

# Sequence Valves



## APPLICATIONS

### Sequence Cartridges

Sun sequence cartridges are normally closed pressure control elements designed to modulate flow from port 1 (inlet) to port 2 (outlet) (like a relief valve) as long as the pressure at port 1 exceeds the pressure setting plus the back pressure at port 3 (the control chamber drain). Unlike relief valves, sequence valves generate a constant pressure at the inlet port irrespective of the pressure on the outlet port. When pressures at port 1 and port 2 both exceed the setting of the valve, the valve goes “full open”, or “sequences”. This function is achieved by draining the spring chamber separately to tank. Sequence valves can be used to sense pressure (port 1) in one circuit and then open and supply oil to a secondary circuit (port 2) at a predetermined pressure.

- A typical application would be when maintained clamping pressure is required in the primary circuit while work is being performed in the secondary circuit.
- A sequence valve can be used as an accurate pressure limiting valve where there is varying back pressure on the tank port.

- Another application would be to maintain a minimum “pilot pressure” in an open flow circuit. (Unlike a relief valve, the “full open” feature of a sequence valve, above its setting, tends to eliminate parasitic losses in the system at working pressures. (See Figure 1 on page 2.)
- A sequence valve can also function as an adjustable bypass pressure compensator. (See Figure 2 on page 2.)

Sun Hydraulics’ sequence valves have flow capacities up to 120 gpm (460 L/min) and are fully adjustable over a range of operating pressures up to 5000 psi (350 bar) (6000 psi [420 bar] intermittent). (Air piloted versions have lower pressure ranges.) Prior to shipping, **all** Sun sequence valves are factory pressure set with a flow of 4 gpm (16 L/min).

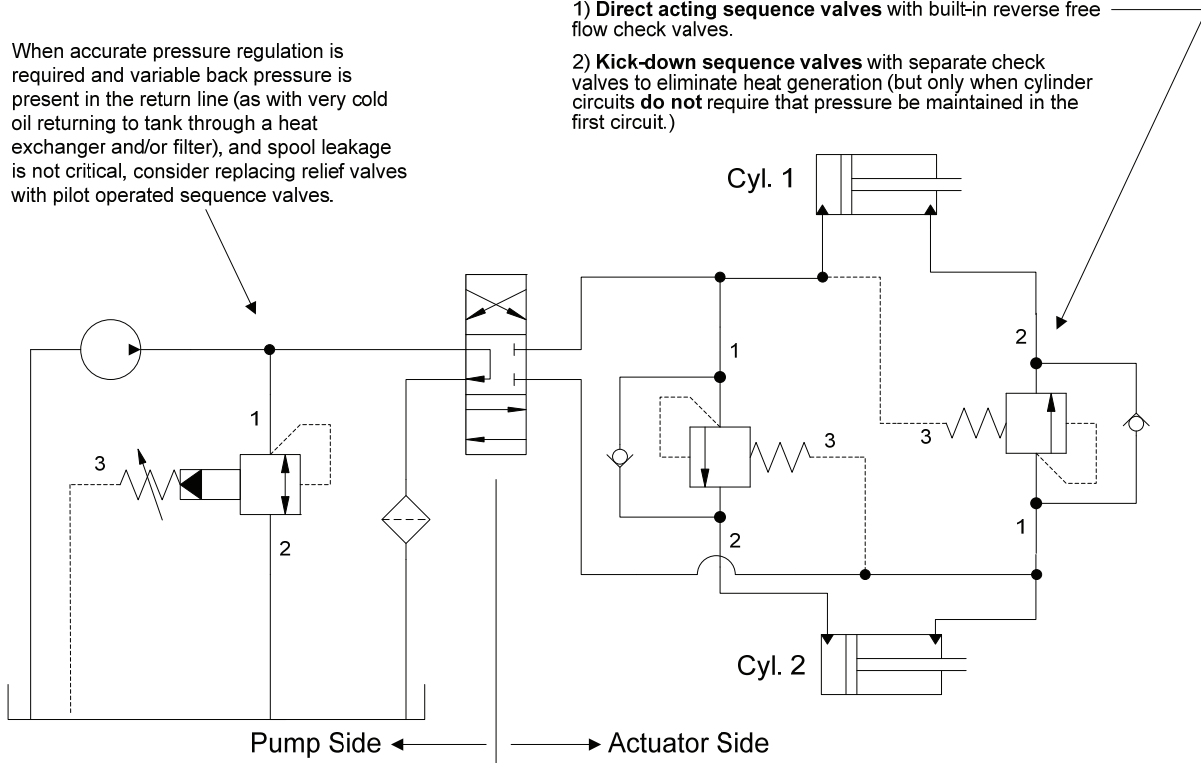
**NOTE:** All Sun three port sequence cartridges are functionally interchangeable (i.e. same flow path and same cavities for a given frame size).

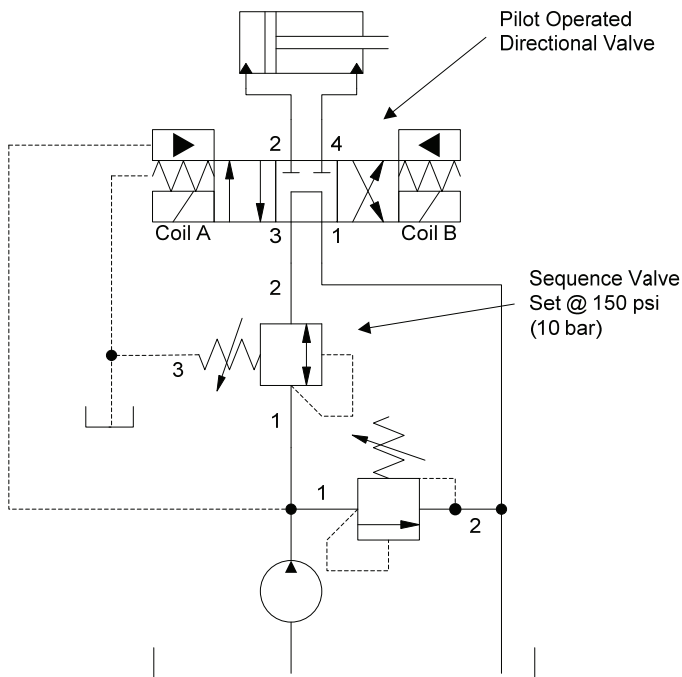
*This drawing is not a real circuit and is intended for description only.*

When accurate pressure regulation is required and variable back pressure is present in the return line (as with very cold oil returning to tank through a heat exchanger and/or filter), and spool leakage is not critical, consider replacing relief valves with pilot operated sequence valves.

When cylinder motion must be sequenced (such as extending cylinder 1 before cylinder 2, and retracting cylinder 2 before cylinder 1), consider:

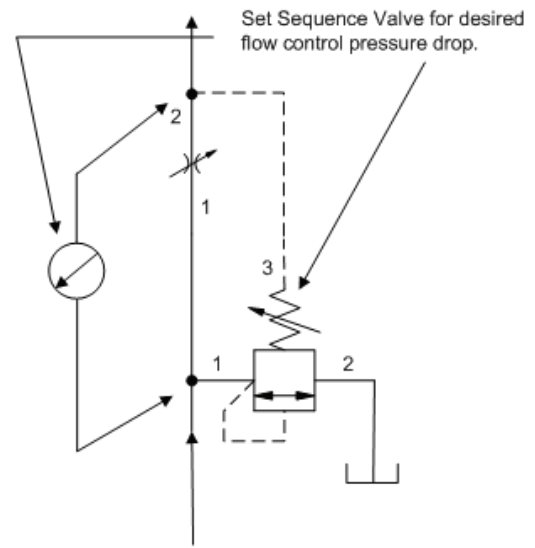
- 1) **Direct acting sequence valves** with built-in reverse free flow check valves.
- 2) **Kick-down sequence valves** with separate check valves to eliminate heat generation (but only when cylinder circuits **do not** require that pressure be maintained in the first circuit.)





A Sequence Valve can be used to maintain a minimum pilot pressure for directional valve actuation in lieu of a back-pressure check valve. When system pressure rises above the sequence valve setting, parasitic pressure drop, based on the valve's pressure setting, disappears. (Only open-valve pressure drop remains.)

Figure 1



A Sequence Valve can be used as an adjustable bypass compensator.

Figure 2

These drawings are not real circuits and are intended for description only.

## Design Concepts and Features

### Three Port Direct Acting Pressure Generating Sequence Cartridges —SX\*A and SC\*A (with reverse flow check)

The performance parameters optimized in Sun's SX\*A and SC\*A sequence valves are:

- Suitable for use in load holding applications.
- Reverse flow from port 2 to port 1 is blocked. (Use SC\*A with reverse flow check if reverse flow is required.)
- Low hysteresis (reseats at 90% of valve setting) and very low leakage (10 drops per minute at reseal).
- There is no pilot flow from the drain port, **but this port must not be plugged**, as this could cause malfunction.
- Fast opening and closing (2 ms typical response time).
- Insensitivity to varying oil temperature and oil-borne contamination.
- Reliable cold oil closing and exceptional hot oil stability (no oscillation).
- Rugged, robust, construction withstands high pressure shocks or back pressure.
- The pressure override curve is steeper than pilot operated versions.

**NOTE:** See General Sequence Valve Note on page 3.

### Two Port Direct Acting Pressure Regulating Sequence Cartridges – SXCB and SCCB (with reverse flow check)

The performance parameters for Sun's SXCB and SCCB sequence valves are the same as the SX\*A and SC\*A valves, except there is no port 3; the spring chamber is referenced to atmosphere. Additional performance parameters include:

- Two port sequence valves are only available in Series 1 frame size (15 gpm/60L/min).
- Over a period of time, external fluid "weepage" may occur. (Approximately 1 drop per 4000 cycles)

### Three Port Pilot Operated Pressure Regulating Sequence Cartridges – RS\*C

Sun's RS\*C balanced piston, two stage, sequence cartridge valves are optimized to operate over a wide flow range, up to 120 gpm (460 L/min). Performance parameters include:

- Flatter pressure override curve as compared to direct acting versions.
- Stable operation.
- The pilot orifice is protected by a 150 micron stainless steel filter screen. (Continued on page 3.)

(Continued from page 2.)

- The minimum pressure setting is determined by the main spool bias spring, which establishes the lowest pressure at which pilot flow will open the main spool.
- Reverse flow from port 2 to port 1 is blocked. (If reverse flow is required, use an external check or an SC\*A with reverse flow check.)
- Low hysteresis and low spool leakage between port 1 and port 2 and is frame size dependant (approximately 2-5 in<sup>3</sup>/min per 1000 psi [32-82 cc/min per 70 bar]).
- Pilot flow out of port 3 will be about 20 in<sup>3</sup>/min (0,33 L/min) with 1000 psi (70 bar) at port 1. The actual pilot flow is dependent on the pressure at port 1 and will rise and fall in relation to this pressure. (Go to Sun's web site to view performance graphs on individual RS\*C product pages.)
- Valve may be "blocked" by shutting off the pilot flow at port 3 (with a two-way valve, for instance), thus causing the valve to remain closed even at its set point. If port 3 is then "vented" to drain, the valve will operate normally, opening at its set point.

**NOTE:** See General Sequence Valve Note at bottom of page.

### **Three Port Pilot Operated Pressure Regulating Sequence Cartridges – RS\*S**

Sun's RS\*S balanced poppet, two stage, sequence cartridges have similar features to the RS\*C series except a poppet replaces the spool in the main stage. The modified performance parameters include:

- Slightly higher hysteresis (+/- 2%).
- Pressure override curve greater than RS\*C balanced piston valve, but lower than direct acting versions.
- Seated poppet design achieves very low leakage (10 drops/min at reseal).
- Poppet design almost eliminates cavitation erosion that can occur in manifolds adjacent to the valve discharge holes.
- RS\*S sequence valves are only available in Series 4 size (120 gpm/460 L/min).

**NOTE:** See General Sequence Valve Note at bottom of page.

### **Three Port Pilot Operated Kick-Down Sequence Cartridges – SQ\*B**

Sun's SQ\*B balanced piston kick-down sequence cartridges shift completely open after the pressure setting for port 1 is attained. The valve will stay open as long as the pressure at port 1 (inlet) exceeds the pressure at port 2 (outlet). Performance parameters of Sun's kick-down sequence valves include:

- Very accurate trigger point (valve setting).
- Typical response time of 40 ms.
- At nominal full flow(s), pressure drop is very low, reducing heat generation. (Approximately 50 psi (4 bar) for SQEB at 10 gpm (40 L/min).)
- Low spool leakage in closed mode (before reaching "trigger point") from port 1 to port 2 or port 2 to port 1. (Leakage is frame size dependant and varies approximately 2-5 in<sup>3</sup>/min per 1000 psi [32-82 cc/min per 70 bar].)
- If reverse flow is desired, a separate free flow check is required.

- Once opened, the valve can only be reset by **stopping all flow** through the valve. Centering or reversing the directional valve will usually reset the sequence valve.
- Should not be used in load holding applications.
- Pilot flow out port 3 of 20 in<sup>3</sup>/min (0,33 L/min), and will rise relative to the pressure rise on port 1. (See individual valve performance graphs on Sun's web site.)
- The pilot orifice is protected by a 150 micron stainless steel filter screen.

**NOTE:** See General Sequence Valve Note at bottom of page.

### **Three Port Air Controlled Pilot Operated Sequence Cartridges – RS\*E**

Sun's RS\*E balanced piston sequence valves use compressed air over a diaphragm instead of an adjustable spring to provide remote control of the valve pressure setting. Performance parameters/features include:

- Hydraulic pressure setting is directly proportional to air pressure setting (pilot ratio equals 20:1; i.e. 10 psi (0,7 bar) air pressure is equal to a 200 psi (14 bar) valve setting).
- Maximum operating pressure = 2000 psi (140 bar).
- Maximum air pressure should not exceed 150 psi (10 bar).
- Most other performance characteristics are similar to RS\*C relief valves.
- The pressure at port 3 determines minimum setting and must not exceed 1000 psi (70 bar).

May be useful as an explosion proof valve where remote pressure control is required.

### **Four Port Pilot Operated Vented Relief (Sequence) Cartridges – RV\*D (Also see Tech Tips for Relief Valves)**

Sun's RV\*D balanced piston, two stage, vented, pressure regulating cartridges provide both a drain port (port 4) plus a remote pilot port (port 3). These cartridges combine the features of pilot operated, vented, relief valves with those of pilot operated sequence valves. Performance parameters include:

- With drain port (port 4) connected to tank, the valve is insensitive to any back pressure on port 2.
- Can be used as a dual pressure sequence valve by connecting the pilot (port 3) to a remote, selectable, pilot source. (The main stage pressure setting must be set higher than that of the remote relief.)
- Valve may be "blocked" by shutting off the pilot flow at port 4. As with the RS\*C sequence valves previously described, if port 3 is then "vented" to drain, the valve will operate normally, opening at its set point.
- Any pressure at the drain port (port 4), is directly additive to pressure setting at the inlet (port 1).

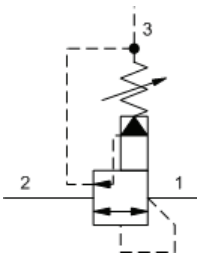
### **General Sequence Valve Note:**

Any pressure at port 3 (drain) is directly additive to the pressure setting at port 1 (inlet).

**Sequence Valve Overview**

Function	Description	Nominal Capacity	Model	Cavity	Symbol
3 Port	Direct Acting without Reverse Flow Check	15 gpm (60 L/min.) 30 gpm (120 L/min.)	SXCA SXEA	T-11A T-2A	
3 Port	Direct Acting with Reverse Flow Check	15 gpm (60 L/min.) 30 gpm (120 L/min.) 60 gpm (240 L/min.) 120 gpm (480 L/min.)	SCCA SCEA SCGA SCIA	T-11A T-2A T-17A T-19A	
2 Port	Direct Acting without Reverse Flow Check	15 gpm (60 L/min.)	SXCB	T-13A	
2 Port	Direct Acting with Reverse Flow Check	15 gpm (60 L/min.)	SCCB	T-13A	
3 Port	Pilot Operated, Balanced Piston	7.5 gpm (30 L/min.) 15 gpm (60 L/min.) 30 gpm (120 L/min.) 60 gpm (240 L/min.) 120 gpm (480 L/min.)	RSBC RSDC RDFC RSHC RSJC	T-163A T-11A T-2A T-17A T-19A	
3 Port	Pilot Operated, Balanced Poppet	120 gpm (480 L/min.)	RSJS	T-19A	

**Sequence Valve Overview (continued)**

Function	Description	Nominal Capacity	Model	Cavity	Symbol
3 Port	Kick-Down	7.5 gpm (30 L/min.) 15 gpm (60 L/min.) 30 gpm (120 L/min.) 60 gpm (240 L/min.) 120 gpm (480 L/min.)	SQBB SQDB SQFB SQHB SQJB	T-163A T-11A T-2A T-17A T-19A	
3 Port	Pilot Operated, Balanced Piston, Air Controlled	30 gpm (120 L/min.) 60 gpm (240 L/min.) 120 gpm (480 L/min.)	RSFE RSHE RSJE	T-2A T-17A T-19A	