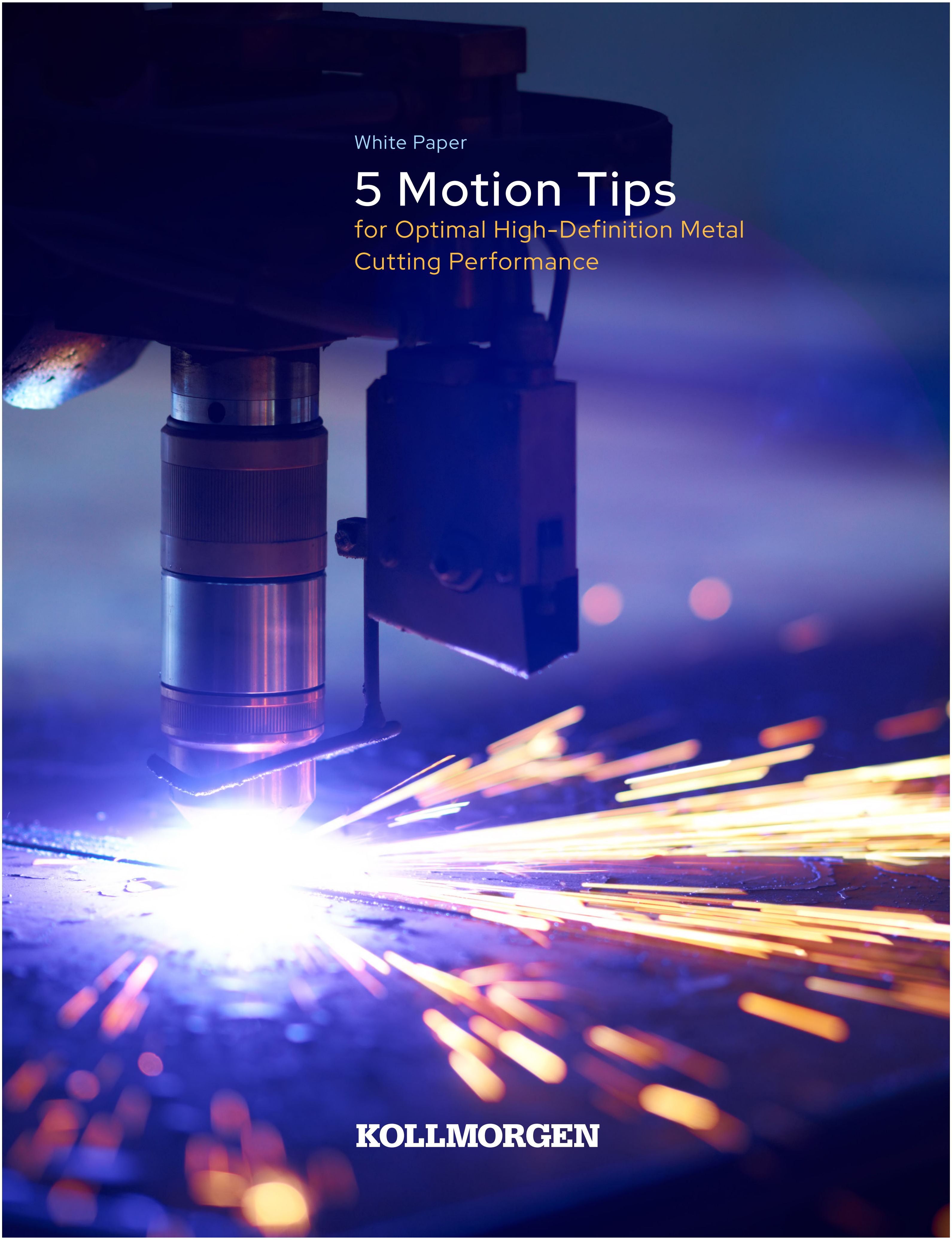
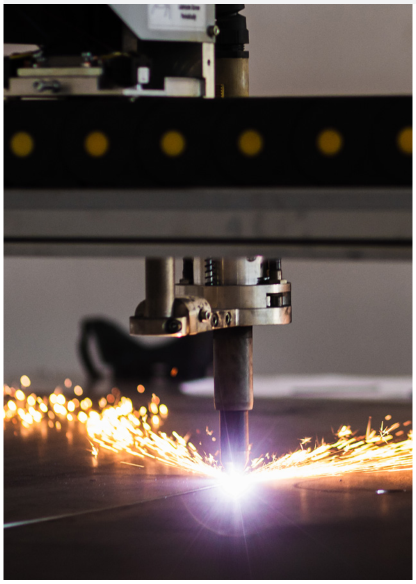


White Paper

5 Motion Tips

for Optimal High-Definition Metal Cutting Performance

KOLLMORGEN



Laser, waterjet and plasma cutting machines all have one thing in common: customers are looking for next-generation performance.

When manufacturers purchase a new or upgraded machine, they're focused on the capabilities that will allow faster, more reliable production of higher-quality products. That means your reputation and success as a machine builder depend on demonstrating the best performance, the best design and the best integration.

All of these qualities depend on optimizing the motion system. Five key opportunities for improvement include the **fieldbus architecture, control loop bandwidth, servo motor design, feedback selection and cabling.**

1. CHOOSE THE RIGHT FIELDBUS ARCHITECTURE

While several different bus types have been used in the past, modern metal forming systems almost universally employ one of the several versions of Ethernet for both ease of use and maximum performance. But even within the Ethernet family, performance is relative, and choosing the wrong bus architecture can significantly reduce the speed of execution, degrading cut quality and precision.

Whether using an industry-standard controller such as Hypertherm or a custom controller, the position points that define the cut are streamed from the controller to the drive in a deterministic manner. The time intervals between each x/y set of points are strict and undeviating. Additionally, for highly dynamic applications such as precision cutting, these time intervals are very short—typically within the range of 500 microseconds to 1 millisecond. Longer time intervals mean a less precise cut, while varying time intervals mean a distorted cut.

Ethernet connectors look the same, but different versions of Ethernet don't behave the same, and it's essential to choose the right version for the right job. Any drive's fieldbus ports, however, must support a version of industrial Ethernet, and all devices on the bus must be compatible and correctly configured.

Not all industrial Ethernet protocols are equal in their ability to transmit deterministic data in real time across all devices on the fieldbus. Kollmorgen recommends EtherCAT for its fast, real-time performance as well as its support for CANopen, FailSafe over EtherCAT (FSoE) and other characteristics.

ORGANIZATION	RESPONSE TIME (for 100 axles)	JITTER	DATA RATE
Ethernet/IP CIPSync ODVA	1ms	<1ms	100Mbit/s
Ethernet Powerlink EPSG	<1ms	<1ms	100Mbit/s
PROFINET-IRT PNO	<1ms	<1ms	100Mbit/s
EtherCAT ETG	0.1ms	<0.1ms	100Mbit/s

Performance Comparison for Common Architectures
(Source: IEBmedia)

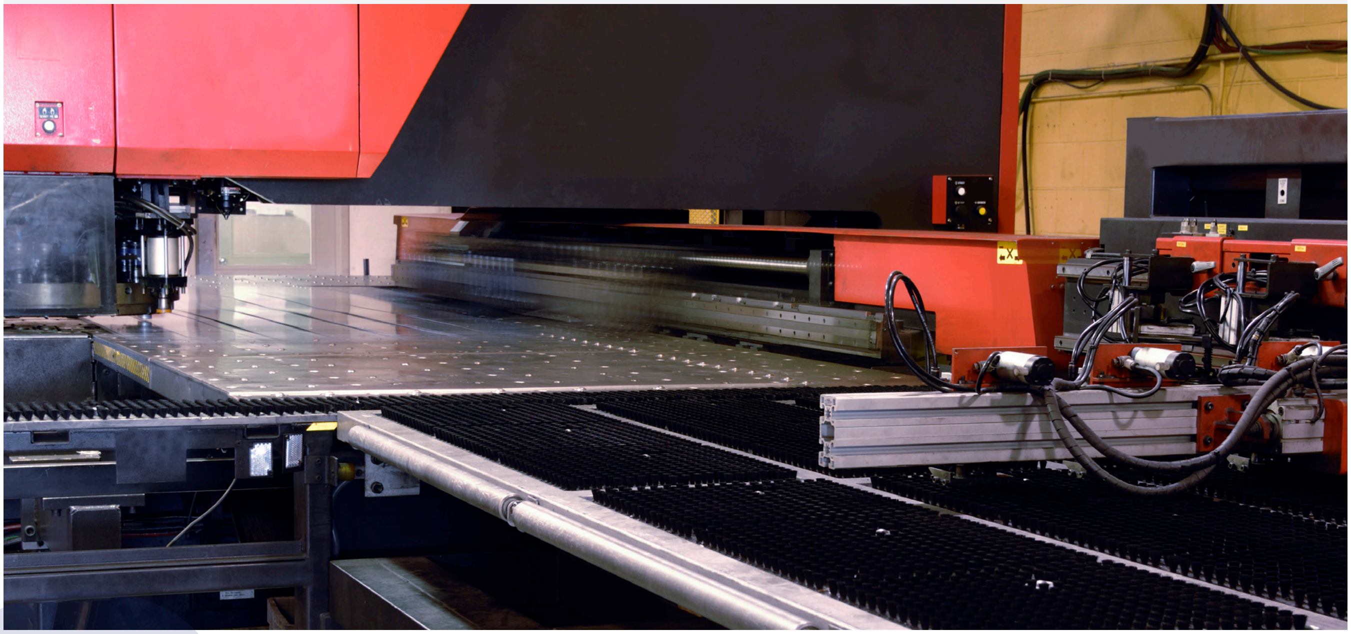
2. OPTIMIZE BANDWIDTH

Higher bandwidth is intrinsically related to higher speed. With increasing control loop bandwidth, the system achieves stiffer motor behavior, decreased error and improved transient response times. The result is more responsive control over position, velocity and torque. For many everyday cutting applications, these factors may not be critical. But for next-generation cutting machines, control loop bandwidth is essential to performance.

However, while high bandwidth enables high performance, it also requires high-performing motion components. The risk is that higher frequencies can cause instability issues if the drive and motor aren't able to take advantage of the rapid changes in the control loops. For example, a motor with high inertia may not be able to achieve the required acceleration, and those insufficiencies feed back into the control loops.

Another common issue is bandwidth-matching. In a multi-axis application, you need sufficient bandwidth to perform the required moves on each axis. But if the bandwidth doesn't exactly match between the different axes, the shape of the cut will be distorted as the axes respond at different rates to the control loop feedback. While not directly related to bandwidth, applications incorporating a gantry also need cross-coupling between the axes on the two parallel sides to ensure coordinated motion.

Your drives should provide simple, highly accurate tools for matching bandwidth across axes. When deciding on a servo motor, look for low inertia designs to provide the acceleration and torque response needed in high-bandwidth, high-performance applications without creating disturbances in the system. Kollmorgen's 2G Motion System achieves this, while it also includes a gantry mode algorithm that makes cross-coupling between gantry sides simple.



3. SELECT AND SIZE MOTORS APPROPRIATELY

Another common mistake is to undersize a motor or select the wrong motor design without accounting for the risk of voltage or current saturation. Put simply, a motor's torque constant, or Kt, cannot be higher than what the bus voltage will allow. If the drive can't supply the necessary voltage or current, you may not be able to get the motor to perform the required movements.

The solution is to incorporate electrical calculations up-front as part of the motor selection process. With a precise understanding of the available current and voltage, you can objectively evaluate the motor design and size you need. You may need to move to a bigger motor. Alternatively, you can consider the same motor with a different winding that offers a new balance of voltage and current requirements. There's a high likelihood you can get the performance you need without upsizing the motor, or even gain the ability to downsize.

Look for a partner that delivers motion engineering and product selection expertise to eliminate voltage and current saturation problems and ensure optimum performance given the realities of your electrical supply.

4. MATCH FEEDBACK DEVICES TO YOUR APPLICATION REQUIREMENTS

Feedback devices provide information to the drive or controller to ensure that the motor or load reaches the required speed and position at the right time. The feedback devices selected for a particular application have a significant influence on cost, speed and accuracy.

Incremental encoders provide two output signals indicating movement and direction. These signals can only track relative position, and therefore require use of a digital interface to calculate absolute position. In the event of a power interruption or application failure, the axis must be returned to a home position before restarting since the encoder doesn't track absolute position. In some applications, this can be a safety issue. Incremental encoders are also somewhat susceptible to electrical noise interference and may require input filters and other measures to ameliorate the problem.

Absolute encoders generally cost more than incremental encoders, but provide several advantages. Because they generate digital codes representing the motor shaft angle, absolute encoders provide exact position and speed information with no need for further processing. If power is interrupted, an absolute encoder reports the correct position upon restart with no need to return to a home position. These encoders are also capable of very high resolution, provide excellent noise immunity, and are available in single-cable options.

4

Resolvers are another option. These analog devices are designed around an electrical transformer, using voltage comparisons between rotor and stator windings to provide absolute position throughout a turn of the motor shaft. Resolvers are rugged devices often specified for use in harsh environments, but typical resolvers don't provide the resolution needed for the highest-precision cutting applications.

The Kollmorgen SFD feedback combines a rugged resolver architecture with added electronics that make it a higher precision device, provide plug and play setup and has the benefit of a single cable option.

All of these feedback types have their uses, but it's essential to choose the most appropriate technology for the machine performance you want to achieve. In particular, be aware that inexpensive feedback devices have hidden costs, such as difficulties in tuning motion to reliably meet your requirements.

5. CHOOSE CABLES FOR RELIABILITY AND PERFORMANCE

Finally, it's easy to overlook the importance of cable selection, but this is not an area to scrimp or treat as an afterthought. If the wire gauges in the cable are undersized, you will experience problems with efficiency and reliability. If cables aren't properly grounded and shielded, electrical noise can cause errors in feedback and overall system performance.
If insulation and connectors are substandard, failures are likely over long-term use.

The number, size, weight, flexibility and layout of cables can also make a difference. For example—particularly in a gantry system—cables are part of the load, causing drag, weight and compliance issues that the servo system must compensate for. In most cases, a single-cable design may be useful since it's easier to route and lighter in both the cable and the connector than a two-cable system.

A gantry driven by a larger motor may benefit from the flexibility of two cables instead of a thicker and stiffer single cable. As with all aspects of machine design, cable selection requires finding the right balance of properties while never compromising on quality.

For Answers, Partner With Kollmorgen

Kollmorgen is more than a supplier. We're a partner, dedicated to your success. We give you direct engineer-to-engineer access to the designers who create our motion systems and who understand how to address specialized metal-forming requirements. Our self-guided design tools help you model, choose and optimize products online. And with our global footprint of manufacturing, design, application and service centers, you always have access to dependable supply, co-engineering expertise, and personalized support that no other partner can provide. Whether you're upgrading an existing machine or designing the next-generation machine that will define the state of the art for your customers, we can help you engineer the exceptional.

Ready to discover all your machine is capable of? Visit www.kollmorgen.com/metal-forming