

Power Liftgate Function

Activation Parameters

The power liftgate feature on the Freestar/Monterey can be operated from several activation points as follows:

- Pressing the overhead console button once.
- Pressing the power liftgate button located on the remote keyfob twice.
- Pressing the liftgate trim-mounted switch once.
- Pulling the outside release handle located on the liftgate.

All of these activation methods are disabled when the vehicle's transmission is in a position other than the park position. The power liftgate controller also disables power operation when vehicle speed exceeds 5 kilometers per hour, providing a redundant disable feature.

Power operation via the liftgate trim-mounted switch and the outside release handle is inhibited when the power door lockout control, located in the overhead console, is placed in the "off" position. The overhead console button and the power liftgate button on the keyfob continue to operate, regardless of the position of the power door lockout control. Additionally, the liftgate trim-mounted switch is inaccessible and inhibited from functioning when the liftgate is closed.

When the power liftgate is activated, the direction of liftgate travel is determined as follows:

- If the liftgate is not currently performing a power operation (i.e. the liftgate is at rest or is being manually operated), the liftgate position relative to the fully closed position determines the direction of power operation. If the liftgate is less than approximately 20 degrees of travel from the fully closed position, the liftgate will power open on customer activation. Otherwise, the liftgate will power close.
- If the liftgate is performing a power operation at the time of customer activation, the liftgate will reverse and move in the opposite direction, except that, the liftgate will not reverse from a power open to a power close when the liftgate travel is less than approximately 20 degrees from fully closed. In this situation, the liftgate power operation ceases and motion of the liftgate is determined by external forces (e.g. strut force, gravity)

Power Operation

Normal power liftgate open sequence is as follows:

- When the power liftgate is activated using the keyfob, visual feedback is provided via illumination of the interior lights. The visual feedback only occurs when the ignition is "off".
- The liftgate latch release motor is driven in the release direction.
- Once the latch has been released, the liftgate clutch is engaged and the main drive motor is driven in the open direction.
- When the liftgate is within approximately three degrees of the full open position, the main drive motor is turned off and the clutch is disengaged.
- The liftgate struts push the liftgate the remainder of travel to the full open position.

Normal power liftgate close sequence is as follows:

- When the power liftgate is activated, audible and visual feedback is provided to indicate that the door will be closing.
- After one second, the clutch is engaged and the main drive motor is driven in the close direction.
- When the liftgate reaches the secondary latch position, the main drive motor is turned off and the clutch is disengaged. The latch cinch motor is then engaged to pull the liftgate to the primary latch position.
- Once the primary latch position is reached, the latch cinch motor is turned off.

Audible Feedback

The power liftgate system is equipped with a sound transducer located in the left D-Pillar. The system uses this transducer to provide feedback to the customer on the operation of the power liftgate.

An audible chime will be provided as follows:

- A repetitive one chime per second indication lasting three seconds will be sounded at the beginning of a power close operation. The first chime occurs before movement of the liftgate in the closed direction.
- A repetitive one chime per second indication lasting three seconds will be sounded when an obstacle is detected during a power close or power open operation.
- A continuous tone lasting one second will be sounded when the customer requests activation during conditions when the power liftgate function is inhibited based on either transmission position, vehicle speed, insufficient battery voltage, or Power Door Lockout Control position.

Obstacle Detection

The power liftgate system uses two methods to detect obstacles – change in liftgate speed and pinch strip contacts.

The primary method of obstacle detection uses an optical sensor that monitors both the speed and position of the liftgate. The optical sensor is located in the power liftgate drive assembly and is designed to detect movement of the liftgate. The optical sensor also provides information to the power liftgate controller to determine the direction of travel.

During a power operation in either the closing or opening direction, the power liftgate controller monitors liftgate speed by measuring the width of the pulses from the optical sensor. When the liftgate speed is slower than expected, (as determined by thresholds set within the controller software), the power liftgate controller interprets this as potential contact with an obstacle.

The secondary method of obstacle detection uses pinch strips located along the outer part of the D-Pillar from the top of the liftgate opening to the top of the tail lamp assembly. A pinch strip is a rubber bulb that contains two lengths of conductive material run in parallel along the length of the bulb. When the bulb is sufficiently compressed causing the conductive material to make contact during a power close operation, the power liftgate controller interprets this as potential contact with an obstacle. The pinch strips are not used to detect potential obstacles during the power open operation.

When a potential obstacle is detected by either method during a power close operation, the power liftgate controller reverses the liftgate motion from closing to opening, regardless of

liftgate position. When a potential obstacle is detected during a power open operation, the power liftgate controller will cease power operation of the liftgate and revert to manual operation, regardless of liftgate position.

The power liftgate function described to this point applies to any Ford Freestar or Mercury Monterey vehicle, including any vehicle included in NHTSA Recall No. 06V-069 that has not had the recall service completed.

Liftgate Strut Function

At the end of a power open cycle (typically within approximately 3 degrees from the full open position) the power liftgate controller turns off the main drive motor and disengages the clutch. At this point the position of the liftgate is determined by the performance of the liftgate struts as described below.

When the struts are operating as intended, the liftgate will rise to the full open position unless the liftgate stopped at a point in travel that is less than the "crossover point" of the struts. The crossover point is a position in the travel of the liftgate where the strut begins to provide assist during liftgate opening. The crossover point is a function of the geometry of the strut attachment points between the body and liftgate and is approximately 20 degrees from the fully closed position. If the liftgate is stopped below the crossover point, the struts provide minimal input force and the liftgate will descend back to the closed position.

Strut performance, and thus the crossover point, will vary slightly with ambient temperature. Lower ambient temperatures may degrade strut performance due to the decrease in gas pressure. Additionally, struts may experience a slow loss of gas pressure over time, which will degrade performance. Under these conditions, the customer will observe that the liftgate may not open fully. If the performance is degraded sufficiently, the customer could experience a condition where the liftgate will descend slowly or "sag." Excess weight added to the liftgate (e.g. ice/snow build-up or temporary attachment of a bicycle carrier) can also cause a condition where the liftgate struts are unable to maintain the liftgate position.

Prior to implementation of the remedy associated with NHTSA Recall No. 06V-069, under extreme conditions where a strut loses most or all of its pressure within a short time period, the liftgate could descend more rapidly following a power open operation.

Updated Power Liftgate Strategy

A new feature called "drift control" was added to the power liftgate controller software to resolve an unsupported liftgate condition. This upgraded feature was the remedy associated with the above recall. When the liftgate power open operation is ended, the updated software installed in the power liftgate controller will briefly monitor the liftgate position after the clutch is disengaged. Monitoring is independent of the liftgate position at the time the power open operation is ended. If the liftgate moves in the closed direction by at least ten optical sensor counts within 500 milliseconds from the point that the clutch is disengaged, the power liftgate controller determines that an unsupported liftgate condition exists; the system response is described in "Unsupported Liftgate Closing Sequence" below.

After 500 milliseconds, the controller no longer monitors liftgate position until the next power open operation. This allows for manual operation of the liftgate after a power open operation. If a power close operation is activated during the 500 millisecond period, the system will simply complete a power close cycle.

The agency requested information relating to the "nominal speed thresholds (including tolerances) required to activate the power close feature. The "drift control" feature incorporated in the updated power liftgate controller software does not directly monitor or utilize liftgate speed to determine whether a liftgate is unsupported. As indicated earlier, the system operates by monitoring the number of pulses supplied by the optical sensor for the first 500 milliseconds after the clutch is disengaged.

The power liftgate motor is a rack and pinion based mechanism, where the rotational motion of a motor is transferred to a linear based motion of the rack. Additionally, an intermediate linkage (power liftgate arm) transfers the linear motion of the rack back into rotational motion of the liftgate. As a consequence, the amount of liftgate rotation angle change will vary with liftgate position. Ford has measured the amount of liftgate vertical travel from clutch release to clutch engagement with one liftgate strut removed on vehicles equipped with "drift control" and obtained approximately 4 to 5 inches of travel at the liftgate hem flange relative to the ground. This range results from tolerances within the system.

Unsupported Liftgate Closing Sequence

Once an unsupported liftgate has been detected, the following sequence will bring the liftgate to the fully closed position in a controlled manner:

- The clutch is re-engaged to prevent further liftgate travel as described previously.
- A chime is sounded with a four chime per second repetition rate.
- When the clutch is re-engaged, the chime sounds for two seconds before initiation of the power close, at which time the main drive motor is driven in the close direction. The chime will continue to sound as the door closes.
- Once the secondary latch position is reached, the chime stops sounding, the main drive motor is turned off and the latch cinch motor is driven until the primary latched position is reached.

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If the liftgate power feature is activated during a power close operation while "drift control" is engaged, the liftgate will power reverse to the full open position. Once the full open position is reached, the clutch is disengaged, and the controller will monitor for an unsupported liftgate once again, as described above. If an unsupported liftgate is again detected, the liftgate will perform the closing sequence as described above.

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Obstacle Detection During "Drift Control"

During a "drift control" event, both the primary and secondary obstacle detection methods remain active. If an obstacle is detected during a power close operation that resulted from an unsupported liftgate, the liftgate will power reverse to the full open position, maintain the clutch engagement, and perform another controlled power close sequence.

If an obstacle is detected for four consecutive cycles, the power close sequence is aborted, leaving the liftgate resting on the obstacle. At this point, the liftgate can be operated in the manual mode.

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System Disable – Multiple Unsupported Liftgate Operations

If an unsupported liftgate is detected on ten consecutive power open operations, the power liftgate controller will disable all power liftgate functionality and set a diagnostic trouble code indicating Power System Disabled Due to High Manual Closing Speed. If a power open operation does not engage drift control, the count of consecutive drift control operations is restarted. Power reversals due to obstacle detection do not count toward disabling the power liftgate system, nor do they cause the count of consecutive operations to be restarted. If the power system is disabled, the liftgate can still be operated manually. The power system will be re-enabled when the diagnostic trouble code is cleared via a diagnostic request, or when power is removed from the power liftgate controller and re-applied such as disconnecting and reconnecting the battery.

Manual Operation

As noted above, the liftgate can also be operated in manual mode by selecting the "off" position on the power door lockout control. When the switch is in the "off" position, the exterior handle releases the latch without power open operation. The operator must then pull the liftgate open past the strut crossover point and then the liftgate struts will provide lift assist to the liftgate. The "drift control" system is not operational when the liftgate is manually operated. If one of the struts does not provide the intended level of support while the door is being operated manually, the customer will have clear indication from increased force required to raise the liftgate and the liftgate will not remain in the open position.