Temposonics®

Magnetostrictive Linear-Position Sensors

Integrated Sensor and Controller Provides
Enhanced Performance and
Reduced System Integration Costs

Technical Paper

551054 A

Introduction

Today's engineers that are developing motion control systems have less time to spend on optimizing individual servoactuator axes to enhance process performance. In fact, they have barely enough time to select the proper system components. As a result, more are relying upon products that directly interface with standard off-the-shelf solutions.

At the same time, the pressure is on to reduce engineering development and system capital costs - factors that are particularly pertinent when deciding whether to retrofit, upgrade, or scrap older systems. To off-load machine controller overhead and reduce, if not eliminate, the need for additional external programming, system designers are turning more to sophisticated smart devices that include on-board intelligence with self-diagnostics and remote programming capabilities. This, in turn, is helping to drive the move towards distributed, fieldbus-based control architectures. The ability of smart devices to share relevant feedback and diagnostic information over an industrial network reduces the need for traditional centralized control architectures.

However, to put this capability to good use requires a skill set that is not yet prevalent in the machine control industry. As a result, component suppliers have produced a variety of new options for control system engineers. One of these options, the servo sensor, incorporates a digital controller inside a standard feedback sensor package; it offers high-performance position control, cost savings, and simplicity of application for motion control.

Servoactuator control system options

The utility of fluid power to produce precise motion and loads is shown by its long history and tremendous range of operation. Because of their inherent efficiency and power throughput capability, hydraulic servoactuators have been used extensively for precise motion control in metals production, wood and paper processing, plastics manufacturing, and materials testing industries - to name a few. Typical fluid power servoactuator control systems include the following components:

- Hydraulic or pneumatic cylinder - Produces forces or torques required to create motion.
- Control valve - Servo or servoproportional device used tocontrol fluid power for cylinder position, velocity or load.
- Current driver - May be required to produce drive signals for servo-type control valves.
- Feedback sensors - Provide feedback in various forms for motion controller.
- Motion (axis) controller - Typically located at or near the process controller. Optionally may reside on board a control valve or position sensor.
- Process controller - Typically a programmable logic controller (PLC) or proprietary machine controller; although industrial PC controllers are becoming more prevalent. the PLC controls all aspects of process including motion controller commands.

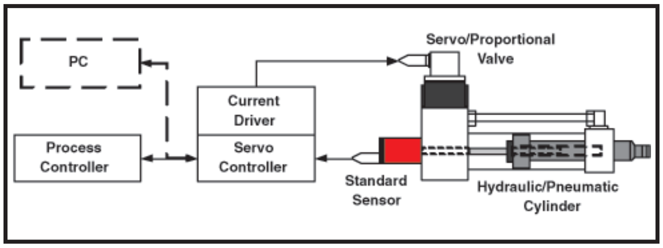

Figure 1 *– Traditional Servoactuator Control – Position Feedback Example*

The most common position feed back servoactuator configuration is shown in Figure 1. This approach uses a motion controller external to the control valve and position sensor. Its advantages is that control engineers are familiar with it, and components are readily available.

An alternative to the external controller configuration uses microprocessor-based intelligence built into the control valve or feedback sensor. Servoactuator examples of these approaches using the so-called motion control valve and servo sensor are shown in Figures 2 and 3 respectively. (See page 2).

One advantage of this on-board control approach is that the cost of the servo controller can be significantly less than that of a more traditional motion controller. Most external motion controllers are designed for wide range of use and, therefore, end up being overdesigned for many of the individual applications they are called upon to control. At the same time, the reduced complexity of the on-board servo controller simplifies control system setup and tuning, and reduces device-level training requirements. Elimination of the external controller also saves space and reduces costs associated with installation and cabling, particularly for multiaxis systems. These savings make the on-board control approach ideal for retrofit and controls upgrade situations.

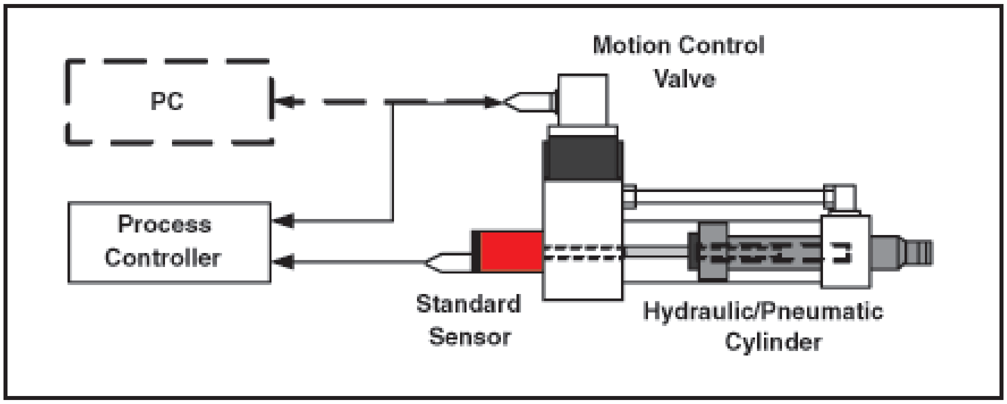

***Figure 2** – Servoactuator Control Utilizing Motion Control Valve - Position Feedback Example*

When it comes to diagnostics and device performance optimization, manufacturers of components with on-board controls have distinct advantages. Since the manufacturer can determine the critical health variables associated with its product, simple diagnostic algorithms can be developed specifically for that device. In addition, manufacturers can routinely integrate the necessary unit specific data automatically into the on-board controller at the factory to enhance device performance, leaving the control system designer with one less thing to worry about. The other benefit of this control optimization is that the control algorithm complexity and overhead can be reduced even further, resulting in faster, more efficient controller code without having to sacrifice performance.

An advantage of the servo sensor approach is that signal delay and noise resulting from cabling is all but eliminated. More demanding servo control applications, such as those seeing large load or system natural frequency variations, often require minimal phase delay and/or velocity feedback. It is considerably easier to derive a clean velocity output within the sensor. Doing so outside of the sensor requires significant filtering, which adds to signal delay, thereby compromising closed-loop system performance. The point is that, from the feedback perspective, applying your closed-loop control directly at the source is preferred.

Servo controller tuning, diagnostics and the interface between the servo controller and the process controller, must use some type of serial communications link. The choice of which to use will depend as much on the designer's training and resources available to implement a networked solution, as on the performance and functionality of the network. Because it relies on a number of different feedback signals, the only practical way the motion control valve can communicate such data is via an industrial fieldbus. The advantage of this approach is that more system information (from any of the fieldbus slaves) is available to each device for a more sophisticated control capability. The bad news is that information update rate is limited by the fieldbus baud rate, and more nodes on a given network will add to the update delay.

The limitations of fieldbus network communication rates can be overcome by sound system architectural design and clever programming, but the expertise and resource investment can be significant. The servo sensor solution relies on a simple standard high speed serial interface with a familiar communications protocol. The approach of providing the highest performance, along with interface simplicity, illustrates the goal of applying the servo sensor as quickly, painlessly, and effectively as possible.

The servo sensor approach

One of the fundamental limitations of a feedback control system is the accuracy of the feedback device used, be it static linearity and resolution or dynamic responsiveness. For more than 25 years, high-performance magnetostrictive position sensors have been a feedback standard for challenging servo control applications.

Today, the performance and accuracy of these products have been combined with device level intelligence in an extremely small physical envelope to help create a wide array of direct outputs. Besides traditional analog and digital pulse outputs, these products offer high-speed serial data, fieldbus, even closed-loop servo positioning. Not only can the designer select a sensor model that will interface directly with the industry standard de jour, he or she can also take advantage of programming flexibility within a given standard (e.g. multi-magnet CAN, DeviceNet, CANOpen, etc.) for highly-optimized system solutions.

The servo sensor is a complete servo controller installed and interfaced inside a standard high-performance sensor platform. Using the standard modular design platform, the servo sensor consists of a Servo Controller Module (SCM), driver module, and Sensing Element (SE) combined inside the sensor body (aka, application housing). Proprietary magnetostrictive sensing technology is integrated directly with the SCM that enables the servosensor to perform extremely fast position measurements and servo control outputs. Hydraulic cylinder typically can be positioned to less than 0.001 inch at update rates under 1ms - more than adequate for a

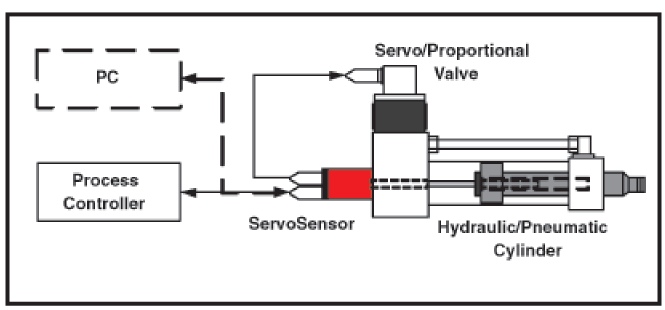

***Figure 3** – Servoactuator control utilizing ServoSensor position controller*

large percentage of position servocontrol applications. The tuning of standard PID controller gains and control limits, and programming of set point data, communication and sensor parameters are accomplished via an RS-485 link and an industry-standard ASCII communications protocol. The user interface can be accomplished via the process controller, portable HMI, or standard PC using an RS-232 or RS-485 converter. Multiple servo sensors can be accessed using a single RS-485 drop and discrete I/O ensure that the servo sensor and control valve operation can be immediately shut down safely for safety purposes.

Application of the servo sensor

The servo sensor design is packaged in the familiar threaded rod-style application housing, or can be supplied in the profile-style version that features an aluminum extrusion package designed for a guided or floating position magnet. The rod-style servo sensor is well suited for hydraulic-cylinder applications such as might be found in the wood processing, metal forming and machining industries' heavier production process machines. The profile-style servo sensor is ideal for mounting externally to pneumatic as well as hydraulic cylinders, or even stationary machine surfaces in close proximity to moving members. With this type of sensor, the position magnet can be easily connected to the moving surface by linkage with a variety of end-joint connection options. This enables the servo sensor to be applied to a wide range of machine control in the rapidly growing specialty packaging machine industry where pneumatic controls are often used. In cases like this, designers now have an option to upgrade their control capability without having to reinvest in servomotor or electrohydraulic control solutions.

Two critical elements have been developed to create a truly seamless integration of the servo sensor solution with today's PLC platforms. The first is so-called Multivendor Interface (MVI) module, which provides the hardware link between the PLC and the RS-485 hardware interface. Two examples of this are the Prosoft MVI56-GSC communication module designed specifically for the Allen Bradley ControlLogix platform, and the F2-CP128 coprocessor from AutomationDirect for its 240/250 PLC platforms. Both devices can communicate at a maximum of 115.2 Kbaud. Each MVI card can interface up to 16 servo sensors while the AutomationDirect coprocessor can accommodate five, meaning up to 35 axes on a single AutomationDirect PLC platform. Similar solutions are also available for the AB PLC-5 and AutomationDirect 450.

To eliminate the programming requirement between the servo sensor and PLC, third-party vendors have written libraries of translator code specific to each PLC platform. The benefit of this approach is that the translator code can be provided at a modest cost for a given platform in the form of a flash card or EPROM memory chip that installs directly onto the MVI card. Once each axis is individually tuned for its application, all the control engineer needs to be concerned with is completing the process PLC programming.

The result is a highly-integrated, high-performance smart axis system that requires minimal process overhead and programming. This solution saves capital and installation costs, and allows the system engineer to focus more attention on other important development tasks, including the next project.

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MTS® SENSORS

UNITED STATES
MTS Systems Corporation
Sensors Division
3001 Sheldon Drive
Cary, NC 27513
Tel: (800) 633-7609
Fax: (919) 677-0200
(800) 498-4442
www.mtssensors.com
sensorsinfo@mts.com

GERMANY
MTS Sensor Technologie
Gmbh & Co. KG
Auf dem Schuffel 9
D-58513 Lüdenscheid
Tel: +49 / 23 51 / 95 87-0
Fax: +49 / 23 51 / 56 491
www.mtssensor.de
info@mtssensor.de

JAPAN
MTS Sensors Technology
Corporation
Ushikubo Bldg.
737 Aihara-cho, Machida-shi
Tokyo 194-0211, Japan
Tel: + 81 (42) 775 / 3838
Fax:+ 81 (42) 775 / 5512
www.mtssensor.co.jp
info@mtssensor.co.jp