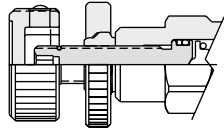
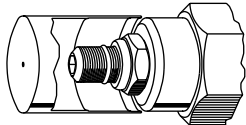
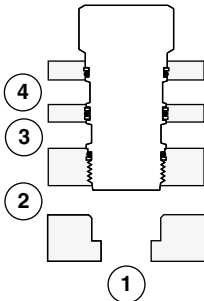
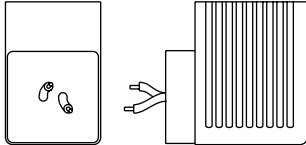
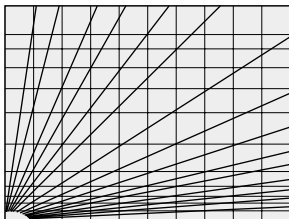


# General Information

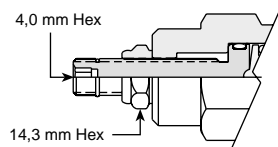
	<i>Page</i>	
Cartridge Control Options	162	
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# Cartridge Control Options

## General Purpose Controls (for use in systems where adjustment may be changed after installation.)

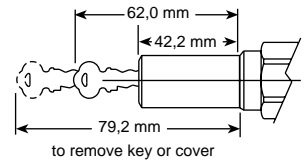
### L Standard Screw Adjustment

O-ring seal on adjust screw. Adjust screw positively retained. Overset protection-pilot spring cannot go solid.



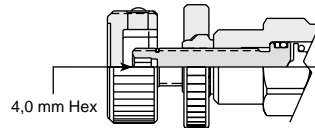
### Key Lock Kit

Optional adjustment Key Lock Cover Kit for L controls allows adjustment to be locked with a key to prevent unauthorized changes in valve setting. Adjustment is easily accessible when lock assembly is removed. Requires replacement of standard locknut with special locknut which accepts lock assembly, and a new wire stop ring for overset protection.



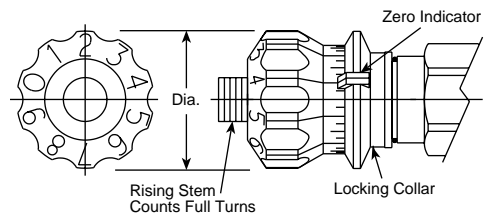
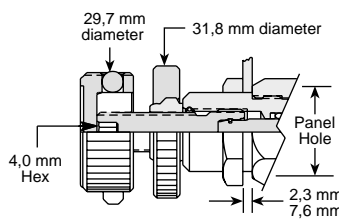
### K Handknob with Lock Knob

Handknob and lock knob added to L control. Sun handknob kits for field conversion are available.



### H Calibrated Handknob with Detent Lock

Fully calibrated handknob for flow control cartridges. 40 radial calibrations per turn. Moveable zero indicator. (Minor disassembly required.) Rising detented locking collar positively locks adjustment knob against vibration or accidental tampering. Any desired setting may be recorded and repeated. U.S. Patent #4,577,831.



### O Handknob with Panel Mount

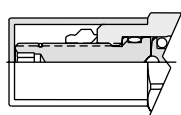
Special threaded cartridge hex body with panel nut for mounting cartridge through access hole in control panel. Handknob and lock knob included.

#### Panel Hole:

Series 1 cartridges 190 mm dia.  
Series 2 cartridges 25,4 mm dia.  
Panel nut hex size identical to cartridge hex size.

### C Tamper Resistant Factory Set

Cover press-fit onto L control cartridge shoulder. Valves may be ordered in this configuration from Sun. **Specify pressure setting on order.** Setting stamped on cartridge hex. Sun kits for field conversion are available.

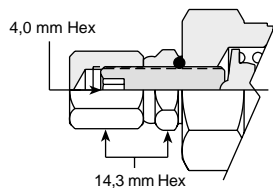


Diameter	28,7 mm	35,1 mm	41,1 mm	41,1 mm
Series	1	2	3	4
	NCCB	NCEB	NCFB	NCEB
	NCCC	NCEC	NCFC	NCEC
	NFCC	NFDC	NFEC	NFCC
	NFCD	NFDD	NFED	NFDD
	FDBA	FDCB	FDEA	FDFB

## Special Purpose Controls (for use in systems where adjustment is seldom changed after installation)

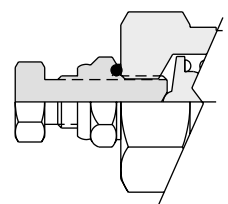
### J Socket Head Set Screw with Cap

Stem seal - Seal under locknut. Adjusting screw not retained. No overset protection.



### F Wrench Adjustment

Stem seal - Seal under locknut. Adjusting screw is not retained. Overset protection-pilot spring cannot go solid.



## Counterbalance Cartridge Controls

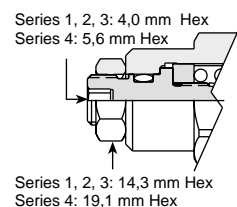
All Sun counterbalance cartridges are built with a leakproof adjustment - O-ring seals are on the adjusting screw-but are not designed for frequent adjustment in the field. Cartridges that are factory pre-set by Sun to a customer specified pressure setting are available and can be installed directly on a machine without the need for further adjustment.

### C Tamper Resistant Factory Set

See "C" Control description above.

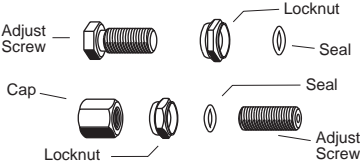
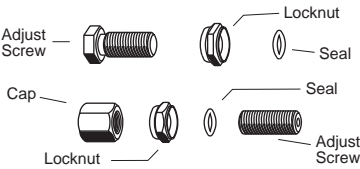
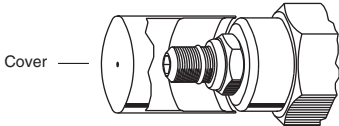
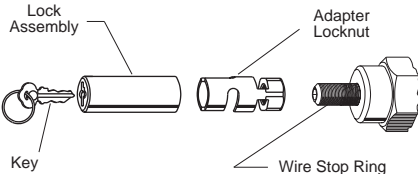
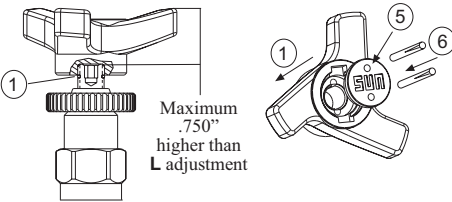
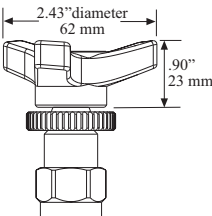
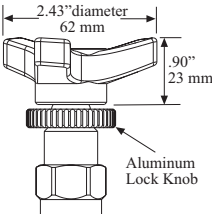
### L Standard Leakproof

**Screw Adjustment.**  
O-ring seal on adjust screw.



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# Cartridge Control Kits

Service Kit Number Description	Use specifically with Control/Cartridge	Description	Notes
Adjustment Screw Kit 991-006	All <b>F</b> controls		To assure a complete seal on the stem - release all pressure on the cartridge after setting. <b>Then...</b> tighten locknut (and cap, on <b>J</b> ).
Adjustment Screw Kit 991-010	All <b>J</b> controls		
Tamper Resistant Cover 991-000	For all Sun cartridges with <b>L</b> adjustment Series 0 - hex 19,0 mm 991-004 Series 1 - 22,2 mm hex 991-001 Series 2 - 28,6 mm hex 991-002 Series 3 - 31,8 mm hex 991-003 Series 4 - 41,0 mm hex 991-032 Series 1 - 22,2 mm hex (CB**, CC**) 991-033 Series 2 - 28,6 mm hex (CB**, CC**)		<ol style="list-style-type: none"> <li>1. Adjust valve to desired setting and tighten locknut.</li> <li>2. Using an arbor press or a soft hammer, install cover until it seats on cartridge hex.</li> <li>3. Cover is a press fit on cartridge shoulder.</li> </ol>
Key Lock Kit 993-008	For all Sun cartridges with <b>L</b> adjustment (except Series 0 and counterbalance cartridges).		<ol style="list-style-type: none"> <li>1. Remove original wire stop ring and locknut.</li> <li>2. Thread on the adapter locknut and install new wire stop ring through slot provided.</li> <li>3. Adjust valve to desired setting and tighten adapter locknut.</li> <li>4. Slide lock assembly over adapter, lock and remove key.</li> </ol>
Three-winged Handknob Kit 991-034	For all Series 1, 2, 3, 4 valves with <b>L</b> or <b>O</b> adjustment except counterbalance cartridges.	<p>Install while cartridge is screwed in cavity to prevent damage.</p>  <p>Maximum .750" higher than <b>L</b> adjustment</p>	<ol style="list-style-type: none"> <li>1. Do not remove stop ring.</li> <li>2. Install lock knob by snapping onto the locknut.</li> <li>3. Install star knob until contact is made with the stop ring.</li> <li>4. Caution during installation on flow control valves (that have no stop ring). Make sure valve can be shut with hand knob installed.</li> <li>5. Insert pins in cover so that they project on backside.</li> <li>6. Put cover on with inserted pins and drive pins in until flush with cover.</li> </ol>
	The handknob can be used as a Maximum Setting Limiter.		<p>When knob is used as a maximum Setting Limiter:</p> <ol style="list-style-type: none"> <li>1. Set valve at desired maximum setting.</li> <li>2. Tighten lock nut (110 lbs. inch).</li> <li>3. Remove stop ring.</li> <li>4. Install lock knob.</li> <li>5. Install handknob until flush with the lock knob.</li> </ol>
Three-winged Handknob Kit with 1 3/8" dia. aluminum lock knob. 991-039	This kit should be used in applications where there is high vibration and a plastic lock knob may loosen.	 <p>Aluminum Lock Knob</p>	Follow installation instructions described above.

Cartridge Control Kits continue on next page

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# Cartridge Control Kits

Service Kit Number Description	Use specifically with Control/Cartridge	Description	Notes
<b>K</b> Handknob Kit 991-211  991-222  Panel Handknob Kit 991-215  Panel Handknob Kit 991-216	Use this kit to adapt all <b>L</b> controls to <b>K</b> controls (except Series 0 and counterbalance cartridges).		Only cartridges date stamped "41" or later and originally supplied with plastic knobs. Lock knob snaps onto locknut furnished on cartridge.
	<b>K</b> control for Series 0		
	<b>O</b> controls All Series 1 cartridges 22,2 mm hex M20 thread		
<b>H</b> Calibrated Handknob Kit  991-219  991-220  991-221	<b>H</b> controls All series of flow controls		Only for cartridges originally supplied with an <b>H</b> handknob. Valves can not be modified in the field.  <b>Note:</b> The <b>H</b> control is <b>Only</b> available for the cartridges shown to the left.
	<b>FDCB, NCEB, NCEC, NFDC, NFDD</b> only  <b>FDEA, FDFA, NCFB, NCFC, NCGB, NCGC, NFEC, NFED, NFFC, NFFD</b> only		
	<b>FDBA, NCCB, NCCC, NFCC, NFDC</b> only		
Lockwire Kit 991-012	All <b>M, Q</b> and <b>R</b> controls (except solenoid operated cartridges).		
Adjustment Screw Kit 991-112-003 Viton 991-112-007 Buna-N	<b>CKCA L**CKCD L**</b> <b>CKCB L**CPCA L**</b> <b>CKCC L**</b>		Only cartridges date stamped "62" or earlier.
Adjustment Screw Kit 991-212-003 Viton 991-212-007 Buna-N	<b>CKEA L**CKED L**</b> <b>CKEB L**CPEA L**</b> <b>CKEC L**</b>		

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# Cavity Plugs

It is sometimes desirable to remove a Sun cartridge valve and still maintain the integrity of the hydraulic system. This may be necessitated by the need to flush a system after repairs or a piping change, or to change an operating function in the circuit. For these requirements, Sun offers two styles of cavity plugs - all ports blocked and main ports open to flow.

## Plugs for Two Port Cavities:

Series	Cavity	All Ports Open			All Ports Blocked		
		Cavity Plug Model Code*	Buna-N	Viton	Cavity Plug Model Code	Buna-N	Viton
P	T-8A	<b>XAOA-XX*</b>			<b>XACA-XX*</b>		
0	T-162A	<b>XZOA-XX*</b>			<b>XZCB-XX*</b>		
1	T-10A	<b>XFOA-XX*</b>			<b>XFCA-XX*</b>		
	T-13A					<b>XGCA-XX*</b>	
2	T-3A	<b>XCOA-XX*</b>			<b>XCCA-XX*</b>		
	T-5A					<b>XDCA-XX*</b>	
3	T-16A	<b>XIOA-XX*</b>			<b>XICA-XX*</b>		
4	T-18A	<b>XKOA-XX*</b>			<b>XKCA-XX*</b>		

## Plugs for Three Port Cavities

Series	Cavity	Ports 1 to 2 Open Port 3 Blocked			All Ports Blocked		
		Cavity Plug Model Code*	Buna-N	Viton	Cavity Plug Model Code	Buna-N	Viton
P	T-9A	<b>XAOB-XX*</b>			<b>XACBXX*</b>		
0	T-163A	<b>XZOB-XX*</b>			<b>XZCB-XX*</b>		
1	T-11A	<b>XEOA-XX*</b>			<b>XECA-XX*</b>		
2	T-2A	<b>XBOA-XX*</b>			<b>XBCA-XX*</b>		
3	T-17A	<b>XHOA-XX*</b>			<b>XHCA-XX*</b>		
4	T-19A	<b>XJOA-XX*</b>			<b>XJCA-XX*</b>		

## Plugs for Four Port Cavities (Internal Locating Shoulder)

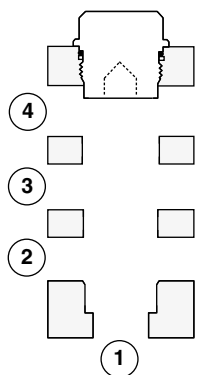
Series	Cavity	Ports 1 to 2 Open Port 3 and 4 Blocked			All Ports Blocked		
		Cavity Plug Model Code*	Buna-N	Viton	Cavity Plug Model Code	Buna-N	Viton
1	T-21A	<b>XMOA-XX*</b>			<b>XMCA-XX*</b>		
2	T-22A	<b>XNOA-XX*</b>			<b>XNCA-XX*</b>		
3	T-23A	<b>XPOA-XX*</b>			<b>XPCA-XX*</b>		
4	T-24A	<b>XQOA-XX*</b>			<b>XQCA-XX*</b>		

\*Insert in the seventh position model code digit N to order Buna-N seals or V to order Viton seals.

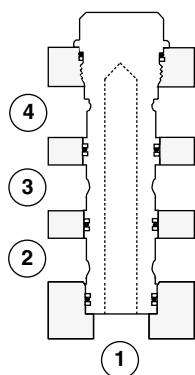
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## Cavity Plugs

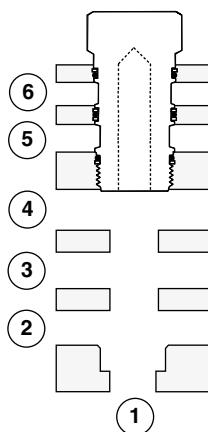
### Plugs for Four Port Cavities (External Locating Shoulder)



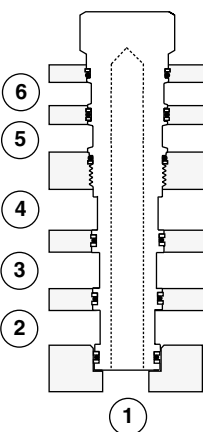
Series	Cavity	All Ports Open		All Ports Blocked			
		Cavity Plug Model Code*	Buna-N	Viton	Cavity Plug Model Code*	Buna-N	Viton
1	T-31A	XFOA-XX*			XRCA-XX*		
2	T-32A	XCOA-XX*			XSCA-XX*		
3	T-33A	XIOA-XX*			XTCA-XX*		
4	T-34A	XKOA-XX*			XVCA-XX*		



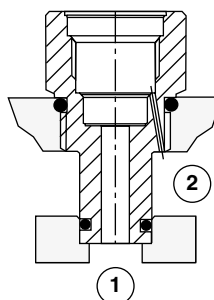
### Plugs for Six Port Cavities



Series	Cavity	Ports 1, 2, 3 and 4 Open Ports 5 and 6 Blocked		All Ports Blocked			
		Cavity Plug Model Code*	Buna-N	Viton	Cavity Plug Model Code*	Buna-N	Viton
1	T-61A	XMOA-XX*			XRCC-XX*		
2	T-62A	XNOA-XX*			XSCC-XX*		
3	T-63A	XPOA-XX*			XTCC-XX*		
4	T-64A	XQOA-XX*			XVCC-XX*		



### Cavity Adaptor (Converts Waterman 12-2 Cavity to the Sun T-8A Cavity)



Cavity	All Ports Open		
	Cavity Plug Model Code*	Buna-N	Viton
12-2	XAAA-8X*		

\*Insert in the seventh position model code digit N to order Buna-N seals or V to order Viton seals.

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# Sun Solenoid Electrical Connector Options

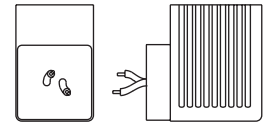
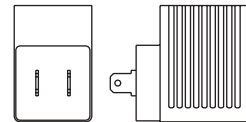
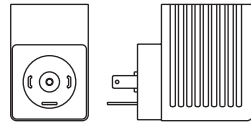
Sun Hydraulics has a range of pilot flow and full flow solenoid products with operating pressures up to 350 bar. These products are available with the coil configuration options shown below. If you only require pilot flow and want to operate these packages in a 350 bar system, Sun offers a screw-in adapter that converts the Waterman 12-2 cavity to a Sun T-8A cavity.

## Connector Options for Sun Pilot Flow Solenoid Valves (DAAA, DBAA)

ISO / DIN 43650

SAE J858-A

Twin Lead



Description	Coil only part number	Coil only part number	Coil only part number
115 V AC 50/60 Hz	760-211	N/A	N/A
230 V AC 50/60 Hz	760-223	N/A	N/A
6 V DC	760-206	760-506	760-706
12 V DC	760-212	760-512	760-712
24 V DC	760-224	760-524	760-724
28 V DC	760-228	760-528	760-728
36 V DC	760-236	760-536	760-736
48 V DC	760-248	760-548	760-748

## Connector Options for Sun Full Flow Solenoid Valves (DLDA, DTDA, DMDA, DNDA) and Proportional Valves (RBAP, PRDP, PRDL)

ISO/DIN 43650

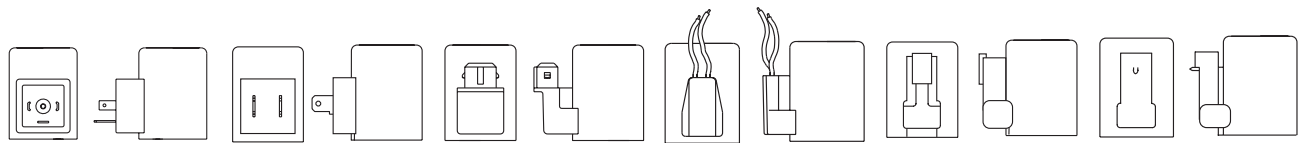
Twin Spade  
(SAE J858A)

AMP® Junior Timer

Twin Lead

Metri-Pack

Deutsch

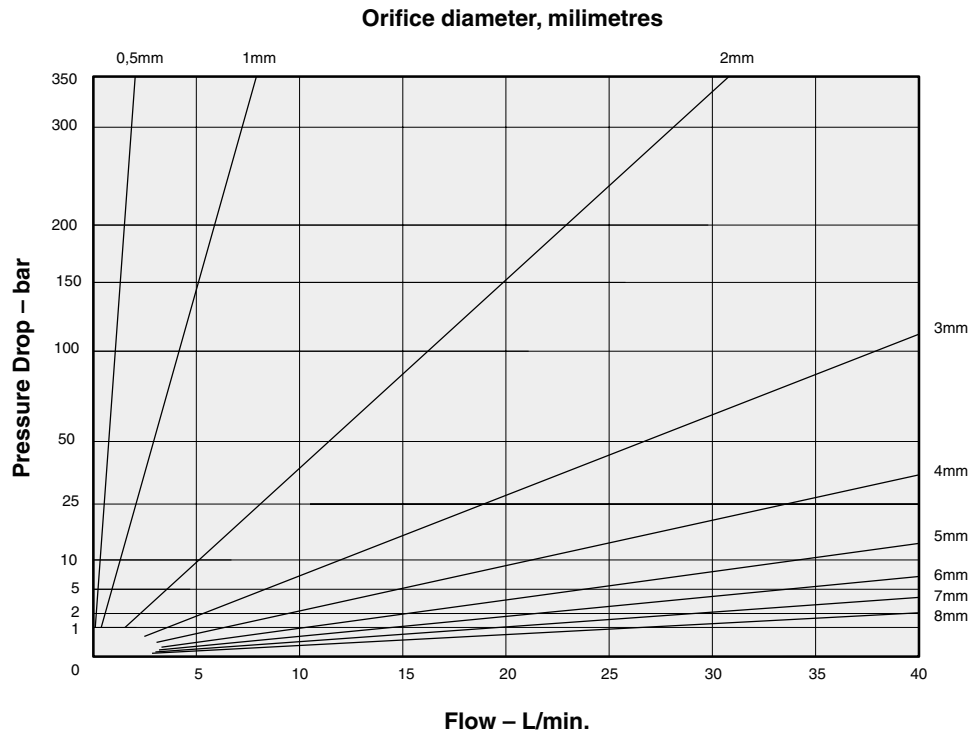


Description	Coil only part number	Coil only part number	Coil only part number	Coil only part number	Coil only part number	Coil only part number
115 V AC 50/60 Hz	770-211	N/A	N/A	N/A	N/A	N/A
230 V AC 50/60 Hz	770-223	N/A	N/A	N/A	N/A	N/A
12 V DC	770-212	770-512	770-612	770-712	770-812	770-912
24 V DC	770-224	770-524	770-624	770-724	770-824	770-924
48VDC	770-248	770-548	770-648	770-748	770-848	770-948

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**ORIFICE PRESSURE DROP DATA**

No allowance has been made for viscosity effects, or regain of pressure downstream.



These charts are based on the formula:

$$Q = \alpha A \sqrt{\frac{2AP}{\rho}}$$

Where:

- Q = Flow m<sup>3</sup>/sec.
- α = orifice coefficient
- A = orifice dia. cm<sup>2</sup>
- Δ P = pressure drop N/m<sup>2</sup>
- ρ = density Ns<sup>2</sup>/m<sup>4</sup>

This equation becomes:

$$Q \text{ (l,min)} = 0.4212 \times d^2 \text{ (mm)} \sqrt{\text{pressure drop (bar)}}$$

when c = 0.6  
ρ = 0.9 g/cm<sup>3</sup>

