Tech Brief – The Benefits of High Voltage

Tech Tip – High Voltage . . . is it REALLY a benefit?

At DC Power, we think output voltage is equally as important as output current capability. Our High-Output Alternators will typically make 3 – 5 tenths of a volt more than the OEM unit that they replace. This is a good thing. Let's explain why.

The Basics

Let's first consider that a healthy stock charging system will have:

1. A "standing voltage," measured at the battery, of between 12.6 and 12.7 Volts DC (VDC hereafter) with the engine not running and all accessories turned OFF. Few people know, but a battery that rests at just 12.4 VDC is only charged to 75% of its capacity!
2. A "running voltage," also measured at the battery, of between 13.8 and 14.4 VDC with the engine running and all accessories turned OFF.

When you begin to exceed the capability of the stock alternator, like you would when adding even a few current hungry aftermarket accessories, both of the above will be compromised. This is after all why you are considering the purchase of a DC Power High-Output Alternator. [We explain this in-depth in our *Getting Your Vehicle the Power It Needs* tech brief.]

When properly installed, a DC Power High-Output Alternator will have a running voltage of between 14.2 and 15.0 VDC. Unlike the factory alternator, our units can maintain this higher voltage EVEN WHEN you ask them to provide a bunch of current to your current hungry accessories.

So for the sake of this explanation, let's say that running voltage of your stock alternator was a really healthy 14.4 VDC and that the running voltage of your newly installed DC Power High-Output Alternator was 14.8 VDC. That doesn't sound like a big difference, but let's dig a little deeper.

The Power Formula

OK, to understand this fully, we need to discuss a mathematical formula. Don't worry, this is easy. This formula is known as the Power formula, and expresses the relationship between:

- Power
- Current
- Voltage

It simply states that Power is the Product of Current and Voltage:

- Power = Current X Voltage
- P = I X E or P = IE

Power is expressed in Watts, Voltage expressed in Volts, and Current in Amperes (or Amps).

[Depending on which version of the formula you look at, I or A can be used to represent Current and E or V can be used to represent Voltage. For the sake of simplicity, we'll stick to P = IE.]

We'll come back to this shortly. Next, you need to understand that there are three different types of accessories commonly found in modern vehicles: those with a regulated power supply; those with an unregulated power supply; those with no power supply whatsoever.

Accessory Types

Those with a Regulated Power Supply

These accessories have an on-board power supply that enables the unit's operating characteristics to remain constant regardless of its input voltage. Accessories with regulated power supplies typically have an operating input voltage range of between 10.5 and 15.0 VDC or thereabouts. HID Headlights, AC Power Inverters, Aftermarket Ignition Systems, and on-board computers (such as ECMs or PCMs) are examples of these. Some Audio Power Amplifiers have regulated power supplies and their manufacturers point out that they will make their rated power even when faced with very low operating voltages.

Those with an Unregulated Power Supply

These accessories have an on-board power supply that enables the unit's operating characteristics to vary based on changes of its input voltage. Accessories with unregulated power supplies typically also have an operating input voltage range of between 10.5 and 15.0VDC or thereabouts. This type of power supply would be most commonly found in Audio Power Amplifiers. Some Audio Power Amplifiers have unregulated power supplies and their manufacturers typically point out they will make their rated power at the standing voltage of the battery (12.6 VDC) and make more than their rated power when the vehicle is running. [We'll let you decide which is better . . . !]

Those with no Power Supply Whatsoever

Halogen headlights, electric water pumps, electric fuel pumps, electric fans, electric windows, etc. are all examples of accessories that do not have a power supply of any kind. Therefore, their operating characteristics will be influenced by rising or dropping voltage. To get an idea of what we're talking about, turn your headlights ON with the engine OFF and notice their brightness. Now, start your engine and notice that their brightness increases. This is because the headlights saw in increase in operating voltage FROM the standing voltage TO the running voltage.

Regardless of the type of accessory, it is vitally important to understand the impact voltage has on current – so let's get to it! For the sake of this explanation, we'll point out that accessories with an unregulated power supply and accessories with no power supply whatsoever will behave similarly with changes in input voltage.

Example – Accessory with a Regulated Power Supply

For this example, we've gotten our hands on a very popular brand of Audio Power Amplifier with a tightly regulated power supply. The amplifier used in this example is a JL Audio 500/1v2 subwoofer amplifier.

In an effort to get extremely accurate (and replicable) results, we are driving the amplifier's input section with a 50 Hz test tone via a Rockford Fosgate OSC-2 sine wave generator. In addition, we have connected the amplifier's speaker outputs to a 2 ohm resistive load. Unlike a speaker that presents an ever changing load to an amplifier, the resistive load will remove this variable. We increased the gain of the sine wave generator just until we could observe a 5.0 amp draw at 14.80 VDC and then lowered voltage and captured the results.

Tech Brief – The Benefits of High Voltage

14.80 VDC = 5.0 Amps of input current

14.40 VDC = 5.1 amps of input current

13.50 VDC = 5.4 Amps of input current

12.60 VDC = 5.7 Amps of input current

11.00 VDC = 6.3 Amps of input current

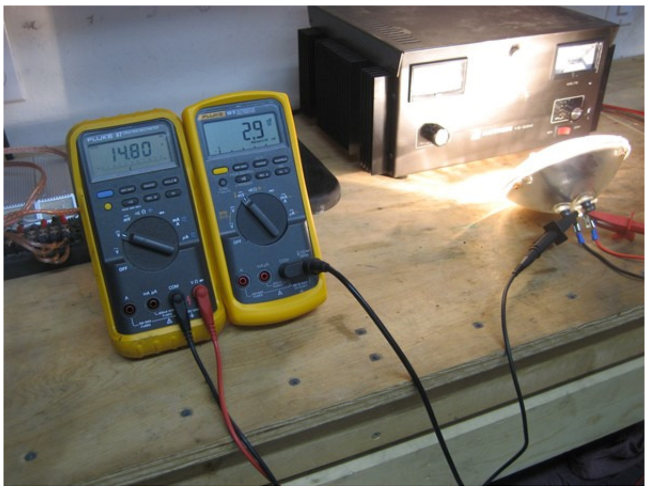
OK, so let's put the power formula from above to work for us and consider how much input power the amp requires as voltage is lowered:

14.80 VDC X 5.0 Amps = 74.00 Watts of Input Power
14.40 VDC X 5.1 Amps = 73.44 Watts of Input Power
13.50 VDC X 5.4 Amps = 72.90 Watts of Input Power
12.60 VDC X 5.7 Amps = 71.82 Watts of Input Power
11.00 VDC X 6.3 Amps = 69.30 Watts of Input Power

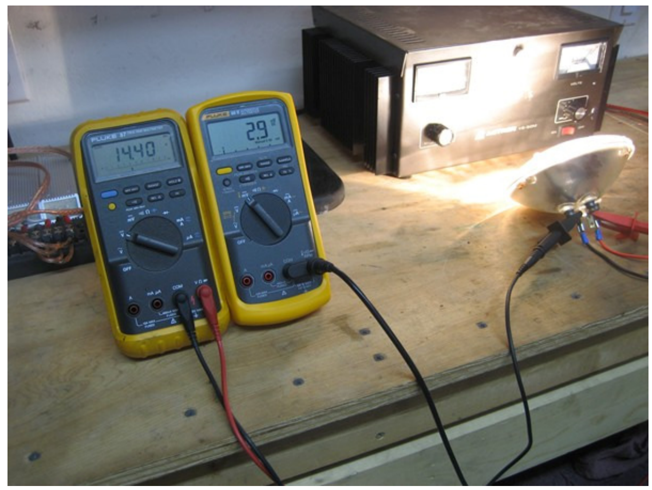
True to the manufacturer's promise, the measured output voltage of the amplifier changed very little as voltage was decreased (these measurements are not shown). More importantly, notice how the current requirement of the amplifier increase as the input voltage is lowered. One only has to look at the results a little differently to realize the benefit of high input voltage with such an accessory. *As input voltage is increased, the input current requirements decrease!* This allows the amplifier to do its work more efficiently. Keep in mind, the above example shows only a 5 Amp draw – JL Audio recommends the use of a 50 Amp fuse for this amplifier – that's 10 times as much as our example illustrates. In addition, the amplifier will require even more current than the fuse value on music with bass heavy content, albeit briefly. Now consider a trunk full of these amplifiers powering a car full of speakers . . . High Voltage is a good thing!

Example – Accessory with no Power Supply Whatsoever

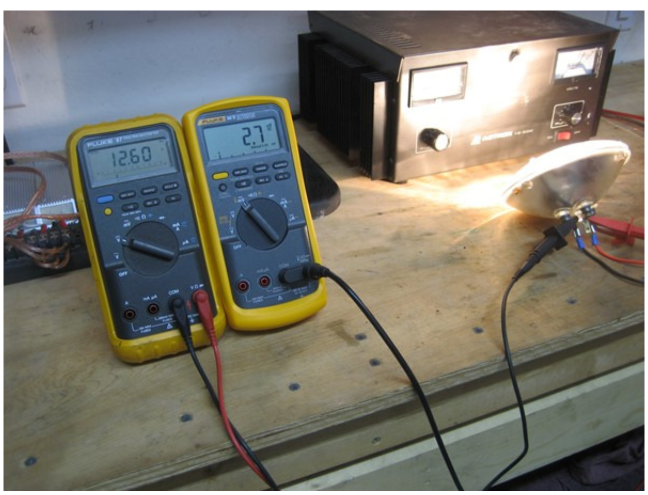
For this example, we used a halogen headlight that will be replacing the ancient stock headlights on a 1968 Pontiac GTO. This is representative of how the multitudes of these kinds of accessories in your vehicle are affected by input voltage.



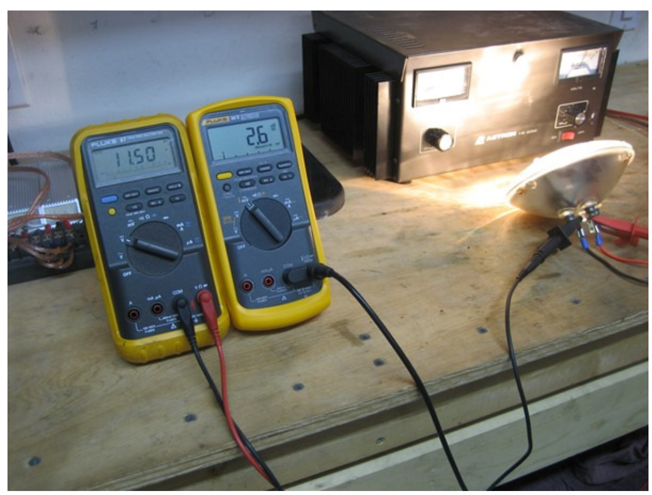
14.80 VDC = 2.9 Amps of input current



14.40 VDC = 2.9 Amps of input current

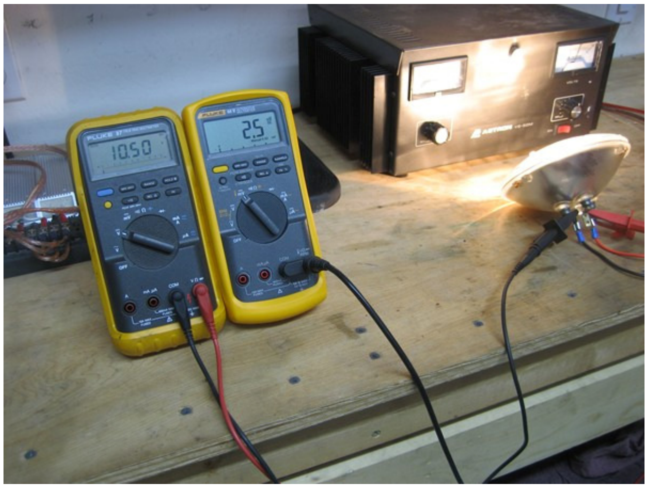


12.60 VDC = 2.7 Amps of input current



11.50 VDC = 2.6 Amps of input current

Tech Brief – The Benefits of High Voltage



10.50 VDC = 2.5 Amps of input current

Again, let's put the power formula from above to work for us and consider how much input power the headlight requires as voltage is lowered:

14.80 VDC X 2.9 Amps = 42.92 Watts of Input Power
14.40 VDC X 2.9 Amps = 41.76 Watts of Input Power
12.60 VDC X 2.7 Amps = 34.02 Watts of Input Power
11.50 VDC X 2.6 Amps = 29.90 Watts of Input Power
10.50 VDC X 2.5 Amps = 26.25 Watts of Input Power

Unlike the amplifier example above, notice the difference in brightness in the headlight as input voltage is increased (it is most dramatic between the last picture and the first). As input voltage is increased to these kinds of accessories, they are able to do their job better - brighter headlights, quicker power windows, cooling fans that spin faster and move a greater volume of air, etc.

By now, it should be obvious to you that a higher running voltage is beneficial to every type of accessory in your vehicle. At DC Power, we've known this for years . . . which is why our alternators deliver greater output voltage than the OEM unit they replace. And now, you know it too!

FAQ

Will a high-output alternator damage my electrical system?

This is the most common question we are asked by first-time customers. Thankfully, the answer is NO. Based on the concept of supply and demand, alternators only charge as much as required of them at any given time to meet the vehicle's electrical requirements. There are two reasons for this:

1. Alternators are rated via their maximum output capability. If a given alternator has a 250 amp rating, this means that it is capable of producing a maximum of 250 amps of current – *but only if this is required of it.*
2. Based on the requirements of your vehicle, it may or may not require your alternator's maximum output as it will only consume what it requires. It is far better to have more output capability than you require as it's always there if or when you need it!

How do alternators determine how much current to produce?

This would be the second most common question we are asked. Quite simply, the voltage regulator monitors the voltage set-point, and regulates the alternators output so that it maintains that voltage.

- When voltage drops below the set-point, the voltage regulator directs the alternator to increase its output
- When voltage rises above the set-point, the voltage regulator directs the alternator to decrease its output

DC Power High-Output Alternators are incredibly good at maintaining the set-point voltage as they can monitor and change their output up to 400 times per second!

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