Stepper motors Q & A

- Basics

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What is the significance of source voltage?

Source voltage is the maximum voltage the drive electronics can provide to the motor. In order to achieve a given steady state phase current, source voltage must be at least large enough for the required current to flow according to ohms law:

> For example, a typical motor has a phase resistance of 6.8 ohms, and a target phase current of 1 A RMS. Given V = I * R then V (volts) must be at least 1 A * 6.8 ohms = 6.8 V.

Why is source voltage typically so much larger than this?

That is because stepper motor phase windings have significant inductance. Inductors resist change in current flowing through them. The rate of change in current is proportional to the inductance and voltage applied. The greater the applied voltage, the greater the rate of change in current that can be achieved. This is the key to understanding why high source voltages are required. Stepper motor drives rapidly change the size and direction of currents flowing through the phases to execute steps. Larger source voltages allow the target phase current to be achieved faster.

This is the main reason why torque drops off as speed increases; as speed rises an increasing proportion of time is spent waiting for current to reach the setpoint versus time spent at the setpoint current. The effect is the average phase current decreases, and torque drops off.

AML motors are characterised with a source voltage of 67 V; reducing this will cause torque to drop off faster than the published data show.

Reducing source voltage may be perfectly acceptable if motor speed is kept low. Customers should perform their own evaluations to determine performance at source voltages other than 67 V.

How is phase current regulated?

Modern stepper drives use a chopping technique to regulate phase current; in a simplified explanation, this comprises switching element that can turn on or off current to the phase, and measurement circuitry that monitors phase current. Initially, the switch is turned on, and current in the phase starts to rise at a rate proportional to the source voltage and phase inductance.

Once the setpoint current is reached, the switch rapidly cycles off and on to maintain the desired average phase current. Remember that phase current does not change instantly when the switch turns on and off, it ramps up and down. Hence, when the switch turns off, current begins to ramp down by a small amount,

then the switch is turned on again, and it ramps up again. The electronics work to keep this difference small, and the average current at the setpoint value.