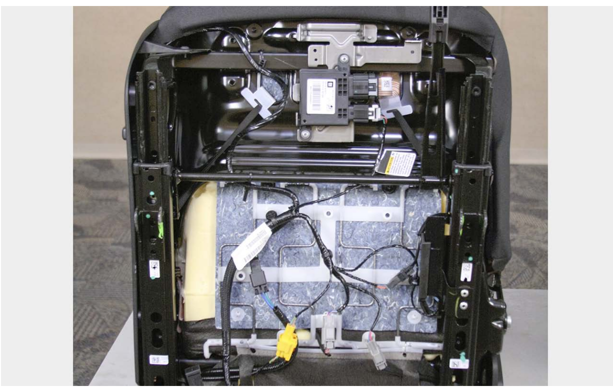
Ford / Lincoln

Ford / Lincoln uses a thermo-electric device to heat or cool the air supply. The climate-controlled seat system is able to heat and cool the front seats. Each climate-controlled seat is operated by push buttons on the HVAC module located on the instrument panel. Each front seat temperature is then monitored and controlled by the Dual Climate-Controlled Seat Module located on the passenger front seat track.

Switches for seat climate control are located on the center console.

The serviceable climate-controlled seat system parts may include:

- an air filter.
- cushion and backrest manifolds.
- cushion and backrest foam pads and trim covers.
- a heat / cool seat switch.
- fuses.
- ventilation ducts.
- blowers.



As seat design becomes more complex, so does system diagnostics.

Issues with the operation of the climate-controlled seats requires:

- a scan tool. Problems may set DTCs.
- a check for signs of obvious physical damage such as torn seat covers, damaged seat frames, or punctures in the seat cushions.
- referencing diagnostic charts to diagnose the problem.

Mercedes-Benz has a seat comfort system called Airscarf that blows warm air through the head restraint.

Blower vents for the Airscarf system can be seen from the backside of the head restraint.

Switches for the climate-controlled seat and Airscarf system are located on the interior door trim panel.

Beginning with the 2010 Ford Taurus, some Ford / Lincoln vehicles now have a seat option called Active Motion. With this particular feature, the bottom cushion provides a massaging motion to help a driver avoid back pain. Other vehicle makers, such as Mercedes-Benz, are also including this type of option into their seat systems.

An optional offering on the Mercedes-Benz SL Class is Airscarf, which:

- blows warm air through the front head restraints. There is a fan inside each front head restraint, and warm air ducted to the fans.
- is referred to as a neck-level heating system.
- forms an invisible "scarf" around the driver and passenger.

Module Wrap Up

Topics discussed in this module included:

- keyless entry systems.
- theft deterrence systems.
- rain sensing wipers.
- climate-controlled seats.