Bulletin HY11-3327/UK

Press Report Hydraulic Control Axis

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Hydraulic control axis in industrial hydraulics
A precision machine element that is easy to handle

Equal in status to electromechanics

With everyone talking about electromechanical linear axes, hydraulics is creating less of a commotion - but the message is at least as interesting and innovative. How sophisticated hydraulics has become today is demonstrated by Parker Hannifin, with its highly dynamic control valve DF*plus* and the electrohydraulic controller Compax 3F. While Parker Hannifin, the world's biggest fluid engineering manufacturer, publicly presented its highly dynamic, hydraulic control valve DF*plus* back in 2003, the Compax 3F electrohydraulic controller was added in 2006. This combination makes it easy for design engineers to produce high-speed precision movement axes in a simple way.

For example, a blow-moulding machine manufacturer is fitting out the machines it produces with this type of hydraulic control axes. One of the reasons for doing this is that the precise positioning capability of the hydraulic control axis in the region of the filling pin eliminates the need for several individual movements of different machine elements. This not only reduces the degree of complexity of the structural design but also reduces the costs for additional axes, programming, assembly, initial operation and servicing.

The positioning accuracy achieved in the case described, of about 20 to 30 micrometres, is of particular interest because the process involved made it necessary for technical reasons to employ relatively long oil lines. In principle, however, the accuracy of such a hydraulic control axis is in the range of ten micrometres.

Such precision - and in special applications even greater precision - has already been achieved by hydraulic control axes for many years. The crucial difference with the Parker system however is the ease with which it can be put into practice. Instead of complex servo hydraulics, as were necessary in the past whenever dynamics and precision had to meet demanding requirements, it proves to be a much more affordable alternative.

Dynamics on a par with servo valves

This is all thanks to the DF*plus* control valve. It is based on a principle that has been used for decades for vibrating the diaphragms of loudspeakers. Parker Hannifin has now become the first valve manufacturer to succeed in using this so-called 'voice coil' technique to control the high forces within a hydraulic valve. The result is dynamics on a par with modern servo valves. The difference is that the 'new' actuator principle makes the structure of the valve comparatively simple.

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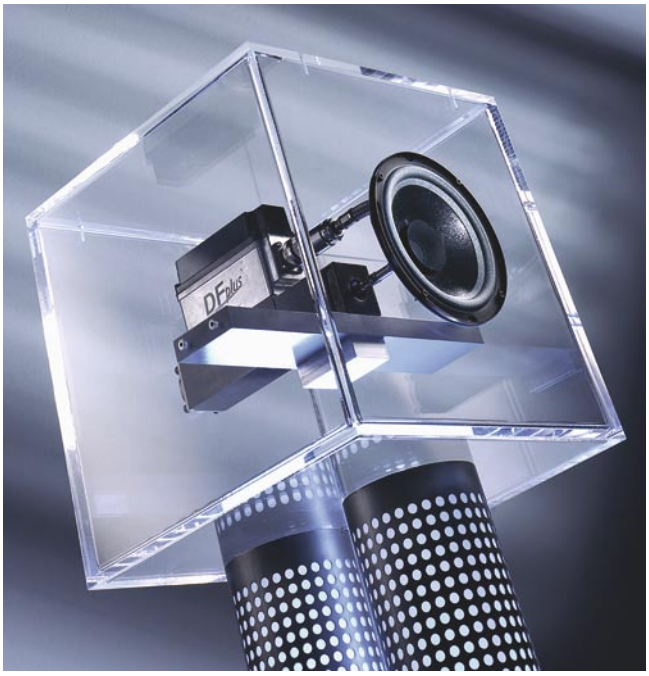
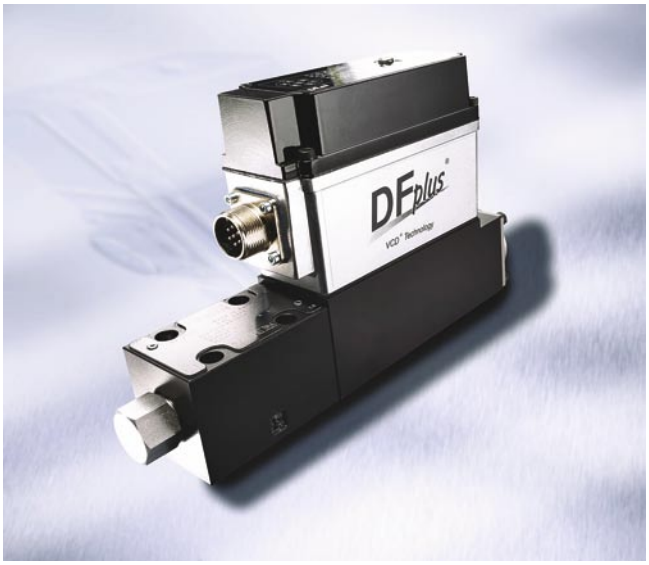


The highly dynamic control valve DFplus produces a frequency of 350 Hz and is even able to "make music" if it is used to move a loudspeaker diaphragm.

The direct coupling of the coil and the valve spool produce a force transmission without any play or friction. The result is an outstanding frequency response; the actual value of the valve spool therefore exactly follows the sinusoidal setpoint input. The step response of such a hydraulic valve is less than 3.5 milliseconds for the



The valve spool actuator, an innovation in the field of hydraulics, provides the DFplus with a response time of 3.5 ms. In this time, the spool covers 90 percent of its deflection.

NG6 model. In this time, the valve spool covers around 90 percent of its actual deflection. For a hydraulic valve that controls pressures of up to 350 bar, that is a world-class performance.
Together with the integrated displacement measuring system and the onboard electronics, this ensures the greatest dynamics and outstanding controllability - the ultimate aim in precision positioning.
The second decisive component in establishing hydraulic control axes in sophisticated applications such as plastics technology, machine tools and testbed construction is the electrohydraulic controller. With the Compax 3F, Parker Hannifin has now added the final piece to complete its range. On the hardware side, the controller electronics are based on the same platform as the long-established Compax 3 for electromechanical drives.

Technology independently designed

For this reason, almost all the programs already written for the Compax 3 can be integrated into the new electrohydraulic controller. This gives design engineers extremely interesting options. They can independently work on technology and always decide on the best solution - because in many cases the hydraulic approach is compelling in its simplicity, compactness and price. This is particularly true in situations where many axes have to be placed within a confined space - a situation frequently encountered in the case of machine tools.

The electrohydraulic controller Compax 3F makes high-precision positioning control possible.

Logically, the Compax 3F can also be used to program defined travel profiles, which contribute to flexible process optimization. All this is possible because Parker Hannifin has made the valve and the controller optimally match each other.
Quite apart from this, the Compax 3F can also be used as a standalone unit. For easy handling, it is programmed to conform to industrial standard IEC 61131-3. This means that it processes different programming languages and allows both text-based and graphics-based commands to be entered. The data exchange can take place via the integrated RS232 interface and by bus line (Profibus, CANopen, DeviceNet, Power Link Industrial Ethernet).
In the practical development of this electrohydraulic controller, the designers at Parker concentrated intensively on ease of use, with the result that control engineers are very quickly able to operate, program and parameterize the devices.
For this purpose, a so-called hydraulic manager was integrated, providing a much easier operating environment.
In the equipment database contained within the controller, all the company's products can be found. The control engineer just has to choose the appropriate ones. Because the typical setting values of the valves, cylinders etc. have already been stored, the high-speed pre-parameterization takes place almost automatically. To optimize a process, the parameters can be systematically adapted for a particular axis or a different automation variant. Because Parker Hannifin has followed an open-source strategy here, products from other manufacturers can, of course, also be integrated in the Compax 3F. Once the devices and typical setting values have been entered, they can be stored in the hydraulic manager and selected again from the menu next time they are needed.

Oscilloscope function simplifies initial operation

Another feature that is very much appreciated in practical applications is the so-called servo manager with integrated oscilloscope function. This four-channel oscilloscope reproduces the movement scenarios of the individual machine elements in synchronous time. This means that the control engineer immediately sees how the hydraulic cylinder responds to the deflection of the spool in the DF*plus*. The same applies, for example, with respect to the deflection of the spool after feedforwarding the setpoint signal and much more. This allows a first functional safety check to be provided both before, and of course also during, the actual initial operation - that is to say without actual movements in the machine.
The sophisticated, high-tech DF*plus* and Compax 3F

graphically show that industrial hydraulics has come of age - and is ready and able to meet the demands of the most varied application areas. What is more, system-based thinking of the kind demonstrated by Parker Hannifin provides users with ready-to-install units that adapt themselves optimally to processes, machines and automation solutions. The electrohydraulic control axis for highly dynamic operations is one example of the key role played by modern hydraulics. True to the 'plug and produce' ideology, this technique proves on a daily basis that it is equal in status to electromechanical drive technology.

The VCD® plunger coil with principle Parker patent

The highly dynamic DF*plus* control valve is based on the Voice Coil Drive (VCD). This kind of spool deflection achieves exceptional dynamic performance because a comparatively lightweight coil former axially moves the valve spool directly - that is, without any diversion or damping. This coil former encloses a magnet that is fixed within the housing. If current flows through the coil, the corresponding relative movement takes place. In addition, the lack of direct friction represents an ideal initial situation in terms of dynamics, wear and controllability.

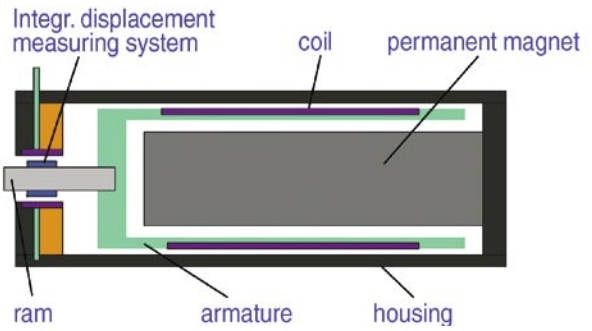
Highly efficient magnets as a key to force development

The Voice Coil Drive is the key component of the DF*plus* control valve. The now technically possible build-up of high field intensities within a hydraulic valve has only been accomplished by the development of new magnets from neodymium-iron-boron (NdFeB). These make it possible to develop forces of around 100 N, which is necessary with the pressure level that is encountered in hydraulics and against the background of highly dynamic step responses of the valve spool.

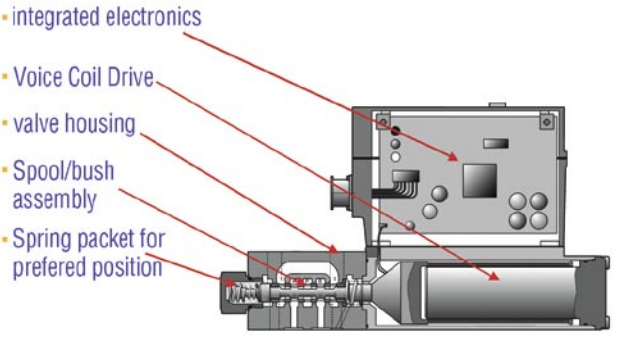
The new VCD principle enables the hydraulic valves to achieve a frequency of around 350 Hz, which is well above that of conventional proportional valves; this even puts some servo valves in the shade, and at the same time is also much less expensive.

Endurance tests with 100 Hz have shown that DF*plus* valves with Voice Coil Drive perform a billion switching operations without any trouble.

Parker Hannifin has been the first to succeed in transferring this kind of movement control, which has been known for decades from loudspeaker technology, to hydraulics with pressures of up to 350 bar. A notable aspect of this new valve drive is that the force development always remains constant, irrespective of the stroke. Such a solution therefore proves to be much easier to control than traditional solenoid actuators.



The directly coupled spool drive has a displacement measuring system at the transition. Together with the onboard electronics, highly dynamic and precise position controllers can be constructed.



The Voice Coil Drive is based on a movable plunger coil, which surrounds the fixed magnet. When current is applied by means of the onboard electronics, this valve drive develops a force of up to 100 N.

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