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Stepper Drive Q&A – Avoiding Common Mistakes

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What are the most common mistakes that engineers make when specifying and working with stepper drives?

Combined with Kollmorgen step motors, Kollmorgen P7000 stepper drives provide unique level of system smoothness, functionality and performance ideal for single or multi-axis applications that require high-speed performance or low-speed smoothness.

1) Believing that a motor will achieve the data sheet's rated speed-and-torque when it is matched to "any" driver.

    a. Just like servo, the motor's stall torque, rated torque, and rated speed are all dependent as much on the drive and motor being matched as they depend on the available voltage and current. A performance curve (speed-torque-curve) with a matched drive is the most reliable reference.

    b. A motor's stall torque is not an indication of the torque a motor can generate while moving — especially acceleration and deceleration where higher torque is required.

2) Specifying a microstepping drive for the wrong reasons.

    a. Hoping for precise positioning: Microstepping was developed to allow motors to slew through low-end resonant regions or to even run within these low end regions. The drive will divide the 1.8º step angle up to 250 times, but the individual pulses may not be uniform. Therefore the position and velocity will not be uniform down to the microstep pulse.

    b. Eliminate resonance issues: Microstepping will significantly reduce resonance at very low speeds. However, resonance is not only at low speeds for stepper motors. There is a region towards the mid-speed range that has a resonance period — microstepping will not help this. Drivers with anti-resonant algorithms are the best way to handle those resonances.

What are some of the problems that can occur when engineers choose the wrong stepper for the job? Describe the nature of the mismatch as well as the resulting problems.

1) Improper sizing will manifest itself in numerous ways.

    a. Under-sizing a motor will at best cause excessive heat, unsatisfactory acceleration and deceleration, and generally poor performance. At worst, the motor will "lose" pulses, position improperly, or stall altogether under heavy loading or high acceleration / deceleration.

b. Over-sizing a motor will cause it to run louder (audible noise) and generate higher EMI / RFI. It may also cause users to pay more for a motor and driver in terms of money, as well as panel space or machine space, than necessary.

c. Proper load-inertia to rotor-inertia matching is also critical, as the system is essentially open loop. Even after adding an encoder, the inertia mis-match cannot be much more than one order of magnitude. A larger mismatch will cause the motor to lose pulses, mis-position, draw excessive current, or even stall.

d. Engineers should understand the machine's characteristic frequency (omega-natural), as well as its anti-resonant frequency, and avoid step rates that are within the motor step rate. A microstepping drive with anti-resonant circuitry will help this greatly, but the machine will still "ring" at certain motor speeds if care is not taken to select a motor drive combination that can perform outside of these resonances. If one chooses the wrong stepper for such an application, the mistake will manifest itself as a noisy machine that vibrates at certain speeds and performs unreliably.

What's your best advice on how to use stepper drives successfully?

1) Make sure to understand the machine's mechanical limitations and requirements such as mechanical resonant frequency, mechanical bandwidth, load inertia, static and dynamic friction, etc. This is true for any equipment that has motion, irrespective of how precise.

2) Use a sizing program such as MOTIONEERING® to properly size the motor and drive based on reliable speed-torque performance curves.

3) Select a driver that matches the available bus voltage and has the desired features, and select a motor that offers the required performance curve — outside the machine's resonant frequency — using the performance curves of the matched motor and driver.

4) Don't "force" steppers into high-speed or high-performance applications where a servo may provide a more optimized performance. Just like steppers, servos have come down in price over the years, and are much easier to apply.

ABOUT KOLLMORGEN

Kollmorgen is a leading provider of motion systems and components for machine builders around the globe, with over 60 years of motion control design and application expertise.

Through world-class knowledge in motion, industry-leading quality and deep expertise in linking and integrating standard and custom products, Kollmorgen delivers breakthrough solutions unmatched in performance, reliability and ease-of-use, giving machine builders an irrefutable marketplace advantage.

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