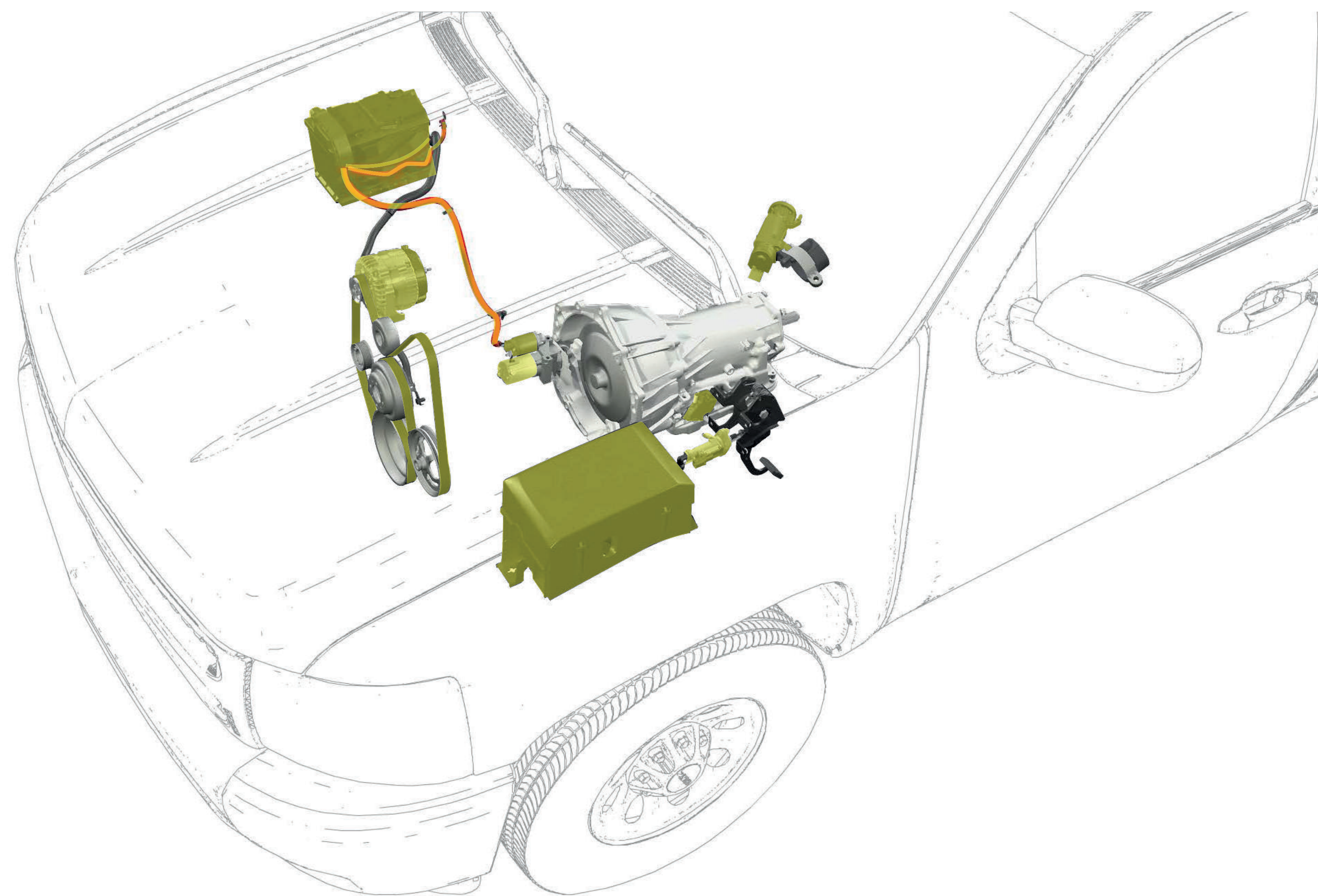


Overview

The Starting and Charging System is a critical system in your vehicle. The Starting system provides the ability to crank the engine electrically from the drivers' position. The first car with electric starting was the 1912 Cadillac. The electric starter motor was designed by Charles Kettering one of the founders of DELCO, which later became ACDelco. The electric energy needed to operate the starter comes from the battery, and to recharge the battery a charging system is used. The charging system is responsible for generating electrical energy while the engine is running. This energy is used to charge the battery, operate the vehicle lights and electrical components. The heart of the charging system is the alternator. It is driven off the engine crankshaft through the accessory drive belt.



[Battery](#)

[Battery Cables](#)

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[Starter Solenoid](#)

[Alternator/Generator](#)

[Accessory Drive Belt](#)

[Voltage Regulator](#)

[Ignition Switch](#)

[Park/Neutral Switch](#)

[Clutch Switch](#)

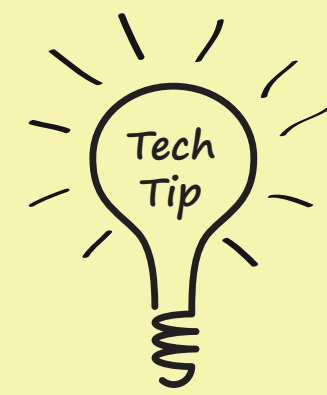
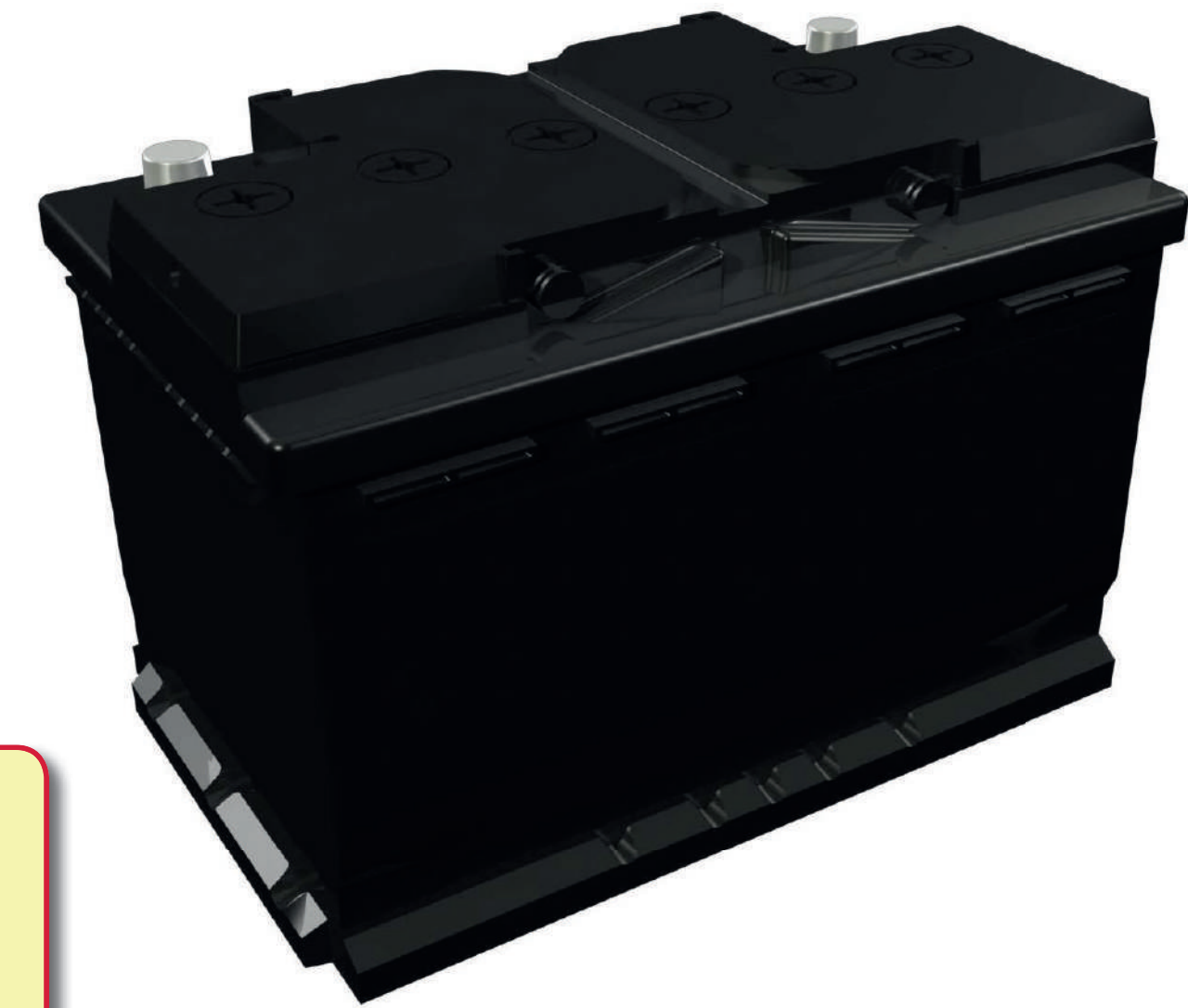
[Start Relay](#)

Battery

Description/Function: A Battery is a galvanic device, meaning it produces an electrical charge by chemical reaction. The battery provides the electrical power needed to operate the starter motor and the lights and accessories while the engine is off. The battery also serves as an “electric accumulator” to absorb voltage spikes and fluctuations that may occur during normal vehicle operation. Several types of batteries are used in cars and trucks. They are Conventional Lead-Acid, Valve Regulated Lead-Acid (VRLA), Absorbed Glass Mat (AGM) or Gel Cell, and Deep Cycle (RV house battery).

Faults/Symptoms:

- Low voltage - Discharged
- Not retaining charge - Sulfated
- Low voltage – shorted plates
- Leaking electrolyte – damaged case



Electrolyte can be neutralized with a mixture of baking soda and water, can also be used to clean battery tray and battery.

Some batteries have removable caps located under a label across top of battery, remove to check electrolyte levels, distilled water can be added to low cells.

Clean battery terminals and posts, corrosion can lead to no-crank.

If specific gravity tests below 1.225 or varies more than 50 points between cells recharge battery.

Discharged batteries can freeze in cold weather; make sure batteries are fully charged before onset of cold weather.

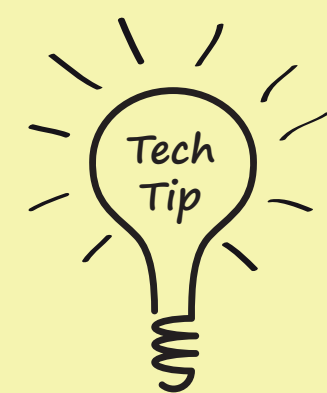
A fully charged battery will have an open circuit voltage of 12.6 volts or higher after surface charge is removed.

Battery Cables

Description/Function: Heavy electrical cables that connect the battery to the starter motor and vehicle electrical system.

Faults/Symptoms:

- Excessive voltage drop
- Corrosion
- Hard/No Crank
- -Discharged battery



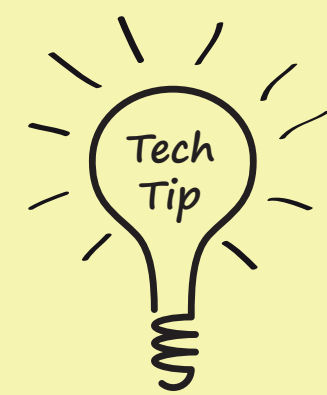
Check voltage drop while cranking, should not exceed 1.5 volts on either cable.

Starter Motor

Description/Function: The starter consists of a powerful DC motor coupled to a sliding gear called a starter drive pinion. The pinion slides into mesh with the ring gear mounted on the engine flywheel. The sliding pinion is shifted by an electro-magnetic starter solenoid. The solenoid is also responsible for switching on the starter motor. Current flows from solenoid contact switch to field winding, brushes, commutator and armature windings causing motor to operate.

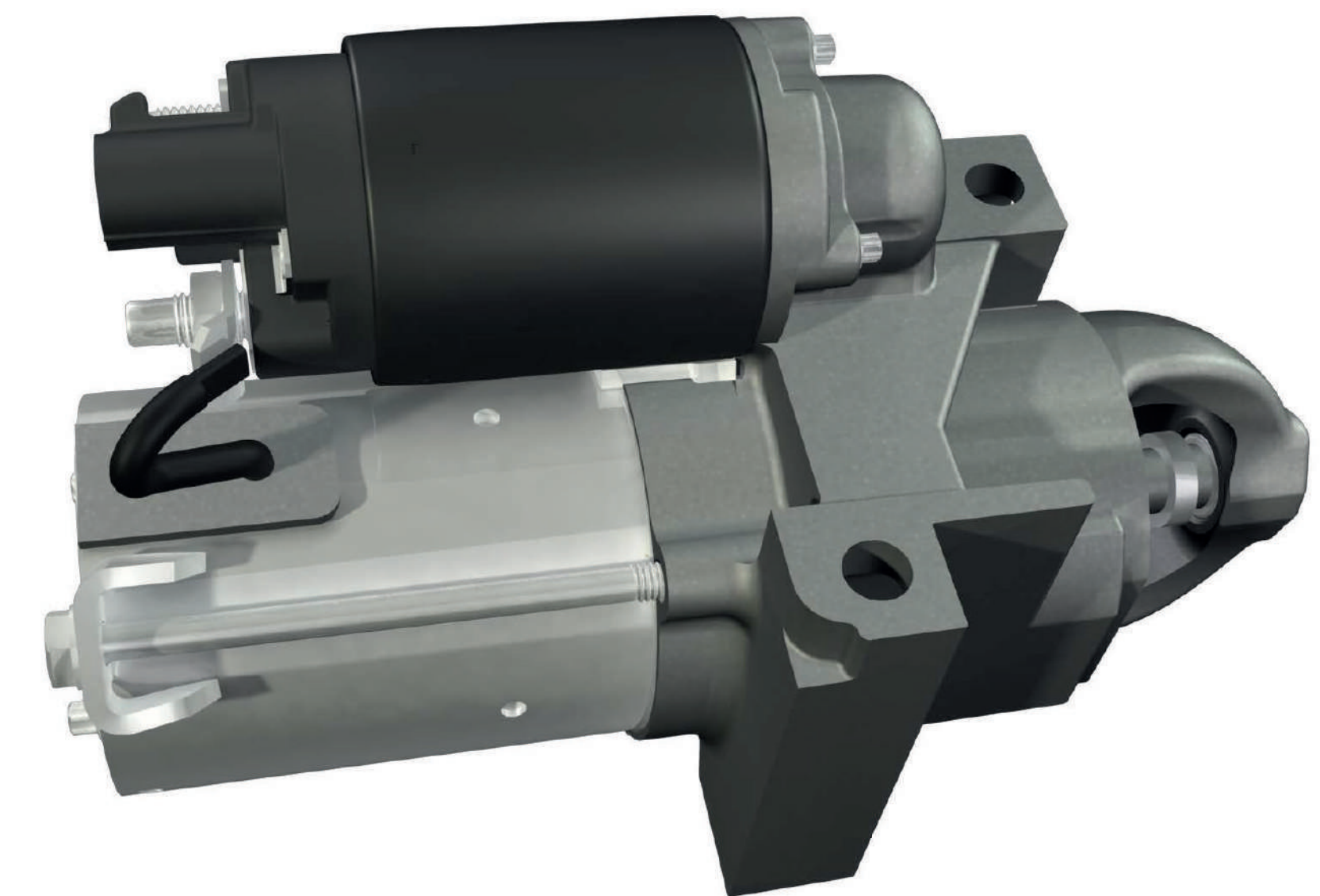
Faults/Symptoms:

- Worn commutator or brushes
- Worn bearings/bushings
- Open armature or field winding
- Worn or damaged gear reduction
- Worn or damaged pinion/overrunning clutch
- Loose or cracked pole magnet
- Inoperative or no crank
- Abnormal noises
- Failure to engage or disengage flywheel



Some older vehicles used shims to set starter pinion to flywheel clearance. The clearance should be about 0.032" using a wire gauge, or a paper clip.

Check voltage drop on both the positive and negative circuits from battery to starter, should be less than 1.5 volts total while cranking.

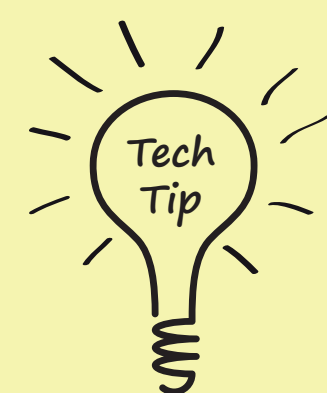


Starter Solenoid

Description/Function: The starter solenoid is an electromagnetic actuator with two coils or windings. The pull-in and hold-in windings. When the key is rotated to the start position both solenoid windings are energized. The windings work together magnetically to pull and hold in the plunger. The plunger moves the shift lever causing the starter drive pinion to engage with the flywheel ring gear on the engine. At the same time, the solenoid switch contacts in the solenoid energize the starter motor windings. As soon as the solenoid switch contacts close, current stops flowing through the pull-in winding. The hold-in winding remains energized to hold the plunger, shift lever, starter drive pinion, and solenoid switch contacts in place to continue cranking the engine.

Faults/Symptoms:

- Open or shorted pull-in or hold-in windings
- Worn or damaged solenoid switch contacts
- Binding or damaged shift lever
- Binding or stuck solenoid plunger
- Inoperative – no-crank
- Abnormal noises
- Failure to engage or disengage flywheel



No crank? Use DMM min/max to check voltage at start terminal at solenoid with ignition switch in start position. If battery voltage not present, problem is with start circuit, check Park/Neutral switch, start inhibit relay, ignition switch. Or clutch switch.

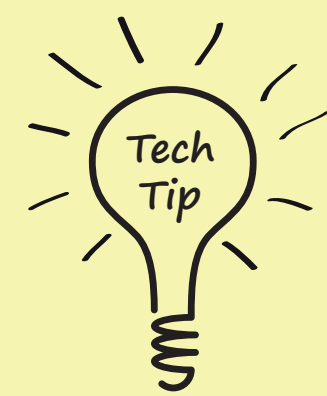
Slow crank? Check voltage drop across solenoid contact switch terminals using DMM min/max. Should be less than 1 volt while cranking.

Alternator/Generator

Description/Function: The Alternator/Generator is driven by the engine usually via a belt. The spinning rotor within the alternator generates an electrical current in the stationary stator windings. The rotor winding receives excitation current from the voltage regulator through carbon brushes riding on copper slip rings. The alternating current produced must be rectified into direct current; this is done with a diode bridge rectifier inside the alternator. The direct current then flows out to the vehicle electrical system to perform the needed work.

Faults/Symptoms:

- Open or shorted stator windings
- Open or shorted rotor windings
- Worn brushes or slip rings
- Open or shorted diodes
- Worn bearings
- Bent or damaged pulley/cooling fan
- Low or no output
- Excessive AC ripple
- Abnormal noise
- Charge indicator on



At 2500 rpm the alternator/generator should produce 12.6-15.0 volts.

AC ripple should be less than 0.5 volts

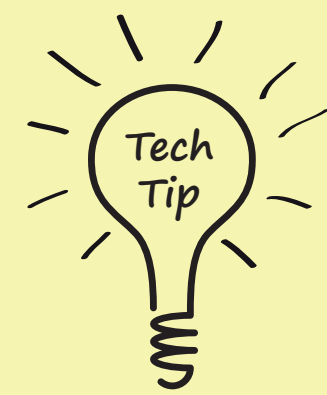
More than 0.5 milliamps current on the charge wire with engine and key off indicates diode leakage (short).



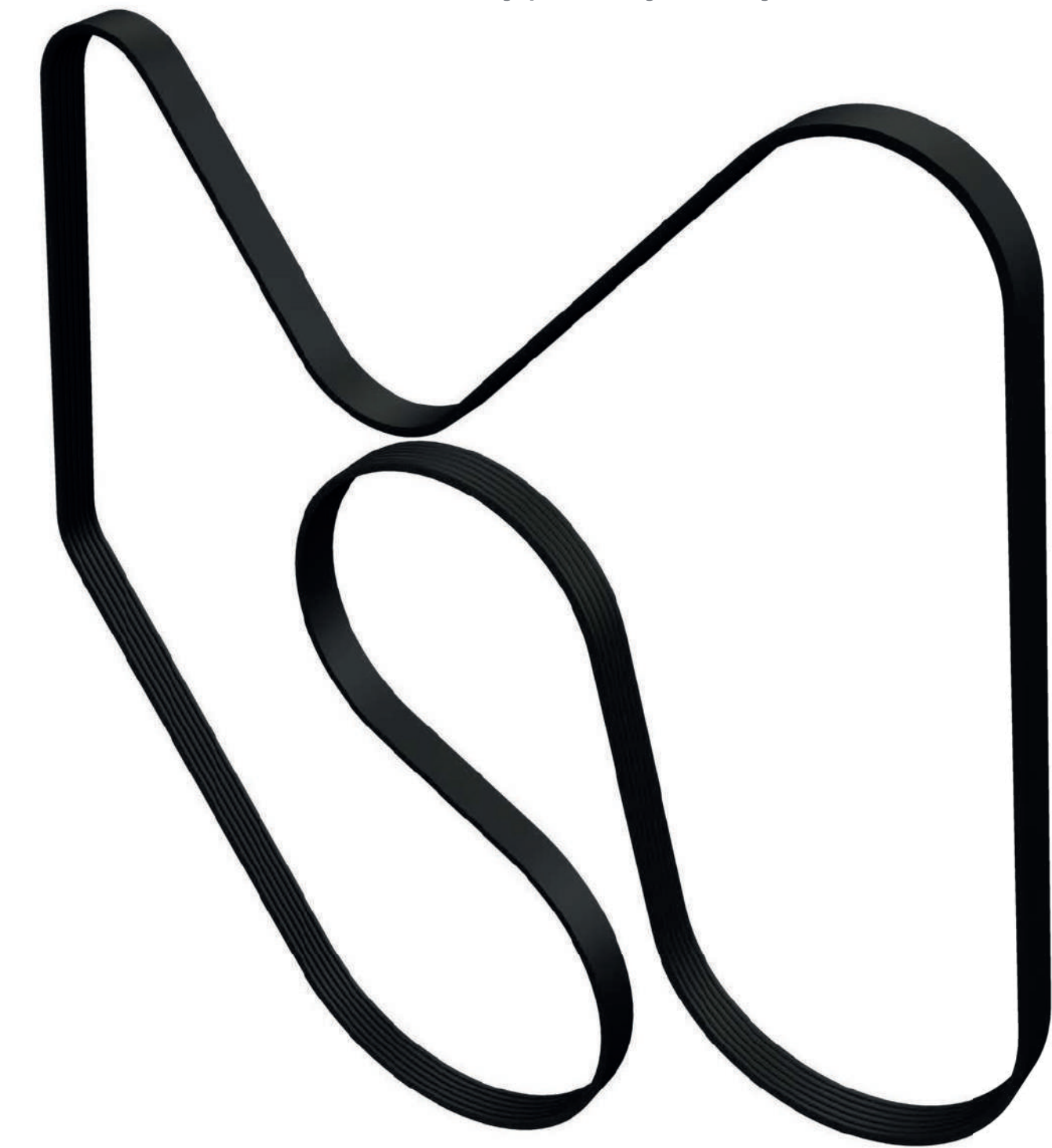
Accessory Drive Belt

Description/Function: The accessory drive belts can be a single flat multi-ribbed serpentine belt or a combination of multi-rib belts and V-belts. Typically they are constructed of poly fiber reinforced synthetic rubber. Their function is to transfer power from the engine crankshaft to the engine ancillary components such as the water pump, alternator and power steering pump.

Faults/Symptoms: Belt Slip – A worn belt can slip when high loads such as A/C usage, high electrical demand such as headlights and fans are operating. This causes the pulleys to heat up, leading to accelerated bearing failure in the ancillary component. Hydroplaning – worn belt ribs bottom out in pulley grooves, no space for water to escape, belt slips. Stretching – worn belt stretches causing tensioner to slack beyond working range, causes belt slip. Misalignment – worn tensioner roller or idlers cause belt to track off center, wears edge of belt.



If the belt shows signs of cracking, edge wear, glazing, or piling of rubber the belt and tensioner should be replaced. The multi-rib belts of today are made from EPDM and can visually look ok however may be totally worn out. A close inspection to the belt to pulley fit is required. If the peaks of the ribs are bottoming out, the belt is worn out. Also don't forget the idlers and tensioner. It is recommended that they be replaced whenever the belt is to avoid possible early belt wear.

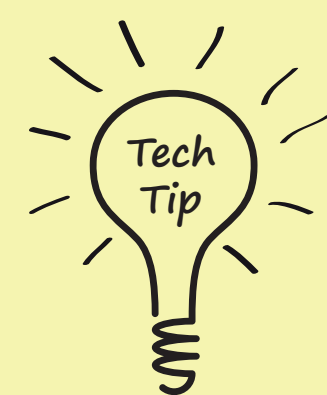


Voltage Regulator

Description/Function: The alternator must be regulated to maintain a steady voltage output throughout the engine speed range. This is handled by the voltage regulator. The voltage regulator is an electronic device that varies the rotor excitation current based on the alternator output voltage. The regulator can maintain the alternator output between 12.5 and 15.0 volts depending on conditions across the entire engine speed range.

Faults/Symptoms:

- Open or shorted rotor circuit
- Internal malfunction
- No excitation current output
- Charge indicator on
- Abnormal noise



Some alternators/generators have a provision for full fielding; this tests whether the alternator/generator or regulator is at fault. If the alternator has no output when full-fielded then problem is not with the regulator.

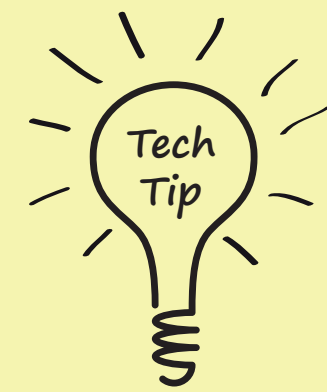


Ignition Switch

Description/Function: The ignition switch initiates the starting process. In older vehicles the switch provided the current directly to the starter solenoid, late-model vehicles use the ignition switch as an input to a control module which activate starter relays that supply the starter solenoid current.

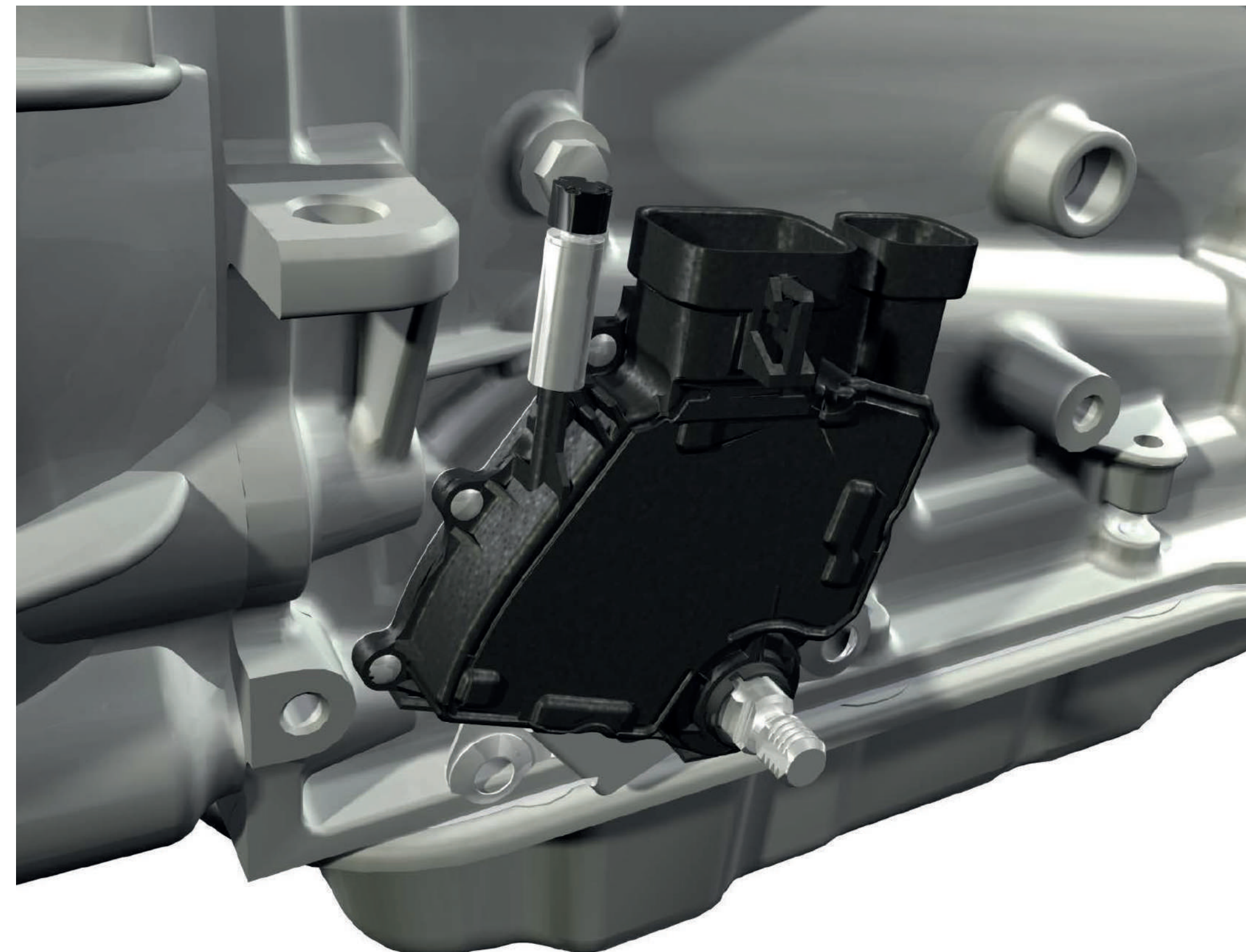
Faults/Symptoms:

- Open circuit/High Resistance
- Short circuit
- Mechanical damage
- No Crank
- No Start
- Inoperative electrical accessories



Test ignition switch using DMM.

Late model vehicles use power-mode-ing, use a scan tool to monitor ignition switch function.

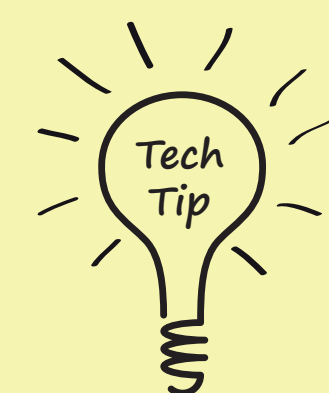


Park/Neutral Switch

Description/Function: Vehicles with automatic transmissions have a park/neutral switch function that prevents the starter from cranking the engine if the gear selector is in any gear position other than PARK or NEUTRAL. The switch can be a stand-alone part or a function of a gear range sensor. Typically located on the transmission at the shift lever shaft.

Faults/Symptoms:

- Open circuit/High Resistance
- Short Circuit
- Water intrusion or mechanical damage
- No Crank
- Inoperative gear range indicator "PRNDL"



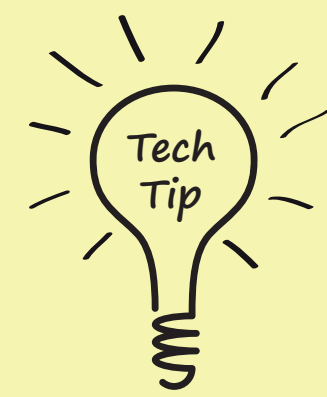
Some switches/sensors are inputs to the TCM or PCM, check switch function using scan-tool.

Clutch Switch

Description/Function: Vehicles with manual transmissions may have a clutch pedal switch that prevents the starter from cranking if the clutch pedal is not depressed. The switch may control a starter relay and not the S circuit directly.

Faults/Symptoms:

- Open circuit/High Resistance
- Short Circuit
- Out-of-adjustment
- No Crank
- Crank without depressed pedal



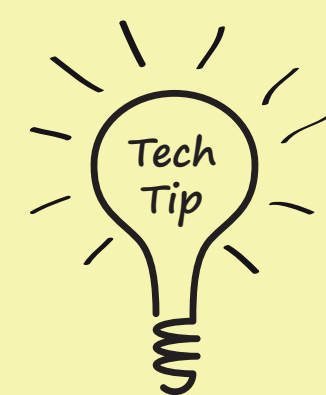
Follow adjustment procedure in service information.

Start Relay

Description/Function: Relays are commonly used in the Start circuit to inhibit the start circuit for anti-theft and safety purposes, ie: park/neutral and clutch pedal switch. The relay can handle the high current of the starter solenoid and allows lighter gauge wiring for the switches and sensors.

Faults/Symptoms:

- Open or shorted coil windings
- Worn or damaged switched contacts
- Sticking
- Inoperative – no-crank
- Starter chatter



Some vehicles use a common type of relay for multiple functions, swap with another relay in the relay panel with the same part number to quickly rule out the relay.