

**ELECTROHYDRAULICS**

CANopen fieldbus comes to

# Proportional Hydraulics

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Proportional valves with CANopen interface mark a new era of valve design.

**A**lthough fieldbus systems were established some time ago for electrical drives, hydraulics has been slow to follow suit. In particular, industrial proportional valves with fieldbus interfaces have not been widely available. One reason for this delay has been economics. The high dynamics of servo hydraulics demand high-speed fieldbus systems *and* high processing power — it is difficult to achieve both at a reasonable cost. Also, the acceptance of fieldbuses within hydraulic systems has been restricted because of the special nature of the hydraulics market.

The limited space in the electronics housing and the

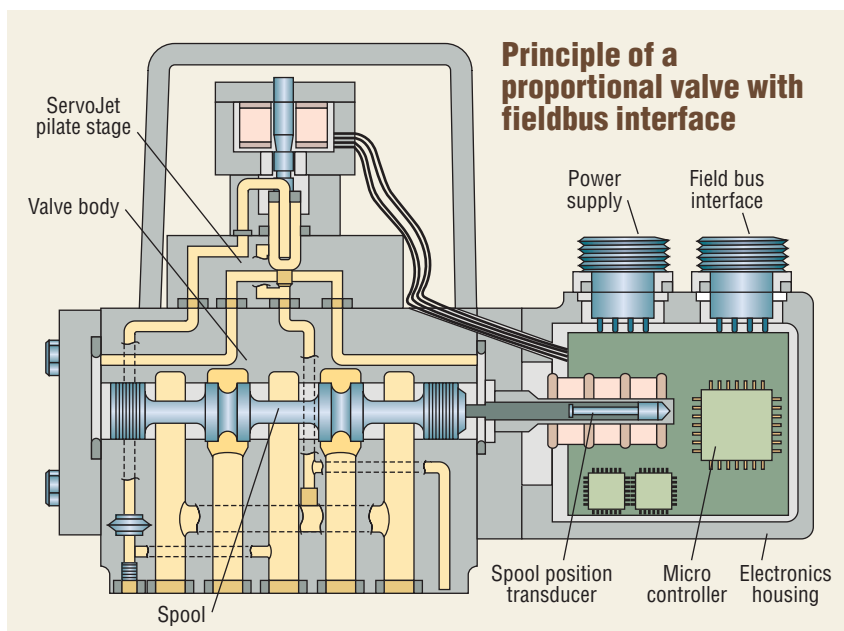
extremely harsh environment to which proportional valves are exposed presents a real challenge to integrating the required electronics. Therefore, the technology inside the valve must change from analog to digital microcontroller-based electronics. This, in itself, represents a considerable challenge.

### Fieldbus for proportional hydraulics

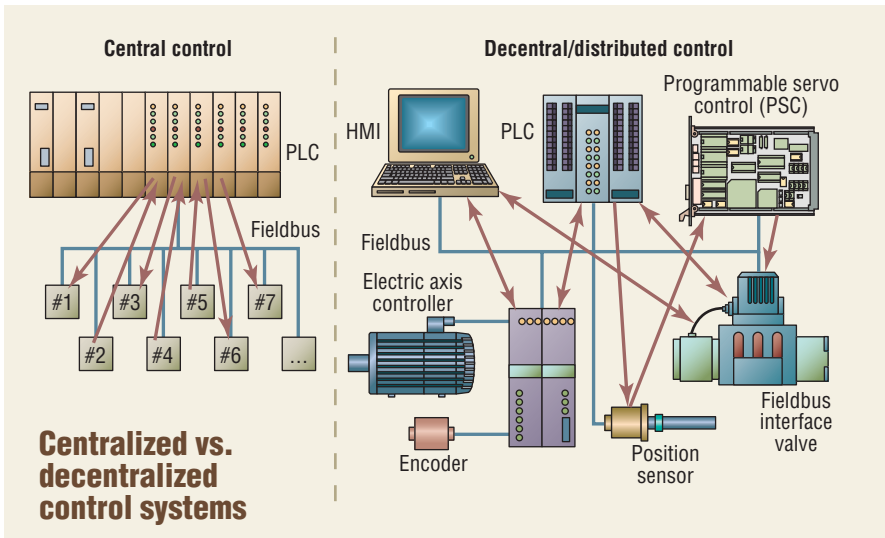
A fieldbus selection usually is based on the requirements and demands of a specific industrial sector, machine, or customer. To incorporate fieldbus technology successfully into hydraulics, it is best to support open, standardized, or internationally accepted fieldbus systems. This ensures that a wide range of compatible components are available that easily can be adapted to hydraulic motion control systems.

In addition to the fieldbus standard — which describes the data exchange mechanisms — a specification of available functions and parameters for each specific device is required. The so-called device profile is a standardized specification of the device functionality and applies to all devices of the same family, such as proportional valves.

**Proportional valve for fieldbus application incorporates a microcontroller and other components to monitor and control the valve digitally.**



**Decentralized control assigns the tasks of a subsystem to local devices, which substantially reduces the complexity and required processing power of the main control device.**



A device profile is required for compatibility and interoperability within a system.

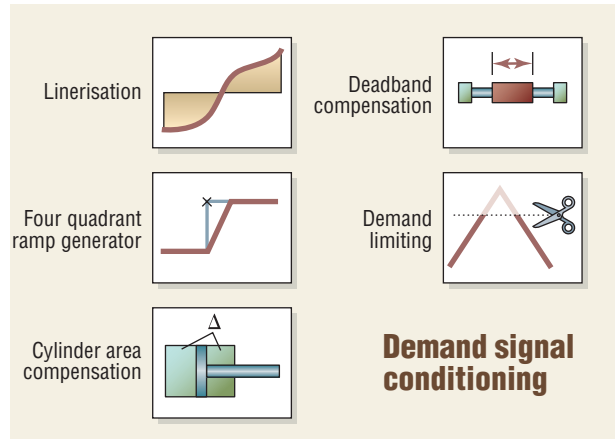
Such a device profile for hydraulic proportional valves does not yet exist. However, a profile is under development by a group of manufacturers. This group meets at the VDMA, the German Machinery and Plant Manufacturer's Association. The objective of this group is to produce guidelines for bus-specific implementations and distribute them to several bus system organizations for approval. This standardization process will be the key to a breakthrough of fieldbus technology in hydraulic systems.

**Valve functionality**

The valve functionality is based on a proposal that currently is under development by VDMA. The resulting proportional valve includes features, that haven't been possible to date.

**The current release includes** demand signal conditioning, ramp generators and tuning capabilities:

- linearization of flow characteristics,
- four-quadrant ramp generator,
- cylinder area compensation of the actuator,



- adjustable deadband compensation,
- demand signal limiting, and
- tuneable loop closure for the spool position.

**Valve status, parameter settings** and process values are completely transparent via the fieldbus:

- The status-word parameter provides overall information about the valve status.
- All parameters and process values are fully accessible via the bus.
- Unauthorized access to sensitive parameters is prevented by password protection.
- The error of the spool position controller is monitored and signalled if it exceeds the limit.

**VDMA's current release includes demand signal conditioning, ramp generators, and tuning capabilities**

**Simplified maintenance is ensured** by efficient diagnostics mechanisms:

- Errors are signalled via emergency messages.
- Occurred errors are listed in a chronological error list.
- The reason for a malfunction is described by an error code.
- The valve can be identified by the manufacturer's name, device type and serial number, which are stored in the device.

The demand value represents the flow rate of the fluid and is transmitted with a resolution of 16 bits. It is also possible to read the actual value, which corresponds to the spool position of the valve.

## Loop closure with CANopen

Reception of the demand value and the transmission of the actual value is handled via the highly efficient process data object (PDO). Loop closure via the bus is possible due to the high transfer rate of the CAN bus (up to 1 Mbit/s). For high performance motion or pressure controls in hydraulic applications, a cycle time in the range between 0.5 to 2 ms is advisable. The illustration at right shows the maximum number of motion control axes in closed-loop control applications, whereby a position sensor with 4-byte input data and the fieldbus interface valve with 2-byte output data are assumed for each axis.

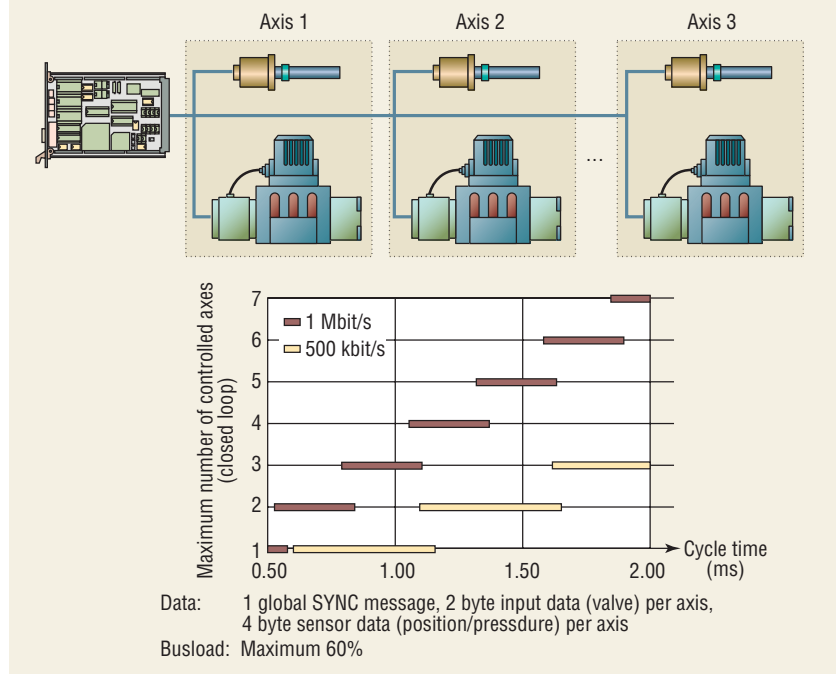
The required cycle time affects the maximum number of devices within a network, which are simultaneously within a loop. However, it should be noted that more devices can be handled by one CAN network, when only a limited number of loops are closed at a time. This applies especially to machines, where a machine cycle is divided up into separated processing phases, so that the loop closure for some devices can be temporarily interrupted.

Potential applications for this proportional valve are small systems, such as production-cells and small or mid-size machines. In lower performance applications, where no loop closure is required, the system is expandable to 64 devices, which is the maximum allowable extension of a CAN-bus system.

## Outlook

In addition to the fieldbus technology, incorporation of digital electronics in the valve provides a platform for future innovations. The built-in microcontroller enables supplementary functions that traditionally have are processed by external control systems. Because the valve is completely encapsulated, the fieldbus is a prerequisite

## Maximum number of axes for closed-loop control



**Maximum control axes in closed-loop applications using a position sensor with 4-byte input data and the fieldbus interface valve with 2-byte output data for each axis.**

to configure and access these built-in functions.

Incorporating functions into the valve electronics has considerable advantages:

- The costs and the wiring for the external electronics could be saved.
- The motion and pressure control tasks would be processed by a highly specialized device, thereby simplifying the planning and the setup of an application.
- The bus load would be significantly reduced by closing the control loop locally. This could be achieved easily by using pres-

sure-control valves with integrated pressure transducers.

As a result, the basic proportional valve will migrate to an 'intelligent' device, which will take over the complete control for one axis. The result would be an *Axis Control Valve* that includes the functionality of up-to-date external electronics. ■

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