

HIGH OUTPUT AND SEVERE DUTY ALTERNATORS

Charging System Operation

Before we consider whether a special High Output or Severe Duty alternator is required, it is important to understand how a standard charging system operates. An alternator is designed to “top off” the battery, or typically bring a 75% charged battery back up to a 100% charge. Newer PCM computer-controlled systems may even set the “strategy” to only maintain an 80% charge for fuel economy purposes (due to the horsepower drag a harder working alternator places on the engine).

The biggest misunderstanding of charging systems is that a 100 amp alternator should be able to produce 100 amps at any time (including low rpm cruising or at idle). An alternator’s output capability is highly dependent on its rpm’s. Thus, when the alternator is turning slowly, output is reduced, and it may not be able to keep up with the vehicle’s electrical demands at that moment. During higher engine rpm operation, the alternator produces more output and “makes up for lost (battery charging) time.”

However, the vehicle’s electrical demands must be met during every second of operation. During low rpm operation and reduced alternator output, the electrical system “dips into” the battery to supply the rest of the amperage needed to power the vehicle. The exact charging voltage at any given moment will vary according to battery state of charge, the amount of electrical load on the system, and temperature. A battery’s electro-chemical activity declines in colder temperatures, so higher charging voltages are needed for the battery to readily accept a charge.

Most properly functioning charging systems produce a charging voltage of 14-14.5 volts with all accessories off (headlights, wipers, etc.). Voltage is electrical “pressure”. So, as the alternator’s “volume” of output (or amperage) increases, its voltage naturally decreases. Therefore, it’s important to know how much amperage an alternator is producing before mistakenly believing a voltage regulator is malfunctioning. An alternator may be functioning normally even if only registering 13.0 volts – provided it is producing a substantial amount of amperage at the time. Also, many late model vehicle computers may override the regulator, and temporarily command the alternator to charge at a reduced rate.

Charging output can also be checked using an adjustable carbon pile load tester. It is vital never to disconnect a battery cable with the engine running to “test” the alternator. Even a momentary disconnection can create a powerful voltage spike capable of damaging the alternator’s or vehicle’s electronics. Battery function may be checked using a battery “conductance” tester, which sends a test pulse through the battery to gauge the overall state of battery health, and its remaining service life.

Charging System Stress Factors

Realizing the vehicle’s electrical appetite is fed by a combination of alternator output and battery reserves, we can now consider how various factors introduce stress into the charging system:

1) **HEAT/RESISTANCE.** Alternators work inside an oven. Under-hood temperatures may approach 300 degrees. Even when an alternator is producing low output, it is still running hot. As demand and amperage output increases, the alternator runs even hotter. Furthermore, alternators replenishing batteries are like water pumps filling reservoirs. The “pipes” (wires) need to be clean, or kinks/bottlenecks can develop. When bottlenecks develop in a charging system (due to corroded output wires or connectors), the added resistance creates more heat within the alternator.

Older batteries may also develop more resistance (due to internal corrosion from acid), and lose storage capacity. Since the battery frequently supplements the alternator’s output, an older battery throws more of the overall load-handling responsibility back onto the alternator. Therefore, alternators need batteries in good condition for their own survival. When alternators are repeatedly replaced on a vehicle, the battery (even if still functioning) is most often the culprit.

2) **DRIVING HABITS.** Each time the engine is cranked, it typically takes the alternator 15-20 minutes to fully replenish the battery, because the starter draws several hundred amps during each cranking cycle. When a vehicle is only used for very short trips, the alternator may not have enough time to do its job, and the battery may become chronically undercharged. Undercharging also causes the battery plates to become sulfated, and shortens battery life.

3) **COST.** A key factor in the size and maximum output capability of an OEM alternator is cost. A manufacturer will not equip a vehicle with a more expensive 150 amp alternator if a 100 amp unit will seemingly do the job. The battery simply plays a larger role in making up any shortfall. Therefore, both the battery and alternator are often forced to work harder - even in “normal” conditions.

Special Operating Conditions

An “original equipment” alternator means just that – it was sized and designed to meet the vehicle’s needs as originally equipped from the factory with typical options like air conditioning, power windows, etc. used in routine driving conditions. There is very little extra output capacity designed into an OEM alternator. Problems may occur when using stock alternators in the following manner:

1) **PROLONGED IDLING.** Commercial service or emergency response vehicles often overwhelm the stock charging system because the vehicles may often sit around idling for prolonged periods. The alternator does not spend enough time in a higher rpm operating range, where it can develop higher output. Plus, not much cooling air enters the engine compartment when the vehicle is not moving down the road.

2) **SPECIAL ACCESSORIES.** With a standard charging system already operating at its design limits, adding power-hungry accessories like big stereos, snow plows, wheelchair lifts, blower motors, auxiliary or emergency lighting, etc. often results in low voltage performance and shortened alternator life-spans .

3) **ENGINE-OFF POWER DRAW.** Sometimes it’s not the special accessories that strains a charging system, it’s a vehicle operator’s habit of using those accessories with the engine off. Upon restart, the alternator works extra hard while bringing a more depleted battery back up to full charge.

High Output / Severe Duty Alternator Designs

To address the needs of special use vehicles, two different custom alternator designs are employed: The “High Output” unit (HO) or the “Severe Duty” unit (SD). The HO-type is built for enhanced upper rpm power, and will not provide much additional amperage at idle. The SD-type provides more low rpm output for extended idle applications, as well as a modest increase in maximum high rpm output.

HO/SD performance and durability increases are achieved through a variety of modifications: Heavier gauge rotor and stator windings, extra-high current output diodes, heavier duty bearings, and smaller diameter pulleys to increase alternator speed and output at idle (note: some belt tensioners may not allow for significant changes in pulley diameter). While HO/SD units cost more, the savings from increased reliability and extended alternator/battery life more than offsets the added expense.

Note: When experiencing short alternator life or poor charging performance, a common reaction is to “throw amps at the problem”, and believe HIGH OUTPUT solves all problems. Make sure to check “all the usual suspects” (corroded wires, bad batteries, abnormal draws w/engine off, etc.), as well as factory service bulletins, before concluding an HO/SD modification is desired.

Lastly, keep in mind that HO/SD components are typically only available for vehicles likely to be modified with special accessories. For many vehicles, a “High Output” upgrade may not be possible.

Integrated High Output/Severe Duty Charging System Solution

Once a “High Output” solution is chosen, remember the alternator is but one part of the overall charging system. For safety reasons, modifications should not be made without also upgrading the battery, alternator output wiring harness, and charging system MegaFuse (or circuit breaker).

Just like alternators, OEM batteries are “sized” to meet the needs of the vehicle as originally equipped. A typical battery is sized so all the system loads present (during prolonged use) do not exceed 10% of the battery’s rated capacity. You will need to measure or determine the approximate amount of “additional” amperage the modified vehicle will require. As a general guideline, for low rpm/extended idle-time applications, a new battery with 30-50% greater capacity than the OEM battery should be installed. The new battery should also feature a higher reserve capacity (RC) rating.

Of course, whenever substantially higher output (HO) alternators are retrofit into “stock” vehicles, the wire carrying the alternator output current to the battery must be beefed up with heavier gauge wiring and larger fuses. As a very general guideline, 120-140 amp units require # 2 gauge wires, and 140-225 amp units can require #1 or #0 gauge. The actual amperage of the H.O. alternator will determine fuse size.

Also, depending on the needs of the special vehicle accessories added, a second battery may be required along with a dual-battery isolator. (Caution – typically diesel engines require two batteries to start the vehicle, thus a dual battery isolator is not recommended for use on diesel driven vehicles). Or, if equipped with a gasoline engine and dual batteries are already present, adding an isolator may help if the (main) cranking battery is being depleted due to special accessories running with the engine off. Dual batteries like to “equalize” their charges, so if not kept “isolated”, the lower-charged battery will always drag down the other battery until they are equally charged. Some newer battery isolators feature transistors rather than diodes. The transistor-type is recommended because it introduces far less added resistance into the circuit, which can create voltage regulator malfunctions.

For further assistance, please visit our website at www.bbbind.com to contact our technical support team.