

More choices link motors and drives to controls

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Communication networks for coordinated or synchronized motion control are not new. But most solutions involve much wiring. Recently, several digital networks have emerged that promise to cut wiring and installation time by 50% or more, and offer total system digital control. Here's a look at their capabilities.

One network recently gained important attention. At the Hannover Fair, GM Powertrain Group and GM Europe announced to suppliers that they will standardize on the Sercos network. About a month after the GM announcement, Kollmorgen and Delta Tau announced their motion control network, Macro. Recently, Allen-Bradley announced a new network that the company claims will compete with Sercos. And Fieldbus, Profibus, and Interbus-S also claim motion control ability.

Suddenly, motion-control networks are hot.

Despite market positioning, these networks are not necessarily competitive with each other. Profibus and Sercos, for example, can co-exist within a manufacturing application, even though each controls motion tasks. Many manufacturing applications will require several networks, for example, Profibus, Sercos, a device-level bus, and TCP/IP can all function together in an application. The difference is that of those networks that claim to control motion, each controls a different level of motion.

Technological advances

Influences contributing to the recent emphasis on digital networks include a



Several firms in Europe and the USA offer VME-Bus/Sercos interface circuit cards for VME-BUS based control systems. Digital drives with Sercos interface have already been presented by ABB, AEG, Bosh, Indramat, Siemens, Square D, and AMK Co. Photo courtesy of Square D Co.

need to reduce wiring and system setup time and a need to accommodate the increasing use of digital drives and digital

feedback and control systems.

As more functions are executed digitally — including closing velocity loops

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— it's desirable not to convert these functions to analog. But it wasn't until technology produced ASIC chips, digital signal processors (DSPs), and more efficient, capable network architectures, that vendors could create digital networks that functionally compete with the analog standard, and reduce the amount of wiring by more than 50%.

Going digital not only helps reduce voltage offset and noise problems, it can also improve diagnostics. Digital operation gives users the ability to analyze and evaluate system performance. Some systems can even automatically diagnose system problems from a central control.

The "Which network is best?" debate

Market positioning is segmenting network choices along the following issues:

- Analog vs. digital.
- Synchronized motion control vs. asynchronous control.
- Peer-to-peer network communications vs. master-slave.
- Open vs. closed network.

Analog vs. digital. Analog ± 10 -V velocity command interface between a motion controller and a drive is the international standard. It connects drives and controls from different manufacturers without problems. However, digital-to-analog conversion needs are limited to the resolution of a converter — often 16 bits — which restricts how fast a motor or drive can position a load. Digital networks generally offer resolutions to 32 bits.

In the dynamics of drive control, a network must be able to deliver data samplings at least every 125 to 250 microseconds. For analog drives, this is not a problem with a ± 10 V interface. The analog system continuously acts upon the velocity command. Now, with the development of DSP chips, digital networks are available that offer transmission speed comparable with the analog network.

Synchronized motion control vs.

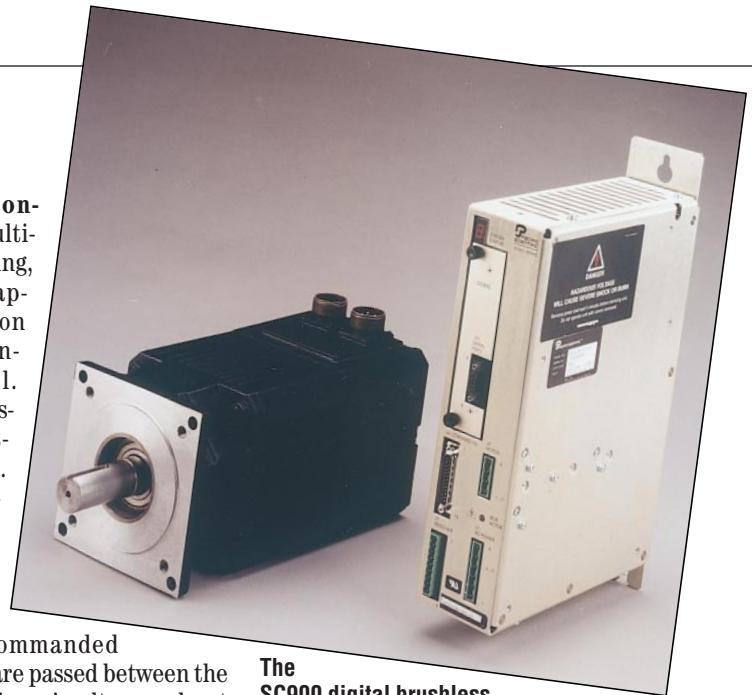
asynchronous control. Robotics, multi-axes CNC machining, and high-speed applications function best with synchronous control. Synchronization establishes the network heart beat. The network provides cyclical, precise timing between the motion controller and the drives. All commanded and actual values are passed between the control and the drives simultaneously, at defined times within the cycle, with microsecond accuracy. All drives act upon the commanded values simultaneously, at a precise time within the update cycle.

One particular benefit of synchronization is the ability to reconstruct the state of a machine for diagnosis. Another is the reduction or elimination of harmonics in drives.

One caution about synchronization, though, not all digital networks have it. This feature must be built-in to a network, it is a function of a network's message format.

But not every motion application requires this ability. If your application does not, there are asynchronous digital network choices. These choices include vendor proprietary networks, a few PLC vendor networks, and manufacturing automation networks such as Profibus.

Peer-to-peer vs. master slave. Depending on your application, you may need a peer-to-peer or a master-slave configuration. Several vendors debate the benefits and drawbacks of each, with some saying that only with master-slave arrangements will you get the transmission speeds you need, others saying no, peer-to-peer works best. Some say synchronization functions best in a master-slave network configuration. Others say only peer-to-peer arrangements allow independent device action on a network.



The SC900 digital brushless servo drive, from Motion Technology Div., Pacific Scientific, offers ± 10 V analog torque and velocity signals and interchangeable Sercos interface cards. The company also offers Sercos-compatible PC-based controls and software.

The networks discussed later have these features in various combinations. It will be up to the user to decide if a feature is exclusive to one network configuration or another.

Open vs. proprietary. Open networks include these standard ones: the ± 10 -V analog network, Sercos, Fieldbus, Interbus-S, and Profibus. Many other networks are proprietary, which means either you are locked into that vendor's products or you must handle the integration work.

The networks

Some of these networks are available immediately. Some are still being developed. Here's a look at several of the recent news makers.

Sercos. The Serial Real-time Communications System (Sercos) has several features and capabilities typical of available high-performance networks. Differences are noted in subsequent network descriptions. Sercos is an open, digital al-

ternative to the ± 10 -V analog system. An accepted standard offering 32-bit precision, it transmits data over a fiber-optic cable set up in a ring arrangement. With plastic fiber-optic cable, the network can be 60-m long, with glass fiber cable, it can be 250 m. It can transmit data at a rate of 4 Mbit/sec.

Capable of synchronization, it operates with one master and several slaves — up to 254 devices total. A slave can be one drive or a group of drives. The master handles all system functions for tightly coupled, high performance, variable-load motion control.

Communication occurs cyclically, at a time chosen during initialization. The options are 0.062, 0.125, 0.25, 0.5, or 1 ms, or any integral multiple of 1 ms. Each drive synchronizes its clock off the master message. It uses the timing to calculate its strobe-rate reply timing. Data are sent in a format called telegrams. Each telegram includes timing and synchronization pulses; torque, velocity, and position control; and real-time data.

Many parameters are set during initial startup. Drives

receive an operating mode, either velocity, torque, or position, and the exact configuration of their cycle data. From the control's initial position commands, the drives close their own loops and set their trajectories from parameters stored in memory.

Nontime-critical data include: torque limits, travel limits, time constants, and gains. Drives return data on speed, torque, and position measurement to the master. Such tight coupling improves noise immunity, position resolution, and permits high path velocities with high path accuracy.

According to vendors, the cost to make a drive and control compatible with Sercos is equivalent to the cost of an analog interface. This network can also be used to send I/O data through the same fiber cable.

Macro. The recently announced "Motion And Control Ring Optical," from Kollmorgen and Delta Tau, is a nonproprietary digital interface that connects multiaxis motion con-

trollers, amplifiers, and I/O. It offers transmission speeds to 100 Mbaud. It will update each amplifier and controller in less than 25 μ sec intervals. This protocol is on an ASIC chip that embeds into drives, sensors on the motors, and other devices.

Data from a controller are written into a receiving node's memory location, with the network hardware handling transmission details. Data transmit serially, in packets. Each packet equals 96 bits.

One fiber optic cable provides a controller with position feedback; flag status such as limits, home flag, registration; plus amplifier and machine input status. It accommodates several controllers, or master-slave configurations, in one ring.

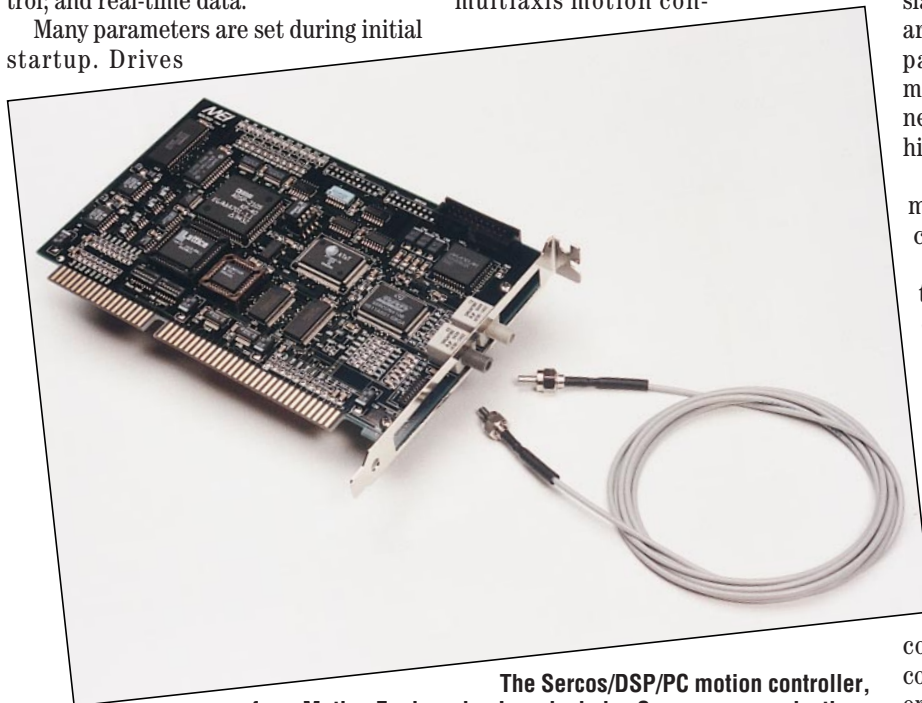
IPCA. From Advanced Concepts and Technology, Pitney Bowes Inc., this is a network for coordinated, high-performance motion control applications. The company is currently seeking standards acceptance.

It supports peer-to-peer and master-slave schemes in ring or multidrop cable arrangements. Its architecture is compatible with any processor or wiring method. The company also plans for this network to support other networks in a hierarchical or peer arrangement.

This network is modular. Off-the-shelf modules are available to create a specific solution.

It offers three types of communication. In Central control node, one processor functions as the central processor and handles all application monitoring and control functions. Peripheral control node uses intelligent I/O modules as an interface to motors, solenoids, and sensors, with the Central control controlling the modules. In Distributed control node, processor-based devices share system control with no central control.

The network uses a repeating communication Tic Period that is user configurable. This timing establishes coordinated control. At power up, the network data rate is set to 625 Kbaud. The data rate can go as high as 10 Mbaud. A



The Sercos/DSP/PC motion controller, from Motion Engineering Inc., includes Sercos communications between drives and controllers over fiber optic cable. The DSP feature computes trajectory generation and coordinated control.

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network with 31 devices, peer-to-peer, will have a data rate of less than 5 msec.

The **Socapel PAM Ring** network is a multitasking system for axis coordination applications. From Atlas Copco Controls Inc., it handles control needs with 32-bit floating point accuracy. It uses fiber optic cabling, in a ring configuration, supporting up to 254 devices.

It offers synchronized transmission of all time-critical set-points, with a cycle time of 1 msec if necessary. It offers event-driven transmission of data that are noncritical. The user selects the appropriate cycle time. Axis movements can be programmed and reconfigured on the fly.

It integrates with VME-based PLCs and can communicate with full-duplex serial RS 422 ports.

Other options

Other networks available for motion control offer the needed speed, but may not offer synchronization. Read through network specifications carefully to ensure a network meets your application needs.

ControlNet is a real-time network that will handle coordinated motion control. Introduced at IPC 1995, it is a proprietary network from Allen-Bradley. Positioned at the mid-level of plant network needs, future products will include adjustable speed drives interfaces. Present compatible products are Allen-Bradley's PLC-5 family.

The network sends time-critical digital and analog I/O data deterministically and repeatedly over RG6 coax cable. It has a data transmission rate of 5 Mbits/sec. Up to 99 nodes can be attached in bus, tree, or star topology. Connected devices can use peer-to-peer or master-slave communication.

Positioned as a complementary solution to Fieldbus, it is similar in architecture to Profibus. The company claims it works in high-speed material handling, assembly, labeling, closed-loop flow control, press web, and turbine control appli-

cations. Plans are to keep it a proprietary network to meet user requirements for single vendor responsibility for systems maintenance and repairs.

Interbus-S has been available for several years, primarily in Europe. It is an open network, connecting automation products from sensors and actuators to motors and drives to PLCs, PCs, and larger host computer systems. It supports 256 devices, over a distance of 7 miles. It can update 1,000 I/O points in 3 msec, 4,096 I/O points in 15 msec.

With one cable to connect all devices, it uses two communication channels within that cable. One channel handles the real-time critical information, the other channel handles data from simple devices with no need for real-time data transfer.

A group of European drive manufacturers, Drivecom, have standardized on this protocol for communications with PLCs and PCs. Two chips are embedded into products. All input and output data are updated simultaneously.

Profibus is a European standard, originally developed for process control. It can handle various communication needs, however. This open network comes in several versions. In its full-featured version, it can work with all types of I/O from discrete devices to drives, robots, and smart instruments. It can pass a range of data formats, from bits to full packets, in peer-to-peer or multi-master configurations.

The full-feature version has a transmission rate of 12 Mbaud over copper wire or fiber-optic cable. It can transmit over distances to 5 miles.

It has been available in the U.S. for several years, but has not achieved the critical mass of users needed to make it a de facto standard. The Profibus Trade Organization initially worked for official standards acceptance. Now, it is taking the specification directly to the marketplace. ■

Information for this article was supplied by Advanced Concepts and Tech-

For more information

To find out more about any of these networks contact:

For **ControlNet**: Allen-Bradley Response Center, Dept. AG/0061, 10701 Hampshire Ave. South, Bloomington, MN 55438, Tel:800-338-4235, Ext. 0061, Fax:800-500-0329, or

For **Interbus-S**: Phoenix Contact InterBus Systems Group, P.O. Box 4100, Harrisburg, PA 17111, Tel:1-800-888-7388, Fax:717-944-1625, or

For **IPCA**: Pitney Bowes Inc., 35 Waterview Drive, Shelton, CT 06484 Tel:203-924-3109 Fax: 203-924-3385, or

For **Macro**: Kollmorgen Motion Technologies Group, 201 Rock Road, Radford, VA 24141, Tel:703-639-2495, Fax:703-731-0847, or

Delta Tau, 9036 Winnetka Ave., Northridge, CA 91324, Tel:818-998-2095, Fax:818-998-7807, or

For **Profibus**: Siemens Profibus Center, P.O. Box 1255, Johnson City, TN 37605-1255, Tel:800-964-4114, Fax:615-461-2838 or

For **Sercos**: Sercos N.A., 25 Tri-State International Center, Suite 100, Lincolnshire, IL 60069, Tel:1-800-5-Sercos, Fax:708-374-8010, or

For **Socapel PAM**: Atlas Copco Controls Inc., 12300 Perry Highway, Wexford, PA, 15090, Tel:412-935-0440, Fax:412-935-9640, or

nology, Pitney Bowes Inc.; Allen-Bradley Co.; Atlas Copco Controls Inc., Automation Intelligence Inc., Pacific Scientific Co.; Delta Tau Inc.; Kollmorgen Corp.; Phoenix Contact Inc.; Predictive Technology Inc.; Sercos N.A.; Western Michigan University.