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# Starter System testing

## TASK OBJECTIVE

At the completion of this task the technician will be able to properly perform a voltage drop test on an electric start circuit. The technician will be able to explain the results of the test as well as the meaning of the results obtained when higher or lower than expected. The technician will then perform an amperage draw test on an electric start circuit. The technician will be able explain the meaning of the results as well as explaining the problem item if the amperage draw is higher or lower than specified.

**INTRODUCCTION**

**Starter System diagnosis:**

As with any troubleshooting procedure involving a battery-powered device or system, the vehicle’s battery should be tested before attempting to find and identify any other potential starting system problems. If the battery is discharged, bring it to full charge. Make sure both the battery and charging system are fully functional before continuing with your starter system diagnostics.

Also keep in mind that some vehicles are equipped starter ‘inter-lock’ or ‘lock-out’ safety devices, which disable the electric starter system if, for example, the vehicle is in gear. Always refer the vehicle’s electrical schematics to determine what safety-interlock devices are used on the vehicle, and include these devices in your diagnostic procedures.

**Low Current Circuit Testing**

Since a starting system’s low-current circuit controls the function of the high-current circuit, your diagnostic tests should begin with the low–current circuit. If, when the starter button is pushed or the ignition switch is turned to the ‘start’ position, you can hear an audible ‘click’ from the starter relay, it is probably safe to assume that the problem is in the high-current side of the system. If you do not hear the audible ‘click’ that a relay normally makes when it is activated (when its high-current contacts close), then proceed to check the low-current circuit wires connections and components.

Begin by making sure that battery voltage is reaching the ignition and or starter switch. If the system includes any safety interlock devices, test these devices to ensure that they are functioning properly and not mechanically stuck in a position that would disable the starter circuit.

Check the low-current side of the relay by performing a resistance test through the relay winding. Resistance through this winding should be within the specification provided in the vehicle’s shop manual. Also check resistance between the coil winding terminals and the relay housing. Resistance here should be infinite. If your ohmmeter registers a readable resistance value between the coil winding and the housing, the winding is internally shorted to ground.

**Voltage Drop**

A voltage drop test is one of the easiest electrical tests to perform; yet, in terms of diagnostic effectiveness, it is one of the most valuable. Voltage drop in a circuit represents lost voltage or pressure. Voltage (electrical pressure) is normally lost in a circuit as current passes through the resistance offered by each of the circuit’s electrical components. Switches, circuit and terminal connections and relays, however, should add little or no resistance to a circuit.

Voltage drop measurement can be very effective in detecting the presence of interference resistance in a starter circuit. As we know, in a series circuit, total resistance (Rt = R1 + R2 + R3 + R, etc.) is equal to sum of all of the resistors (loads) in the circuit. If there is additional resistance in a circuit due to a corroded connection or damaged wire, voltage available to the starter will be reduced.

Total voltage in a series circuit is Et = El + E2 + E3 + E etc. In other words each part of the circuit will consume an amount of voltage proportional to its resistance. For example, if there is excessive resistance between the battery and starter which causes a voltage drop of 2 additional volts across the circuit, voltage available at the starter motor would be reduced by 2 volts. This would result in the same starter motor performance as would occur if the battery in an otherwise good system was discharged to 10 volts. If you have ever tried to start a vehicle with only 10 volts available at the battery, you can appreciate what a reduction of 2 volts can do to the performance of a starter system.

Again, a voltage drop test is a quick and effective way to detect resistance interference in a starter circuit.

**PRECAUTIONS**

1. Always ensure that the engine cannot start during these tests. Either remove the spark plug leads from the spark plugs and connect them to grounding device or disable the primary side of the ignition system by disconnecting the ignition control module or primary ignition coil wires. On fuel injected units disable the fuel injectors so no excess fuel will be injected into the engine.
2. Do not crank the engine for a period longer than 15 seconds.
3. Allow a 2-minute interval between each voltage measurement to permit the starter to cool.

**PROCEDURES**

Before performing your voltage drop tests, ensure that the battery is fully charged and all battery and starter cable connections are clean and properly tightened. Also, keep in mind that each test is performed with the starter circuit activated and the starter actually cranking the engine over. In other words, these are live-circuit tests.

**TEST 1:**

Interference resistance can be found anywhere in circuit on both the positive and negative sides. It is recommended, however, that you check the positive side first, beginning with the portion of the circuit between the positive ( + ) battery terminal and high-current input terminal on the starter relay.

Place your voltmeter’s positive ( + ) probe on the positive ( + ) battery terminal and negative ( - ) probe on the high-current input terminal on the starter relay. Make sure the test leads are attached directly to the battery post and relay terminal, not to the cable connectors. Connecting to the cable connectors will test the cable only, not the connections between the battery and cable and cable and relay terminal. Activate the starter to crank the engine. The voltmeter reading should not exceed 0.2 volts or 2% of battery voltage per ten foot of cable, whichever is greater.

**TEST 2:**

The second voltage drop test is performed across the high-current terminals of the starter relay. Connect the positive ( + ) voltmeter lead to the relay’s the high-current input terminal and the negative ( - ) voltmeter lead to the relay’s high-current output terminal and engage the starter system. Here again voltage drop reading should not exceed 0.2 volts.

**TEST 3:**

The third voltage drop test is performed between the relay’s high-current output terminal and the starter motor input terminal. Connect the positive ( + ) voltmeter lead to the relay’s high-current output terminal and the negative ( - ) voltmeter lead to the starter motor’s input terminal, and engage the starter system. The voltmeter reading should not exceed 0.2 volts.

**TEST 4:**

Test 4 is performed across the starter motor itself. Connect the positive ( + ) voltmeter lead to the starter motor’s input terminal and the negative ( - ) voltmeter lead to a chassis ground, and engage the starter system. The voltmeter reading should be as close to base battery voltage as possible.

**TEST 5:**

Test 5 is intended to ensure that resistance through the ground circuit back to the battery’s negative post is not excessive. Touch the positive ( + ) voltmeter lead to the starter motor housing and the negative ( - ) voltmeter lead to the battery’s negative post. Here again, the voltmeter reading should not exceed 0.2 volts.

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| **Test - Starter Circuit Voltage Drop (modified)** |  |

Starter Circuit Voltage Drop

**Ampere Draw**

During starter operation, a high amperage draw occurs from the battery to the starter. This high amperage cannot be measured using a standard multi-meter (the high current flow would destroy the meter). Starter current draw can, however, be measured indirectly, using a high-amperage shunt and a voltmeter, or directly with an inductive ammeter or amp probe.

**High Amperage Current Shunt**

A high-amperage shunt is simply a piece of heavy gauge wire (usually around 8 gauge) cut to an exact length with a terminal soldered to each end. The shunt is installed in series with negative battery cable and a digital voltmeter attached as illustrated below. When the starter circuit is activated, the voltmeter will indirectly measure current flow by measuring the voltage drop across the shunt. The exact construction of the shunt, the material from which it is made, its diameter and length, ensure that the voltage reading accurately represents the amperage passing through the circuit. Generally speaking, when using a shunt, 0.010 volts equals 10 amperes of current flow.

**Inductive Current Measurement**

An inductive ammeter is highly recommended for measuring current flow beyond 10 amps. An inductive ammeter measures current flow through a circuit without actually having to be connected to the circuit. It does so by sampling the magnetic field produced by the current flowing through a circuit and translating the field strength into an ampere reading. The instruments pictured below are both inductive current (amperage) measuring devices.

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| Test - Current Shunt (A00E6AS - modified) | **Test - Inductive Ammeter (F06H2HA)** |

Measuring Starter Draw (Amperage)

**PROCEDURES**

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| 1. Perform the following procedures and record the information. | | | | | | | | | |
| 1. What is the specification for the starter solenoid low, current side? (ohms)\_\_\_\_\_\_\_\_\_\_\_\_ | | | | | | | | | |
| 1. Measure the resistance value of the solenoid low current side and record:\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | | | | | | |
| 1. Is it within specification? | YES | |  | NO | | |  |  | |
| 1. What is the battery base voltage while cranking? | | | | | | | | | |
| 1. Perform voltage drop on the starter system while cranking and record data below. | | | | | | | | | |
| 1. Battery positive lead to solenoid? | | | | | | | | | |
| 1. Across solenoid? | | | | | | | | | |
| 1. Solenoid to starter terminal? | | | | | | | | | |
| 1. Across starter motor? | | | | | | | | | |
| 1. Starter ground to negative battery terminal? | | | | | | | | | |
| 1. Are any of the voltage drops out of specification? | YES | |  | NO | | |  | | |
| 1. If so which one? | | | | | | | | | |
| 1. Do all of the voltage drops add up to the battery base voltage while cranking? | | | | | | | | | |
| 1. Perform an amperage draw test on the starting system. | | | | | | | | | |
| 1. Record the Amperage. | | | | | | | | | |
| 1. Can this reading be used as a specification for starter draw on this engine? | | YES | | |  | NO | | |  |

**QUESTIONS:**

1. What is the maximum amount of voltage drop you should see across a conductor while cranking the engine?

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# Instructor sign off-- Go \_\_\_\_\_\_\_\_\_