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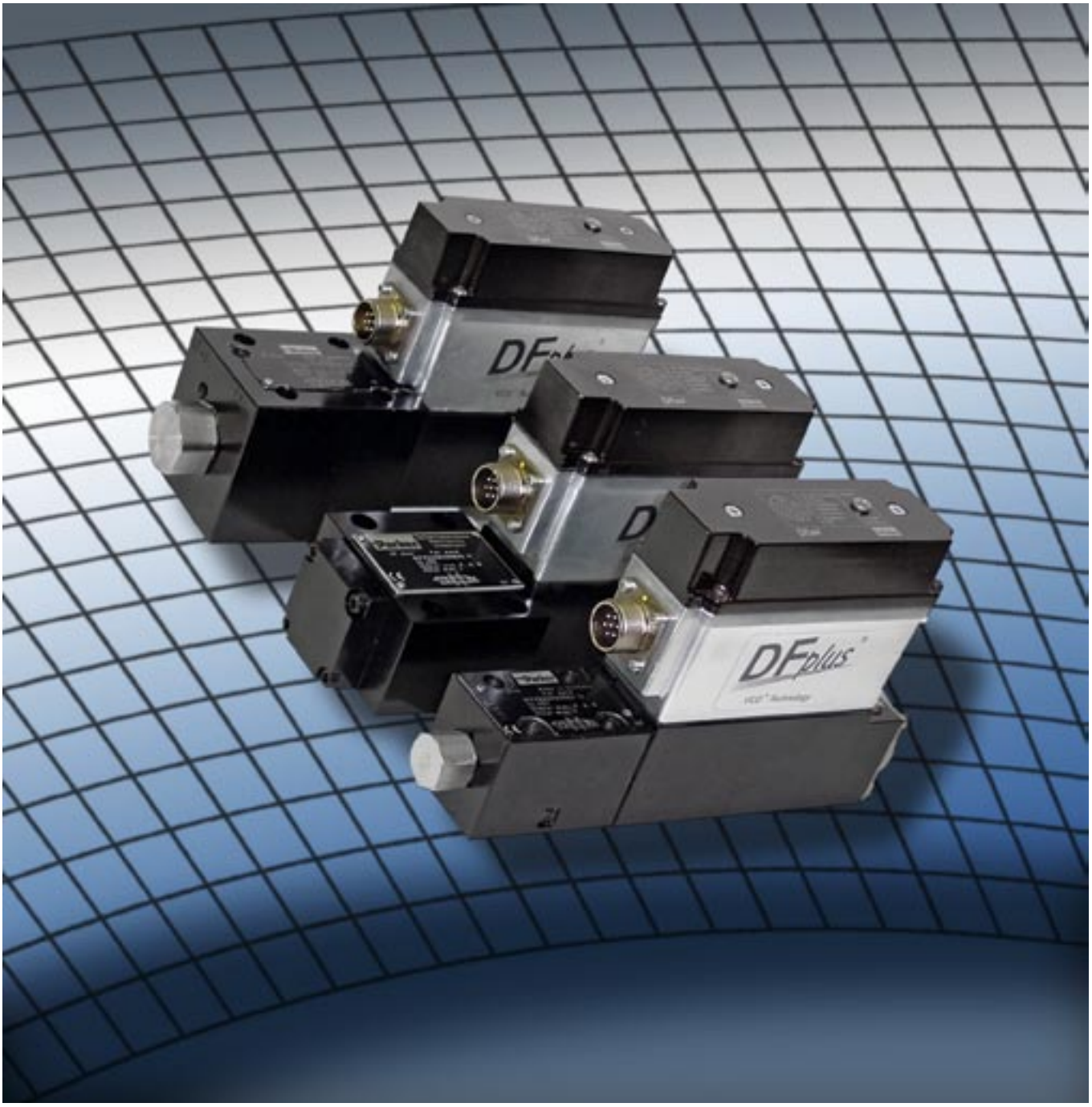
Press Report
DF*plus*®



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Hydraulic systems

Modern control valves optimise the possible applications of hydraulic systems solutions

Modern times

In recent years hydraulic systems have demonstrated themselves to be extremely innovative. They have been able to improve their image and are at the same level as electromechanical solutions. The next step is the development of hydraulic control valves, which will leave servovalves way behind, because they are considerably more cost-effective and have the same properties. The world's largest fluid technology manufacturer has now made a great step forwards on this path.

The 1990s were shaped by trends and the ideology that hydraulics had served its purpose and in the future purely electrical drive solutions would provide the greatest portion of modern machine developments. At the start it did indeed look like a change in technology, mainly in the particularly demanding stationary applications. However hydraulics took on the competition with the passion, for which this sector is known. It eventually turned out that as ever it was not possible to replace hydraulic systems.

Since electronics have been used to make hydraulic valves directly "compatible" with the machine controller, hydraulic control processes now possess the dynamics and accuracy which are demanded in modern machines and systems. A major contributor to this has been Parker Hannifin, the world's largest fluid technology company. As a system supplier they offer all the necessary components to develop optimum concepts and to optimise them for specific applications.

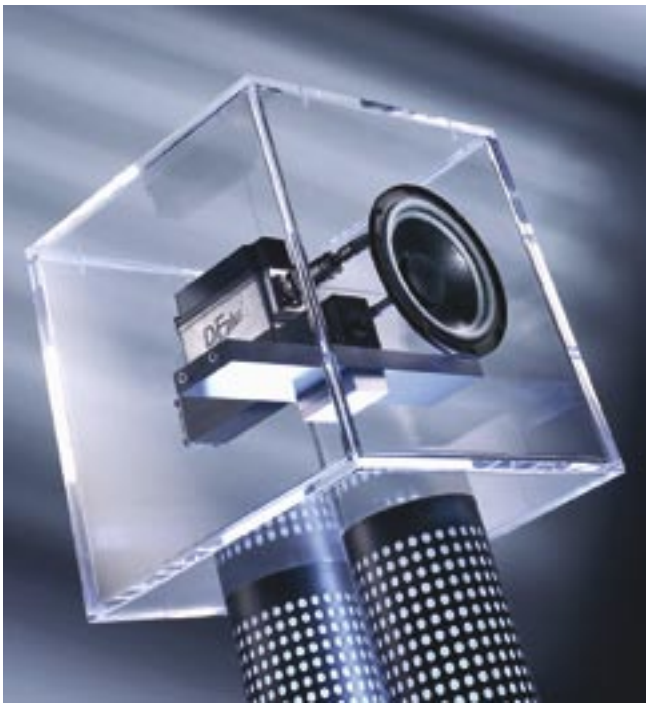
Through the resulting experience plus the meticulous search for innovative solutions, a high-tech control valve has been created which breaks all the previous limits. The route to this promising new development with the designation DFplus followed the maxim: "Make everything a little bit different – but at the same time better." According to the manufacturer's information it is the fastest proportional directional control valve on the market today.

In fact it provides all the advantages of servo and proportional valves – and in spite of this cannot be compared with either. The reason for this is the fact that with lots of development effort, Parker has succeeded in integrating the advantages of the two valve technologies into one component and at the same time has been able to exclude their disadvantages.

A brief background: On the basis of their technical construction, servovalves operate extremely sensitively and are therefore ideal for highly-dynamic, accurate control applications. Their disadvantage is the necessary high fluid purity and their high cost. Proportional valves on the other hand are very robust and comparatively cost-effective. However these cannot be accurately controlled to the extent that is frequently required.

The control valve without compromises

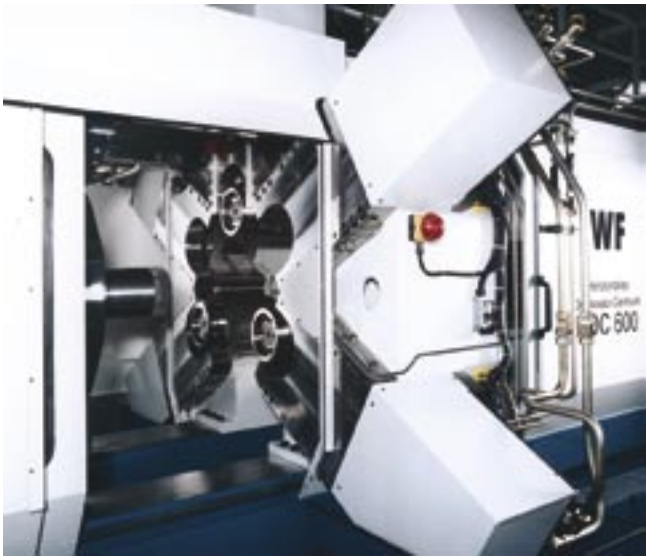
Those who therefore use hydraulic servo or proportional valves in their machines or systems, must first make the decision as to which compromises they will have to accept. The new DFplus on the other hand is so-to-speak compromise-free. Parker engineers have gotten there on a double-fold way. On the one hand, they take the well-proven spool-bush technology. On the other, they achieve the axial adjustment by a solid, permanent-magnet cylinder and a moving coil of corresponding dimensions. The principle is the same as with loudspeakers.



Audible dynamics in the kHz range:
Fully-functioning DFplus loudspeaker model. The valve spool in the control valve is operated by a system consisting of a magnetic cylinder and coil, which operates like a music speaker.

According to the current direction the magnetic cylinder moves the coil to the left or right and thereby the rigidly-connected valve spool in the bush. The bearer on which the coil is wound consists of a high-strength plastic which can even withstand extreme mechanical loads. The moving valve spool-coil system is only supported in the valve bush. Supplementary bearings are unnecessary with this solution which appreciably reduces the total internal friction losses.

Control valves display their dominance especially in highly dynamic control processes such as found for example in plastic injection moulding or blow moulding machines. The step response is less than 3.5 milliseconds in the NG 6 size. That is the time in which the valve spool has achieved 90 percent of the actual set point



On the NG 6 valve the step response is about 3.5 milliseconds, which is really phenomenal for an hydraulic slide valve.

which has been preset via the set value. By comparison; the fastest miniature pneumatic valves react within one millisecond, but can only apply a fraction of the force which these hydraulic control valves supply. Another comparison: In the case of controllers we speak of "real time" within this order of magnitude of time. What hydraulics can offer here satisfies the highest technical demands.

This can be seen in several places. Because there is no need for the powerful centering or feedback springs, which are normally found in proportional valves, the available force, which can be transmitted to the valve spool via the coil, is automatically increased. The most important factor for a highly dynamic valve is a high useful force.

The dynamic of the control valve is so high that it can be used for example in the fast processes in try-out presses.

By comparison: Typical proportional solenoid valves provide useful forces of 70 N or 35 N in the case of dual stroke magnets. The DFplus on the other hand achieves 100 N. In the hydraulic valve with the patented VCD drive (Voice Coil Drive) there is merely one weak spring package at the opposite end from the spool, which ensures that in the event of power failure the valve travels to a defined preferred position.

The direct coupling of coil and valve spool leads to force transmission which is both free of play and requires no damping. As a consequence of the extremely low friction losses in the drive a tremendous frequency response is obtained. This means that the actual value of the valve spool accurately follows the sinusoidal input signal (set value) in its deflection. Even with increasing frequency the two amplitudes stay the same. This is most important to be able to control highly-dynamic processes without additional compensation.

A second important aspect of frequency response is the phase-frequency characteristic. This shows to what extend the set points and actual values are similar when looked at in the time domain. With normal proportional valves it is normally the case that with increasing frequency a perceptible lag is displayed. However, the lower this offset remains the better is the achievable control quality – as in the case of the DFplus.

In the case of moving platforms, e.g. those in flight simulators or comparable rides which can be found in theme parks, the high congruence of set and actual values causes extremely dynamic behaviour. In such and similar applications it can be anticipated that expensive servovalves can be dispensed with in favour of highly-dynamic control valves. This can naturally also be expressed in numbers: The DFplus achieves a frequency characteristic in the small signal range of 350 Hz with -3dB amplitude gain and -90° critical frequency. Highly-dynamic servovalves are around 420 Hz/-3dB (250 Hz/-90°), proportional valves or control valves from other manufacturers are in the range of a maximum 180 Hz/-3dB (212 Hz/-90°).

Apart from the purely technical aspects of using such a dynamic proportional valve instead of a servovalve, there are a whole series of economic aspects. Each servovalve for example requires control oil. If this is fed externally high costs arise for the additional pipework, filtering etc. At the same time this means that the number of possible error sources grows. If many servovalves are present in a machine or system then it is absolutely necessary for machine and system builders to dimension oil coolers somewhat larger – this does not have a considerable effect on the overall costs. On top of this is the necessary fine-filtering to protect the pilot control.

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The speciality of the valves is that they provide extremely good frequency response and phase-frequency characteristic up to frequencies of 350 Hz via the patented VCD principle (Voice Coil Drive).

As an alternative to this there are servovalves which have an internal control oil supply. Here it is true that the additional pipework becomes unnecessary, however the required higher cooling capacity remains as does the fine-filtering. In this case the whole volumetric oil flow must pass through the fine filter – via full-flow filtering plus any necessary partial flow filtration, all of which can have an emphatic financial effect, which affects not only the machine and system manufacturers but also the end users.

The fact that there are alternative solutions has been adequately documented. The replacement of servo or proportional valves in existing machines is additionally supported by the fact that the control electronics on the valve can process all common input signals. Moreover the flange dimensions meet the standard NG6 (CETOP 3) or NG10 (CETOP 5) as well as the size 04 conforming with ISO 10372, which is very widespread in the case of servovalves.

Fundamentally, with the new DFplus which was first introduced at the Hanover Trade Fair 2003, machine and system manufacturers are able to achieve the most efficient movements without lots of design effort. An example: Because of its powerful moving coil drive, the NG6 valve permits a maximum pressure drop of 350 bar. There then flows through the valve up to 90 litres/min of hydraulic fluid. In particular applications it is thus possible to even replace an NG 10 control valve, which saves the user additional costs. The amount of spool stroke is thereby 1.2 millimetres in each direction.

The positioning accuracy is 0.5 micrometers

DFplus control valves possess an integrated displacement measurement system, which unlike other solutions is not located in a pressure-tight pipe, but is mounted in the oil chamber instead. On the design side this offers the advantage that the gap between the position transducer

The hydraulic control valve is available in nominal sizes of 6, 10 and the size 04 (ISO10372), as is widely used for servovalves. NG 16-32 are currently in preparation.
The NG 10 has step response times of 6 milliseconds. With a 70 bar pressure drop a volumetric flow of 100 litres per minute takes place.

cores and the induction coils remains extremely small and hence a positioning accuracy of 0.5 micrometers is achieved at the valve spool.

For power transmission between the active coil shell or the passive displacement measurement system and the integrated control electronics, Parker Hannifin has developed a completely new solution which has been patented. The company will not divulge any more on this part of the valve.

When looking at all the details, which characterise this hydraulic control valve – the DFplus, one feeling is clearly perceptible: A new hydraulic era has dawned for machine and system builders. These particularly striking control valves prove that hydraulic systems have for a long time now opened themselves up for electromechanical drive technology without having to pay dearly for this advantage – neither through technical control acrobatics nor through additional costs. Their areas of application stretch from axis drives on punching machines as far as testing and simulating applications. For this there are the nominal sizes 6 and 10. Sizes NG 16-32 are currently in preparation. The time is ripe for “normal“ control valves which are convincing because of their exceptional servo-qualities.

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