

Battery Testing

WARNING

Before testing a battery, read the appropriate safety information.

Both the starting system and the charging system depend on good, strong batteries for proper vehicle performance. The diagnostic process for batteries begins with a thorough visual inspection. Then, if any problems are identified, these problems must be corrected before proceeding with electrical tests. The ACDelco recommended electrical tests include battery conductance test, load testing, and cable voltage drop testing. A voltage drop test may be used to identify the possibility of high resistance problems. Depending on test results, the battery may need replacement, terminals may need cleaning, or cables may need to be replaced. Conductance testing is for batteries that have been in service in a vehicle. New batteries that have never been installed in a vehicle can only be checked with a DVOM.

To properly perform these tests, you also need to understand battery capacity rating and how to determine the battery's state of charge.

Begin your diagnosis by talking to the person who owns or drives the vehicle with the concern.

When a battery is suspected as the cause of an automotive concern, start by determining whether or not the battery has worn out (usually from normal use) and should be replaced. You can make this determination in one of two ways:

- Use an electronic conductance tester to test the battery before doing a load test
- Recharge the battery and retest.

Specific Gravity Test (Filler-Cap Batteries)

Specific gravity is a unit of measurement that determines the sulfuric acid content of the electrolyte. A battery with a fully charged specific gravity of 1.270 corrected to 80°F contains an electrolyte with approximately 36% sulfuric acid by weight. The remainder of the electrolyte is like water. A specific gravity greater than 1.265 indicates a higher acid concentration in the electrolyte. A lower specific gravity indicates a weaker acid content. The following table, Figure 4-8, lists typical specific gravity values at various states of charge.

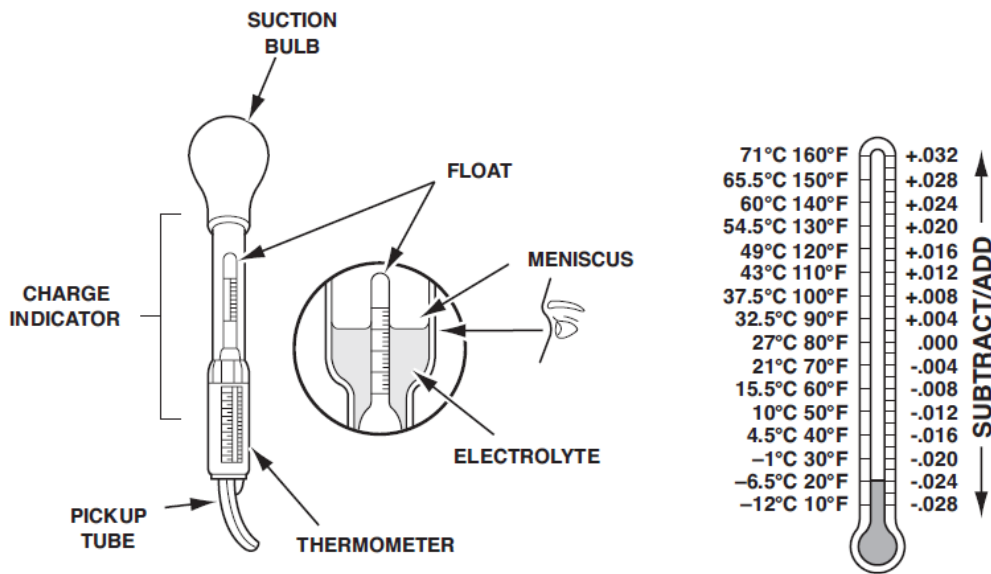
Charge Level	Specific Gravity	Voltage (12)	Voltage (6)
100%	1.270	12.73	6.4
75%	1.225	12.45	6.2
50%	1.190	12.24	6.1
25%	1.155	12.06	6.0
Discharged	1.120	11.89	6.0

Figure 4-8, Typical Charge Level and Specific Gravity Table

A hydrometer, a bulb-type syringe, is used to measure the specific gravity of a battery's electrolyte. It extracts electrolyte from a cell. A glass float inside the hydrometer barrel is calibrated to read specific gravity of the electrolyte. The lower the float sinks in the electrolyte, the lower specific gravity of the electrolyte.

Refer to the following procedure when using a hydrometer to measure specific gravity:

1. Draw electrolyte from the first battery cell into the hydrometer. With the bulb fully expanded, the float should be lifted free so that it does not touch the sides or bottom of the barrel.
 2. With your eye level to the surface of the fluid in the hydrometer barrel, read the specific gravity level on the float.
 3. Record the value for that cell.
 4. Repeat steps 1–3 for all remaining cells.
 5. If the range between the highest and lowest values is greater than .050, or the lowest value is less than 1.225, charge the battery.
 6. Recheck the specific gravity for all battery cells.
- If the range is still greater than .050 points, or the lowest value is still less than 1.225, replace the battery.
 - If the charge revives the battery, proceed with the load testing.



Example:

Electrolyte Temperature	40°F
Hydrometer Reading	1.250
Subtract Specific Gravity	<u>-0.016</u>
Corrected Specific Gravity Equals	1.234

Example:

Electrolyte Temperature	100°F
Hydrometer Reading	1.240
Add Specific Gravity	<u>+0.008</u>
Corrected Specific Gravity Equals	1.248

A fully charged battery has a specific gravity of 1.270

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Figure 4-9, Hydrometer

Battery Test Procedures

Filler Cap Battery—Preliminary Tests

1. **Visual Inspection.** When physical damage is present, replace battery. If none, check electrolyte levels.

Fluid should be above top of plates in all cells. If so, proceed to step 2. (Be sure no spark or open flame is near while caps are off.) If not, add water, replace vent caps, and charge battery for 15 minutes at 15–25 amps to mix electrolyte. Proceed to step 2.

2. **Specific Gravity Check.** Hydrometer reading of all cells should be at least 1.225 and show less than 0.050 between high and low, at electrolyte temperature of 80°F.

More than 0.050 difference: replace battery. Less than 0.050, but some cells read less than 1.225: recharge battery. Replace vent caps, charge at rate less than 50 amps, until all cells measure proper specific gravity. If charging does not bring up specific gravity, replace battery.

3. **Conductance Test** (see Conductance further down in this section).
4. **Electrical load Test.** Measuring voltage tells only part of the story. A load test should also be performed to accurately determine a battery's condition. One of the most common ways of conducting a load test is with a carbon pile load tester. Batteries can be tested inside or outside of the vehicle.

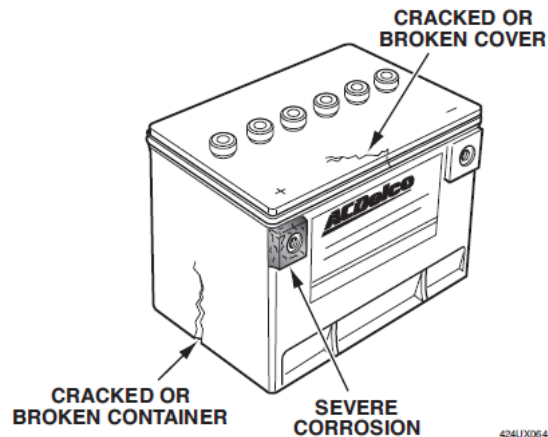


Figure 4-10, Damaged Filler Cap Battery

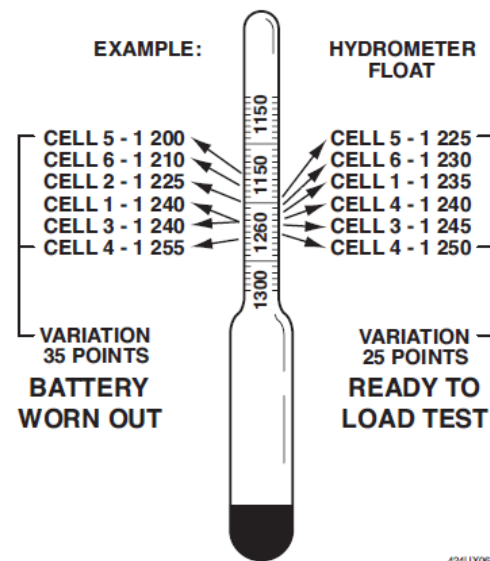


Figure 4-11, Hydrometer

Filler Cap Battery–Removing Surface Charge

If the vehicle has been taken out of service or disconnected from charger within 24 hours, use the following procedure to remove surface charge on battery before testing.

1. Apply a 300-ampere load with a carbon pile to remove the surface charge.
2. Remove the load at the end of 15 seconds.
3. Wait 15 seconds for the battery to recover if the battery has been fully charged.

Remove vent caps first, then proceed as directed below. If a blue haze or smoke is seen in any cells during the test, stop immediately and replace the battery.

Filler Cap Battery–load Test

1. Follow the safety procedures on page vi of this manual.
2. Connect voltmeter and battery load tester across the battery terminals. If the battery is in the vehicle, connect the battery tester cable clamps to terminal studs. If the battery is out of the vehicle, install adapters and connect tester clamps to the adapters.
3. Place thermometer in one of the center cells. Cover battery with a damp cloth.
4. Before load testing do a conductance test to see if the battery is damaged.
5. Connect load tester and set the ampere load equal to one-half the cold cranking amperes at 0°F (–18°C) rating of the battery (or the load test value printed on the battery label) for 15 seconds.
6. Observe voltage after 15 seconds with load on.
7. Refer to load test table, Figure 4-13.
8. If voltage is less than table value, replace the battery. If voltage is equal to or greater than table value. return the battery to service.

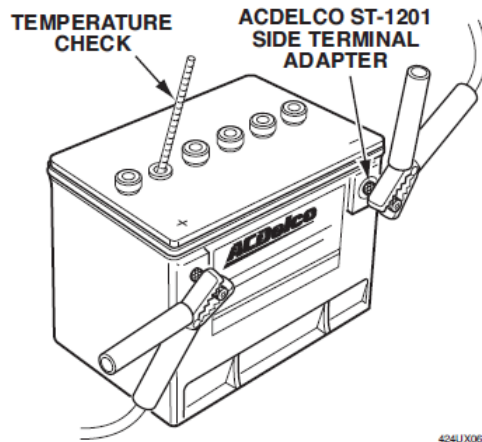


Figure 4-12, Filler Cap Electrical Load Test

6 Volt Minimum Voltage	12 Volt Minimum Voltage	Temperature
4.8	9.6	70°F and above
4.7	9.5	60°F
4.7	9.4	50°F
4.6	9.3	40°F
4.5	9.1	30°F
4.4	8.9	20°F
4.3	8.7	10°F
4.2	8.5	0°F

Figure 4-13, Load Test Table for 6V and 12V Batteries

Maintenance-Free Battery– Preliminary Tests

1. **Visual Inspection.** When physical damage is present, replace battery and look for cause.

Check for cracked or broken case or cover.
Check terminal area for loose or broken parts.

2. **Check without Hydrometer.** Open Circuit Voltage Check. If the OCV is below 12.45 volts @ 75°F, the battery must undergo a conductance test then charged.

Check with Hydrometer (if so equipped).

Indicator is a temperature-compensated hydrometer. In normal operation, one or two indications appear.

Green dot visible. Battery is ready for conductance test then load test. Do not charge. Proceed to step 3. Replace battery if hydrometer is clear or light yellow and if a cranking complaint exists that is caused by the battery.

Dark–no dot visible. Do a conductance test then recharge the battery. Shake or tilt battery to bring green dot into view. A battery that has sat in a completely discharged condition or is extremely cold may not accept current for several hours after starting the charger.

Clear Eye. Do not test. Scrap the battery immediately.

3. **Conductance Test.** Perform a conductance test before doing any load test or recharge. This will determine if the battery is safe to perform further work.

Maintenance-Free Battery–Removing Surface Charge

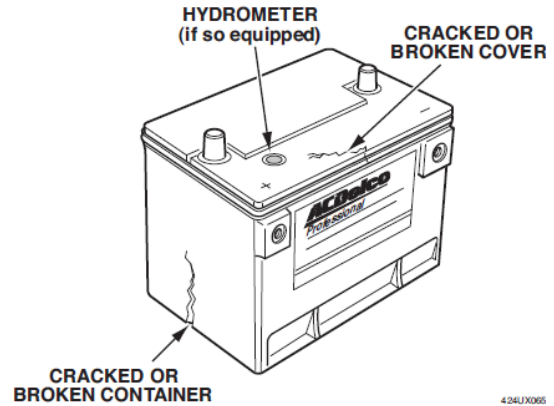
If the vehicle has been taken out of service or disconnected from charger within 24 hours, use the following procedure to remove surface charge on battery before testing. Always do a conductance test before doing a load test.

Maintenance-Free Battery–load Test (includes AGM Batteries)

Follow directions below. For ACDelco heavy-duty batteries with threaded stud terminals, attach clamp to terminal adapters. Always perform a conductance test before load testing.

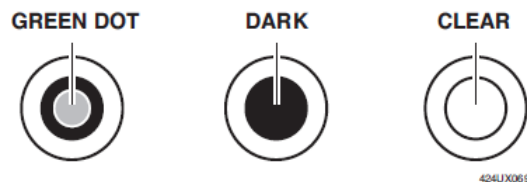
1. If the battery is in the vehicle, remove the battery cables. Always remove the ground cables first.
2. Make sure the terminals are free of dirt or corrosion. This can be done with a wire brush or special cleaning tool.
3. Connect a voltmeter and the load tester across the battery terminals. Side post batteries will require terminal adapters. Never use a bolt for testing purposes.
4. Set the tester to the load rating shown on the battery label.
5. Apply the load to the battery for 15 seconds.

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Figure 4-14, Damaged Maintenance-Free Battery



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Figure 4-15, Hydrometer Check

6. At the end of the 15 seconds, with the load still applied, read the voltage.
7. Refer to Load Test Table, Figure 4-13.

The voltage output greatly depends on the temperature of the battery. Therefore, it is necessary to determine the battery temperature by touch and by the temperature of the surrounding air the battery was exposed to during the last few hours.

Service technicians often use automatic battery testers which can test the starting and charging systems as well as the battery.

During a battery load test, the tester will place a load on the battery to simulate a high-discharge rate for about 15 seconds, then release to let the battery recover.

The tester will then apply the load again. The tester uses a number of variables including temperature, recovery voltage, and other electrical factors to accurately diagnose the battery.



Figure 4-17, Terminal Adapters

Conductance Testers

Another tester that has come on the market is the conductance tester. These state-of-the-art testers are highly accurate and do not require the battery to be charged before testing it. One example is the Midtronics EXP 800, which is extremely popular because it is quick and easy to use.

After connecting the tester to the battery terminals and entering the Cold Cranking Amp rating, the tester will evaluate the battery and classify it according to one of the four conditions displayed in the “Battery Condition” window.

Conductance

Conductance is a measurement of the battery’s ability to produce current. Conductance measures the plate surface available in the battery, which determines how much power the battery can supply. As a battery ages, the plate surface can sulfate or shed active material that adversely affects its ability to perform. Conductance testers determine a battery’s true state of health by detecting cell defects, shorts, and open circuits, which also reduce the battery’s ability to deliver current. To measure conductance, the conductance tester sends a small signal through the battery, then measures a portion of the AC current response. Conductance testers must not be used on new, never installed batteries. New, never installed batteries are often not fully finished when they are made. For this reason, conductance testing should not be used until several weeks after the battery is installed.

Load Testing vs. Conductance Testing

A load test measures voltage drop when a load equal to one half of the battery’s CCA rating is applied for 15 seconds. The voltage must not drop below 9.6 volts. The battery must have at least 75% state of charge. The battery must be at room temperature, or compensated.

A conductance tester can test the battery as received, allowing testing immediately without waiting for the battery to be charged.

A load test produces heat and sparks, which can be dangerous around a previously charged battery where flammable hydrogen gas from the charging process may ignite and cause an explosion.

Conductance testing is passive so there is no sparking or heat generated. No heat means that as many batteries as required can be tested without waiting for the tester to cool down.

CCA Rating and Conductance Testing

Conductance testers report the output of the battery's relative power in CCAs. This value is related to the actual power available in the battery in relation to that battery's rating.

For example, a 700 CCA rated battery measuring 525 CCA available power does not mean that the battery would pass a CCA test at 525 CCA. The available power reading shows that the battery is not able to perform up to its rated ability (700 CCA).

In comparison to another battery when fully charged, the 700 CCA battery measuring 525 CCA is not stronger than a 500 CCA battery showing 500 CCA available power when fully charged. The available power number is meant for comparison to its own rating.

In Vehicle Conductance Testing

Conductance testers allow accurate testing with the battery installed in the vehicle with the engine off. If the battery posts are too dirty or heavily corroded, some testers will not allow the test. Many testers can detect excess computer or ignition noise which could interfere with a proper test. It should be noted that tests done with the battery disconnected will be more accurate.

Stud Adapters

Use side terminal adapters for testing side terminal batteries to provide a good connection. Only use clean, stud adapters to ensure an accurate test. Do not use steel bolts for battery tests. Always tighten stud adapters using a wrench to ensure a good connection. Refer to Figure 4-17.

Top Stud Group 31 batteries have lead pads with steel threaded studs. Install female stud adapters and tighten down to the lead for best results. Testing on the steel thread will cause inconsistent and inaccurate test results.

AGM Batteries

Conductance tester may be used to test AGM batteries, automotive and heavy duty, if the test unit has an AGM setting. Without this setting, the results will be invalid.

NOTE

For an AGM battery, only use conductance testers with an AGM setting. .

Charging

Conductance tests can be performed on discharged batteries to determine the condition of the battery, however, the results may not be accurate. If a battery is good but in a low state of charge, fully charge the battery before returning it to service. Some batteries will indicate "charge and retest". Fully charge these batteries before retesting.

CAUTION

On newer equipment, if the test indicates "bad cell" or "replace", do not charge the battery. Charging a battery with one or more bad cells could cause an explosion and serious harm to the user. Always follow equipment manufacturer's instructions.



Surface Charge

Normally, when testing batteries out of the vehicle, removal of surface charge is not required. Surface charge does not affect the reading of a fully charged battery.

When testing in the vehicle turn on the vehicle's high-beam headlights for one minute, turn the lights off and allow the battery to recover for one minute to ensure that a recent jump-start does not affect the tester reading.