3-Way, 2-Position Spool-Type Solenoid Valves

Multi-Functional Flow Control for Fixed Displacement Pumps

Parker

ENGINEERING YOUR SUCCESS.

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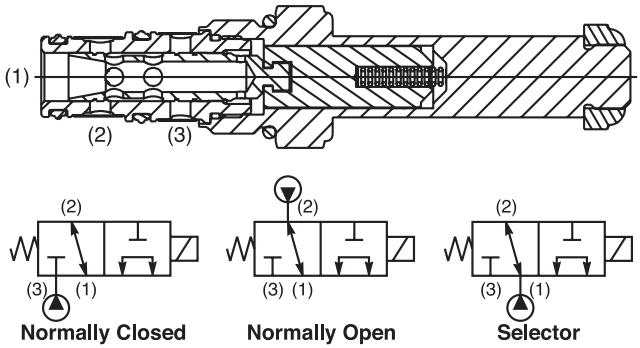
Fixed displacement pumps are a cost-effective solution for a variety of construction vehicles, from mini excavators, backhoes and dump trucks to larger hand-held snow blowers, skid-steer loaders and street sweepers. But since the amount of pressurized fluid delivered is driven by a constant speed motor, such pumps can only provide a consistent amount of flow, thereby limiting their functionality to less dynamic applications. Further, they do not allow for a no-flow scenario; when the machine and its motor are running, flow occurs whether or not it is actually needed to perform a specific hydraulic function.

For engineers designing simple hydraulic circuits, adding one or more 3-way, 2-position spool-type solenoid valves to fixed displacement pump hydraulic systems can extend their capabilities for a nominal investment. This article will explain how such valves work while exploring some of the multi-functional applications made possible by these cleverly designed yet highly cost-effective valve solutions.

How 3-Way, 2-Position Spool-Type Solenoid Valves Work



Three-way, 2-position valves typically feature a three-ported design allowing flow paths in several different configurations, while only connecting two ports in any single position. The valve consists of a series of tapered cylinders with diameters that get smaller from top to bottom. It fits snuggly into a machined cavity port. A seal separates the two possible pathways, i.e., a supply port where pressure exists only when the valve is actuated and a tank port that acts as the hydraulic fluid reservoir.

When work is being performed, a spool-type valve's cylinder-inside-a-cylinder configuration slides back and forth, enabling the pressurized hydraulic fluid to flow to one or the other of the ports, depending upon the function required.

Essentially, these valves allow design engineers to switch (divert) between two functions or to simply dump flow where it is not needed, thereby significantly increasing the types of work fixed displacement pumps can perform. Actuation can be achieved using solenoid coils, manual means, electronics or piloted using hydraulic oil. There are even complex systems that combine two or more actuation methods to optimize performance.

Three-way, 2-position valves are further differentiated by their position at rest. The "normally open" design allows flow to travel from the pressure port when at rest; the "normally closed" design does not.

Typical Applications

Smaller-scale construction equipment using fixed displacement pumps can perform multi-directional functionality when used with 3-way, 2-position valves. These valves overcome the inherent limitations of constant flow by changing the flow path, for example, from up and down movement to lateral or tilt movement, as required by the specific application. Such solutions are more economical and more compact than the typical alternative of doubling the size of the valve and pump to achieve greater flow.

In applications where the circuit designer wants to divert flow from one leg of a circuit to another, several 3-way, 2-position valves can be a cost-effective solution, emulating a traditional directional spool valve in a customizable manifold setup. If dumping is required and the system demands more than a single additional function, these valves can similarly be used in tandem to meet specific functional and real estate requirements.

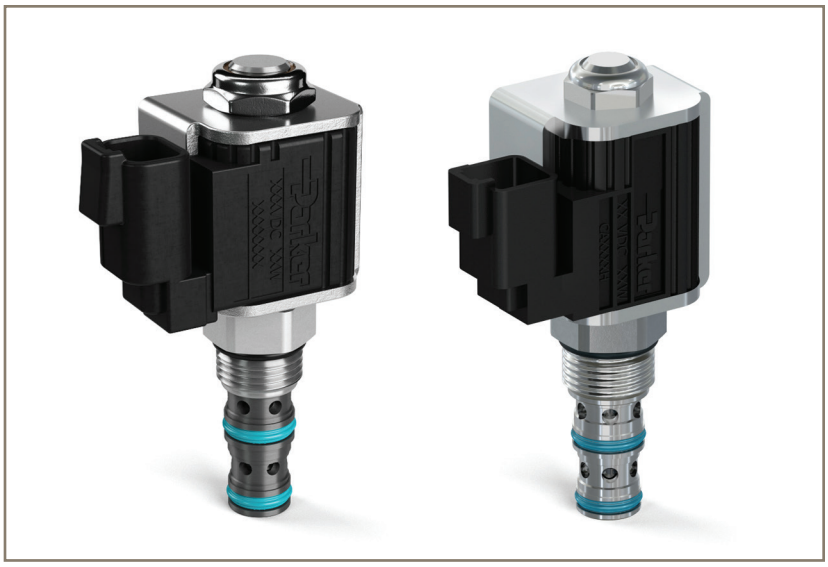
Three-way, 2-position valves are also useful for applications where flow is not constantly required. Unlike variable flow pumps, fixed displacement pumps are not able to turn flow off except by stopping the motor and therefore all equipment activity. A construction equipment design team can use these valves to dump the oil back to the pump, constantly circulating the hydraulic fluid until it is again needed to perform a function. No more deadheading and blowing out a pump because the uncompressible fluid has no place to go and exerts continual pressure on the system. Just flip a switch and the circulating fluid does its job; switch it back, and the fluid recirculates through the system until it is again needed.

Spool-type solenoid valves work well in applications where the fluid is placed in and out of a holding pattern as functions cease and then resume. However, for applications such as bucket lifts where loads need to be sustained in position for a longer time, poppet-style solenoid valves[1] are recommended.

1 Poppet-style valves are a topic for separate discussion but essentially, they are designed with a spherical or conical, rather than a cylindrical shape, and are therefore capable of achieving a tighter seal. Such valves are the preferred solution for load-holding applications.

Differentiating 3-Way, 2-Position Valves

All 3-way, 2-position spool-type solenoid valves are not created equal. Here are some of the factors to be considered when comparing manufactured valves.



- **Flow and pressure requirements** vary greatly by application, but from a design perspective, the higher the GPM and the PSI, the more versatile the valve.

- From an operational perspective, it is essential that pressure closely follows actuation. Similarly, when the valve closes the response needs to be immediate. Valves that demonstrate **low hysteresis** provide predictable performance regardless of the direction of actuation. This characteristic facilitates the programming of functions while ensuring the end user is able to operate the equipment more intuitively.

- Valves that integrate easily with a full range of hydraulic system components provide design engineers with the flexibility of modular build-outs, allowing designers to customize a manifold block in as compact a design as possible. **Modular designs** economize on space and labor requirements, providing designers with greater flexibility as functional requirements evolve.

- **Ergonomic** valve configurations optimize equipment controllability. Quick actuation and precise alignment enable intuitive operator use. Ergonomically designed hydraulic circuits give OEMs a competitive edge by enabling intuitive operation that improves safety and efficiency and lowers energy usage and operational costs for equipment users.

- **Maintenance and replacement requirements** are another consideration. The coil on top of these valves is continually pushing or pulling so coil replacement needs to be easy. The wires and connectors can also wear due to corrosion or from being over-energized with current. Ideally, the valve should be removable from the manifold with minimal effort and without removing the entire block assembly.

- **Temperature resistance** is a critical performance factor for the valve's seal. Nitrile seals with a 250° F temperature threshold are the industry standard. Cold temperature resistance should also be considered.

Additional Valve Selection Considerations

By partnering with the world leader in fully integrated hydraulic systems, OEM design engineers benefit from envelope-expanding performance thresholds and a depth of real-world experience with a vast range of hydraulic applications.

- **Ease of Maintenance** - The modularity of Parker hydraulic system designs makes component replacement fast and easy. When the coil requires replacement in a Parker 3-way, 2-position spool-type solenoid valve, all that is required is to remove a single coil nut. Then, without removing the valve from the manifold, the new coil can be dropped into place before retightening the cartridge valve.

- **Superior Seal Performance** - As part of the Parker Winner's Circle series of hydraulic components, these valves feature seals made from a proprietary compound that can sustain both higher and lower temperature thresholds than the nitrile seal compounds used by most valve manufacturers. Fluorocarbon seals with high-temperature thresholds of 400°F are also available for equipment used in extreme environments.

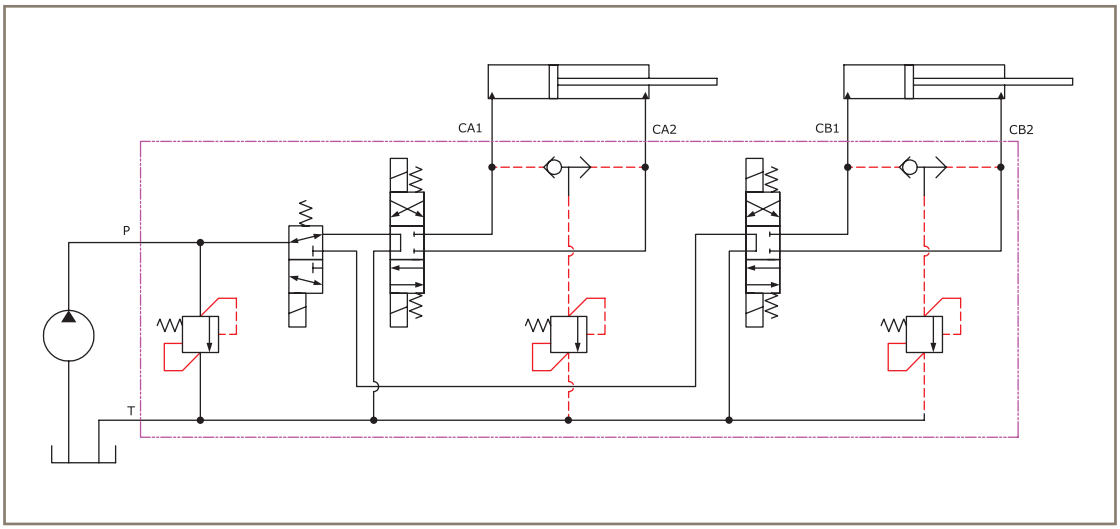
- **Nominal Pressure Drop During Flow** - Although some pressure loss during flow is inevitable with any 3-way, 2-position valve configuration, pressure drop with the Parker design is considerably lower in comparison with other manufactured valves due to a less restrictive flow path.

- **Exceptional Actuation Response** - Responsiveness at actuation is also superior, with a response time of only 50 milliseconds.

- **Convenient On-Line Procurement** - The Parker 3-way, 2-position spool-type solenoid valves are readily available for on-line purchase in sizes -8 and -10. Additional sizes are also available through the Parker worldwide distribution network.

- **Manual Override** - Two manual override functions help to ensure worker safety.

Perhaps most importantly, the Parker global footprint ensures predictable availability and serviceability, including **design support** to optimize efficiency and **field-based troubleshooting** on every continent.



About Parker

As the leading global provider of fully integrated hydraulic systems and advanced hydromechanical and electromechanical subsystems and components, the Parker Hydraulic Systems Division is ideally positioned to provide the engineering expertise, precision manufacturing and reliable distribution network needed by construction equipment OEMs and their customers to meet the challenges of an increasingly competitive global market.

About the Author

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