Selecting the right servo requires choosing the right communication platform

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Servos are inherently capable of delivering high performance. To maximize that capability requires selecting the best communication platform. But selecting the wrong one may negate the basic benefits of servos and remove your product from the competitive race. This article gives you some insights so you can make the right choice.

Machine tool designers — the first to use precision motion control — had the most influence on early servo drive technologies. Today, this influence continues. However, servo designers are now also relying heavily on the inputs from engineers who design and retrofit specialty machines. Table 1 lists some of the typical industries and applications that are increasingly using precision motion control — servos, step-motor drives, and related products.

As the designs of servo drives have evolved, so have the interfaces between the motion controllers and servo drives. *Platform types* define the type of interface with each platform having its advantages and constraints.

Platforms are recognized by three types: traditional, centralized, and decentralized. Although Table 2 summarizes these types, one of the best ways to understand the differences is to discuss the evolution of each, benefits each "brings to the party," price of admission, and which way the technological winds are blowing. Naturally, variations amoung manufacturers produce some overlaps of the various types.

Table 1 — Common applications for precision motion control devices

Applications		Industries
Specialty machinery	**Machine tool**	
Registration/tracking Smart conveyors Bag making Filling Packing & labeling Cut-to-length Feed-to-length Flying cutoffs Tension control Wind/unwind Robotics	Metal cutting Metal forming Transfer machines	Packaging Material handling Textile/garments Food/dairy processing Woodworking Fitness/medical Converting Printing Wire & cable Rubber/tires

Traditional

In the traditional platform, the motion controller contains the position regulator and the servo drive, which includes the velocity and current regulators plus the power amplifier. This configuration offers maximum flexibility, because most motion controllers send a 0 to ±10-Vdc velocity command to the servo drive, Figure 1. Nearly a universal standard, this

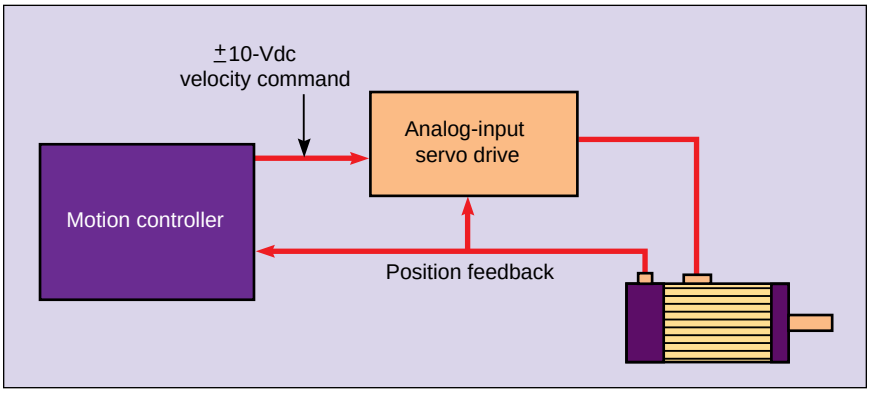

Figure 1 — Simplest and oldest of the platforms, the traditional platform uses a 0 to ± 10-Vdc analog signal. The output from the encoder or resolver mounted on the motor serves both as a speed feedback for the drive and a position feedback for the motion controller.

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analog signal enables connecting a motion controller from one vendor to a servo drive of various technologies from another vendor.

During the quarter-century or more ago that this velocity signal became a standard, hydraulic servos were initially more popular than electrical, and this analog standard worked equally well with both systems. Today, this ± 10-Vdc signal is still the most common and flexible interface.

However, with flexibility goes three basic limitations:

• The analog velocity command suffers from analog offset voltage that can change with temperature causing position errors. This analog signal is also sensitive to electrical noise. For best results with the traditional platform, the motion controller and the drive should be in the same cabinet. This minimize problems caused by electrical noise entering the velocity command signal.

• An encoder mounted on the motor produces pulses that serve two purposes — a speed feedback signal for the drive and a position feedback signal for the motion controller. This dual usage makes the wiring more complex. Some systems use a resolver on the motor, but the basic problems are the same.

• In general, most manufacturers are now producing both motion controllers and servo drives based on digital technologies. Although it is possible to convert a digital command to analog and an analog command back to digital, these conversions add costs and reduce performance by adding time delays and reducing resolution.

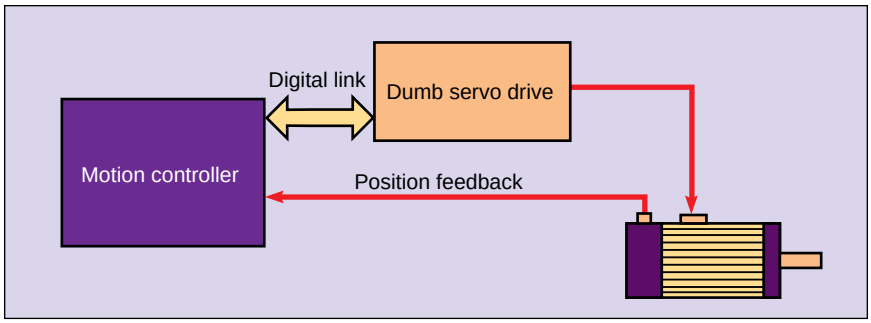


Figure 2 — The centralized platform incorporates all the intelligence in the motion controller and has a simple digital signal interface to the dumb servo drive.

Centralized

Inherently digital, the centralized platform was developed several years ago for machine tools and it is becoming the standard platform for this market. In this platform, all the regulators (position, velocity, and current) are included in the motion controller, Figure 2. This leaves the servo as a "dumb" servo drive containing power amplifier, interface for the power switch turn *On* and *Off* signals and drive enable, plus output signals to the motion controller for drive fault, and current feedback. Internally this drive has fault protection including overvoltage, overtemperature, and overcurrent.

Although the current feedback signal may be analog, it is converted to digital in the motion controller so the controller is completely digital. The digital regulator can compensate for any offset voltages in the current feedback signals.

The link between the motion controller and drive works best if the controller and drive are in the same cabinet to minimize electrical noise problems.

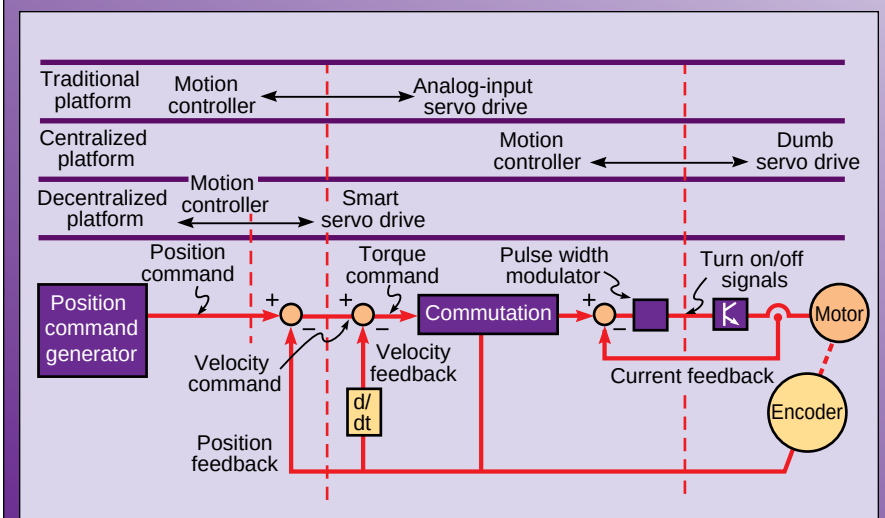
Other than selecting a dumb drive with the proper current and voltage ratings, the unit is void of set-up or other adjustments.

In general, the centralized platform offers the highest performance at the lowest cost. Three factors are responsible for this economic advantage: integration of all regulators in the centralized motion controller, eliminating the D/A and A/D converters, and eliminating the feedback to the servo drive.

There are drawbacks. There is no standard for the interface between the motion controller and the servo drive. Thus, the same manufacturer must supply both devices. In turn, this limits the drive solu-

Basic drive topology

Typical for all types of servo drive systems, this block diagram of a brushless dc (BLDC) servo illustrates the lines of demarcation for the three servo platforms. For simplicity, the regulators after the summing junctions are omitted.



tion to those devices a specific manufacturer offers.

Some suppliers are offering a different version of the centralized platform whereby the motion controller supplies sinusoidal (analog) current commands, rather than power device *On-Off* signals, to the servo drive. This design retains the high-performance current regulator in an active servo drive. These analog signals offer an opportunity for electrical noise to disrupt operation. The analog approach also requires more set-up time than a purely digital system.

A third variation integrates the motion controller and servo drive in a single enclosure, called "positioning drive module." Operating with a standard centralized platform, this unit is well-suited to single-axis motion control applications. This optimizes cost, package size, performance, and ease of use (one box replaces two). Some include a network drop (a connection that puts all items in parallel). This capability places the unit in the decentralized platform category.

Table 2 — Comparison of precision motion control communication platforms

	Traditional platform	Centralized platform	Decentralized platform
Strengths	•Worldwide standard. •Interfaces to wide variety of servo technologies and servo vendors. •Most user adjustments can be moved to motion controller if torque command interface is used.	•Position feedback goes only to motion controller. •All user adjustments in motion controller.	•Position feedback goes only to servo drive. •User interface can be consolidated at motion controller. •Allows for more flexibility and modularity.
Weaknesses	•Position feedback to servo drive and motion controller. •Offsets in analog velocity command cause position errors. •Sensitive to electrical noise. •Motion control and servo drive should be close in same box. •Cumbersome cabling.	•No accepted open standard with little activity to create one. •Less flexibility.	•No widely accepted open standard, but many open interfaces are being proposed.
Performance	Medium, not improving	High, not improving	Low, getting better
Cost	Medium, not improving	Low, not improving	High, moving lower
Suitability for machine tool	Better	Best	Good
Suitability for general purpose, simple motion	Good	Good	Good, best if long distance between controller and drive
General purpose: **-Registration** **-Electronic cam** **-Tight synchronization**	Better	Best	Poor, getting better

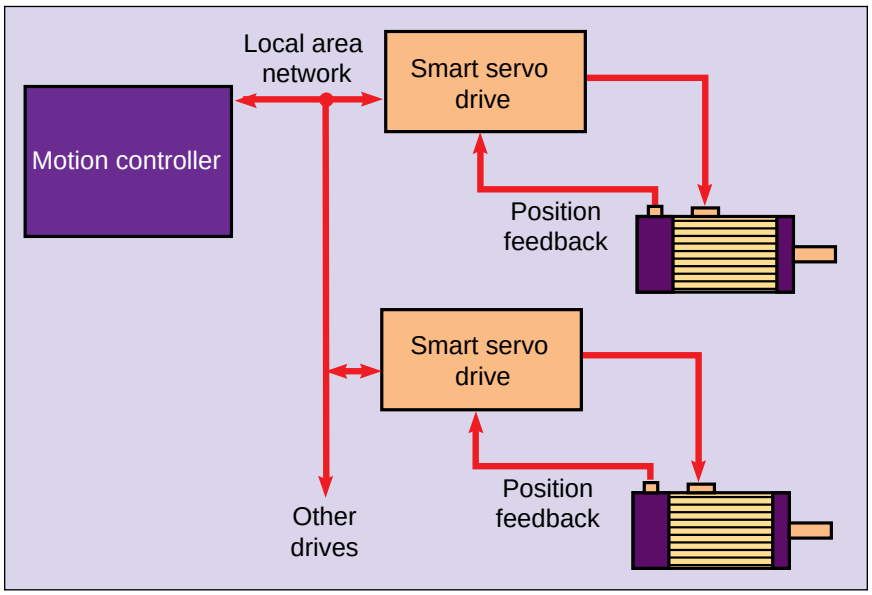


Figure 3 — The most versatile of the three, the decentralized platform has a local area network that can connect to one or more servo drives. The type of link determines the maximum distance between units. For example, a fiber optic network enhances noise immunity and enables long distances between components.

Decentralized platform

The motion controller gives position commands to a smart drive via a high-speed communication network. In most decentralized platforms, the smart drive includes the current, velocity, and position regulators, Figure 3.

Operating typically at 1 to 10 Mbits/sec, this network incurs a price penalty, generally $50 to $200 per drop depending on the specific network. Offsetting this cost are the advantages of long-distance communications capability and the ability to connect other types of

drives, controllers, and input/output devices to the same network. This versatility does limit the performance for precision motion control as compared to the other platforms.

The best applications for this platform are larger control applications covering long distances with other control devices connected to a network, and where higher versatility and reduced wiring cost offset higher component cost and lower performance. The network — which may be a noise-immune fiber-optic type — eliminates many wires between the various control and sensing elements.

At this time in the technological development scale, the cost and performance constraints prevent the decentralized platform from being accepted for machine tools and in precision motion control applications requiring electronic gearing, high-speed registration, and similar tight-synchronization requirements.

Trends and expectations

Present technological trends indicate we will see some shifting.

Traditional platform will remain a strong player with its base eroding only as new technologies offer more value — superior reliability with less total cost including initial and operational costs.

Centralized platform, which has the current regulator in the servo drive, will probably be eliminated by pure dumb drives as motion controller engineers become more comfortable with incorporating the current regulator technology in the motion controller.

Decentralized platform, even with its present limitations, probably holds the brightest promise and could be the standard platform for precision motion control. With standardization efforts, this can become universal like the ± 10-Vdc analog interface. Reasons: simple interconnections will support both short and long distances between system components, costs will fall, and reliability of high-speed communications will increase. Plus, as personal computers play a larger role in industrial motion control, a standard network interface to servo drives and other distributed devices (including I/Os and operator terminals) will make such a network a logical choice. ■