Eaton®
XCEL[45] Steering Control Units

Powering Business Worldwide

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XCEL^{45} Steering Control Unit

Steering Control Units

The Steering Control Unit (SCU) is fully fluid linked. This means there is no mechanical connection between the steering unit, the pump and the steering cylinders. The unit consists of a manually operated directional control servo valve and feedback meter element in a single body. It is used principally for fluid linked power steering systems but it can be used for some servo-type applications or any application where visual positioning is required. The close coupled, rotary action valve performs all necessary fluid directing functions with a small number of moving parts. The manually actuated valve is coupled with the mechanical drive to the meter gear. The control is lubricated and protected by the power fluid in the system and can operate in many environments.

Advantages

Steering control units offer the following advantages:

- Minimizes steering linkage—reduces cost, provides flexibility in design.
- Provides complete isolation of load forces from the control station—provides operator comfort.
- Provides continuous, unlimited control action with very low input torque.
- Provides a wide selection of control circuits and meter sizes.
- Can work with many kinds of power steering pumps or fluid supply.

Features

- Open Center
- Load Sensing
- Close Center
- Q-amp
- Bolt on priority
- Dual Gerotor
- Integral Valves
- Cylinder Dampening

XCEL^{45}

The XCEL^{45} steering unit is an innovative steering platform that provides smooth and reliable steering.

The XCEL^{45} is designed for mid-range flow applications.

The XCEL^{45} has robust housing design which provides 190 bar max [2755 psi] system pressure capability for all models

Applications

- Construction Machinery
- Agriculture Machinery
- Heavy-Duty Equipment
- Marine
- Forestry Machinery
- Mining Equipment

Specification Data

Max.System Pressure	190 bar	[2755 psi]
Max. Back Pressure	35 bar	[500 psi]
Rated Flow		
50 - 125cc/r	7.5-15 LPM	[2-4 GPM]
160 - 250cc/r	15-30 LPM	[4-8 GPM]
320 - 500cc/r	30-45 LPM	[8-12 GPM]
Input Torque		
Powered Standard	1.7-2.8 Nm	
Powered Low Torque	1.3-2.2 Nm	
Powered Supper Low Torque	<1.4 Nm	
Non-powered	136 Nm	
Max. System Operating Temperature	93°C	[200°F]
Max. Differential Between Steering Unit and Other System Temperature	28°C	[50°F]
Fluid ATF Type A and Most Petroleum Based Fluids See Eaton Technical Bulletin 3-401		
Recommended Filtration: ISO 20/18/13 cleanliness level		

Hydraulic Circuit Explanation

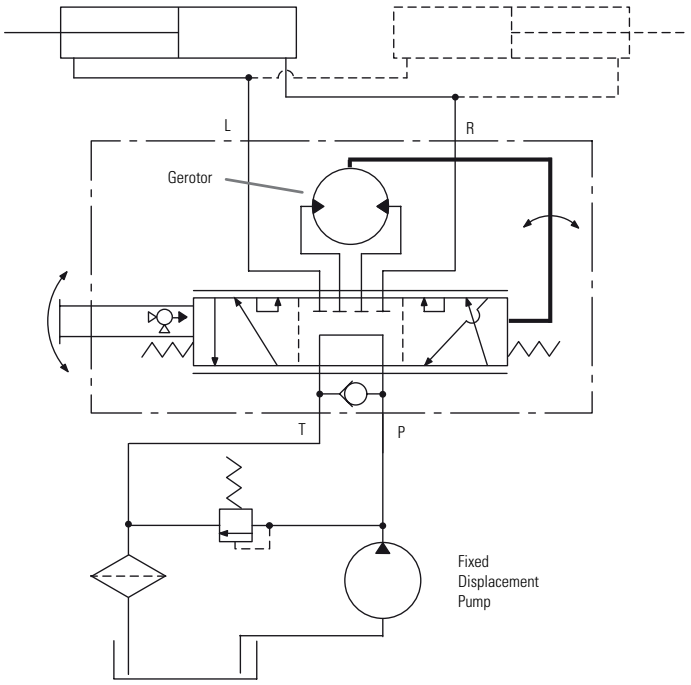
Neutral Circuits: Open Center & Close Center

Open Center

- Simplest, most economical system
- Uses a fixed displacement pump
- In neutral position pump and tank are connected
- Most suitable on smaller type vehicles

Applications

- Lawn and Garden Equipment
- Utility Vehicles



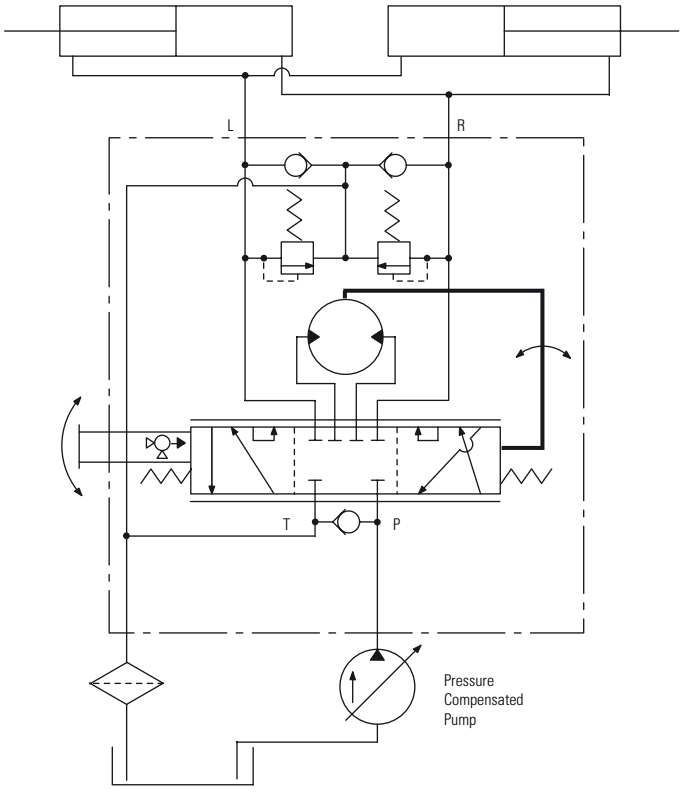
Open Center System

Close Center

- Uses a pressure compensated variable displacement pump
- In neutral position pump and tank are disconnected
- Most suitable on large construction equipment

Applications

- Construction Industry



Closed Center System

Hydraulic Circuit Explanation

Neutral Circuits: Load Sensing

Load Sensing Circuits

Load sensing power steering uses conventional or load sensing power supplies to achieve load sensing steering. The use of a load sensing steering unit and a priority valve in a normal power steering circuit offers the following advantages:

- Provides smooth pressure compensated steering because load variations in the steering circuit do not affect axle response or maximum steering rate.
- Provides true power beyond system capability by splitting the system into two independent circuits. Pressure transients are isolated in each circuit. Only the flow required by the steering maneuver goes to the steering circuit. Flow not required for steering is available for use in the auxiliary circuits.
- Provides reliable operation because the steering circuit always has flow and pressure priority.

Load sensing steering control units and priority valves can be used with open center, closed center or load sensing systems. Use in an open center system with a fixed displacement pump or a closed center system with a pressure compensated pump, offers many of the features of a load sensing system. Excess flow is available for auxiliary circuits.

Listed below are the components of a typical load sensing control circuit and a brief application description.

Pump-May be fixed displacement, pressure compensated, or flow and pressure compensated design.

Priority Valve-Sized for design pressure drop at maximum pump output flow rate and priority flow requirements. The minimum control pressure must assure adequate steering flow rate and must be matched with the steering control unit. A dynamic signal priority valve must be used with a dynamic signal steering control unit.

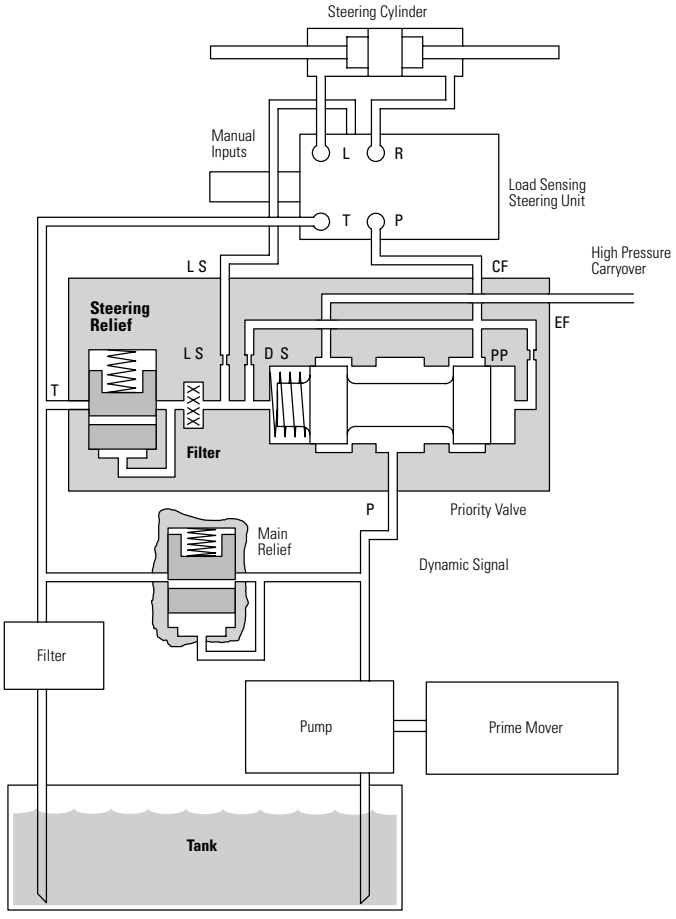
Steering Control Unit-Designed for specific rated flows and control pressures. It must be matched with a control pressure in the priority valve to obtain maximum steering rates. Higher flow rates require higher control pressures. Neutral internal bleed assures component temperature equalization

LS Line-A LS line is always needed to sense pressure downstream from the variable control orifice in the steering control unit. This is balanced by an internal passage to the opposite side of the priority control spool.

The total system performance depends on careful consideration of the control pressure chosen and pressure drop in the CF line.

Steering Relief Valve-Must be factory set at least 10 bar[145PSI] above the maximum steering cylinder pressure requirement. Most of the flow will be directed to the auxiliary circuit (EF) when the relief setting is exceeded.

System Main Relief Valve-A pressure relief valve for the auxiliary circuit and/or a main safety valve for the protection of the pump is recommended and sized for the maximum pump output flow rate. If a main relief valve is used, it must be set above the priority circuit steering relief valve pressure setting.



LS Load Sensing
DS Dynamic Signal
PP Pilot Pressure
CF Control Flow
EF Excess Flow

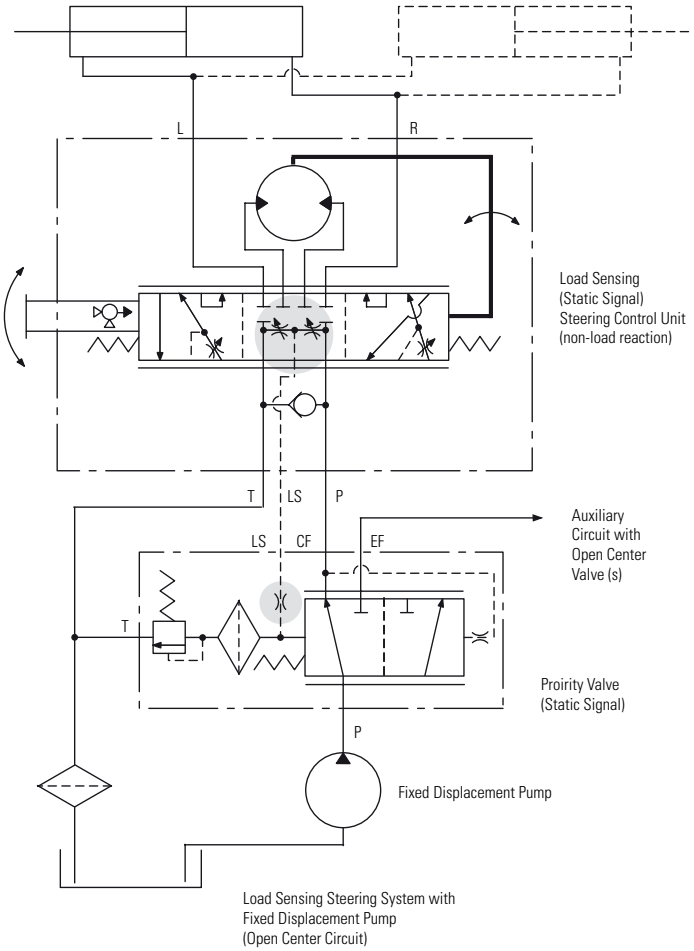
Load Sensing Circuits: Signal Systems

Two types of load sensing signal systems are available -Dynamic and Static

Static Signal

In a Static Signal system, the pump and priority valve senses a static pressure in the sensing line. The effective control pressure is the pressure caused by the spring in the priority valve minus pressure losses in the control flow line.

Used for conventional applications where response or circuit stability is not a problem. The load sensing pilot line should not exceed 2 meters [6 feet] in length.



Hydraulic Circuit Explanation

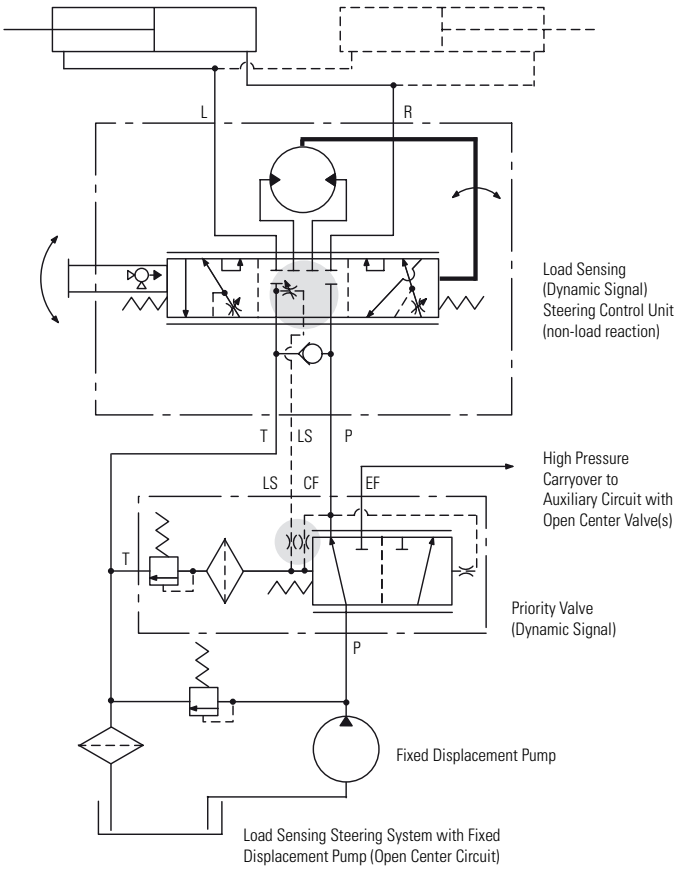
Neutral Circuits: Load Sensing

Dynamic Signal

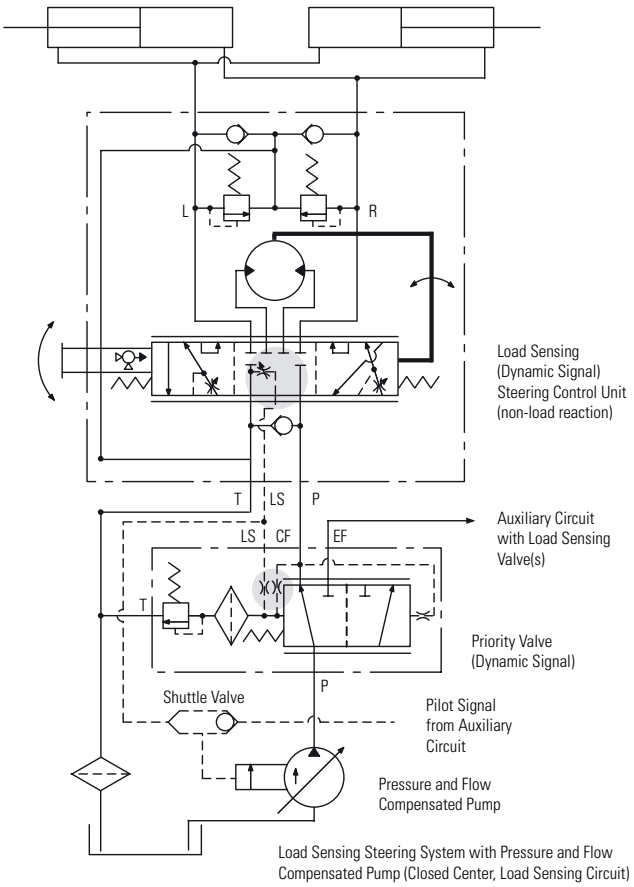
In a Dynamic Signal system, the pump and priority valve senses a pressure in the load sensing line caused by the spring and a small amount of flow through the dynamic signal orifice from the control flow line.

Used for more difficult applications. The Dynamic Signal systems offer the following benefits:

- Faster steering response.
- Improved cold weather start-up performance.
- Increased flexibility to solve problems related to system performance and stability



Load Sensing Steering System with Fixed Displacement Pump (Open Center Circuit)



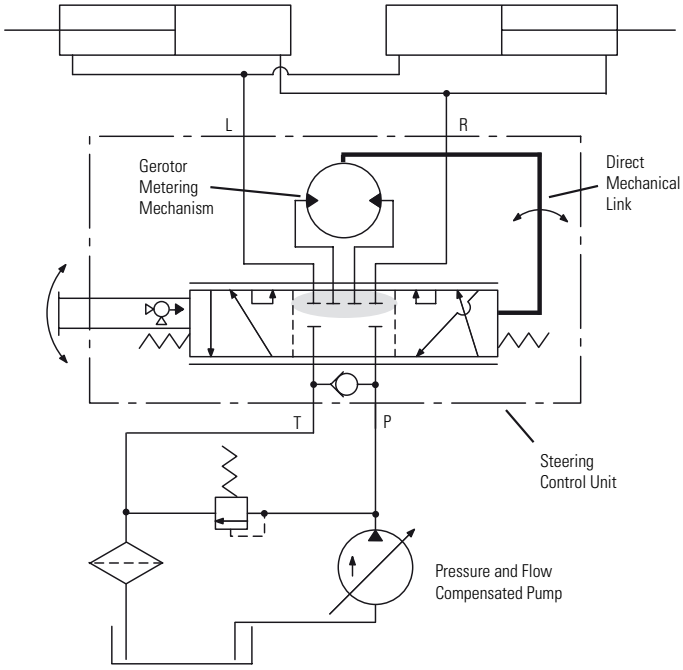
Load Sensing Steering System with Pressure and Flow Compensated Pump (Closed Center, Load Sensing Circuit)

Hydraulic Circuit Explanation

Work Circuits: Non-Load Reaction and Load Reaction

Non-Load Reaction

A non-load reaction steering unit blocks the cylinder ports in neutral, holding the axle position whenever the operator releases the steering wheel.



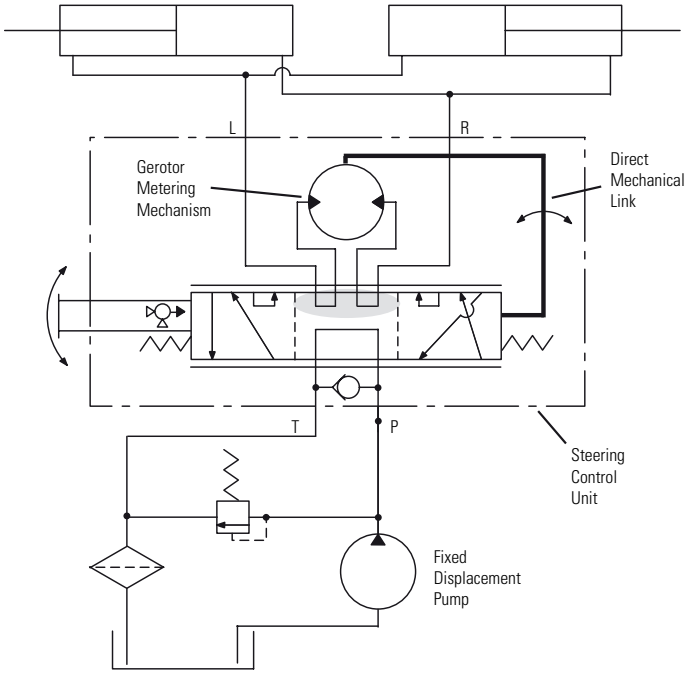
Non-Load Reaction Circuit

Load Reaction

A load reaction steering unit couples the cylinder ports internally (in the neutral position) with the meter gear set. Axle forces are then allowed to return the steering wheel to its approximate original position. Comparable to automobile steering, gradually releasing the wheel mid turn will allow the steering wheel to spin back as the vehicle straightens.

The cylinder system used with load reaction units must have equal oil volume displaced in both directions. The cylinders should be a parallel pair (as shown) or one double rod end unit.

Do not use with a single unequal area cylinder system



Load Reaction Circuit

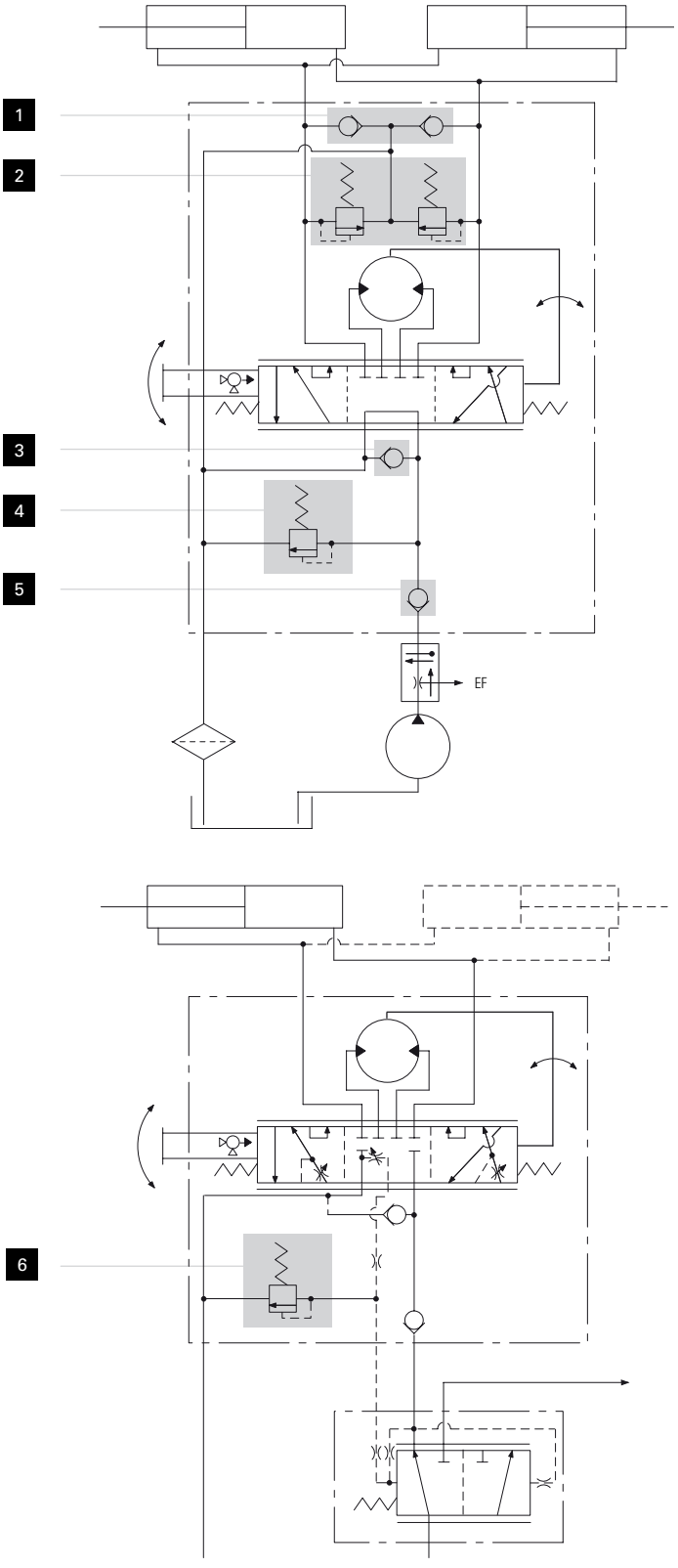
Steering Control Units with Integral Valve

Integral valves are available for the XCEL[45] steering control unit. Included are: Inlet Relief Valve, Cylinder Port Shock Valves, LS-Relief Valve, and Anti-Cavitation Valves for cylinder ports. In addition, a Manual Steering Check Valve for limited manual steering is included.

The integral valves eliminate the need for a separate valve block, and provides versatility to meet any steering circuit standard.

Valve Description:

1. **Anti-cavitation check valve for cylinder ports-** (R & L) protects steering circuit against vacuum (cavitation) conditions.
2. **Cylinder Port Relief Valves-**R & L) protects hoses against pressure surge created by ground forces on the steered axle.
3. **Manual Steering Check Valve**-**converts unit to a hand operated pump for limited manual steering. **Steering units with displacements larger than 160 cc/r [9.8 in3/r] may require a separate power source for limited operation.
4. **Inlet Relief Valve-**limits maximum pressure drop across the steering unit protecting the steering circuit.
5. **Inlet Check Valve-**prevents oil from returning through the steering unit when pressure on the cylinder side is greater than pressure on the inlet side to prevent steering wheel kick.
6. **LS-Relief Valve-**Limits maximum pressure in the steering circuit (LS units only)



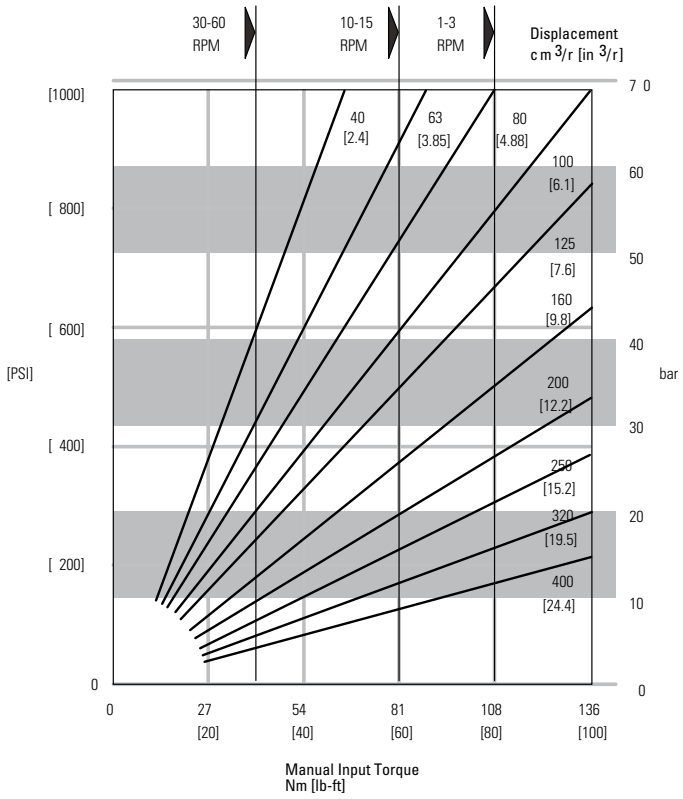
Manual Steering

Description

The steering control unit can provide steering flow when the pump or engine fails. It will pump oil through the meter (gerotor) as the operator applies input or torque to the steering wheel which provides limited manual steering.

Use of Graph

1. Determine steering work port pressure required to preform the desired steer-ing maneuver from vehicle test data. This defines the approximate manual steering pressure level required. Find this value on the vertical axis and construct a horizontal line on the graph.
2. Find the input torque limit on the horizontal axis. Follow this vertically until it crosses the required pressure line of step 1.
3. The maximum steering unit displacement is identified by the first angled line to the left of this inter-section.



1) Maximum flow less than 7,6 l/min [2 GPM].

2) Actual steering pressures required and manual steering capabilities must be verified with vehicle testing. The above curves are intended as a design guide only.

XCEL[45] Dual Displacement

Description and Features

The dual displacement steering control unit allows off road vehicles to retain manual steering capability while reducing the number of components in their system. By using two displacement in one unit the dual displacement offers a better solution to manually steer a vehicle in an unpowered mode without the need of a back-up power system. This simplifies the design and provides a more economical machine.

The dual displacement steering units use two gerotors and a pressure controlled logic valve. The logic valve switches between one displacement for manual steering and the total of both displacements for powered operation. The logic valve is spring returned to the smaller manual displacement when inlet pressure falls bellow 8 bar [120 psi].Above 8 bar[120psi] the logic valve connects both gerotors to provide full powered displacement.

Manual steering Capabilities in unpowered mode

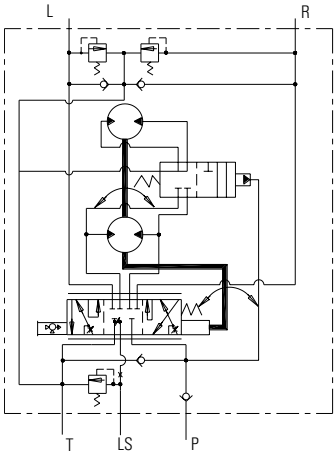
- Eliminates the need of a back-up emergency system.
- Engages the a small displacement in an unpowered mode and allows manual steering.
- Allows vehicles to meet ISO/TUV road regulations

Performance in powered mode

- Both gerotors are engaged to steer the vehicle.
- Same performance as other Eaton steering units.

Additional Features

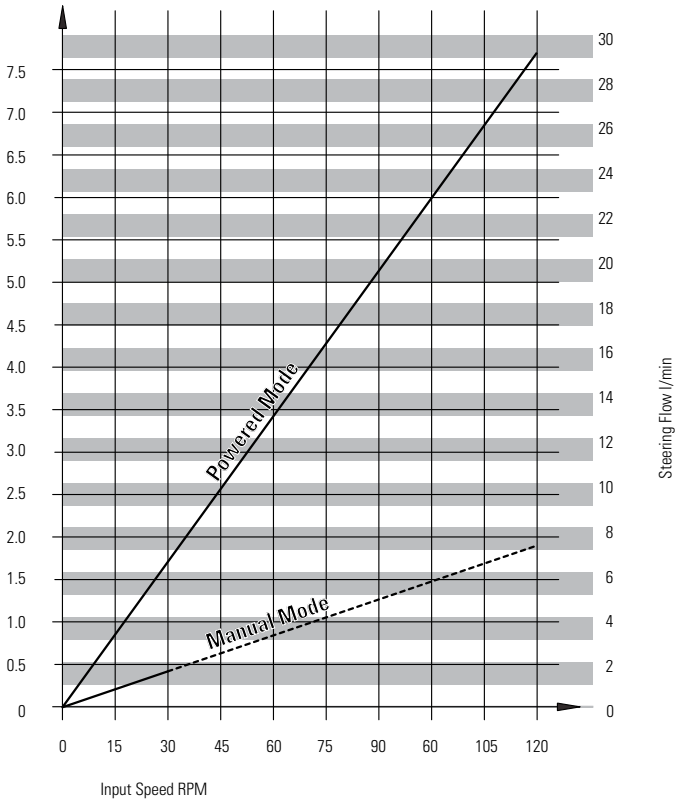
- Steering circuit: Load Sensing Dynamic Signal
- Max. system pressure:190bar[2755 psi].
- Valve options and other features: same as those available on other units
- Innovative low noise design



Displacement Chart

Gerotor 1 Manual displacement	Gerotor 1 and 2 Powered displacement
cm^3/rev	cm^3/rev
80	185
60	220
60	260
60	310
80	205
80	280
100	300
125	285
125	325

Manual 60 cm^3/r [3.6 in^3/r]
Powered 244 cm^3/r [14.9 in^3/r]



Flow vs RPM (for each operating mode)

Eaton Patented Technology

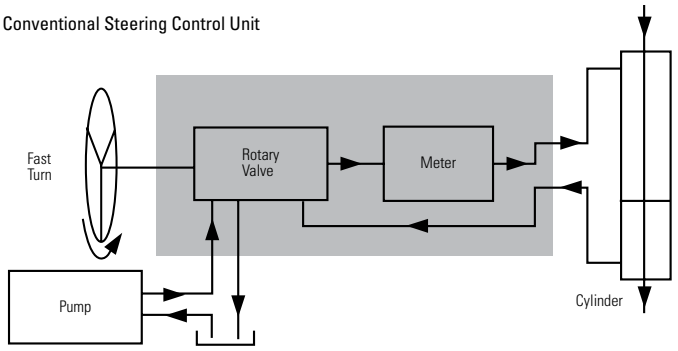
Q-Amp (Flow Amplification) for Load Sensing Circuits

Description and Advantage

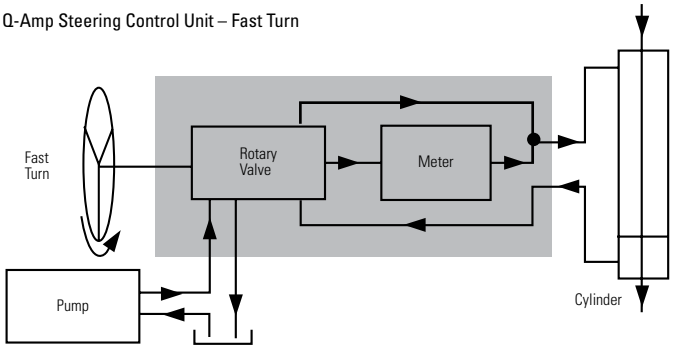
Q-Amp steering units have built in variable orifices that provide flow directly to the cylinder without going through the gerotor section. The orifices do not open until after the gerotor begins to rotate and then gradually open until the desired flow is achieved which is proportional to the flow going through the gerotor.

A typical Q-Amp unit has a ratio of 1.6:1 which means the flow of the cylinder is 1.6 times the flow going through the gerotor when turning the steering wheel at medium to fast speeds. (See model code for available rations)

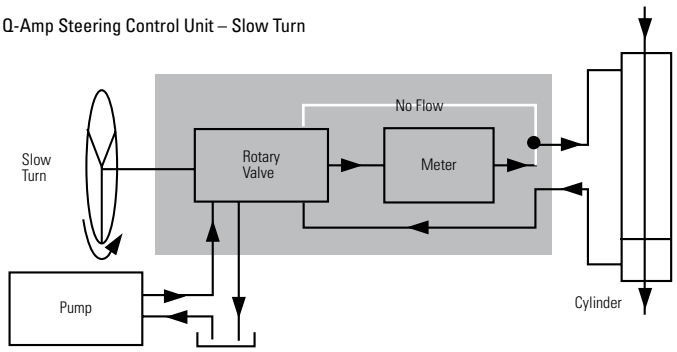
Conventional Steering Control Unit



Q-Amp Steering Control Unit – Fast Turn

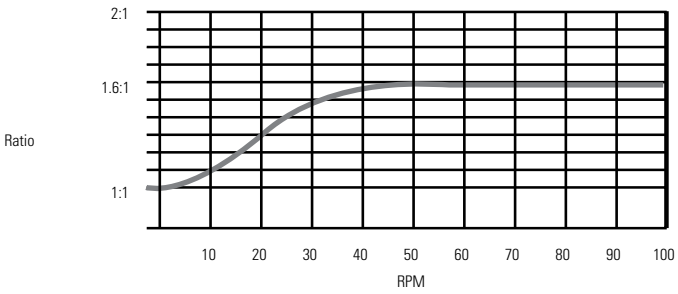


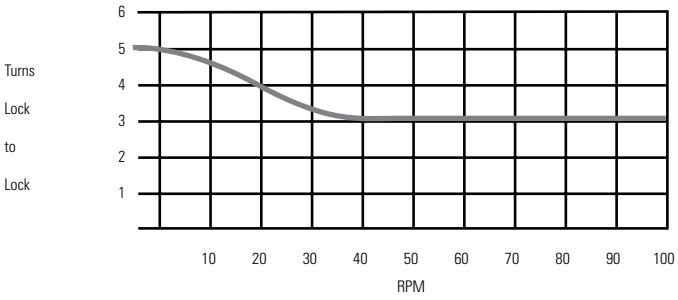
Q-Amp Steering Control Unit – Slow Turn



Features

Variable Ratio





Manual Steering

Steering a vehicle with loss of engine power may not be possible with a large displacement steering control unit(SCU).Q-Amp with manual feature has the smaller additional flow requirement of the larger displacement SCU for power steering.

Single Cylinder (Unequal area)

On vehicles with one single unequal area cylinder the steering wheel turns lock to lock are more in one direction than the other. When extending the rod one would get more turns than when retracting it. A different Q-Amp ratio while turning in one direction versus the other can be used to give an equal number of turns lock to lock in each direction.

Covered By One or more of the following U.S. and foreign Patents: 4759182, 4862690, 4781219. Unequal area Q-Amp.

Eaton Patented Technologies

Cylinder Damping

Description

Cylinder damping can help smooth the steering action of large articulated vehicles such as loaders, scrapers, and skidders. These vehicles have overhanging weight with high inertial loads. This energy is dissipated by the cylinder damping orifices which bleed a small amount of flow from the cylinder port to tank.

Cylinder Damping has 3 different levels of application. Three levels can be engineered to fit your application.

Benefits

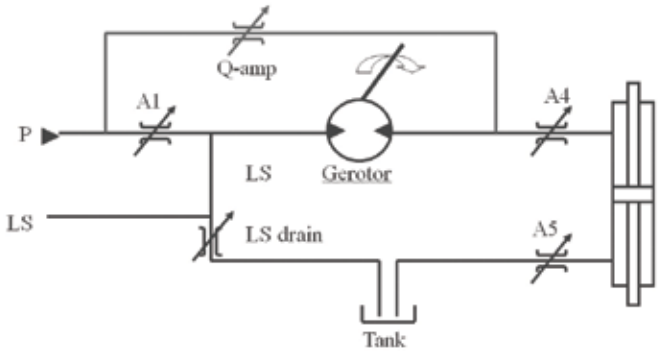
- Reduces jerking motion on medium and large articulated vehicles.
- Damps or stabilizes unstable systems.

Applications— Large Articulated Vehicles

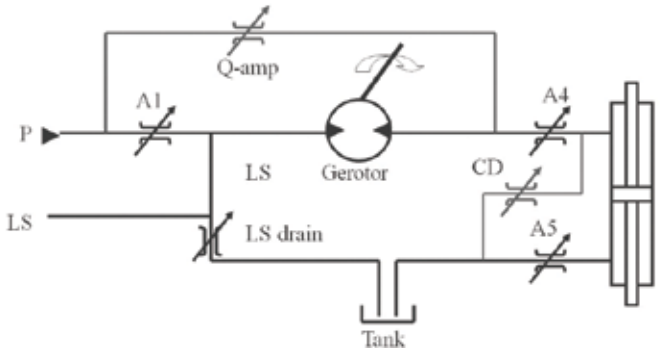
- Wheel Loaders
- Skidders
- Scrapers

Steering Control Units with Cylinder Damping
Patent No. 5080135

Flow Amplification without Cylinder Damping



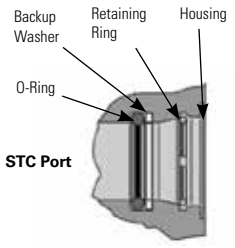
Flow Amplification with Cylinder Damping

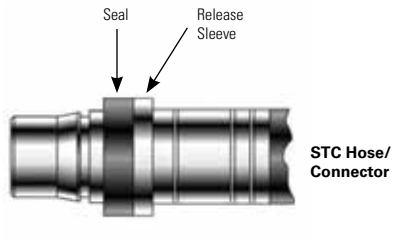


Eaton Patented Technologies

STC Direct Porting

With the Snap-To-Connect (STC) Direct Porting option, the fitting profile is machined into the SCU housing, eliminating the need for extra STC fittings. This revolutionary and patented porting technology provides leak-proof sealing and has operating pressure capability exceeding 4500PSI (310bar).





Benefits

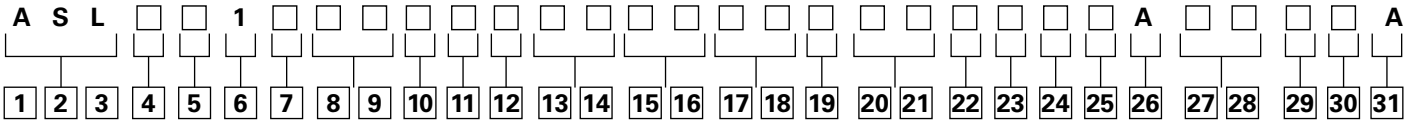
- STC Direct Ports provide a great opportunity for significant cost savings compared to threaded fittings
- Eliminates the need for assembly tools during installation
- Eliminates installation variability
- Improves ergonomics - reduces installer effort to connect
- Improves serviceability
- High quality, leak-proof seal
- Eliminates connector leakage
- Compact design and overall lighter weight

Model Code

Customer Order Information

The following 31-digit coding system has been developed to identify all of the configuration options for the XCEL[45] steering control units. Use this model code to specify a unit with the desired features. All 31-digit of the code must be present when ordering. You may want to be photocopy the matrix below to ensure that each number is entered in the correct box.

This model code shows Preferred Products only. For a complete model code listing all available options, please contact your Eaton representative.



Nos	Feature	Code	Festure Description
1 2 3	Product Series	ASL	Series Xcel[45] Steering Control
4	Unit Type	A	Standard
		B	Dual Displacement
5	Nominal Flow Rating	1	11.3 L / min [3.00 gal/min]
		2	22.7 L / min [6.00 gal/min]
		3	45 L / min [12.00 gal/min]
		4	37 L / min [10.00 gal/min] Q-AMP
		5	75 L / min [20.00 gal/min] Q-AMP
6	Inlet Pressure Rating	1	190 bar [2755 lbf/in2]
7	Return Pressure Rating	A	21 bar [300 lbf/ in2] Maximum
		B	10 bar [145 lbf/ in2] Maximum (For low input torque)
8 9	Displacement	01	40 cm^3/r [2.4 in3/r]
		02	50 cm^3/r [3.1 in3/r]
		03	63 cm^3/r [3.85 in3/r]
		04	80 cm^3/r [4.88 in3/r]
		05	100 cm^3/r [6.1 in3/r]
		06	125 cm^3/r [7.6 in3/r]
		07	160 cm^3/r [9.8 in3/r]
		08	200 cm^3/r [12.2 in3/r]
		09	250 cm^3/r [15.2 in3/r]
		10	320 cm^3/r [19.5 in3/r]
		11	400 cm^3/r [24.4 in3/r]
		12	500 cm^3/r [30.5 in3/r]
		13	240 cm^3/r [14.4 in3/r] / 80 cm^3/r [4.8 in3/r]
		14	280 cm^3/r [16.8 in3/r] / 80 cm^3/r [4.8 in3/r]
		15	220 cm^3/r [13.2 in3/r] / 60 cm^3/r [3.6 in3/r]
		16	310 cm^3/r [18.9 in3/r] / 60 cm^3/r [3.6 in3/r]
		17	300 cm^3/r [18.3 in3/r] / 100 cm^3/r [6.1 in3/r]
		18	260 cm^3/r [15.9 in3/r] / 60 cm^3/r [3.6 in3/r]
		19	205 cm^3/r [12.5 in3/r] / 80 cm^3/r [4.8 in3/r]
		20	185 cm^3/r [11.3 in3/r] / 60 cm^3/r [3.6 in3/r]
		21	325 cm^3/r [19.8 in3/r] / 125 cm^3/r [7.6 in3/r]
		27	160 cm^3/r [9.8 in3/r] / 60 cm^3/r [3.6 in3/r]
10	Flow] Amplication	A	NONE (NO Q-AMP)
		B	1.60:1.00
		C	2.00:1.00
11	Neutral Circuit	A	Open Center
		B	Lond Sensing, Static signal
		C	Lond Sensing, Dynamic signal
		D	Close Center
12	Load Circuid	A	Non-Load Reaction
		B	Load Reaction

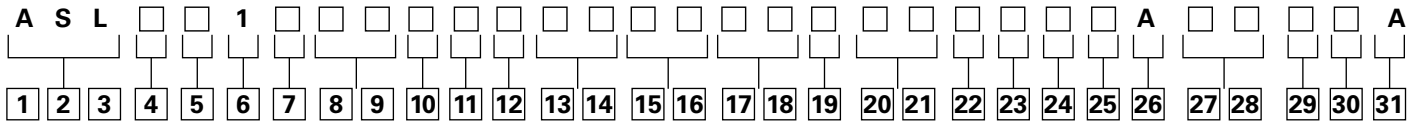
Nos	Feature	Code	Festure Description					
13 14	Valve Options		MSC	ICV	IRV	ACV	CRV	LSRV
	MSC = Maual Steering	01	•					
	Check Valve	02	•	•				
	ICV = Inlet Check Valve	03	•		•			
	IRV = Inlet Relief Valve	04	•	•	•			
	CRV = Cylider Relief Valve	05	•	•		•	•	
	ACV = Anti-Cavitation	06	•			•	•	
	Relief Valve	07	•	•	•	•	•	
	LSRV= Load Sensing	08	•		•	•	•	
	Relief Valve	09	•	•	•	•		
		10	•	•		•		
		11	•			•		
		12	•					•
		13	•	•		•		•
		14	•			•	•	•
		15	•	•				•
		16	•	•		•	•	•
15 16	Inlet or Load Sensing Relief Valve Setting	00	NONE					
		04	75 bar [1087 lbf/in2]					
		05	65 bar [940 lbf/in2]					
		06	85 bar [1230 lbf/in2]					
		07	115 bar [1670 lbf/in2]					
		08	60 bar [870 lbf/in2]					
		09	63 bar [915 lbf/in2]					
		10	70 bar [1015 lbf/in2]					
		11	80 bar [1160 lbf/in2]					
		12	90 bar [1305 lbf/in2]					
		13	95 bar [1377 lbf/in2]					
		14	100 bar [1450 lbf/in2]					
		15	105 bar [1522 lbf/in2]					
		16	110 bar [1595 lbf/in2]					
		17	120 bar [1696 lbf/in2]					
		18	125 bar [1812lbf/in2]					
		19	130 bar [1885 lbf/in2]					
		20	140 bar [2030 lbf/in2]					
		21	150 bar [2175 lbf/in2]					
	``	22	155 bar [2247 lbf/in2]					
		23	160 bar [2320 lbf/in2]					
		24	165 bar [2392 lbf/in2]					
		25	175 bar [2537 lbf/in2]					
		26	180 bar [2610 lbf/in2]					
		28	190 bar [2755 lbf/in2]					
		29	135 bar [1960 lbf/in2]					
		30	170 bar [2465 lbf/in2]					
		31	142 bar [2059 lbf/in2]					

Model Code

Customer Order Information

The following 31-digit coding system has been developed to identify all of the configuration options for the XCEL[45] steering control units. Use this model code to specify a unit with the desired features. All 31-digit of the code must be present when ordering. You may want to be photocopy the matrix below to ensure that each number is entered in the correct box.

This model code shows Preferred Products only. For a complete model code listing all available options, please contact your Eaton representative.

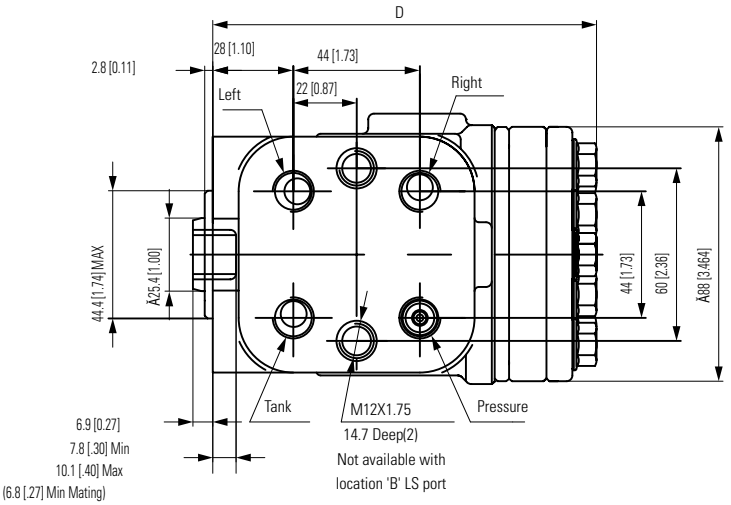


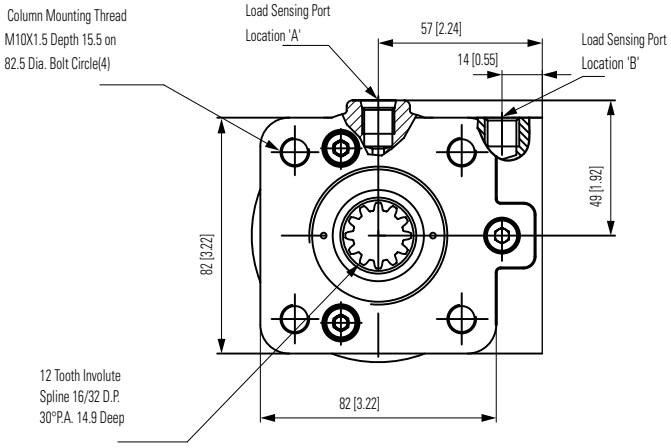
Nos	Feature	Code	Festure Description
17 18	Cylider Relief Valve Setting	00	None
		07	115 bar [1670 lbf/in2]
		14	100 bar [1450 lbf/in2]
		15	105 bar [1522 lbf/in2]
		16	110 bar [1595 lbf/in2]
		17	120 bar [1740 lbf/in2]
		18	125 bar [1812 lbf/in2]
		20	140 bar [2030 lbf/in2]
		21	145 bar [2102 lbf/in2]
		22	150 bar [2175 lbf/in2]
		23	160 bar [2320 lbf/in2]
		25	175 bar [2537 lbf/in2]
		27	185 bar [2682 lbf/in2]
		28	190 bar [2755 lbf/in2]
		29	200 bar [2900 lbf/in2]
		30	210 bar [3045 lbf/in2]
		31	220 bar [3190 lbf/in2]
		32	225 bar [3262 lbf/in2]
		33	230 bar [3335 lbf/in2]
		34	235 bar [3407 lbf/in2]
		35	240 bar [3480 lbf/in2]
		36	250 bar [3625 lbf/in2]
		37	195 bar [2830 lbf/in2]
		38	205 bar [2972 lbf/in2]
19	P,T,L and R Port Size	A	4X M18 x 1.5-6H Metric Port
		B	4X M18 x 1.5-6H Metrc O-ring Port
		C	4X M20 x 1.5-6H Metric Port
		D	4X M20 x 1.5-6H Metric O-ring Port
		E	4X G .500 BSP Straight Thread Port
		J	4X .750-16 UNF-2B SAE O-ring Port
		M	Bolt On Valve
20 21	Additional Port (LS Port)	AA	NONE
		AB	M12 x 1.5-6H Load Sensing Metric Port
		AC	M12 x 1.5-6H Load Sensing Metric O-ring Port
		AD	G .250-19 BSP Straight Thread Load Sensing Port
		AF	.4375-20 UNF-2B Load Sensing SAE O-ring Port
		AH	Bolt On Valve Load Sensing Port On Port Face
		AJ	.4375-20 UNF-2B Load Sensing SAE O-ring Port On Port Face
		AK	G .250-19 BSP Straight Thread Load Sensing Port On Port Face

Nos	Feature	Code	Festure Description
22	Mounting Thread	A	4-M10X1.5 Mounting Threads Mounting Face
		B	4-3/8-16 Mounting Threads Mounting Face
23	Mounting Threads Port Face	A	NONE
24	Mechanical Interface	A	Internal Involute Spline, 12 Teech 16/32 DP 30 Degree PA
25	Input Torque	1	Low
		3	Standard
		2	Super Low
		4	Neutral Low (For Q-amp Feature)
26	Fluid Type	A	Reference Eaton Techincal Bulletin 3-401
27 28	Special Features	AA	NONE
29	Paints & Packaging	1	Black Paint
		2	Blue Paint
30	Identification	0	Eaton Product Number On Namplate
		1	Bar Code, Customer Number On Name Plate
31	Design Code	A	001

XCEL[45] Steering Control Unit

Installation Dimensions





Load Sensing Port Options:

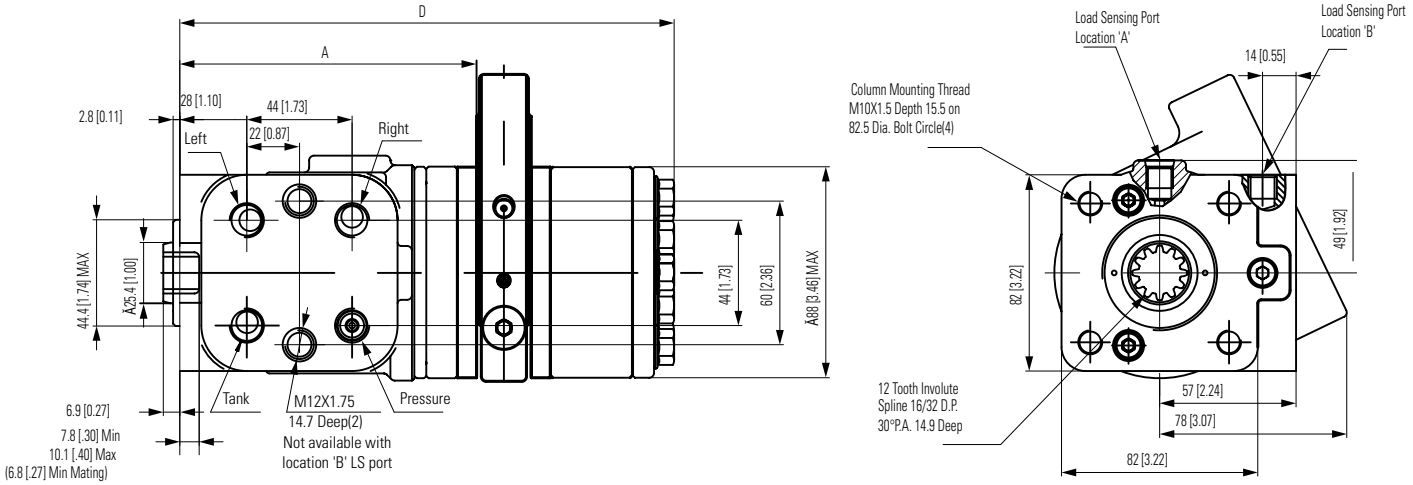
Option A- Only used for LS units with LS relief valve in priority valve

Option B- Only used for LS units with LS relief valve in steering unit

Port	Load Sensing Thread	Flange Thread
M18X1.5	M12X1.5	M10X1.5
M18X1.5 O-ring	M12X1.5 O-ring	M10X1.5
M20X1.5	M12X1.5	M10X1.5
M20X1.5 O-ring	M12X1.5 O-ring	M10X1.5
G-1/2 BSP	G-1/4-19 BSP	M10X1.5
3/4-16 UNF	7/16-20 UNF	M10X1.5
3/4-16 UNF	7/16-20 UNF	3/8-16 UNC

Displacement	Dimension B
cm^3/rev	mm
50	126.5
63	128
80	130.5
100	133
125	136
160	141
200	146
250	152
320	162
400	172
500	184

Dual Displacement
Installation Drawing



Load Sensing Port Options:

Option A- Only used for LS units with LS relief valve in priority valve

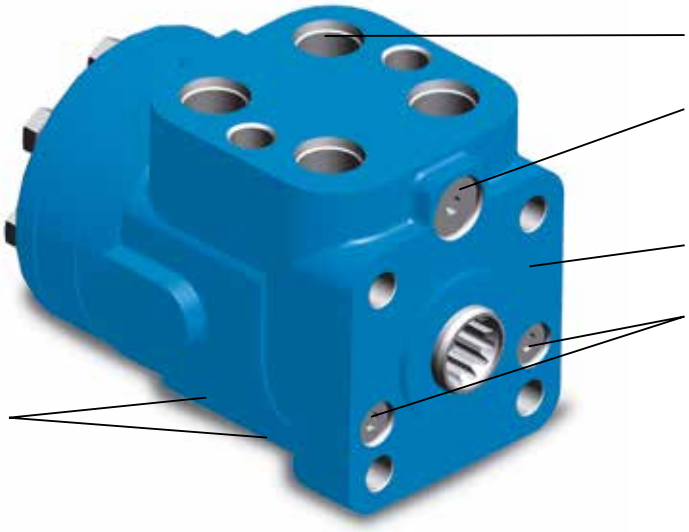
Option B- Only used for LS units with LS relief valve in steering unit

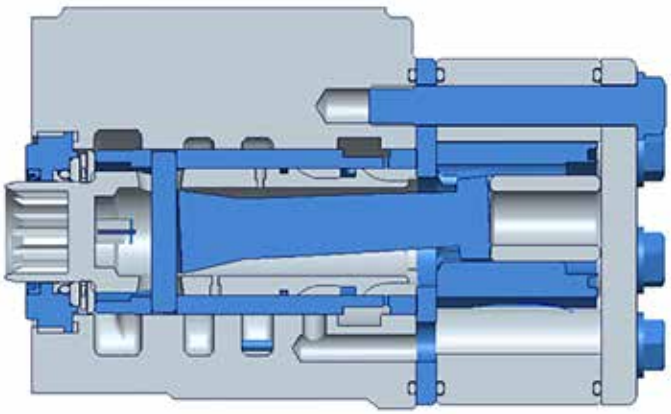
Port	Load Sensing Thread	Flange Thread
M18X1.5	M12X1.5	M10X1.5
M18X1.5 O-ring	M12X1.5 O-ring	M10X1.5
M20X1.5	M12X1.5	M10X1.5
G-1/2 BSP	G-1/4-19 BSP	M10X1.5
3/4-16 UNF	7/16-20 UNF	M10X1.5

Displacement Powered (Manual) CC/R	Dimension A mm	Dimension D mm
185 (60)	121.2	191.5
220 (60)	121.2	197
260 (60)	121.2	203.8
310 (60)	121.2	213.5
205 (80)	124.7	195
280 (80)	124.7	207.3
300 (100)	128.2	210.8
285 (125)	133	208.8
325 (125)	133	215.6

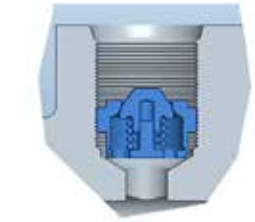
XCEL[45] Steering Control Unit

Section Drawing and Integral Valves





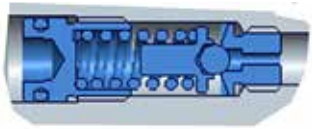
AA



BB

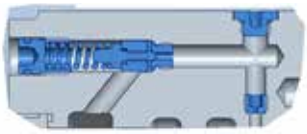
CC

DD



EE

FF



Priority Valve
Introduction

The load sensing priority valve separates the steering and auxiliary functions. The flow is supplied first on a priority basis to the steering circuit (CF) to satisfy the steering requirements. All remaining flow is directed to the auxiliary circuit (EF). When steering is inactive all flow goes to the auxiliary circuit (EF).

There are two types of signals available: static and dynamic.

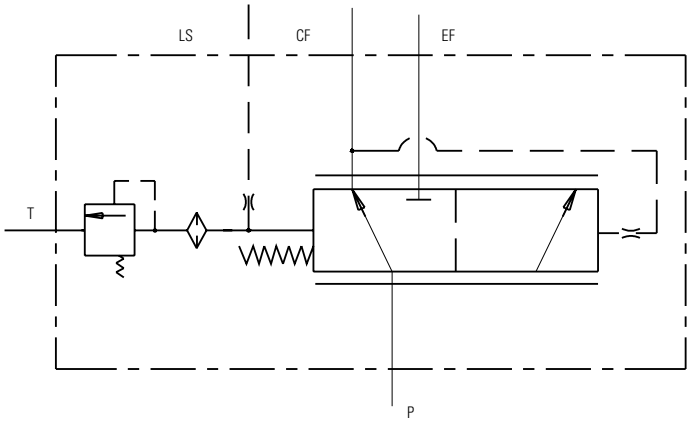
In a static signal system, the pump and priority valve senses a static pressure in the sensing line.

Static Signal Priority Valve must be used with Static Signal Load Sensing SCU.

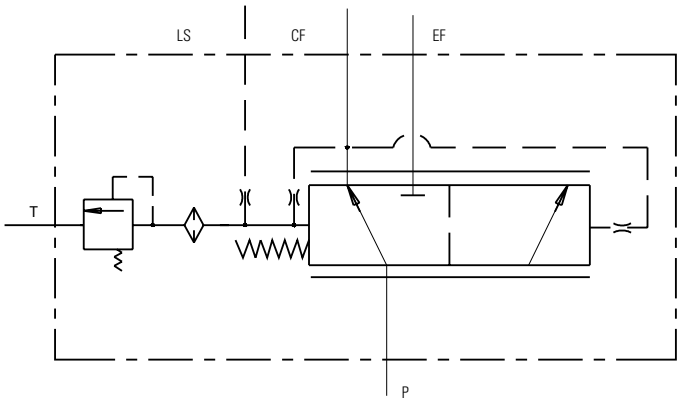
In a dynamic signal system, the pump and priority valve senses a pressure in the load sensing line caused by the spring and a small amount of flow through the dynamic signal orifice from the control flow line.

Dynamic Signal Priority Valve must be used with Dynamic Signal Load Sensing SCU

Static signal



Dynamic signal



There are 4 types of Priority Valve

- **BOPV:** The Priority Valve is designed mounted onto Steering unit directly, which will save room for installation.
- **VLC / VLE / VLH:** In-Line designed Priority Valve, Need a LS Line to connect LS Ports in Steering Control Unit and Priority Valve

Specifications:

BOPV

- Rated flow: 60LPM
- Load circuit: Dynamic signal
- Rated inlet pressure: 241 bar

VLC

- Rated flow: 60LPM
- Load circuit: Dynamic signal & Static Signal
- Rated inlet pressure: 241 bar
- Max. LS Relief Valve: 190 bar

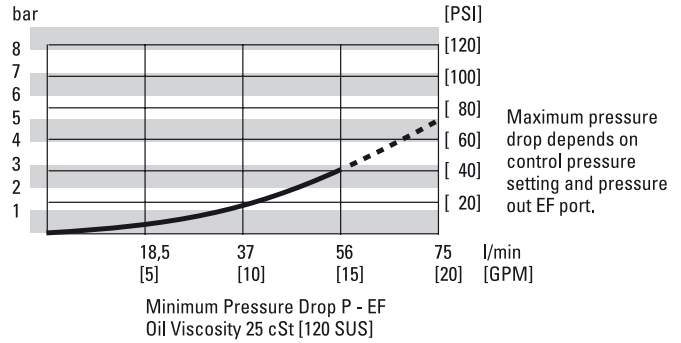
VLE

- Rated flow: 150LPM
- Load circuit: Dynamic signal & Static Signal
- Rated inlet pressure: 241 bar
- Max. LS Relief Valve: 190 bar

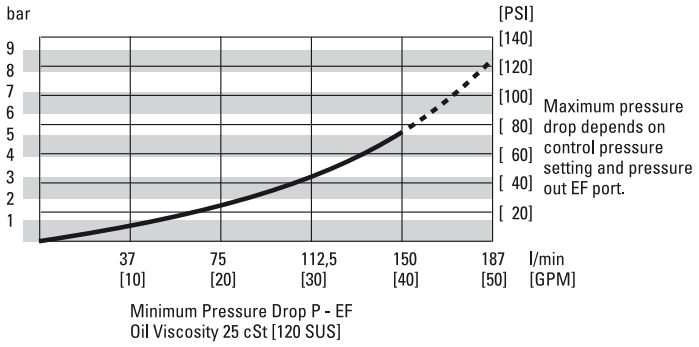
VLH

- Rated flow: 240LPM
- Load circuit: Dynamic signal & Static Signal
- Rated inlet pressure: 241 bar
- Max. LS Relief Valve: 190 bar

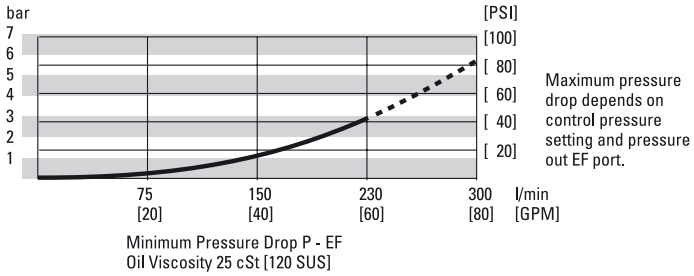
VLC Series Pressure drop Curve



VLE Series Pressure drop Curve



VLH Series Pressure drop Curve



Priority Valve

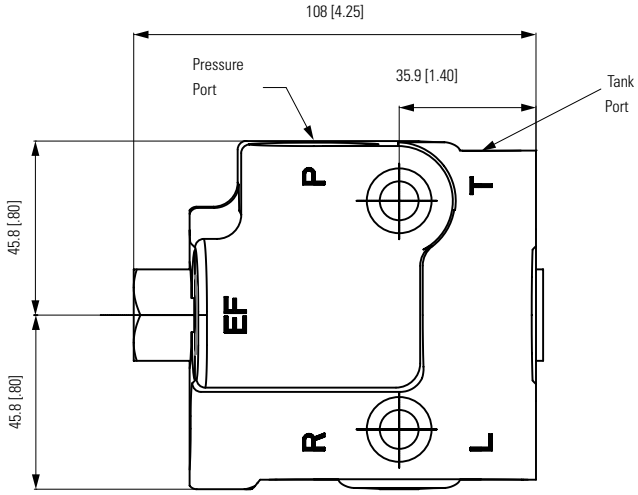
Bolt On VLC Priority Valve (BOPV)

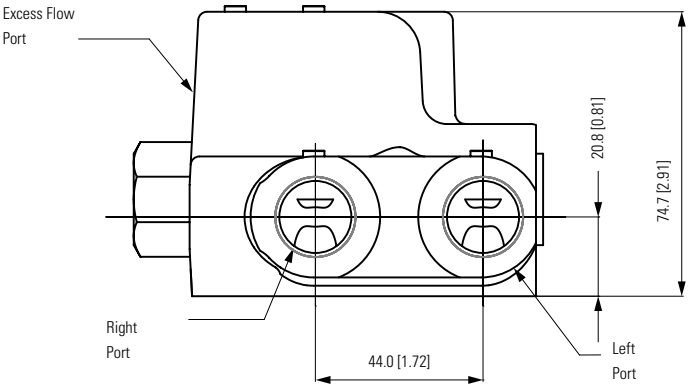
The Bolt On VLC Priority Valve is designed to be directly mounted onto the port face of a Load Sensing Steering Control Unit.

Benefit:

- Packaged design, eliminating connecting pipes and save the installation room.

Dimensions





Part Number

	Control Pressure (Bar)		
Port & Thread	**5.2**	**7.6**	**10**
P&EF- G1/2-14 R&L&T-3/8-19	880-1450	880-1480	880-1490
P&EF-M20X1.5 R&L&R-M18X1.5	880-1550	880-1580	880-1590
P&EF-G1/2-14 R&L&R-G1/2-14	880-1750	880-1780	880-1790

The BOPV is ordered by a product number (together with Eaton Xcel[45] Units)

880-1450

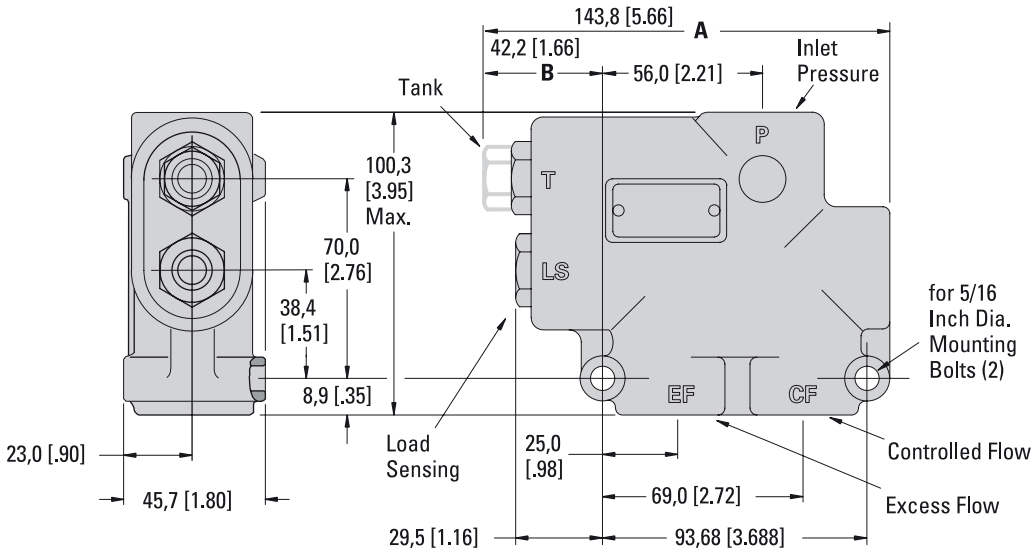
Product Number

Please contact Engineering for more information

Priority Valve

VLC in Line Priority Valve

Dimension	A	B
With LS relief valve (SAE thread)	143	41
With LS relief valve Metric &R (BSP)	166	64
Without LS relief valve	126	24



Priority Valve is ordered by a product number

881 - 1203 - 065

- 065 — System Pressure Code Number
- 1203 — Product Number for VLC In-Line Priority Valve

VLC In-Line Priority Valve

Port & Thread	Signal Type & Control Pressure Bar [PSI]				
	Dynamic 5.2 [75]	Static 5.2 [75]	Dynamic 7.6 [110]	Static 6.9 [100]	Dynamic 10.0 [145]
P&EF: 7/8-14 UNF CF: 3/4-16 UNF LS&T:7/16-20 UNF	881-2101	/	881-2102	881-1103	881-2103
P&EF: M22X1.5 O-ring CF: M18X1.5 O-ring LS&T: M12X1.5 O-ring	881-2201	881-1202	881-2202	881-1203	881-2203
P&EF: G1/2-14 CF: G1/2-14 LS&T: G1/4-19	881-2301	881-1302	881-2302	881-1303	881-2303
P&EF: M22X1.5 CF: M18X1.5 LS&T: M12X1.5	881-2501	881-1502	881-2502	881-1503	881-2503

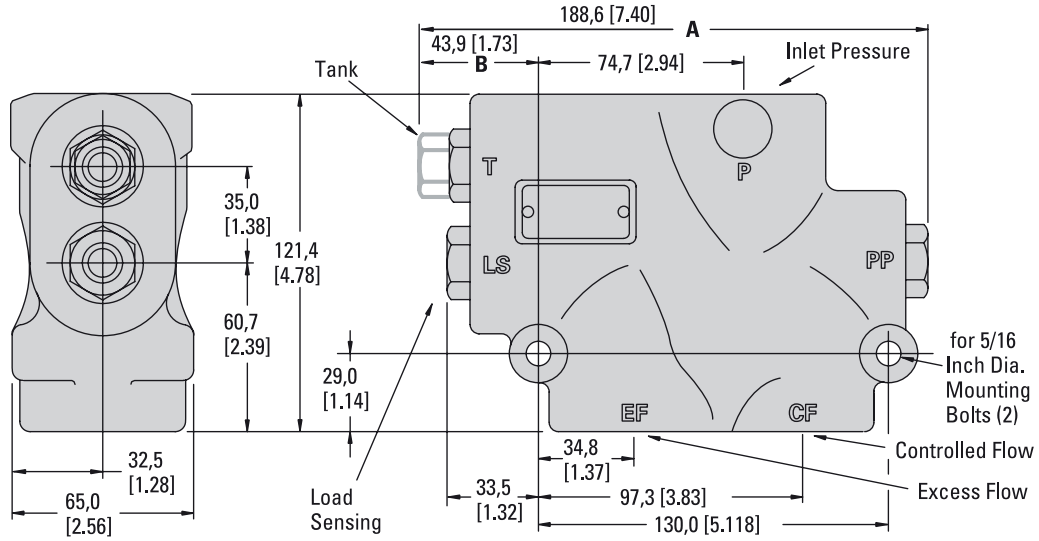
Note: Select a number from this table and take reference of the connection dimensions of Steering Control Unit on Page 18 & Page 19.

Please always show your selected product number when you place an order.

Priority Valve

VLE in Line Priority Valve

Dimension	A	B
With LS relief valve (SAE thread)	186	41
With LS relief valve Metric &R (BSP)	209	64
Without LS relief valve	169.5	24.4



Priority Valve is ordered by a product number

882 - 1103 - 065

- 065 — System Pressure Code Number
- 882 - 1103 — Product Number for VLE In-Line Priority Valve

VLE In-Line Priority Valve

Port & Thread	Signal Type & Control Pressure Bar [PSI]			
	Static 6.9[100]	Dynamic 8.6[125]	Static 10.3[150]	Dynamic 12.8[185]
P&EF: 1-1/16-12 UNF CF: 3/4-16 UNF LS&T: 7/16-20 UNF	/	882-2302	882-1303	882-2303
P&EF: G3/4-14 CF: G1/2-14 LS&T: G1/4-19	882-1702	882-2702	882-1703	882-2703
P&EF: M27X2 O-ring CF: M22X1.5 O-ring LS&T: M12X1.5 O-ring	882-1902	882-2902	882-1903	882-2903

Note: Select a number from this table and take reference of the connection dimensions of Steering Control Unit on Page 18 & Page 19.

Please always show your selected product number when you place an order.

VLC & VLE In-Line Priority Valve

Customer Order Information

System Pressure Code Number

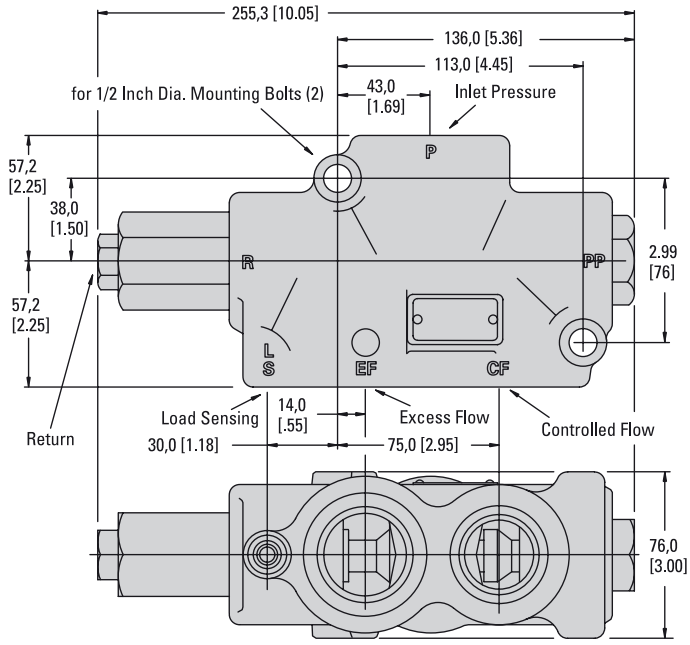
Number	Bar	[psi]	Number	Bar	[psi]	Number	Bar	[psi]
017	78	1125	037	112	1625	056	145	2100
018	79	1150	038	114	1650	057	147	2125
019	81	1175	039	116	1675	058	148	2150
020	83	1200	040	117	1700	059	150	2175
021	84	1225	041	115	1725	060	152	2200
022	86	1250	042	121	1750	061	153	2225
023	88	1275	043	122	1775	062	155	2250
024	90	1300	044	124	1800	063	157	2275
026	93	1350	045	126	1825	064	159	2300
027	95	1375	046	128	1850	065	160	2325
028	97	1400	047	129	1875	066	162	2350
029	98	1425	048	131	1900	067	164	2375
030	100	1450	049	133	1925	068	166	2400
031	102	1475	050	134	1950	069	167	2425
032	103	1500	051	136	1975	070	169	2450
033	105	1525	052	138	2000	071	171	2475
034	107	1550	053	140	2025	072	172	2500
035	109	1575	054	141	2050	073	174	2525
036	110	1600	055	143	2075	076	179	2600

Note: If there is not a relief valve, the system pressure code number is 000. Select a pressure code from this table and include it in the product number you determined.
Please always show your selected product number when you place an order.

Priority Valve

VLH in Line Priority Valve

Dimensions



Priority Valve is ordered by a product number

883 - 2702 - 065

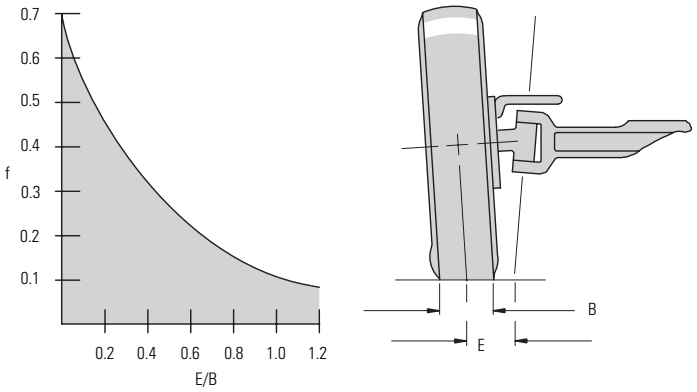
- 065 — System Pressure Code Number
- 883 - 2702 — Product Number for VLH In-Line Priority Valve

VLH In-Line Priority Valve

Port & Thread	Signal Type & Control Pressure Bar [PSI]	
	Dynamic 5.9[85.5]	**Dynamic 11.4[165.3]**
P&EF: 1-5/8-12 UNF CF: 1-1/16-12 UNF LS&T: 7/16-20 UNF	/	883-2203
P&EF: M42X2 O-ring CF: M27X2 O-ring LS&T: M12X1.5 O-ring.	883-2702	883-2703

Note: Select a number from this table and take reference of the connection dimensions of Steering Control Unit on Page 18 & Page 19.
Please always show your selected product number when you place an order

Step One: Kingpin Torque



Typical values based on rubber tired vehicles on dry concrete.

$$T = w \bullet f \sqrt{\frac{B^2}{8} + E^2}$$

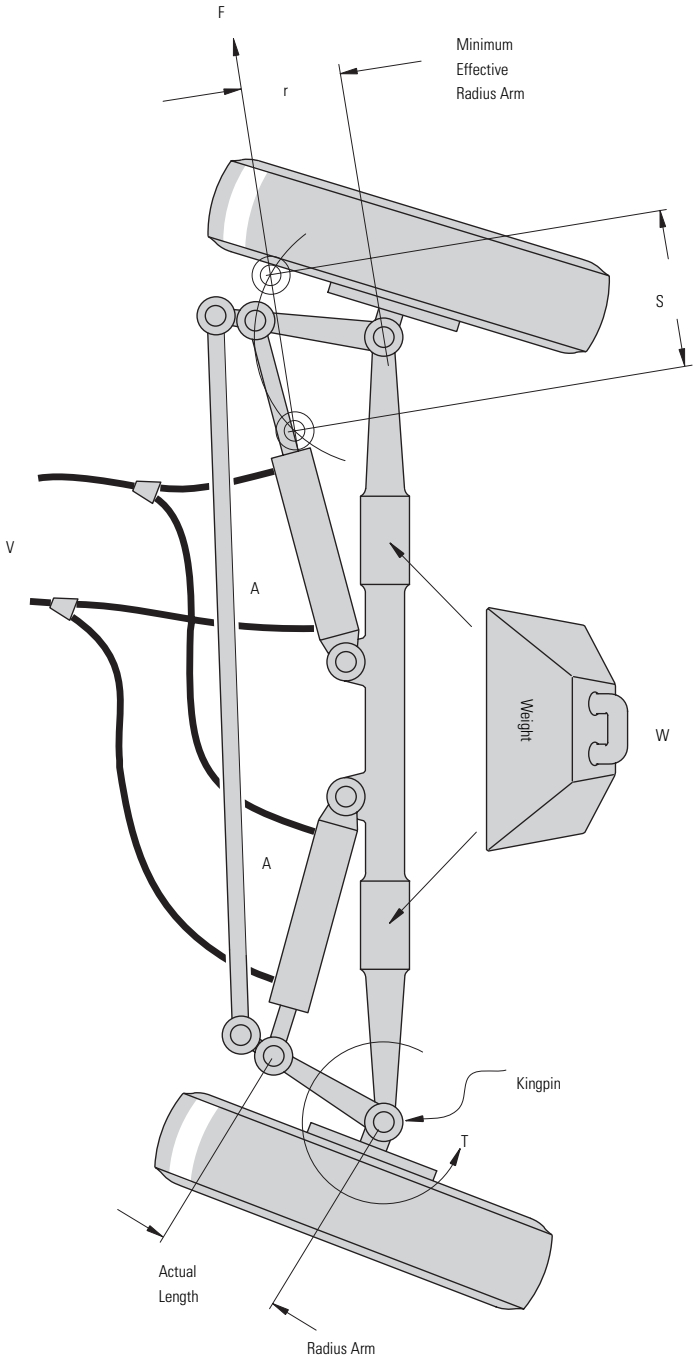
T = Total Kingpin Torque required to steer axle.

W = Vehicle Weight supported by the steered axle.

f = Coefficient of friction (dimensionless). Based on 0.7 as a Maximum. Determine from chart at left.

B = Nominal width of the tire print (see diagram above).

E = Kingpin Eccentric (use nominal tire width).



Step Two:

Force Required

$$F = \frac{T}{r}$$

F = Force required for the axle.

T = Kingpin torque as determined in Step 1. The value calculated in Step 1 is the total torque for the axle. If the steered axle is power driven, double this value to ap- proximate the additional dynamic loads.

r = Effective radius arm about the kingpin axis at which the cylinder force is applied. The effective radius is the mini mum distance from kingpin to the axis of the cylinder… not the actual length of the arm.

Cylinder Area

$$A = \frac{E}{P}$$

A = Cylinder area for the axle cylinder set.

F = Force required

P = Hydraulic pressure

For vehicle with a steered axle that can never be overloaded use 80% of the steering circuit relief valve setting. For moderately loaded vehicles use 60%. For vehicles that can be severely overloaded use 30%.

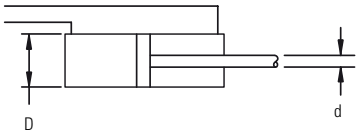
Cylinder Diameter

Once the required cylinder set area is determined, the cylinder diameter can be calculated.

D = Inside diameter of cylinder.

d = Rod diameter as required.

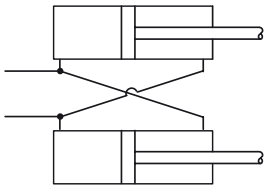
Differential Cylinder



$$D = \sqrt{\frac{4A}{\pi} + d^2}$$

Note: $\left(\frac{d}{D}\right)^2 \leqslant .15$

Cross Connected Cylinder

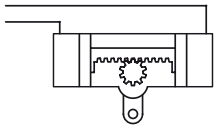


$$D = \sqrt{\frac{2A}{\pi} + \frac{d^2}{2}}$$

Balanced Cylinder

$$D = \sqrt{\frac{4A}{\pi} + d^2}$$

Opposed Cylinder



$$D = \sqrt{\frac{4A}{\pi}}$$

Cylinder Stroke

S = Stroke Length

The cylinder stroke is determined by axle geometry. That is, the required stroke is a function of the radius arm and the total angle through which the arm turns.

Differential Cylinder (Large Volume) $V = S \times \frac{\pi}{4} \times D^2$

Differential Cylinder (Small Volume or Balanced Cylinder) $V = S \times \frac{\pi}{4} \left(D^2 - d^2\right)$

Cross Connected Cylinder $V = S \times \frac{\pi}{4} \left(2D^2 - d^2\right)$

Cylinder Volume V = Volume $V = S \times A$

The volume of oil required to move cylinder rod(s) through the entire stroke.

Step Three:

Selecting Steering Unit Displacement

Before proceeding further, a decision must be made as to the number of steering wheel revolutions desired for the application to steer the axle from full one side to the other. Depending on vehicle usage, this will vary, normally 2 1/2 to 5 1/2 with 4 being a good typical value

$$\text{Displ.} = \frac{V}{N}$$

V = Volume full stroke

N = number of steering wheel revolutions lock to lock

Once this calculation is complete, select the closest standard steering unit displacement from the catalog information.

Now the number of steering wheel revolutions should be recalculated.

$$N = \frac{V}{\text{displ.}}$$

displ. = Steering unit displacement per revolution.

Note: for different cylinder applications, the cylinder volume will be different for right and left turns and the value N will vary accordingly.

Step Four:

Calculating Required Pump Flow

Pump sizing is important to assure adequate power for steering under all operating conditions. The required pump flow can be calculated by the following equation.

QP =	Rmax. x displ.
QP (L/min):	Required pump flow.
Rmax =	Max. steering wheel input of steering control unit (SCU).
displ. =	Displacement of steering control unit per revolution.

Before proceeding to evaluation required pump flow the maximum required steering wheel speed must be determined. Typically 120 revolutions per minute (RPM) is used for Rmax.

- It is important at engine low idle condition that the maximum steering wheel speed should be more than 60 rpm.
- For engine normal idle condition, maximum steering wheel speed should be more than 100 rpm if possible.
- When using open center SCU connected with pump directly, maximum pump flow should be less than 1.4 times of SCU rated flow. Higher flow into SCU increases pressure-loss of the steering system. If higher flow is unavoidable, install a flow divider valve into the system or use a load sensing system.

Sizing and Application
Articulated Type Steering

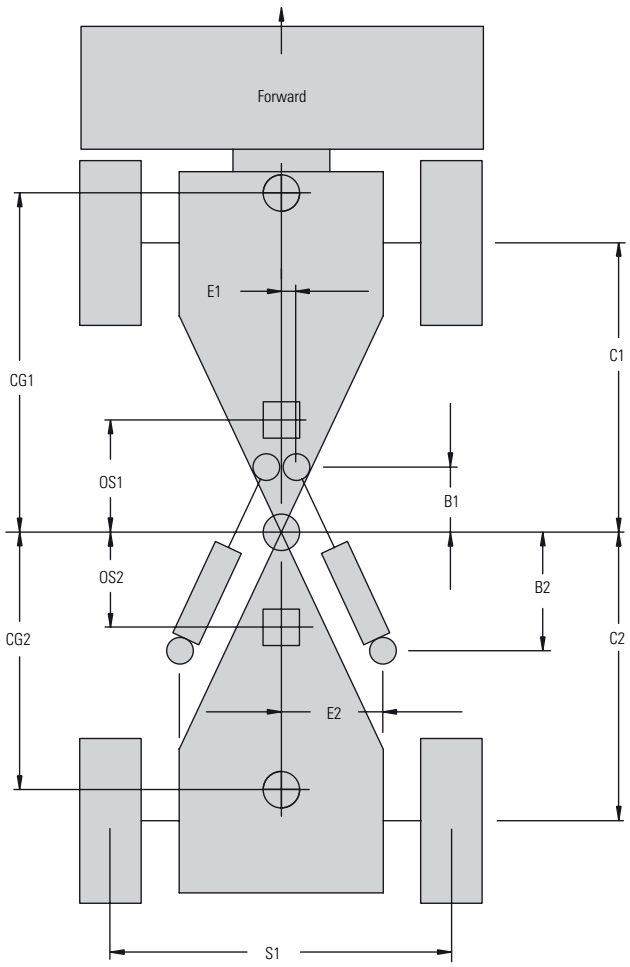
Eaton's Hydraulic Division has developed a computer program to assist articulated vehicle designers with a steering system analysis. The analysis can provide basic system sizing and pressure requirement.

This analysis is intended to be used as a guide only and is not to be used solely as the final determination of system design. Other factors and variables will have to be considered.

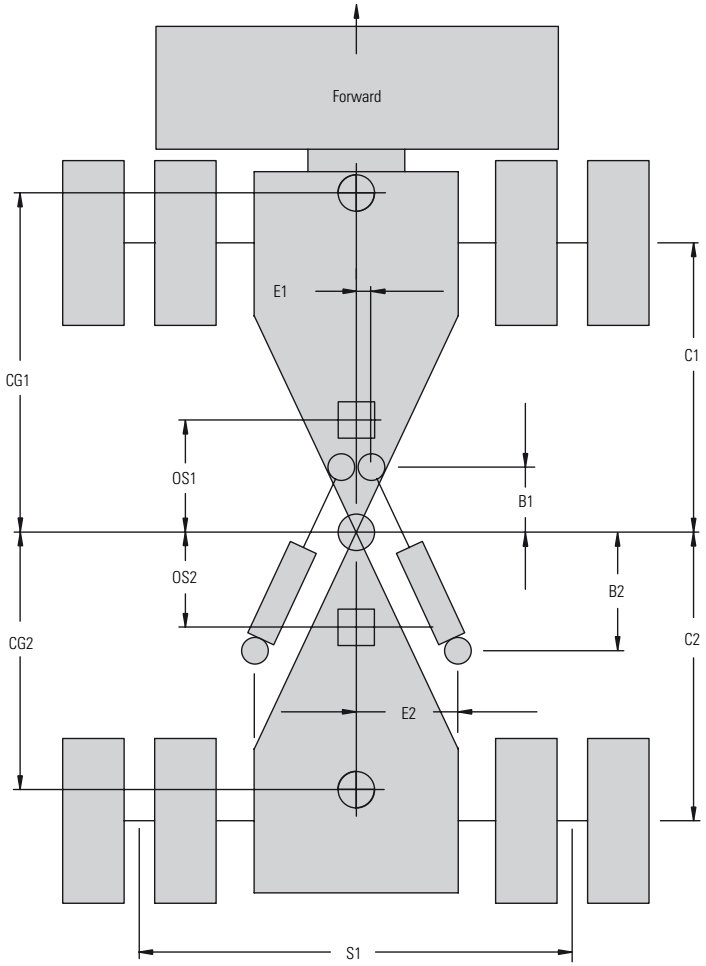
To receive output from this program, provide the required information by using the form on the following page.

Contact an Eaton Hydraulics Division Sales Representative

Twin Cylinders with a Single Wheel Set



Twin Cylinders with a Dual Wheel Set



Sizing and Application

Articulated Vehicle Steering Analysis

Clip out this form or photocopy when needed.

Manufacturer_____

Vehicle Type _____

Model Number _____

Completed By _____ Date _____

Indicate Unit of Measurement Used_____

1. Turns Lock to Lock_____
2. Time Lock to Lock _____
3. Max. Steering Wheel RPM _____
4. Cylinder Rod Diameter_____
5. Cylinder Bore Diameter _____
6. Cylinder Stroke _____
7. Pump: GPM Hi Idle_____

   GPM Lo Idle_____
8. Steering Relief Pressure _____
9. Auxiliary Relief Pressure _____
10. Hydraulic Schematic (attach) _____
11. B1 _____
12. B2 _____
13. C1 _____
14. C2 _____
15. E1 _____
16. E2 _____
17. S1 _____
18. Weight - Front Axle

    Unloaded _____
19. Weight - Rear Axle

    Unloaded _____
20. Weight - Front Axle

    Loaded _____
21. Weight - Rear Axle

    Loaded _____
22. Articulation Angle (lock to lock) _____
23. Steering Circuit Line Size, Lengths, Type, Location

    (please note on schematic ref. 10.) _____
24. Is Steering Through Brakes

    Statically Required? _____
25. Are Locking Differentials Used?

    Front _____ Rear ____ Both _____
26. Is There A Differential Between the Front and Rear

    Differentials? Yes _____ No_____
27. Tire Size _____ Pressure _____

    Width _____ Ballast _____

Note:

1-10 Should always be completed; this information is needed for basic steering system sizing.

1-27 Needed for sizing and an analysis of steering pressure characteristics.

Sizing and Application

Articulated Vehicle Steering Analysis

Clip out this form or photocopy when needed.

Manufacturer_____

Vehicle Type _____

Model Number _____

Completed By _____ Date _____

Indicate Unit of Measurement Used_____

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