

Subaru Starter Service

Subaru starter motors offer long service life. That's why it's important to correctly determine whether the starter, or another component is responsible for a no-start condition. This article covers starter motor construction and service tips.

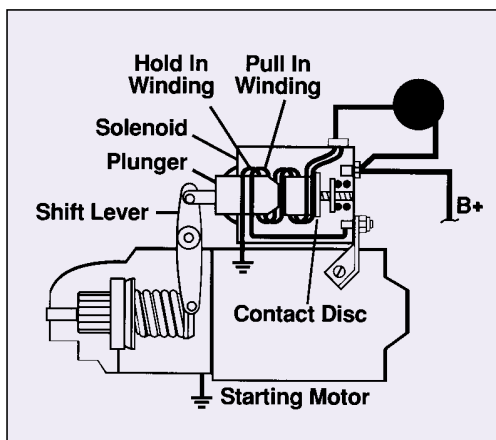
Subaru starters are of either the reduction gear or direct drive type. Operation of both starter types is similar, with the exception of the method of delivering the starter drive to the flywheel. The drive pinion on direct drive starters is connected directly to the starter armature shaft. On reduction gear starters, cranking power is directed through a set of reduction gears before it reaches the drive pinion, then the flywheel.

The components of the starter assembly are:

- Drive Pinion/ One-way Clutch
- Armature
- Commutator
- Field Shoes
- Brushes/Brush Holders
- End Caps/Bushings

The components of the magnetic switch/solenoid are:

- Pull-in Winding
- Hold-in winding
- Plunger
- Return Spring
- Shift Lever
- Starter Motor Contacts



Magnetic Switch/Solenoid

Starter Operation

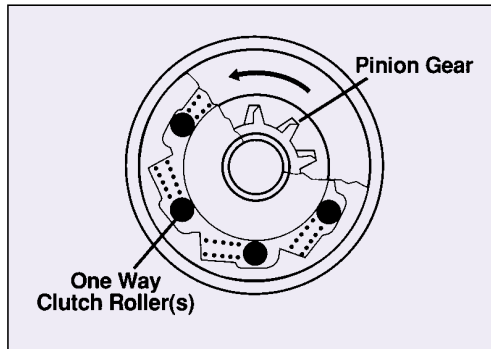
When the ignition switch is turned to the START position, battery voltage (B+) is allowed to energize the magnetic switch/solenoid pull-in and hold-on coils. The field created by the coils moves the plunger which in turn moves the shift lever engaging the starter pinion with the flywheel. The movement of the plunger also activates the starter motor switch contacts. This allows B+ voltage from the battery cable to flow to the starter motor through the magnetic switch.

The starter rotates the pinion which rotates the flywheel to crank the engine. When the engine starts, the

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one-way clutch “freewheels” to protect the starter armature and commutator from an “overspeed” condition.

When the ignition switch is released from the START to the ON position, this eliminates the flow of B+ voltage to the magnetic switch/ solenoid which collapses the field. The plunger spring returns the plunger to its original position moving the shift lever which disengages the pinion from the flywheel. The plunger also releases the switch contacts and the starter motor stops rotating.



Starter One-Way Clutch

An occasional problem with starting systems is a defective hold-in winding in the solenoid. In this situation, the solenoid will “click” rapidly. This occurs because the pull-in winding moves the plunger but the hold-in winding is not energized. Since no hold-in field is created and the pull-in winding field is released as the start switch is engaged, the plunger return spring returns the plunger to the pre-start position. This process repeats and the plunger moves back and forth rapidly. This action will momentarily engage the flywheel, and occasionally may rotate the flywheel enough to start the engine.

Note: These symptoms are similar to those caused by a defective battery or battery connections. Therefore, a battery performance test, and an inspection of the battery connections must always be performed prior to troubleshooting the starter system.

Starter/Solenoid Testing Procedures

Use an ohmmeter to test the pull-in

and hold-in windings. Always refer to the appropriate model year Subaru Service Manual.

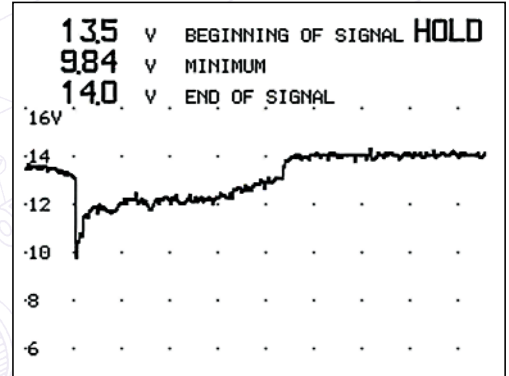
Use a voltmeter to conduct a starter motor test for intermittent operation.

Complete the following steps:

1. Connect the voltmeter leads to the starter motor terminal and to a ground.
2. Bypass the solenoid by connecting a jumper cable from the solenoid B+ terminal to the solenoid starter motor terminal. This spins the starter, but does not engage the magnetic switch/solenoid.
3. If there is a steady voltage reading the starter motor components are okay.

- Brushes
 - Commutator
 - Armature
4. A variable voltage reading indicates a problem in:
 - Brushes are arching
 - Commutator is dirty or has a defective segment
 - Armature is open or has a shorted winding

Finally, be sure to test all cables using the voltage drop method.



Starter Motor Cranking Voltage Test

Troubleshooting Starter Problems With Voltage Drop Tests

Misdiagnosis of starter problems often result in unnecessary battery or starter replacements and customer comebacks because a part replacement doesn't solve the problem. At times, a new battery can hide starter problems. But as the battery charge lowers, the starter problem reappears and the customer returns.

There are four basic starter system problems:

- The engine cranks slowly, and may not start.
- The starter spins but the engine doesn't crank.
- The engine cranks, but will not start.
- The starter is noisy.

We will consider only the first condition, as the remaining three are mechanical in nature, or involve other engine systems.

Engine Cranks Slowly

This is the most common starter problem encountered. Most often the problem is electrical. Several considerations are possible. Each must be eliminated in the most logical order:

- Is there a voltage drop in the starter voltage feed line that is keeping the starter from getting enough battery current?
- Is the battery at fault; too dis-

charged to maintain an adequate load voltage or too low in capacity?

- Is the starter motor defective? Is the armature dragging?
- Is the engine worn or oil very cold, which puts extra drag on the starter motor?

Test Starter Motor Current Draw

The easiest way to measure starter motor current draw is to use an inductive current meter for direct measurement of current draw. If an inductive current meter is not available, a second method uses a battery load tester and a voltmeter — preferably digital. This method has limited effectiveness when the starter motor draw is excessive because it drains the battery too much in Step 2. It may even burn a fusible link open.

Step 1: Disable the ignition system according to recommended procedures.

Step 2: Place a voltmeter across the battery terminals and crank the engine for ten seconds. Record the battery voltage at the end of ten seconds just before cranking is stopped.

Step 3: Place a load tester on the battery and adjust the variable carbon pile until the battery voltage equals the reading obtained when cranking the engine for ten seconds.

Step 4: Note the current draw reading on the Load Tester. This is the current drawn by the starter motor when cranking. The problem with this test is that the first 10 second test, in step 2, may lower the battery state of charge,

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due to a defective starter, to a point so low that battery will fail to deliver the voltage recorded in Step 3.

Step 5: Compare the current draw with the specifications. If the current draw exceeds specs, replace the starter motor.

When current draw is below specs, the cause must be determined with additional troubleshooting. It could be a defective starter motor or a voltage drop caused by a bad connection or cable.



Starter Voltage Drop Test

Starter Motor Current Draw Below Specs

If the starter motor is not receiving sufficient operating voltage, due to a voltage drop, it cannot draw enough current to develop enough torque to crank the engine.

Measure voltage at the battery terminal of the starter motor while cranking. The voltmeter should be connected between the BAT input to the starter motor and ground. The reading should be the same as actual battery voltage when the starter motor is engaged — about 9.6-11.0 volts. If the voltage is the same at the BAT input, it means there is no voltage drop (or loss) between the battery positive terminal and the starter motor's BAT input.

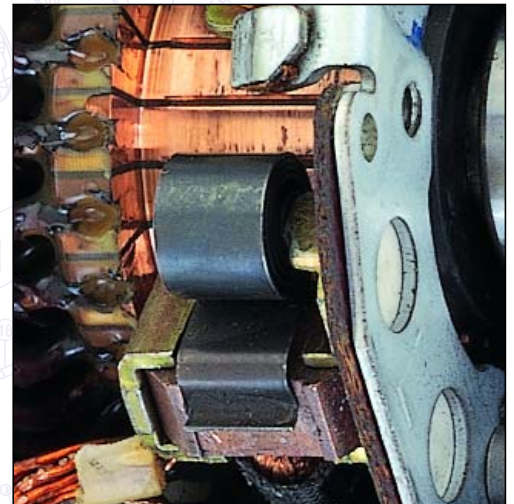
If Voltage Is Too High

If battery voltage doesn't drop much

when the starter is engaged (11.0 volts or higher), the starter is not drawing enough current to pull the battery voltage down, as normally happens. Check the starter motor ground by measuring the starter motor voltage drop. Connect the positive voltmeter lead to the starter motor ground and the negative lead to chassis ground (engine block).

If the ground voltage drop is below 0.3 volt, it is okay. If the voltage drop is above 0.3 volt, clean the starter motor ground connections.

If no reason can be found for the low starter motor current draw, suspect a defective starter motor that is either partially open or has a high resistance. Check the brushes in the motor or replace the starter motor.



Starter Motor Commutator and Brush

If Voltage Is Too Low

If voltage at the starter motor BAT input is lower than actual battery voltage during cranking, it indicates unwanted resistance is causing a voltage drop. This prevents full battery voltage from reaching the starter motor.

During normal cranking, if the battery voltage drops to 11.0 volts and the voltage measured at the starter motor is 7.5 volts, for example, it indicates an unwanted voltage drop of 3.5 volts exists between the battery positive terminal and the starter motor BAT input. In this case the starter motor is only getting 7.5 volts to operate.

The voltage drop in this circuit should be no more than 0.5 volt, and

preferably less. Find the point where voltage is dropped by measuring individual sections of the circuit to locate a voltage drop. Repair the connection, or if the voltage drop is due to high resistance in the cable, replace the cable.

Measuring Starter System Voltage Drops

When measuring voltage drops in the starting system, observe the following general procedures:

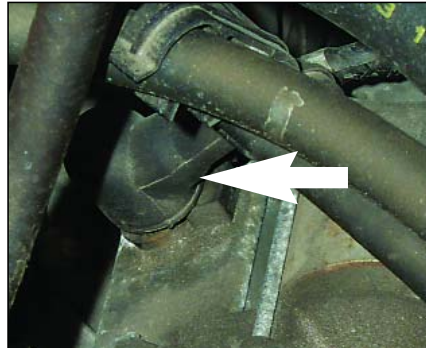
- Place the voltmeter test lead probe tips across a point in the circuit to be measured.
- Always use a digital voltmeter (DC accuracy at least $\pm 0.5\%$) when measuring voltage drops to get accurate reading of the small voltage levels being measured.

The following parts of the circuit should be a voltage drop tested when the starter motor turns

slowly and the battery has tested good:

• *Starter Feed Circuit Voltage Drop*

This test measures the entire voltage drop of the voltage feed circuit to the starter motor. It checks the solenoid, starter cable and connections, and should read less than 0.5 volt. If not, check voltage drops across each component, cable and connection.



Starter Motor Positive Terminal

• *Solenoid Switch Voltage Drop*

The voltage drop should be less than 0.3 volts. If not, clean the solenoid connections. If this doesn't help, the internal switch plate is defective and solenoid should be replaced.

• *Starter Motor Cable Voltage Drop*

The voltage drop should be less than 0.3 volt drop. If not, clean the connections or replace the high resistance cable. Also, visually inspect the cable to make sure the cable insulation is not worn off where a possible short to ground could occur.

• *Battery Cable Voltage Drop*

The voltage drop should be less than 0.3 volt. If not, clean the connections at both ends of the cable to the starter motor. If this doesn't help to reduce the voltage drop, replace the battery cable.