Movable Glass (GLA01)

Textbook

I-CAR®

Version 5.2

GLA01-STMAN1-E

This page is intentionally left blank.

Contents

This page is intentionally left blank.

Introduction

I-CAR®

This page is intentionally left blank.

Obligations To The Customer And Liability

The collision repair industry has an obligation to correctly repair the customer's vehicle. Collision repairs must be performed using:

- recommended or tested procedures from vehicle makers, I-CAR, and other research and testing organizations.
- quality replacement parts and materials.
- repair processes and parts as written and agreed upon in the repair order. If items on the repair agreement are not consistent with the repair order, it can be considered fraud.

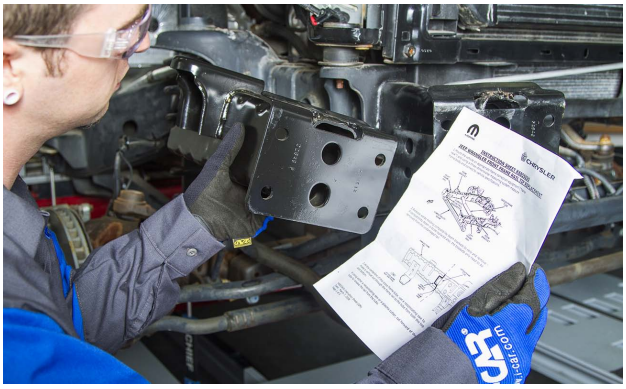
Performing proper collision repairs requires using parts and procedures that keep remaining warranties intact.

Collision repairs must restore:

- safety.
- structural integrity.
- durability.
- performance.
- fit.
- finish.

Throughout the damage analysis and repair process the repairer and insurer must:

- communicate with each other.
- maintain constant communication with the customer.
- be in agreement with each other and the customer on how repairs will be performed.
- inform the customer of any changes in the repair plan from the original repair agreement, and explain the changes and why they have to be made.



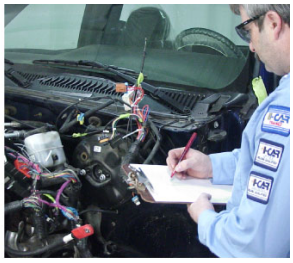
To reduce liability:

- make sure that all repairs are performed thoroughly, correctly and as listed in the damage report.
- follow proper procedures.
- have documentation of required repairs with detailed record keeping available for customers.

Technicians are considered the experts and are expected to be knowledgeable on how to perform a quality repair.

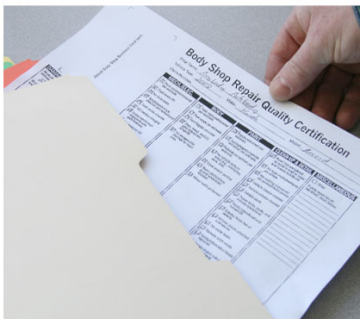
Liability insurance that covers the repair facility may not always cover all damages. For example:

- the policy may not cover faulty repairs, leaving liability responsibility completely on the facility.
- a shop owner may find that repair facility liability coverage may not cover the full amount awarded in a lawsuit. The shop owner would have to pay the difference.



It is difficult to reduce the risk of liability exposure. The part that the repairer can control is the chance of being found at fault. Chances can be minimized by:

- using recommended or tested procedures from the vehicle makers, I CAR, or other research and testing organizations.
- using quality replacement parts and materials that restore fit, finish, durability, and perform at least as well as the original.
- keeping thorough records.



Keeping thorough records includes more than recording the date, mileage, and pre-existing damage. Record keeping also includes:

- making sure all notes are legible.
- verifying the repairs that were made or not made.
- having the customer sign a waiver for repairs that they do not want performed. Repairers must determine their liability on not repairing safety systems such as restraint and anti-lock brake systems.
- keeping computer printouts or worksheets on file showing wheel alignment readings or vehicle dimensions before and after repairs.
- keeping scan tool printouts and records of computer codes for airbag, anti-lock brake, emission, and powertrain control module (PCM) systems.

- attaching the OEM or other tested procedure printout to the vehicle repair order.
- keeping receipts for all sublet work performed.

Refer to "Video: Topics Off Limits" in the presentation. This video identifies topics that should not be brought up in class.

This page is intentionally left blank.

Module 1 - Movable Glass Overview

I-CAR®

This page is intentionally left blank.

Movable Glass In Vehicles

Learning objectives for this module include:

- explaining the role of movable glass in vehicles.
- identifying different types of movable glass construction.
- identifying types of movable glass drive mechanisms.
- determining glass ordering and identification issues.
- identifying special cautions when working with movable glass.

One of the functions of movable glass is to provide ventilation when the sunroof is slid back.

Movable glass in vehicles provides:

- visibility into and out of the passenger compartment.
- protection from the elements and flying debris for both the vehicle occupants and interior. Movable glass also provides protection from theft, since when the glass is in the closed position the vehicle can be locked up to reduce access to the passenger compartment.
- ventilation of the passenger compartment.
- access into and out of the passenger compartment.

Tempered safety glass shatters into small pellets and falls from the opening when it breaks.

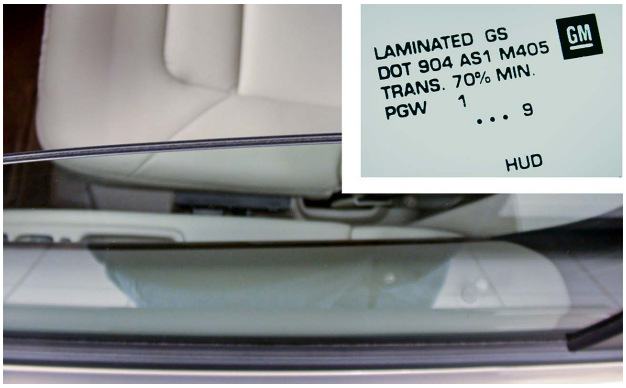
Tempered safety glass:

- is commonly used for movable glass in vehicles.
- breaks by shattering into small pellets that have no jagged or sharp edges. Once the surface film of a piece of tempered glass has been penetrated, the glass simply shatters into pieces that fall from the opening.
- is made by heat-treating single pane float glass. The glass is heated to approximately 1,200°F and then rapidly cooled. This process toughens the outer surface of the glass as many as ten times over standard float glass. Float glass is made in a single operation by floating a molten ribbon of glass over a bath of molten tin. The glass gradually cools as it travels across the surface of the

molten tin bath producing a flat glass sheet.
- is limited in its repairability to light scratches and scuffs. There are a variety of glass scratch repair systems available. Refer to the equipment maker for information on the repairability of specific scratches. Traditional glass scratch repair systems use a slurry compound and hard felt buffing pads to remove scratches. The slurry compound is an abrasive in a paste form. Systems are also available that do not use an abrasive slurry compound.

Glass Weld Systems, Inc. has a scratch repair system that removes scratches without removing glass. This results in a distortion-free repair. Information on this is available at: www.glasweld.com.

Glass Technology has a scratch repair system that does not use a slurry compound to polish the glass. Information on this can be found at: www.gtglass.com.



This laminated side door glass clearly shows the plastic laminate between the two glass layers.

Laminated safety glass:

- is limited in its use in movable glass applications. Laminated side glass may be standard equipment on some vehicles or offered as an option. Some vehicles may have either type of glass used in the side and back glass.
- is made by bonding a plastic layer made of polyvinyl butyral (PVB) between two sheets of glass.
- stays intact when it breaks. The tough plastic inner layer holds the glass together when it breaks.
- that is used in movable glass locations is similar in construction to windshield glass and can have the same types of damage repaired as windshields.

Some reasons for using laminated glass in the side and rear include increased protection against passenger ejection in rollover crashes, increased noise reduction, and increased theft protection when compared to tempered glass.

Refer to “Video: Breaking Glass” in the presentation. This video shows

the difference in how tempered and laminated glass break.

Drive Mechanisms

The most common type of drive mechanism is an electric motor.

Window regulators can be driven by electric motors (power), or human input (manual), with the glass movement controlled by:

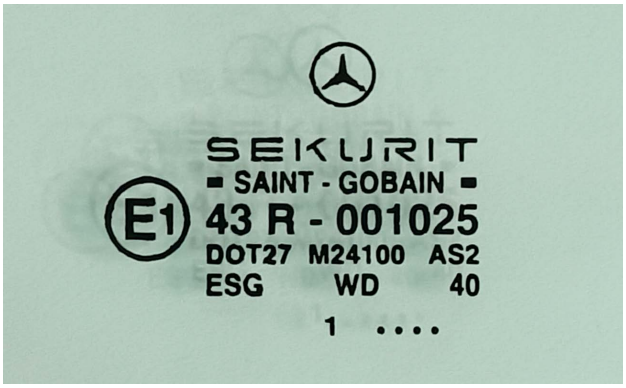
- gears and arms between the drive source and the glass.
- cable and pulley arrangements. Cable-operated regulators allow the glass movement to be faster than was possible with gear-and-arm systems.
- plastic straps. The use of window regulators that have plastic straps to raise and lower the glass is very limited.

These are some of the electrical parts of a power window system.

Electrical parts used in power drive window systems include:

- the electric motor.
- switches to activate the motor.
- wiring harnesses that transmit the electrical signals from the switch to the motor.
- hard-shell connectors or plugs between the wiring harness and related parts.
- relays. A relay is a second switch that is energized by the primary switch or computer that allows current to flow to the drive motor. Relays are necessary because switches and computers cannot handle the amount of electrical current necessary to power the electric drive motor.
- control modules for express and other complex operation modes.
- fuses used for circuit protection. Fuses may be located in a variety of places, with many vehicles having them in more than one location. Service information may be useful when determining locations for specific fuses.

Replacement Glass Ordering



This is an example of a glass marking or "bug" that is located at the bottom of every piece of motor vehicle glass.

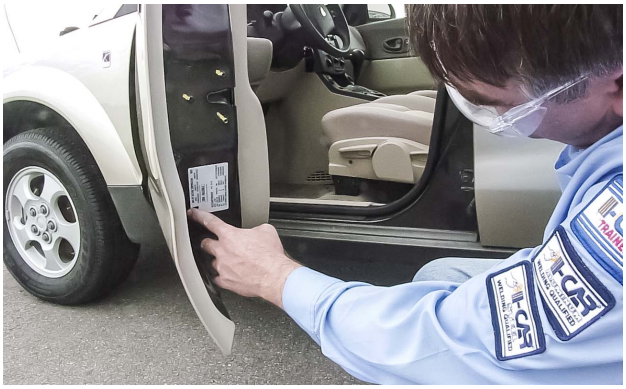
The coding information, or markings, located on the bottom of the glass is called the "bug." The bug may be located in the center or at either end of the bottom of the glass. Federal Motor Vehicle Safety Standard 205 states that all glass is required to be marked according to ANSI Standard Z26.1. This standard requires that all automotive glass be marked with:

- a Department of Transportation (DOT) number. This number is assigned to the glass maker by the DOT.
- the American standard (AS) code. Automotive glass will have either an AS1, AS2, or AS3 code in the bug. AS1 is for windshields and must be laminated with at least a 70% light transmission, and meet certain other requirements for optical quality and penetration resistance. AS2 is for glass anywhere but the windshield, and may be tempered or laminated with at least a 70% light transmission. AS3 is for glass anywhere except windshields and front doors, and may be tempered or laminated with no requirement for minimum light transmission. Privacy tint glass is marked AS3.

Additional markings that may be on the glass include:

- the name of the glass maker.
- whether the glass is tempered or laminated.
- a designation for solar controlled tint, if applicable to the glass. Solar controlled glass will absorb or reflect a high percentage of the sun's infrared (IR) and ultraviolet (UV) rays. This helps control fading interior parts and aids in the efficiency of the air conditioning system.

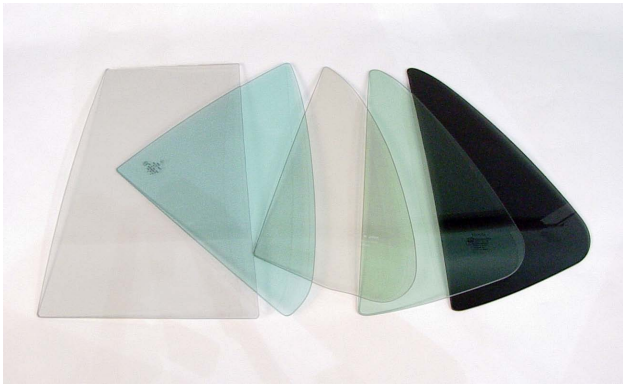
Since these additional markings are not required, and are not consistently marked by the glass maker, the bug is generally not useful when ordering the replacement glass.



This technician is locating the VIN for ordering a replacement glass.

When ordering replacement parts, glass can be identified by:

- supplying the year, make, and model of the vehicle along with the location, tint color, and construction type of the glass.
- the use of vehicle identification number (VIN) driven parts ordering systems that are available through the vehicle maker dealership's parts room.



These are examples of some of the different tint colors that are available for vehicle glass. The glass on the far right is privacy tint.

Factory glass may be clear or tinted. Tinted glass can be a variety of colors. The tint color of the glass may depend on the color of the exterior and interior of the vehicle. Common tint colors include:

- blue.
- bronze.
- green.
- gray.

Privacy tinted glass:

- is extremely dark.
- limits visibility into the vehicle from the outside.
- is only allowed behind the driver and cannot be used for windshields or front door glass.

The top edge of this glass shows the line left where the aftermarket tint film is stopped.

Aftermarket window tinting films:

- often look like factory privacy tint at first glance.

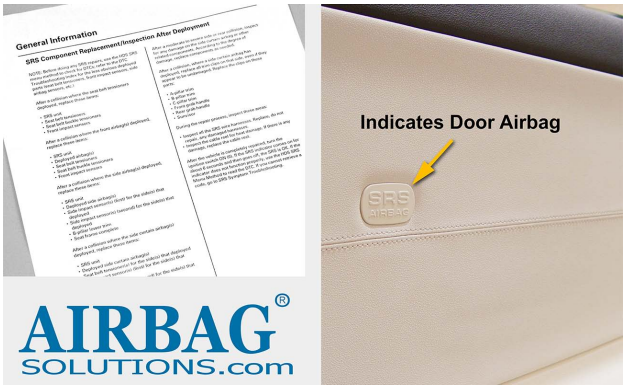
- can be identified by looking at the glass edges. The tint film will usually be trimmed so that it does not go all the way to the glass edge.
- use is limited by regulations that vary from state-to-state.
- can make determining the factory tint color of the glass very difficult.
- are easily scratched or damaged. Extra care is required when working with glass that has aftermarket tint film applied to it.

Special Concerns

This is a side curtain airbag deploying from behind the headliner of a vehicle.

The use of supplemental restraint systems in vehicles has led to:

- airbag modules being located in door shells and seats.
- airbag sensors located in door shells and pillar areas of vehicles. Vehicles with side airbags located in their seats may have the side impact sensors located in their door shells.
- pressure-based side impact sensors in some door panels. These require other impact sensors in other areas in case the door is not impacted. Examples of vehicle makers that use pressure-based side impact sensors include BMW, Mercedez-Benz, Ford, Jaguar, and Volkswagen.
- side curtain airbags located in the roof rails behind the headliner and trim.



These are some of the ways of identifying side airbag system presence in a vehicle.

Some ways of identifying side airbag systems include:

- looking for a supplemental restraints system (SRS), supplemental inflatable restraints (SIR), side impact protection system (SIPS), or airbag warning label on the door trim panel, front seat, sun visor, or interior trim on the A- or B-pillar.
- referring to the vehicle service information online.
- using aftermarket airbag information. There are various information providers that have

airbag-specific repair and / or identification information online.

Airbag identification information is available from:

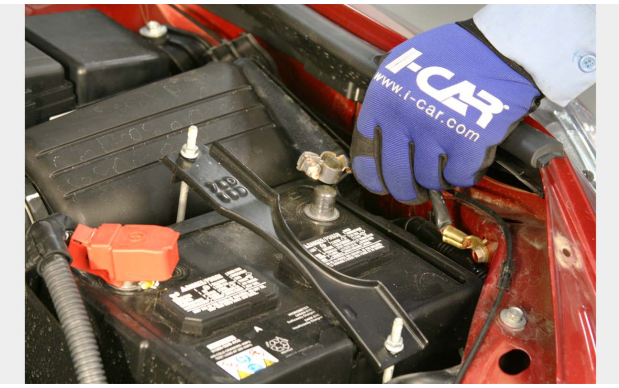
- Motor Information Systems at www.motor.com.
- Mitchell International at www.mitchell.com.
- Airbag Solutions at www.airbagsolutions.com.
- I-CAR at www.i-car.com.

Personal Safety

For safety around an airbag system when working on a vehicle always follow the vehicle maker's recommendations and procedures for disabling and enabling the airbag system. Do not work on or around airbag system parts without first disabling the airbag system. Whenever servicing movable glass assemblies that are in the same vehicle panels as airbags or airbag parts, always disable the airbag system as the first step in the repair. Also be aware that side airbag systems are still enabled in vehicles that have had a front airbag deployment.

Vehicle Protection

Always determine the presence or absence of side airbag systems before beginning work on movable glass assemblies. Observe proper procedures when handling undeployed airbag modules that have been removed from the vehicle. Never carry an undeployed airbag by the wiring and always have the cover facing away from your body. Store undeployed airbags in a clean, dry place, away from sources of heat, sparks, and electrical energy. Store with the covers facing up.

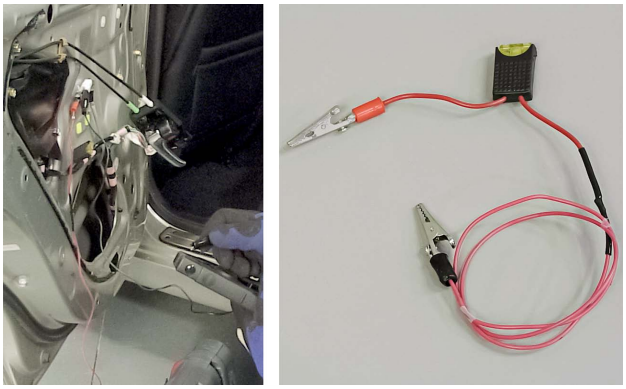


Disconnecting the battery cables will help avoid setting airbag trouble codes.

Some vehicles equipped with side airbags may require the removal of an airbag module during the service of movable glass assemblies. Powering up the electrical system to move the glass for fastener access with the airbag system disabled and airbag parts removed may set a trouble code that must be cleared by a scan tool. To avoid setting airbag diagnostic trouble codes:

- follow the vehicle maker's procedures for the disabling and enabling of the airbag system and service of the movable glass assembly.
- have the key in the OFF position and out of the ignition while working on the vehicle.
- leave the battery disconnected until all parts have been replaced and the airbag system is enabled. Disconnect both cables and

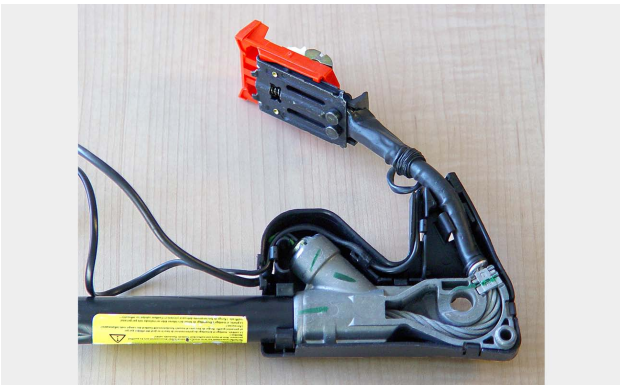
isolate them by taping the ends. This will avoid the possibility of the cables accidentally contacting the battery posts and energizing the vehicle electrical system. Follow the vehicle maker's recommendations for recording and resetting electronic memories when disconnecting the battery.



Fused jumper wires can be used to move a power window glass in a vehicle that has the battery disconnected.

In some instances, it may be necessary to move a power window glass while the vehicle battery is disconnected. Ways to move a power window glass with the battery disconnected include using:

- jumper wires and a remote 12 volt power source. Make sure that the jumper wires have an in-line fuse to prevent accidental shorting. When moving windows with jumper wires, the motor must be unplugged and the wire probes connected to the wiring directly off of the motor. Do not connect jumper wires directly into the wiring harness of the vehicle or to a motor that is connected to the vehicle wiring. Do not use jumper wires to move the window in a door that still has airbag system parts in the shell. This will ensure that airbag parts are not accidentally energized by touching them with the jumper wires.
- a power window or express-down bypass tool. Specialty tools are available that allow rolling the glass up and down with a switch located on the tool. Power is supplied to the motor through leads off the tool, which is plugged into a 12 volt power point source. Do not connect a bypass tool directly into the wiring harness of the vehicle or to a motor that is connected to the vehicle wiring. Do not use a bypass tool to move the window in a door that still has airbag system parts in the shell. This will ensure that airbag parts are not accidentally energized by touching them with the bypass tool leads. Do not use bypass tool leads that puncture the insulation of the wires. This can cause wiring to corrode from moisture intrusion.



This explosive seat belt pre-tensioner is a part of the passive restraint system.

Personal Safety

Disable the restraint system following the vehicle maker's procedures before working near or disconnecting seat belt pre-tensioners.

Seat belt pre-tensioners:

- contain an explosive charge that moves a plunger to remove the slack from the seat belt.
- are part of the passive restraint system.
- use the airbag system sensors and electronic control module to control deployment.
- need to be checked for glass fragments that may get into the retractor mechanism during a collision that causes glass breakage. Do not clean broken glass from a seat belt pre-tensioner assembly without disabling the restraint system.

This technician is removing the power window switch to disable the express down feature.

Many power window systems contain a feature called express down. The express-down feature may only be available on the driver side front door glass while other vehicles may have the express-down feature available on both the driver and passenger side front windows. Considerations when working in a door that has this feature include the potential for injury or damage to parts by unwanted activation of the express-down feature. The express-down feature allows the glass to be rolled completely down without holding the switch down for the entire time the glass is moving. Activating the express-down feature with your hand or door parts in the path of the glass may cause personal injury or part damage.

Ways to protect yourself when working in a door that has the express-down feature include:

- removing power from the power window motor before starting repairs. Ways of removing power from the motor include turning the ignition off and removing the key, disconnecting and isolating the

battery cables, and disconnecting the window motor electrical connector. Do not just disconnect the master window switch. The master switch in the power window system may be wired in series with the switches in the other doors, but this is not always the case. If the master switch is wired in series, and the switch is disconnected, none of the other switches will roll the window up or down. On especially European-made vehicles, each window will have its own independent control switch.

- removing the window switch from the wiring harness.
- using a power window or express-down bypass tool to move the glass.
- moving power windows with jumper wires.

Some vehicles may have a one touch-up feature on the power window systems. The one touch-up feature is similar to the express-down feature except that it rolls the window up.

Since model year 2008, all vehicles are required to have an "anti-pinch" feature included with all powered movable glass. With this system, the glass stops and reverses if there is an obstruction in the glass opening. This prevents a child's hand from being pinched in the glass if, for example, they accidentally lean on the switch with their hand in the opening. When replacing a window motor, the anti-pinch feature must be tested to be sure it is working properly. In many cases, a calibration procedure is required and with some vehicle makers, such as Volvo, a scan tool is required. Follow the vehicle maker instructions for calibrating the anti-pinch feature.

Personal Safety

Never move a power window with your hand inside the door shell. The power drive motors have enough power to cause personal injury if a hand is caught between the glass and any other part of the door. Disconnect the window switch when working inside doors that have the express-down feature. Deactivate the power door glass using the specific vehicle maker's procedure. When activated, the express-down feature allows the glass to move quickly and without stopping, which could cause personal injury.

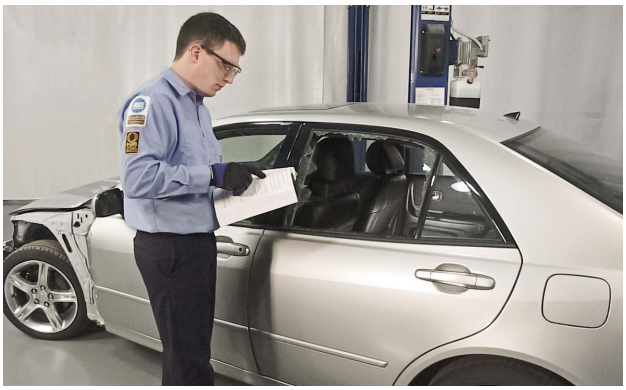
Vehicle Protection

Do not use bypass tool leads that puncture the insulation of the wires for the electric motor. Do not connect a bypass tool directly into the wiring harness of the vehicle or to a motor that is still connected to the vehicle wiring.

These are some of the mechanical fasteners that may be used to fasten a door glass to a window regulator.

When installing glass fasteners that hold movable glass and hardware:

- always use the proper fastener in the correct location. Replace fasteners with the same type and size as those removed. Different types of rivets will have different clamping forces and improper selection could lead to a broken glass. Bolts that are the improper length may cause interference with other parts causing glass damage or improper operation. Also make sure that any protective washers that were present between the fastener and glass are reinstalled.
- observe the proper torque specifications when tightening a fastener. Torque specifications can be found in OEM service information.
- use the correct tightening sequence for multiple fastener applications.
- only use locking compounds, sealers, or lubricants on fasteners where recommended by the vehicle maker. Using lubricants where not recommended can affect torque readings and lead to improper torque. Failure to use locking compounds where called for may result in fasteners working free from vibration and use.



This technician is checking the service information before beginning work on the replacement of the rear door glass of this vehicle.

When working on movable glass assemblies, it is essential to develop a repair plan before starting work. Developing a repair plan would include:

- verifying that the proper parts are available.
- determining if any special tools are required.
- determining what is going to be done.
- determining how the task is going to be done. This may include looking up procedures in the service information.
- identifying any special issues or cautions associated with the tasks to be performed.

Module Wrap-Up

Topics discussed in this module included:

- the role of movable glass in vehicles.
- the different types of movable glass construction.
- types of movable glass drive mechanisms.
- glass ordering and identification issues.
- special cautions when working with movable glass.

Module 2 - Side Door Glass

I-CAR®

This page is intentionally left blank.

Styles Of Roll Up Side Door Glass

Learning objectives for this module include:

- identifying types of roll up side door glass.
- identifying parts of roll up door glass assemblies.
- identifying issues with the repair and replacement of door glass, window regulators, runs, channels, and related parts.
- working with different types of glass-to-regulator attachments.
- determining general guidelines and procedures for the adjustment of roll up door glass assemblies.

This is an example of a framed door glass.

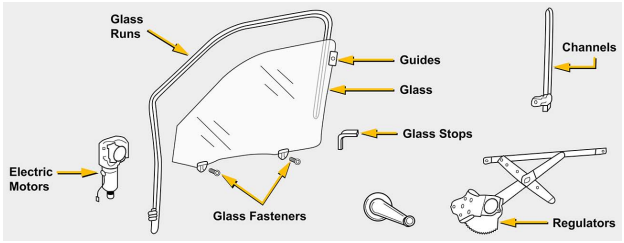
Framed door glass:

- has a frame or portion of the door shell completely surrounding the glass perimeter.
- is not as prone to glass alignment problems as frameless door glass assemblies.
- typically has fewer glass alignment adjustments available than frameless door glass assemblies.

This is an example of a frameless door glass.

Frameless door glass assemblies:

- have no frame or part of door shell surrounding the glass. When the door is opened, the edges of the glass are exposed.
- typically have adjustments available to move the glass in all directions.
- are susceptible to alignment problems.



This illustration shows the main parts of a typical manual door glass assembly.

Parts of a typical roll up door glass assembly include:

- the glass.
- the glass fasteners. These may be clips, clamps, or any type of mechanical fastener such as rivets, bolts, or nuts that are used to secure the glass to the window regulator.
- window channels or tracks. These are typically U-shaped metal channels that the glass slides in as it is being rolled up and down.
- rubber glass runs that line the window channels to cushion the glass as it is rolled up and down.
- window regulators to move the glass up and down.
- electric motors to drive the window regulators.
- glass stops to limit window movement.
- guides that help hold the glass in position and keep it in its tracks or channels as it is rolled up and down.

Replacing Side Door Glass

After picking up large pieces of broken glass, smaller pieces can be removed by vacuuming.

To clean up broken glass in a vehicle:

- carefully remove the large pieces with a gloved hand, and dispose of properly.
- remove any broken pieces of glass that may be stuck in the runs. Use caution to avoid damaging the run. Do not use a screwdriver to clean broken glass pieces from the run. The hard sharp edges of the screwdriver blade may damage the run. Specialized tools are available for cleaning broken glass from the runs. The tool has a smooth rounded ball on the end that is pushed through the run to dislodge glass fragments from it.
- turn the blower motor on high, with the selector in the A/C or VENT position, to clear the vents of any glass fragments.
- vacuum up remaining glass pieces using an up-and-down, dabbing, motion. Pulling the vacuum hose back-and-forth over glass fragments could possibly damage the vehicle interior.

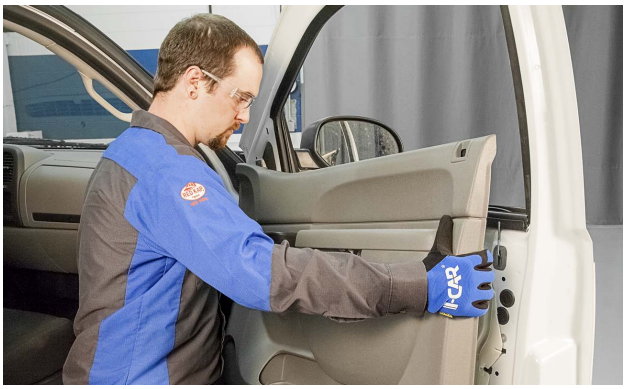
Personal Safety

When working around glass, always wear approved safety glasses for eye protection and gloves for hand protection.

Vehicle Protection

When working with glass on vehicles, keep in mind that broken glass is sharp and can cause damage to interior and painted surfaces. Always place protective

coverings on vehicle surfaces that could be damaged during the repair.



The door trim panel is being carefully removed to avoid damaging it.

In order to access the glass, the door interior trim panel on most vehicles must be removed. Issues involved with the removal of these trim panels include:

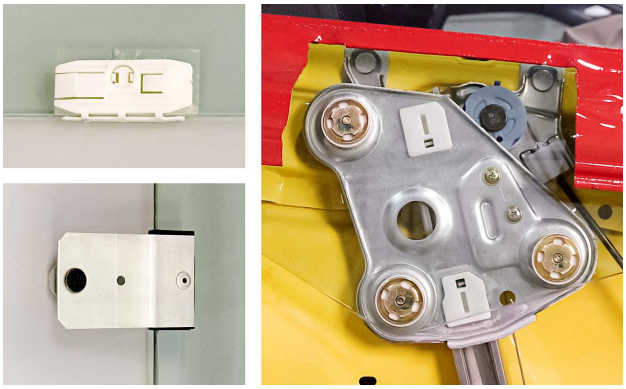
- the variety of possible attachment types to the door shell. This makes identifying necessary removal procedures before starting work important. Some panels can be attached with push-in retainers while others may have fingers or hooks that slide down and into slots in the door shell. Service information is a good source when determining the attachment method of the trim panel.
- fasteners that may be difficult to see. Fasteners may be hidden behind lights, switches, or removable covers.
- the use of special tools. Specialized tools needed for door trim panel removal may include a window crank removal tool and trim pad removal tools.

Always follow the correct procedures for door trim panel removal to avoid damaging the panel.

Caution is used while removing the moisture barrier to avoid tearing it.

After removal of the trim panel:

- remove the plastic moisture barrier to access the glass. Use caution when removing the moisture barrier to avoid tearing it. If the moisture barrier is torn, it must be repaired with waterproof tape, if it can be. If the door is equipped with a pressure sensor, there will be a different type of moisture barrier that if damaged must be replaced.
- clean up any broken glass that remains in the door bottom and the lower glass runs using a vacuum.



These are examples of some of the ways a door glass may be fastened into a vehicle.

The door glass may be fastened to the regulator:

- by bonding into a channel. This channel is sometimes called a sash. The sash channel is attached to the regulator with bolts, nuts, rivets, or by sliding over a roller guide that is attached to the end of the regulator lifting arm.
- with studs and nuts. The nuts may be a special design that requires the use of a specialized tool for removal.
- with bolts.
- with rivets. The glass can either be riveted directly to the regulator or riveted to brackets that are then attached to the regulator with bolts or nuts.
- with plastic retainers or clips.
- with clamps. Door glass may be held to the regulator by clamps that work like small vises clamping the glass between two jaws with a rubber insulator located between the glass and the clamp.

There may be plastic, protective washers located between the glass and the fasteners. To avoid breaking the glass, always replace fasteners with the same type as those removed and follow all torque recommendations.

This technician is wearing appropriate hand and eye protection while removing the door glass from a truck.

Some of the steps required to remove the glass from the door include:

- locating the holes to access the fasteners in the door shell.
- positioning the glass so that the fasteners are aligned with the access holes in the door shell.
- disconnecting the power to the electric drive motor, if applicable. This is especially important on windows with an express-down feature.
- removing any necessary parts for fastener access or glass removal. This may include channels, runs, glass stops, guides, and belt weatherstripping. In many applications, both the inner and outer belt weatherstripping requires removal for window glass removal and installation.

- removing the glass-to-regulator fasteners.
- removing the glass from the door shell. Some door glass may have guide clips, often called butterfly clips, on one or both of the glass sides. These clips snap into the window channels to help hold the glass in position as it is rolled up and down. To remove the glass from the door, these clips must be popped out of the channel.

Refer to “Video: Window Guide (Butterfly) Clips” in the presentation. This video shows an example of glass that uses a butterfly clip.

A special bit and guide tool are being used to cut the head off of the rivets used to fasten this door glass.

Rivets that hold glass and related parts can be removed by drilling. This can be made easier by punching out the center mandrel first and then drilling the rivet out with a conventional drill bit. When punching out the center mandrel, be sure to place supports between the glass and outer door panel to stabilize the glass. Special punches are available that have a head that centers the punch on the rivet and holds it while the mandrel is tapped out.

Special drill bits are also available that remove the rivet head while leaving the center mandrel untouched. If the mandrel does not protrude from the rivet head sufficiently to hold the bit in place, a rivet head drill bit guide tool may be used to keep the bit centered on the rivet head.

Sometimes when drilling out rivets, the rivet head will spin and not allow the drill bit to cut. If the back of the rivet can be accessed, a pair of locking pliers can be used to hold the rivet. If the back of the rivet is not accessible, special tools are available to prevent the rivet from spinning. There are plastic wedges that hold the protective washers tight against the rivet head in cases where the glass is broken. Another tool has teeth that cut into the rivet in the opposite direction of the drill bit rotation that hold the rivet head while the drill bit drills the center of the rivet out through an opening in the center of the tool.

Once the rivet head has been removed, any remaining pieces of the rivet can be removed by tapping them out with a

punch. These procedures can also be used when removing rivets that fasten window regulators to door shells, or any other riveted-in window assembly part.

These are some tools that can be used to install rivets.

Rivets used to fasten the door glass to the regulator:

- must be the correct type, diameter, and length.
- are used with plastic protective washers between the glass and the rivets.
- are installed with a 6 mm (1/4") rivet gun. An extended length head on the rivet gun will allow rivets that are recessed in tight areas to be set.

This information also applies to the installation of rivets used to fasten regulators or any other part of a movable glass assembly.

These are examples of window retaining nut tools (left) and special retaining nuts and protective washers (right) used to fasten the door glass in some vehicles.

Considerations for the removal and replacement of door glass that is fastened to the regulator with bolts or nuts include:

- retaining nuts that hold the glass to the regulator. The nuts may be a special design with a large, thin, flat head. Special tools are required to remove these nuts.
- using plastic protective washers between the glass and the fasteners.
- following the recommended torque specifications when tightening the glass-to-regulator fasteners.

There are a number of different urethane and primer combinations that can be used as the adhesive when a glass is bonded into a channel.

When working with glass bonded into channels, consider:

- the removal of the remaining pieces of broken glass and adhesive from the channel. Special tools are available to perform this task. Place the channel in a vise to securely hold it while removing the glass fragments and adhesive.
- that glass primer is required when using urethane as an adhesive. Use the primer recommended by the adhesive maker. Prime both the glass and the metal channel. Failure to follow this step can lead to premature separation of the glass from the channel.
- the proper positioning of the channel onto the glass. This may require a dry test-fit of the glass and channel into the door before bonding the glass into the channel.
- the cure time of the adhesive used. Once the glass is bonded into the channel, it should not be disturbed until the recommended cure time has elapsed.

This door glass is being positioned in the door shell and fastened to the window regulator.

Personal Safety

When carrying glass, always wear approved safety glasses and gloves. Never carry the glass over your head or under your arm. Carry the glass with your palms up and arms in front so that if dropped, the glass will fall away from you.

Some tasks required to install the replacement glass in the door may include:

- transferring any necessary parts to the new glass as a bench operation.
- positioning the glass in the door shell and supporting it as necessary.
- manually raising and lowering the glass in the tracks to check for binding. Raise and lower the glass by hand before connecting it to the regulator. If a severe binding condition is present, this will avoid the possibility of damaging the regulator when rolling up the glass.

- installing the glass-to-regulator fasteners and torquing them to their proper specifications. Be sure to reinstall any protective washers that were between the glass and fasteners.

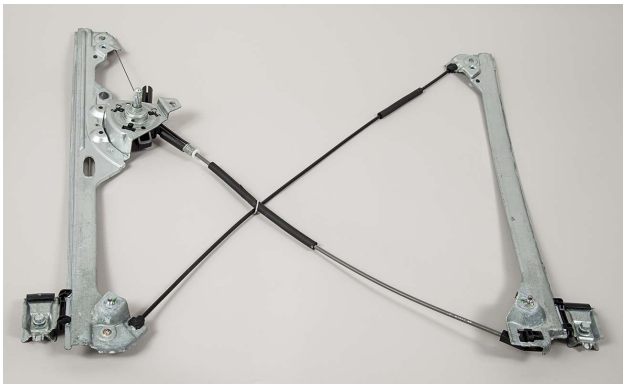
Some vehicles may have side impact protection foam in the door shell that needs to be removed to access the glass. This foam must be reinstalled to maintain the proper side impact protection of the vehicle. This is especially important with doors that contain side airbag pressure sensors.

This technician is installing the door glass into the door shell.

Additional tasks required for installing door glass may include:

- reinstalling all parts that were removed for fastener access or glass removal.
- reconnecting the power to the window motor. This may include plugging the window motor in and reconnecting the battery cables.
- checking for proper operation, glass fit, and glass sealing.
- adjusting the glass or channels for proper fit and operation.
- reinstalling the moisture barrier and trim panel. This is especially important with doors that contain side airbag pressure sensors.

Window Regulators



This is an example of a cable operated window regulator.

Roll up door window regulators can be either powered by an electric motor or manually driven by human input. The movement of the glass may be controlled by a:

- cable and pulley arrangement.
- gear and lifting arm assembly. Single-arm designs have a one-piece arm with a gear or sprocket on one end that contacts the drive source. On the other end, a roller guide slides into the glass sash channel and pushes or pulls the glass up and down. Dual-arm designs have two arms that are attached at a pivot joint towards the center. One end of each arm has a roller guide that slides into the glass sash channel. On the

other end, one arm has a gear or sprocket that contacts the drive source. The other arm has another roller guide that slides in a horizontal channel in the door shell.
- plastic strap between the drive source and the glass.

This window regulator is being removed through an access hole in the inner door shell.

Required steps when removing window regulators may include:

- removing the door glass.
- positioning the regulator at its midpoint, half up and half down, on gear-and-arm style regulators. This may be necessary in order to feed the regulator out of the door shell.
- identifying the regulator-to-door attachment method. Regulators can be attached with bolts or rivets. Rivets can be a special design called a “T” or peel-type and must be replaced with the same type rivet.
- removing the regulator-to-door shell fasteners.

It may be necessary to remove the inner door panel as a complete assembly to access the regulator.

This technician is carefully positioning a replacement window regulator into a door shell.

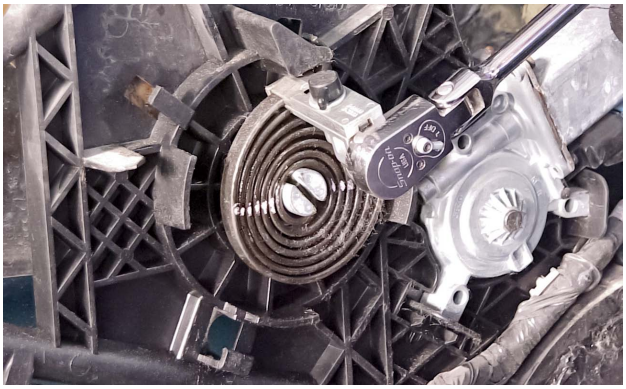
Tasks required when installing a window regulator may include:

- inspecting the replacement regulator to make sure it is undamaged and correct for the application.
- positioning the regulator in the door shell and installing the regulator-to-door shell fasteners.
- installing the door glass.
- checking for proper operation of the window through its full range of movement.

The pulley on this window regulator is being inspected for damage and wear.

When inspecting window regulators, look for:

- bent parts, such as lifting arms or mounting brackets. Many gear-and-arm style regulators have arms made from fairly thin metal and are easily bent.
- loose or missing fasteners. If the regulator is not securely attached to the door shell, the glass may bind when it is rolled up. Also check the door shell for cracks where the regulator-to-door fasteners are located.
- loose or worn pivot joints on lifting arms. Loose pivot joints on dual arm regulators may lead to binding when the glass is rolled up. Also check the roller guides on the end of the lifting arm for damage as these guides are typically made of plastic.
- damaged gears. Stripped or missing teeth on gear-and-arm style regulators may cause the window to be inoperative at certain points in its travel.
- broken cables or straps. Also check the condition of the pulleys that the cables run over.
- the full range of travel when the window is rolled up and down. Roll the window to its fully up and fully down positions while checking for binding and smooth operation.
- the repairability of damaged parts. Typically regulators must be replaced and not repaired when damaged.



A special tool is being used to remove the counterbalance spring from this window regulator.

Gear-and-arm style regulators may be equipped with a counterbalance spring which:

- puts pressure on the lifting arm as the glass is rolled down to reduce the effort needed to raise the glass back up.
- can quickly move the lifting arm on some designs if proper procedures are not followed when removing the regulator or drive motor.

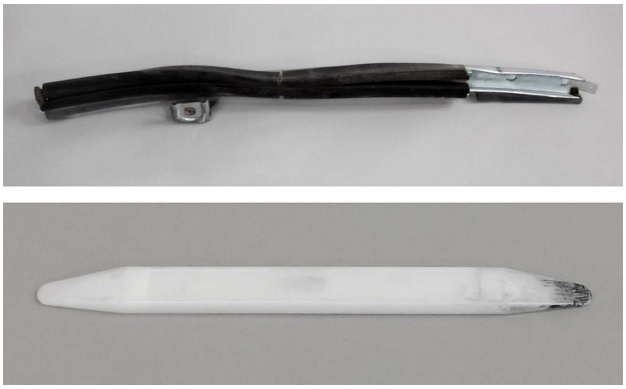
Procedures for working with regulators and motors when a counterbalance spring is present vary from vehicle to vehicle. Always follow vehicle maker recommendations when removing window regulators or drive motors to avoid personal injury or vehicle damage from the sudden unwanted release of counterbalance spring pressure.

Window Channels And Runs

This is a typical lower window channel and glass run.

Window channels are:

- the tracks inside the door shell that the glass moves in. Additional channels may be used to guide the lower portion of the second arm on dual-arm window regulators.
- either bolted, riveted, or welded onto the door shell.
- lined with a rubber run. The run often has a felt-like material on the side that contacts the glass to keep the glass from binding against the rubber.
- usually replaced when damaged.



This is an example of the typical type of damage that will occur to window channels in a collision (top). A plastic glass stick is used to clean out glass fragments that may be stuck in the rubber run (bottom).

When inspecting window channels and glass runs, look for:

- bent or damaged channels.
- loose or missing channel-to-door shell fasteners, which can allow the glass to slip out of the track.
- cracks in the door shell around the channel fasteners. This also may allow the glass to slip out of the track.
- tears or damage to rubber runs. Check inside the run for areas where the felt coating may have been removed. This can cause the glass to bind and tip as it is rolled up and down.
- rubber runs that are not properly seated into the channel. This may cause binding.
- broken glass pieces stuck in the rubber runs. Do not use a screwdriver to clean glass from the run, which may damage the run. Use a cleaning tool or plastic glass stick to open the run and pry the glass fragments out.

Care must be used to avoid damaging glass runs during removal.

Required steps when removing window channels and glass runs may include:

- identifying the attachment method. Weld-on channels are considered a part of the door shell and are typically not serviced separately.
- removing the rubber runs from the channel. These are typically pressed into place and not held with fasteners. Some vehicles may have channel and run assemblies that do not separate and are serviced as a single part.
- removing the channel-to-door shell fasteners.
- removing the channel from the door shell.

The window channel must be correctly positioned in relation to the wiring harness to avoid interference between the wiring and the glass.

Required steps when installing window channels and glass runs may include:

- positioning the replacement channel in the door shell.
- installing the channel-to-door shell fasteners.
- installing the rubber run by pressing it back into the channel, making sure it is fully seated.
- checking for proper window operation and adjusting the window channel glass run assembly as needed. Window channels that hold the glass too tightly will cause binding, while channels that are spaced too far apart may allow the glass to slip out of the track.
- using lubricants to reduce friction between the glass and the run. Do not use grease or oil-based lubricants, which will either harden, attract dirt, or wash off with time. If a lubricant is needed, use only powdered graphite.

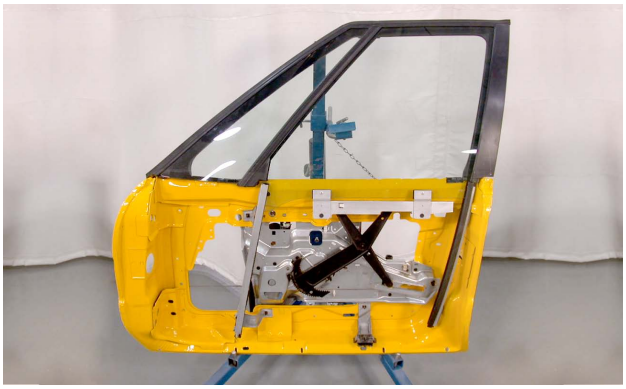
Refer to “Video: Replacing A Window Regulator” in the presentation. This video shows the removal and replacement of a window regulator arm and glass run from the front door of a minivan.

Adjusting Door Glass

Misaligned body panels can make the proper alignment of the door glass impossible to achieve.

When adjusting the door glass for proper alignment:

- verify that the door and surrounding body structure are properly aligned. Misaligned body parts may cause the glass to not fit the opening properly. Attempting to correct a body part misalignment by adjusting the glass may create additional problems.
- repair or replace any worn or damaged regulators and tracks before adjusting the glass.
- use the factory supplied adjustments. If a glass cannot be properly aligned using the factory adjustments, some other problem exists which must be corrected before the glass can be properly adjusted.

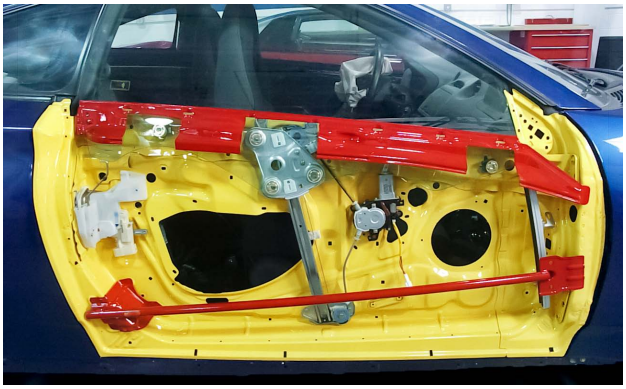


Framed door glass will typically have limited adjustment possibilities.

When aligning the glass in framed door glass assemblies:

- the lower glass run channels may be fixed or adjustable. The lower run channels need to be close enough so that the glass stays in the runs for its entire range of travel, but not so tight to cause binding or excessive effort.
- check the upper frame of the door for distortion. If the upper frame of the door around the glass is bent or distorted, the glass will bind as it is moved. The plane of the glass

runs in the upper window frame must match the plane of the glass runs in the lower glass channels.
- adjustment may be possible by moving the glass at the glass-to-regulator attachment. One way of doing this is to roll the glass all the way up with the fasteners loosened, and then tighten and properly torque them with the glass seated and aligned in the upper window frame.
- some vehicles have plastic guides or butterfly clips that clip together through holes in the glass sides and snap into the glass run channels. If these clips are worn or broken, or if the channel is damaged, the glass may fall out of the channel or tip and bind as it is rolled up. Special pliers are available to remove and replace these butterfly clips without damaging the clips or the glass. When replacing guide clips, use the correct clip for the application.



Frameless door glass is typically very adjustable, with the glass able to be moved in all directions.

Adjustments available on frameless door glass may include:

- travel stops to control how high or low the glass travels in the door shell.
- the inward or outward tilt of the glass. These may include an adjustment to pull the bottom of the lower channels or window regulator in or out. Moving the bottom of the glass inward will move the top of the glass outward. There may also be movable, cushioned blocks at the top of the door shell that push against the glass for vertical positioning of the bottom of the door glass. If a frameless door glass requires adjustment of the inward or outward tilt, it suggests other possible issues or damage to the door or vehicle.
- adjustments at the mounting points of the lower glass channels.
- movement of the glass at the glass-to-regulator attachment. This adjustment will typically allow the glass to be moved forwards and rearwards in the door shell.

Refer to Module 2, “Activity: Aligning Frameless Door Glass” in the presentation for an activity on misaligned door glass.

Module Wrap-Up

Topics discussed in this module included:

- the types of roll up side door glass.
- the parts of roll up door glass assemblies.

- issues with the repair and replacement of door glass, window regulators, runs, channels, and related parts.
- different types of glass-to-regulator attachments.
- general guidelines and procedures for the adjustment of roll up door glass assemblies.

This page is intentionally left blank.

Module 3 - Rear Body Movable Glass

I-CAR®

This page is intentionally left blank.

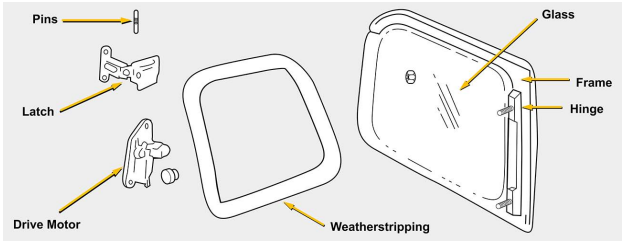
Hinged Vent Window Glass

Learning objectives for this module include:

- identifying parts of rear body movable glass assemblies.
- determining locations of rear body movable glass.
- replacing movable rear body glass and related parts.
- identifying special cautions when removing and replacing rear body movable glass.

Hinged vent windows are commonly found in the quarter panels of minivans.

The most common style of movable glass that is located in rear body sides or quarter panels is the hinged vent window. Hinged vent windows are typically found in rear body sides or quarter panels of minivans and extended cab pickup trucks.



This diagram shows the typical parts of a hinged vent window assembly.

Hinged vent glass assemblies vary in design and construction. Parts of a typical hinged vent glass assembly include the:

- glass.
- frame that the glass bolts to. On designs that have a separate removable frame, the weatherstripping will typically be attached to the frame and the frame will be bonded or bolted to the glass opening similar to a stationary glass installation.
- hinges that hold the glass to the vehicle. The hinges may be separate removable parts or built into the glass and not serviced.
- latch assembly.
- weatherstripping.
- electric drive motor for power units. This motor typically makes up the body side half of the latch assembly.
- friction pins that hold the halves of the latch together.

Always check the latches on hinged side-vent windows for damage following a collision.

Some special considerations when working with hinged quarter panel vent glass include:

- side curtain airbags and related parts, if applicable. Disable the airbag system following the vehicle maker's recommendations before working on or around airbag modules or airbag parts.
- avoiding damage to interior trim parts during removal. Service information can be helpful when determining attachment and removal methods for interior trim parts. Never use excessive force to remove a panel. If the trim part cannot be removed easily, look for hidden fasteners or specific procedures that may be necessary.
- avoiding damage to rear air conditioning and heater units behind interior panels, if applicable.
- the use of a friction pin to hold halves of the latch together. Some glass replacements may require removal of this pin to separate halves of the plastic latch. Special pliers are available to remove and install these pins without damaging the latch. If the tool is not available, the pin can be carefully driven out with a small pin punch.
- plastic latch assemblies. The transfer of collision energy from a front impact can break the latch even when there is no damage to the glass or surrounding panels. Always check the latches on hinged side-vent windows for damage following a collision, especially on vehicles with deployed airbags.
- the electric motor. Many side-vent windows, especially in minivans, are power driven. The electric motor may be attached directly to the glass through the latch arm. The motor may make up the vehicle side of the latch assembly.

This hinged vent glass is taped to the vehicle at the top to hold it in place while the fasteners are removed.

Some of the steps required to replace a hinged side glass include:

- removing necessary interior trim for access.
- locating fasteners that hold the glass to the vehicle.
- properly supporting the glass so it does not fall out when the fasteners are removed. To support the glass, either tape it to the vehicle at the top or have an assistant hold it while the fasteners are removed.
- removing the fasteners that hold the glass in and lifting the glass from the vehicle.
- transferring any necessary parts to the replacement glass. These may include hinges and latches.

Follow these procedures in reverse order to reinstall the hinged side glass.

Refer to “Video: R&R Movable Quarter Vent Glass” in the presentation. This video shows the steps necessary to remove and replace a movable power vent glass in a minivan.

Rear Liftgate Glass

Many sport utility vehicles have a hinged liftgate glass in their rear liftgate.

Rear tailgate or liftgate movable glass is typically a hinged design with hydraulic lifting struts to hold the glass open.

The hydraulic lift struts on this hinged liftgate glass are fastened to ball studs on the glass and the vehicle with spring clips.

Personal Safety

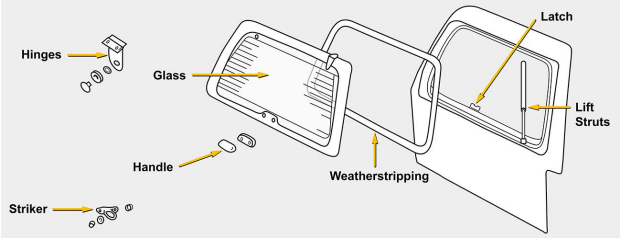
Use care when working with hydraulic lifting struts. Always wear appropriate eye and hand protection.

Considerations for servicing hinged rear liftgate glass include:

- the hydraulic lift struts. The struts that hold the glass open are compressed when the glass

is closed. They should only be removed when they are in the fully extended position with the glass fully opened. Disconnecting the lift struts with the glass closed may result in sudden extension of the strut assembly. This could cause personal injury or vehicle damage. Bent struts should be replaced and not straightened.

- the hydraulic lift struts may bind causing glass breakage when closing the glass if excessive force is used. When closing a hinged liftgate glass, use caution and work the glass up and down slowly to help loosen sticking struts.
- disconnecting the wiring from defroster grids. The wiring connector may have a locking tab that has to be pressed to release the connector from the spade on the glass. Using excessive force to separate the wiring connector may result in separation of the spade from the glass. Also inspect the defroster grid and spade for corrosion.
- when it is necessary to transfer parts from the original to the replacement glass. This should be done as a bench operation.



This diagram shows the typical parts of a hinged liftgate glass assembly.

Parts of a hinged liftgate glass assembly may include the:

- glass.
- hinges that hold the glass to the liftgate.
- latch, typically bolted into the liftgate shell and similar in design to a hood latch.
- latch striker, usually bolted to the glass opposite of the lifting handle.
- lifting handle on the outside of the glass.
- hydraulic lifting struts.
- weatherstripping on the glass opening pinchweld of the hatch. A pinchweld is formed where two mating flanges are welded together.

Removing a hinged liftgate glass will require removing or disconnecting the hydraulic lifting struts.

Some of the steps required to remove a hinged liftgate glass include:

- removing trim for fastener access.
- carefully disconnecting the wiring from the defroster heating grid.
- removing or disconnecting the hydraulic lifting struts. The lift struts may be held in place by a spring clip that is snapped over a ball stud. The spring clips can be removed by carefully prying them free with a small flat blade screwdriver.
- properly supporting the glass to avoid it falling out when the fasteners are removed. This may require the help of an assistant.
- removing fasteners that hold the glass to the hatch and lifting the glass from the vehicle. This may include removing the hinges from the hatch and leaving the hinges attached to the glass.

Follow these procedures in reverse order to reinstall the hinged liftgate glass.

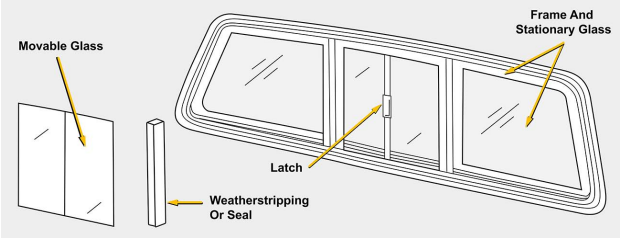
Refer to “Video: Replacing Hinged Liftgate Glass” in the presentation. This video shows the removal and installation of a typical hinged rear liftgate glass.

Rear Sliding Glass

Sliding backglass is a popular option on many pickup trucks.

Movable glass assemblies found in pickup truck cab backs are typically:

- sliding window assemblies. These windows may have both fixed and movable glass. Sliding backglass is typically manually operated, however, there may be power operated versions available on some applications.
- bonded or gasket-set similar to a stationary backglass.
- replaced as complete assemblies. On some applications, the movable glass and latch assembly may be serviced separately. Some vehicles may have the latch bonded to the glass with an adhesive. If one of these latches becomes separated from the glass, it cannot be reattached and the glass must be replaced.



This diagram shows the typical parts of a sliding backglass assembly from a pickup truck.

Sliding windows are typically serviced as complete modular assemblies. If the frame or stationary glass portion is damaged, the entire assembly usually requires replacement. Sometimes certain parts may be serviced separately.

These parts include the:

- movable glass.
- latch for the movable glass.
- weatherstripping or seal for the movable glass.

Module Wrap-Up

Topics discussed in this module included:

- the parts of rear body movable glass assemblies.
- locations of rear body movable glass.
- replacing movable rear body glass and related parts.
- special cautions when removing and replacing rear body movable glass.

Module 4 - Sunroofs

I-CAR®

This page is intentionally left blank.

Types Of Sunroofs

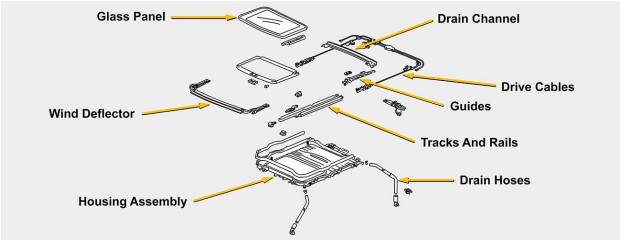
Learning objectives for this module include:

- identifying types of sunroof assemblies.
- identifying parts of sunroof assemblies.
- replacing sunroof assemblies.
- preventing and fixing water leaks in sunroof assemblies.

This is a typical modular sliding sunroof assembly.

Sliding sunroofs are typically:

- factory installed, however, there are aftermarket sliding sunroof assemblies available. Typical aftermarket designs have the glass panel slide back on the outside of the roof of the vehicle, while OEM sunroof installations usually have the glass panel slide back between the roof outer skin and the interior headliner. Be aware that there may be exceptions to this. Another difference between OEM and aftermarket sunroofs is the rubber trim around the roof opening on aftermarket sunroofs compared to the flanged sheet metal or rolled edge on an OEM sunroof.
- power driven.
- cable operated for the glass panel movement.
- a modular design. In many cases when it is necessary to remove and install a complete sunroof assembly, such as for roof skin replacement, the sunroof may be removed and installed as a modular assembly requiring little disassembly of the sunroof parts.

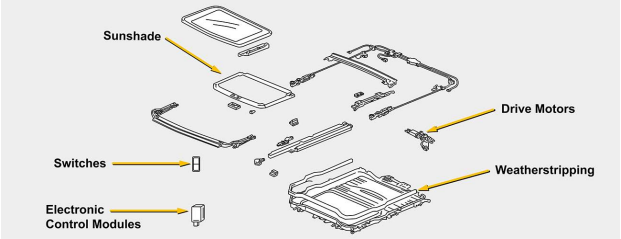


This diagram shows the typical parts of a sliding sunroof assembly.

Parts of a factory sliding sunroof assembly may include the glass panel and the housing assembly. The housing assembly may consist of:

- tracks and rails that the glass panel slides in.
- guides to help the glass panel raise and lower at the correct time.
- a drain channel to direct water to the drain hoses.
- drive cables to push and pull the glass panel open and closed.
- drain hoses to direct water outside the passenger compartment.

- a wind deflector to direct air over the opening when the glass is slid back and the vehicle is in motion. When the sunroof is opened, the wind deflector will pop up slightly over the level of the roof skin in front of the opening.



This diagram shows some additional parts of a sliding sunroof assembly.

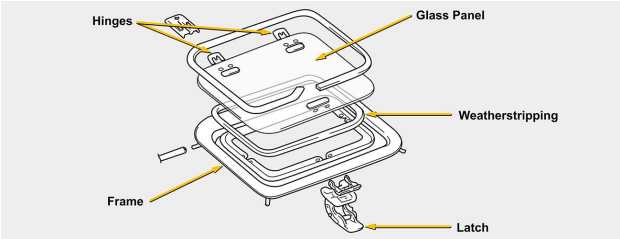
Additional parts of sliding sunroof assemblies may include:

- weatherstripping around the glass panel and the seal between the housing and roof.
- the electric motor that drives the sliding glass panel.
- the switch to control the electric motor.
- electronic control modules for complex operation modes, such as express open and close and vent-only open.
- wiring harnesses and connectors for the electric motor and control modules.
- a movable sunshade on the interior to either block or allow light through the glass panel.

This is an example of a typical aftermarket hinged, or pop up, sunroof assembly.

Hinged, or pop-up, sunroofs are typically:

- aftermarket add-ons.
- modular assemblies bolted into a hole cut in the roof panel.
- opened and closed manually.
- removable for an open air feel. The glass panel is typically removable, leaving an opening in the roof similar to an open sliding sunroof.



This diagram shows the typical parts of a hinged sunroof assembly.

The main parts of a hinged sunroof assembly include the:

- glass panel.
- frame.

- hinges.
- latch.
- weatherstripping.

When the panoramic glass roof is completely open, it covers the backglass.

The Lincoln MKZ has had a sliding panoramic roof option since 2013 that:

- is 15.2 sq ft, larger than any current sedan.
- is 5 mm thick, tempered glass.
- opens by sliding back, almost covering the backglass. The privacy glass appears dark from the outside but is only slightly tinted from the inside. An open roof does not affect rearward visibility.
- has an aluminum and ultra-high-strength steel (UHSS) roof frame.

The panoramic roof has to be initialized after any repairs. The ten-step process includes turning the driver and passenger map light switches on and off. The passenger map light switch is turned on and off four times within six seconds. The process also involves cycling the ignition switch. Refer to the vehicle-specific service information for the complete procedure.

Sunroof Removal And Replacement

Removal of a modular sliding sunroof assembly will typically require two technicians.

Considerations when working with sliding sunroof assemblies include:

- following the vehicle maker's procedures. OEM service information typically has information on the replacement and service of sunroof assemblies.
- remove and install as complete assemblies where possible. This will ensure that alignment and cable timing will not be disturbed.
- using caution to avoid damaging interior trim parts, such as the headliner, when they need to be removed for access. Headliners on some vehicles may be bonded to the roof of the vehicle with an adhesive. Follow the vehicle maker's recommendations for the removal and installation of bonded-in headliners.
- side curtain airbags between the roof structure and the headliner. Disable the airbag system

following the vehicle maker's procedures when working around side airbags.
- the express-open feature. Power sliding sunroofs may have an express-open feature that functions similar to the express-down feature found on power windows. With express open, the sunroof can be slid to its fully open position with one touch of the switch.

Refer to "Video: Modular Sunroof Assembly R&I" in the presentation. This video shows the removal and installation of a modular sunroof assembly.

Inspection Of Sunroofs

An I-CAR gap gauge is being used to check the flushness of this sunroof glass panel.

When visually inspecting sunroof assemblies, look for:

- damage to the glass panel.
- misalignment of the glass panel. When adjusting the glass panel for alignment, procedures may vary from one vehicle maker to another. Many vehicles simply require that the fasteners that hold the glass to the sliding mechanism be loosened, the panel shifted, and the fasteners torqued.
- damaged or loose weatherstripping.
- damage to the housing and related parts.
- damaged, loose, or plugged drain hoses. Many water leak problems in sunroof assemblies can be traced to the sunroof drain hoses.
- broken loose or frayed drive cables.

When inspecting the operation of a power sliding sunroof, do not forget to check the vent open feature.

When inspecting the operation of power sunroof assemblies:

- look for the full range of travel. This is important after a collision because sunroof assembly parts may be damaged from collision energy transfer, especially if the roof was in the open position at the time of the collision. Open and close the sunroof completely, verifying that the glass panel slides smoothly and reaches the fully opened position. Also verify that when the roof is fully closed, the glass panel is properly aligned in the opening and flush with the outer roof skin.
- verify the proper operation of the express-open feature, if applicable. The express-open feature on sunroofs operates the same as the express-down feature on front door glass. The switch is depressed, held momentarily, and then released. The sunroof will then move to its fully opened position without having to hold the switch down the entire time.
- verify proper operation of the vent-open feature. Most power sunroof assemblies are equipped with this feature, which tilts up just the back of the glass panel to allow ventilation of the passenger compartment.
- verify proper operation of the wind deflector. When the sunroof glass is slid back, the wind deflector should pop up at the front of the opening to deflect air over the opening while the vehicle is in motion.
- check sunroof operation before replacing the sunroof glass. If glass panel replacement is necessary due to a cracked or broken glass, cycle the sunroof through its full range of travel before removing the cracked glass looking for interference that may be the cause of the glass breakage. Any damage to the housing or tracks can then be repaired before replacing the glass, avoiding the possibility of breaking the replacement glass panel when opening and closing the sunroof.

Note that the operation of the power sunroof may have to be relearned if the battery is disconnected, or the roof, motor, or switch has been replaced.

Adjustments To Sunroofs

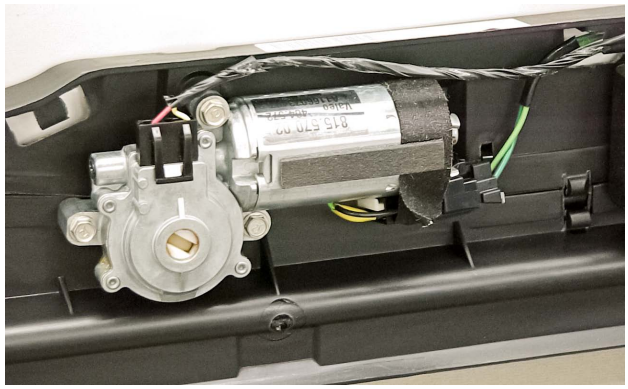
Aligning the glass panel on this sliding sunroof is done by loosening the fasteners that hold it to the sliding mechanism.

Because of the differences in design and construction of sunroofs between vehicle makers, and their overall complexity, it is important to follow the vehicle maker's recommendations when attempting to make adjustments.

A common alignment problem on sliding sunroofs is the flushness of the glass panel to the roof skin when the sunroof is fully closed.

With the sunroof in the fully closed position, verify that the glass panel is:

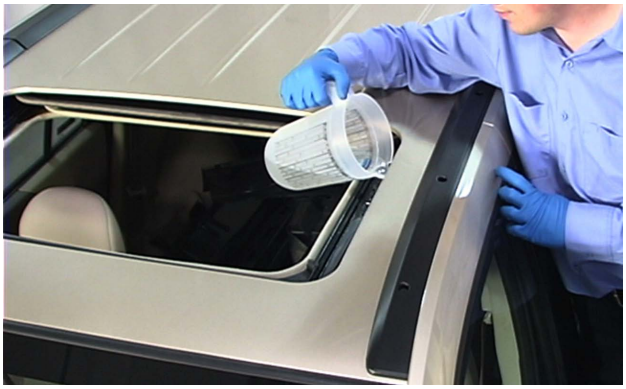
- centered in the roof opening.
- flush to the roof panel around the entire perimeter.



Always follow the vehicle maker recommendations when adjusting the timing of the drive motor and cables on a sliding sunroof.

The timing of the drive motor and cables that move the glass panel in a sliding sunroof assembly:

- may be critical to the proper operation of the unit.
- may be set or adjusted by a variety of methods. Procedures used to set or adjust cable timing are typically vehicle specific.
- should only be set or adjusted using the specific vehicle or part maker's recommendations. Service information should be available whenever a sunroof assembly has been disassembled and requires setting the timing of the cables and mechanism to the motor or glass panel.



Water can be poured into the sunroof drain channel to verify that the drain hoses are not plugged.

When servicing sunroof assemblies, inspect the:

- drain hoses at the corners of the housing assembly. The weatherstripping is not designed to completely seal against water. The sunroof housing has drain channels built into it that route water to drain hoses which carry it outside the passenger compartment. Water may leak into the passenger compartment if these drain hoses are plugged

with debris. Water accumulates in the drain channels until it spills over into the vehicle. Also, if the drain hoses are cut or have holes, water will enter the passenger compartment at the point of the hose damage. Hoses may be damaged by heat from welding or cut by sharp metal in the collision or during repairs.

- frame-to-roof seal. This seal is critical to prevent water leaks on aftermarket hinged sunroofs. When a bolt-on hinged sunroof is removed and installed, the old sealer should be cleaned from the sunroof frame and the roof skin and replaced with the sealer recommended by the vehicle or part maker.
- glass panel weatherstripping. On sliding sunroofs, if the weatherstripping on the glass panel is damaged or does not contact the sides of the opening in the roof, more water may be allowed into the drain channels than the drain hoses can handle. This can result in overflow and water in the passenger compartment. On hinged sunroofs, the seal between the glass panel and the weatherstripping on the opening is critical to controlling water entry into the vehicle. The glass panel should make contact with the weatherstripping around its complete perimeter.

Module Wrap-Up

Topics discussed in this module included:

- types of sunroof assemblies.
- parts of sunroof assemblies.
- the replacement of sunroof assemblies.
- water leaks in sunroof assemblies.

This page is intentionally left blank.

Module 5 - Inspection And General Troubleshooting

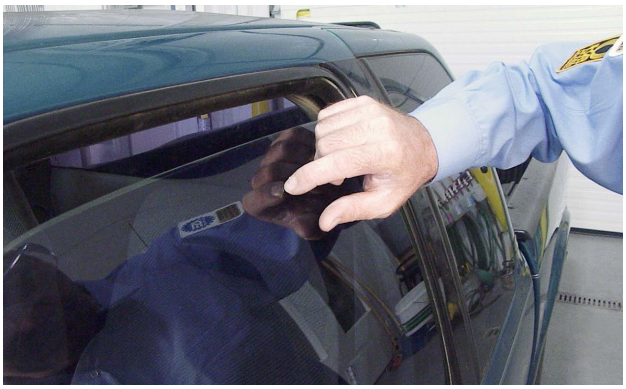
I-CAR®

This page is intentionally left blank.

Inspection Of Movable Glass

Learning objectives for this module include:

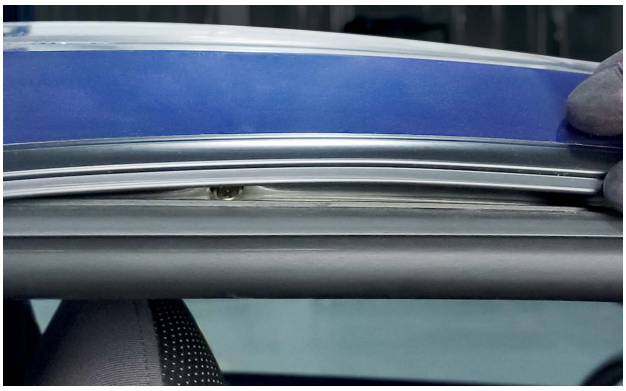
- inspecting movable glass assemblies following a collision.
- identifying potential problems with replacement glass.
- determining what to inspect after repairs are completed to movable glass assemblies.
- troubleshooting water and air leak problems.
- troubleshooting the electrical operation of movable glass assemblies.



Vehicles that have been in a collision should have their glass inspected for damage from flying debris.

Flying debris in a collision may cause damage to the glass of a vehicle other than completely breaking it. After a collision, inspect the glass for:

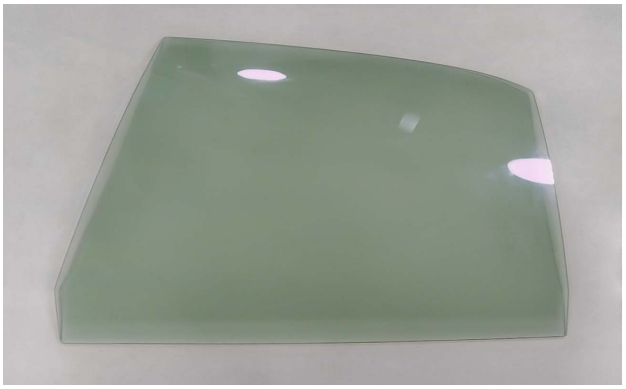
- scratches.
- chips.
- pits.
- cracks.
- star breaks.
- bullseyes.



Damaged or misaligned weatherstripping may be a source of air or water leaks.

After a collision, also inspect movable glass assemblies for:

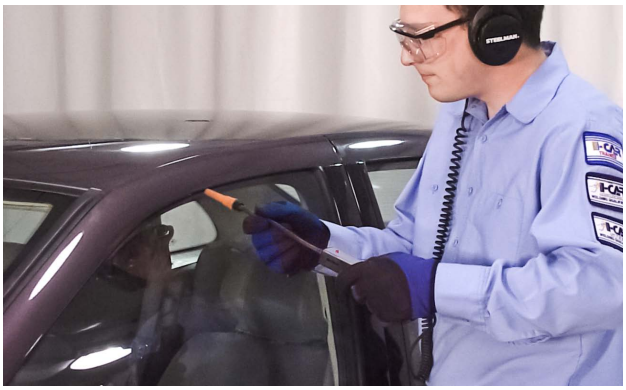
- damaged weatherstripping.
- proper operation through the full range of movement.
- glass panel misalignment.



Always verify that the replacement glass is correct for the application before beginning repairs.

Before installing the replacement glass, inspect it for:

- the correct shape and thickness. Verify that the replacement glass is the correct glass for the application.
- the correct type of glass construction. Verify that the glass is of the correct type, either tempered or laminated, to match the original glass. Do not substitute a tempered glass for laminated or vise versa. This will affect the powered safety features, such as anti-pinch.
- visible damage. Verify that the replacement glass does not have any scratches, scuffs, chips, or rough edges.
- the correct tint color.
- lamination separation on laminated glass.
- optical distortion. Make sure that there are no flaws in the glass that cause distortion when looking through it.



Upon completion of a glass replacement, always check the installation for air and water leaks.

After completing repairs, inspect the movable glass assembly for:

- proper fit or alignment of the glass.
- water and air leaks.
- damage to the glass or surrounding vehicle parts.
- proper operation of the glass through its entire range of movement. Glass movement should be smooth with no catching or binding.

Troubleshooting Glass Problems

Water leaks in glass assemblies can cause damage to a vehicles interior.

Problems common to all movable glass assemblies may include:

- water leaks.
- air leaks.
- inoperative power operation.
- glass misalignment.

A misalignment at the top corner of this glass is a source of both air and water leaks.

Causes of water and air leaks in movable glass assemblies may include:

- glass misalignment.
- damaged weatherstripping.
- vehicle structure misalignment.
- vehicle panel misalignment.

A visual inspection of the glass sealing surface, while water is being applied, will pinpoint the location of water entry when a leak exists.

When diagnosing water leaks in movable glass assemblies:

- perform a visual inspection. Look for gaps between the weatherstripping and the glass.
- remove any necessary interior trim to allow visibility of the glass-to-weatherstripping seal.
- protect the interior from water damage by covering with appropriate covers.
- apply water to the area of the leak and look for water entering the inside of the vehicle.

There are a variety of methods used to apply water when diagnosing water leaks.

Never use a high pressure source to test for water leaks.

Once it has been determined that a water leak exists, pinpoint the exact location of water entry by:

- running water over the specific area using a water hose. Work from the lowest point upward.
- spraying water on specific points using a water bottle. Work from the lowest point upward.

An ultrasonic leak detector can be used to pinpoint the source of both air and water leaks.

Methods used to diagnose an air leak or wind noise include:

- test-driving the vehicle. This will help determine if any air leaks exist and pinpoint the source.
- visually inspecting the glass assembly for gaps between the glass and weatherstripping.
- using an ultrasonic leak detector. This tool consists of a transmitter that is placed inside the vehicle near the area of the leak, and a receiver with a wand that is run over the area of the suspected leak. When the wand is over an area of a leak, the sound waves from the transmitter will be picked up by the receiver which emits an audible beep.
- the tracing powder or chalk test. To perform this test, chalk or powder is applied in an unbroken line to the contact surface of the weatherstripping. The door or glass panel is closed completely without slamming. The door or glass is then opened and the powder line on the weatherstripping is inspected. Gaps or irregularities in the powder line on the weatherstripping indicate areas with a poor seal.
- the air pressure test. This test is performed by masking off the pressure relief valves in the vehicle and turning the blower motor fan on HIGH in the VENT position with the windows closed. Look for escaping air around the glass at the weatherstripping by spraying a soapy water solution on the outside and looking for bubbles, or by listening with a stethoscope for the sound of escaping air.
- the soap bubble test. This can also be performed by blowing air on the glass-to-weatherstripping seal at low pressure. This is done from the inside with a blow gun while looking for bubbles on the outside.
- the paper test. This is done by inserting a sheet of paper or a dollar bill between the glass and weatherstripping with the glass or door closed. Then pull the paper out while monitoring the pressure. Areas where the paper slides out with little or no resistance may indicate a poor seal.

All of the methods used to find air leaks can also be used to help pinpoint the source of water leaks.

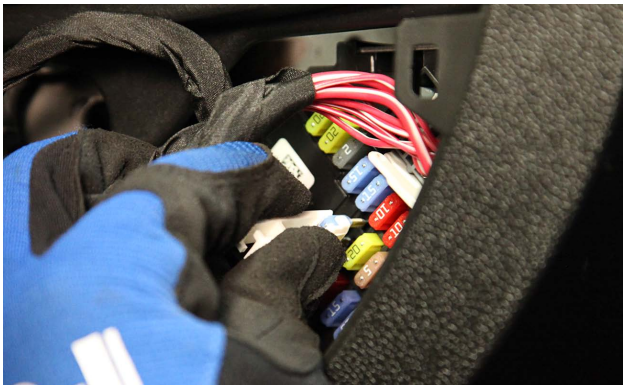
Refer to “Video: Air Leak Diagnosis” in the presentation. This video shows the various methods used to find the source of air leaks and wind noise in movable glass assemblies.

The weatherstripping is being replaced after a water leak was found.

After finding an air or water leak in a movable glass assembly, repairing the leak may include:

- aligning the glass.
- inspecting and aligning or replacing the weatherstripping.
- retesting to verify that the repair has corrected the leak.

Troubleshooting Electrical Problems

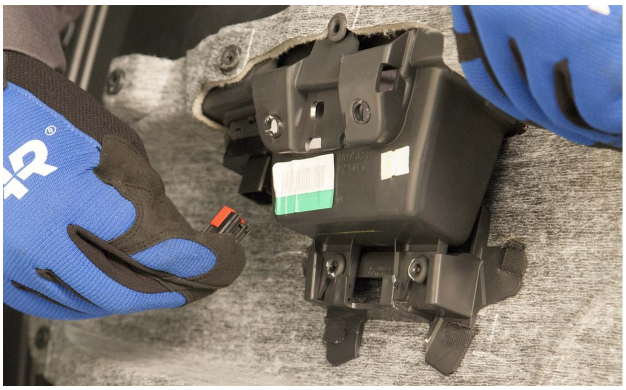


Always check the fuse for the appropriate circuit when the electrical operation of a power window system is inoperative.

Problems with the electrical operation of a power driven movable glass assembly that result from collision damage may be a:

- blown fuse. When the electric operation of a power glass assembly is inoperative, first check the fuse for the circuit involved. A blown fuse will often be a symptom of another problem such as damaged wiring.
- damaged wires. Wires may be cut completely through or the insulation may be intact and the wire broken inside. This may occur when the wires are pinched between two parts in a collision.
- loose or damaged connectors. Hard shell connectors may get damaged in a collision. They also may not get properly reconnected during repairs. Make sure that all connectors are properly seated together.
- poor ground. Check that all grounds have been reconnected and that any fasteners holding them are tight. Also look for

corrosion, paint, or undercoating between ground connectors and the vehicle body.
- faulty switch.
- faulty electric motor. Electric motors may be checked using fused jumper wires and a portable 12 volt power source.



When working with electrical problems in movable glass applications, always follow the vehicle maker's instructions.

Considerations with the repair of electrical and electronic parts of power movable glass assemblies may include:

- following the vehicle maker's procedures and recommendations. A wiring diagram should be used when troubleshooting electrical problems.
- using jumper wires. Jumper wires can be used to test the power window electric motor by connecting them directly to the motor, thereby bypassing the switch. Jumper wires should contain an inline fuse for the circuit protection in case of accidental shorting.

Use of a DVOM is recommended when performing electrical circuit diagnosis on modern vehicles.

Digital volt-ohm meters (DVOMs):

- may be used to measure voltage (volts), resistance (ohms), and amperage (amps) in circuits.
- are invisible to the circuit being tested. Unlike test lights, which can introduce voltage and amperage into the circuit being tested, the DVOM will have no effect on the circuit.
- are recommended for use on electronic circuits. Because they are invisible to the circuit, use of a DVOM is the only recommended way to perform circuit tests on vehicle circuits containing computers. Test lights may introduce enough voltage into the circuit to damage computers or deploy airbag modules. Since so many vehicle circuits contain computers, it is not recommended to use anything but a DVOM when performing circuit diagnosis.

Module Wrap-Up

Topics discussed in this module included:

- movable glass assemblies following a collision.
- potential problems with replacement glass.
- what to inspect after repairs are completed to movable glass assemblies.
- water and air leak problems.
- the electrical operation of movable glass assemblies.

This page is intentionally left blank.