chapter 58

HORN, WIPER, AND BLOWER MOTOR CIRCUITS

OBJECTIVES: **After studying Chapter 58, the reader will be able to:** • Prepare for ASE Electrical/Electronic Systems (A6) certification test content area "G" (Horn and Wiper/Washer Diagnosis and Repair) and content area "H" (Accessories Diagnosis and Repair). • Describe how the horn operates. • List the components of a wiper circuit. • Explain how the blower motor can run at different speeds. • Discuss how to diagnosis faults in the horn, wiper, and blower motor circuits.

KEY TERMS: Horns 646 • Pulse wipers 649 • Rain sense wipers 653 • Series-wound field 649 • Shunt field 649 • Variable-delay wipers 649 • Windshield wipers 648

HORNS

PURPOSE AND FUNCTION

Horns are electric devices that emit a loud sound used to alert other drivers or persons in the area. Horns are manufactured in several different tones ranging from 1,800 to 3,550 Hz. Vehicle manufacturers select from various horn tones for a particular vehicle sound. ● **SEE FIGURE 58–1.**

When two horns are used, each has a different tone when operated separately, yet the sound combines when both are operated.

FIGURE 58–1 Two horns are used on this vehicle. Many vehicles use only one horn, often hidden underneath the vehicle.

HORN CIRCUITS

Automotive horns usually operate on full battery voltage wired from the battery, through a fuse, switch, and then to the horns. Most vehicles use a horn *relay.* With a relay, the horn button on the steering wheel or column completes a circuit to ground that closes a relay, and the heavy current flow required by the horn then travels from the relay to the horn. Without a horn relay, the high current of the horns must flow through the steering wheel horn switch. ● **SEE FIGURE 58–2.**

The horn relay is also connected to the body control module, which "beeps" the horn when the vehicle is locked or unlocked, using the key fob remote.

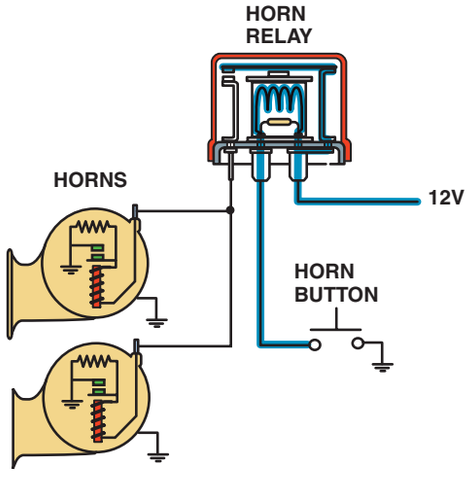


FIGURE 58–2 A typical horn circuit. Note that the horn button completes the ground circuit for the relay.

HORN OPERATION

A vehicle horn is an actuator that converts an electrical signal to sound. The horn circuit includes an armature (a coil of wire) and contacts that are attached to a diaphragm. When energized, the armature causes the diaphragm to move up which then opens a set of contact points that de-energize the armature circuit. As the diaphragm moves down, the contact points close, re-energize the armature circuit, and the diaphragm moves up again. This rapid opening and closing of the contact points causes the diaphragm to vibrate at an audible frequency. The sound created by the diaphragm is magnified as it travels through a trumpet attached to the diaphragm chamber. Most horn systems typically use one or two horns, but some have up to four. Those with multiple horns use both high- and low-pitch units to achieve a harmonious tone. Only a high-pitched unit is used in single-horn applications. The horn assembly is marked with an "H" or "L" for pitch identification.

HORN SYSTEM DIAGNOSIS There are three types of horn failure.

- No horn operation
- Intermittent operation
- Constant operation
- Weak or low volume sound

If a horn does not operate at all, check for the following:

- Burned fuse or fusible link
- Open circuit
- Defective horn
- Faulty relay
- Defective horn switch
- Poor ground (horn mounting)
- Corroded or rusted electrical connector

If a horn operates intermittently, check for the following:

- Loose contact at the switch
- Loose, frayed, or broken wires
- Defective relay

HORN SOUNDS CONTINUOUSLY A horn that sounds continuously and cannot be shut off is caused by horn switch contacts that are stuck closed, or a short-to-ground on the control circuit. This may be the result of a defective horn switch or a faulty relay. Stuck relay contacts keep the circuit complete so the horn sounds constantly. Disconnect the horn and check continuity through the horn switch and relay to locate the source of the problem.

INOPERATIVE HORN To help determine the cause of an inoperative horn, use a fused jumper wire and connect one end to the positive post of the battery and the other end to the wire terminal of the horn itself. Also use a fused jumper wire to substitute a ground path to test or confirm a potential bad ground circuit. If the horn works with jumper wires connected, check ground wires and connections.

- If the horn works, the problem is in the circuit supplying current to the horn.
- If the horn does not work, the horn itself could be defective or the mounting bracket may not be providing a good ground.

HORN SERVICE When a horn malfunctions, circuit tests are made to determine if the horn, relay, switch, or wiring is the source of the failure. Typically, a digital multimeter (DMM) is used to perform voltage drop and continuity checks to isolate the failure.

- **Switch and relay.** A momentary contact switch is used to sound the horn. The horn switch is mounted to the steering wheel in the center of the steering column on some models, and is part of a multifunction switch installed on the steering column.

  CAUTION: If steering wheel removal is required for diagnosis or repair of the horn circuit, follow service information procedures for disarming the airbag circuit prior to steering wheel removal, and for the specified test equipment to use.

  On most late-model vehicles, the horn relay is located in a centralized power distribution center along with other relays, circuit breakers, and fuses. The horn relay bolts onto an inner fender or the bulkhead in the engine compartment of older vehicles. Check the relay to determine if the coil is being energized and if current passes through the power circuit when the horn switch is depressed.

  Obtain an electrical schematic of the horn circuit and use a voltmeter to test input, output, and control voltage.

- **Circuit testing.** Circuit testing involves the following steps.

  STEP 1 Make sure the fuse or fusible link is good before attempting to troubleshoot the circuit.

  STEP 2 Check that the ground connections for the horn are clean and tight. Most horns ground to the chassis through the mounting bolts. High ground circuit resistance due to corrosion, road dirt, or loose fasteners may cause no, or intermittent, horn operation.

  STEP 3 On a system with a relay, test the power output circuit and the control circuit. Check for voltage available at the horn, voltage available at the relay, and continuity through the switch. When no relay is used, there are two wires leading to the horn switch, and a connection to the steering wheel is made with a double contact slip ring. Test points on this system are similar to those of a system with a relay, but there is no control circuit.

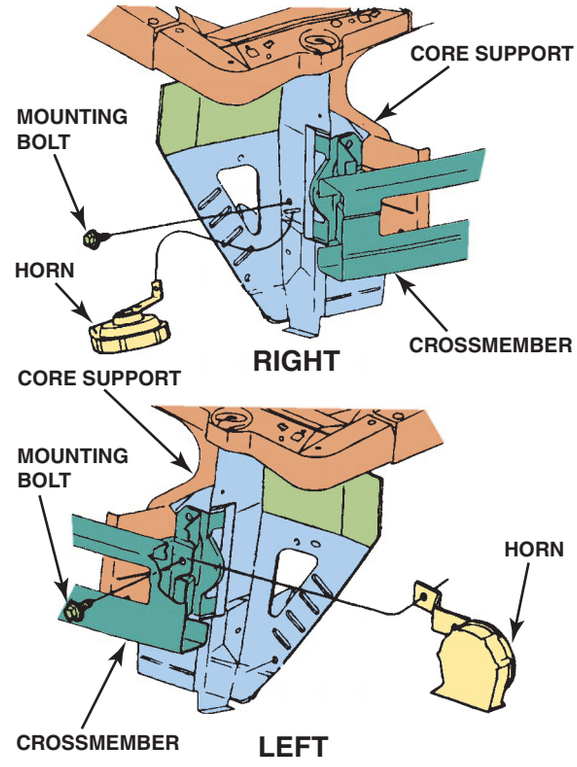


FIGURE 58–3 Horns typically mount to the radiator core support or bracket at the front of the vehicle.

HORN REPLACEMENT Horns are generally mounted on the radiator core support by bolts and nuts or sheet metal screws. It may be necessary to remove the grille or other parts to access the horn mounting screws. If a replacement horn is required, attempt to use a horn of the same tone as the original. The tone is usually indicated by a number or letter stamped on the body of the horn. To replace a horn, simply remove the fasteners and lift the old horn from its mounting bracket.

Clean the attachment area on the mounting bracket and chassis before installing the new horn. Some models use a corrosion-resistant mounting bolt to ensure a ground connection. ● **SEE FIGURE 58–3.**

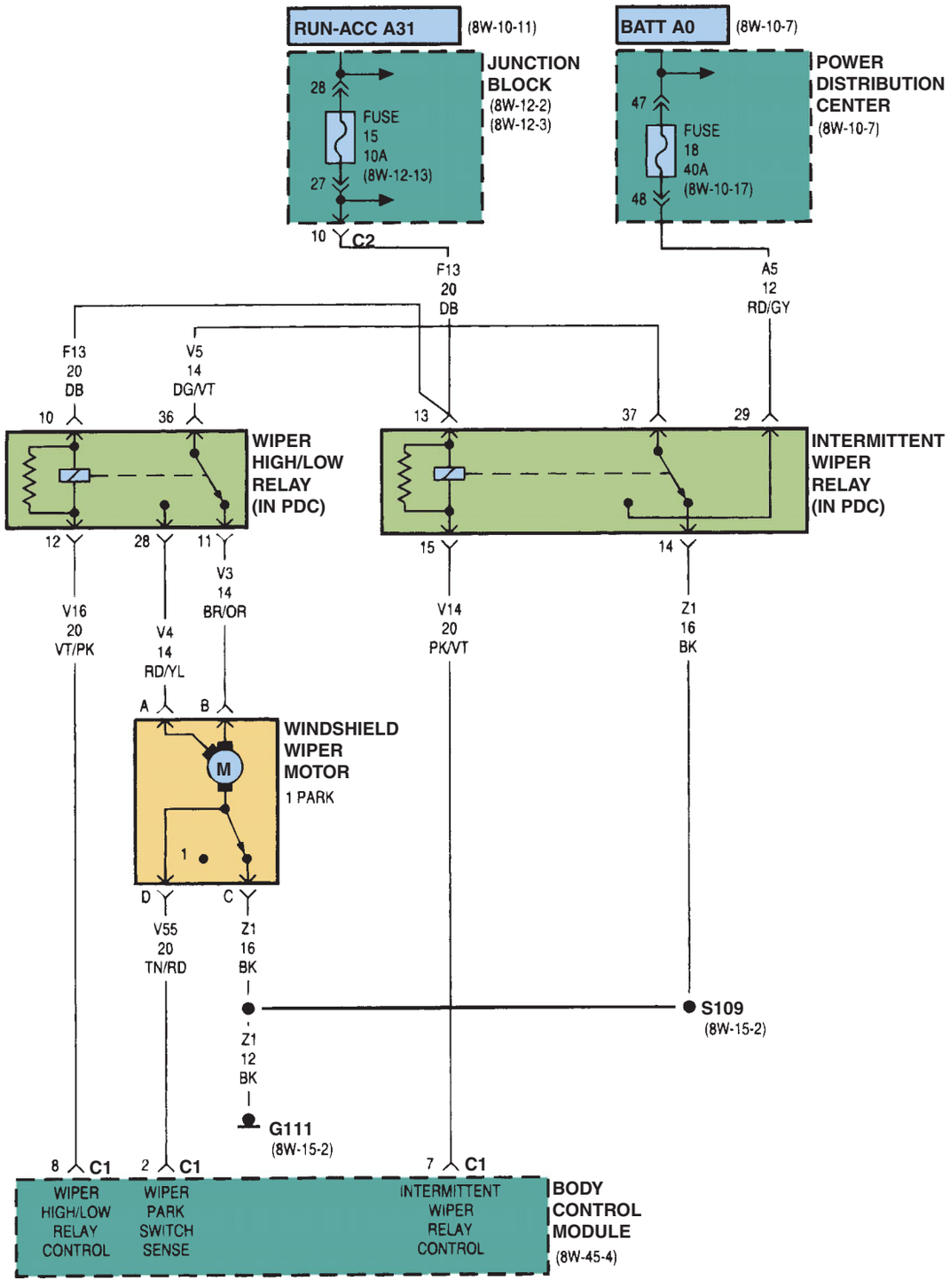


FIGURE 58–4 A circuit diagram is necessary to troubleshoot a windshield wiper problem.

WINDSHIELD WIPER AND WASHER SYSTEM

PURPOSE AND FUNCTION

Windshield wipers are used to keep the viewing area of the windshield clean of rain. Windshield wiper systems and circuits vary greatly between manufacturers as well as between models. Some vehicles combine the windshield wiper and windshield washer functions into a single system. Many minivans and sport utility vehicles (SUVs) also have a rear window wiper and washer system that works independently of the windshield system. In spite of the design differences, all windshield and rear window wiper and washer systems operate in a similar fashion.

COMPUTER CONTROLLED

Most wipers since the 1990s have used the body computer to control the actual operation of the wiper. The wiper controls are simply a command to the computer. The computer may also turn on the headlights whenever the wipers are on, which is the law in some states. ● **SEE FIGURE 58–4.**

WIPER AND WASHER COMPONENTS

A typical combination wiper and washer system consists of the following:

- Wiper motor
- Gearbox

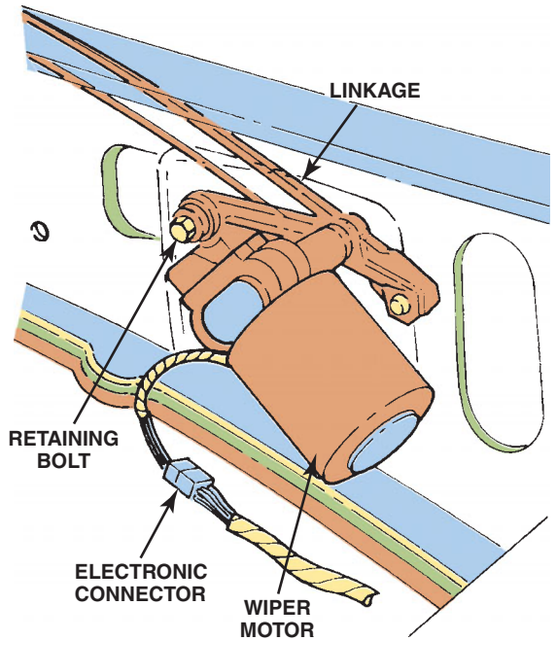


FIGURE 58–5 The motor and linkage bolt to the body and connect to the switch with a wiring harness.

- Wiper arms and linkage
- Washer pump
- Hoses and jets (nozzles)
- Fluid reservoir
- Combination switch
- Wiring and electrical connectors
- Electronic control module

The motor and gearbox assembly is wired to the wiper switch on the instrument panel or steering column or to the wiper control module. ● **SEE FIGURE 58–5.**

Some systems use either a one- or two-speed wiper motor, whereas others have a variable-speed motor.

WINDSHIELD WIPER MOTORS

The windshield wipers ordinarily use a special two-speed electric motor. Most are compound-wound motors, a motor type, which provides for two different speeds.

- **Series-wound field**
- **Shunt field**

One speed is achieved in the series wound field and the other speed in the shunt wound field. The wiper switch provides the necessary electrical connections for either motor speed. Switches in the mechanical wiper motor assembly provide the necessary operation for "parking" and "concealing" of the wipers. ● **SEE FIGURE 58–6** for a typical wiper motor assembly.

- **Wiper motor operation.** Most wiper motors use a permanent magnet motor with a low speed + brush and a high speed + brush. The brushes connect the battery to the internal windings of the motor, and the two brushes provide for two different motor speeds.

  The ground brush is directly opposite the low-speed brush. The high-speed brush is off to the side of the low-speed brush. When current flows through the high-speed brush, there are fewer turns on the armature between the hot and ground brushes, and therefore the resistance is less. With less resistance, more current flows and the armature revolves faster. ● **SEE FIGURES 58–7 AND 58–8.**

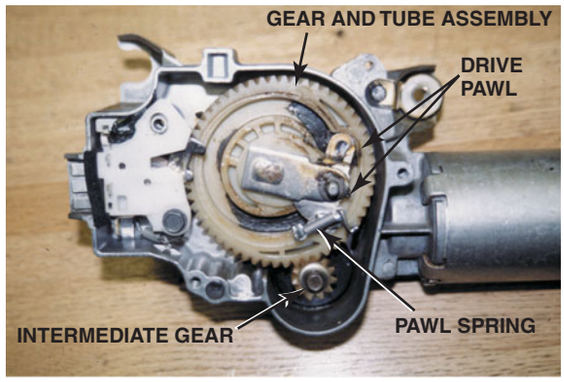


FIGURE 58–6 A typical wiper motor with the housing cover removed. The motor itself has a worm gear on the shaft that turns the small intermediate gear, which then rotates the gear and tube assembly, which rotates the crank arm (not shown) that connects to the wiper linkage.

- **Variable wipers.** The **variable-delay wipers** (also called **pulse wipers**) use an electronic circuit with a variable resistor that controls the time of the charge and discharge of a capacitor. The charging and discharging of the capacitor controls the circuit for the operation of the wiper motor. ● **SEE FIGURE 58–9.**

HIDDEN WIPERS

Some vehicles are equipped with wipers that become hidden when turned off. These wipers are also called *depressed wipers.* The gearbox has an additional linkage arm to provide depressed parking for hidden wipers. This link extends to move the wipers into the park position when the motor turns in reverse of operating direction. With depressed park, the motor assembly includes an internal park switch. The park switch completes a circuit to reverse armature polarity in the motor when the windshield wiper switch is turned off. The park circuit opens once the wiper arms are in the park position. Instead of a depressed park feature, some systems simply extend the cleaning arc below the level of the hood line.

WINDSHIELD WIPER DIAGNOSIS

Windshield wiper failure may be the result of an electrical fault or a mechanical problem, such as binding linkage. Generally, if the wipers operate at one speed setting but not another, the problem is electrical.

To determine if there is an electrical or mechanical problem, access the motor assembly and disconnect the wiper arm linkage from the motor and gearbox. Depending on the type of vehicle, this procedure may involve:

- Removing body trim panels from the covered areas at the base of the windshield to gain access to the linkage connectors
- Switching the motor on to each speed (If the motor operates at all speeds, the problem is mechanical. If the motor still does not operate, the problem is electrical.)

If the wiper motor does not run at all, check for the following:

- Grounded or inoperative switch
- Defective motor
- Circuit wiring fault
- Poor electrical ground connection

If the motor operates but the wipers do not, check for the following:

- Stripped gears in the gearbox or stripped linkage connection
- Loose or separated motor-to-gearbox connection
- Loose linkage to the motor connection

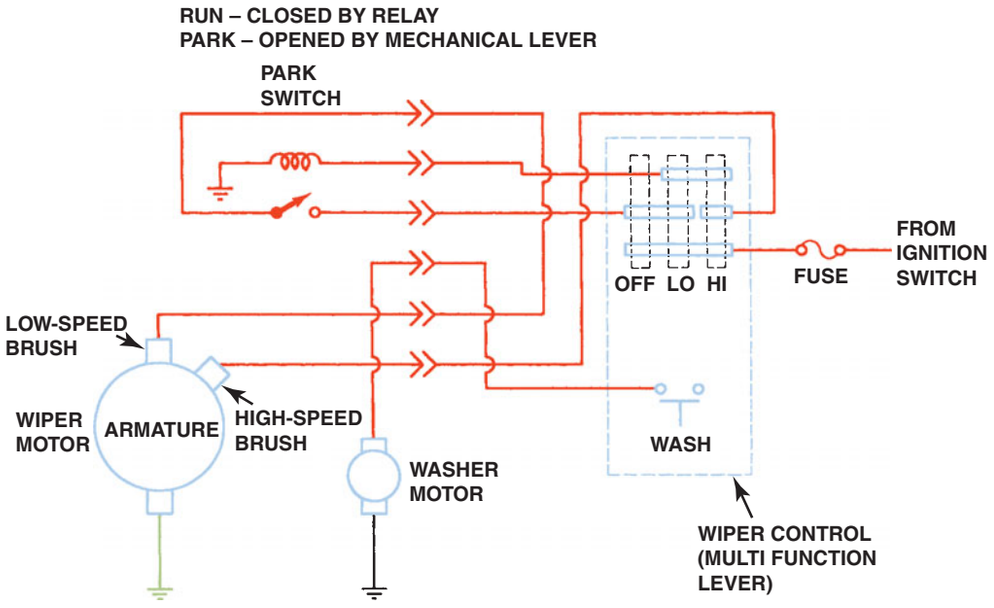


FIGURE 58–7 A wiring diagram of a two-speed windshield wiper circuit using a three-brush, two-speed motor. The dashed line for the multifunction lever indicates that the circuit shown is only part of the total function of the steering column lever.

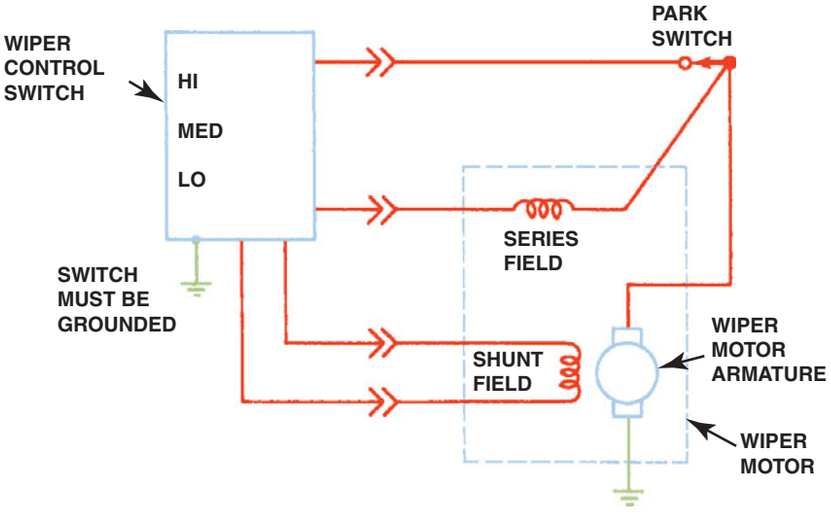


FIGURE 58–8 A wiring diagram of a three-speed windshield wiper circuit using a two-brush motor, but both a series-wound and a shunt field coil.

If the motor does not shut off, check for the following:

- Defective park switch inside the motor
- Defective wiper switch
- Poor ground connection at the wiper switch

WINDSHIELD WIPER TESTING

When the wiper motor does not operate with the linkage disconnected, perform the following steps to determine the fault. ● **SEE FIGURE 58–10.**

To test the wiper system, perform the following steps.

STEP 1 Refer to the circuit diagram or a connector pin chart for the vehicle being serviced to determine the test points for voltage measurements.

STEP 2 Switch the ignition on and set the wiper switch to a speed at which the motor does not operate.

STEP 3 Check for battery voltage available at the appropriate wiper motor terminal for the selected speed. If voltage is available to the motor, an internal motor problem is indicated. No voltage available indicates a switch or circuit failure.

? FREQUENTLY ASKED QUESTION

How Do Wipers Park?

Some vehicles have wiper arms that park lower than the normal operating position so that they are hidden below the hood when not in operation. This is called a *depressed park position.* When the wiper motor is turned off, the park switch allows the motor to continue to turn until the wiper arms reach the bottom edge of the windshield. Then the park switch reverses the current flow through the wiper motor, which makes a partial revolution in the opposite direction. The wiper linkage pulls the wiper arms down below the level of the hood and the park switch is opened, stopping the wiper motor.

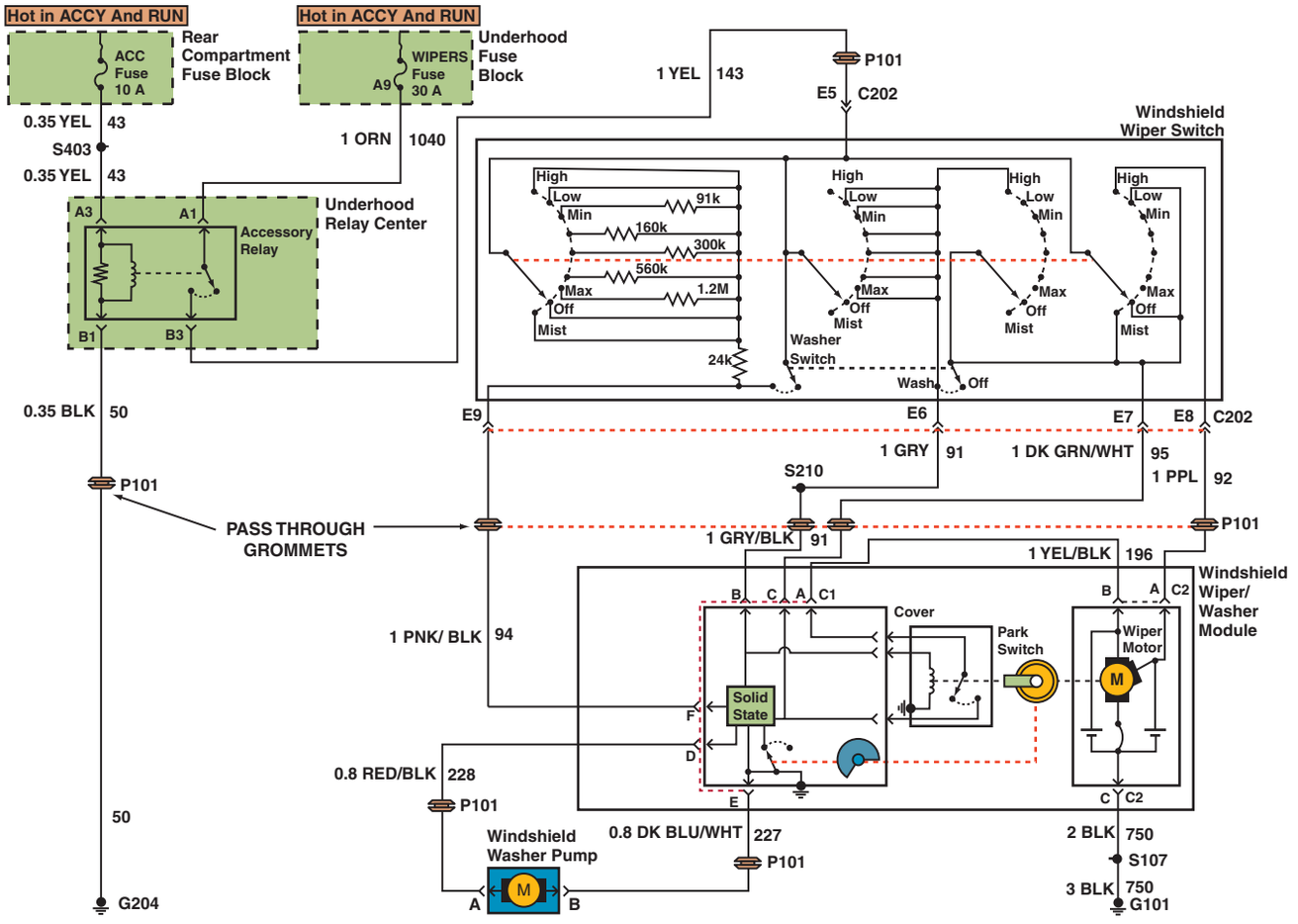
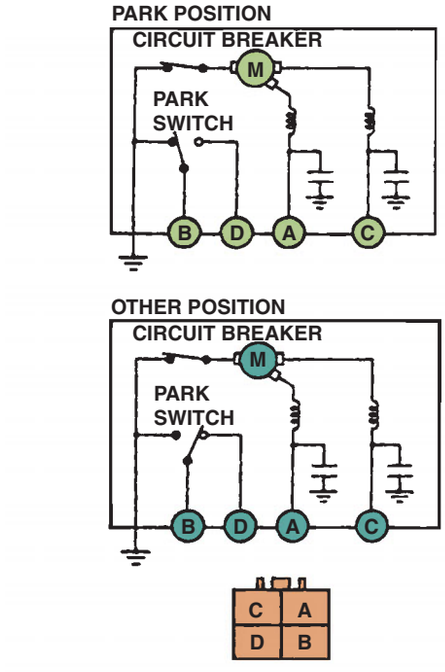


FIGURE 58–9 A variable pulse rate windshield wiper circuit. Notice that the wiring travels from the passenger compartment through pass-through grommets to the underhood area.



TERMINAL	OPERATION SPEED
C	LOW
A	HIGH

FIGURE 58–10 A wiper motor connector pin chart.

STEP 4 Check for proper ground connections.

STEP 5 Check that battery voltage is available at the motor side of the wiper switch. If battery voltage is available, the circuit is open between the switch and motor. No voltage available indicates either a faulty switch or a power supply problem.

STEP 6 Check for battery voltage available at the power input side of the wiper switch. If voltage is available, the switch is defective. Replace the switch. No voltage available to the switch indicates a circuit problem between the battery and switch.

WINDSHIELD WIPER SERVICE

Wiper motors are replaced if defective. The motor usually mounts on the bulkhead (firewall). Bulkhead-mounted units are accessible from under the hood, while the cowl panel needs to be removed to service a motor mounted in the cowl. ● **SEE FIGURE 58–11.**

After gaining access to the motor, removal is simply a matter of disconnecting the linkage, unplugging the electrical connectors, and unbolting the motor. Move the wiper linkage through its full travel by hand to check for any binding before installing the new motor.

Rear window wiper motors are generally located inside the rear door panel of station wagons, or the rear hatch panel on vehicles with a hatchback or liftgate. ● **SEE FIGURE 58–12.**

After removing the trim panel covering the motor, replacement is essentially the same as replacing the front wiper motor.

Wiper control switches are either installed on the steering column or on the instrument panel.

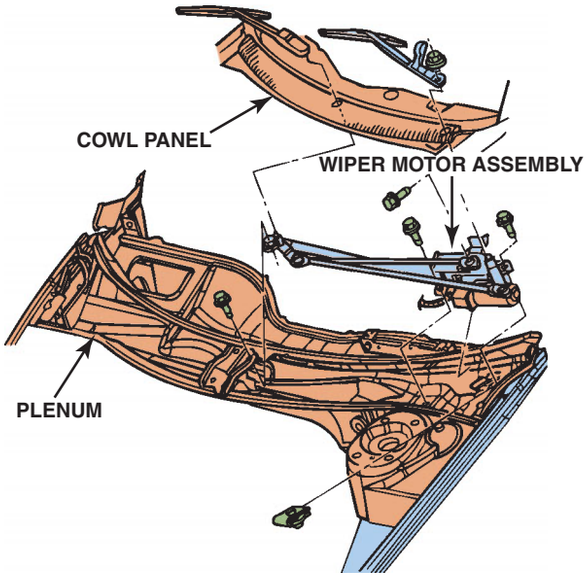


FIGURE 58–11 The wiper motor and linkage mount under the cowl panel on many vehicles.

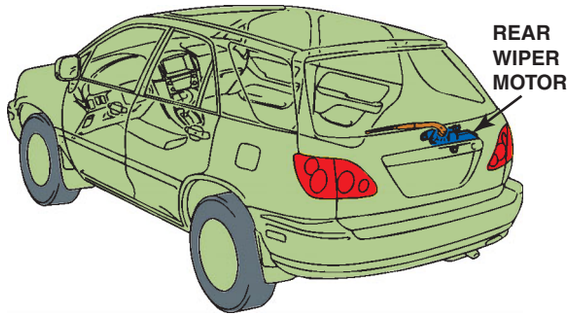


FIGURE 58–12 A single wiper arm mounts directly to the motor on most rear wiper applications.

Steering column wiper switches, which are operated by controls on the end of a switch stalk (usually called a *multifunction switch*), require partial disassembly of the steering column for replacement.

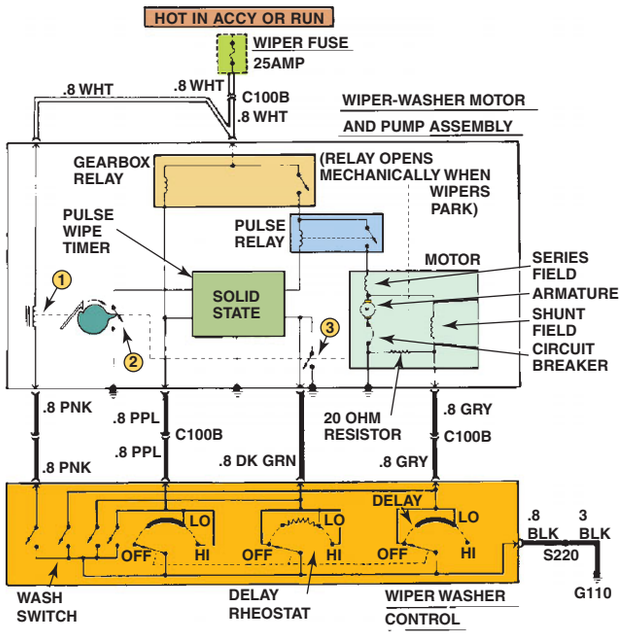
PULSE WIPE SYSTEMS Windshield wipers may also incorporate a delay, or intermittent operation, feature commonly called pulse wipe. The length of the delay, or the frequency of the intermittent operation, is adjustable on some systems. Pulse wipe systems may rely on simple electrical controls, such as a variable-resistance switch, or be controlled electronically through a control module.

With any electronic control system, it is important to follow the diagnosis and test procedures recommended by the manufacturer for that specific vehicle.

A typical pulse, or interval, wiper system uses either a governor or a solid-state module that contains either a variable resistor or rheostat and capacitor. The module connects into the electrical circuitry between the wiper switch and wiper motor. The variable resistor or rheostat controls the length of the interval between wiper pulses. A solid-state pulse wipe timer regulates the control circuit of the pulse relay to direct current to the motor at the prescribed interval. ● **SEE FIGURE 58–13.**

The following troubleshooting procedure applies to most models.

STEP 1 If the wipers do not run at all, check the wiper fuse, fusible link, or circuit breaker and verify that voltage is available to the switch.



① RATCHET RELEASE SOLENOID
(OPERATED WHEN WASH SWITCH DEPRESSED)
② WASHER OVERRIDE SWITCH
(CLOSED DURING WASH CYCLE)
③ HOLDING SWITCH
(OPEN AT THE END OF EACH SWEEP)

FIGURE 58–13 Circuit diagram of a rheostat-controlled, electronically timed interval wiper.

STEP 2 Refer to a wiring diagram of the switch to determine how current is routed through it to the motor in the different positions.

STEP 3 Disconnect the switch and use fused jumper wires to apply power directly to the motor on the different speed circuits.

- If the motor now runs, the problem is in the switch or module.
- Check for continuity in the circuit for each speed through the control-to-ground if the wiper motor runs at some, but not all, speeds.

WINDSHIELD WASHER OPERATION Most vehicles use a positive-displacement or centrifugal-type washer pump located in the washer reservoir. A momentary contact switch, which is often part of a steering column–mounted combination switch assembly, energizes the washer pump. Washer pump switches are installed either on the steering column or on the instrument panel. The nozzles can be located on the bulkhead or in the hood depending on the vehicle.

WINDSHIELD WASHER DIAGNOSIS Inoperative windshield washers may be caused by the following:

- Blown fuse or open circuit
- Empty reservoir
- Clogged nozzle
- Broken, pinched, or clogged hose
- Loose or broken wire
- Blocked reservoir screen
- Leaking reservoir
- Defective pump

To diagnose the washer system, follow service information procedures that usually include the following steps.

TECH TIP

Use a Scan Tool to Check Accessories

Most vehicles built since 2000 can have the lighting and accessory circuits checked using a scan tool. A technician can use the following:

- Factory scan tool, such as:
  - Tech 2 or Multiple Diagnostic Interface (MDI) (General Motors vehicle)
  - DRB III or Star Scan or Star Mobile or WiTech (Chrysler-Jeep vehicles)
  - New Generation Star or IDS (Ford)
  - Honda Diagnostic System (HDS)
  - TIS Tech Stream (Toyota/Lexus)
- Enhanced aftermarket scan tool that has body bidirectional control capability, including:
  - Snap-on Modis, Solus, or Verus
  - OTC Genisys
  - Autoengenuity

Using a bidirectional scan tool allows the technician to command the operation of electrical accessories such as windows, lights, and wipers. If the circuit operates correctly when commanded by the scan tool and does not function using the switche(s), follow service information instructions to diagnose the switch circuits.

STEP 1 To quick check any washer system, make sure the reservoir has fluid and is not frozen, and then disconnect the pump hose and operate the washer switch.

NOTE: Always use good-quality windshield washer fluid from a closed container to prevent contaminated fluid from damaging the washer pump. Radiator antifreeze (ethylene glycol) should never be used in any windshield wiper system.

● **SEE FIGURE 58–14.**

STEP 2 If fluid squirts from the pump, the delivery system is at fault, not the motor, switch, or circuitry.

STEP 3 If no fluid squirts from the pump, the problem is most likely a circuit failure, defective pump, or faulty switch.

STEP 4 A clogged reservoir screen also may be preventing fluid from entering the pump.

WINDSHIELD WASHER SERVICE When a fluid delivery problem is indicated, check for:

- Blocked, pinched, broken, or disconnected hose
- Clogged nozzles
- Blocked washer pump outlet

If the pump motor does not operate, check for battery voltage available at the pump while operating the washer switch. If voltage is available and the pump does not run, check for continuity on the pump ground circuit. If there is no voltage drop on the ground circuit, replace the pump motor.

If battery voltage is not available at the motor, check for power through the washer switch. If voltage is available at and through the switch, there is a problem in the wiring between the switch and pump. Perform voltage drop tests to locate the fault. Repair the wiring as needed and retest.

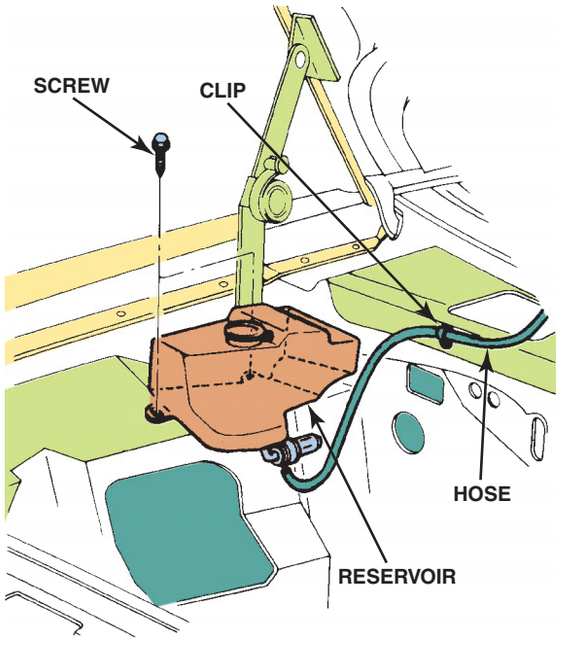


FIGURE 58–14 Disconnect the hose at the pump and operate the switch to check a washer pump.

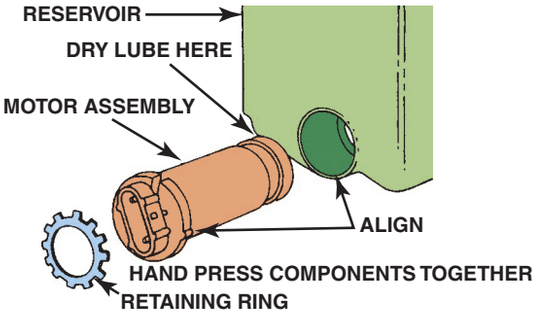


FIGURE 58–15 Washer pumps usually install into the reservoir and are held in place with a retaining ring.

Washer motors are not repairable and are simply replaced if defective. Centrifugal or positive-displacement pumps are located on or inside the washer reservoir tank or cover and secured with a retaining ring or nut. ● **SEE FIGURE 58–15.**

RAIN SENSE WIPER SYSTEM

PARTS AND OPERATION **Rain sense wiper** systems use a sensor located at the top of the windshield on the inside to detect rain droplets. This sensor is called the *rain sense module (RSM)* by General Motors. It determines and adjusts the time delay of the wiper based on how much moisture it detects on the windshield. The wiper switch can be left on the sense position all of the time and if no rain is sensed, the wipers will not swipe. ● **SEE FIGURES 58–16 AND 58–17.**

The control knob is rotated to the desired wiper sensibility level.

The microprocessor in the RSM sends a command to the body control module (BCM). RSM is a triangular-shaped black plastic housing. Fine openings on the windshield side of the housing are