

Achieving Industry Leading Precision Velocity Control in Coating and Laminating Applications

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In web handling applications much of the coating focus is placed on achieving perfect velocity control - and rightly so, as operators know all too well that velocity ripple causes uneven coating and unsightly horizontal bars across the substrate. There is one solution to overcoming these challenges – perfect velocity control. Simply put, when metering the coating material is perfect, perfect velocity will result in an even application of the coating.

As an example, consider film coating, where if one were depositing a dark film onto the substrate material varying velocity would result in a series of dark and light “bars” across the material.

But knowing the solution and effectively achieving it are two very different things.

As a starting point, there are a number of factors that directly impact the ripple problem, including:

- Mechanical transmissions cause tooth or belt chatter, and each gear tooth or timing belt will cause a torque/velocity perturbation in the roll resulting in the “bar” effect, sometimes referred to as banding
- Machine mechanics, along with imperfections in the motor, feedback device, and drive control loop, combine to foil the notion of perfect velocity



Correcting for these variables will go a long way toward achieving the desired velocity control. Here we'll focus on overcoming motor, feedback and drive imperfections.

Motor

The motor's primary contribution to velocity ripple is its electromagnetic cogging, which is usually at the pole or slot frequency or some multiple of it. The best way to overcome electromagnetic cogging is to begin with a low cogging motor that requires less correction.

All standard Kollmorgen motors, including [AKM™](#), [Direct Drive Rotary \(DDR\)](#), and [Cartridge DDR™](#), are under 1% pk-pk cogging. This is very good, and nearly always superior compared with standard competitive options due to better electromagnetic design, and simulation of the electromagnetic circuit.

[Cartridge DDR](#) or [frameless direct drive motors](#) are the best weapon on precision coating lines because they eliminate mechanical transmissions, and with Cartridge DDR having the added advantage of being easy to implement.

Feedback

Since the feedback device is in the control loop, any error of the device itself is “corrected” by the drive in the servo loop, and ends up as a velocity ripple on the coating roll.

No feedback device is perfect, but sine encoders offer the best performance for such applications in terms of resolution and accuracy (+/-25 arc-sec is typical), particularly when compared with a resolver at +/- 10 arc-min. As the servo loop gain is increased the error in the feedback device is amplified and transferred into the coating roll. So, starting with as precise a feedback device as possible is very important to minimize velocity ripple.

Drive

The drive can add to and correct various velocity ripple components. It adds to the ripple by having uneven current loop gains in each of the phases, i.e. phase A might be 1% higher than phase B or C and this causes a torque error in the motor. Likewise, the amplitudes of each phase might be slightly different adding an error to the torque as well. The drive can correct these by having digital adjustments in the current loops to take out these offset errors.

One can also reduce the velocity ripple of the system by using harmonic correction in the current waveform. For example, when the characteristic of the cogging in the motor (frequency and amplitude) is known, this can be corrected by applying an anti-phase ripple in the 3 phase current from the drive. The same can be done with the feedback device to correct a repeatable error. Both the motor and feedback error frequencies are well known and repeatable so all we are left to do is adjust phase and amplitude.

The Kollmorgen Coating and Laminating Advantage:

- Precise velocity control
- Lower material costs
- Less scrap
- Minimum changeover time
- Higher quality
- Greater uptime
- Superior OEE (overall equipment effectiveness)

ABOUT KOLLMORGEN

[Kollmorgen](http://www.kollmorgen.com) 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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