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Motion Control™ TECHNOLOGY

Sensor Technology Leads Manufacturing into Predictive Maintenance

Flexible Digital Servo Drives Speed Machine Control Design

QuickSilver Servo Motors Drive Autonomous Vehicles

Electronic Motion Controller Simplifies Hydraulic Press Controls

Maxon Drive Prevents Bottlenecks for Bottle Cap Maker

New Products

Cover image courtesy of Kollmorgen.

Flexible Digital Servo Drives Speed Machine Control Design

Advances in digital hardware technology and software innovations now allow a single digital servo drive to be configured to work in a variety of machine control architectures.

For the machine builder, that means only having to work with one drive from a single vendor to fulfill various applications. Not only that, but setting up the drive for a particular machine control type requires simple configuration in the drive's setup software. There is no traditional programming language to learn, write or debug.

In the machine control structure, the servo drive provides the link from the motors and I/O to the machine's central controller, typically a PLC (Programmable Logic Controller) or IPC (Industrial PC). Traditionally, the servo drive provided the power conversion and contained the servo current and velocity loops.

With the incorporation of digital technology, servo drives can now control the servo position loop, have more digital and analog I/O, can communicate on a bus network, and can accept multiple feedback types. That said, in any given application, the servo drive capabilities that are utilized depend primarily on the machine's control architecture and the other components that are specified prior to the drive.

Because it serves as the "heart of the control," a machine designer will often select the PLC or IPC control platform and software prior to drive selection. Key factors for selecting the machine controller are:

- Ability to integrate an HMI
- Ability to integrate I/O
- Programming language/capability
- Execution capability
- Connectivity to higher-level controllers
- Ability to close servo loops
- Application need for centralized or decentralized control
- End customer preference

The motor type may also be selected prior to the drive, as the motor must be able to meet the mechanical and dynamic motion capabilities of the application. For example, a linear motor would be used if the application requires high dynamic indexing greater than can be achieved with a rotary motor with a ball screw or bell and pulley, in order to convert the rotary to linear motion. Alternatively, if a motor is needed that will mate well with a gearbox in order to obtain good mechanical advantages, a traditional rotary-style servomotor would be selected.

Other key motor selection factors include:

- Accuracy, repeatability, torque density, torque ripple
- Mounting configurations and physical constraints of the application
- Feedback types: dig enc, sine encoder, resolver, encoder with halls

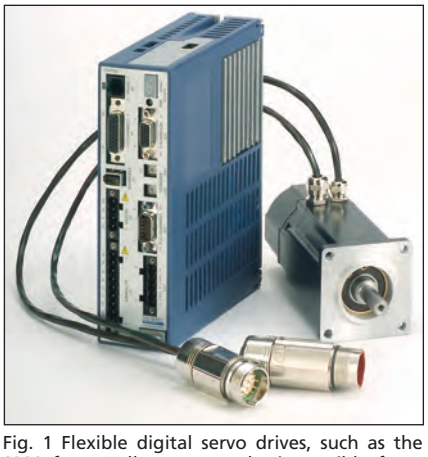

Fig. 1 Flexible digital servo drives, such as the S200 from Kollmorgen, make it possible for a single drive to be configured for a diverse range of machine control architectures.

The servo drive must be compatible with the motor and/or controller, which have often already been selected. Based on the capabilities of the PC or PLC controller, the servo drive will provide many of the following functions, in addition to basic power conversion and current loop control:

- Compatibility to the feedback device
- Velocity loop servo control
- Position loop servo control
- Machine I/O control (motion related) Travel Limit switches home switch, etc.
- Controller interface part (digital, analog, Bus) with commands and status information flowing
- Motor brake control
- Profile generation

Today's high performance servo drives are capable of far more than simply being configured to fit into the control scheme of the machine and performing basic functions. They can actually increase machine performance, shorten the time it takes to get the machine up and running, and lower total machine cost.

Operating Mode Selection

The servo drive can be used as a simple current loop with power amp, all the way to a unit that closes all the servo loops, controls I/O, and performs some or even all of the machine control. A few examples are:

Current loop only — In some applications, it is desirable to close the servo velocity and position loops outside the drive in a central controller. This allows extremely tight motion coordination between two or more motors. Applications such as machine tool, robots, and electronic assembly require very tight coordination between axes to achieve the desired machine performance such as smooth surface finish and micron level positioning.

Some machine developers want to develop their own control algorithm, while others will use a commercial machine controller such as the Kollmorgen eXMP that provides advance motion kinematics to control multiple axes of motion. The drive will accept either an analog or digital current command. For a digital command, a motion bus such as SynqNet can be used. With an update rate of 250 microseconds for each axis, there is no degradation of performance when compared with an analog interface. Additional motor feedback information can be sent through the bus, completely eliminating the feedback cable.

Master/slave — In a master/slave configuration, the drive's purpose is simply to position the motor, and thus the machine, by following a master pulse train from a controller. Traditionally, such applications that have tended to use stepper motors, transition to servo systems to achieve higher machine production rates.

Another example is an encoder mas-

ter signal from either another drive, or an encoder wheel where the drive is electronically geared to another section of the machine. These applications are often found in the web converting and packaging industries.

Motion indexing in the drive — In some applications, the drive stores and executes motion indexes using an internal profile generator. Multiple motion profiles, or tasks can be created using the drive's software setup environment. Additionally, in some applications the need for a separate PLC is eliminated. And it's not just saving the cost of the PLC itself; it is also the cost of wiring, extra cabinet space, spare parts and the need to learn a programming language.

On-the-fly switch operation mode — Some applications call for switching OPMODES on the fly. Drives with this functionality enable users to reduce cycle time while maintaining machine process performance, by eliminating the need to stop the machine to switch opmodes.

Two common examples include position control to gearing in an electronic gearing application, or position-to torque control in a clamp application.

I/O functionality

I/O can to be configured for various application needs. For example, digital inputs can be used to start a motion profile, limit motion, represent a travel limit and switch opmode, among multiple other functions. But rarely are all these functions needed in every application.

So instead of having 20 or more dedicated inputs (one for each function), or having to write application code to implement a particular function, a configurable drive has a smaller set of three to six inputs, which are configurable for the particular application's need. The same holds true for digital outputs. Applications using a digital bus such as Profibus or DeviceNet benefit from the flexible I/O, because the controller can use the drive I/O as a remote I/O point, eliminating the need to add another dedicated remote I/O node.

Control of the motor's brake, often required in vertical motion applications, is integrated into the drive. With digital servo drives, the brake automatically disengages when the drive is enabled (motor torque applied), and engages when the drive is disabled (no motor torque applied). Additionally, synchronization timing of brake engagement and disengagement with the drive enabled or disabled can be delayed or advanced through a user setting, in resolutions of milliseconds. These adjustments calibrate the servo system to the machine load to prevent unwanted motor movement that could result in lower production rates, or even machine damage.

Fig. 2. This S300 digital servo drive from Kollmorgen offers a wide range of inputs and outputs.

Tuning for higher performance

Today's machines face ever-increasing competition, and as a result must be manufactured to minimize production cost while maximizing production rates. To reduce cost, manufacturers will sometimes modify load structures to make them lighter, but also more compliant and susceptible to resonance when required to change speeds quickly. Flexible digital drives help overcome such challenges by providing advanced control schemes with tuning filters and observers to maintain, and even increase overall machine performance.

System Error Control

Often, when a fault occurs or the machine operator pushes the machine emergency-stop button, for safety reasons it is desirable to bring the machine to a complete stop as rapidly as possible. Flexible digital servo drives can be configured to automatically decelerate at a higher rate than normal. This functionality at the drive level eliminates the need to develop extra code for the controller.

GUI's in a flexible digital drive provide a user interface that walk the user through setting the drive up for the power voltage, motor and feedback, and machine limits (position limits, top speed, mix current, etc.), and initial tuning gains. This time-saving feature frees the machine builder to focus on other areas of machine development.

Feedback Flexibility

Various motor feedback choices are available to machine builders. The one selected for the application depends primarily on customer preference, application needs, and vendor preference. For example, resolvers are rugged and well-suited for high vibration, high temperature applications such as material stamping machines. Sine encoders offer the highest precision and are well suited for use with pick-and place circuit board, component insertion machines.

A drive that can interface with both, as well as to potentially more cost-effective digital encoders, offers the user the ability to optimize cost vs. performance for each application. In high accuracy applications that use rotary to linear motion conversions, the drive can interface to a second linear position feedback device connected directly to the load.

This article was written by Carroll Wontrop, Senior System Engineer for Kollmorgen, Radford, VA.

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