Shuttle Cartridges

Sun shuttle cartridges offer solutions for a multitude of circuit conditions where shuttle valves are required. They are available in single ball (free floating), back-to-back, plus 2-position and 3-position spool type shuttle configurations. The single ball type shuttle valves are available in Series 0 and Series 1 (plus an insert style), while the back-to-back style is available in Series 1 only. The spool type shuttle valves are available in four frame sizes, from Series 1 through Series 4.

Applications

Ball Type Shuttle Valves

Sun single ball and back-to-back shuttle valves are each available in two 2-port and two 3-port versions, in order to allow flexibility in manifold design. There are 2-port versions that offer a third external port in the hex body, which offers an easy connection to external devices, thus saving manifold size and machining. They have nominal flow capacities of 1.25 gpm (4,7 L/min) and 2.5 gpm (10 L/min) for Series 0, and Series 1, respectively. All versions are rated at 5000 psi (350 bar) on all ports, with a maximum leakage of 5 drops/min (0,3 cc/min).

- Single ball shuttles can be used in multiple circuit sensing, connecting the highest input signal to the output port. When the input signal(s) decay, they allow pressure bleed-down of the output signal.
- Back-to-back, dual check valve versions are also used where sensing is needed from multiple input sources. They ensure that no intermittent high pressure signals can be fed back to other elements of the circuit.
  - ◊ Be aware that back-to-back shuttle valves do NOT allow the output signal to bleed down when the input signal(s) decays. A bleed orifice, with a resulting parasitic fluid loss, would have to be added in the circuit to facilitate output signal bleed down. Using single ball shuttles in a cascade circuit will solve the bleed down problem, however additional shuttles are required as compared to a back-to-back shuttle circuit. (See Figure 1.)

    Note: *Sun offers five standard manifolds which contain from two to six cavities, arranged as cascade shuttle circuits. For example, some of the more common line mount body model codes, with –6 SAE ports, include* ***XVW*** *(2-cavity),* ***XVS*** *(3-cavity),* ***VVK*** *(4-cavity),* ***VVN*** *(5-cavity), and* ***VVR*** *(6-cavity).*

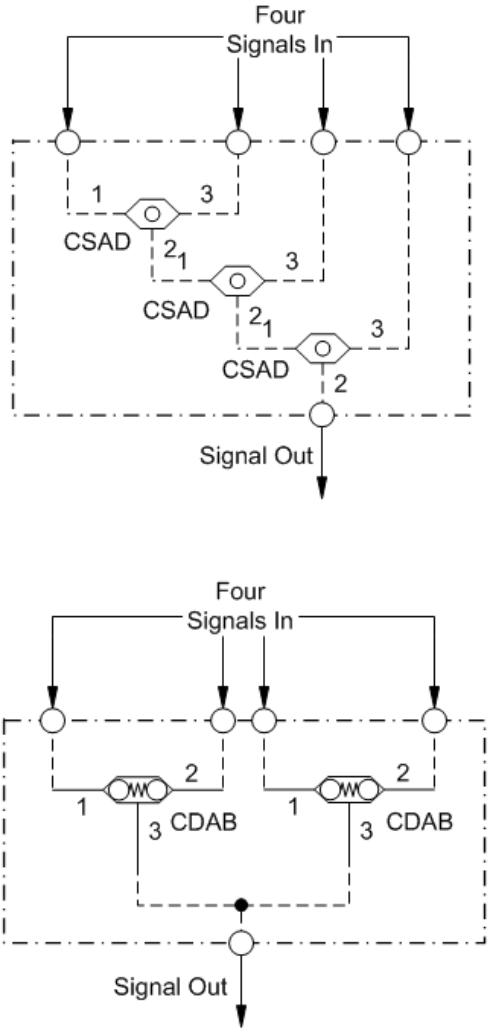


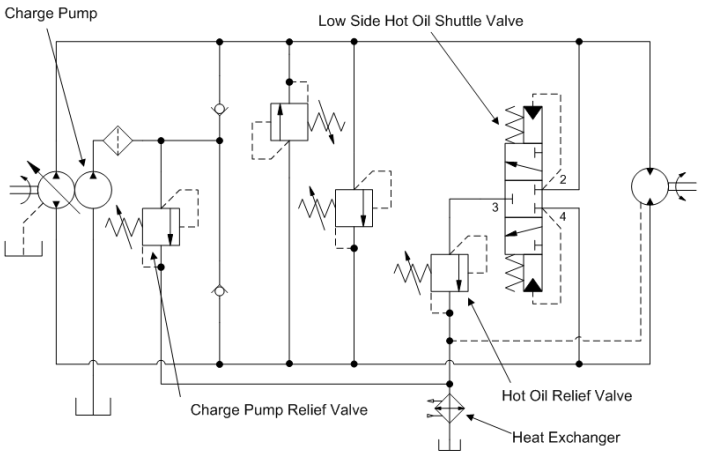
Figure 1.
Single Ball Shuttles vs. Back-to-Back Shuttles
This example has four input signals. Using three single ball (CSAD) shuttles will guarantee that the output signal will decay along with the input signals. With the back-to-back (CDAB) shuttles, only two are required, but the output signal can be trapped when the input signals decay.

Spool Type Shuttle Valves

All Sun spool type shuttle valves are 4-port cartridges, although, in all cases, port 1 is not used. They are offered in four frame sizes (Series 1 through Series 4), and have nominal flow capacities from 10 to 120 gpm (40 to 480 L/min), depending on model. All versions are rated at 5000 (350 bar) on all ports and are offered in three basic configurations.

- Low side, 3-position
- High side, 3-position
- High side, 2-position, spring offset

Low side, 3-position shuttles are most often called “hot oil valves” and are used for loop flushing in hydrostatic, closed loop, hydraulic transmission circuits. With the charge pump relief valve set at 100-150 psi (7-10 bar) above the relief at the outlet of the shuttle, the valve will constantly bleed charge pump volume out of the loop for cooling and filtering. With equal pressures at ports 2 and 4, the valve remains in the neutral position with all ports blocked. When either port 2 or port 4 sees a higher pressure, the opposite work port (the low side of the loop) is connected to the common port 3, thus allowing hot oil to exit the loop. (See Figure 2.)

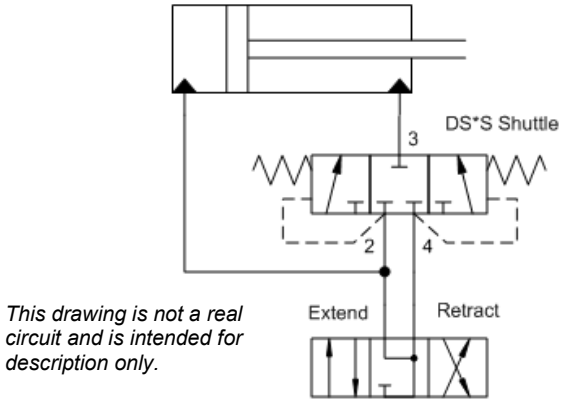


This drawing is not a real circuit and is intended for description only.

Figure 2.
Typical Closed Loop Hydrostatic Transmission Circuit

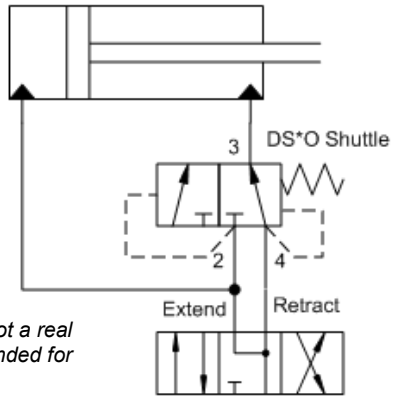
High side, 3-position shuttles are typically used in full-time regeneration circuits. These spring centered versions will block all ports in neutral, when pressure on ports 2 and 4 are equal, thus preventing a cylinder from extending. When port 2 or port 4 sees a higher pressure, it will be connected to the common port 3. (See Figure 3.)

High side, 2-position shuttles are also typically used in full-time regeneration circuits. However, in the spring offset position, when pressure on port 2 is lower than the spring value or the port 4 pressure, port 4 will be connected to port 3. When the pressure on port 2 is higher than the spring value or port 4 pressure, port 2 will be connected to port 3. This configuration can be used to allow the cylinder to float in the neutral position. Also, by not blocking the rod end, the likelihood of rod-end pressure intensification is minimized. (See Figure 4.)



This drawing is not a real circuit and is intended for description only.

Figure 3.
Full Time Regeneration with Rod End Blocked in Neutral



This drawing is not a real circuit and is intended for description only.

Figure 4.
Full Time Regeneration with Cylinder Float in Neutral

Design Concepts and Features

*Two Port Single Ball Shuttle Cartridges — CSA**

Two port single ball shuttles, CSAA (Series 1) and CSAW (Series 0), have an external port for the output signal. The CSAC and CSAY versions have the output signal at port 2 and an external port for one of the input signals.

*Two Port Single Ball, Insert Style, Shuttle Cartridges — CS*N*

Two port single ball, insert style shuttles, CS*N, are meant to be “buried” in a manifold or actuator. The CSAN version is rated at 1.25 gpm (4,7 L/min), while the CSZN version is rated at 1 gpm (4 L/min). The output signal for both valves is at port 2. The detailed T-162DP or T-382A cavity information should be studied closely when applying these valves.

Two Port Back-to-Back Shuttle Cartridges — CDAA and CDAC

The two port back-to-back shuttle, CDAA, has an external port for the output signal. The CDAC version has the output signal at port 2 and an external port for one of the input signals.

*Three Port Single Ball Shuttle Cartridges — CSA**

Three port single ball shuttles, CSAB (Series 1) and CSAX (Series 0), have the output signal at port 3, while the CSAD and CSAZ versions have the output signal at port 2.

Three Port Back-to-Back Shuttle Cartridges — CDAB and CDAD

The three port back-to-back shuttle, CDAB, has the output signal at port 3, while the CDAD version has the output signal at port 2.

*Four Port Low Side, 3-Position, Hot Oil Shuttle Cartridges —DS*H*

Performance parameters include:

- The spool incorporates a hydraulic stop that eliminates mechanical impact upon shifting and, therefore, the potential for internal damage.
- The hydraulic stop design feature results in a small pilot flow (23 in^3/min [0,38 L/min]) from the work ports (port 2 or 4) to the common port (port 3). This feature allows the hot oil relief valve pressure to be set, or confirmed, with the transmission in neutral.
- Four shifting pressures are available 50, 75, 100, and 150 psi (3,5, 5, 7, and 10,5 bar). *(**Be aware:** Low shift pressures can result in charge pump pressure alone, causing inadvertent valve shifting. **Use care when selecting shift pressure!**)*.

*Four Port Low Side, 3-Position, Delayed Shift, Hot Oil Shuttle Cartridges—DS*D*

Sun's unique low side, delayed shift hot oil shuttle cartridges, DS*D, were designed to address some common hydrostatic transmission problems.

- With a sudden drop in load, a standard hot oil shuttle will quickly shift from one side of the loop to the other, following the highest loopside pressure. In some dynamic applications, such as drill or auger drive circuits, high pressure and flow transients can be seen outside the hydrostatic loop causing damage to components down stream of the shuttle valve (i.e. the heat exchanger, filter, and the motor case).
- Sudden loop flow losses can cause cavitation damage to the pump or motor when instantaneous losses are larger than charge pump flow.

With the delayed shift feature, the shuttle valve centers quickly when work port pressures reverse, but it remains centered as long as the two work ports are at a value equal to or greater than 300 psi (20 bar) plus the hot oil relief setting (e.g. with a 200 psi [14 bar] hot oil relief setting, the shuttle valve will not shift off center until one side of the loop drops below 500 psi [34 bar]). Only after the low side of the loop has truly been established will the valve start a controlled shift, which results in an approximate additional 2 second delay. Performance parameters include:

- The same hydraulic spool stop, with resulting pilot flow, as found in the DS*H shuttles.
- The hot oil relief valve pressure can also be set, or confirmed, with the transmission in neutral.
- Only one shift pressure (75 psi [5 bar]) is offered with the delayed shift design.
- Currently, the delayed shift shuttle is offered in only two frame sizes; Series 2 and 3.

*Four Port High Side, 3-Position Shuttle Cartridges — DS*S*

Performance parameters include:

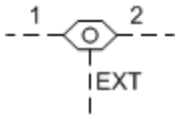
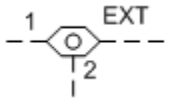
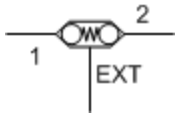
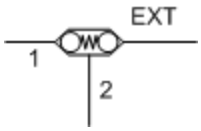
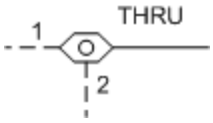
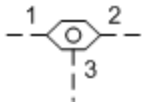
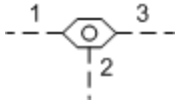
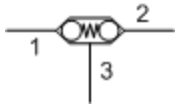
- Four shifting pressures are available: 30, 75, 100, and 150 psi (2, 5, 7, and 10,5 bar).
- Maximum leakage is 3 in^3/min @ 1000 psi (50 cc/min @ 70 bar).
- Provides overrunning load control in regeneration applications.
- This valve will not prevent cylinder drift due to spool leakage.

*Four Port High Side, 2-Position, Shuttle Cartridges — DS*O*

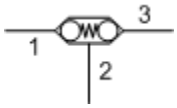
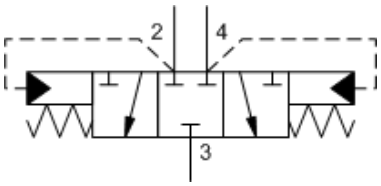
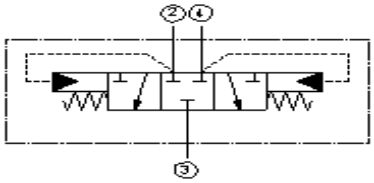
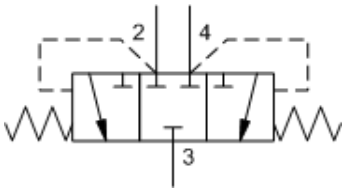
Performance parameters include:

- Two shifting pressures are available: 30 and 75 psi (2 and 5 bar).
- Maximum leakage is 3 in^3/min @ 1000 psi (50 cc/min @ 70 bar).

Shuttle Cartridge Valves Overview

Function	Description	Nominal Capacity	Model	Cavity	Symbol
2 Port	Single Ball, Signal External	2.5 gpm (10 L/min.) 1.25 gpm (4,7 L/min.)	CSAA CSAW	T-13A T-162A	
2 Port	Single Ball, Signal at Port 2	2.5 gpm (10 L/min.) 1.25 gpm (4,7 L/min.)	CSAC CSAY	T-13A T-162A	
2 Port	Back-to-Back Check, Signal External	2.5 gpm (10 L/min.)	CDAA	T-13A	
2 Port	Back-to-Back Check, Signal at Port 2	2.5 gpm (10 L/min.)	CDAC	T-13A	
2 Port	Single Ball, Insert Style, Signal at Port 2	1.25 gpm (4,7 L/min.) 1.0 gpm (4 L/min)	CSAN CSZN	T-162DP T-382A	
3 Port	Single Ball, Signal at Port 3	2.5 gpm (10 L/min.) 1.25 gpm (4,7 L/min.)	CSAB CSAX	T-11A T-163A	
3 Port	Single Ball, Signal at Port 2	2.5 gpm (10 L/min.) 1.25 gpm (4,7 L/min.)	CSAD CSAZ	T-11A T-163A	
3 Port	Back-to-Back Check, Signal at Port 3	2.5 gpm (10 L/min.)	CDAB	T-11A	

Shuttle Cartridge Valves Overview (continued)

Function	Description	Nominal Capacity	Model	Cavity	Symbol
3 Port	Back-to-Back Check, Signal at Port 2	2.5 gpm (10 L/min.)	CDAD	T-11A	
4 Port	Low Side (Hot Oil), 3 Position	10 gpm (40 L/min.) 20 gpm (80 L/min.) 40 gpm (160 L/min.) 80 gpm (320 L/min.)	DSCH DSEH DSGH DSIH	T-31A T-32A T-33A T-34A	
4 Port	Low Side (Hot Oil), Delay Shift, 3 Position	20 gpm (80 L/min.) 40 gpm (160 L/min.)	DSDD DSFD	T-32A T-33A	
4 Port	High Side, 3 Position	15 gpm (60 L/min.) 30 gpm (120 L/min.) 60 gpm (240 L/min.) 120gpm (480 L/min.)	DSCS DSES DSGS DSIS	T-31A T-32A T-33A T-34A	
4 Port	High Side, Spring Offset	15 gpm (60 L/min.) 30 gpm (120 L/min.) 60 gpm (240 L/min.) 120gpm (480 L/min.)	DSCO DSEO DSGO DSIO	T-31A T-32A T-33A T-34A