

TECHNICAL PRODUCT INFORMATION

Cartridge Installation

Sun cartridge valves are manufactured from carbon steel with all external parts zinc plated to protect against corrosion. Critical internal working parts (sliding spool valves often have a clearance between fixed and working parts of 5 microns or less) are heat treated and precision ground or lapped, to ensure repeatable, reliable performance.

Sun cartridge valves are available in five different sizes with capacities doubling from one size to the next. These cartridges can only be used in a Sun cavity that matches the external configuration of the cartridge. When installing cartridges in their cavities, they should be torqued to the recommended value.

All cartridges have Buna-N seals as standard, with Viton optional. Buna-N seals have an operating range of -50° F to 200° F. Viton seals have an operating range of 0° F to 250° F.

Filtration

As with any precision hydraulic component, clean oil contributes to long life and reliable performance. The most common cause of failure of a cartridge is dirt in the hydraulic fluid, which can then lodge in the working parts of the cartridge and interfere with operation.

Most Sun pilot operated valves feature a 150 micron stainless steel screen or equivalent, to protect the control orifice from contamination. This filter is produced from electrochemically etched stainless steel sheets to provide a consistent screening material.

It is recommended that hydraulic fluid used in systems with Sun valves have an ISO 4406 contamination level of 18/15 or better at all times. Consult your Authorized Distributor for filtration requirements to meet this cleanliness level.

Pressure and Flow Rating – Performance Data

Unless otherwise specified, Sun cartridges are rated to 5000 psi (6000 psi intermittent). All Sun cartridges are designed with a 4:1 safety factor. This means the minimum burst pressure is at least four times the maximum rated operating pressure.

All performance data in this catalog is derived using Chevron ISO Grade 32 petroleum based hydraulic fluid having a specific gravity of 0.87 at 60° F. All tests are conducted at 110° F.

Leakage is often specified in units of drops per minute in this catalog. For reference, 250 drops equal 1 cubic inch.

All performance data provided is developed in our laboratory.

Materials

All manifolds and bodies are available in aluminum or ductile iron. Aluminum bodies are made of wrought 6061-T6 grade aluminum and have a maximum pressure rating of 3000 psi, a proof rating of 6000 psi, and a burst rating of 12,000 psi.

Ductile iron bodies are made of continuous cast, grade 65-45-12 iron. Ductile iron bodies have a maximum pressure rating of 5000 psi, with a proof rating of 10,000 psi, and burst rating of 20,000 psi.

Porting Options

Sun offers many porting options in its mounting configurations, including, but not limited to: SAE Code 61 and 62 split flanges, NPTF dry seal threads, SAE O-ring threaded ports, and BSPP (Whitworth) threads.

Please note that some bodies with SAE O-ring threaded ports utilize a modified spot face diameter for conservation of materials.

Sandwich Interface Patterns

Most sandwich and subplate bodies are available in the following interface configurations:

ISO 02	NFPA D02	NG 4
ISO 03	NFPA D03	NG 6
ISO 05*	NFPA D05	NG 10
ISO 07	NFPA D07	NG 16
ISO 08	NFPA D08	NG 25

* Available with X and Y ports

Testing

All cartridge valves go through functional testing before shipment. Tests are performed using petroleum based hydraulic fluid (ISO Grade 32) at a temperature of 110° F (SUS = 130). Test stand cleanliness is maintained at ISO 17/14 or better.

Standard and special set pressure controls are set at the following flow rates:

- Load Control Valves - 2 in.³/min.
- Pressure Reducing Valves - 0 flow (blocked control port).
- All Other Valves - 4 GPM.

Sun Service Instructions

Cartridge valves are basic service items and they are easily removed in the field. See **Caution** below and the Sun Service Bulletin for details.

A non-functioning cartridge should be returned to Sun through your local Authorized Distributor for evaluation. A full report of our findings will be issued upon request.

Caution! – Prior to removing any cartridge:

1. **Refer to the equipment manufacturer's documentation for recommendations relating to precautions for securing any moving elements associated with the hydraulic system or equipment. (If documentation does not exist, ensure that all loads are adequately supported.)**
2. **Ensure that the hydraulic system is de-pressurized.**

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Solenoid Cartridge Valves

Sun Hydraulics offers a variety of pilot solenoid cartridges and direct acting full flow solenoid cartridges to suit most application requirements.

Full Flow Valves Rated for Reliability

- Direct acting full flow solenoid cartridges will operate reliably at their maximum pressure (3600 psi) and flow ratings (10 GPM).
- All pressure and flow ratings are conservative to ensure that the final circuit will function as the designer intended.
- These solenoid cartridge valves will operate at rated conditions with a life expectancy in excess of 20 million cycles.

Multiple Versions

Two port, 2 position / 2-way solenoids are available in either spool or poppet versions, each offered in both normally open and normally closed configurations.

- Spool version exhibit maximum leakage rates of 5 in³/min. at 3600 psi and are recommended for high flow requirements where leakage is not critical.
- Poppet version exhibit maximum leakage rates of 10 drops/min. at 3600 psi.
- Three port, 2 position / 3-way spool type cartridges exhibit all of the features of the two position / 2-way spool cartridges.
- Solenoid cartridges feature a standard push-type manual override.

Designed for Application Flexibility

These direct acting valves require no minimum pressure for their operation.

- An efficient coil and tube design generates maximum force output with only 22 watts of power, so the valves exhibit consistent and reliable operation.
- The high force output of the solenoid ensures that there is enough power to overcome flow forces that may otherwise prevent the valve from shifting.

- Within each cartridge version, the normally open and normally closed configurations have virtually identical performance, allowing them to be used interchangeably.
- Together these features afford the circuit designer greatly increased flexibility.

Connector and Voltage Options

- All solenoids are DC type devices.
- An internal bridge rectifier is used in the coil for AC applications.
- Coils will operate reliably from 80% to 120% of the rated voltage with a maximum ambient temperature of 122°F.
- DC coils are offered in 12 and 24-volt versions with twin lead, DIN or AMP® Junior Timer connectors.
- AC coils are available in both 115 or 230-volt options and feature DIN connectors.
- All coils employ internal transient voltage suppression protection to protect externally connected electrical switching.

High Pressure Solenoid Pilot Controls

- These small spool-type cartridges handle flows up to approximately .25 GPM and will accommodate pressure up to 5000 psi at all ports.
- All pilot solenoid cartridges are rated for a fatigue life of greater than 20 million cycles at their maximum working pressure and flow ratings.

Low Power Consumption

The highly efficient tube design of the pilot solenoids requires only 12 watts to shift the valve.

- Voltage and temperature tolerances of the pilot solenoids are identical to those of the full flow valves.
- All coils employ internal transient voltage suppression protection to protect externally connected electrical switching.
- Both AC and DC coils are offered with AC coils employing an internal bridge rectifier.
- DC coils are offered in various voltage options from 6 to 48-volts.
- Connector options include DIN, SAE twin spade and twin leads.

- AC coils are offered in 115- and 230-volt options and feature DIN connectors.

Integrated Pilot Control

While all of the pilot control solenoid cartridges can be used individually in manifolds to control other devices, the 2-way cartridges offer the added benefit of being able to be directly installed into other Sun cartridges to provide electrically operated high flow and high pressure control.

- The T-8A cavity is offered as a control option on many of Sun's ventable and pilot operated cartridges to offer high performance, 5000 psi electrically controlled products at a competitive price.
- Directly integrating the electrical control in the main stage function results in a product that offers improved control characteristics; separate pilot lines are eliminated and only a single cavity needs to be machined to accommodate both the control and primary function.
- Sun also offers a range of cartridges that incorporate solenoid pilot controls to provide directional control for flow ranges from 15 to 120 GPM.

2-way or 3-way

Pilot control solenoid cartridges are available in either a two port, 2 position / 2-way (DAAA), or a three port, 2 position / 3-way (DBAA), each of which exhibits internal leakage rates of 10 drop/min. maximum at 5000 psi.

- The 2-way versions fit into Sun's existing T-8A cavity.
- The 3-way versions fit the T-9A cavity.
- Both are offered in normally open and normally closed configurations with a variety of voltage and connector options.
- The pilot control solenoid valves include a push-type manual override as a standard feature.

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Line Mounted Bodies

Sun Hydraulics offers many different line mount bodies for its screw-in cartridges, all available in a choice of either aluminum or ductile iron. These passive mounting configurations greatly simplify the installation of cartridges in both new and existing circuits. Because oil flow is confined within the body, leakage points are minimized. The result is a reliable hydraulic circuit with a high degree of stiffness.

Line mount bodies feature one or more cavities with various porting options for oil distribution. Sun offers ports in the following configurations:

- NPTF – National Pipe Tapered for Fuels (1/4” to 1 1/4”)
- BSPP – British Standard Pipe Parallel (1/4” to 1 1/4”)
- SAE – Modified (see table below) Straight Thread with O-ring Boss (4 through 20)
- SAE Code 61 and Code 62 Four-Bolt Split Flange (1/2” through 2”)

Material Properties

Grade 6061-T6 Aluminum — Material Pressure Rating 3000 psi

For its aluminum bodies, Sun uses a 6000 series aluminum alloy that offers high strength characteristics and good corrosion resistance in the finished product. The mechanical properties of grade 6061-T6 aluminum are:

Ultimate Strength (Tension)	45,000 psi
Yield Strength (Tension)	40,000 psi
Elongation	12%
Brinell Hardness	95
Ultimate Shear Strength	30,000 psi
Fatigue Endurance Limit	14,000 psi
Elasticity	10 X 10 ⁶ psi

Grade 65-45-12 Ductile Iron — Material Pressure Rating 5000 psi

Sun uses a ductile iron that offers high tensile strength and good ductility for its iron bodies. All ductile iron bodies use iron produced by the continuous cast method which provides a body that possesses a dense, homogeneous structure with minimal inclusions for high pressure integrity. After machining, all ductile iron bodies go through a surface impregnation process in which the material is chemically blackened. The mechanical

properties of grade 65-45-12 ductile iron are:

Ultimate Strength (Tension)	65,000 psi
Yield Strength (Tension)	45,000 psi
Elongation	12%
Brinell Hardness	170 - 207
Ultimate Shear Strength	58,000 psi
Fatigue Endurance Limit	30,500 psi
Elasticity	24.4 X 10 ⁶ psi

Sun’s Modified SAE Straight Thread with O-ring Boss

To conserve material, Sun modifies the SAE standard counterbore diameter on its SAE straight threads. The modification uses a smaller spotface than the standard SAE diameter which may result in certain fittings not seating correctly. The table below compares Sun’s SAE counterbore diameters with the standard SAE specification. Swivel and ORS fittings do not present interference problems with the Sun modified counterbore diameter. However, the across corner dimension of certain hex fittings will interfere with the spotface and therefore may not seat correctly. A column of comparative specifications is shown in the table and hex fittings that present interference problems are identified with an asterisk.

SAE Counterbore Diameters

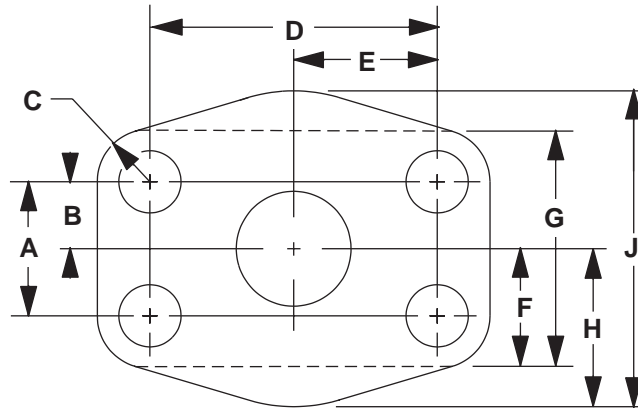
SAE Size	SUN Counterbore Diameter	SAE Recommended Counterbore Diameter	Standard Fittings Hex Size		
-4	.672	.828	.500	.5625	.6875 (*)
-6	.812	.969	.6875	.750 (*)	.9375 (*)
-8	1.031	1.188	.8125	.875	1.000 (*)
-10	1.188	1.344	1.000	1.125 (*)	
-12	1.469	1.625	1.125	1.250	1.375 (*)
-16	1.750	1.910	1.375	1.500	1.625 (*)
-20	2.188	2.270	1.6875	1.875	

(*) Hex fittings that present interference problems.



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SAE Flange Pattern Specifications



SAE Code 61

Nominal SAE Flange	SAE Maximum Recommended Working Pressure
3/4"	5000 psi
1"	5000 psi
1 1/4"	4000 psi
1 1/2"	3000 psi
2"	3000 psi

SAE Code 62

Nominal SAE Flange	SAE Maximum Recommended Working Pressure
1/2"	6000 psi
3/4"	6000 psi
1"	6000 psi
1 1/4"	6000 psi
1 1/2"	6000 psi
2"	6000 psi

SAE Code 61

Four-Bolt Flange Pattern

SAE Flange	A	B	C	D	E	F	G	H	J
3/4"	.875	.438	.344	1.875	.938	.812	1.625	1.031	2.062
1"	1.031	.516	.344	2.062	1.031	.938	1.875	1.156	2.312
1 1/4"	1.188	.594	.406	2.312	1.156	1.062	2.125	1.438	2.875
1 1/2"	1.406	.703	.469	2.750	1.375	1.250	2.500	1.625	3.250
2"	1.688	.844	.469	3.062	1.531	1.500	3.000	1.906	3.812

Inch Mounting Dimensions

SAE Flange	Hole Diameter	Hole Thread	Hole Thread Depth	Hole Counterbore Diameter
3/4"	.41	.375-16 UNC	.875	.594
1"	.41	.375-16 UNC	.875	.594
1 1/4"	.47	.438-14 UNC	1.125	.688
1 1/2"	.53	.500-13 UNC	1.062	.781
2"	.53	.500-13 UNC	1.062	.781

Reference: J518 4-Bolt Flange

Metric Mounting Dimensions

SAE Flange	Hole Diameter	Hole Thread	Hole Thread Depth	Hole Counterbore Diameter
3/4"	.42	M10 x 1.5-6H	.875	.69
1"	.42	M10 x 1.5-6H	.875	.69
1 1/4"	.42	M10 x 1.5-6H	1.125	.69
1 1/2"	.50	M12 x 1.75-6H	1.062	.75
2"	.50	M12 x 1.75-6H	1.062	.75

Reference: DIN 20066 4-Bolt Flange

SAE Code 62

Four-Bolt Flange Pattern

SAE Flange	A	B	C	D	E	F	G	H	J
1/2"	.719	.359	.312	1.594	.797	.750	1.500	.938	1.875
3/4"	.938	.469	.406	2.000	1.000	.938	1.875	1.188	2.375
1"	1.094	.547	.469	2.250	1.125	1.062	2.125	1.375	2.750
1 1/4"	1.250	.625	.562	2.625	1.312	1.188	2.375	1.531	3.062
1 1/2"	1.438	.719	.656	3.125	1.562	1.375	2.750	1.875	3.750
2"	1.750	.875	.719	3.812	1.906	1.688	3.375	2.250	4.500

Inch Mounting Dimensions

SAE Flange	Hole Diameter	Hole Thread	Hole Thread Depth	Hole Counterbore Diameter
1/2"	.34	.312-18 UNC	.812	.500
3/4"	.41	.375-16 UNC	.938	.590
1"	.47	.438-14 UNC	1.062	.688
1 1/4"	.53	.500-13 UNC	1.000	.781
1 1/2"	.66	.625-11 UNC	1.375	.969
2"	.78	.750-10 UNC	1.500	1.156

Reference: J518 4-Bolt Flange

Metric Mounting Dimensions

SAE Flange	Hole Diameter	Hole Thread	Hole Thread Depth	Hole Counterbore Diameter
1/2"	.34	M8 x 1.25-6H	.812	.562
3/4"	.42	M10 x 1.5-6H	.938	.688
1"	.50	M12 x 1.75-6H	1.062	.750
1 1/4"	.59	M14 x 2.0-6H	1.000	.875
1 1/2"	.66	M16 x 2.0-6H	1.375	1.000
2"	.81	M20 x 2.5-6H	1.500	1.250

Reference: DIN 20066 4-Bolt Flange