How to Test Your Alternator

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The first sign of alternator trouble may be dim headlights or an engine that is slow to crank (or will not crank). The alternator keeps the battery charged, and supplies voltage for the entire electrical system. So if the alternator, voltage regulator or wiring that connects the charging system to the battery and electrical system goes bad, it can create serious problems.

Alternator charging problems can be caused by electrical faults in the charging system itself, by poor wiring connections at the battery or elsewhere, or by a slipping or broken drive belt. If there is no charging output, the battery will quickly discharge. You may have 20 minutes to an hour of driving time before everything goes dead and the vehicle shuts down.

Once battery voltage drops below a certain threshold, the onboard electronics, ignition and fuel systems may stop working normally and cause the engine to stall. The battery will not have enough reserve power to restart the engine, so the vehicle will be stranded until the problem can be diagnosed and repaired.

Recharging the battery or jump starting the battery with booster cables from another battery or vehicle may get the engine running again, but it will not be for long if the charging system is not producing normal voltage.

Warning: Never disconnect a battery cable while the engine is running to "test" your alternator. Doing so can produce a high voltage spike that may damage the alternator or other electronics.

ALTERNATOR CHARGING OUTPUT

The alternator is the heart of the charging system. It generates all the power needed to keep the battery fully charged and to operate everything electrical in the vehicle. The alternator is mounted on the engine and is belt-driven off the crankshaft pulley by a serpentine belt or v-belt. The alternator produces alternating current (AC), which is converted to direct current (DC) by a six diode rectifier, which is usually located inside the back of the unit. Diodes only pass current in one direction, which is how they convert AC current to DC. Three positive diodes control the positive side of the AC sine wave, while three negative diodes control the negative side.

The alternator's charging output increases in proportion to the electrical load on the charging system and engine speed. Output is low at idle and increases with RPM. Maximum output is typically achieved at speeds above 2,500 RPM.

ALTERNATOR VOLTAGE REGULATION

Charging output of the alternator is controlled by a voltage regulator which may be mounted inside or on the back of the alternator (internally regulated), or somewhere else under the hood (externally regulated). On most newer vehicles, the powertrain control module (PCM) regulates charging output.

On older vehicles, the voltage regulator was electro-mechanical and used magnetic contacts to control the charging output of the alternator. Since the 1980s, most voltage regulators are solid-state electronic and use transistors to control charging output.

The actual output voltage produced by the alternator will vary depending on temperature and load, but will typically be about 1-1/2 to 2 volts higher than battery voltage. At idle, most charging systems will produce 13.8 to 14.3 volts with no lights or accessories on (although some may charge at a slightly higher voltage depending on temperature, engine RPM, type of battery, and the battery's state of charge). This can be measured by connecting the positive (+) and negative (-) test leads of a voltmeter to the battery posts while the engine is running.

The left photo shows normal alternator charging voltage with the engine idling. The photo at the right shows low charging voltage with the engine idling.
A low reading tells you the charging system is not generating enough voltage to keep the battery charged or to meet the vehicle's electrical needs.

HOW TO TEST ALTERNATOR CHARGING VOLTAGE

Most alternators that are charging properly should produce a voltage of about 13.8 to 14.2 volts at idle with the lights and accessories off. Always refer to the vehicle manufacturer's specifications. Many Asian vehicles, for example, have higher charging voltages of around 15 volts.

When the engine is first started, the charging voltage should rise quickly to about two volts above base battery voltage, then taper off, leveling out at the specified voltage.

The exact charging voltage will vary according to the battery's state of charge, the load on the vehicle's electrical system, and temperature. The lower the temperature the higher the charging voltage, and the higher the temperature the lower the charging voltage. The "normal" charging voltage on a typical application might be 13.9 to 15.1 volts at 77 degrees F. But at 20 degrees F. below zero, the charging voltage might jump as high as 14.9 to 15.8 volts for a short period of time. On a hot engine on a hot day, the normal charging voltage might drop to 13.5 to 14.3 volts.

HOW TO TEST ALTERNATOR AMPERAGE OUTPUT

In addition to checking the alternator's voltage output, you also need to check its current or amperage output. Amperage is how much current the alternator generates at a specified voltage and speed. Not long ago, an 80 amp alternator was considered a high output unit. Most late model alternators produce 120 to 155 amps or more. Current

output increases with engine speed, from around 20 to 50 amps at idle up to the unit's maximum output at 2,500 RPM or higher (refer to a service manual for the exact charging output specifications for your vehicle).

Charging output can be measured with an inductive amp probe clamped around the BAT (B+) wire that connects to the alternator. It can also be measured on an alternator bench tester in a auto parts store.

Alternator power ratings can also be given in Watts (which is volts times amps). Many alternators in foreign vehicles are rated in watts rather than amps. The important point here is to make sure a replacement alternator has the same power rating (in amps or watts) as the original so the charging system can maintain the same power output as before, should the alternator need to be replaced. In fact, on some applications upgrading to a higher output replacement alternator may be recommended if the vehicle has a history of alternator failures, or the vehicle has a megawatt aftermarket sound system, emergency or off-road lighting, or other power-hungry electrical accessories.

ALTERNATOR DIAGNOSIS CHART

CHARGING SYSTEM TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	ACTION
Warning lamp does not light, with ignition ON and engine off	1. Blown fuse 2. Lamp burned out 3. Wiring connections loose 4. Defective relay 5. Defective regulator	1. Check CHARGE, IGN, AND ENGINE fuses; replace as needed after correcting cause 2. Replace lamp 3. Check voltage drop in circuit, tighten loose connections 4. Check relays, if used, for continuity and proper operation 5. Check alternator output
Warning lamp does not go out with engine running; battery overcharged or undercharged	1. Loose or worn drive belt 2. Defective battery or battery connections 3. Blown fuse or fusible link 4. Defective relay, regulator, or alternator 5. Defective wiring	1. Check drive belt; adjust or replace as needed after correcting cause 2. Check battery and its connections 3. Check fuse and fusible link; replace as needed 4. Check charging system output and component operation, as needed 5. Check voltage drop
Noise	1. Loose or worn drive belt 2. Worn alternator bearings 3. Defective diode	1. Check drive belt; adjust or replace, as needed 2. Replace the alternator 3. Replace the alternator

Source: Toyota

AA1Car.com Alternator Diagnosis Chart

Symptom:	Possible Causes:
Alternator fails to charge (indicator light may be on) 	— Slipping or broken alternator belt — Open diodes — Open circuit in stator windings — Open charging circuit — Open field circuit — Worn brushes or slip rings — Defective voltage regulator
Low charging rate (battery run down) 	— Slipping alternator belt — Corroded/loose battery terminals — High resistance in charging circuit — Poor alternator/regulator ground — Open or grounded stator windings — Shorted or open alternator diodes — Defective regulator — Poor regulator ground (A-circuit) — No positive voltage to regulator (B-circuit)
Excessive charging rate (battery may have low water) 	— Regulator not properly grounded (B-circuit alternators) — No positive voltage to regulator (A-circuit alternators) — Regulator set too high or contacts stuck (older mechanical regulators) — Defective regulator — Grounded alternator field circuit
Battery fails to hold charge (or battery dead) 	— Low charging rate (or battery dead) — Voltage drain on battery when ignition is off — Surface corrosion on battery — Sulfated battery plates — Low or contaminated electrolyte — Damaged battery cells
Alternator noise 	— Bad shaft bearing — Open or shorted diodes — Open or shorted stator windings — Mechanical interference or rubbing — Loose or bent pulley

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ALTERNATOR OVERHEATING

High underhood temperatures are hard on alternators, and high electrical loads create even more heat. The higher the charging load on the alternator, the hotter it runs. To control the heat, alternators have an internal and/or external fan that pulls air through the housing to help cool the "rotor" (the rotating part inside the alternator) and the

"stator" (the stationary field coils or windings that surround the rotor). Some high output units have two fans to increase cooling.

If the alternator is working hard under a heavy load at low RPM (especially during hot weather), there may not be enough cooling to prevent the unit from overheating. Excessive heat may damage the windings and/or wiring connections inside the unit, causing it to fail. This tends to be more of a problem on vehicles where the location of the alternator restricts airflow and cooling.

BAD ALTERNATOR WIRING CONNECTIONS

The alternator may be forced to work harder than normal if the battery cables, ground straps or other electrical connections in the charging circuit are dirty or loose. A poor connection increases resistance and causes a voltage drop across the connection. This, in turn, reduces the flow of current through the charging circuit.

The electrical system is, after all, just a big series of loops that carry current from the charging system to the battery, and from the battery to all of the vehicle's electrical accessories and electronics. The return path is usually the vehicle body, which serves as the main ground circuit for almost everything. All the power supply and ground connections must therefore be in excellent condition to minimize resistance and the load on the charging system. In fact, poor ground connections are an often overlooked cause of low charging output and alternator failure.

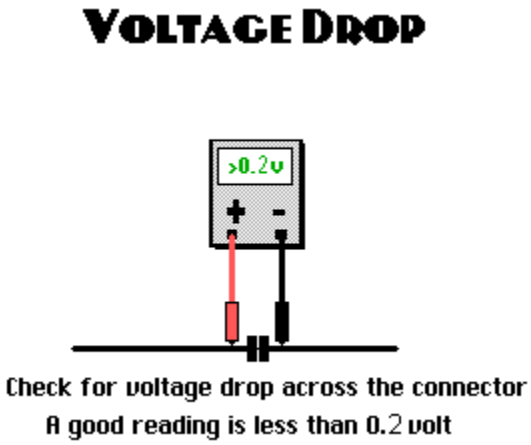
ALTERNATOR DIODE FAILURES

One of the most common causes of charging problems is the failure of one or more diodes in the alternator. Alternators have six diodes (three negative and three positive) that convert the alternating current (AC) to direct current (DC). They are called a diode trio because each negative diode is paired with a positive diode.

When the engine is running, charging current from the alternator flows through the diode trio via the BAT (B+) connection on the back of the alternator. A little current also flows through the charging light indicator circuit. On GM alternators, the indicator light circuit is terminal 1. On European alternators, the indicator light circuit is usually called 61 or D+. On Asian alternators, it is usually labeled L. This terminal leads to the ground side of the alternator warning light. When the alternator is charging, the diode trio supplies voltage to the ground side of the indicator light. This offsets the battery voltage applied to the positive side of the light, causing the light to go out once the engine starts. If the alternator stops charging, current flows though the light circuit from the positive side causing the charging system warning light to come on.

If one of the diodes fails, it may cause the charging system indicator light to glow dimly. If two or more diodes fail, the light will get brighter. At the same time, the feedback current from the diode trio will reduce the alternators ability to produce current. So the more diodes that fail, the less power the alternator will generate.

A bad connection or open circuit between the alternator output terminal and the positive battery terminal will force the charging current to follow a parallel route through the diode trio and out of the alternator. This heavier than normal current flow through the diodes will cause them to overheat and fail. Consequently, if you have replaced an alternator before because of bad diodes, and the replacement fails for the same reason, there is likely a bad connection or open circuit between the alternator BAT (B+) terminal and the positive side of the battery circuit. Do a voltage drop test to check the entire circuit.



ALTERNATOR CIRCUIT VOLTAGE DROP TESTS

With the engine idling, touch one test lead of your voltmeter to the battery positive (+) post, and the other test lead to the BAT (B+) terminal on the alternator. Ideally, the voltmeter should read less than 0.2 volts.

If you see a voltage reading greater than 0.2 volts, it means there is excessive resistance somewhere in the circuit causing a voltage drop in the wiring circuit. Check all the wiring connections (use electronics cleaner to clean connections), and make sure the terminal connectors on the ends of the wires are clean and tight.

A negative side ground circuit test is made by touching one voltmeter test lead to the alternator housing, and the other test lead to the negative battery post (not the terminal clamp) with the engine running and charging system loaded. If good, the voltage drop should be 0.2 volts or less. If higher, inspect and clean all ground connections as needed. Also, check for broken, loose or missing ground straps between the engine and body.

If the alternator output circuit and ground circuits test good (voltage drop less than 0.2 volts) and the vehicle has a history of repeated alternator failures due to burned out diodes, check for a shorted indicator light terminal.

Checking for voltage drops in a circuit is a good way to find hidden problems that may be causing a charging problem. Voltage drop tests must be done while the engine is

idling with a charging load on the system. In other words, there must be voltage flowing through the circuit for the voltage drop test to detect a problem. Voltage always follows the path of least resistance, so if the connection being tested has too much resistance some of the voltage will flow through the voltmeter and create a small voltage reading.

ALTERNATOR VIBRATIONS

Loose alternator mounting bolts and brackets can cause vibrations which may damage the alternator. A bad belt tensioner can also be another source of damaging vibrations (which is why the tensioner should always be checked when changing a serpentine belt).

A cycling buzzing noise may indicate an alternator bearing failure, or a bad diode that is allowing current to flow in the wrong direction. Either way, the alternator will have to be rebuilt or replaced.

ALTERNATOR REPLACEMENT TIPS

See the related article on How To Replace an Alternator.

Have your old alternator bench tested. Alternators have one of the highest warranty return rates of any component on a vehicle. Many units are returned needlessly either because of faulty diagnosis (there was nothing wrong with the original unit or the replacement unit), or because an overlooked problem caused a repeat failure. One way to reduce this problem is to take your old alternator to an auto parts store with an alternator bench tester and have it tested BEFORE you buy a replacement. If the old alternator tests bad, you need to replace it. But if it tests good, the problem is something else in the charging system.

Most auto parts stores have an alternator bench tester. Have your old unit tested to see if it is good or bad.
If your alternator tests good, the problem is not a bad alternator but something else.

Have the NEW alternator bench tested, too. For added insurance, you might also ask the parts store to bench test the new or reman alternator they are selling you to make sure it is charging properly. Better to catch a defective unit at the store than after you have installed it on your car.

Check the wiring harness and terminals. One way to minimize the risk of premature failures and unnecessary warranty returns is to always check for resistance (voltage drops) in the charging circuit connections. This includes both the positive and negative battery cable connections, alternator power circuit and ground circuit as just described.

Voltage drops on the positive side can cause undercharging.

Voltage drops on the negative side can cause overcharging (fools the voltage regulator into thinking the battery is low).

Use a battery charger to recharge the battery. Alternators are designed to maintain battery charge, not to recharge a dead battery. If the battery is run-down or dead, therefore, it should be recharged with a battery charger before the vehicle is driven, or before a replacement alternator is installed. This will minimize the stress on the charging system and reduce the risk of overheating and failure.

Test the battery to make sure it is still good. The condition of the battery should always be tested if it fails to hold a charge or a charging problem is suspected. The problem may be an old battery that needs to be replaced, not a bad alternator.

Get the correct alternator pulley. Make sure the pulley on the replacement alternator is the same as the one on the old unit. Many late model alternators are now equipped with an overrunning pulley decoupler that allows the alternator to momentarily disengage from the belt drive where there are sudden changes in belt speed. This reduces noise and harshness, and prolongs the life of the serpentine belt. If a replacement alternator with an ordinary direct drive pulley is installed, it could lead to premature belt failure. For more information about this subject, see www.decouplerpulley.com.

Replace the serpentine belt. If the serpentine belt has more than 50,000 miles on it, throw it away and replace it with a new one.

Check the automatic belt tensioner. If the automatic belt tensioner is rusted, weak or stuck, it won't maintain the proper tension on the serpentine belt, allowing it to slip.

MORE ALTERNATOR CHARGING CHECKS

* On some GM vehicles, a voltage drop of up to 0.5 volts on the positive side may be acceptable. Check service specifications.

* If a battery keeps running down and the charging system appears to be functioning normally, the problem may be a higher than normal parasitic electrical drain on the battery when the key is off. On most vehicles, the normal drain on the battery should be 50 milliamps or less. But on some late model Fords, the normal drain may 300 to 400 milliamps with a few drawing as much as 850 milliamps for up to an hour after the engine is shut off (the modules are in stand-by mode during this period). After all the modules shut down, though, the current drain on the battery should drop to 50 milliamps or less.

- Peak loads and prolonged idle conditions can result in battery discharge, since the alternator cannot keep up with the power usage. Idling for long periods of time with the lights, defrosters, heater, radio on can pull more amps out of the battery than the charging system can put back into it. You may think you have a charging problem, but there is nothing wrong with the alternator.

Charging Related Recalls

Chrysler Alternator Failure Recall - October 2014
Chrysler issued recall # 106345 for alternator failures on the following models: 2011-2014 Chrysler 300, Dodge Charger, Challenger, and Durango; and 2012-2014 Jeep Grand Cherokee (manufactured April 22, 2010 to January 2, 2014) with a 3.6L engine and 160 amp alternator. Chrysler says the alternator may fail without warning, causing the battery to run down and/or the vehicle to stall.In the affected vehicles, the alternator may suddenly fail.

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How To Replace an Alternator

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