

## How a DC Motor's In-rush Current Can Affect Voltage Drop

DC motors are used for many different reasons in today's vehicles. How they are applied is based on what they are going to do. Some are turned on and left on. Examples of these include cooling fans, heater blower, air pumps, air compressors, fuel pump, windshield wipers, and water pump.

Some are turned on but not left running for any length of time. These include power windows, seat (tilt, forward, reverse, bolster, lumbar), sunroof, power door locks, windshield washer, and starter motor.

Some are "pulsed on". These include stepper motors that operate in incremental movements of 1°, 5°, 18° etc. based on their design. The motor is pulsed to get it to move. Its movement can be reversed by reversing the voltage polarity. These include idle air control, HVAC door mode, and throttle plate movement on "drive by wire" systems.

Some are turned on, then "pulsed" to stay running at various speeds. These include heater blower motors that are pulse width modulated. Pulse width modulated motors have the voltage turned on and off very rapidly in a fixed frequency time frame. The longer the motor is "pulsed on" within the frequency time frame, the faster the motor runs. Effective voltage is based on the percent of on time.

All DC motors are subject to in-rush current. DC motors at rest appear as a dead short! Initial DC motor in-rush current is very high. Small DC motors can have an initial in-rush current of 300% of rated operating current. Medium DC motors can have an initial in-rush current of 400% of rated operating current. Large DC motors can have an initial in-rush current of 500 to 700% of rated operating current. For example, a starter motor could have an instantaneous in-rush current of 1000 Amps when first turned on.

This initial in-rush current can have an impact on the current path connections. Each current path connection contains microscopic peaks and valleys in the metal of which it is made. High in-rush current values can arc across and pit connections in any current path containing a motor. In time, connections can develop excessive resistance. Resistance causes heat, and heat causes more resistance. The end result is a drop in voltage needed to overcome the resistance encountered in the current path. The voltage pushing the current does nothing more than obey Ohm's law for any series circuit (current path).

A current path that sees current from any motor is sooner or later going to develop some degree of voltage drop due to the pitting of the metal caused from high in-rush current values.

Loose fitting connections in motor current paths will accelerate the development of surface conditions that bring on load affecting voltage drops.

A voltage drop test between the battery positive (+) terminal and the input pin to a motor will find a problem on the voltage feed side of the motor. A voltage drop test between the output pin of the motor and the battery negative (-) terminal will find a problem on the ground side of any motor. The motor must be on for each of these tests. There will be no voltage drop without current flow.

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