

Steering Catalog

Steering Control Units
Torque Generators
Steering Columns



EATON

Powering Business Worldwide

Literature Referenced in this Catalog:

- Eaton Technical Bulletin 3-401
- Eaton Flow Divider Catalog E-VLFL-MC001-E
- Eaton Relief Valve Catalog 11-510
- Eaton Gear Pumps Series 26 Model 26000 Catalog 11-609
- Eaton Char-Lynn Low Speed High Torque Motors Catalog E-MOLO-MC001-E2
- Vickers® Screw in Cartridge Valves Catalog V-VLOV-MC001-E2
- Vickers® Proportional Valves Catalog 539
- Vickers Solenoid Operated Directional Valves Catalog GB-C-2015

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Information contained in this publication is accurate as of the publication date and is subject to change without notice. Performance values are typical values. Customers are responsible for selecting products for their applications using normal engineering methods.

Description and Advantages

Steering Control Units

The Char-Lynn® 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.

Char-Lynn power 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.

SERIES 5 (291-XXXX-XXX, 292-XXXX-XXX, 293-XXXX-XXX, 294-XXXX-XXX)

Displacement	31.5 - 146 cm ³ /r	1.92 - 8.9 in ³ /r
Flow	11 - 19 l/min	3 - 5 GPM
Pressure	140 bar	2030 PSI

SERIES 10 (200-XXXX-XXX, 220-XXXX-XXX)

Displacement	58.7 - 739 cm ³ /r	3.58 - 45.1 in ³ /r
Flow	11 - 76 l/min	3 - 20 GPM
Pressure	275 bar	4000 PSI

SERIES 20 (236-XXXX-XXX)

Displacement	60 - 985 cm ³ /r	3.6 - 60 in ³ /r
Flow	38 - 114 l/min	10 - 30 GPM
Pressure	241 bar	3500 PSI

SERIES 25 (251-XXXX-XXX, 252-XXXX-XXX, 253-XXXX-XXX)

Displacement	490 - 1230 cm ³ /r	30 - 75 in ³ /r
Flow	95 - 151 l/min	25 - 40 GPM
Pressure	241 bar	3500 PSI

SERIES 40 (281-XXXX-XXX, 282-XXXX-XXX, 283-XXXX-XXX)*

Displacement	1230 - 3030 cm ³ /r	75 - 185 in ³ /r
Flow	151 - 227 l/min	40 - 60 GPM
Pressure	241 bar	3500 PSI

* For all other product numbers consult steering website.

Description and Advantages

Torque Generator

Char-Lynn torque generators have been completely redesigned to meet the needs of the changing marketplace. These torque generators have served the industry well, providing:

- Power assist for vehicle steering
- Power assist on gates and valves, eliminating the large hand wheels
- Powerful rotary motion with effortless manual rotary input on numerous other applications

Today's market includes power steering on electric lift trucks. These new torque generators have been designed with features that greatly improve the operator's comfort as well as the vehicle's performance.

SERIES 217, 227

Displacement	76 - 160 cm ³ /r	4.7 - 9.6 in ³ /r
Flow	15 l/min	4 GPM
Pressure	69 and 172 bar	1000 and 2500 PSI

Use the Torque Generator as rotary power assist for:

- Large indexing tables
- Manually operated gates and valves
- Manual positioning devices
- Mechanical steering systems
- Turntables

Customized Steering Columns

Char-Lynn columns can be custom built to your exact specifications. The column and mounting flange is of a sturdy single weldment design. These columns have high thrust and side load capacity with low shaft torsional friction. A tilt column is also available.

STEERING COLUMNS (204-XXXX-XXX)

Jacket Length	56 - 836 mm	2.2 - 33 inch
Horn Wire	with and without	with and without
Upper Ends	10 Upper End Types	10 Upper End Types

Hydraulic Circuit Explanation

Neutral Circuits: Open Center and Open Center Power Beyond

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

Open Center Power Beyond

The power beyond steering control unit supplies steering and auxiliary valve functions. The power beyond unit is used on medium pressure, open center (fixed displacement pump) systems.

When not steering, the power beyond unit directs all inlet flow to the auxiliary circuit. However once steering is initiated, part of the auxiliary flow is diverted to steering. Since steering has priority, all flow, if required, will be diverted to steering. The tank port of the steering unit has flow only when steering is operated. Thus, flow out of the auxiliary ("PB") port and the tank port will fluctuate or stop depending on steering input.

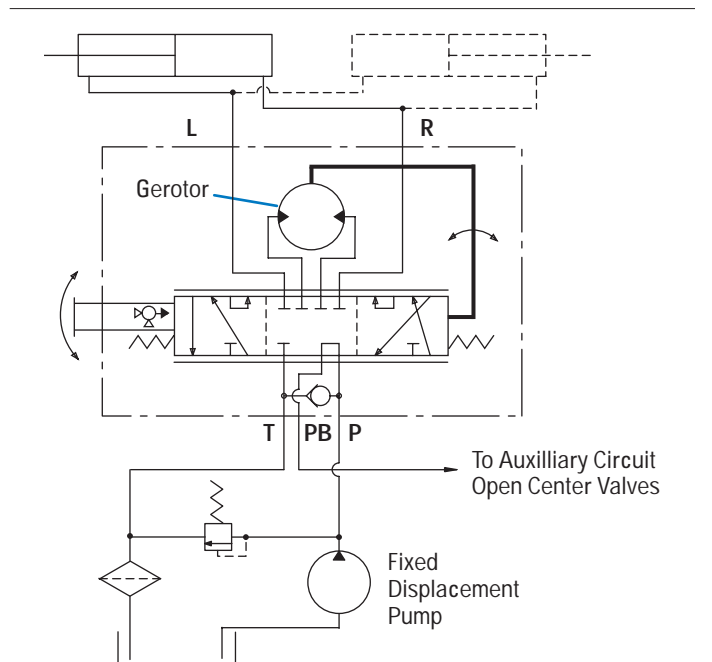
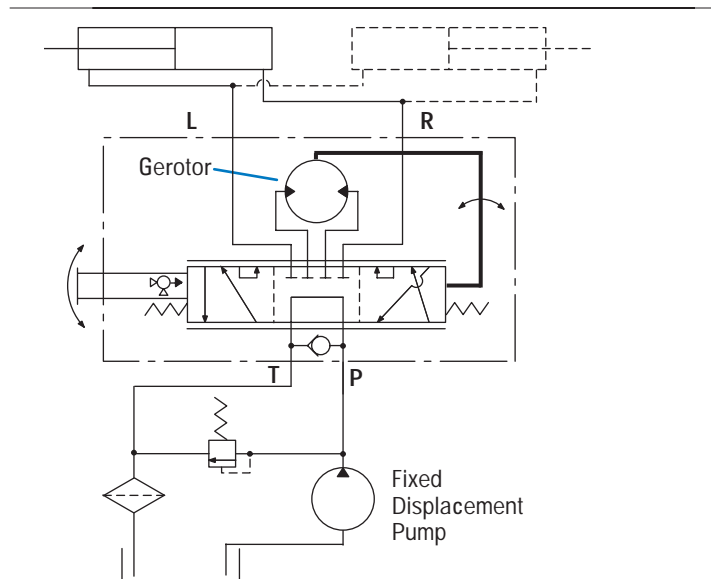
The following special considerations should be addressed when applying power beyond steering:

- Auxiliary valves (connected to PB) must be open center type. Slight bump or kick may be felt in steering wheel when auxiliary functions are activated during steering operations.
- Pump flow not used for steering is available at power beyond (PB) outlet, except at steering stops where total pump flow goes over the system relief valve. Avoid auxiliary functions that require constant flow while steering.

- Flow is only directed to the tank port when steering is operated. Avoid systems where return flow from tank port is used for auxiliary functions.
- Inlet pressure to the steering unit will be the higher of steering system pressure or auxiliary valve pressure.
- Generally avoid systems where heavy use of auxiliary functions occur while steering.

Applications

- Lawn and Garden Equipment
- Utility Vehicles

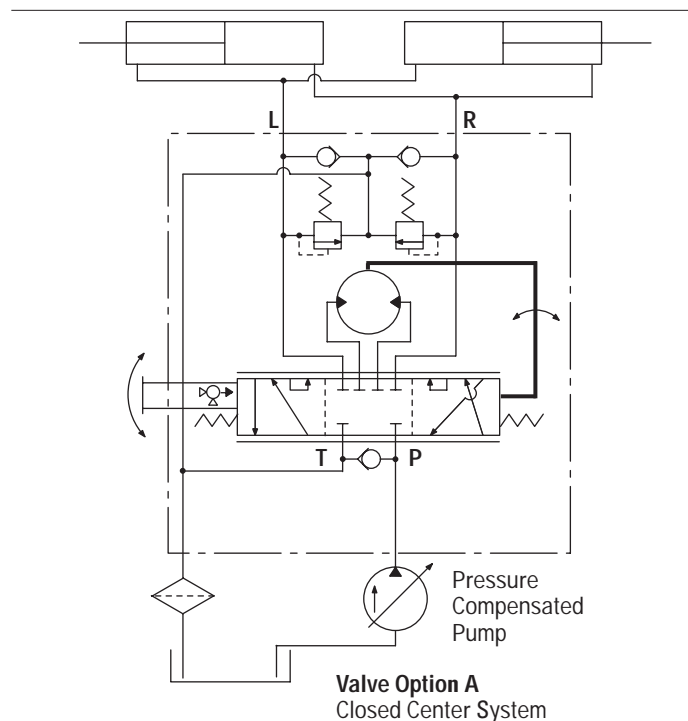


Hydraulic Circuit Explanation

Neutral Circuits: Closed Center

Closed Center

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



Closed Center with Neutral Bleed

Neutral Bleed Feature

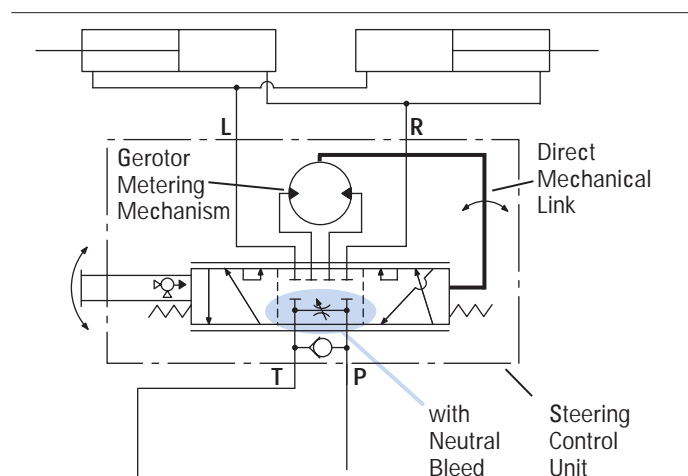
Closed Center Steering Control Units are available with and without neutral bleed feature. Most applications may not require the bleed feature, however, the maximum temperature differential between components within the steering circuit must not exceed specification (50° F or 28° C). Order unit with the bleed feature if the temperature differential may exceed this limit. The neutral bleed feature allows a small flow of fluid to pass through the unit when in neutral to reduce the thermal differential.

Typical applications where neutral bleed is required are:

- Remote steering position from power source.
- Extended engine idle operation when vehicle is parked.
- High duty cycle operation sharing a common reservoir with the steering circuit.

Applications

- Construction Industry



Neutral Circuits: Load Sensing

Char-Lynn 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.

Char-Lynn 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.

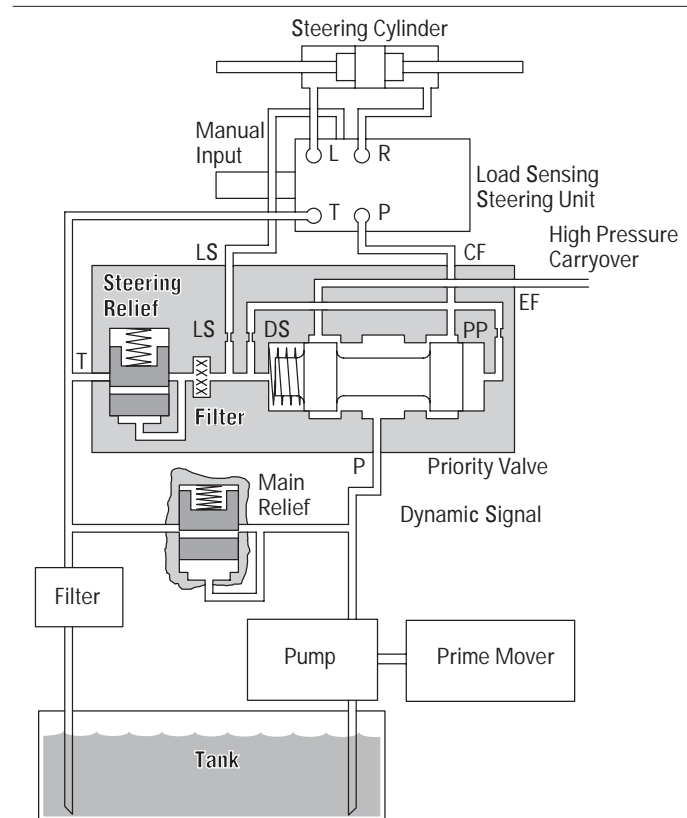
Steering Control Unit— Designed for specific rated flows and control pressures. It must be matched with a control pressure in the priority valve to obtain maximum steering rates. Higher flow rates require higher control pressures. Neutral internal bleed assures component temperature equalization.

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 [145 PSI] 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

Hydraulic Circuit Explanation

Neutral Circuits: Load Sensing

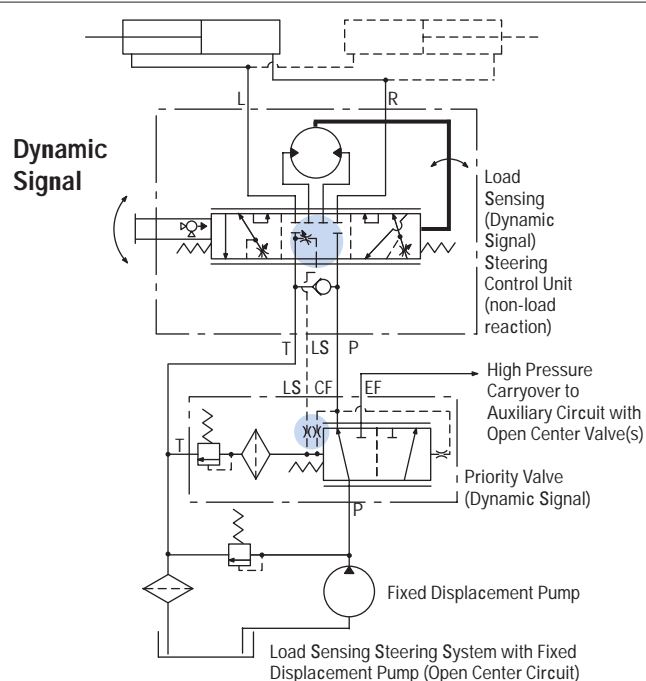
Load Sensing Circuits— Signal Systems

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

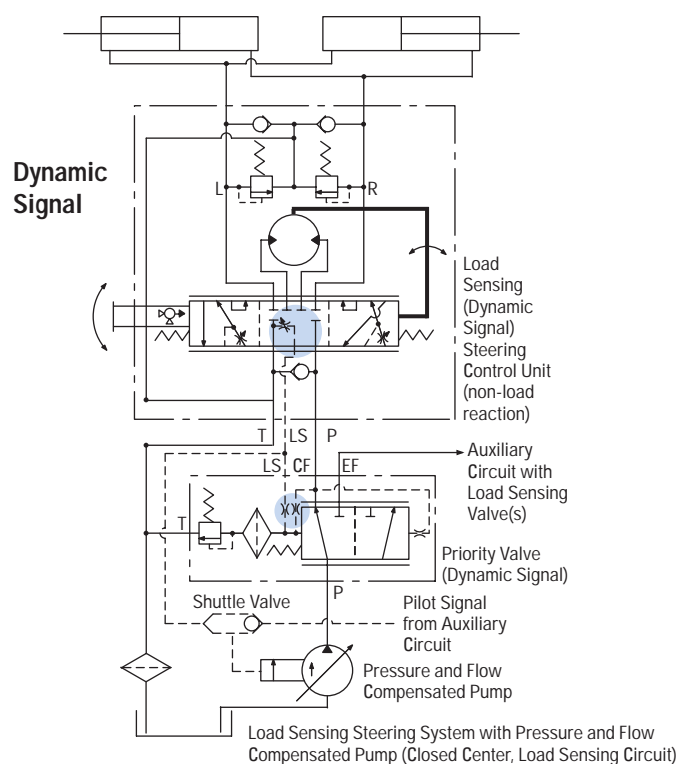
Dynamic Signal—Used for more difficult applications. The dynamic signal systems offer the following benefits:

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

Dynamic Signal— Open Center Pump



Dynamic Signal— Load Sensing Pump



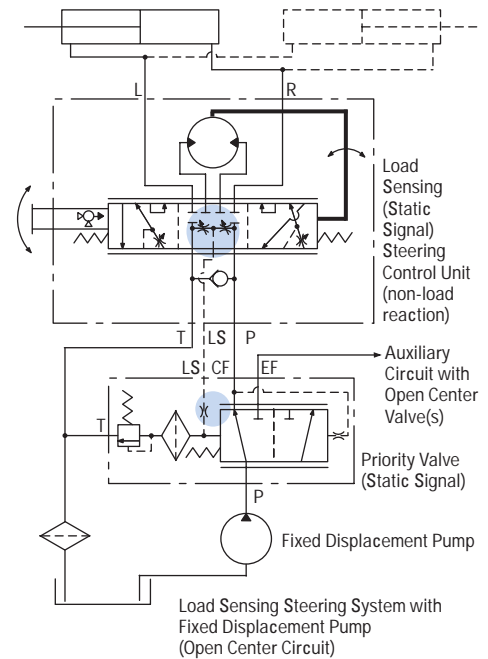
Hydraulic Circuit Explanation

Neutral Circuits: Load Sensing

Static Signal— Open Center Pump

Static Signal—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.

Static Signal

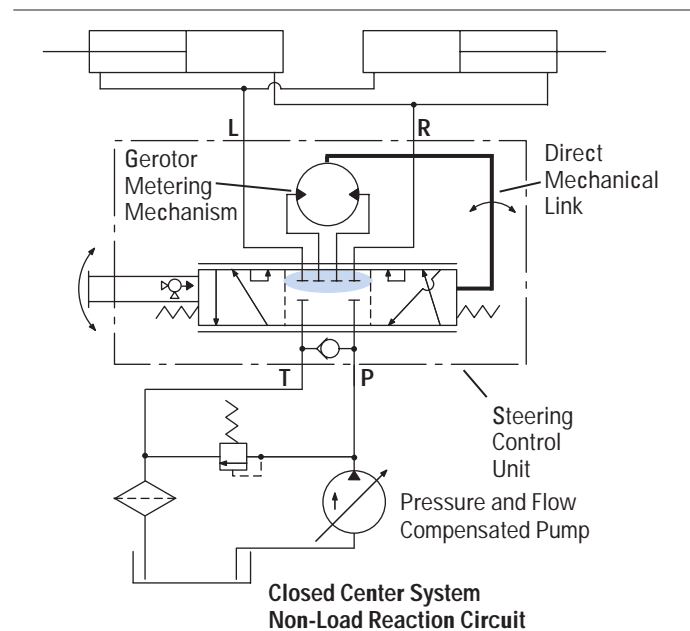


Hydraulic Circuit Explanation

Work Circuits: Non-Load Reaction and Load Reaction

Non-Load Reaction

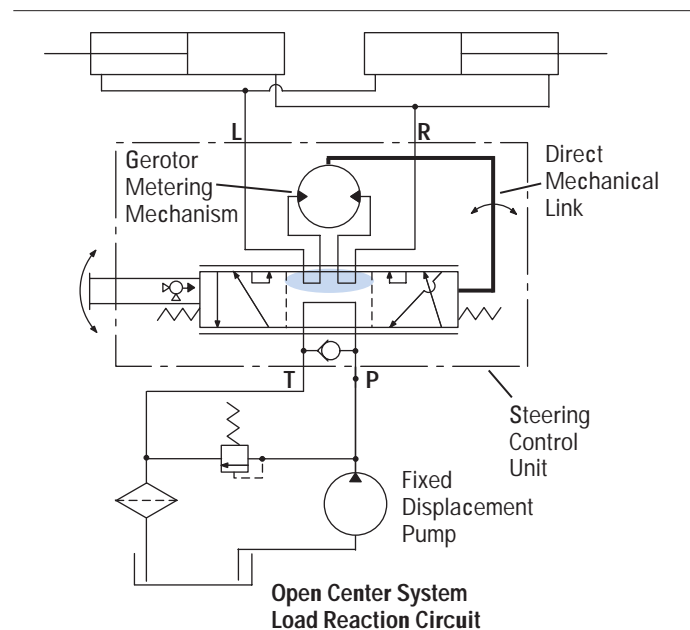
A non-load reaction steering unit blocks the cylinder ports in neutral, holding the axle position whenever the operator releases the steering wheel.



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.**



Steering Units with Integral Valves

Integral valves are available for the Char-Lynn 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. Included in all units except Series 20, 25, and 40.**

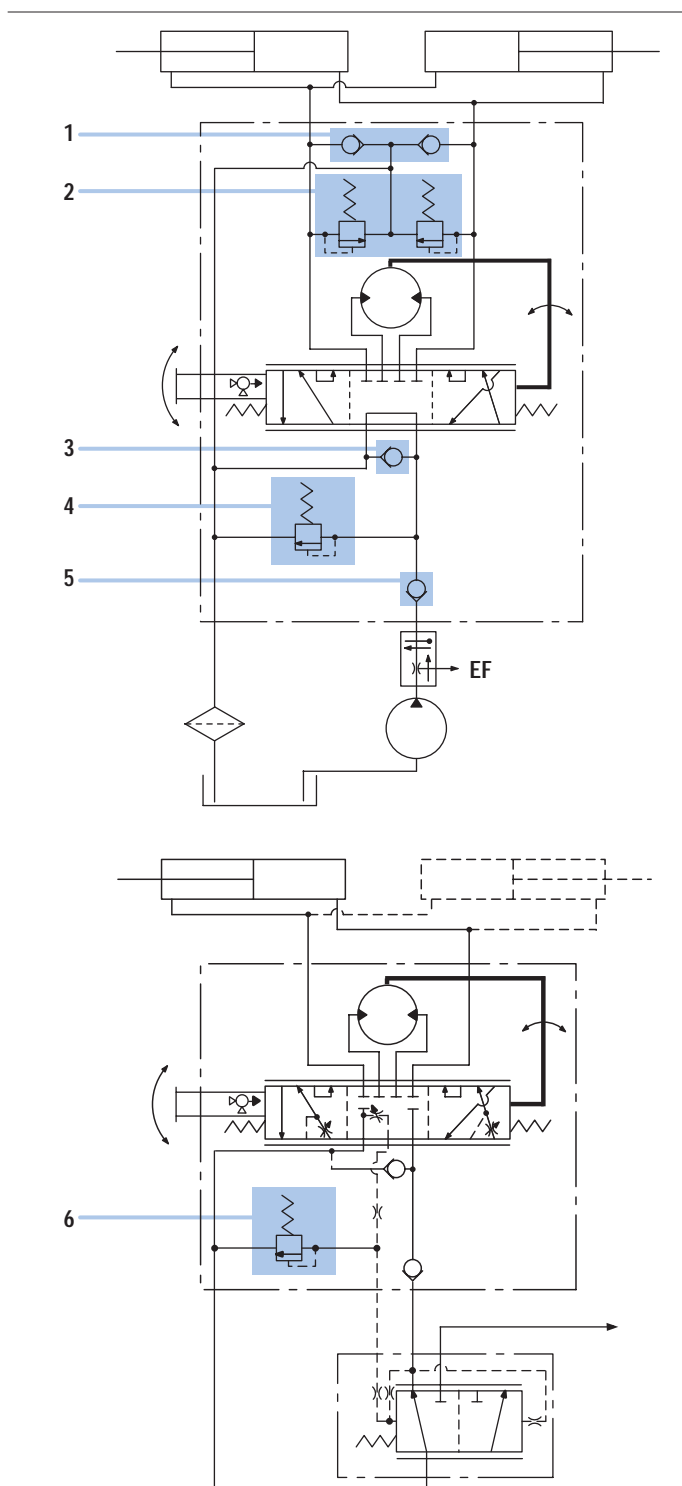
4 Inlet Relief Valve—limits maximum pressure drop across the steering unit protecting the steering circuit.

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)

**Steering units with displacements larger than 185 cm³/r [11.3 in³/r] may require a separate power source for limited operation.



Special Features and Application

Manual Steering

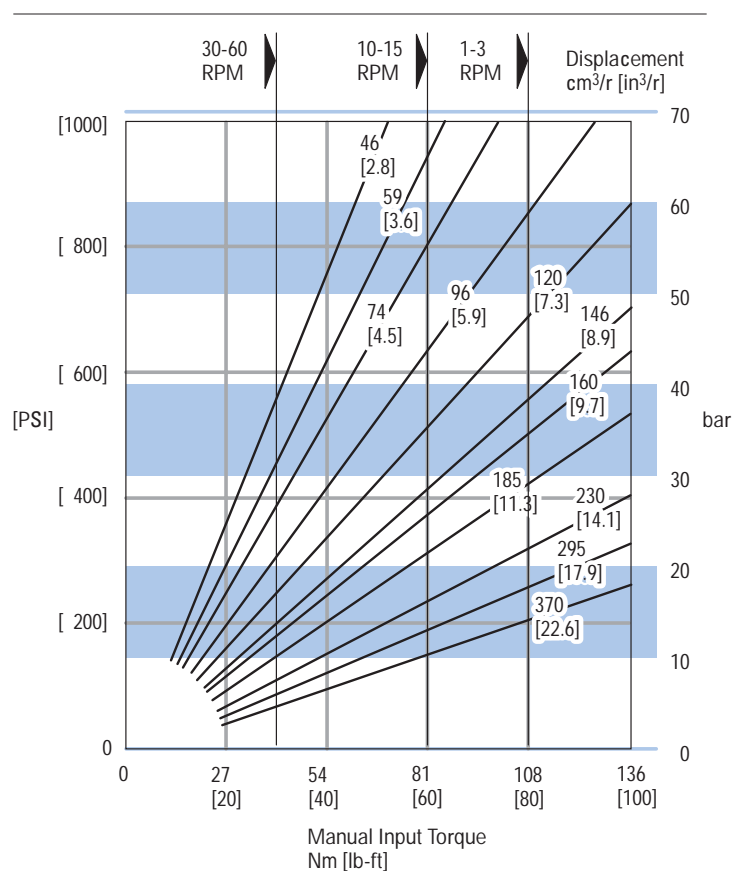
Description

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.

This feature is available in all steering models except for Series 25 and 40.

Use of Graph

1. Determine steering work port pressure required to preform the desired steering 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 intersection.



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.

Special Features and Application

2-Speed

Description

Eaton's 2-Speed technology offers two operator-selectable metered modes at any time, with the touch of a button or the flip of a switch, and provides the operator flexibility to significantly improve the overall steering experience. 2-Speed technology is available on the Series 10 Steering Control Unit (SCU).

Dual Steering Modes

Typically, the gerotor between the SCU housing and the shift valve is the smaller gerotor (first gerotor). The shift valve is activated by the operator, which allows or prevents flow to the second gerotor. A separate solenoid valve provides the pressure pilot signal to shift the aforementioned valve. The OEM will define and provide the operator switch to activate the solenoid valve.

Metered Steering Mode 1

– The steering unit operates the same as a traditional hydrostatic steering control unit. Steering (flow) is a function of steering wheel rotations (rpm). Metered (gerotor) steering provides precise, responsive, and smooth steering. All the flow is metered by the first gerotor, resulting in a greater number of turns lock-to-lock. In case of pressure loss, the shift valve automatically prevents flow to the second gerotor and emergency steering is available via the first gerotor.

Metered Steering Mode 2

– The steering unit operates the same as a traditional hydrostatic steering control unit, except the flow is metered for a combined displacement of two gerotors. As with Mode 1, steering (flow) is a function of steering wheel rotations. As the total displacement per rotation is the sum of the two gerotor displacements, the number of turns lock-to-lock may be significantly decreased. Operator effort is greatly reduced during the work cycle. The number of turns lock-to-lock could go down to 0.5, where the ratio of the two gerotor displacements could vary from 1:1 to as high as 5:1, providing great flexibility in the design.

Benefits

- Manual steering capability in unpowered mode ("emergency steering")
- Steering flow is always proportional to steering speed
- Allows for excellent roadability and operator selectable quick-steer for work cycles

Features

- Open Center, Load Sense
- All Integral Valves
- Wide Angle
- Max System pressure: 241 Bar [3500 psi]

Applications

- All Ackerman Steering
- Tractors, Telehandlers, Sweepers, Forestry Equipment, Backhoes, Loaders
- Sprayers, Combines, Motor Graders

Special Features and Application

Dual Displacement

Description

The dual displacement steering control unit allows manufacturers of off road vehicles to retain manual steering capabilities while reducing the number of components in their system. By using two displacements in one unit we offer a better solution to manually steer a vehicle in an unpowered mode without the need of a back-up power system—resulting in a more economical machine.

The dual displacement steering unit uses two gerotors and a pressure controlled logic valve. The logic valve switches between two displacements, 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 below 8 bar [120 psi]. Above 8 bar [120 psi] the logic valve connects both gerotors to provide full powered displacement.

Manual steering capabilities in unpowered mode

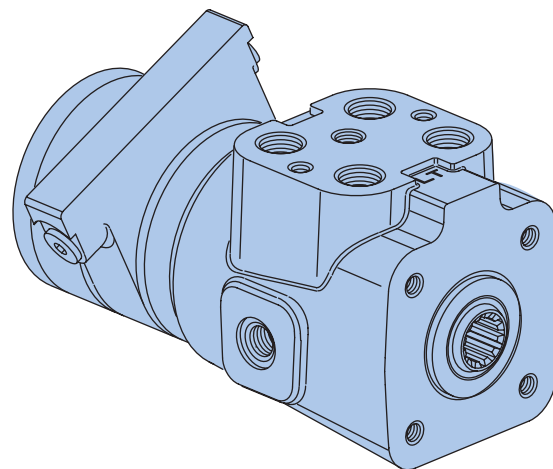
- Eliminates the need of a back-up emergency system.
- Engages the small displacement in an unpowered mode and allows manual steering.
- Allows vehicles to meet ISO/TUV road regulations without the need of the currently used emergency system.

Performance in powered mode

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

Additional Features

- Steering circuit: Load Sensing Dynamic Signal
- Max. system pressure: 241 bar [3500 psi].
- Valve options and other features: same as those available on Series 10 (single displacement) units

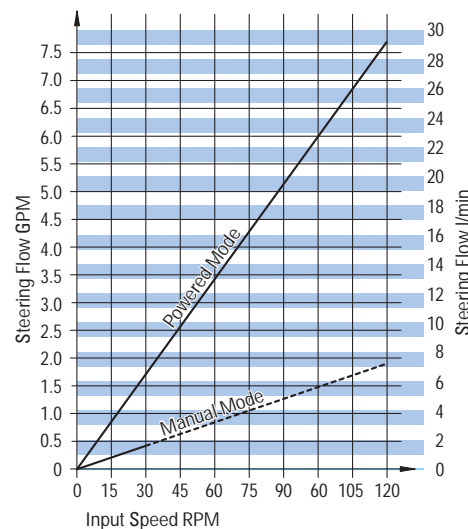


DISPLACEMENT CHART:

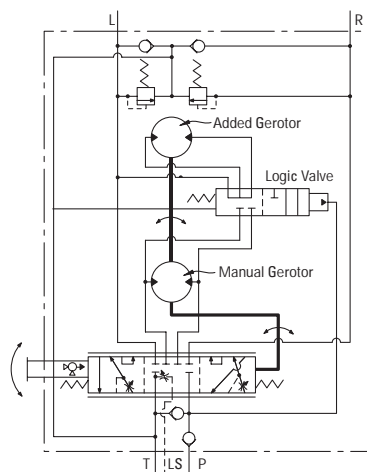
Gerotor 1 Manual displ.	Gerotor 1 and 2 Powered displ.	Gerotor 1 Manual displ.	Gerotor 1 and 2 Powered displ.
in ³ /rev	in ³ /rev	cm ³ /rev	cm ³ /rev
3.6	9.5	60	156
3.6	10.9	60	179
3.6	12.5	60	205
3.6	13.3	60	218
3.6	14.9	60	244

For any other displacement please see your Eaton Representative.

Manual 60 cm³/r [3.6 in³/r]
Powered 244 cm³/r [14.9 in³/r]



Flow vs RPM (for each operating mode)



Eaton Patented Technologies

Q-Amp (Flow Amplification) for Load Sensing Circuits

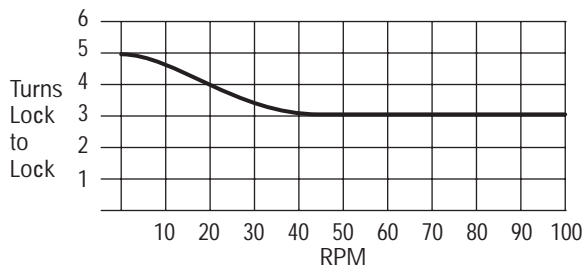
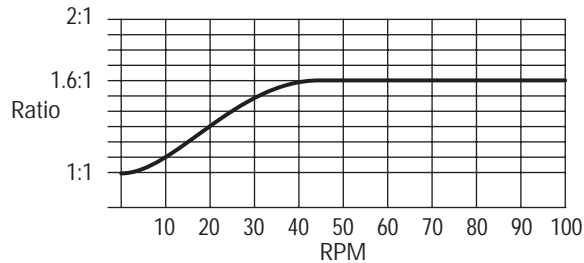
Description

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 ratios.)

Features

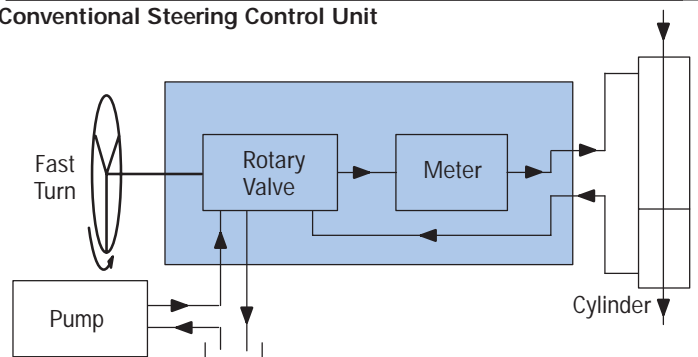
- Variable Ratio



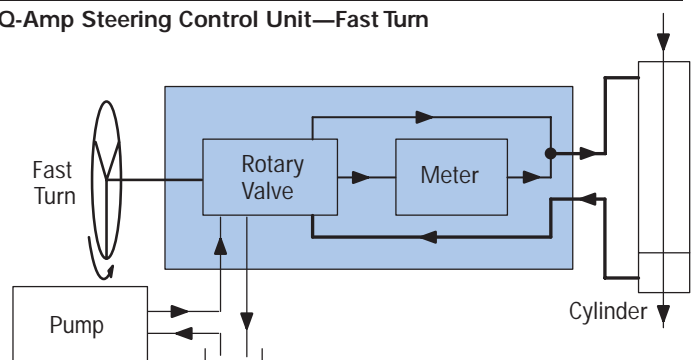
- Manual Steering
Steering a vehicle with loss of engine power may not be possible with a large displacement steering control unit (SCU). Q-Amp with manual feature has the smaller displacement required for manual steering and has the additional flow requirement of the larger displacement SCU for power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

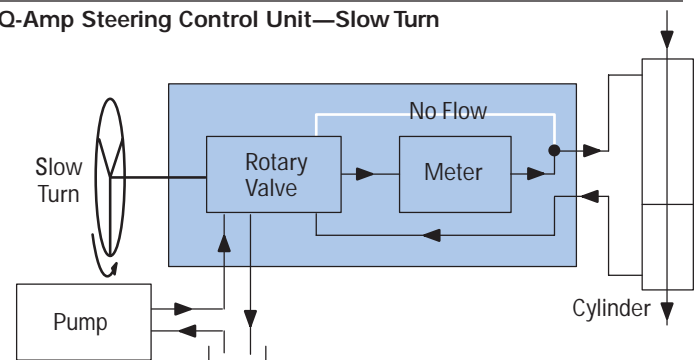
Conventional Steering Control Unit



Q-Amp Steering Control Unit—Fast Turn



Q-Amp Steering Control Unit—Slow Turn



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

Eaton Patented Technologies Q-Amp (Flow Amplification) for Load Sensing Circuits

Applications

Articulated vehicles such as wheel loaders, log skidders, scrapers, trucks, and similar vehicles can benefit from this feature.

While roading, a slow movement of the steering wheel (input speed), will not overcorrect steering. Increasing input speed will produce the additional steering flow required to quickly change the vehicle's direction.

For example, operating log skidders in the woods requires very quick steering. This same log skidder on the road would be extremely difficult to steer a straight normal course. The variable ratio feature provides good steering in both conditions.

Combines, row crop tractors, and large articulated agricultural tractors also can benefit from this feature when traveling down a field. It will be easier to follow rows or furrows, and still be able to make fast turns at the end of the rows.

Variable Ratio

- Wheel Loaders
- Scrapers
- Articulated AG Tractors
- Articulated Dumpers
- Mine Trucks
- Forestry Equipment
- Rough Terrain Lift Trucks

Variable Ratio with Manual Steering

- AG Tractors
- Small Wheel Loaders
- Rubber Tired Excavators
- Sprayers
- Site Handlers
- Graders
- Combines

Eaton Patented Technologies

Wide Angle

Description

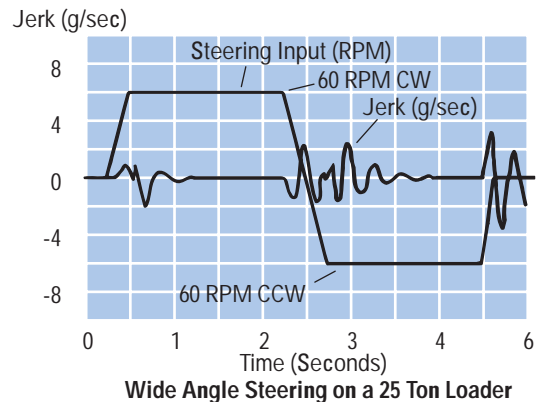
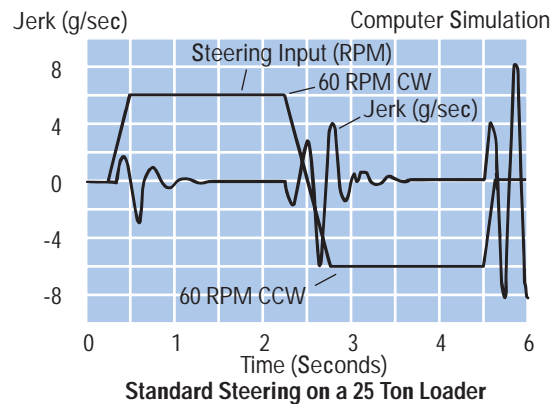
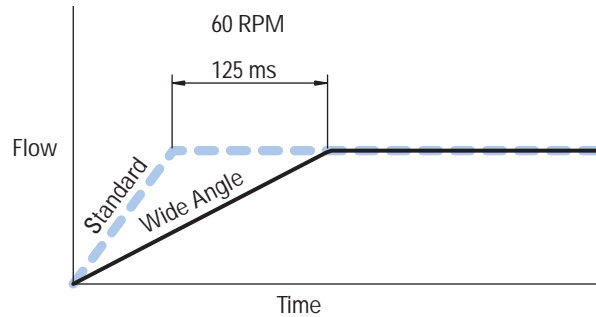
Steering units with wide angle features have been developed to significantly reduce or eliminate the jerky motion of vehicles with articulated steering systems. This has been accomplished by increasing the maximum deflection of the spool relative to the sleeve. Increasing the deflection reduces the gain. This in turn reduces acceleration and jerk levels and provides overall smoother vehicle performance. The steering still responds fast enough so the operator does not notice the reduced gain.

Benefits

- Minimizes jerking motion on medium and large articulated vehicles.
- Jerk reducing valves and accumulators can be eliminated on most vehicles.
- Available on Series 10, Series 20 (standard), and Series 25.
- Eliminates need for cushion valves

Applications

- Articulated Vehicles



These graphs show a computer simulation of the jerk levels and have been verified by actual vehicle tests.

Wide Angle Steering Control Units Patent No. 5080135

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. The number of levels equal to the number of Cylinder Damping (CD) orifices. This technology is available on Series 10, Series 20, Series 25, and Series 40. Not all SCUs come with all 3 levels.

Features

1. Level 1: for slightly jerky vehicle (lower flow rates for the steering unit)
2. Level 2: for jerky vehicle
3. Level 3: for severely jerky vehicle (higher flow rates for the steering unit)

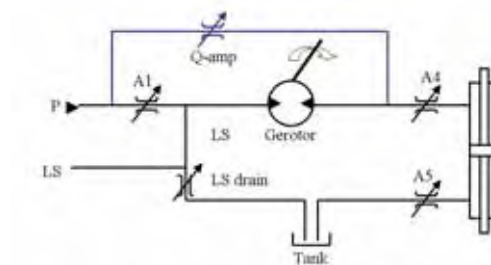
Benefits

- Reduces jerking motion on medium and large articulated vehicles.
- Available on the following steering control units (Series 10, 20, 25, 40).
- Damps or stabilizes unstable systems.

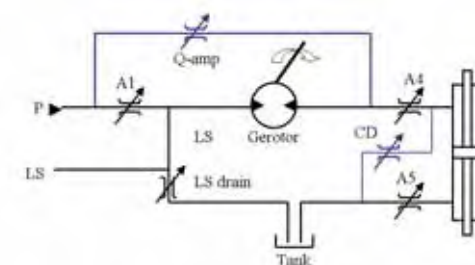
Applications— Large Articulated Vehicles

- Wheel Loaders
- Skidders
- Scrapers

Flow Amplification without Cylinder Damping



Flow Amplification with Cylinder Damping



Steering Control Units with Cylinder Damping
Patent No. 5080135

Eaton Patented Technologies VersaSteer

Description

Eaton's patented VersaSteer™ technology offers operator-selectable Metered or Quick Steering modes at any time, with the touch of a button or the flip of a switch, and provides the operator flexibility to significantly improve the overall steering experience.

Dual Steering Modes

Metered Steering – The steering unit operates the same as a traditional hydrostatic steering control unit. Steering (flow) is a function of steering wheel rotations (rpm). Metered (gerotor) steering provides precise, responsive, and smooth steering.

Quick Steering – Gerotorless (quick) steering provides a much different effect, enabling the operator to put the vehicle in full lock while only turning the steering wheel a few degrees. This is achieved by hydraulically blocking the flow of oil to the gerotor with a shift valve. Full steering flow can be obtained by deflecting the steering wheel $\pm 45^\circ$ for a Series 10 and $\pm 50^\circ$ for a Series 20. Operator effort is greatly reduced during the work cycle.

Benefits

- Provides steering system cost savings by eliminating the need for a separate joystick
- Available on Load Sense steering systems
- Compatible with Integral Valves, Bolt-On Priority Valves, Q-Amp and Cylinder Damping
- Emergency manual steering capability
- Minor size increase – can retrofit to existing vehicles
- Smoother steering with Eaton Patented Wide Angle technology.

Features

- Dual steering modes in one integrated Steering Control Unit (SCU)
- High pressure rating and flow capabilities
- Compatible with current steering options
- Easily retrofit to existing vehicles
- Proven base technology
- Easy one-touch switch (OEM defined)

VersaSteer System Components

- Steering Control Unit
- Solenoid Shift Valve
- Four -04 hoses
- Electric Switch

Series 10 VersaSteer



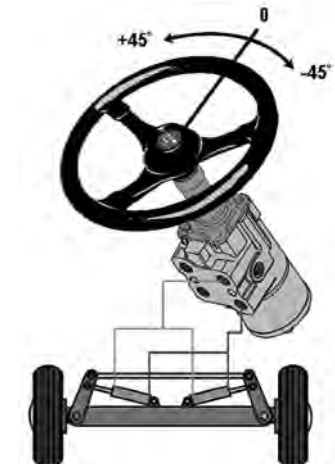
Series 20 VersaSteer



Traditional Metered Steering



Series 10 Quick Steering



SPECIFICATIONS

1. System Pressure Rating -
 - a. 241 Bar [3500 psi] - Series 10
 - b. 241 Bar [3500 psi] - Series 20
2. Back Pressure Rating - 21 Bar [305 psi]
3. Flow Rating
 - a. 15 gpm - Series 10
 - b. 25 gpm - Series 20

VersaSteer is covered under
US Patent No. 6,318,078

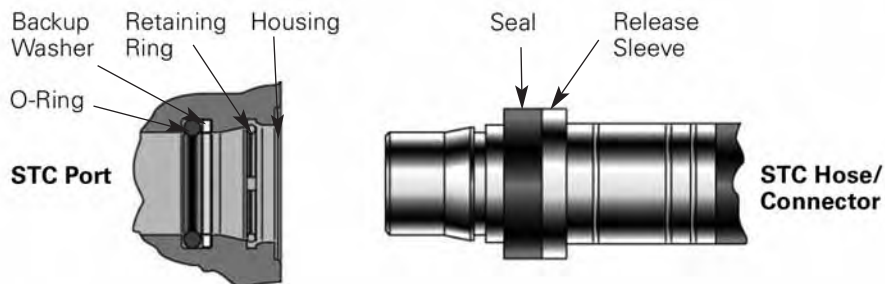
Eaton Patented Technologies STC Direct Porting

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).

STC Direct Porting is available with Series 5 and Series 10 Steering Control Units.

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



Steering Control Units—Series 5

Product Description

The new Series 5 steering control units (SCU) are exciting new products designed for low flow, low pressure applications. The Series 5 units are available in two compact designs:

Option 1:

Square Housing (Mount)
Unit with Side Ports

Option 2:

Round Housing (Mount) Unit
with End Ports

In addition to the installation flexibility provided by the two options above, this new family of products has best-in-class steering feel and provides crisp centering. These units also have better efficiency (lower pressure drop) than competitive units.

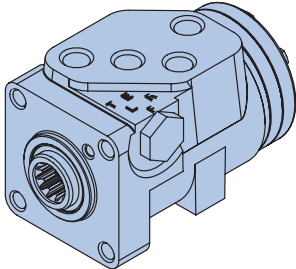
Power Beyond Models—Optional power beyond steering control units supply steering and flow to auxiliary valve functions. The power beyond unit is used in open center (fixed displacement pump) systems in the medium pressure range. When not steering, the power beyond unit directs all inlet flow to the excess flow port (power beyond) for use in the auxiliary circuit. Once steering is initiated, and since steering has priority, inlet flow will be diverted to the steering circuit as required. Flow out the excess flow port (power beyond) and tank port will vary or stop depending upon the steering requirement. The tank port of the steering unit has flow only when steering is operating.

Features

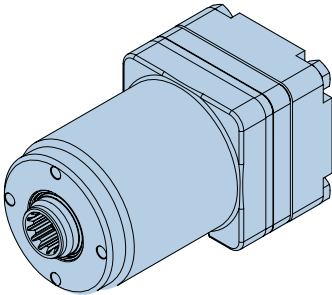
- Open Center
- Load Sensing
- Open Center Power Beyond
- Integral Column
- Manual Steering Check Valve
- Inlet Relief Valve
- Load Sense Relief Valve
- Cylinder Relief Valve
- Anti-Cavitation Valve

Applications

- Lawn and Garden Equipment
- Turf Equipment
- Golf Course Maintenance Equipment
- Lift Trucks
- Compact Utility Tractors



Option 1: Square Housing with Side Ports
refer to Model Code, page 23

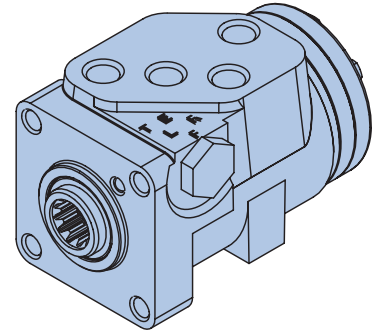


Option 2: Round Housing with End Ports
refer to Model Code, page 24

SPECIFICATIONS	
Max. System Pressure	140 bar [2030 PSI]
Max. Back Pressure	21 bar [300 PSI]
Max. Flow	19 l/min [5 GPM]
Max. Differential	
Between Steering Unit and System Temperature	28° C 50° F
Max. System Operating Temperature	93°C [200° F]
Input Torque	
Powered -Standard	1,7 - 2,8 Nm @ 6,9 bar tank pressure [15 - 25 lb-in @ 100 PSI tank pressure]
Low	1,1 - 2,0 Nm @ 6,9 bar tank pressure [10 - 17,5 lb-in @ 100 PSI tank pressure]
Max. Non Powered	81,4 Nm [60 lb-ft]
Fluid	Petroleum Based Fluids
Recommended Filtration	ISO 18/13 cleanliness level
Port Options	9/16-18 SAE O-ring – 06 STC 3/8 BSP Straight thread ports
Check Valve for Manual Steering	Yes
Optional Relief Valve Settings bar [PSI]	40 [580] 50 [725] 63 [914] 70 [1015] 80 [1160] 90 [1305] 100 [1450] 125 [1812]

Steering Control Units—Series 5

Model Code – Ordering Information



Square Housing with Side Ports - Option 1

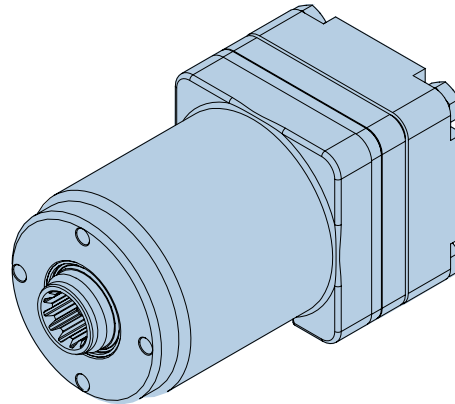
The following 30-digit coding system has been developed to identify all of the configuration options for the Series 5 steering control units. Use this model code to specify a unit with the desired features. All 30-digits of the code must be present when ordering. You may want to photocopy the matrix below to ensure that each number is entered in the correct box.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30				
A	B	R		C	A			0		A												A	0			1	0		B				
1,2,3	Feature		Code		Description										Nos		Feature		Code		Description												
	Product Series		ABR		Series 5 Steering Control Unit										18,19,20,21		Ports and Mounting Threads		4AAN		Square 4 x 9/16 SAE Ports, M10 x 1,5 Column Mounting Threads (Use with Open Center)												
	Nominal Flow Rating		1 B		11 l/min [3 GPM] 19 l/min [5 GPM]														4AKN		Square 5 x 9/16 SAE Ports, M10 x 1,5 Column Mounting Threads (Use with Excess Flow)												
	Inlet Pressure Rating		C		140 bar [2030 PSI]														4AEN		Square 5 x 9/16 SAE Ports, M10 x 1,5 Column Mounting Threads (Use with Load Sense)												
	Tank Pressure Rating		A B		10 bar [150 PSI] 21 bar [300 PSI]														UAAN		Square 4 x -06 STC Direct Ports, M10 x 1,5 Column Mounting Threads (Use with Open Center)												
	Displacement		35 37 39 41 43 46 48		31.5 cm3/r [1.92 in3/r] 39.5 cm3/r [2.41 in3/r] 50.8 cm3/r [3.10 in3/r] 63.1 cm3/r [3.85 in3/r] 73.8 cm3/r [4.50 in3/r] 100 cm3/r [6.10 in3/r] 120 cm3/r [7.33 in3/r]														UBNN		Square 5 x -06 STC Direct Ports, M10 x 1,5 Column Mounting Threads (Use with Excess Flow)												
	Flow Amplification		0		None														UBPN		Square 5 x -06 STC Direct Ports, M10 x 1,5 Column Mounting Threads (Use with Load Sense)												
	Neutral Circuit		A B F		Open Center Open Center, Power Beyond Load Sensing, Dynamic signal														YAAN		Square 4 x G .375 BSP Striaight Thd. Ports, M10 x 1,5 Column Mounting Threads (Use with Open Center)												
	Load Circuit		A		Non-Load Reaction														YBRN		Square 5 x G .375 BSP Striaight Thd. Ports, M10 x 1,5 Column Mounting Threads (Use with Load Sense)												
	Valve Options		01 04 05 12 13		Manual Steering Check Valve Inlet Check Valve, Manual Steering Check Valve Inlet Relief Valve, Manual Steering Check Valve Cylinder Relief Valve, Anti-Cavitation Valve, Inlet Relief Valve, Inlet Check Valve, Manual Steering Check Valve. Cylinder Relief Valve, Anti-cavitation Valve, Inlet Check Valve, Load Sensing Relief Valve, Manual Steering Check Valve										22 23		Input Torque Fluid Type		1 3 A		Low* Standard See Eaton Technical Bulletin 3-401												
	Integral Inlet Relief Valve Setting		00 18 1J 1Z 26 2G 2T 34 3W		None 40 bar [580 PSI] 50 bar [725 PSI] 63 bar [914 PSI] 70 bar [1015 PSI] 80 bar [1160 PSI] 90 bar [1305 PSI] 100 bar [1450 PSI] 125 bar [1812 PSI]										24 25,26 27 28 29		Special Application Special Feature Paint Identification Mechanical Interface		0 AA 1 0 A		None None Black Primer Eaton Product Number on Nameplate Tapered 17919mm (.7055in) diameter, .083:1 and serrated 17.5 (.688) diameter, 40 tooth, M16x1.5-6g, Extension length 65.02 (2.56)												
	Cylinder Relief Setting		00 37 42 55 68		None 103 bar [1490 PSI] 130 bar [1890 PSI] 185 bar [2680 PSI] 200 bar [2900 PSI]														D		Internal involute spline12 tooth, 16/32 DP, 30 degree PA												
	Low torque units need approval from an Eaton Steering Engineer.																		30		Eaton Assigned Design Code		B		Assigned Design Code								

* All low torque units need approval from an Eaton Steering Engineer.

Steering Control Units—Series 5

Model Code – Ordering Information



Round Housing with End Ports - Option 2

The following 30-digit coding system has been developed to identify all of the configuration options for the Series 5 steering control units. Use this model code to specify a unit with the desired features. All 30-digits of the code must be present when ordering. You may want to photocopy the matrix below to ensure that each number is entered in the correct box.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
A	B	R			A			0		A					0	0						A	0			1	0			B
Nos	Feature		Code	Description		Nos	Feature		Code	Description																				
1,2,3	Product Series		ABR	Series 5 Steering Control Unit		18,19,20,21	Ports and Mounting Threads		VAAH	Round 4 x 9/16 SAE Ports, M6 x 1,0 Column Mounting Threads (Use with Open Center)																				
4	Nominal Flow Rating		1 B	11 l/min [3 GPM] 19 l/min [5 GPM]					VAKH	Round 5 x 9/16 SAE Ports, M6 x 1,0 Column Mounting Threads (Use with Excess Flow)																				
5	Inlet Pressure Rating		C	140 bar [2030 PSI]					VAEH	Round 5 x 9/16 SAE Ports, M6 x 1,0 Column Mounting																				
6	Tank Pressure Rating		A	10 bar [150 PSI]					WAAH	Round 4 x -06 STC Direct Ports, M6 x 1,0 Column Mounting Threads (Use with Open Center)																				
7-8	Displacement		35 37 39 41 43 46 48	31.5 cm3/r [1.92 in3/r] 39.5 cm3/r [2.41 in3/r] 50.8 cm3/r [3.10 in3/r] 63.1 cm3/r [3.85 in3/r] 73.8 cm3/r [4.50 in3/r] 100 cm3/r [6.10 in3/r] 120 cm3/r [7.33 in3/r]					WBNH	Round 5 x -06 STC Direct Ports, M6 x 1,0 Column Mounting Threads (Use with Excess Flow)																				
9	Flow Amplification		0	None					WBPH	Round 5 x -06 STC Direct Ports, M6 x 1,0 Column Mounting Threads (Use with Load Sense)																				
10	Neutral Circuit		A B C F	Open Center Open Center, Power Beyond Closed Center Load Sensing, Dynamic signal		22	Input Torque		1 3	Low* Standard																				
11	Load Circuit		A	Non-Load Reaction		23	Fluid Type		A	See Eaton Technical Bulletin 3-401																				
12,13	Valve Options		01 04 05 12	Manual Steering Check Valve Inlet Check Valve, Manual Steering Check Valve Inlet Relief Valve, Manual Steering Check Valve Cylinder Relief Valve, Anti-cavitation Valve, Inlet Relief Valve, Inlet Check Valve, Manual Steering Check Valve.		24 25,26 27 28 29	Special Application Special Feature Paint Identification Mechanical Interface		0 AA 1 0 A	None None Black Primer Eaton Product Number on Nameplate Tapered 17.919mm (.7055in) diameter, .083:1 and serrated 17.5 (.688) diameter, 40 tooth, M16x1.5-6g, Extension length 65.02 (2.56)																				
14,15	Integral Inlet Relief Valve Setting		00 18 1J 1Z 26 2G 2T 34 3W 4C	None 40 bar [580 PSI] 50 bar [725 PSI] 63 bar [914 PSI] 70 bar [1020 PSI] 80 bar [1160 PSI] 90 bar [1310 PSI] 100 bar [1450 PSI] 125 bar [1812 PSI] 140 Bar [2030 PSI]		30	Eaton Assigned Design Code		B	Assigned Design Code																				
16,17	Cylinder Relief Setting		00	None					D	Internal involute spline 12 tooth, 16/32 DP, 30 degree PA																				

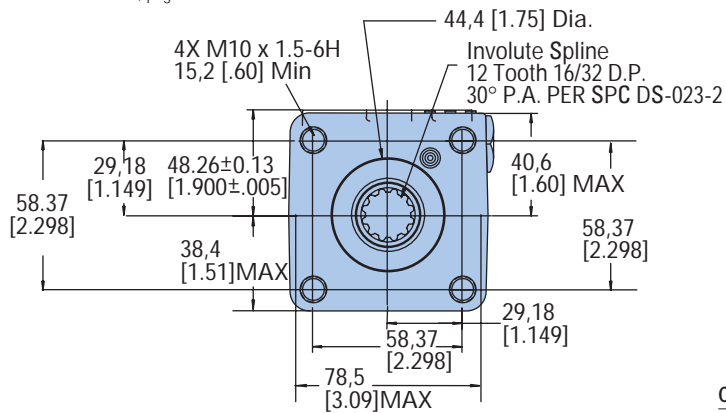
* All low torque units need approval from an Eaton Steering Engineer.

** Plug-O ports rated to 103 bar [1500PSI]

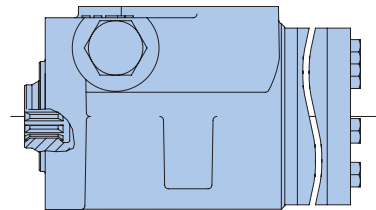
Steering Control Units—Series 5 Installation Drawing

Option 1: Square Housing with Side Ports

refer to Model Code, page 23

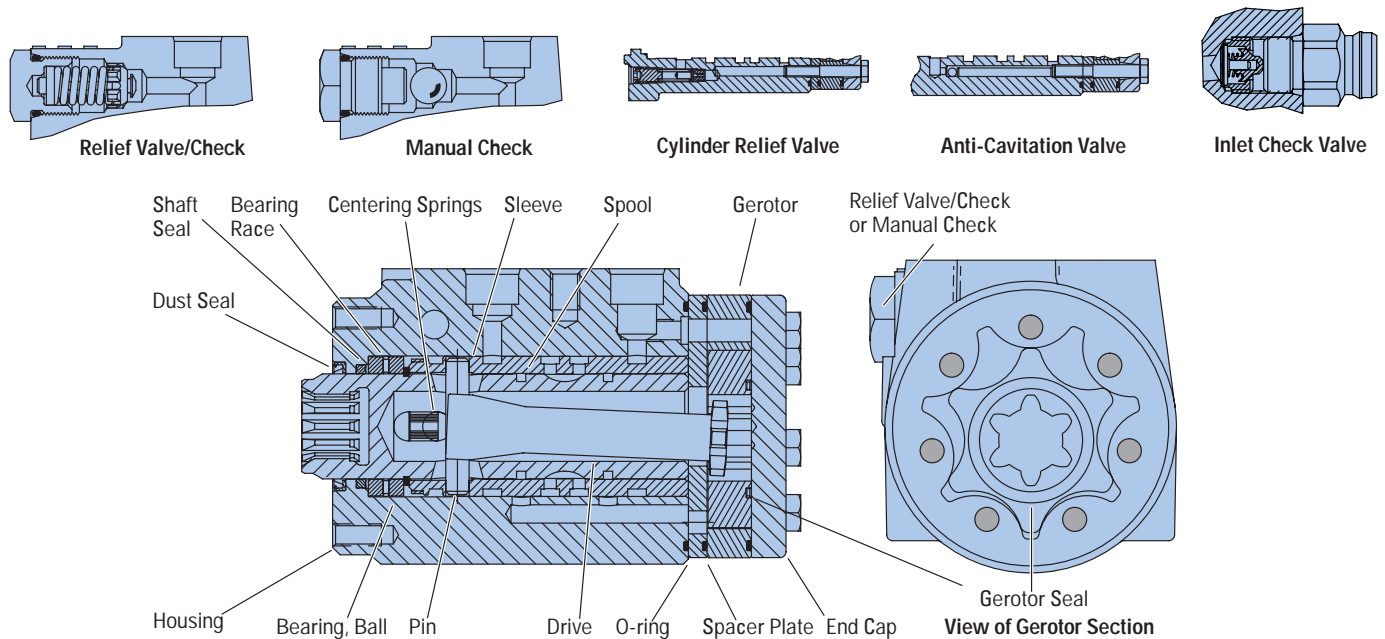


Side View



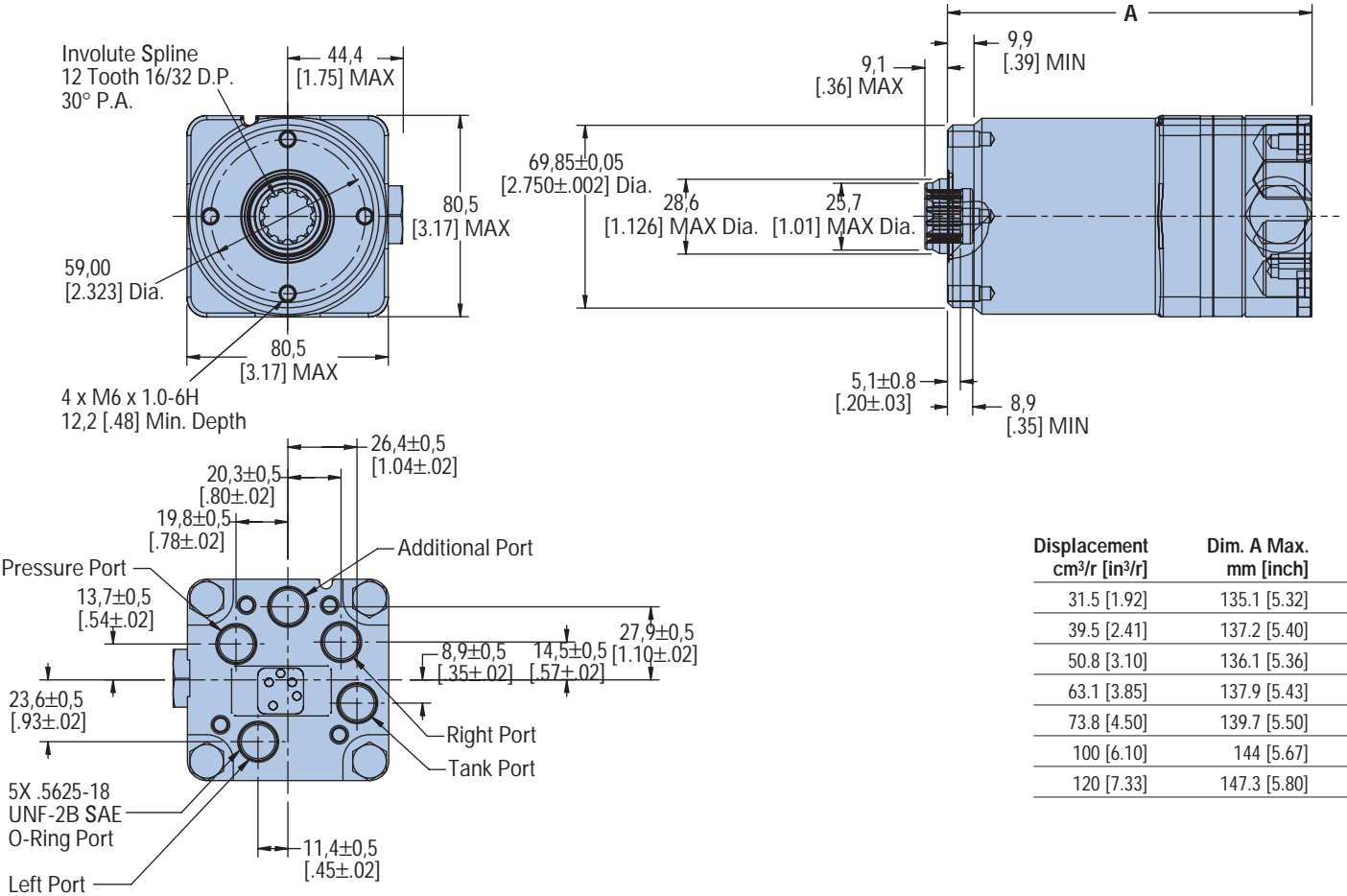
Code	Displacement cm ³ /r [in ³ /r]	Dim. A Max. mm [inch]
35	31.5 [1.92]	123.4 [4.86]
37	39.5 [2.41]	125.2 [4.93]
39	50.8 [3.10]	124.2 [4.89]
41	63.1 [3.85]	126.2 [4.97]
43	73.8 [4.50]	128.0 [5.04]
46	100.0 [6.10]	132.3 [5.21]
48	120.0 [7.33]	135.4 [5.33]

Sectional Drawing

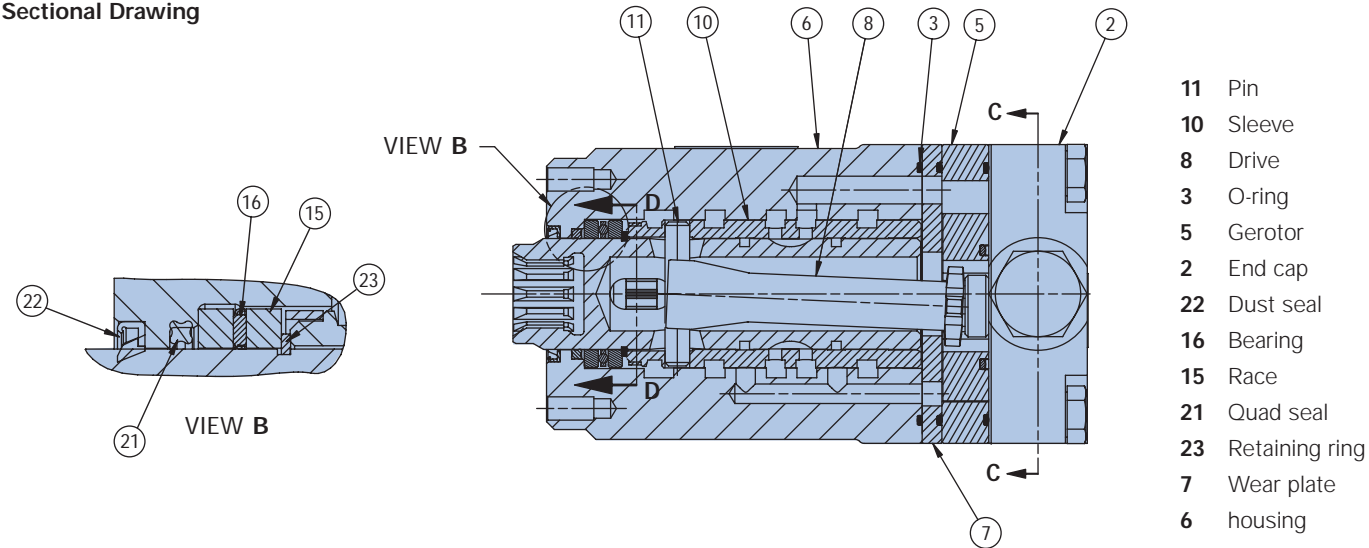


Steering Control
Units—Series 5
Installation
Drawing

Option 2: Round Housing with End Ports

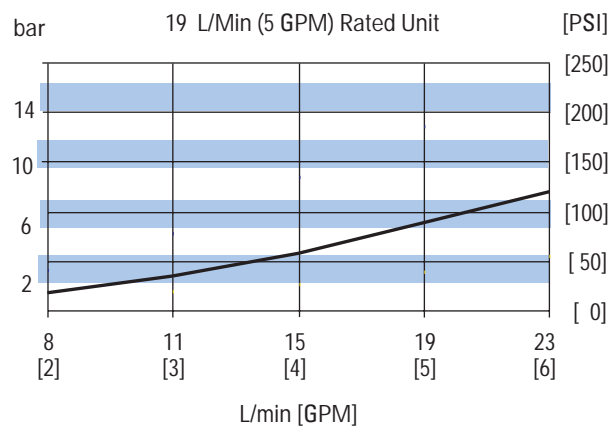
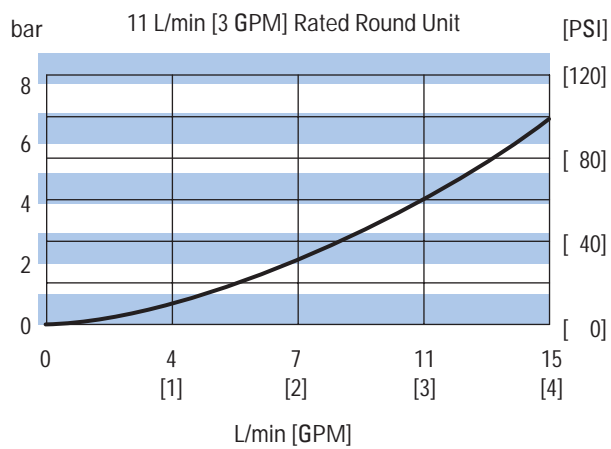


Sectional Drawing

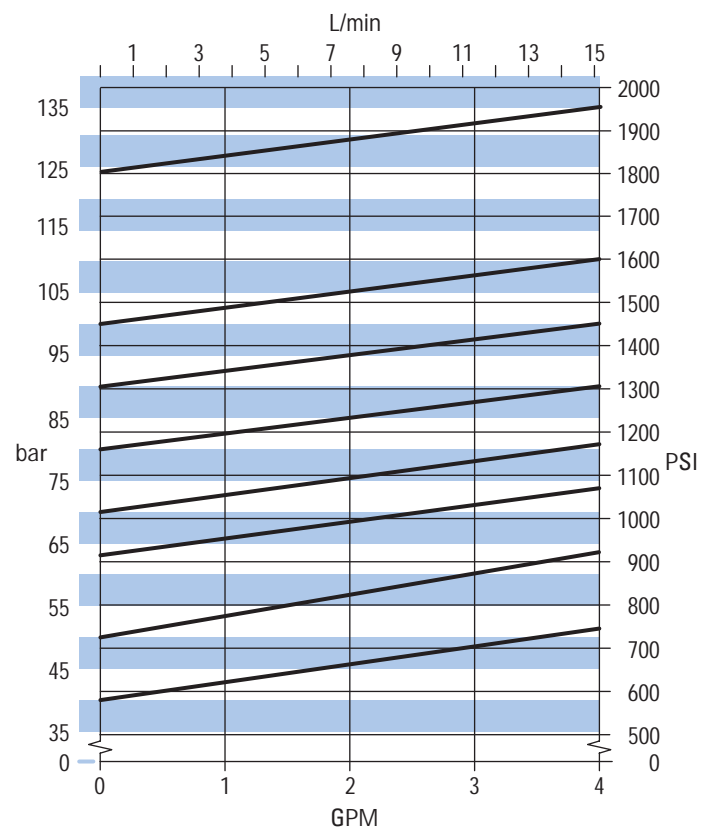


Steering Control Units—Series 5 Performance Data

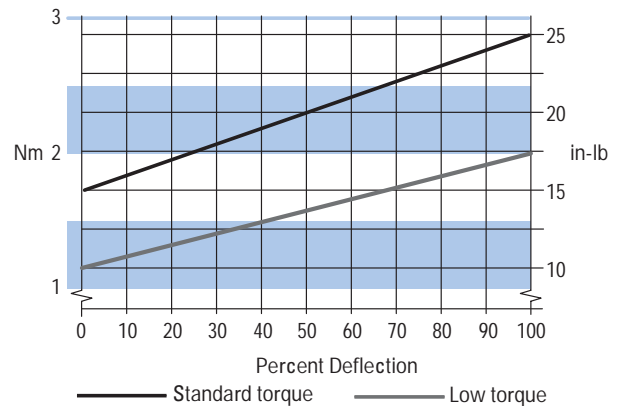
**Neutral Pressure Drop
Inlet to Auxiliary**



Relief Valve Curve



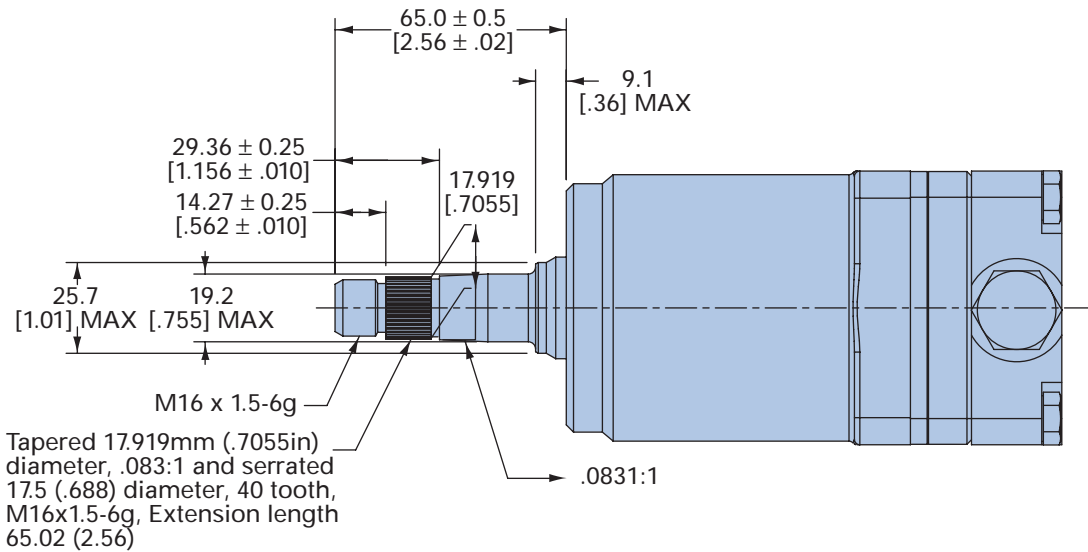
Input Torque Curve



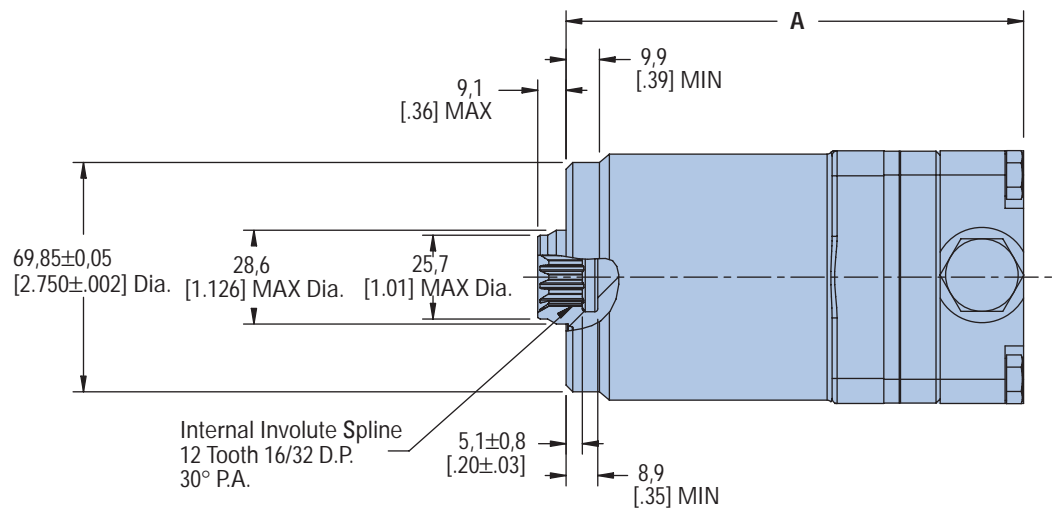
Steering Control Units—Series 5 Integral Column Option

Integral Column
Option Available in
Square Housing with
Side Ports, and Round
Housing with End
Ports

**40 Tooth Serrated Integral
Column Option (Shown on
Round Housing with End
Ports)**



**12 Tooth Internal Spline
Standard Mechanical Interface
(Shown on Round Housing
with End Ports)**



Steering Control Units—Series 10

Product Description

Eaton's Series 10 Steering Control Unit (SCU) facilitates hydraulic fluid flow like no other unit on the market. This highly-engineered product is the ultimate SCU for mid-range flow applications.

Benefits

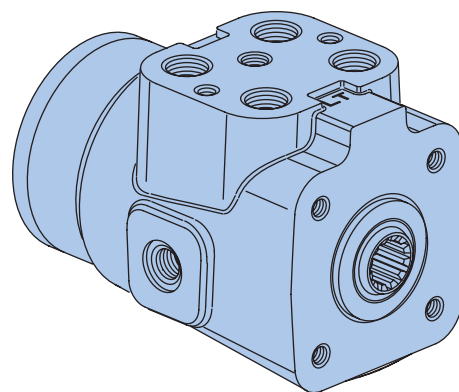
- The new Series 10 SCU has an unprecedented, continuous pressure rating of 275 bar (4000 psi), making it ideal for heavy-duty equipment, such as construction and agricultural machinery.
- Its **high-pressure rating** reduces overall equipment costs, since smaller cylinder sizes can be assigned into the system.
- The new Series 10 incorporates proven Eaton technologies. An internal, balanced architecture and a wide-walled sleeve that is 40% thicker than standard designs offer **increased performance** during transient pressure conditions.

Features

- Open Center
- Power Beyond
- Closed Center
- Load Sensing
- Integral Valves
- Q-Amp
- 2-Speed
- Dual Displacement
- Versa Steer
- Wide Angle
- Cylinder Damping

Applications

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



SPECIFICATIONS

Max. System Pressure	275 bar [4000 PSI]
Max. Back Pressure	21 bar [305 PSI]
Rated Flow	
– Low	7,6 - 15 l/min [2 - 4 GPM]
– Medium	15 - 30 l/min [4 - 8 GPM]
– High	30 - 61 l/min [8 - 16 GPM]
– Low (with Q-Amp)	8 - 19 l/min [2 - 5 GPM]
– Medium (with Q-Amp)	19 - 38 l/min [5 - 10 GPM]
– High (with Q-Amp)	38 - 76 l/min [10 - 20 GPM]
Max. Differential Between Steering Unit and System Temperature	28° C [50° F]
Max. System Operating Temperature	93° C [200° F]
Input Torque Powered	1,1-2,8 Nm @ 6,9 bar back pressure [10-25 lb-in @ 100 PSI back pressure]
Non-Powered	136 Nm [100 lb-ft]
Fluid	See Eaton Technical Bulletin 3-401
Recommended Filtration	ISO 18/13 cleanliness level

PORT SIZES:

Work Ports (4)	Load Sense (LS) Port (1)*
3/4-16 (SAE)	7/16-20
M18 x 1,5 - 6H	M12 x 1,5 - 6H
G 1/2 (BSP) Straight Thread	G 1/4 (BSP) Straight Thread
STC Dash 08**	STC Dash 06**

*Top or side when applicable

**STC® Ports, Aeroquip patented, feature snap to connect technology

Steering Control Units—Series 10

Model Code— Ordering Information

The following 32-digit coding system has been developed to identify all of the configuration options for the Series 10 steering control units. Use this model code to specify a unit with the desired features. All 32-digits of the code must be present when ordering. You may want to photocopy the matrix below to ensure that each number is entered in the correct box.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
A	D	R																			A		A	A		A	A	A	1	0	A

Nos	Feature	Code	Description	Nos	Feature	Code	Description
1,2,3	Product Series	ADR	Series 10 Steering Control Unit	10	Flow Amplification**	A	None (No Q-Amp)
4	Unit Type	B	Dual Displacement			B	1.6 : 1.0 Ratio†
		C	Wide Angle			C	1.6 : 1.0 Ratio (with Manual Steering)†
		D	2-Speed			E	2.0 : 1.0 Ratio (with Manual Steering)†
		E	2-Speed with Wide Angle			G	1.3 : 1.0 Ratio (with Manual Steering)†
		G	Dual Displacement with Wide Angle				†Use with closed center or load sensing only.
		V	Versa Steer, Wide Angle				
5	Nominal Flow Rating	1	11 l/min [3 GPM] (Open Center)	11	Neutral Circuit	A	Open Center
		2	23 l/min [6 GPM] (Closed Center and LS)			C	Closed Center
		3	45 l/min [12 GPM] (OC, CC, and LS)			D	Load Sensing, Static Signal
		4	19 l/min [5 GPM] (Q-Amp)			E	Load Sensing, Dynamic Signal
		5	38 l/min [10 GPM] (Q-Amp)			F	Open center with Power Beyond
		6	76 l/min [20 GPM] (Q-Amp)	12	Load Circuit	A	Non-Load Reaction
		7	23 l/min [6 GPM] (Open Center)			B	Load Reaction (Open Center 3,8 - 30 l/min [1 - 8 GPM] Only)
6	Inlet Pressure Rating	1	276 bar [4000 PSI]—(Load sensing and closed center)	13,14	Special Spool/Sleeve Modification	00	None
		2	207 bar [3000 PSI]—(Open center)	15,16	Valve Options		
7	Return Pressure Rating	A	21 bar [305 PSI] Max.—(standard rating*)		Manual Steering Check		
		B	10 bar [145 PSI] Max.		Load Sensing Relief		
8-9	Displacement cm ³ /r [in ³ /r] — Dual Displacement Combined/Manual	01	352 [21.5] / 60 [3.6]	01	•		
		02	218 [13.3] / 60 [3.6]	02	•	•	
		03	290 [17.7] / 60 [3.6]	03	•		•
		04	440 [26.8] / 146 [8.9]	04	•	•	•
		05	231 [14.1] / 85 [5.2]	05	•		•
8-9	Displacement cm ³ /r [in ³ /r]	40	60 [3.6]	06	•	•	•
		43	75 [4.5]	07	•	•	•
		45	95 [5.9]	08	•	•	•
		48	120 [7.3]	09	•	•	•
		50	145 [8.9]	10	•	•	•
		51	160 [9.7]	11	•	•	•
		52	185 [11.3]				
		54	230 [14.1]				
		57	295 [17.9]				
		59	370 [22.6]				
		61	460 [28.2]				
		64	590 [35.9]				
		66	740 [45.1]				

* 12 GPM open center requires 145psi back pressure

** All Q-amp applications need approval from an Eaton Applications Engineer

Continued on next page

Steering Control Units—Series 10

Model Code— Ordering Information— Continued

Nos	Feature	Code	Description
17,18	Inlet or Load Sense Relief Valve — bar [PSI]	00	None
		18	124 [1800]
		19	131 [1900]
		20	138 [2000]
		21	145 [2100]
		22	152 [2200]
		23	158 [2290]
		24	165 [2390]
		25	172 [2490]
		26	179 [2600]
		27	186 [2700]
		28	193 [2800]
		29	200 [2900]
		30	207 [3000]
		31	214 [3100]
		32	220 [3190]
		33	227 [3290]
		34	234 [3390]
		35	241 [3500]
		36	248 [3600]
		37	255 [3700]
		38	262 [3800]
		39	269 [3900]
		40	276 [4000]
		99	136 [1970]
19,20	Cylinder Relief Valve — bar [PSI] ** Cylinder Relief setting recommendation is 870 PSI (60 bar) above steering inlet/load sense pressure.	00	None
		23	158 [2290]
		24	165 [2390]
		25	172 [2490]
		26	179 [2600]
		27	186 [2700]
		28	193 [2800]
		29	200 [2900]
		30	207 [3000]
		31	214 [3100]
		32	220 [3190]
		33	227 [3290]
		34	234 [3390]
		35	241 [3500]
		36	248 [3600]
		37	255 [3700]
		38	262 [3800]
		39	269 [3900]
		40	276 [4000]
		41	283 [4100]
		42	289 [4190]
		43	296 [4290]
		44	303 [4390]
		45	310 [4500]
		46	317 [4600]
		47	324 [4700]
		48	331 [4800]
		49	338 [4900]

Nos	Feature	Code	Description
21,22,23,24	Ports and Mounting Threads	AAAA	4 x 3/4-16 (SAE) Ports
			None (No Additional Port)
			2 x M12 Mounting Threads Port Face
		AABA	4 x M10 Mounting Threads Mounting Face
			4 x 3/4-16 (SAE) Ports
			7/16-20 Load Sensing Port on Side
		AACA	2 x M12 Mounting Threads Port Face
			4 x M10 Mounting Threads Mounting Face
			4 x 3/4-16 (SAE) Ports
		BAAA	7/16-20 Load Sensing Port Port Face
			2 x M12 Mounting Threads Port Face
			4 x M10 Mounting Threads Mounting Face
		BADA	4 x M18 x 1,5 - 6H Metric O-ring Ports
			None (No Additional Port)
			2 x M12 Mounting Threads Port Face
		BAEA	4 x M10 Mounting Threads Mounting Face
			4 x M18 x 1,5 - 6H Metric O-ring Ports
			M12 x 1,5 - 6H Load Sensing Port on Side
		CAAA	2 x M12 Mounting Threads Port Face
			4 x M10 Mounting Threads Mounting Face
			4 x M18 x 1,5 - 6H Metric O-ring Ports
			M12 x 1,5 - 6H Load Sensing Port Port Face
			2 x M12 Mounting Threads Port Face
			4 x M10 Mounting Threads Mounting Face
			4 x G 1/2 (BSP) Straight Thread Ports
			None (No Additional Port)
			2 x M12 Mounting Threads Port Face
			4 x M10 Mounting Threads Mounting Face

Continued on next page

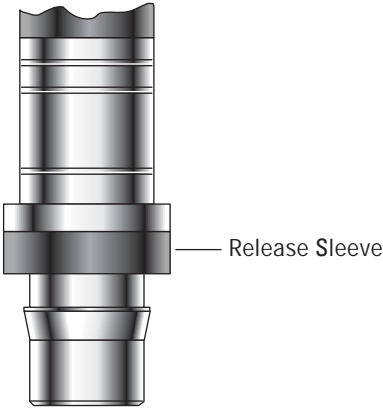
Steering Control Units—Series 10

Model Code— Ordering Information— Continued

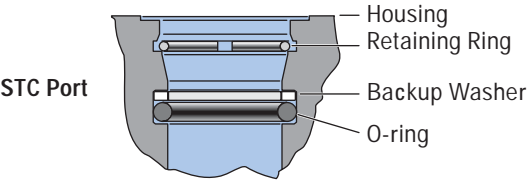
Nos	Feature	Code	Description
21,22,23,24	Ports and Mounting Threads (continued)	CAFA	4 x G 1/2 (BSP) Straight Thread Ports G 1/4 (BSP) LS Straight Thread Port on Side 2 x M12 Mounting Threads Port Face 4 x M10 Mounting Threads Mounting Face
		CAGA	4 x G 1/2 (BSP) Straight Thread Ports G 1/4 (BSP) LS Straight Thread Port on Port Face 2 x M12 Mounting Threads Port Face 4 x M10 Mounting Threads Mounting Face
		DAAA	Dash 08 STC® Ports *** None (No Additional Port) 2 x M10 Mounting Threads Port Face 4 x M10 Mounting Threads Mounting Face
		DAHA	Dash 08 STC® Ports *** Dash 06 STC® Port on Side 2 x M10 Mounting Threads Port Face 4 x M10 Mounting Threads Mounting Face
		DAJA	Dash 08 STC® Ports *** Dash 06 STC® Port Face 2 x M10 Mounting Threads Port Face 4 x M10 Mounting Threads Mounting Face
25	Mechanical Interface	A	Internal Involute Spline, 12 Tooth 16/32 DP 30° PA
26	Input Torque	3	Standard
27	Fluid Type	A	See Eaton Technical Bulletin 3-401
28,29	Special Features	AA	None
30	Paints and Packaging	1	Black Primer
31	Identification	0	Eaton Product Number on Nameplate
32	Eaton Assigned Design Code	B	Assigned Design Code

STC®—Aeroquip

STC Hose/Connector



Dash 08 Port Face (4)
Dash 06 LS Port Side (1)



Patent numbers: 5,553,895
5,226,682
5,570,910

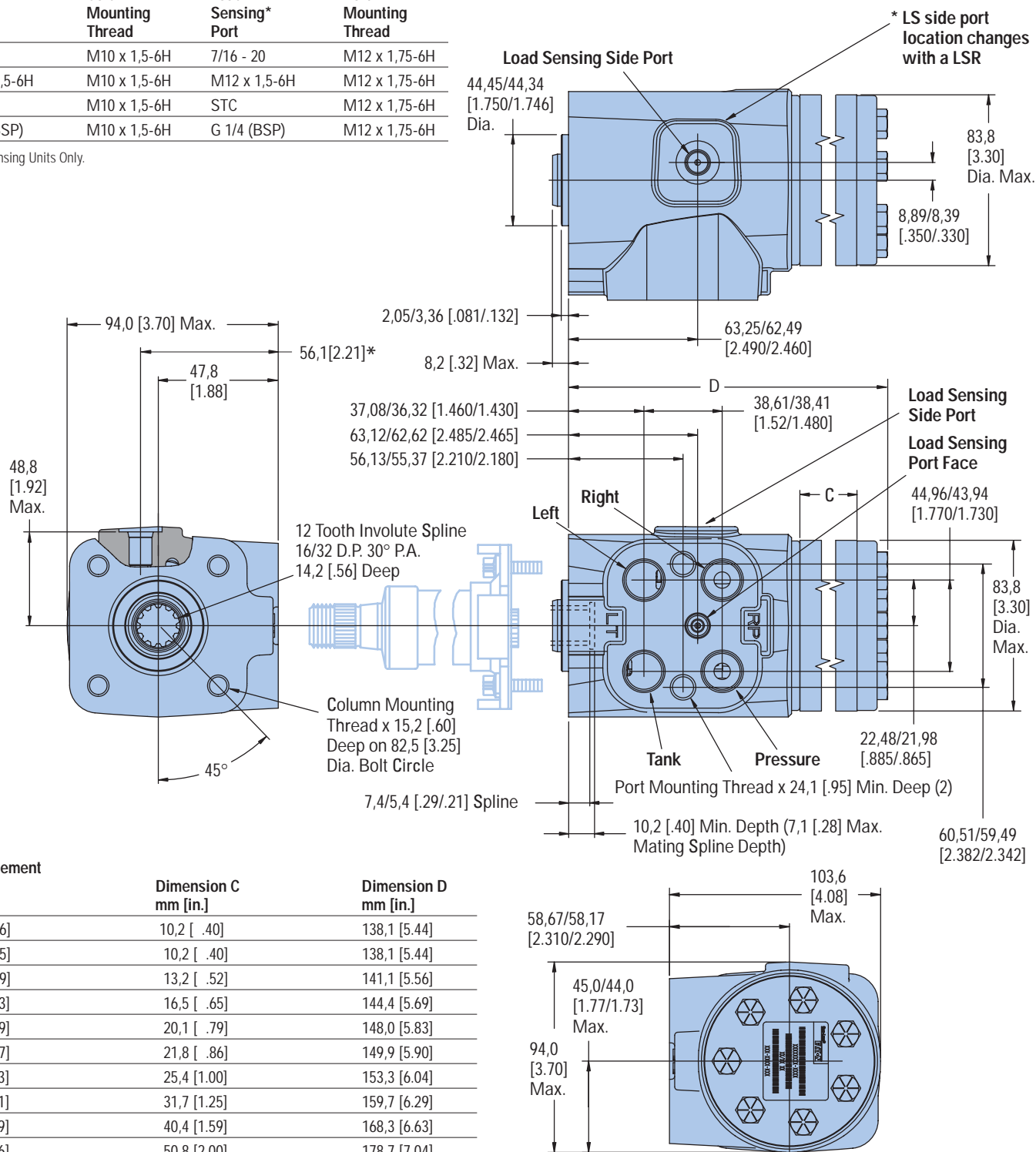
*** STC with inlet check requires threaded adapter. Contact your Eaton Account Representative for assistance.

Steering Control Units—Series 10 Installation Drawing

PORT AND MOUNTING THREAD COMBINATIONS

Port	Column Mounting Thread	Load Sensing* Port	Port Mounting Thread
3/4 -16	M10 x 1,5-6H	7/16 - 20	M12 x 1,75-6H
M18 x 1,5-6H	M10 x 1,5-6H	M12 x 1,5-6H	M12 x 1,75-6H
STC	M10 x 1,5-6H	STC	M12 x 1,75-6H
G 1/2 (BSP)	M10 x 1,5-6H	G 1/4 (BSP)	M12 x 1,75-6H

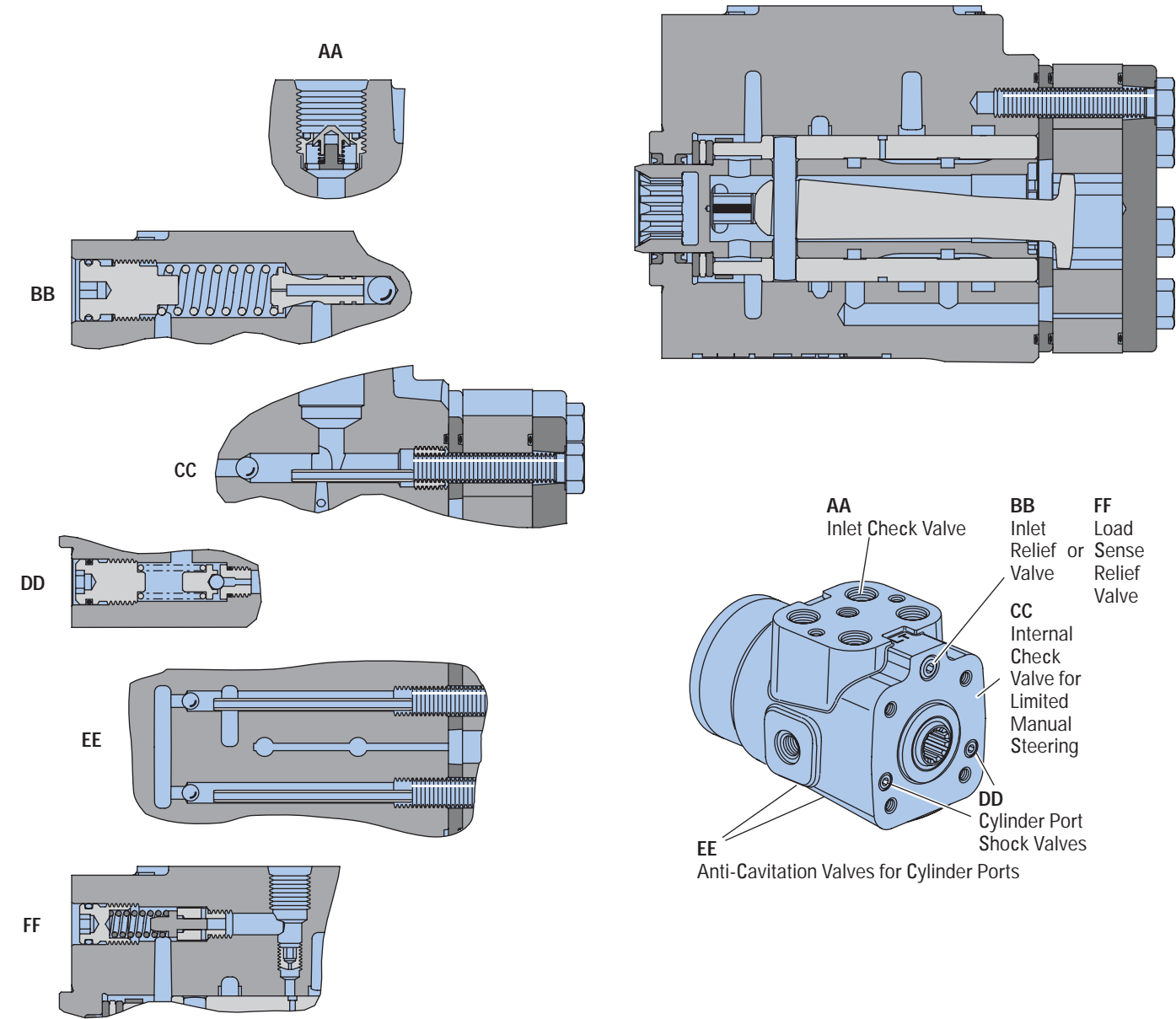
*Load Sensing Units Only.



Displacement cm ³ /r [in ³ /r]	Dimension C mm [in.]	Dimension D mm [in.]
60 [3.6]	10,2 [.40]	138,1 [5.44]
75 [4.5]	10,2 [.40]	138,1 [5.44]
95 [5.9]	13,2 [.52]	141,1 [5.56]
120 [7.3]	16,5 [.65]	144,4 [5.69]
146 [8.9]	20,1 [.79]	148,0 [5.83]
159 [9.7]	21,8 [.86]	149,9 [5.90]
185 [11.3]	25,4 [1.00]	153,3 [6.04]
231 [14.1]	31,7 [1.25]	159,7 [6.29]
293 [17.9]	40,4 [1.59]	168,3 [6.63]
370 [22.6]	50,8 [2.00]	178,7 [7.04]
462 [28.2]	63,5 [2.50]	191,4 [7.54]
588 [35.9]	80,8 [3.18]	208,8 [8.22]
739 [45.1]	101,6 [4.00]	229,6 [9.04]

Steering Control Units—Series 10

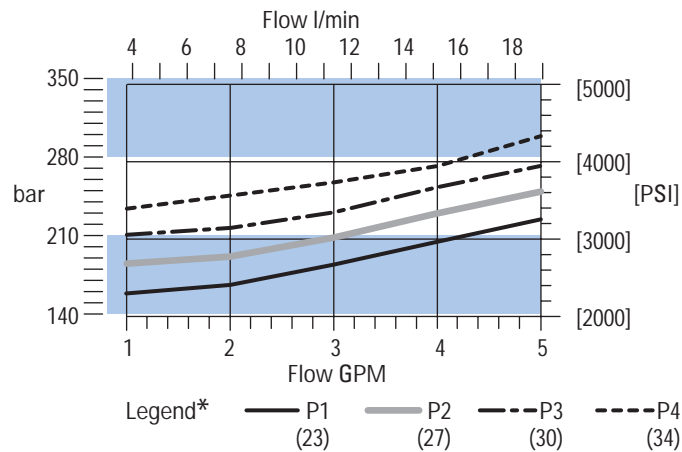
Sectional Drawing and Integral Valves



Steering Control Units—Series 10 Performance Data

Cylinder Relief Valve

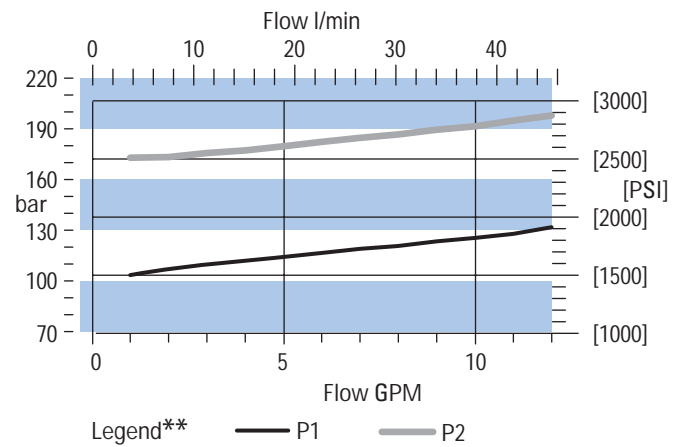
Pressure Drop versus Flow



*The examples above are 4 of 27 pressure settings shown in model code page 30 [Position 19, 20](#)

Inlet Relief Valve

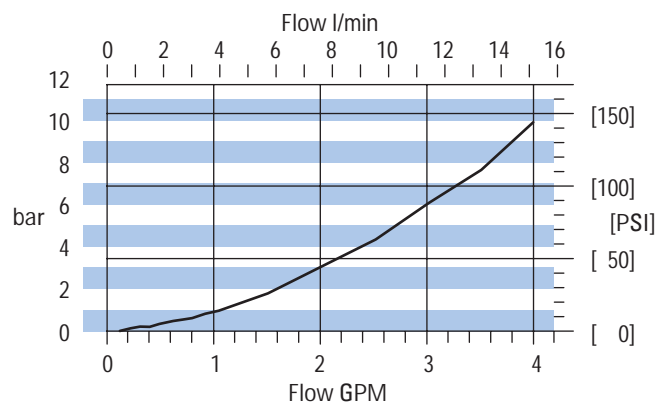
Pressure Drop versus Flow



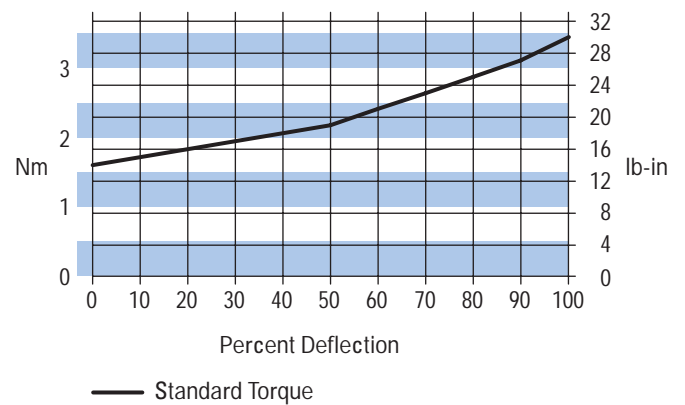
**The examples above are 2 of 24 pressure settings shown in model code page 30 [Position 17, 18](#)

Anti-Cavitation Valve

Pressure Drop versus Flow



Input Torque

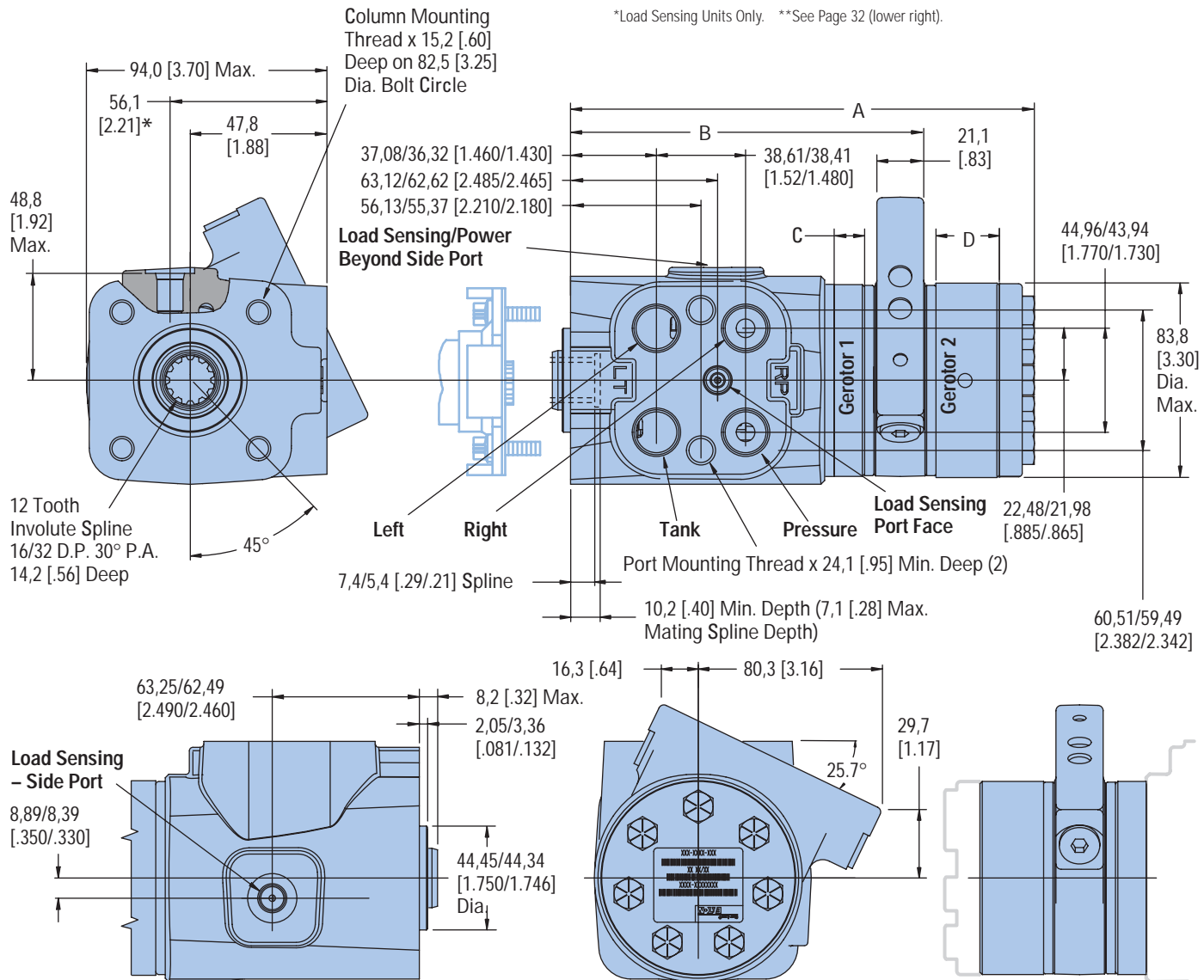


Steering Control Units— Series 10 Dual Displacement Installation Drawing

PORT AND MOUNTING THREAD COMBINATIONS

Port	Column Mounting Thread	Load Sensing* Port	Port Mounting Thread
3/4 -16	M10 x 1,5-6H	7/16 - 20	M12 x 1,75-6H
M18 x 1,5-6H	M10 x 1,5-6H	M12 x 1,5-6H	M12 x 1,75-6H
STC**	M10 x 1,5-6H	STC**	M12 x 1,75-6H
G 1/2 (BSP)	M10 x 1,5-6H	G 1/4 (BSP)	M12 x 1,75-6H

*Load Sensing Units Only. **See Page 32 (lower right).



Powered Displacement cm ³ /r [in ³ /r]	Dimension B mm [in.]	Dimension A mm [in.]
Gerotor 1 and 2		
156 [9.5]	146,5 [5.77]	182,9 [7.20]
179 [10.9]	146,5 [5.77]	186,2 [7.33]
205 [12.5]	146,5 [5.77]	189,7 [7.47]
218 [13.3]	146,5 [5.77]	191,5 [7.54]
244 [14.9]	146,5 [5.77]	195,1 [7.68]

Manual Displacement cm ³ /r [in ³ /r]	Dimension C mm [in.]
Gerotor 1	
60 [3.6]	10,2 [.40]
60 [3.6]	10,2 [.40]
60 [3.6]	10,2 [.40]
60 [3.6]	10,2 [.40]
60 [3.6]	10,2 [.40]

Displacement cm ³ /r [in ³ /r]	Dimension D mm [in.]
Gerotor 2	
95 [5.9]	13,2 [.52]
120 [7.3]	16,5 [.65]
145 [8.9]	20,0 [.79]
160 [9.7]	21,8 [.86]
185 [11.3]	25,4 [1.00]

Steering Control Units— Series 20

Product Description

The Series 20 steering control unit continues Eaton's tradition of innovative design and high quality that began with the first fluid linked power steering system.

You can count on this steering unit to provide the same smooth, predictable steering as the Char-Lynn steering units that provide dependable, trouble-free steering on applications around the world.

- Provides much **smoother steering** function by minimizing jerky motion on articulated vehicles.
- Jerk-reducing valves and accumulators can be eliminated on most vehicles, providing customer savings through fewer components required and **reduced system cost**.
- **Symmetrical valving** provides passageways and valving that are equally placed, and pressure areas that are staged for minimum internal leakage. This results in balance, precise servo response and uniform left or right steering action.
- Eaton's **high capacity gerotor** provides ample fluid displacement from an even more compact unit than was previously offered.

- A **thicker sleeve design** provides stability, especially during pressure and thermal transient conditions.
- The seal and centering spring designs provide **positive, low-effort steering** feel to ensure excellent vehicle control, an important feature for the vehicles for which these steering control units were designed.

Features

- Load Sensing
- Integral Valves
- Q-Amp
- Wide Angle
- Versa Steer
- Cylinder Damping

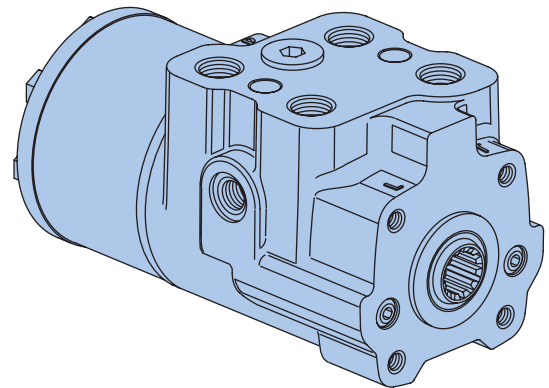
Applications

Articulated Vehicles

- Loaders
- Scrapers
- Skidders
- AG Tractors
- Dumpers
- Sprayers
- Forestry Equipment

Rigid Frame Vehicles

- Front End Loaders
- Large Graders
- Mining Trucks
- Transporters
- AG Tractors



SPECIFICATIONS

Max. System Pressure	241 bar [3500 PSI]
Max. Back Pressure	10 bar [145 PSI]
Rated Flow	95 l/min [25 GPM]
Max. Flow	125 l/min [33 GPM]
Max. Differential Between Steering Unit and System Temperature	28° C 50° F
Max. System Operating Temperature	93°C [200° F]
Input Torque Powered	1,1-2,8 Nm @ 6,9 bar back pressure [10-25 lb-in @ 100 PSI back pressure]
Non-Powered	136 Nm [100 lb-ft]
Fluid	See Eaton Technical Bulletin 3-401
Recommended Filtration	ISO 18/13 cleanliness level

Steering Control Units—Series 20

Model Code – Ordering Information

The following 29-digit coding system has been developed to identify all of the configuration options for the Series 20 steering control units. Use this model code to specify a unit with the desired features. All 29-digits of the code must be present when ordering. You may want to photocopy the matrix below to ensure that each number is entered in the correct box.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
A	C	C		6	A				F											N		A		A	A	1	0	C

Nos	Feature	Code	Description	Nos	Feature					
1,2,3	Product Series	ACC	Series 20 Steering Control Unit	12,13	Valve Options*					
4	Nominal Flow Rating	4	38 l/min [10 GPM] (Q-Amp)		Manual**					
		6	76 l/min [20 GPM] (Q-Amp)		Steering Check		Load Sensing Relief		Inlet** Check Valve	Cylinder Relief Valve
		7	95 l/min [25 GPM] (Non-Q-Amp)							Anti-Cavitation Valve
		A	114 l/min [30 GPM] (Q-Amp)	00						
5	Inlet Pressure Rating	6	241 bar [3500 PSI]	01	•					
6	Return Pressure Rating	A	10 bar [145 PSI] Maximum	02						•
7-8	Displacement cm ³ /r [in ³ /r]	40	60 [3.6]	09	•				•	•
		43	75 [4.5]	10	•			•	•	•
		45	95 [5.9]	13	•		•	•	•	•
		48	120 [7.3]	21			•		•	•
		50	145 [8.9]	24				•	•	•
		51	160 [9.7]	40			•	•	•	•
		52	185 [11.3]							
		54	230 [14.1]							
		57	295 [17.9]							
		59	370 [22.6]							
		61	460 [28.2]							
		64	590 [35.9]							
		66	740 [45.1]							
		69	985 [60.0]							
9	Flow Amplification	0	No Q-Amp							
		1	1.6 : 1.0 Ratio (Actual Displ. 185 to 985 cm ³ /r [11.3 to 60.0 in ³ /r])							
		3	2.0 : 1.0 Ratio (Actual Displ. 60 to 370 cm ³ /r [3.6 to 22.6 in ³ /r])							
10	Neutral Circuit	F	Load Sensing, Dynamic Signal							
11	Load Circuit	A	Non-Load Reaction							
		D	Non-Load Reaction, Cylinder Damped							

*Not all valve options will work with all unit combinations
**76 l/min [20 GPM] Max.

14,15	Load Sensing Relief Valve Setting	00	None
		4N	150 bar [2180 PSI]
		50	160 bar [2320 PSI]
		5A	170 bar [2470 PSI]
		5L	180 bar [2610 PSI]
		5Y	190 bar [2760 PSI]
		68	200 bar [2900 PSI]
		6J	210 bar [3050 PSI]
		6V	220 bar [3190 PSI]
		76	230 bar [3340 PSI]
		7G	240 bar [3480 PSI]

Continued on next page

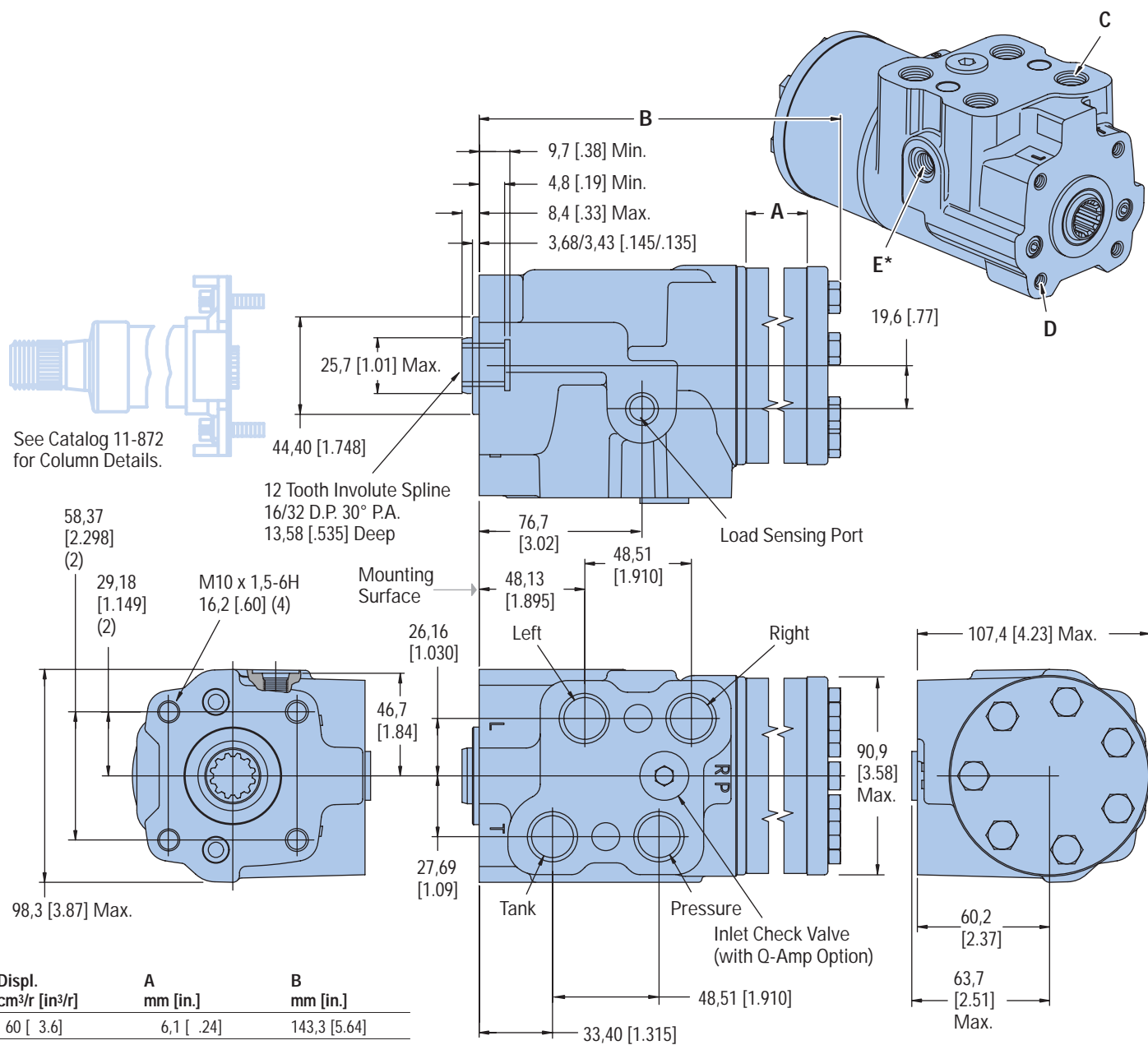
Steering Control Units—Series 20

Model Code— Ordering Information— Continued

Nos	Feature	Code	Description	Nos	Feature	Code	Description
16,17	Cylinder	00	None	22	Input Torque	1	Low
	Relief	6J	210 bar [3050 PSI]			3	Standard (Includes Stiffer Springs)
	Valve	6V	220 bar [3190 PSI]	23	Fluid Type	A	See Eaton Technical Bulletin 3-401
	Setting	76	230 bar [3340 PSI]				
		7G	240 bar [3480 PSI]	24	Special Application Options	1	Wide Angle Deflection
	**Cylinder Relief	7T	250 bar [3630 PSI]			V	Versa Steer, Wide Angle.
	Setting recommen-	84	260 bar [3770 PSI]	25,26	Special Features	AA	None
	dation is 870 PSI	8E	270 bar [3920 PSI]				
	(60 bar) above steering	8R	280 bar [4060 PSI]	27	Paints and Packaging	1	Black Paint
	inlet/load sense	92	290 bar [4210 PSI]				
	pressure.	9C	300 bar [4350 PSI]	28	Identification	0	Eaton Product Number on Nameplate
18,19,20,21	Ports and Mounting Threads	AABN	4 x G 1/2 (BSP) Ports with G 1/4 (BSP) Load Sensing Port on Side, M10 Mounting Threads	29	Eaton Assigned Design Code	C	Assigned Design Code
		DACN	4 x 3/4 (SAE) Ports with 7/16 (SAE) Load Sensing Port on Side, M10 Mounting Threads				
		FAFN	4 x M18 (Metric) Ports with M12 (Metric) Load Sensing Port on Side, M10 Mounting Threads				
		FBFN	4 x M18 (Metric) Ports with M14 (Metric) Load Sensing Port on Side, M10 Mounting Threads				
		RACN*	4 x 7/8 (SAE) Ports with 7/16 (SAE) Load Sensing Port on Side, M10 Mounting Threads				
		SAFN*	4 x M22 (Metric) Ports with M12 (Metric) Load Sensing Port on Side, M10 Mounting Threads				
		SBFN*	4 x M22 (Metric) Ports with M14 (Metric) Load Sensing Port on Side, M10 Mounting Threads				
18,19,20,21	Ports and Mounting Threads (Load Sensing Relief Only)	DADN	4 x 3/4 (SAE) Ports with 7/16 (SAE) Load Sensing Port on Port Face, M10 Mounting Threads				
		AAWN	4 x G 1/2 (BSP) Ports with G 1/4 (BSP) Load Sensing Port on Port Face, M10 Mounting Threads				
		RADN*	4 x 7/8 (SAE) Ports with 7/16 (SAE) Load Sensing Port on Port Face, M10 Mounting Threads				
		FAVN	4 x M18 (Metric) Ports with M12 (Metric) Load Sensing Port on Port Face, M10 Mounting Threads				
		SAVN*	4 x M22 (Metric) Ports with M12 (Metric) Load Sensing Port on Port Face, M10 Mounting Threads				

*Use with 114 l/min [30 GPM]

Steering Control Units—Series 20 Installation Drawing



PORT AND MOUNTING THREAD COMBINATIONS

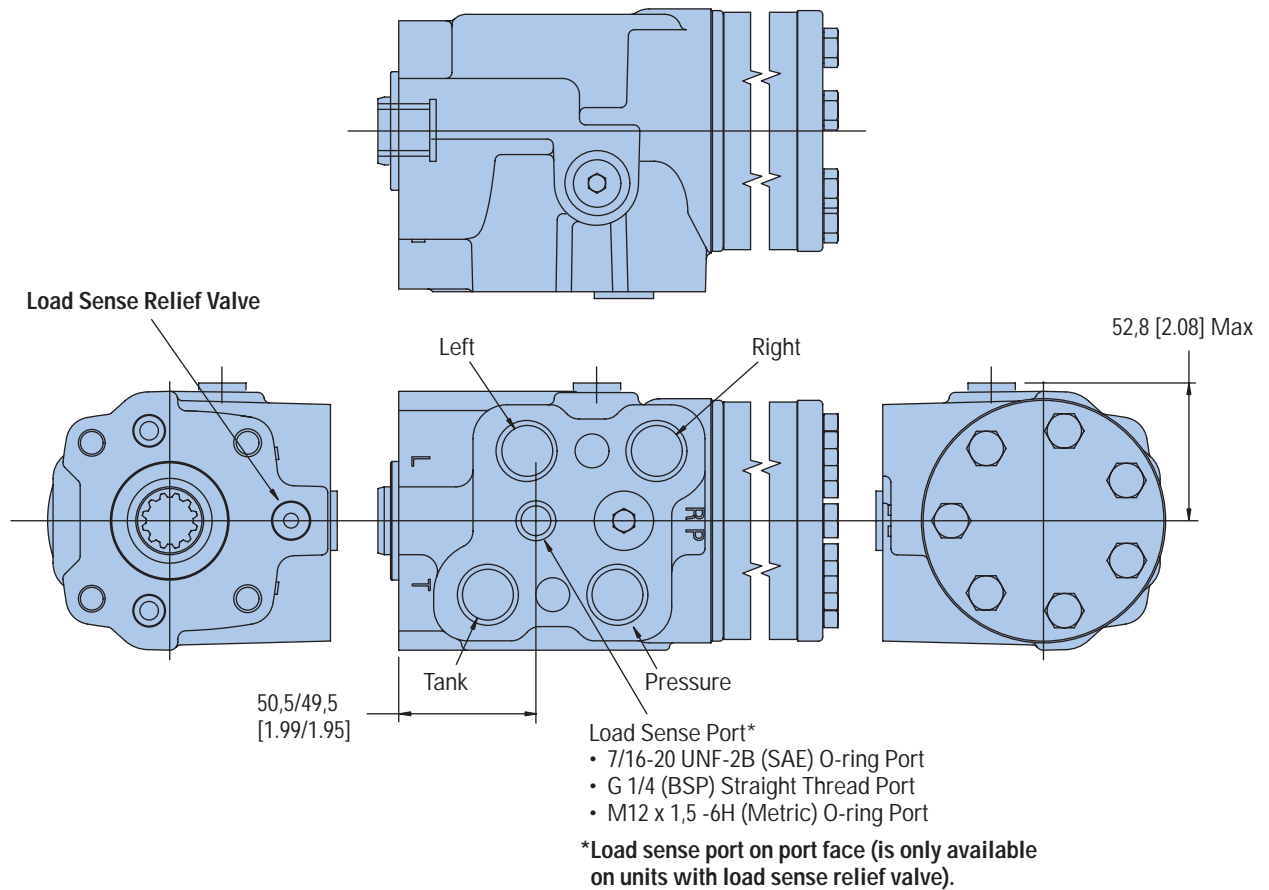
C	D	E*
3/4-16 UNF 2B**	M10 x 1,5-6H	7/16-20 UNF 2B**
G 1/2***	M10 x 1,5-6H	G 1/4***
M18 x 1,5-6H	M10 x 1,5-6H	M12 x 1,5-6H, M14
M22 x 1,5-6H	M10 x 1,5-6H	M12 x 1,5-6H, M14

*Load sensing port option—on side (load sense relief port face only - see page 44).

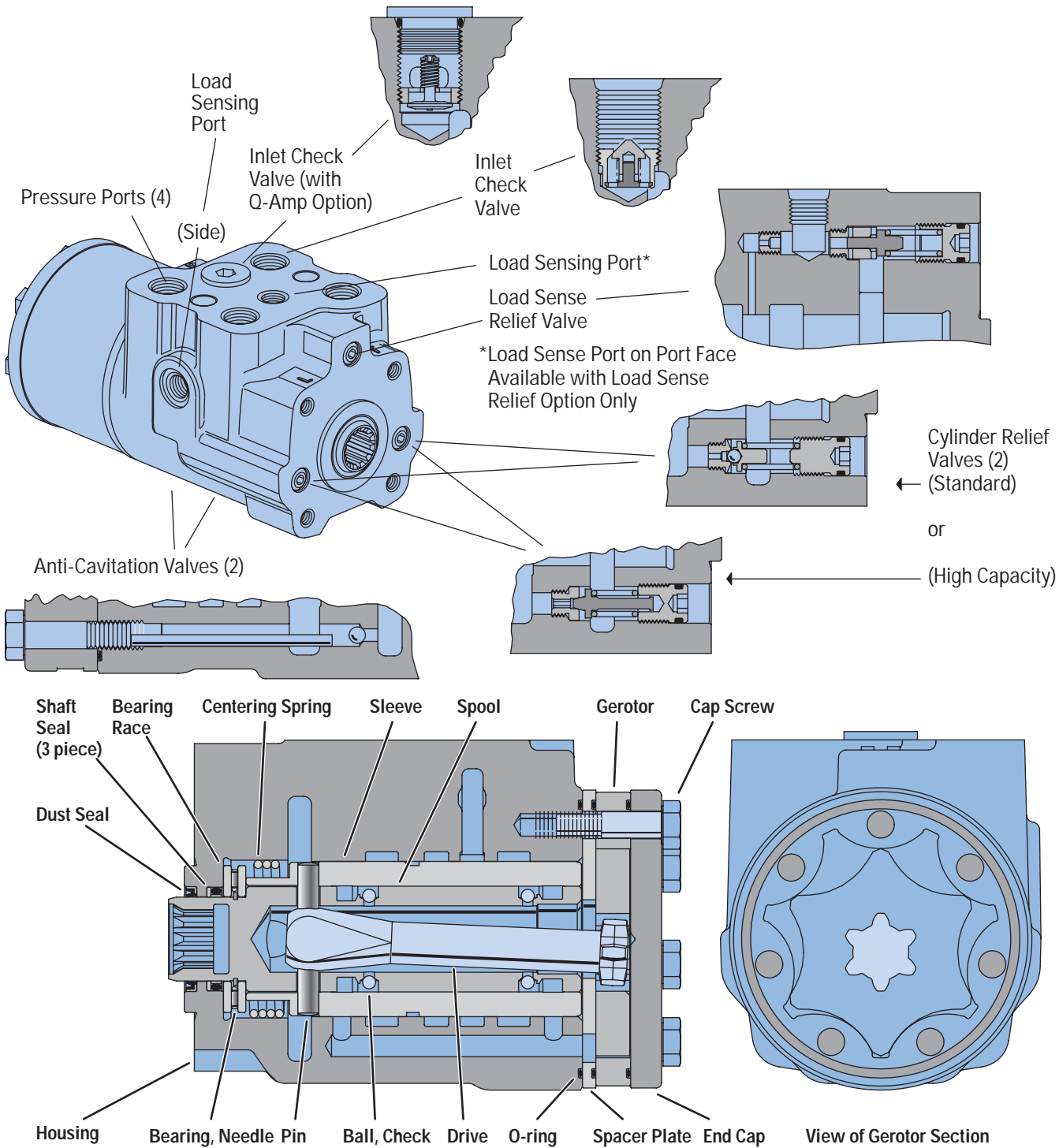
**SAE O-ring Port Port

***BSP Straight Thread Port

Steering Control Units—Series 20 Installation Drawing (Load Sense Relief Option)

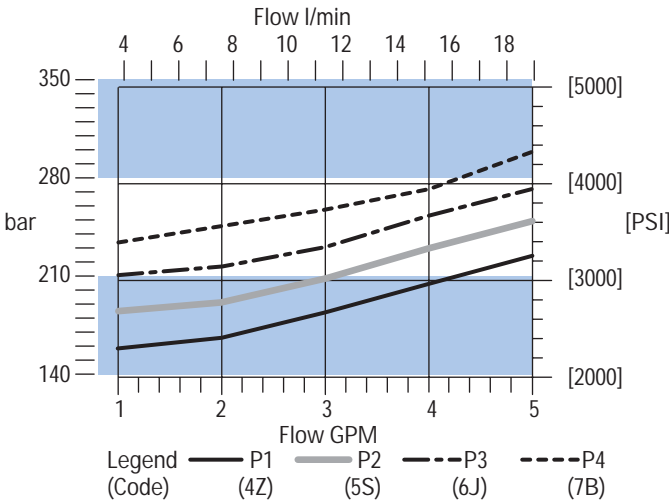


Steering Control
Units—Series 20
Sectional Drawing
and Integral Valves

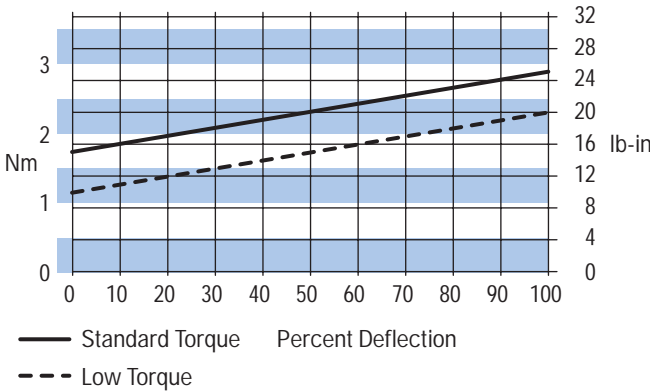


Steering Control
Units—Series 20
Performance Data

Cylinder Relief Valve Pressure
Drop versus Flow



Input Torque



Steering Control Units—Series 25

Product Description

The Series 25 SCU includes two patented designs (Balanced Architecture and Wide Angle) that make it even more responsive, reliable and cost effective.

Features

- Open Center
- Closed Center
- Load Sensing
- Integral Valves
- Q-Amp
- Wide Angle
- Pilot Pressure Port
This is an added feature that can be used for:
 - Pilot pressure to priority valve
 - Diagnostics
- Cylinder Damping

Applications

Articulated Vehicles

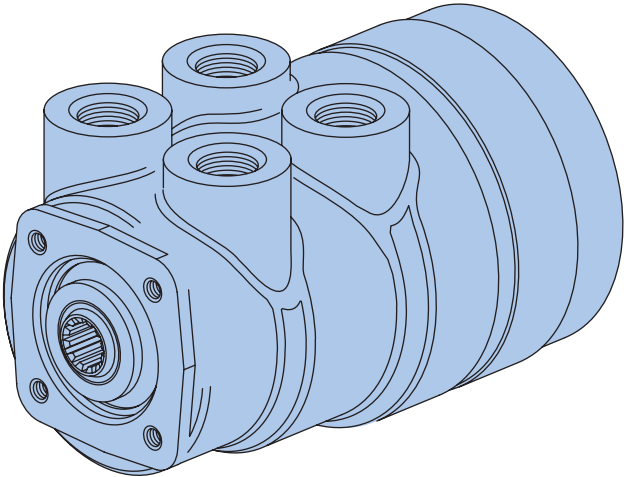
- Loaders
- Scrapers
- Skidders
- AG Tractors

Rigid Frame Vehicles

- Large Front End Loaders
- Graders
- Mining Trucks
- Articulated Dump Haulers
- Transporters

Benefits

- **Balanced architecture** provides passageways that are equal in both directions and pressure areas that are staged for minimum leakage. This gives balance, precise servo response and uniform steering action in both directions while reducing drift.
- **Progressive valving** makes it possible to produce the spool/sleeve valve in a way that assures reliability and reduces costs.
- **Eaton's high capacity gerotor** assembly provides a lot of capacity in a small package.
- **Heavier valve components-** housing, spool and sleeve- provides stability, especially during pressure and thermal transient conditions.
- The seal and centering spring designs provides positive, **low-effort steering feel** assuring excellent vehicle control, an important feature on large vehicles.



SPECIFICATIONS

Max. System Pressure	241 bar [3500 PSI]
Max. Back Pressure	21 bar [300 PSI]
Rated Flow	95 l/min [25 GPM]
Max. Flow	189 l/min [50 GPM]
Max. Differential Between Steering Unit and System Temperature	28° C 50° F
Max. System Operating Temperature	93°C [200° F]
Input Torque Powered	2,8-3,4 Nm @ 6,9 bar back pressure [25-30 lb-in @ 100 PSI back pressure]
Non Powered	†††
Fluid	ATF Type A and most petroleum based fluids
Recommended Filtration	ISO 18/13 cleanliness level

††† Manual steering is **not** possible without hydraulic power.

Steering Control Units—Series 25

Model Code – Ordering Information

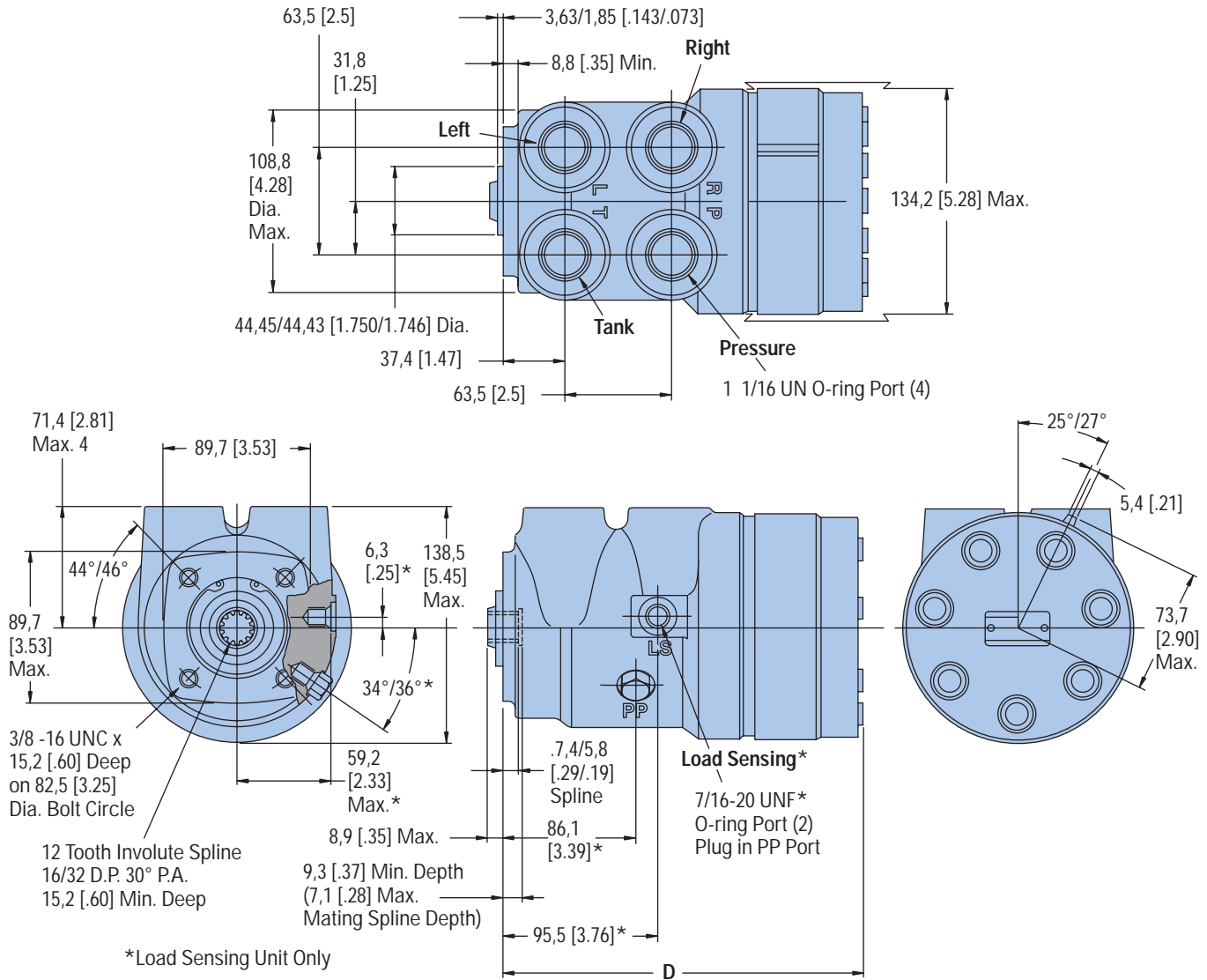
The following 29-digit coding system has been developed to identify all of the configuration options for the Series 25 steering control units. Use this model code to specify a unit with the desired features. All 29 digits of the code must be present when ordering. You may want to photocopy the matrix below to ensure that each number is entered in the correct box.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
A	B	W		6	A								0	0							3	A		A	A	1	0	D

Nos	Feature	Code	Description	Nos	Feature	Code	Description
1,2,3	Product Series	ABW	Series 25 Steering Control Unit	18,19,20,21	Ports and Mounting Threads	EAAA	4 x 1—1/6 Ports with 3/8-16 UNC Column Mounting
4	Nominal Flow Rating	7	95 l/min [25 GPM]			EAGA	4 x 1—1/6 Ports with 7/16 Load Sensing Port and 7/16 SAE Pilot Pressure Port (Capped) with 3/8-16 UNC Column Mounting (Use with Load Sensing Units Only)
		8	151 l/min [40 GPM] (Q-amp only)			NBDN	4 x M27 with M12—LS and M12 PP (Capped) M10 Mounting Threads (Use with Load Sensing Units Only)
		E	189 l/min [50 GPM] (Q-amp only)			NAAN	4 x M27 with M10 Mounting Threads
5	Inlet Pressure Rating	6	241 bar [3500 PSI]	22	Input Torque	3	Standard
6	Return Pressure Rating	A	10 bar [150 PSI]	23	Fluid Type	A	See Eaton Technical Bulletin 3-401
7-8	Displacement cm ³ /r [in ³ /r]	62	490 [30]	24	Special Applications	0	None
		65	625 [38]			1	Wide Angle (Use with Load Sensing Units Only)
		67	795 [48]	25, 26	Special Features	AA	None
		69	985 [60]	27	Paint	1	Black Paint
		71	1230 [75]	28	Identification	0	Eaton Product Number on Nameplate
9	Flow Amplification	0	None	29	Eaton Assigned Design Code	D	Assigned Design Code
		1	1.6 : 1.0 Ratio				
10	Neutral Circuit	A	Open Center				
		C	Closed Center				
		D	Closed Center with Neutral Bleed				
		F	Load Sensing, Dynamic Signal				
11	Load Circuit	A	Non-Load Reaction				
		D	Non-Load-Reaction, Cylinder Damping (Use with Flow Amp and Wide Angle Only)				
12,13	Valve Options	00	None				
		02	Anti-Cavitation Valve				
		21	Anti-Cavitation Valve, Cylinder Relief Valves				
14, 15	Load Sense Relief Valve Setting	00	None				
16,17	Cylinder Relief Valve Setting	00	None				
		6F	207 bar [3000 PSI]				
		70	224 bar [3250 PSI]				
		7H	241 bar [3500 PSI]				
		83	259 bar [3760 PSI]				
		8L	276 bar [4000 PSI]				
		95	293 bar [4250 PSI]				

**Cylinder Relief Setting recommendation is 870 PSI (60 bar) above steering inlet/load sense pressure.

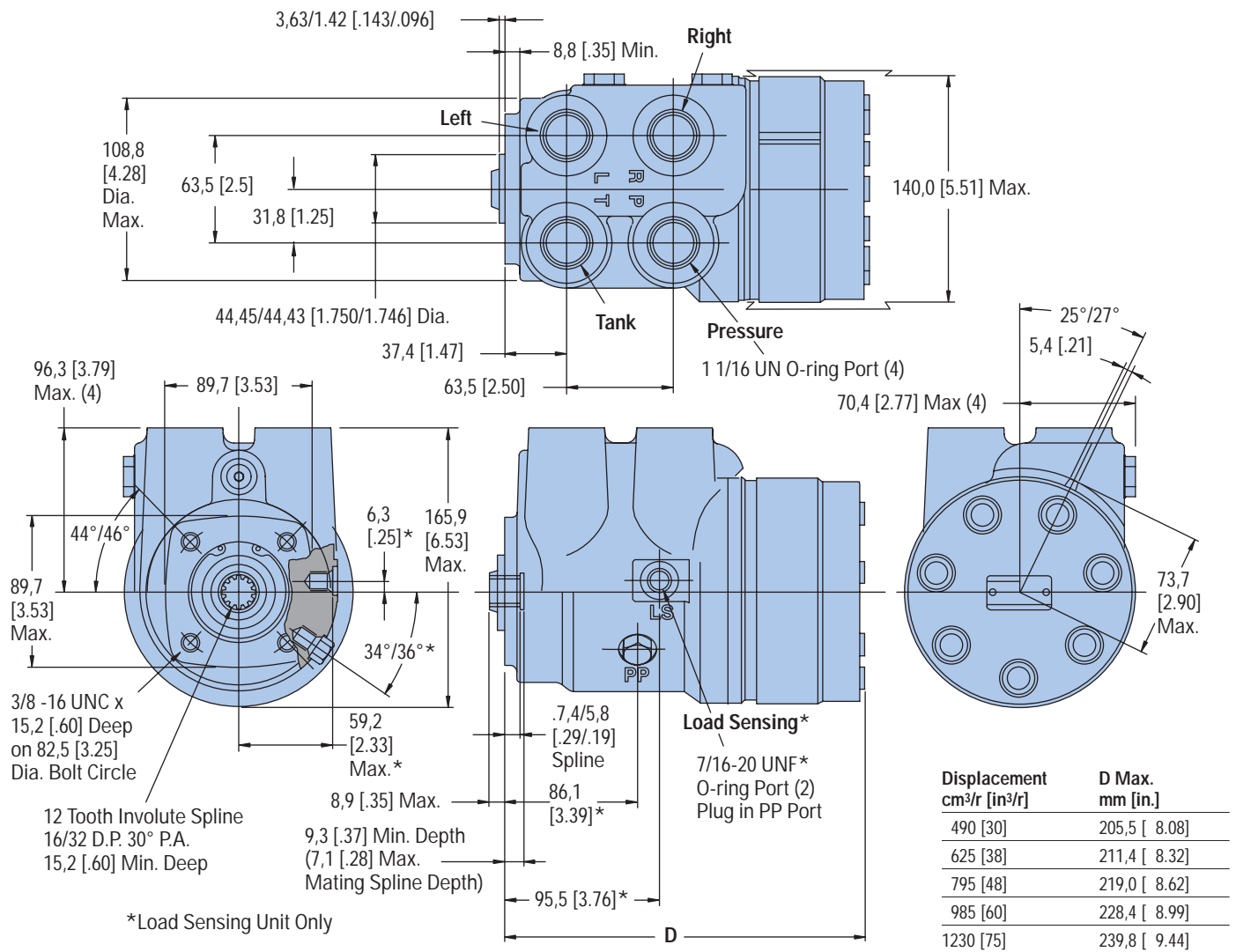
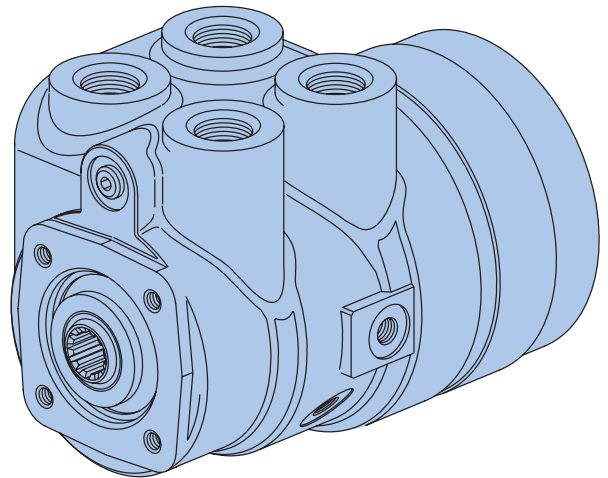
Steering Control Units—Series 25 Installation Drawing



Displacement cm ³ /r [in ³ /r]	D Max. mm [in.]
490 [30]	205,5 [8.08]
625 [38]	211,4 [8.32]
795 [48]	219,0 [8.62]
985 [60]	228,4 [8.99]
1230 [75]	239,8 [9.44]

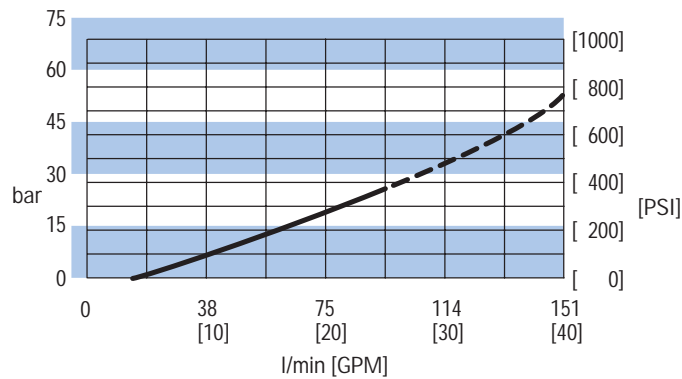
Steering Control Units—Series 25

Installation Drawing with Cylinder Relief, Anti-Cavitation

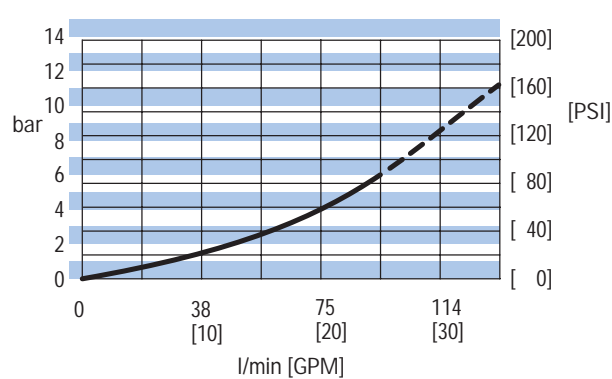


Steering Control Units—Series 25 Performance Data

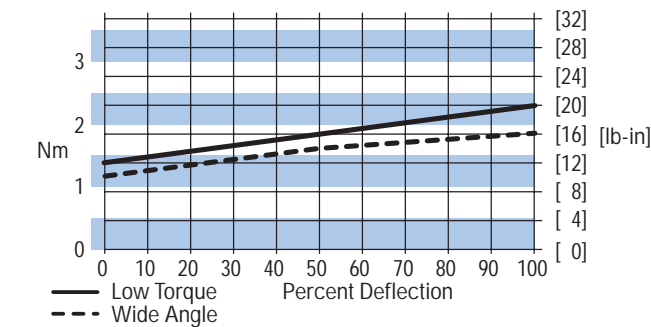
Average Pressure Drop
at Full Valve Deflection



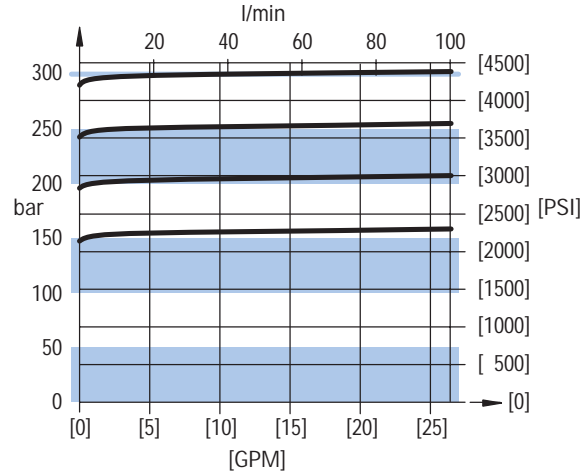
Neutral Pressure Drop - Open Center
Fluid Viscosity 25 cSt [120 SUS]



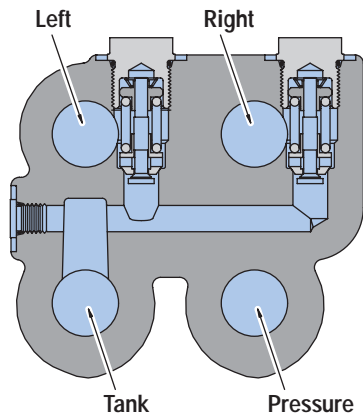
Input Torque



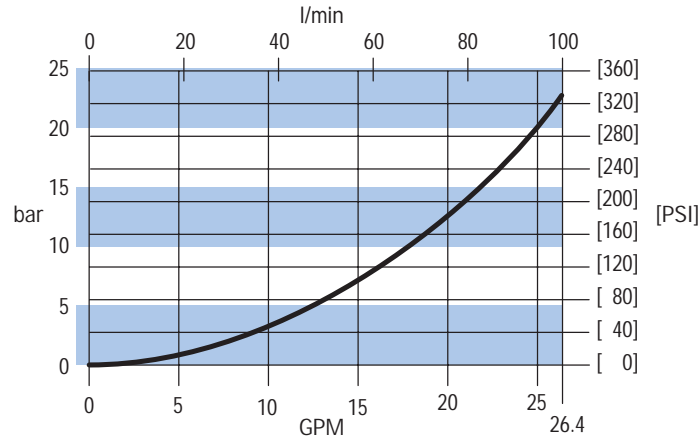
Pressure Relief Characteristics



SCU Valve Section



Check Valve Characteristics



Steering Control Units—Series 40

Product Description

The Series 40 steering control unit includes two patented designs that make it even more responsive, reliable and cost effective.

Benefits

- Symmetrical valving provides passageways and valving that are equal in both directions and pressure areas that are staged for minimum leakage. This gives balance, precise servo response and uniform steering action in both directions.
- Progressive valving makes it possible to produce the spool/sleeve valve in a way that assures reliability and reduces costs.
- Eaton's high capacity gerotor assembly provides a lot of capacity in a small package.
- Heavier valve components—housing, spool and sleeve—provide stability, especially during pressure and thermal transient conditions.
- The seal and centering spring designs provide positive, low-effort steering feel assuring excellent vehicle control, an important feature on large vehicles for which this steering control was designed.

Features

- Open Center
- Closed Center
- Load Sensing
- Q-amp
- Pilot Pressure Port*

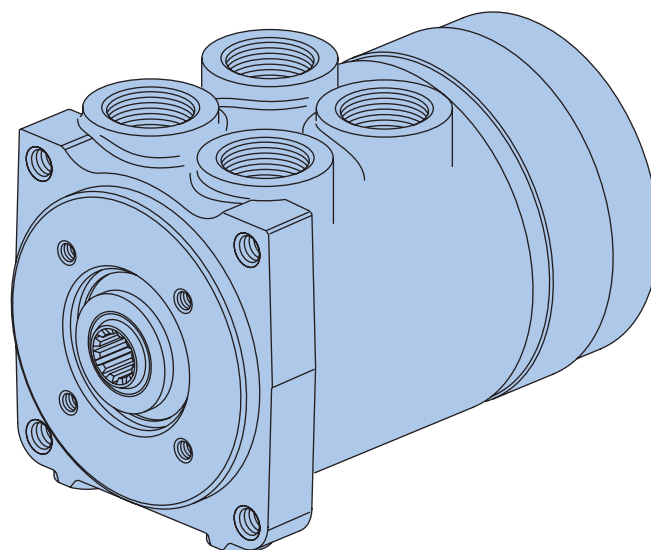
*This is an added feature that can be used for:

1. pilot pressure to priority valve.
 - 2 diagnostics.
- Cylinder Damping

Applications

Articulated Vehicles

- Loaders
- Scrapers Frame Vehicles
- Large Front End Loaders
- Large Graders
- Mining Trucks
- Articulated Haulers
- Transporters



SPECIFICATIONS

Max. System Pressure	241 bar [3500 PSI]
Max. Back Pressure	21 bar [300 PSI]
Rated Flow	151 l/min [40 GPM]
Max. Flow	212 l/min [56 GPM]
Max. Differential Between Steering Unit and System Temperature	28° C 50° F
Max. System Operating Temperature	93°C [200° F]
Input Torque Powered	2,8-3,4 Nm @ 6,9 bar back pressure [25-30 lb-in @ 100 PSI back pressure]
Non Powered	†††
Fluid	ATF Type A and most petroleum based fluids
Recommended Filtration	ISO 18/13 cleanliness level

††† Manual steering is **not** possible without hydraulic power.

Steering Control Units—Series 40

Model Code – Ordering Information

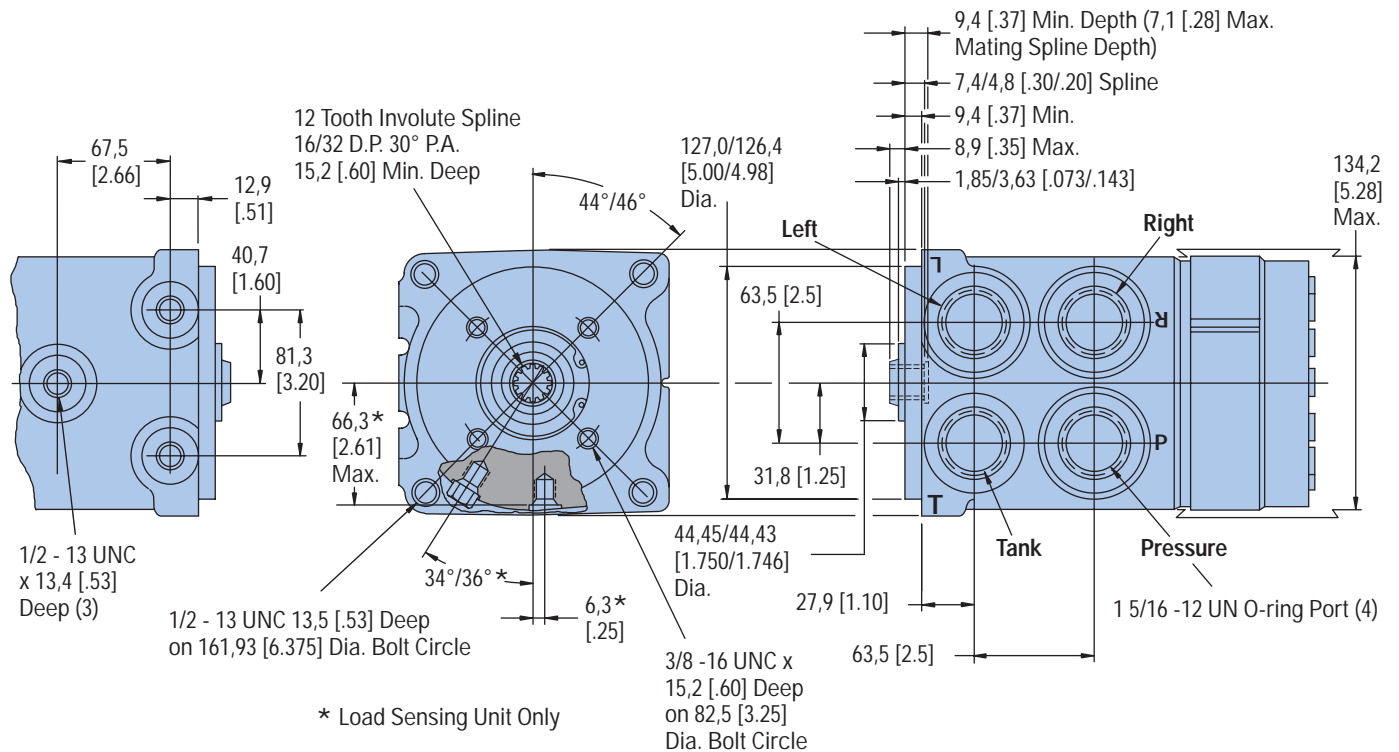
The following 29-digit coding system has been developed to identify all of the configuration options for the Series 40 steering control units. Use this model code to specify a unit with the desired features. All 29 digits of the code must be present when ordering. You may want to photocopy the matrix below to ensure that each number is entered in the correct box.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
A	B	Y		6	B						0	0	0	0	0	0					3	A	0	A	A	0	0	C

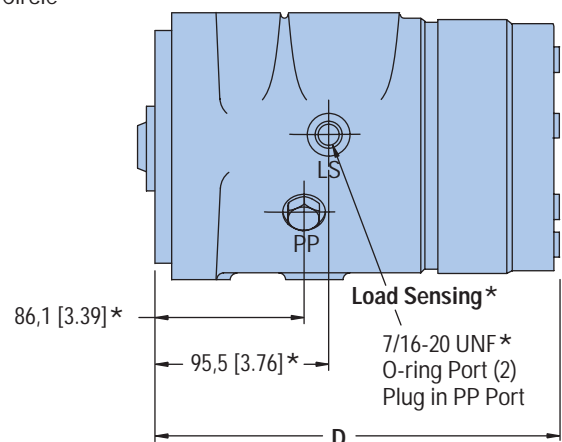
Nos	Feature	Code	Description	Nos	Feature	Code	Description
1,2,3	Product Series	ABY	Series 40 Steering Control Unit	18,19,20,21	Ports and Mounting Threads	GAAA	4 x 1 – 5/16 SAE Ports with 3/8-16 UNC Column Mounting Threads
4	Nominal Flow Rating	8	151 l/min [40 GPM]				
		9	227 l/min [60 GPM] (Q-amp only)				
5	Inlet Pressure Rating	6	241 bar [3500 PSI]			GAGA	4 x 1 – 5/16 SAE ports with 7/16 SAE Load Sensing Port and 7/16 SAE Pilot Pressure Port with 3/8-16 UNC Column Mounting Threads (Use with Load Sensing Only)
6	Return Pressure Rating	B	21 bar [300 PSI]				
7-8	Displacement cm ³ /r [in ³ /r]	71	1230 [75]				
		74	1560 [95]	22	Input Torque	3	Standard
		76	1970 [120]	23	Fluid Type	A	See Eaton Technical Bulletin 3-401
		78	2460 [150]	24	Special Applications	0	None
		80	3030 [185]	25,26	Special Features	AA	None
9	Flow Amplification	0	None	27	Paint	0	No Paint
		1	1.6 : 1.0 Ratio	28	Identification	0	Eaton Product Number on Nameplate
10	Neutral Circuit	A	Open Center	29	Eaton Assigned Design Code	C	Assigned Design Code
		C	Closed Center				
		D	Closed Center with Neutral Bleed				
		F	Load Sensing, Dynamic Signal				
11	Load Circuit	A	Non-Load Reaction				
		E	Non-Load Reaction, Cylinder Damping (Use with Q-amp only)				
12,13	Integral Valve	00	None				
14,15	Integral Inlet Relief Valve Pressure Setting	00	None				
16,17	Cylinder Relief Valve Setting	00	None				

Steering Control Units—Series 40

Installation Drawing

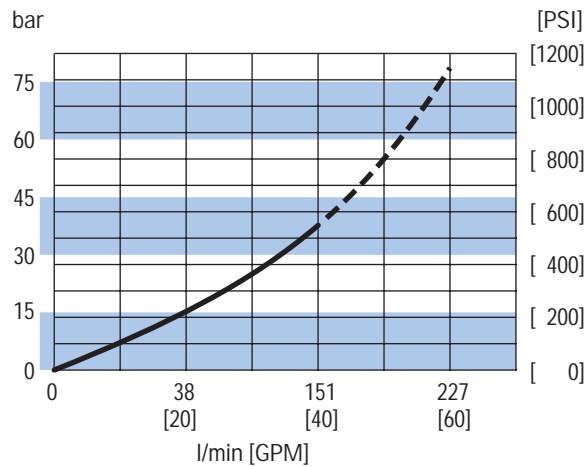


Displacement cm ³ /r [in ³ /r]	D Max. mm [in.]
1230 [75]	230,9 [9.09]
1555 [95]	245,9 [9.68]
1965 [120]	265,2 [10.44]
2460 [150]	288,3 [11.35]
3030 [185]	315,0 [12.40]

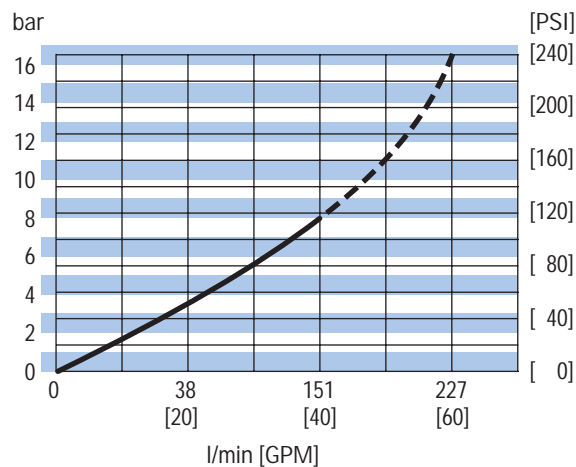


Steering Control Units—Series 40 Performance Data

Average Pressure Drop
Through Open Center
Load Sensing and Closed
Center at Full Valve Deflection



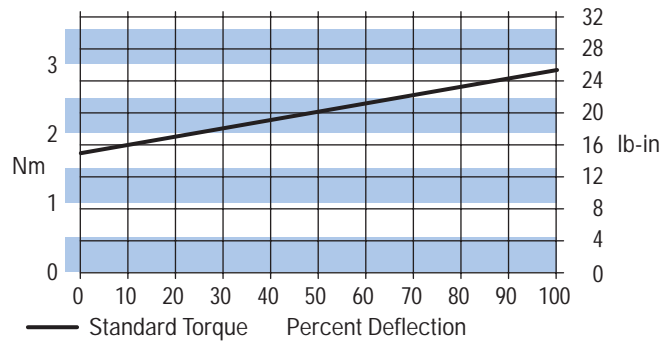
Open Center Neutral
Pressure Drop
Fluid Viscosity 25 cSt [120
SUS]



Input Torque

Applications

- Articulated and Rigid Dump Trucks
- Mining Trucks
- Paving Equipment



Torque Generator

Product Description

Char-Lynn torque generators have been completely redesigned to meet the needs of the changing marketplace. These torque generators provide power assist for steering, eliminating the large hand wheels on gate valves, and provide powerful rotary motion with effortless manual rotary input on numerous other applications.

Features

Today's market includes power steering on electric lift trucks. Char-Lynn torque generators have been designed with features that greatly improve the operator's comfort as well as the vehicle's performance.

The increase in port surface area allows for the additional port requirement for units with the following features:

Power Beyond

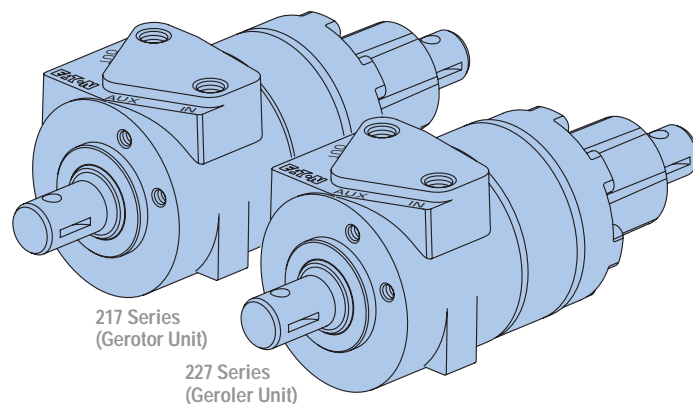
This version has three ports: Inlet (IN), Tank (OUT), and Excess Flow (EF). In the power beyond configuration, flow not used for priority steering exits the EF port and is available for the downstream reach function. Flow used for steering will exit the (OUT) port to tank, and cannot be used for auxiliary functions.

Load Sensing

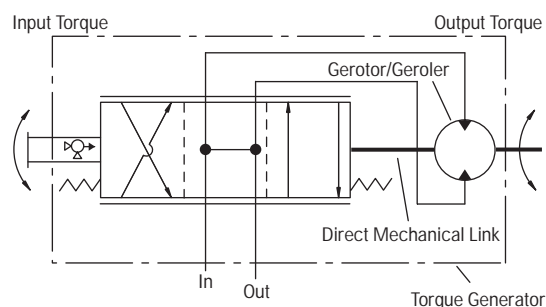
Char-Lynn load sensing torque generators use conventional or load sensing power supplies to achieve load sensing steering. The use of a load sensing torque generator and a priority valve in a normal power steering circuit offers the following advantages:

- Provides smooth pressure compensated steering because load variations in the steering circuit do not affect axle response or maximum steering rate.
- beyond system capability by splitting the system into two independent circuits. 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.
- because the steering circuit always has flow and pressure priority.

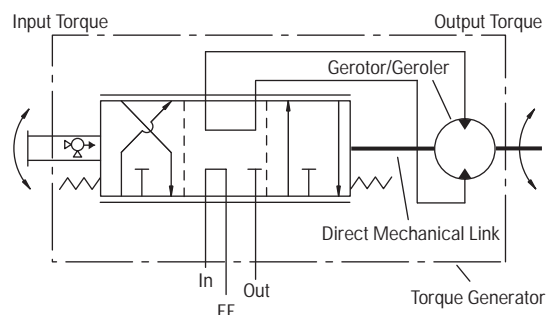
Char-Lynn load sensing torque generators and priority valves can be used with open center, closed center or load sensing systems. Used either in an open center system with a fixed displacement pump or a closed center system with a pressure compensated pump, these torque generators offer many of the features of a load sensing system. Excess flow is available for auxiliary circuits.



Standard Open Center



Power Beyond



Torque Generator

Product Description

Continued

Open Center with Case Drain

This high pressure open center torque generator allows the exit flow from the Torque Generator to operate another function (for example reach/tilt function of a fork lift vehicle). An external case drain is needed to protect seals and to allow for adequate recentring of spool and sleeve. The flow out the case drain is internal leakage only. This is a series circuit with some special characteristics that should be noted:

- A relief valve is required in the down stream circuit as well as a relief valve protecting the torque generator.
- The pressures in this circuit are additive. If it takes 41 bar [600 PSI] for steering and 55 bar [800 PSI] for the reach circuit, the pump will see 96 bar [1400 PSI].
- The relief valve for steering must always be set higher than the relief valve on the downstream function (reach). The margin between the two must be enough to provide adequate steering in the worst case (fork lift stationary and unloaded).

Anti-Friction Needle Bearings

Torque generators are available with anti-friction needle bearings at the power end to allow for direct mount sprockets or pinions when compactness of application does not allow for outboard bearings.

Gerotor or Geroler® Element

This is a fluid displacement element, consisting of an outer ring gear and an internal star. Manual low torque input actuates the spool of the spring centered spool and sleeve valve, allowing high pressure oil to turn the internal star. This star is coupled with a splined drive to the output shaft and also the sleeve of the spool and sleeve valve. High pressure oil turning the star in this gerotor or Geroler element is generating high output torque.

The Geroler elements have not been offered on torque generators in the past. These Gerolers have rolls incorporated into the outer ring, and the rolls provide rolling contact with the star point, minimizing friction and improving efficiency.

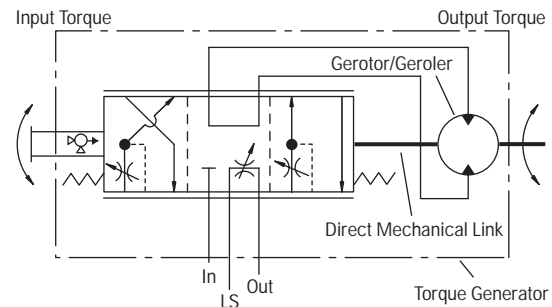
Limited Manual Steering

Relative deflection of the input and output shafts is limited mechanically within the unit so that limited manual steering is still possible in the event of power loss.

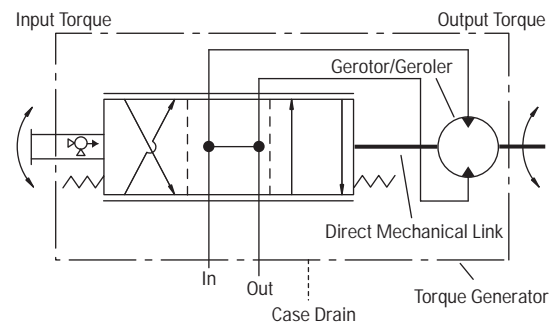
Reaction Torque Resistance

Customer supplied bracket is required for reaction torque resistance.

Load Sensing

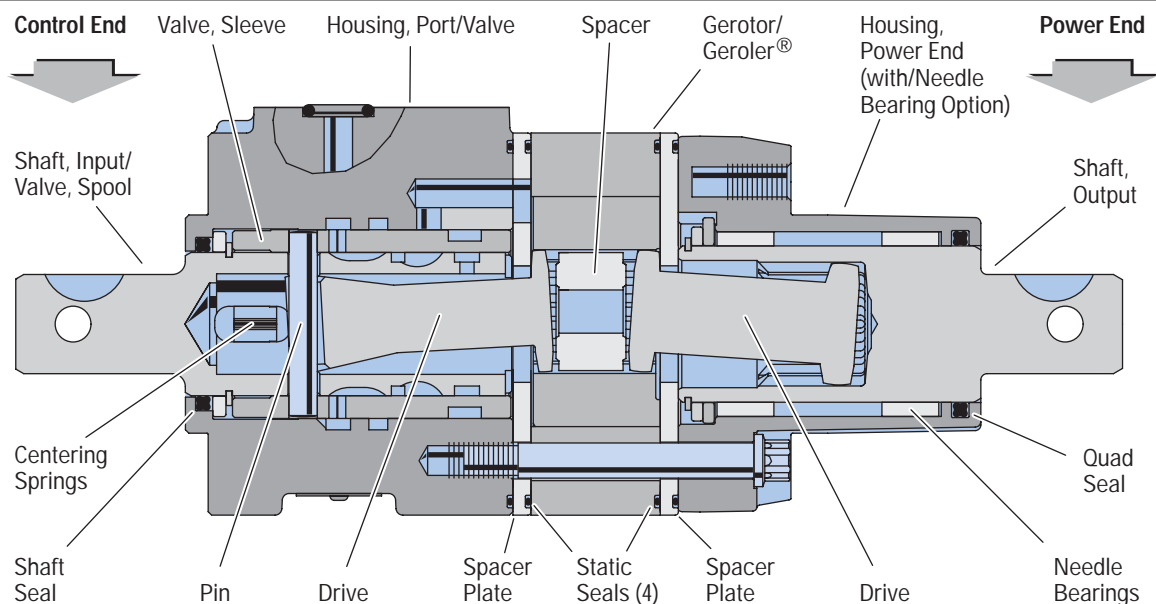


Open Center (with Case Drain)



Torque Generator

Product Information



SPECIFICATIONS 217 SERIES—GEROTOR UNIT

Displacement cm ³ /r [in ³ /r]	76 [4.7]	96 [5.9]	160 [9.7]
Torque Output (at 70 bar [1000 PSI])	62 Nm [550 lb-in]	79 Nm [700 lb-in]	124 Nm [1100 lb-in]
Recommended Flow	11,4 l/min [3 GPM]	13,2 l/min [3.5 GPM]	13,9 l/min [5 GPM]
Max. Operating Speed (at Rated Pressure and Recommended Flow)	125 RPM	118 RPM	102 RPM

SPECIFICATIONS 227 SERIES—GEROLER® UNIT

Displacement cm ³ /r [in ³ /r]	80 [4.9]	102 [6.2]	160 [9.7]
Torque Output (at 70 bar [1000 PSI])	69 Nm [608 lb-in]	86 Nm [760 lb-in]	131 Nm [1160 lb-in]
Recommended Flow	11,7 l/min [3.1 GPM]	15,1 l/min [4 GPM]	18,9 l/min [5 GPM]
Max. Operating Speed (at Rated Pressure and Recommended Flow)	125 RPM	118 RPM	102 RPM

COMMON SPECIFICATIONS 217 AND 227 SERIES

Rated Flow	15,1 l/min [4 GPM]
Max. System Operating Temperature	93° C [200° F]
Input Torque Powered	1,6 - 2,5 Nm [14 - 22 lb-in]
Non-Powered (Max.)	136 Nm [100 lb-ft]
Output Shaft Side Load at Keyway Centerline without Bearing with Bearing	23 kg [50 lb] 272 kg [600 lb]
Fluid	Most petroleum hydraulic fluids—see your Eaton representative for use of fire-resistant and other special fluids
Recommended Filtration	As needed to maintain ISO 18/13 cleanliness level
Rated Pressure	Depends on model—See chart circuit type below

Circuit Type	In Port	Out Port	Aux. Port	Max. In minus Out
Open Center	69 bar [1000 PSI]	3 bar [50 PSI]	—	—
Power Beyond	138 bar [2000 PSI]	3 bar [50 PSI]	138 bar [2000 PSI]	69 bar [1000 PSI]
Load Sensing	69 bar [1000 PSI]	3 bar [50 PSI]	69 bar [1000 PSI]	—
Open Center w/Case Drain	172 bar [2500 PSI]	103 bar [1500 PSI]	3 bar [50 PSI]	69 bar [1000 PSI]

Torque Generator

Model Code

Ordering Information

The following 20-digit coding system has been developed to identify all of the configuration options for the torque generator. Use this model code to specify a torque generator with the desired features. All 20 digits of the code must be present when ordering. You may want to photocopy the matrix below to ensure that each number is entered in the correct box.

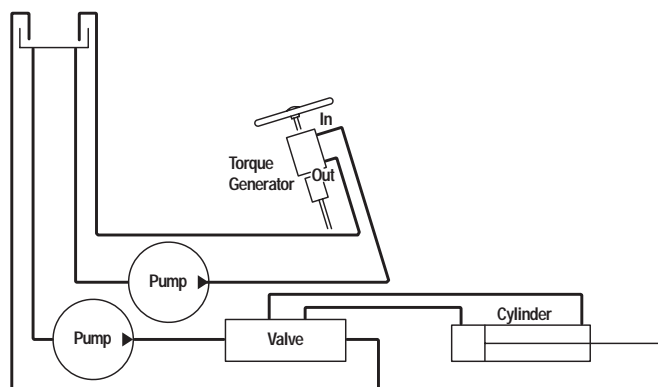
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A	B	P								0	1	A	1	A			A	1	B

Nos	Feature	Code	Description	Nos	Feature	Code	Description
1,2,3	Product Series	ABP	Torque Generator	9	Ports	A	2 x .625 inch Dia. Manifold Ports with 2 x 5/16-18 UNC Mounting Holes (use with port block) - open center only
4,5,6	Circuit Type . and Ratings —Max	A4A	15,1 l/min [4 GPM] Open Center Inlet 69 bar [1000 PSI] Out 3 bar [50 PSI]			B	3 x .625 inch Dia. Manifold Ports with 3 x 5/16 - 18 UNC Mounting Holes (use with port block)
		D4C	15,1 l/min [4 GPM] Open Center Power Beyond Inlet 138 bar [2000 PSI] Out 3 bar [50 PSI] Aux. (PB) 138 bar [2000 PSI] Dp (Inlet – out) <69 bar [1000 PSI] (Limited to 76 [4.7], 80 [4.9], 96 [5.9] cm3/r [in3/r])			C	2 x 9/16 SAE Ports— open center only
		E4B	15,1 l/min [4 GPM] Open Center with High Back Pressure (Case Drain) Inlet 172 bar [2500 PSI] Out 103 bar [1500 PSI] Aux. (CD) 3 bar [50 PSI] Dp (Inlet – out) <69 bar [1000 PSI]	10	Shaft Bearings	0	None
				11	Integral Valves	0	None
		C4D	15,1 l/min [4 GPM] Load Sensing Dynamic Signal Inlet 69 bar [1000 PSI] Out 3 bar [50 PSI] Aux. (LS) 69 bar [1000 PSI]	12	Input Torque	1	Standard
				13	Shaft Ends	A	22,17 [.874] Dia. with Keyway and Cross Hole
				14	Shaft Seals	1	Quad Rings
				15	Mounting Threads	A	5/16-18 UNC
7,8	Displacement cm3/r [in3/r]	08	76 [4.7] Gerotor	16,17	Special Feature	00	None
		10	96 [5.9] Gerotor			01	Port Block Installed
		17	160 [9.7] Gerotor	18	Paint and Packaging	A	Black Primer
		58	80 [4.9] Geroler	19	Identification	1	Eaton Product Number on Nameplate
		60	102 [6.2] Geroler	20	Eaton Assigned Design Code	B	Assigned Design Code
		66	160 [9.6] Geroler				

Torque Generator Conventional System Circuits

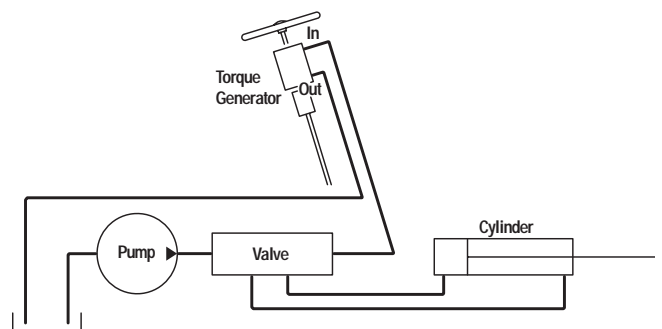
Conventional System with Two Pumps

- Extra cost of two separate circuits



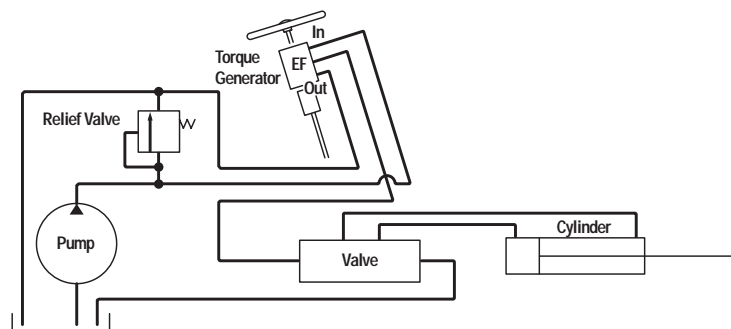
Conventional System with One Pump

- Can result in insufficient steering flow when operating the auxiliary function



Power Beyond Torque Generator

- Parallel circuit
- Steering has priority
- Simple system
- Single relief valve
- Flow to auxiliary function is reduced while steering

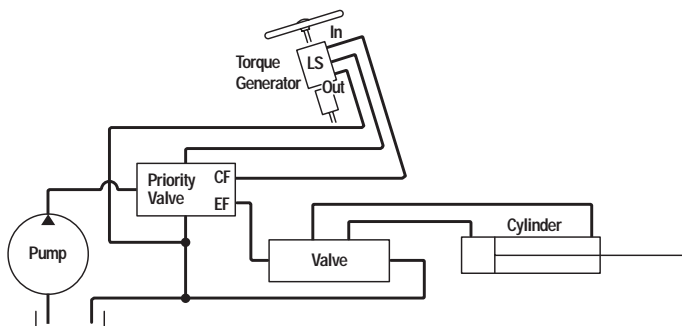


Torque Generator

Conventional System Circuits

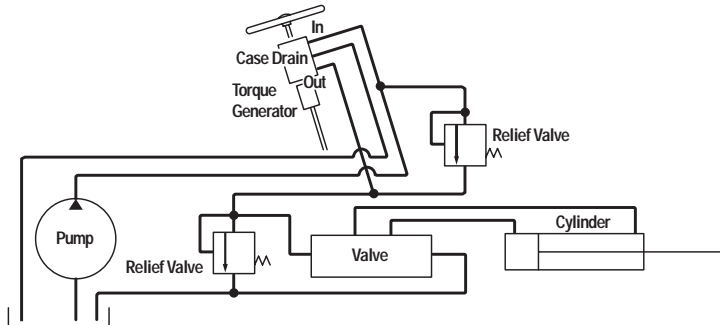
Load Sensing System

- Steering has priority
- Auxiliary function can operate at higher pressure than steering rating; priority valve isolates CF side from EF side pressures.
- Flow to auxiliary functions reduced while steering



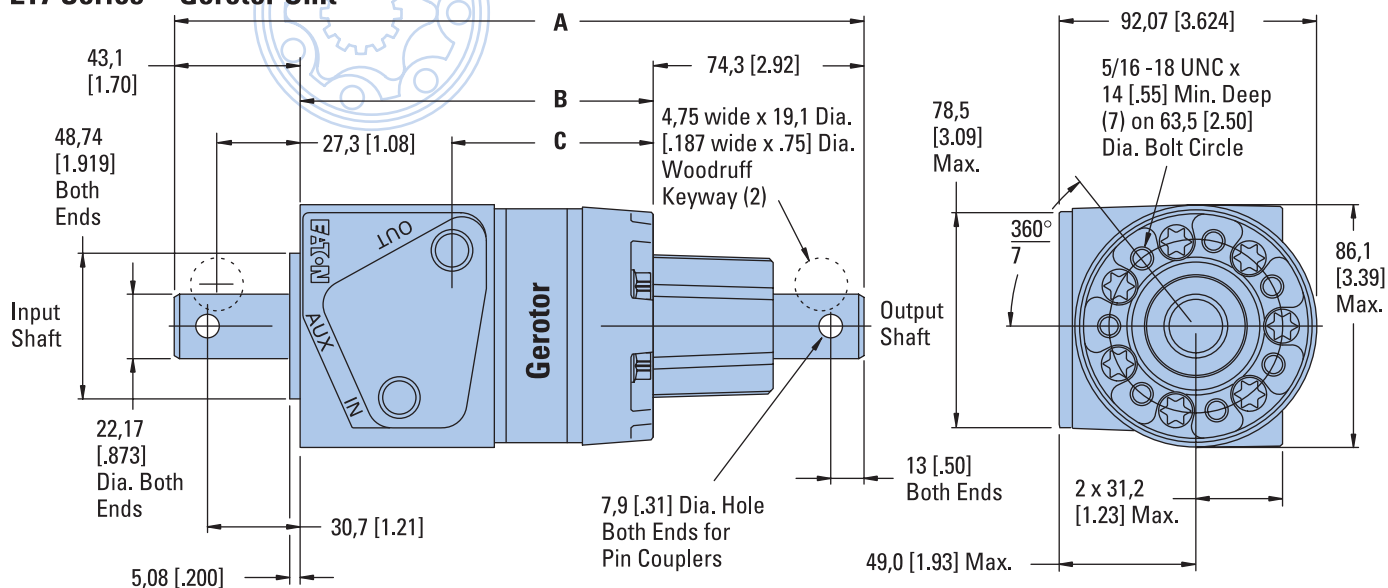
High Back Pressure Torque Generator

- Series circuit; auxiliary and steering pressures are additive
- All flow available to auxiliary function, even while steering
- Separate relief valves required for steering and auxiliary



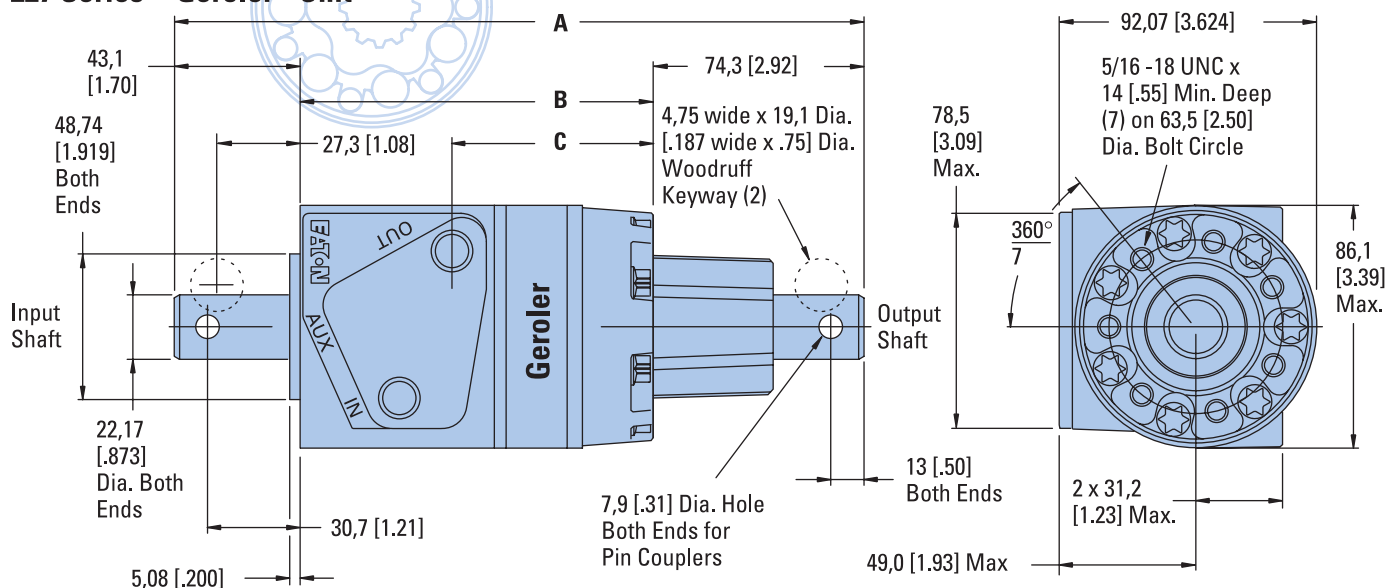
Torque Generator Installation Drawing

217 Series—Gerotor Unit



	Displacement cm ³ /r [in ³ /r]	Dimension mm [inch]		
		A	B	C
217 Series (Gerotor Unit)	96,1 [5.86] 159,6 [9.73]	231,9 [9.13] 240,6 [9.47]	114,5 [4.51] 123,2 [4.85]	60,4 [2.38] 69,3 [2.73]
227 Series (Geroler® Unit)	80,3 [4.90] 101,6 [6.20] 160,0 [9.64]	233,3 [9.18] 237,2 [9.34] 247,5 [9.74]	115,9 [4.56] 119,8 [4.72] 130,1 [5.12]	62,0 [2.44] 65,9 [2.59] 76,2 [3.00]

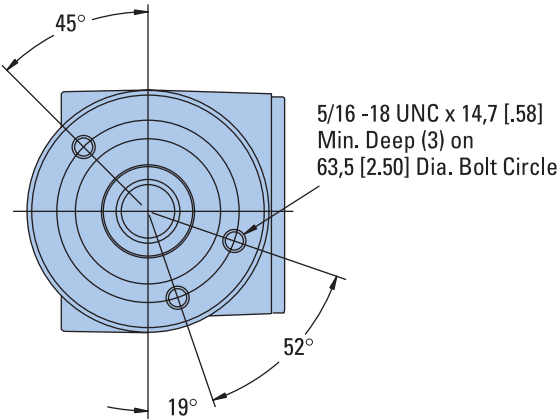
227 Series—Geroler® Unit



Torque Generator

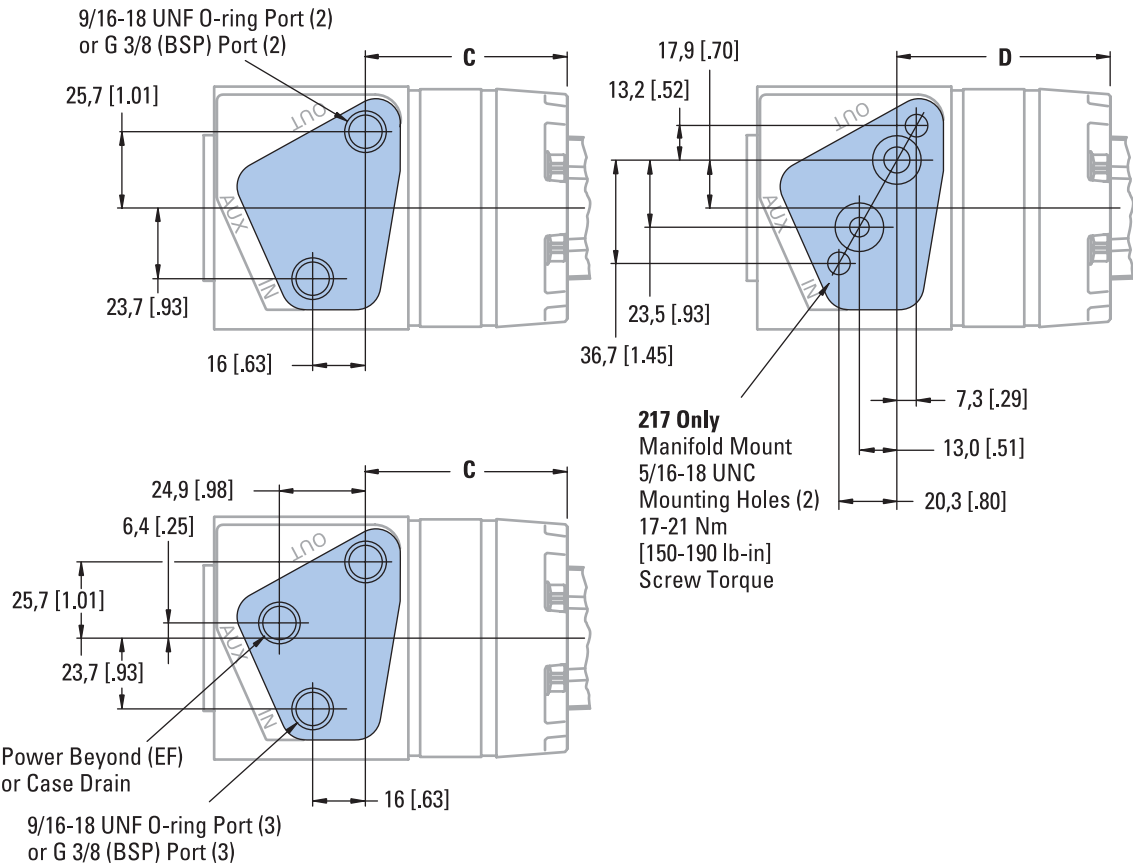
Ports

Input End



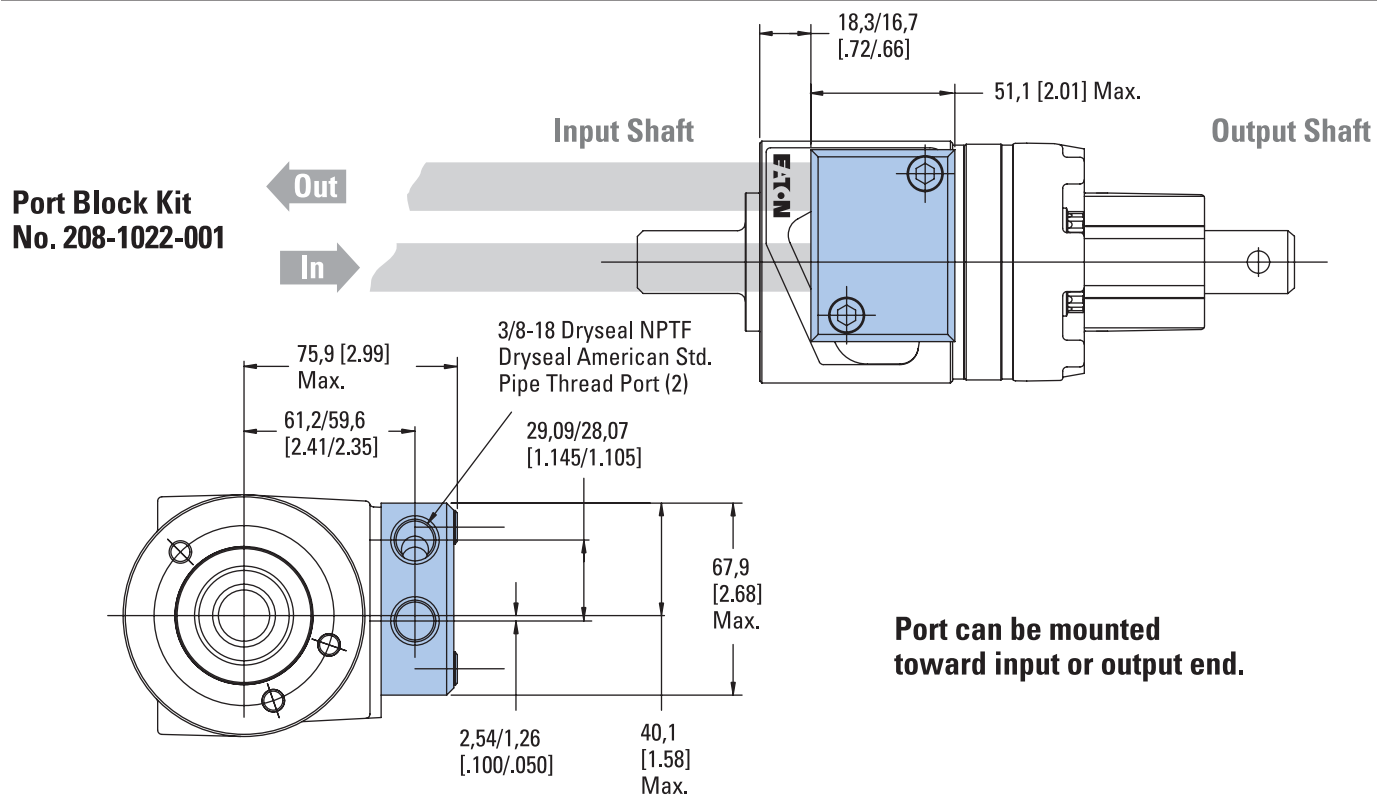
	Displacement cm ³ /r [in ³ /r]	Dimension mm [inch]	
		C	D
217 Series (Geroler® Unit)	96,1 [5.86] 159,6 [9.73]	60,4 [2.38] 69,3 [2.73]	63,5 [2.50] 72,1 [2.84]
227 Series (Gerotor Unit)	80,3 [4.90] 101,6 [6.20] 160,0 [9.64]	62,0 [2.44] 65,9 [2.59] 76,2 [3.00]	

Port Options

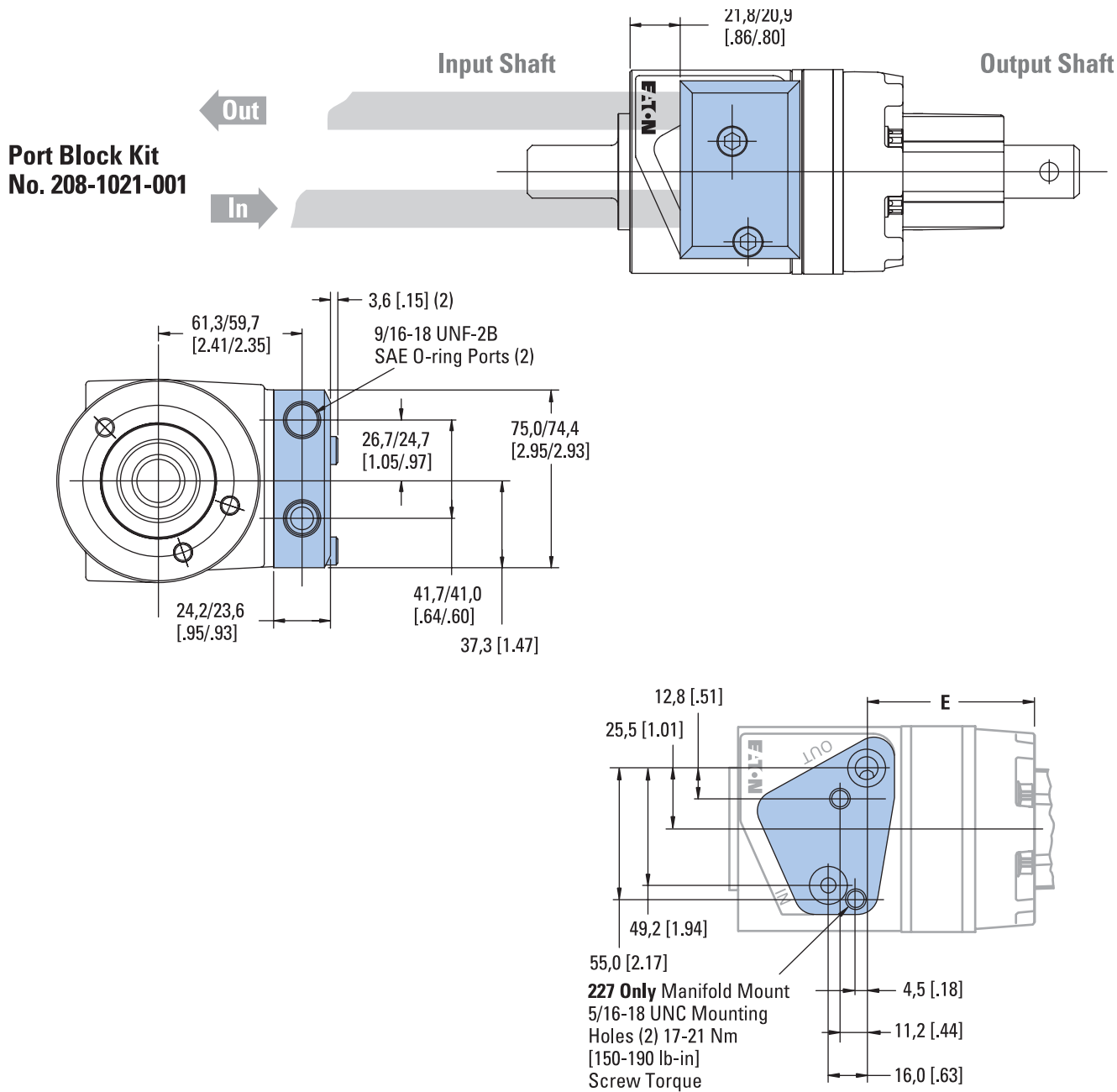


For proper operation it is recommended that the unit be installed so no radial load or thrust load is applied to either the input or output shafts. Misalignment of shafts will cause binding.

Torque Generator—
217 Series
Port Block
Installation Drawing
Port Block with 3/8-18
Dryseal NPTF Ports



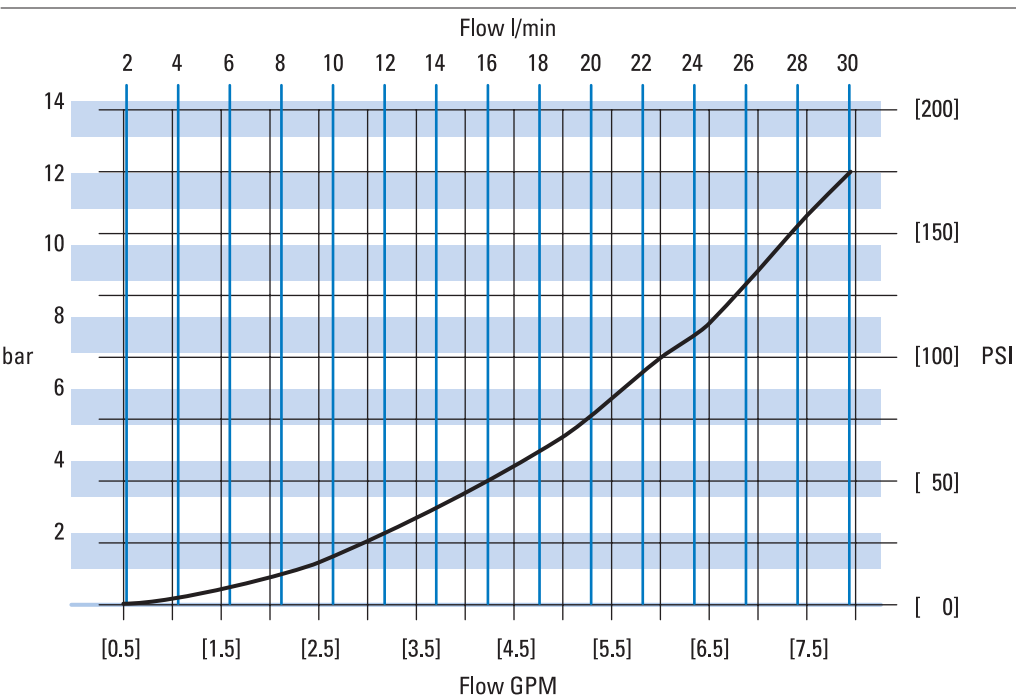
Torque Generator—
 227 Series
 Port Block
 Installation Drawing
 9/16-18 UNF SAE
 O-ring Port



Displacement cm ³ /r [in ³ /r]	Dim. mm [inch]	
	E	
227 Series	80,3 [4.90]	62,0 [2.44]
(Geroler® Unit)	101,6 [6.20]	71,2 [2.80]
	160,0 [9.64]	76,2 [3.00]

Torque Generator Performance Data

Torque Generator
Pressure Drop



Steering System Components

Antijerk Valves

Description

Antijerk Valves provide smoother steering on articulated vehicles, such as Wheel Loaders. This is achieved by a pressure sequence valve mounted on a block. Patent pending.

(For more information see Vickers® Screw-in Cartridge Valves Cat. V-VLOV-MC001-E2.)

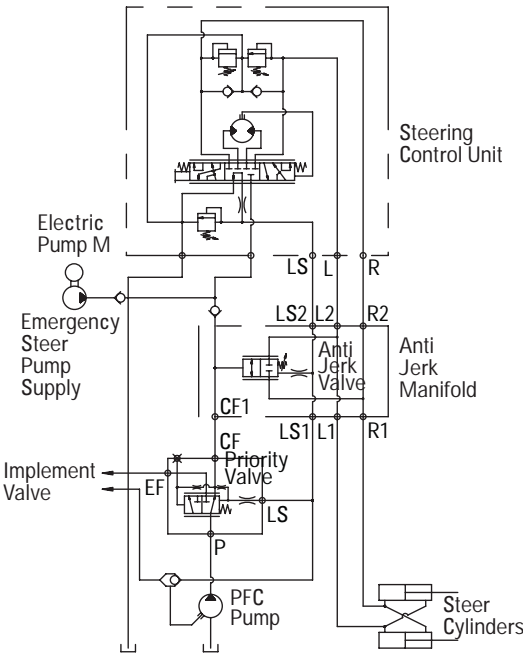
Features

Dramatically reduces jerk when steering is stopped quickly and while making aggressive changes in direction. The valve works by monitoring the margin pressure acting on the steering valve. Margin spikes when steering wheel speed is reduced aggressively. When this

occurs a small amount of damping flow is allowed across the turn ports. Unlike accumulators this valve will not have a negative affect on roading performance, and it is more cost effective than cushion valves.

Applications

CF1 is supply from the pump or priority valve, CF2 should connect to the steering valve UPSTREAM of any check valves, LS1 & LS2 are the steering valve load-sense connection, R&L are pass through ports for the turn lines. The setting of the valve needs to be higher than the normal difference in pressures between CF and LS, i.e. if CF-LS is 150PSI then a good setting to start with is 200PSI.



PSV10-10 Pressure Sequence Valves

SPECIFICATIONS

Pressure Rating for	
Aluminum block	210 bar [3000 PSI]
Ductile Iron block	241bar [3500 PSI]
Temperature Range	-40° to 120°C [-40° to 248°F]
Fluids	All general purpose hydraulic fluids such as: MIL-H-5606, SAE 10, etc.
Filtration	Cleanliness code 18/16/13

Ordering Information

1. Reference Part Number: 5991006-001

Ports:

CF1, CF2	3/4-16 UNF
L1, L2, R1, R2	3/4-16 UNF
LS1, LS2	7/16-20 UNF

Pressure Setting Range: 100-600PSI

2. Specify Ports.

Port Options	Option 1	Option 2	Option 3	Option 4
Ports	8 Size		12 Size	
CF1, CF2	3/4-16 UNF	M18	1 1/6-12UNF	M27
L1, L2, R1, R2	3/4-16 UNF	M18	7/8-18 UNF	M22
LS1, LS2	7/16-20 UNF	M12	7/16-20 UNF	M12

3. Choose Pressure Setting Options: Within the 7-40 bar [100-600 PSI] range with a minimum increment of 3.45 bar [50PSI].

Options:	1	7 bar [100 PSI]
	1.5	10.5 bar [150 PSI]
	---	---
	6	40 bar [600 PSI]

Steering System Components

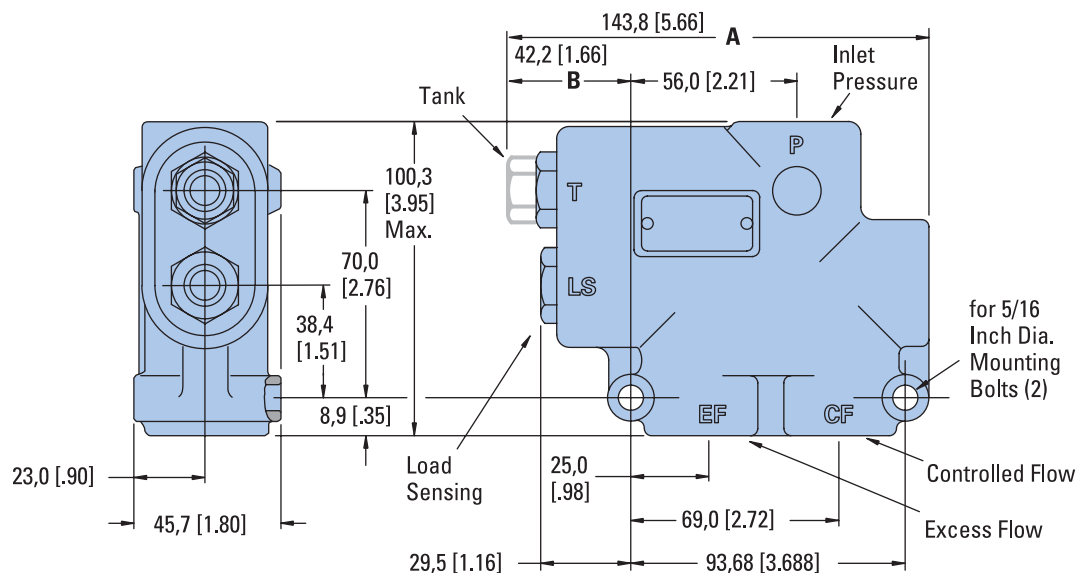
VLC In-Line Priority Valves

60 l/min [16 GPM] Rate Flow

Relief Valve Qualified for
276 bar [4000 psi] max.

Rated CF Pressure is
276 bar [4000 psi]

Rated Inlet and EF Pressure
is 276 bar [4000 psi]



Code Number	System Pressure bar [PSI]
DD	83 [1200]
HE	120 [1725]
LA	138 [2000]
MC	150 [2175]
NC	160 [2300]
QA	172 [2500]
UA	207 [3000]
VD	230 [3325]
VK	240 [3475]

Control Pressure - bar [PSI] / Product Number

Ports (5)	Port Size	Static Signal 3,5 [50]	Dynamic Signal 5,2 [75]	Static Signal 5,2 [75]	Dynamic Signal 7,6 [110]	Static Signal 6,9 [100]	Dynamic Signal 10,0 [145]
P & EF	7/8 - 14	606-1217	606-1232	606-1218	606-1314	606-1219	606-1315
CF	3/4 - 16						
LS & T	7/16 - 20						
P & EF	3/4 - 16	606-1214	606-1327	606-1215	606-1278	606-1216	606-1328
CF	9/16 - 18						
LS & T	7/16 - 20						
P & EF	M22 X 1,5	606-1329	606-1330	606-1331		606-1333	606-1334
CF	M18 X 1,5						
LS & T	M12 X 1,5						
P & EF	R 1/2 - 14	606-1335	606-1336	606-1337	606-1338	606-1339	606-1340
CF	R 1/2 - 14						
LS & T	R 1/4 - 19						

Example: 606-1218-003-QA
 Product Number System Pressure Code Number

The above product number describes a VLC Series with 5,2 bar [75 PSI] control pressure, static signal, 7/8-14 P and EF ports, 3/4-16 CF port, 7/16-20 LS and T ports, 172 bar [2500 PSI] relief valve setting.

For comprehensive information on all steering system components "Valves" see Eaton catalog 11-508.

Steering System Components

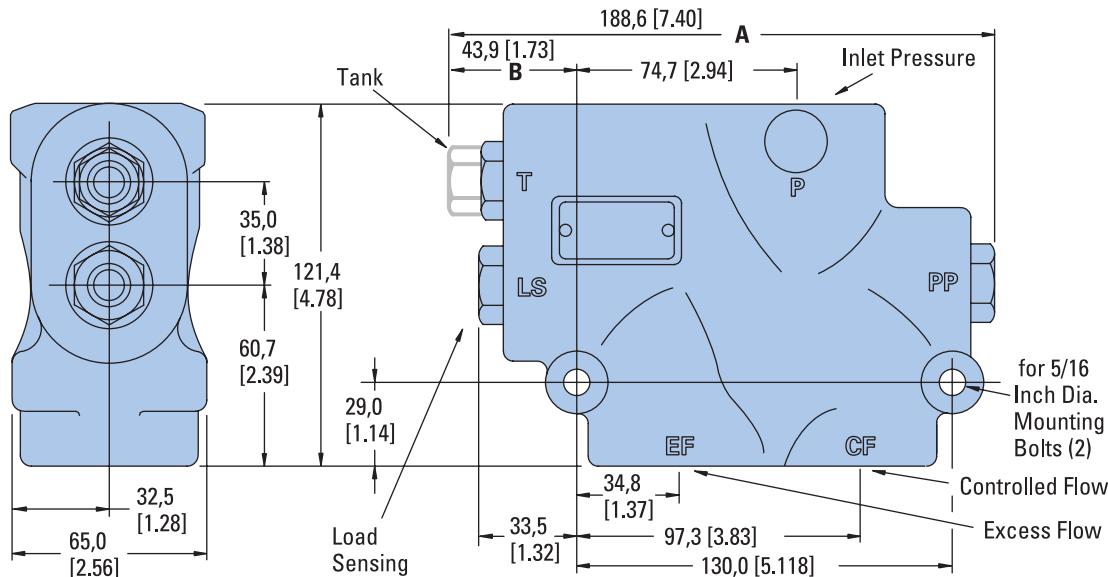
VLE In-Line Priority Valves

**150 l/min [40 GPM]
Rated Flow**

Relief Valve Qualified
for 276 bar [4000 PSI]
Max.

Rated CF Pressure is
276 bar [4000 psi]

Rated Inlet and EF
pressure is 303 bar
[4400 psi]



Example: **606-1094-003-QA**
Product Number System Pressure
Code Number

The product number (above left) describes a VLE Series with 6,9 bar [100 PSI] control pressure, static signal, 1 1/16-12 P and EF ports, 3/4-16 CF port, 7/16-20 LS and T ports, 172 bar [2500 PSI] relief valve setting.

Code Number	System Pressure bar [PSI]
DD	83 [1200]
HE	120 [1725]
LA	138 [2000]
MC	150 [2175]
NC	160 [2300]
QA	172 [2500]
UA	207 [3000]
VD	230 [3325]
VK	240 [3475]

High Pressure*

Control Pressure - bar [PSI] / Product Number

Ports (5)	Port Size	Static Signal 4,5 [65]	Dynamic Signal 5,5 [80]	Static Signal 6,9 [100]	Dynamic Signal 8,6 [125]	Static Signal 10,3 [150]	Dynamic Signal 12,8 [185]
P & EF CF LS & T	1 1/16 -12 3/4 - 16 7/16 - 20	606-1093	606-1294	606-1094	606-1295	606-1095	606-1296
P & EF CF LS & T	1 1/16 -12 7/8 - 14 7/16 - 20	606-1046	606-1341	606-1047	606-1342	606-1048	606-1343
P & EF CF LS & T	1 5/16 -12 7/8 - 14 7/16 - 20	606-1058	606-1344	606-1059	606-1345	606-1060	606-1346
P & EF CF LS & T	1 5/16 - 12 1 5/16 - 12 7/16 - 20	606-1141	606-1347	606-1142	606-1348	606-1143	606-1349
P & EF CF LS & T	1 5/16 -12 1 1/16 - 12 7/16 - 20	606-1350	606-1282	606-1351	606-1281	606-1352	606-1283
P & EF CF LS & T	M27 X 2 M18 X 1,5 M12 X 1,5	606-1353	606-1354	606-1355	606-1356	606-1357	606-1358
P & EF CF LS & T	R 3/4 - 14 R 1/2 - 14 R 1/4 - 19	606-1359	606-1360	606-1361	606-1362	606-1363	606-1364

For comprehensive
information on all steering
system components
"Valves" see Eaton catalog
E-VLFL:MLOO1-E

Steering System Components

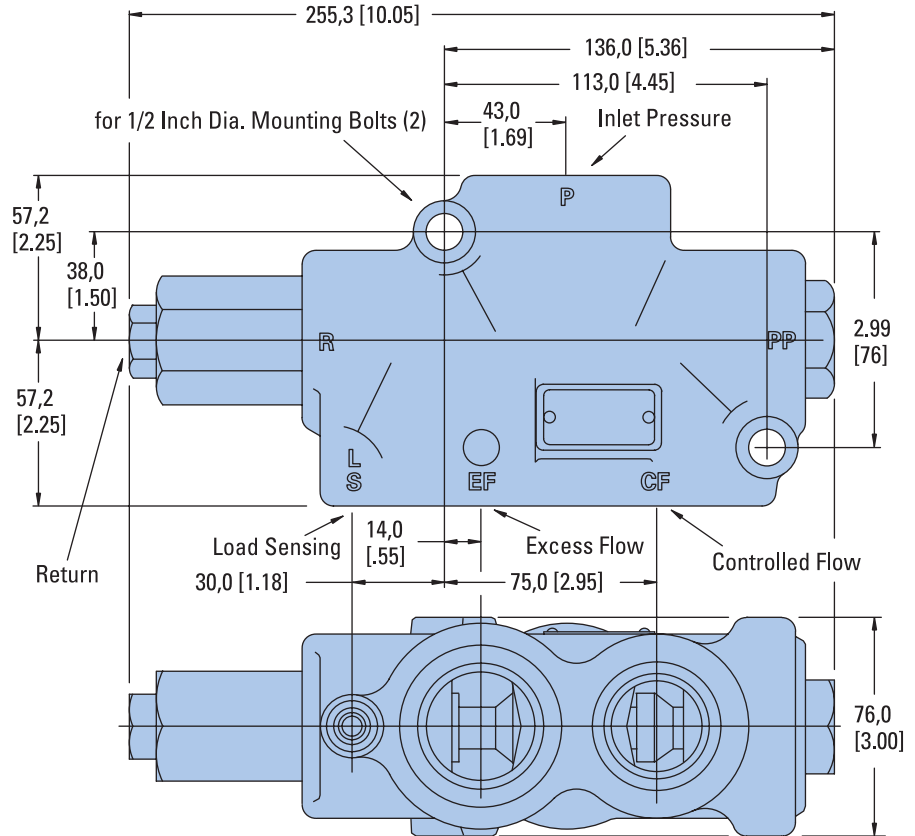
VLH In-Line Priority Valves

**240 l/min [63 GPM]
Rated Flow**

Code Number	System Pressure bar [PSI]
DD	83 [1200]
HE	120 [1725]
LA	138 [2000]
MC	150 [2175]
NC	160 [2300]
QA	172 [2500]
UA	207 [3000]
VD	230 [3325]
VK	240 [3475]

Rated CF Pressure is
276 bar [4000 psi]

Rated inlet and EF Pressure
is 296 bar [4300 psi]



Example: 606-1202-003-QA
 Product Number System Pressure
 Code Number
 X = Design Level — **NOT** part of Order Number.

The product number (above left) describes a VLH Series with 6,9 bar [100 PSI] control pressure, static signal, 1 5/8-12 P and EF ports, 1 5/16-12 CF port, 7/16-20 LS and R ports, 172 bar [2500 PSI] relief valve setting.

Control Pressure - bar [PSI] / Product Number

Ports (5)	O-ring Port Size	Static Signal 5,2 [75]	Dynamic Signal 5,9 [85]	Static Signal 6,9 [100]	Dynamic Signal 7,6 [110]	Static Signal 10,3 [150]	Dynamic Signal 11,4 [165]
P & EF	1 5/8 - 12						
CF	1 5/16 - 12	606-1201	606-1288	606-1202	606-1289	606-1203	606-1290
LS & R	7/16 - 20						
P & EF	1 5/8 - 12						
CF	1 1/16 - 12	606-1368	606-1284	606-1369	606-1285	606-1370	606-1286
LS & R	7/16 - 20						
P & EF	1 5/8 - 12						
CF	3/4 - 16	606-1189	606-1371	606-1190	606-1372	606-1191	606-1373
LS & R	7/16 - 20						

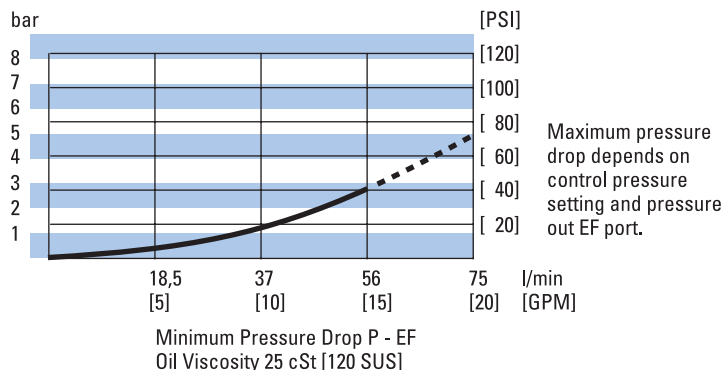
For comprehensive information on all steering system components "Valves" see Eaton catalog 11-508.

Steering System Components

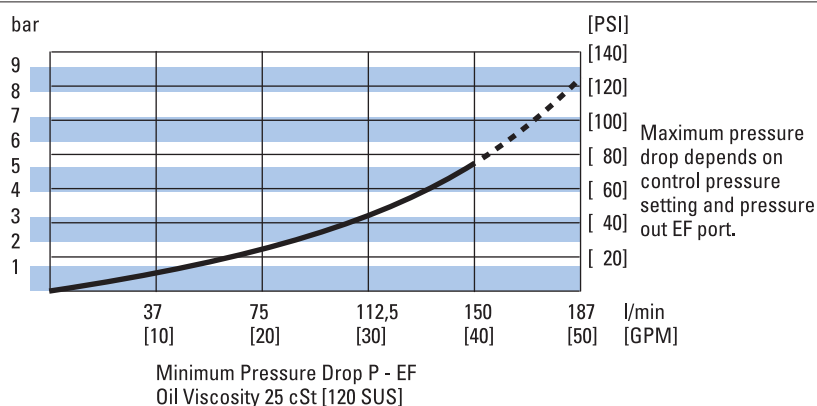
VLC, VLE and VLH Priority Valves

– Pressure Drop Curves

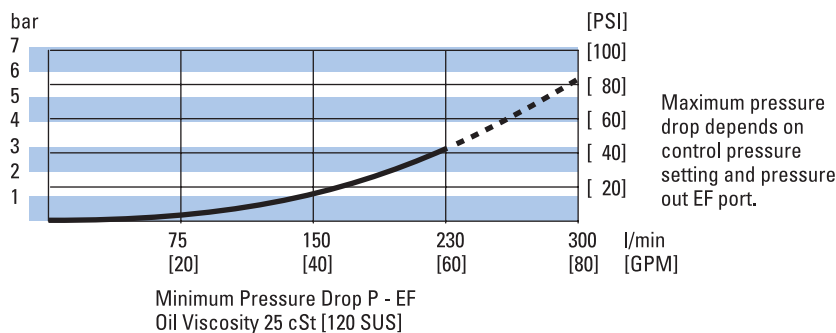
VLC Series



VLE Series

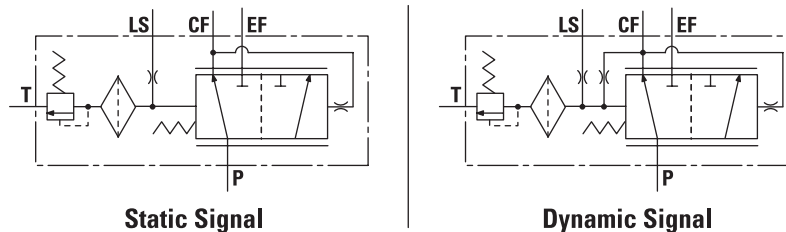


VLH Series



U.S. Patents. Re 26,338; 3,455,210 and 4,043,419 cover circuits using these priority valves. Corresponding foreign patents pending and issued.

Symbols



For comprehensive information on all steering system components "Valves" see Eaton catalog E-VLFL-MLOO1-E

Steering System Components

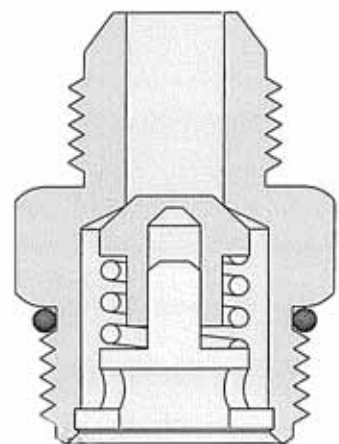
Check Valves

Product Description

These check valves are designed specifically to withstand the rugged duty cycles of a steering system and perform their functions reliably to prevent kickback in the steering wheel.

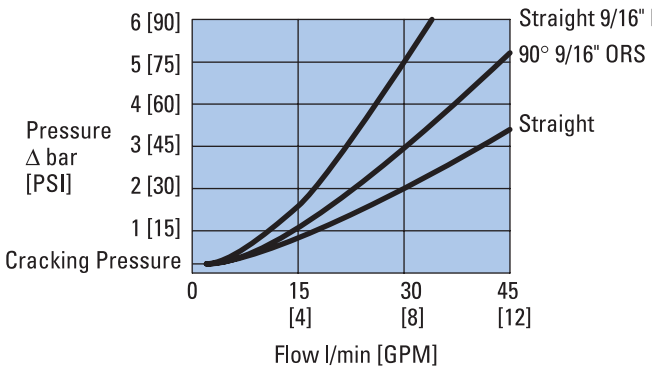
The check valve is installed directly into the pressure port of Char-Lynn steering control unit. Connection of the hose assembly is either a male 37° end or O-ring face seal (ORS).

Straight 90° elbow configurations are available (see installation drawing next page).



Performance Data

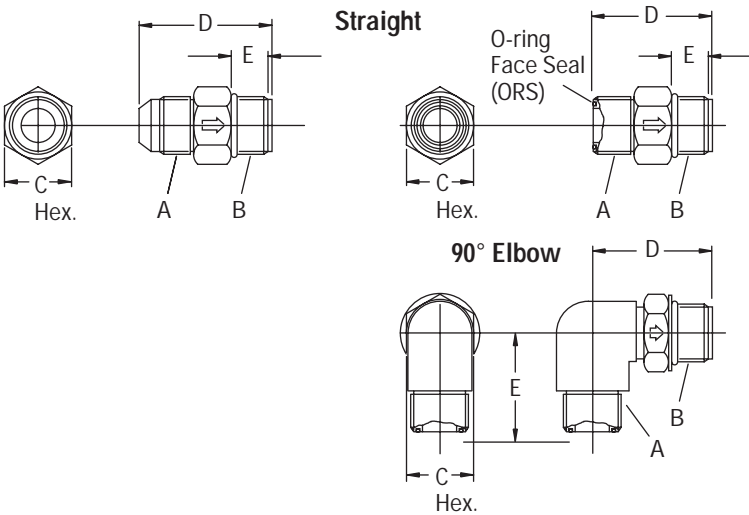
Pressure Drop Curves —
Inlet Check Valves



Steering System Components

Check Valves

Installation Drawing



Configuration	Product Number	Check Valve Dimensions—mm [in.]				
		A	B	C	D	E
Straight	37° 608-1003	3/4-16	3/4-16	22,61/22,10 [.89/.87]	43.69/43.18 [1.72/1.70]	14.48/13.46 [.57/.53]
	37° 608-1004	9/16-18	3/4-16	22,61/22,10 [.89/.87]	41.15/40.64 [1.62/1.60]	14.48/13.46 [.57/.53]
	ORS 608-1007	13/16-16	3/4-16	22,61/21,10 [.89/.87]	39.88/39.37 [1.57/1.55]	14.48/13.46 [.57/.53]
	ORS 608-1009	11/16-16	3/4-16	22,61/22,10 [.89/.87]	38.16/37.59 [1.50/1.48]	14.48/13.46 [.57/.53]
90°	ORS 608-1013	11/16-18	3/4-16	24,13/23,62 [.95/.93]	37,6/35,5 [1.48/1.40]	41.15/40.13 [1.62/1.58]

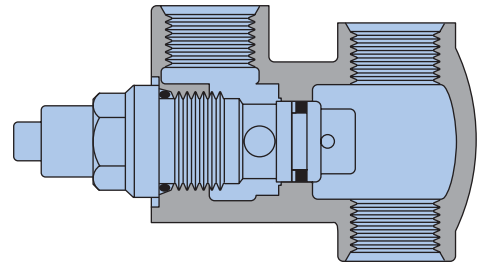
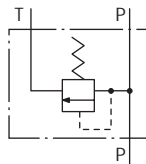
Steering System Components

Relief Valves

Model 32107 In-Line Relief Valve--Direct Acting Cartridge

Specifications

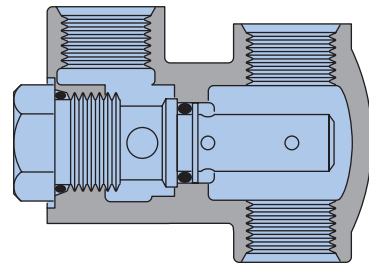
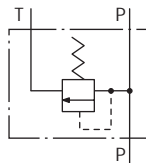
Max. Flow Through Relief Valve	57 l/min [15 GPM]
Relief Valve Setting Range	47–276 bar [675–4000 PSI]
Standard Relief Valve Setting	138 bar [2000 PSI]
Housing Rated Pressure	345 bar [5000 PSI]



Model 32107 In-Line Relief Valve--Pilot Operated Cartridge

Specifications

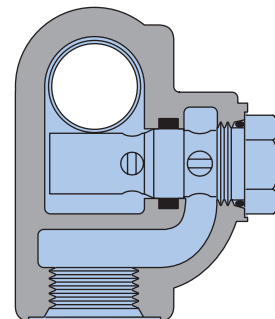
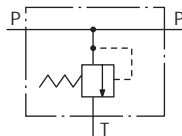
Max. Flow Through Relief Valve	75,7 l/min [20 GPM]
Relief Valve Setting Range	103–241 bar [1500–3500 PSI]
Housing Rated Pressure	345 bar [5000 PSI]



Model 32112 In-Line Relief Valve

Specifications

Max. Flow Through Relief Valve	132,5 l/min [35 GPM]
Relief Valve Setting Range	69–241 bar [1000–3500 PSI]
Housing Rated Pressure	345 bar [5000 PSI]



Comprehensive Relief Valve Description

(see Eaton Relief Valve Catalog 11-510)

Steering System Components

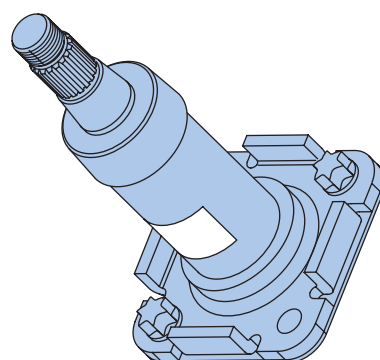
Columns

Product Description

Char-Lynn columns can be custom built to your exact specifications. The column and mounting flange is of a sturdy single weldment design. These columns have high thrust and side load capacity with low shaft torsional friction. Columns are painted with low gloss black finish and the shafts are phosphate coated and oil dipped for corrosion protection.

Features

- Low friction bearings to carry thrust and side loads
- dust boot to protect against dirt and moisture
- Four jacket types are available
- Two lower ends and ten upper ends are available
- Two different horn wire configurations
- available from 56 to 825 mm [2.2 to 32.5 inch]
- pre-assembled to steering units per your request



SPECIFICATIONS

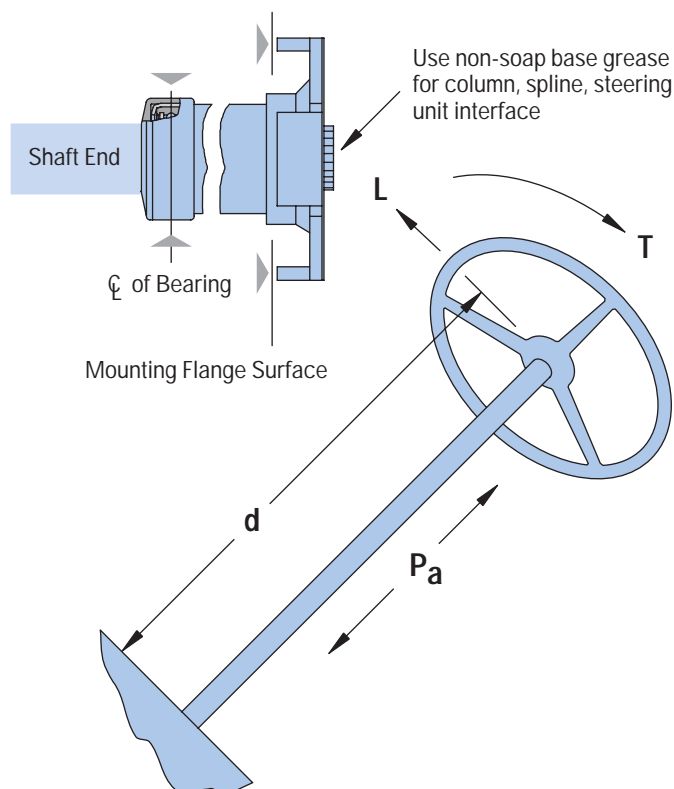
Rated Torsional	81Nm [60 lb-ft]
Rated Bending Moment*	136 Nm [100 lb-ft]
Rated Radial Load**	86 kg [150 lb]
Rated Axial Load	86 kg [150 lb]
Torsional Friction Drag	0,23 kg [2 lb-in]
Recommended Wheel Nut Torque	47 Nm [35 lb-ft]

*Bending moments are taken about the plane of the column mounting surface.

**Radial load at the bearing centerline must not exceed the horizontal bending moment rating.

Five Steps for "How to Order Your Column"

- 1 Select Jacket/Base Type
 - 2 Select Lower Shaft Type
 - 3 Select Upper Shaft End Type
 - 4 Select Length (use suggested standard length)
 - 5 Select Add-On Features
 - a) Horn Wire
 - b) Wire Ends
- Please contact your Eaton Representative if any request differs from our catalog offerings.



Steering System Components

Columns

Model Code, Ordering Information

The following 22-digit coding system has been developed to identify all of the configuration options for steering columns. Use this model code to specify a steering column with the desired features. All 22 digits of the code must be present when ordering. You may want to photocopy the matrix below to ensure that each number is entered in the correct box.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A	C	K																	0	0	

Nos	Feature	Code	Description	Nos	Feature	Code	Description
1,2,3	Product Series	ACK	Steering Column	100		254,0	[10.00]
4,5	Jacket/Base Type (page 74)	SJ	Standard (38 mm [1.50 inch] O.D.)	120		304,8	[12.00]
		MN	Round Series 5 (38mm [1.5 inch] O.D.)	140		355,6	[14.00]
		HG	Heavy Wall (41,4 [1.63 inch] O.D.)	160		406,4	[16.00]
			Tabbed Flange	026		66,1	[2.60]
		SH	Standard With flat Flange	036		92,3	[3.63]
			(38mm [1.50 inch] O.D.) (No Tabs)	062		157,3	[6.19]
		TJ	Tilt Column with Flat Flange, Mechanical Push	081		206,6	[8.13]
Button				103		260,2	[10.24]
				111		282,8	[11.13]
6	Lower Shaft End (see page 75)	1	12 Tooth Spline for Steering Unit	121		308,2	[12.13]
		3	3/4 inch "D" Section (for Noise Isolator)	162		409,3	[16.11]
				182		461,1	[18.15]
				257		651,6	[25.65]
7,8	Upper Shaft End (see illustrations and specifications page 76, 77)	AJ	Standard for all rigid and tilt columns Available with or without Horn Wire	276		701,9	[27.63]
		MJ	Available with or without Horn Wire	302		765,9	[30.15]
		DN	Not Available with Horn Wire	329		835,7	[32.90]
		EJ	Not Available with Horn Wire	AAA		190,5 [7.50]	Above Pivot
		GC	Not Available with Horn Wire			546,4 [21.51]	Below Pivot
		CL	Not Available with Horn Wire	AAB		190,5 [7.50]	Above Pivot
		PT	Available with or without Horn Wire			101,6 [4.00]	Below Pivot
		SV	Available with or without Horn Wire	AAC		127,0 [5.00]	Above Pivot
		YM	Not Available with Horn Wire			127,0 [5.00]	Below Pivot
				12-16	Horn Wire Feature (page 79)	00000	No Horn Wire
						1A045	Single Horn Wire
						2B045	Two Horn Wires
9,10,11	Jacket Length mm [in.] (Suggested Std. Dim.)	022	56,6 [2.23]	17	Horn Brush Wire Terminal End (page 79)	0	None—Select When No Horn Wire Used
		033	82,8 [3.26]			D	SAE J928 Pin and Double End Connector
		058	147,8 [5.82]			K	Blade Receptacle—Insulated (Compatible with SAE J858a)
		078	197,1 [7.76]	18,19	Shaft End Wire Terminal (page 79)	00	None
		099	250,7 [9.87]			01	One Horn Button (Only with One Horn Wire)
		108	273,3 [10.76]			02	One Horn Button with Wire Eyelet (Select with Two horn Wire)
		118	298,7 [11.76]			08	Tinned Bare Wire End
		157	399,8 [15.74]	20,21	Special Feature	00	None
		178	451,6 [17.78]	22	Eaton Assigned Design Code	B	For Tilt columns
		253	642,1 [25.28]				
		273	692,4 [27.26]				
		298	756,4 [29.78]				
		325	826,3 [32.53]				
		060	152,4 [6.00]				
		080	203,2 [8.00]				

BOLT & NUT KITS

Separate kits are available for purchase to use with steering columns

Metric Cap Screw Kit	M10 x 1.5 Thread x 20mm Lenth (Qty 4)	9900157-000
Standard Cap Screw Kit	.375-16 UNC Thread x .75" Length (Qty 4)	9900158-000
Metric Jam Nut Kit	M18 x 1.5 (Qty 1)	9900159-000
Hex Nut Kit	13/16-20 NEF (Qty 1)	9900160-000
Hex Nut Kit	1 1/2 - 12 UNF (Qty 1)	9900161-000

Steering System
Components
Columns
Jacket/Base Type

Example—see model code page 73

Position 4-5

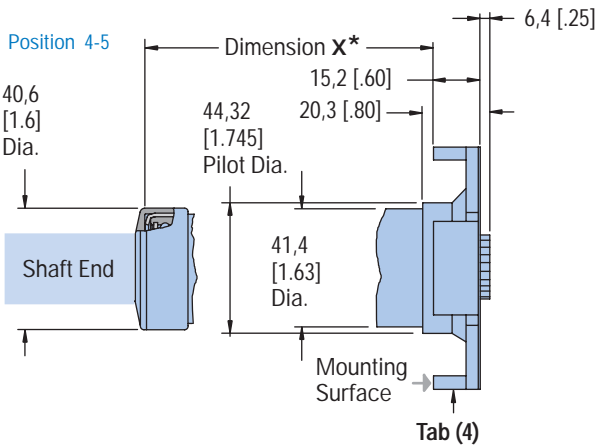
SH Standard with flat flange (No Tabs)

Position 9, 10, 11

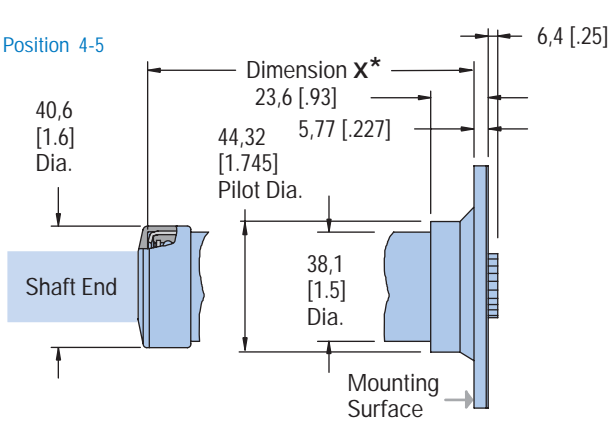
026 66,1 [2.60] (Dimension X)

*Dimension X—see model code page 73 Position 9, 10, 11 (Jacket Length)

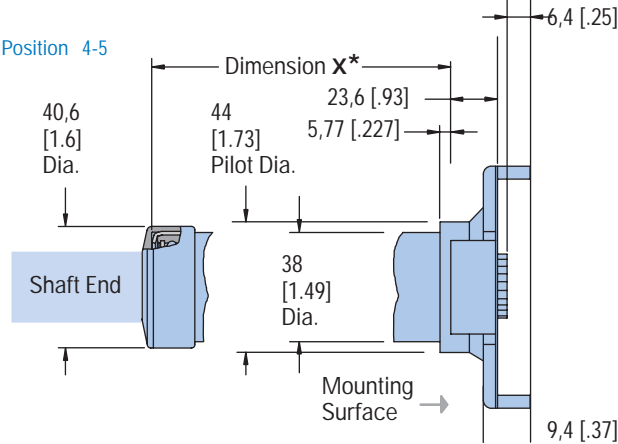
SJ Standard Wall
(Available on Square Series 5, Series 10, 20, 25, 40)



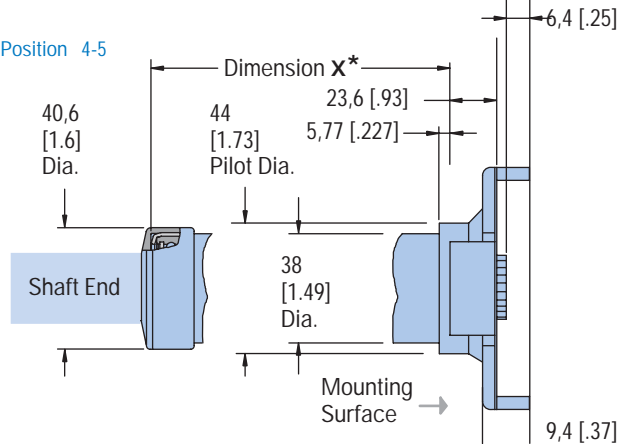
SH Standard Wall
(Available on Square Series 5, Series 10, 20, 25, 40)



HG Heavy Wall
(Available on Square Series 5, Series 10, 20, 25, 40)



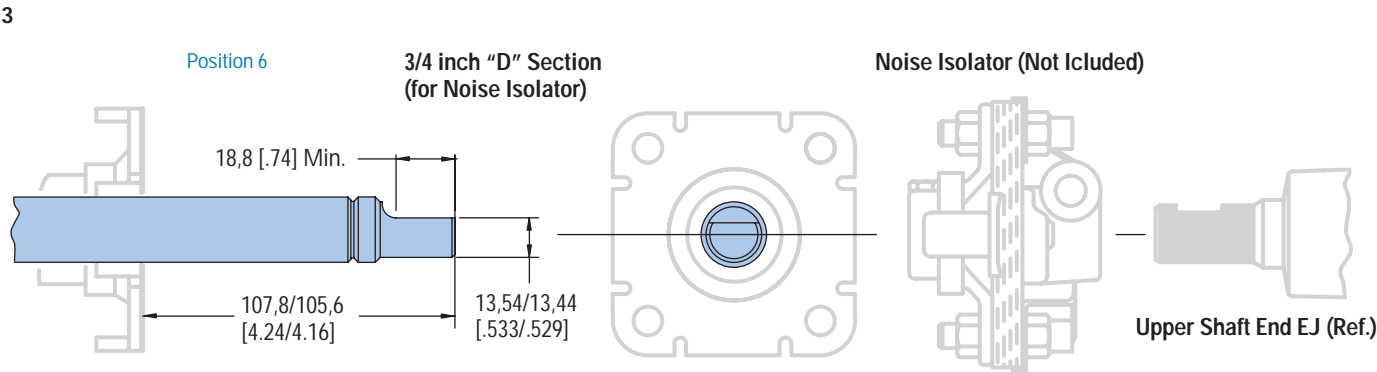
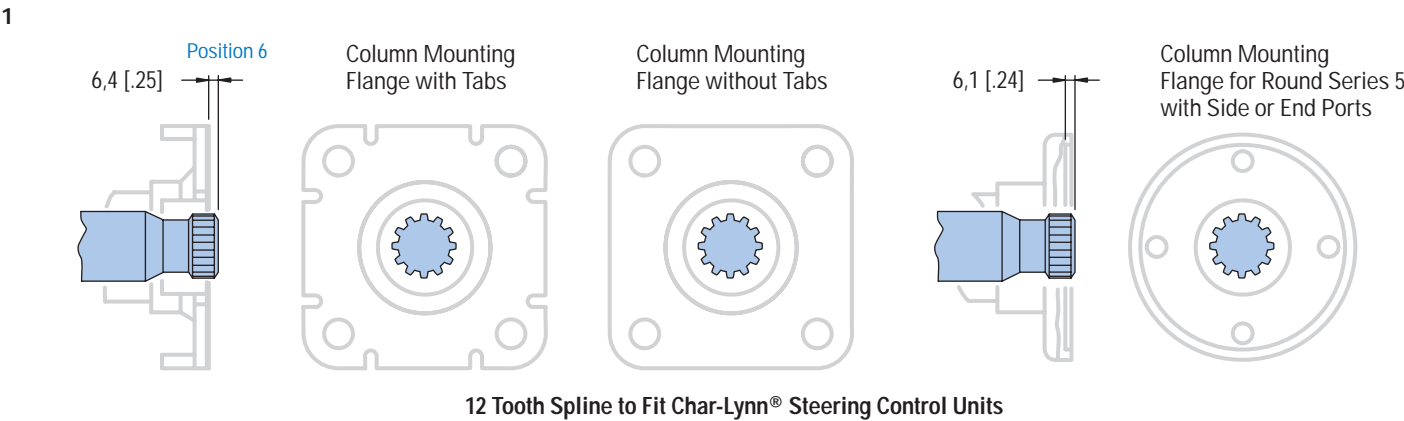
MN
(Round Series 5 with End Ports Only)



Steering System
Components
Columns
Lower End Type

Example—see model code page 73

Position 6
1 12 Tooth Spline for Steering Unit



Steering System Components

Columns

Upper Shaft End

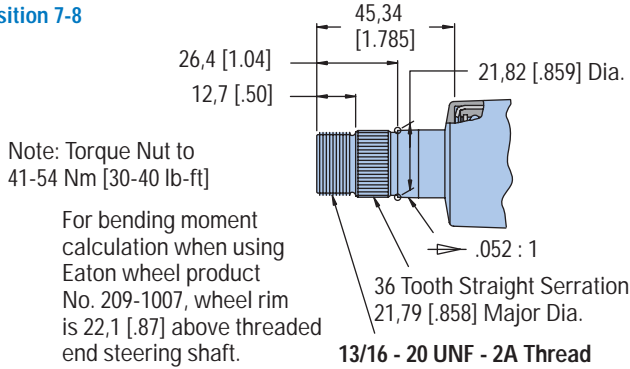
Example—see model code page 73

Position 7-8

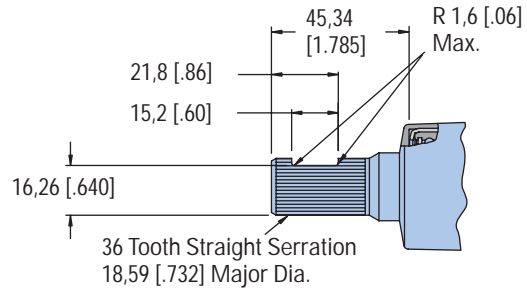
EJ (36 Tooth Straight Serration)

Not available with horn wire

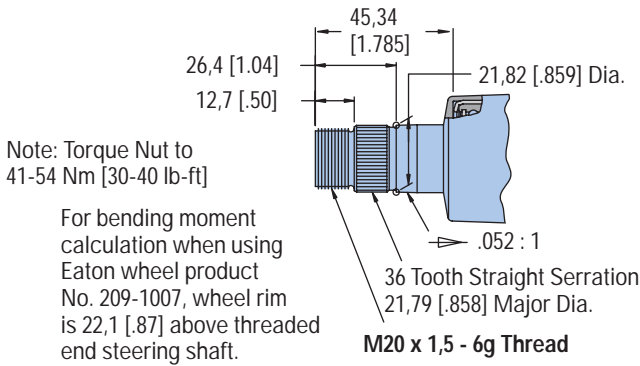
AJ Position 7-8



EJ Position 7-8

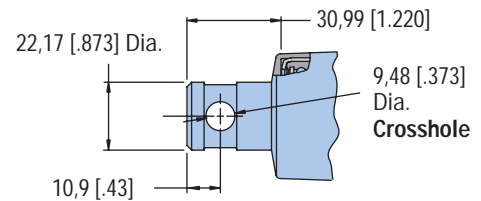


MJ Position 7-8

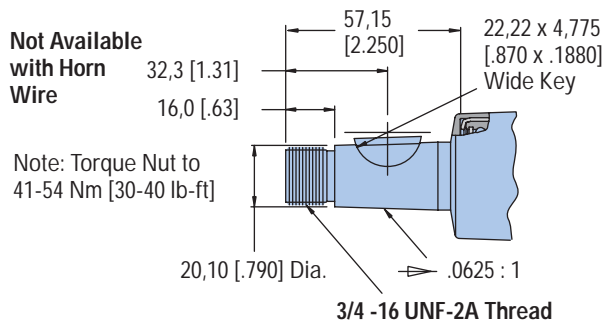


GC Position 7-8

Not Available with Horn Wire



DN Position 7-8



Steering System Components

Columns

Upper Shaft End

Continued

Example—see model code page 73

Position 7-8

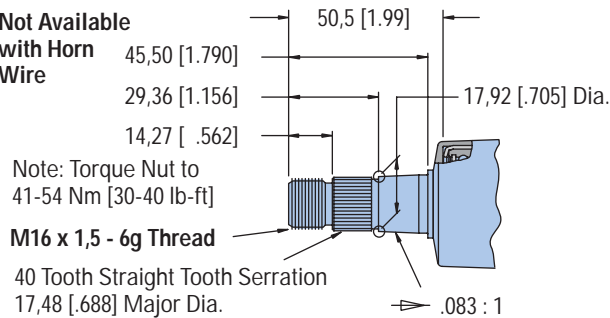
YM (.050 : 1 Taper M18 x 1,5 - 6g Thread)

Not available with horn wire

CL

Position 7-8

Not Available
with Horn
Wire



YM

Position 7-8

Not Available
with Horn
Wire or Tilt

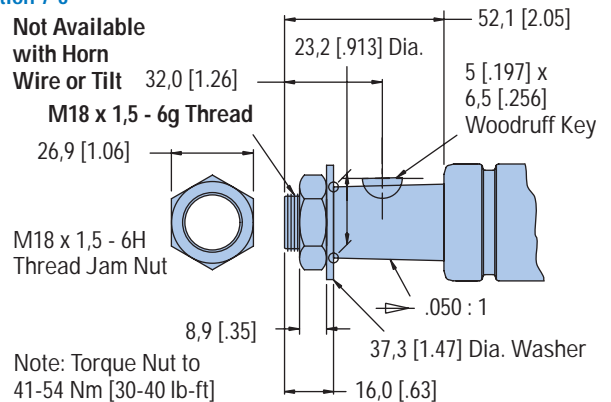
M18 x 1,5 - 6g Thread

32,0 [1.26]

26,9 [1.06]

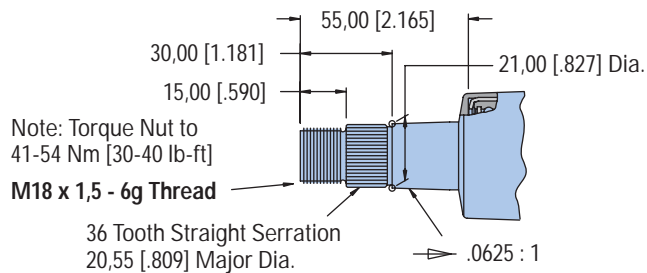
M18 x 1,5 - 6H
Thread Jam Nut

Note: Torque Nut to 41-54 Nm [30-40 lb-ft]



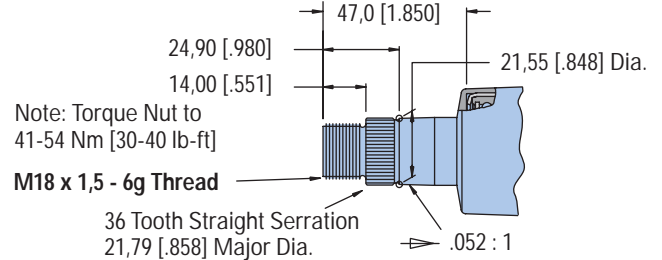
PT

Position 7-8

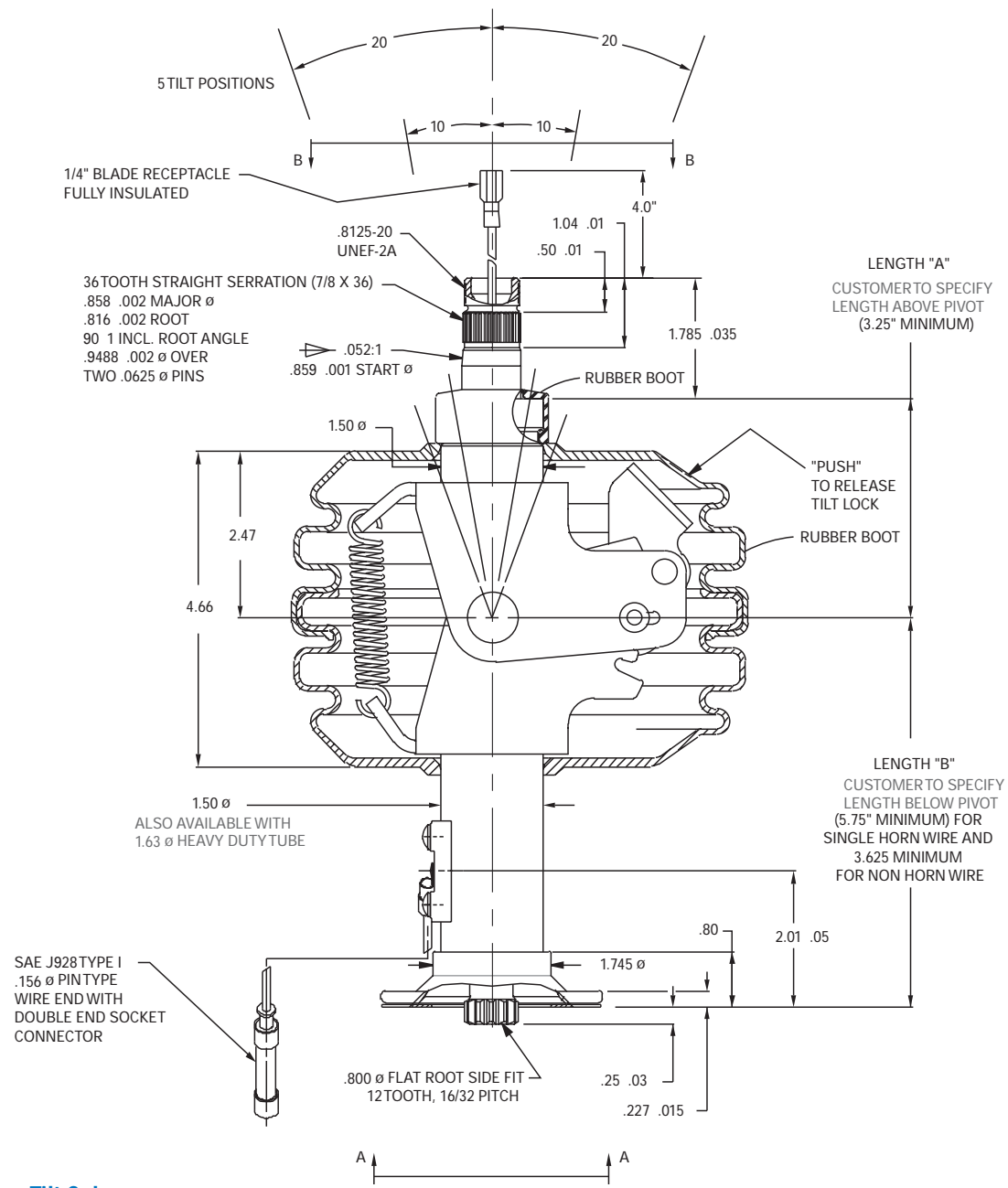


SV

Position 7-8



Steering System
Components
Columns
Tilt Column



How to Order your Tilt Column:

Model Code — Steering Columns

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
A	C	K	T	J		A	J														B

Position	9	10	11	Dim. A Above Pivot	Dim. B Below Pivot
A	A	A	C	127,0 [5.00]	127,0 [5.00]
A	A	A	B	190,5 [7.50]	101,6 [4.00]
A	A	A	A	190,5 [7.50]	546,4 [21.51]

*Dim. A (minimum) above pivot is 165,1 [6.5] (with one horn wire)
**Dim. A (minimum) above pivot is 203,2 [8.0] (with two horn wires)

Steering System Components

Columns

Horn Wire

Electrical

Example—see model code page 73

Position 12-16

1A045 Column with one horn wire

Single Wire

01

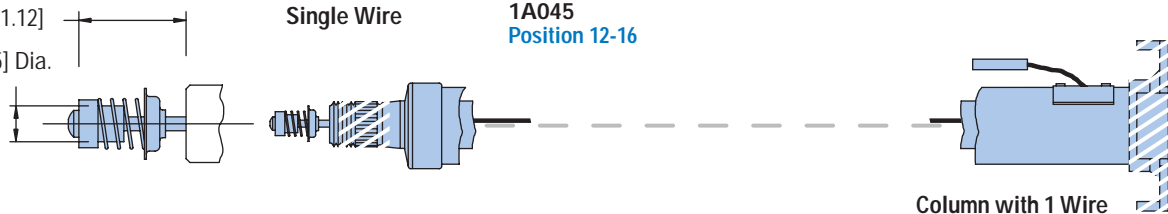
Position 18-19

28,4 [1.12]
9,52 [.375] Dia.

Single Wire

1A045

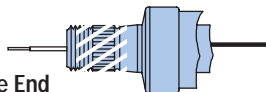
Position 12-16



08

Position 18-19

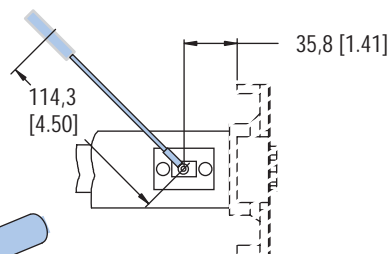
Tinned Bare Wire End



K or T

Position 17

K — Blade
Receptacle
Insulated —
Compatible with
6,4 [.25] Blade
Per SAE J858a



T — SAE J928 Type I 3,96 [.156].
Female Wire End

Two Wire

02

Position 18-19

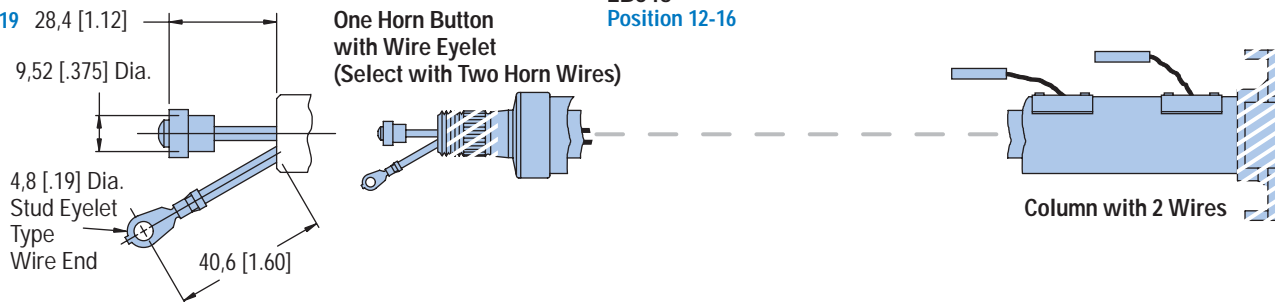
28,4 [1.12]
9,52 [.375] Dia.

4,8 [.19] Dia.
Stud Eyelet
Type
Wire End

Two Wires
One Horn Button
with Wire Eyelet
(Select with Two Horn Wires)

2B045

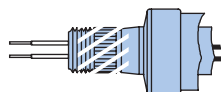
Position 12-16



08

Position 18-19

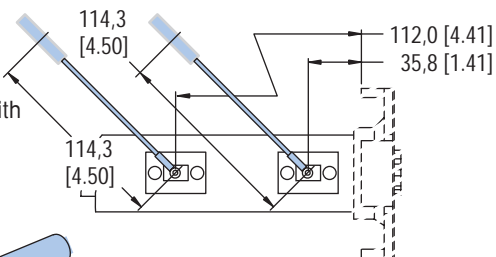
Tinned Bare Wire Ends



K or T

Position 17

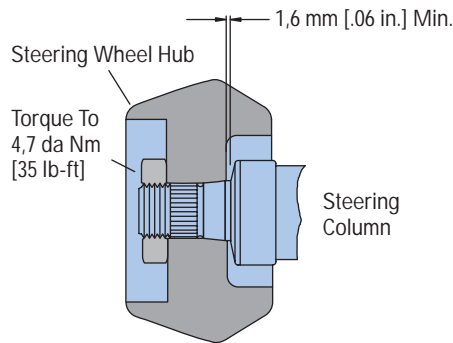
K — Blade
Receptacle
Insulated —
Compatible with
6,4 [.25] Blade
Per SAE J858a



T — SAE J928 Type I 3,96 [.156] Dia.
Female Wire End

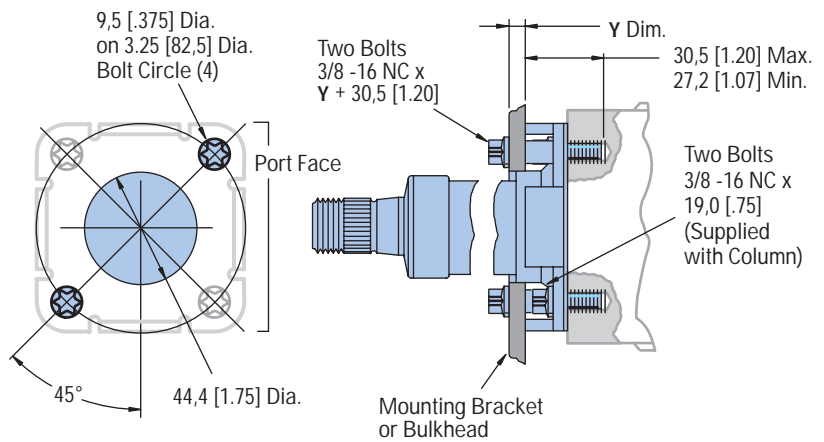
Steering System
Components
Columns and Wheel
Mounting Product
Information

Inspect for Minimum
Clearance at Assembly



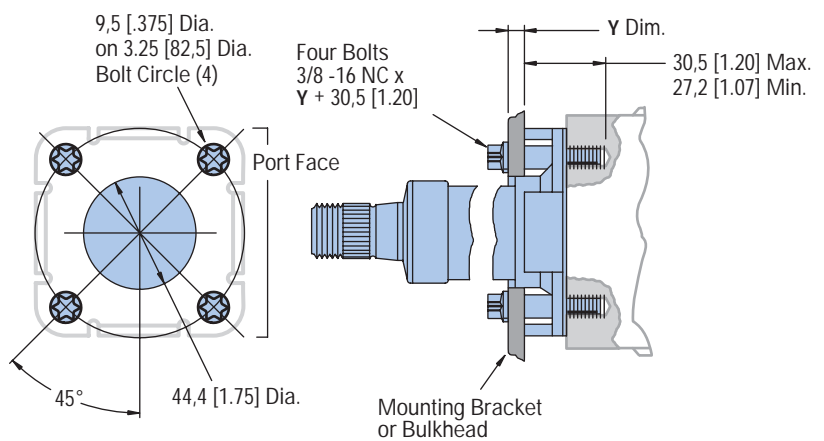
Square Series 5 and
Series 10

Must use two bolts through mounting bracket or bulkhead and two bolts through just the steering column or four bolts through mounting bracket or bulkhead.



Series 20, 25

Must use four bolts through mounting bracket or bulkhead.



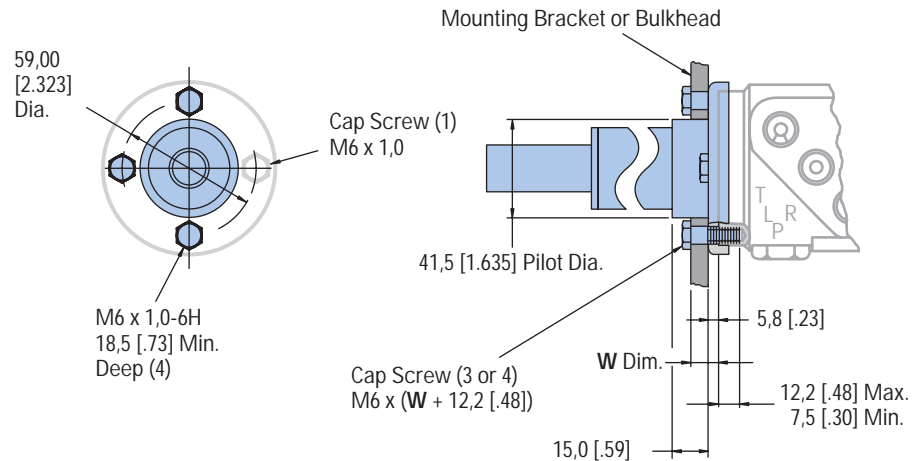
Steering System Components

Columns

Product Information

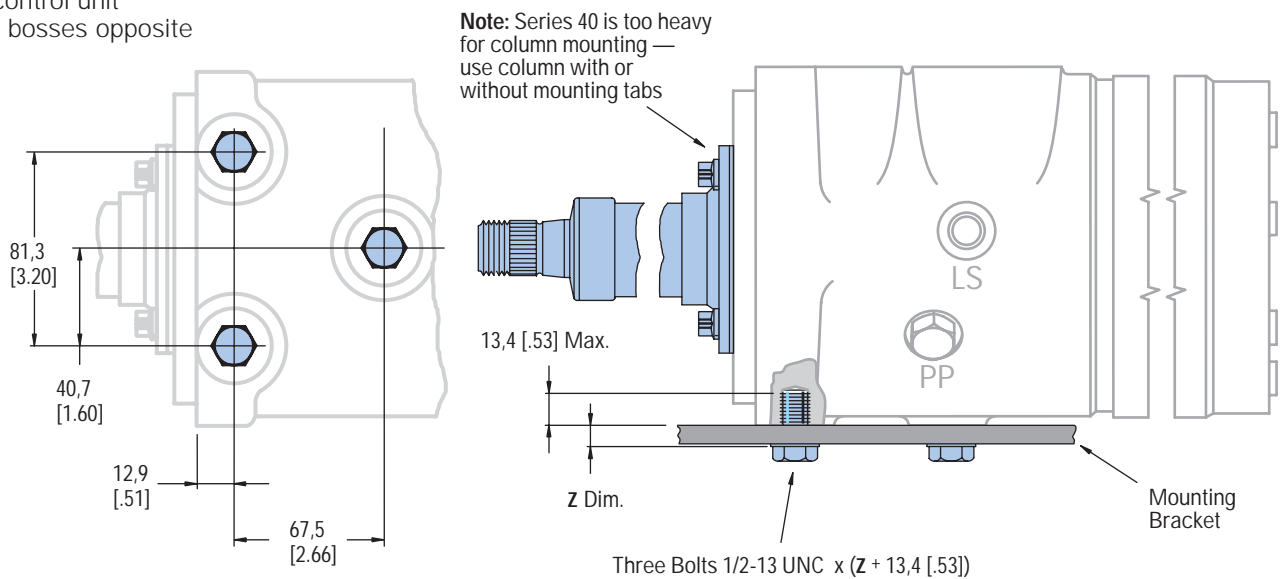
Round Series 5

Must use three bolts minimum.



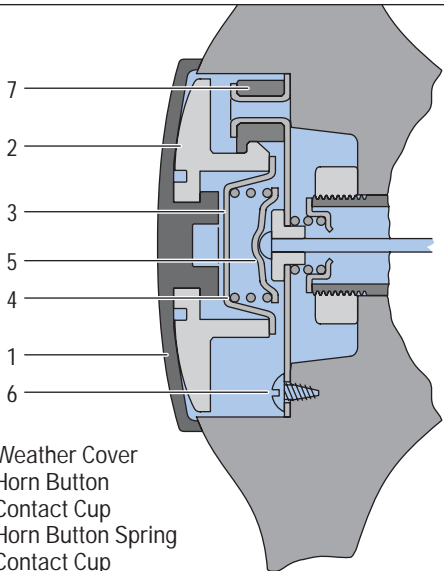
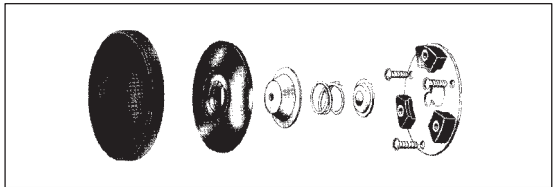
Series 40

Must use three bolts into steering control unit mounting bosses opposite port face.



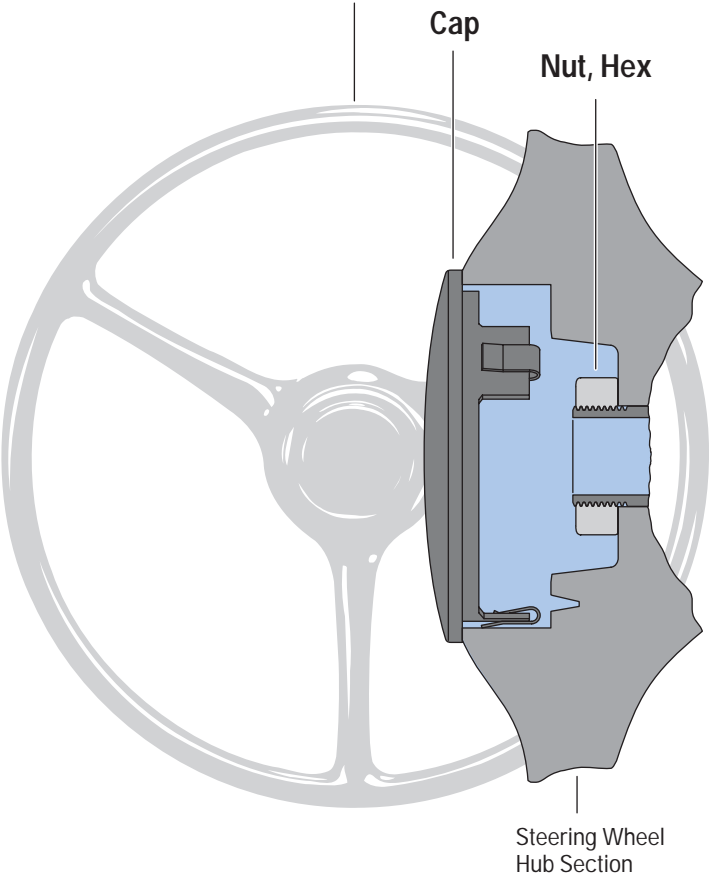
Steering System
Components
Steering Wheels
and Accessories

Horn Button Kit



- 1 Weather Cover
- 2 Horn Button
- 3 Contact Cup
- 4 Horn Button Spring
- 5 Contact Cup
- 6 Screw
- 7 Base Plate Assembly

Steering Wheel



Steering Wheel No. 209-1007

Molded black wheel with three equally spaced spokes, (relatively flat, without recessed hub) diameter 430 mm [17 inch] for column with upper shaft end AJ or MJ.

Note: Steering wheel hub has tapped holes for wheel puller.

Nut, Hex Part Number	Upper Shaft End Configuration (See Page xx, xx)	Thread Size
14517	PT, SV	M18 x 1,5
14593	MJ	M20 x 1,5
14603	CK, CL	M16 x 1,5
21084	AJ	13/16-20 UNF

Horn Button Kit No. 208-1013

For Char-Lynn® steering column with serrated upper shaft end AJ or MJ and Char-Lynn® 430 mm [17 inch] steering wheel.

Cap No. 209-1005

Char-Lynn® steering wheel hub cavity cap, for no horn installations used on steering wheel 209-1007.

Steering System Components

Steering Wheels and Accessories

New Steering Wheels

Eaton Char-Lynn, offers three new steering wheels each with different features:

209-1022: 350mm [14in] diameter, 3-spoke steering wheel with horn button option.

209-1023: 362mm [15in] diameter, 3-spoke steering wheel with knob standard and optional horn button.

209-1024: 400mm [16in] diameter, 3-spoke steering wheel with soft feel and horn button option.

Note: All steering wheels are compatible with column upper shaft end AJ.



Caps

9900308

Char-Lynn, steering wheel hub cavity cap, for no horn installations. Used on steering wheel 209-1022 and 209-1023.

Horn Buttons

9900416

For Char-Lynn, steering column with upper shaft end AJ and steering wheel 209-1022 and 209-1023.

9900417

For Char-Lynn, steering column with upper shaft end AJ and steering wheel 209-1024.

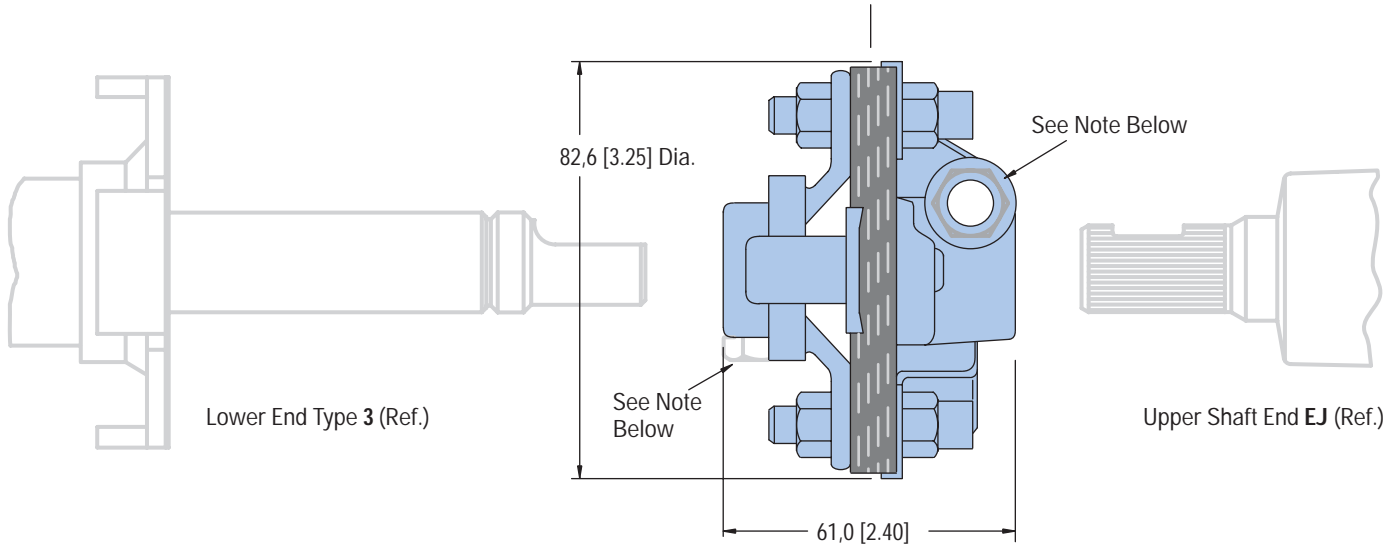


9900415

Char-Lynn, steering wheel hub cavity cap, for no horn installations. Used on steering wheel 209-1024.

Steering System
Components
Steering Wheels
and Accessories

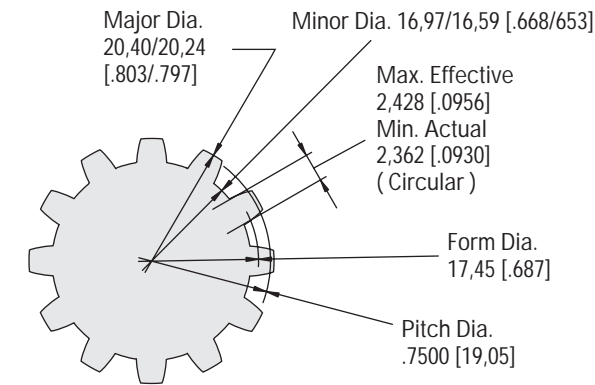
This Noise Isolator is Available from Eaton—
Part Number 208-1017-002



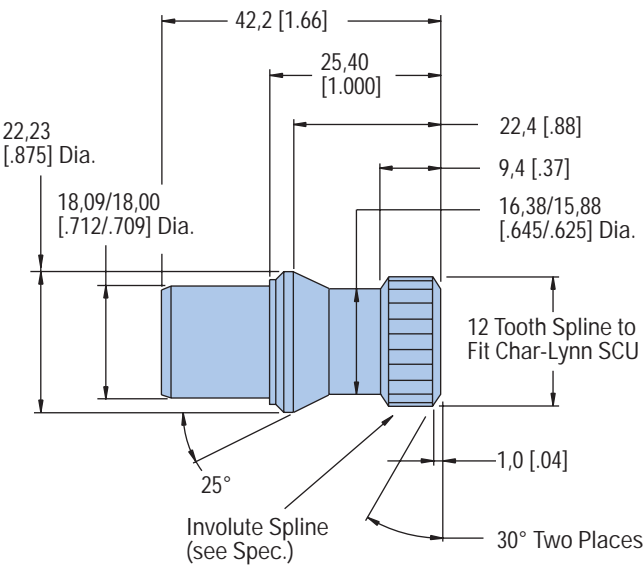
Note: Two screws (3/8-24 UNF x 31,8 [1.25] long — **not included**) are required to join isolator to mating steering columns. Torque screws to 41 Nm [360 lb-in].

Want to Make your Own Column? You Must use these Spline Specs. Lower Shaft End

This Splined Lower Shaft End Part (as shown below) is Available from Eaton—Part Number 8063



Fit	Flat Root Side Fit
Number of Teeth	12
Pitch	16/32
Pressure Angle	30°
Class of Fit	Special
Circular Tooth Thickness	
Max. Effective	2,428 [.0956]
Min, Actual	2,362 [.0930]
Splined End—AISI 8620 Mt'l Case hardened to RC 40-50	



12 Tooth Spline Specification (left)

Can be press fit and welded into a 22,22 [.875] OD x 2,16 [.085] wall steel tube.

Steering System Components

EH Proportional Loadensing Steer Valves

Description

EH proportional steer valves are commonly used for GPS steering, joystick steering, and autoguidance.

This is achieved by a manifold containing a shuttle valve, a counterbalance valve, and a KDG proportional control valve.

Model Code Description

DSV2-8
Shuttle Valve

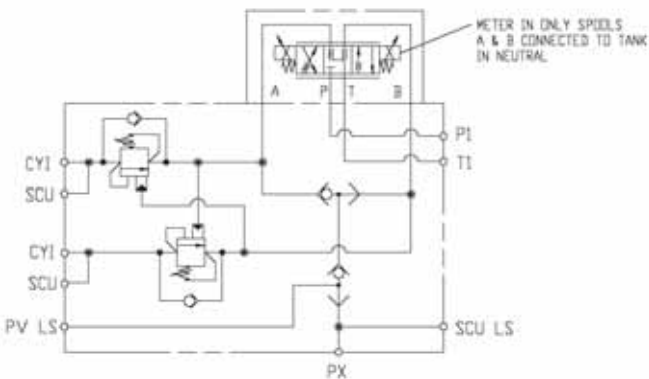
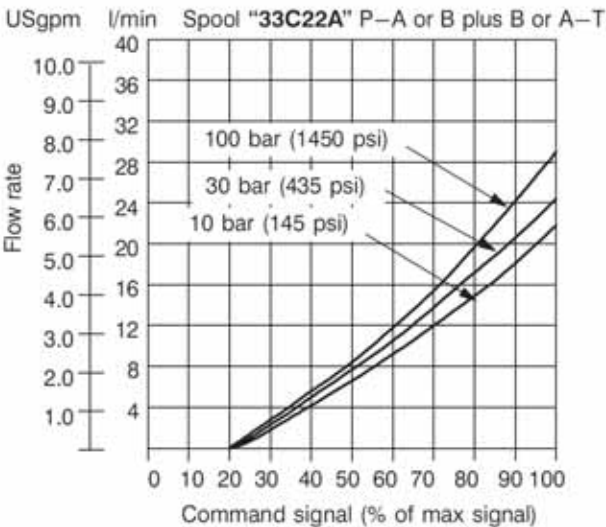
CBV2-10
Counterbalance Valve

KDG4V3S
Proportional Control Valve

(For more information see Vickers® Screw-in Cartridge Valves Cat. V-VLOV-MC001-E2 and Vickers Proportional Valves Cat. 539.)

Features / Applications

- features counterbalance valves on the turn ports to minimize leakage and improve stability. The counter balance valves make it particularly suitable for articulated machines and machines with hydraulic Tie Rods - such as sprayers.
- The valve also features a load sense drain and shuttle checks to resolve the load signal with the steering Orbitrol, making it suitable for use in Dynamic or Static signal systems.



SPECIFICATIONS

Max. System Pressure	210 bar [3000 PSI]
Rated Flow (@5 bar [72.5 PSI] single pass)	19 l/min [5 GPM]

Ordering Information

Choose one of the Part Numbers with different Port Options.

Part Number	Ports		
	P, T	R, L	LS
5991008-001	3/4-16 UNF	3/4-16 UNF	7/16-18 UNF
5991010-001	M18 x 1,5-6H	M18 x 1,5-6H	M12 x 1,75-6H
5991012-001	3/4-16 UNF	9/16-18 UNF	7/16-20 UNF

Steering System Components

Four Wheel Steer Switching Valves

Description

Four Wheel Steer Switching Valves provide three different types of steering by energizing and de-energizing two DG4V-3 valves. DG4V-3 valves are high performance, solenoid operated directional control valves.

- Two Wheel Steering: Energize Solenoid S1
- Four Wheel Steering: Energize Solenoid S2 + S3
- Crab Steering: Energize Solenoid S2 + S4

(For more information on these two valves, see Vickers® Solenoid Operated Directional Valves Cat. GB-C-2015.)

Applications

- Telehandlers
- Sprayers
- Rough terrain Cranes
- Backhoe Loaders

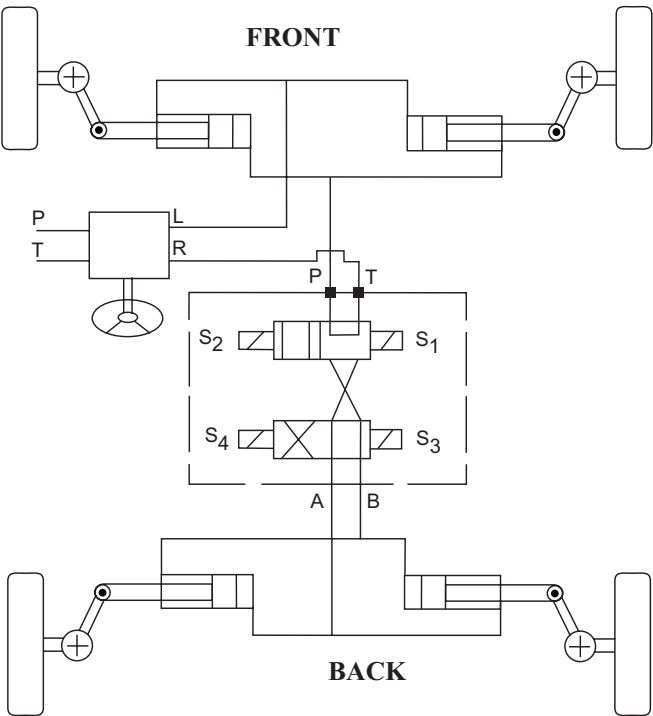
Ordering Information

1. Reference Assembly Number: 02-411452

Coil Rating
12V DC

Ports A, B, P, T
3/4-16 UNF

2. Choose Coil Rating:
12V DC
24V DC
3. Specify Ports if different than above PN.



DG4V-3 Solenoid Operated Directional Valves

SPECIFICATIONS

Rated Flow	80 l/min [21 GPM]
Max. System Pressure	210 bar [3000 PSI]
Internal Leakage when A or B pressurized in two-wheel drive (@200bar, 50°C)	40 ml/min [2.44 in ³ /min]
Pressure drop (@45 l/min [12 GPM])	
Two Wheel Steering	5 bar [72.5 PSI]
Four Wheel Steering	20 bar [290 PSI]
Crab Steering	20 bar [290 PSI]
Electrical Connection Type	AMP

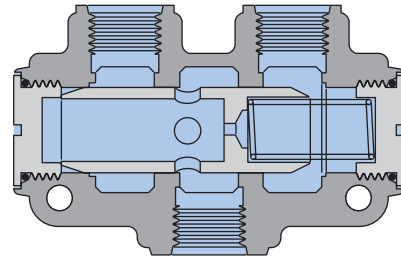
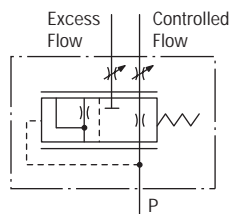
Steering System Components

Flow Divider Valves

Model 32306 Priority Flow Divider

Specifications

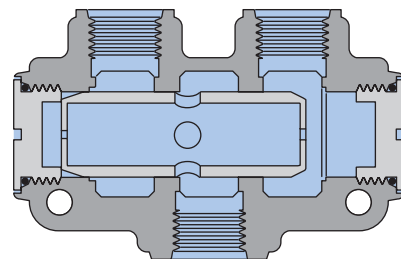
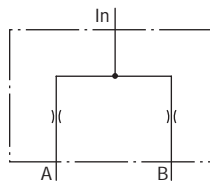
Rated Input Flow	96,6 l/min [25 GPM]
Rated Pressure	172,4 bar [2500 PSI]
Max. Pressure Drop Through Valve at Rated Input Flow	4,5 bar [65 PSI]



Model 32501 Proportional Flow Divider

Specifications

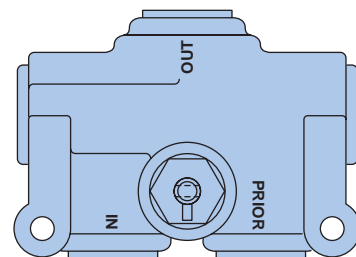
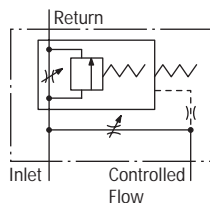
Rated Input Flow	113,6 l/min [30 GPM]
Rated Pressure	172,4 bar [2500 PSI]
Max. Pressure Drop Through Valve at Rated Input Flow	8,6 bar [125 PSI]



Model 32700 Variable Priority Flow Control

Specifications

Rated Input Flow	75,7 l/min [20 GPM]
Rated Pressure	172,4 bar [2500 PSI]
Max. Pressure Drop Through Valve at 56,8 l/min [15 GPM] Input	4,0 bar [48 PSI]
Max. Controlled Flow	36,0 l/min [9.5 GPM]
Controlled Flow Adjustment Range	5,7 - 36,0 l/min [1.5 - 9.5 GPM]
Relief Valve Factory Setting	151,7 bar [2200 PSI] at 36,0 l/min [9.5 GPM]



Comprehensive Flow Divider Description

(see Eaton Flow Divider Catalog E-VLFL-MC001-E)

Steering System Components

Brake Valve

Eaton Hydraulics' load-sensing brake valve makes power brakes an economical and efficient feature on lift trucks.

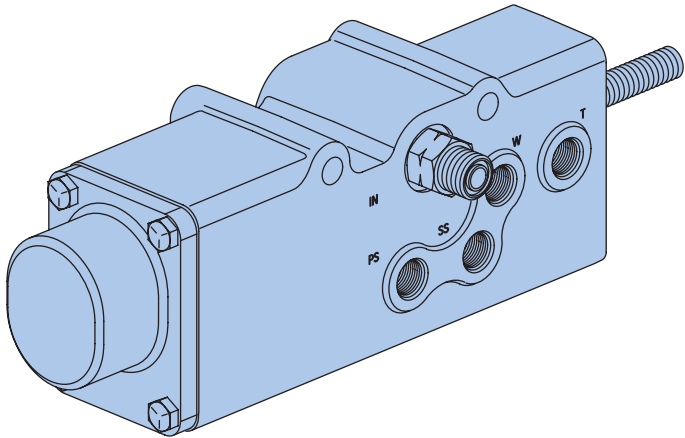
While power brakes in lift trucks can aid productivity, incorporating them into lift trucks has traditionally been expensive. The need for additional flow meant extra plumbing, plus the addition of a dedicated pump or a high pressure accumulator for the brake circuit. The increased system size also meant extra demand on the engine, resulting in reduced fuel economy.

The Eaton brake valve provides a better solution. Used in conjunction with load-sense steering and a priority valve, it can work with an existing system. A dedicated flow source is not required. It also ensures that brakes and steering have priority over the hoist circuit.

Eaton's new brake valve has a shuttle in the sensing port which allows the priority valve to determine whether brakes or steering require higher pressure. The priority valve then shifts to provide adequate flow and pressure for the function with the greatest needs. An integral pressure-compensated flow limiter provides low flow for brake modulation. This feature of the brake valve allows simultaneous braking and steering without steering interruption or pedal kick.

The design of the circuit also increases efficiency. The control flow line of the circuit is connected in parallel to both the brake valve and the steering unit. Thus, brake and steering pressures are not additive during simultaneous operation. The existing steering pressure is usually enough to provide full power braking.

Another feature of the Eaton brake valve is that it accommodates dead engine braking. The valve contains a large internally cored area that acts as a reservoir, providing oil for brake actuation in the manual mode. The valve design allows the volume and pressure required for manual braking to be generated without excessive pedal force. Thus, the load-sensing brake valve offers the benefits of powered brakes and manual brakes in a single package, eliminating the need for an accumulator.



Features

- No dedicated pressure source (separate pump or accumulator) required when the Eaton Power Brake Valve is used
- Reduces plumbing requirements
- Efficient—no parasitic loss
- Self-contained compact package
- Two-stage master cylinder with built-in reservoir provides dead-engine braking
- Lower input efforts and reduced pedal travel for braking
- Optional pilot operated check valve

Specifications—Valve

Max. Rated Pressure	205 bar [3000 PSI]
Rated Flow	11 l/min [3.0 GPM]

For more information, contact Eaton Mobile Valves team.

Steering System Components

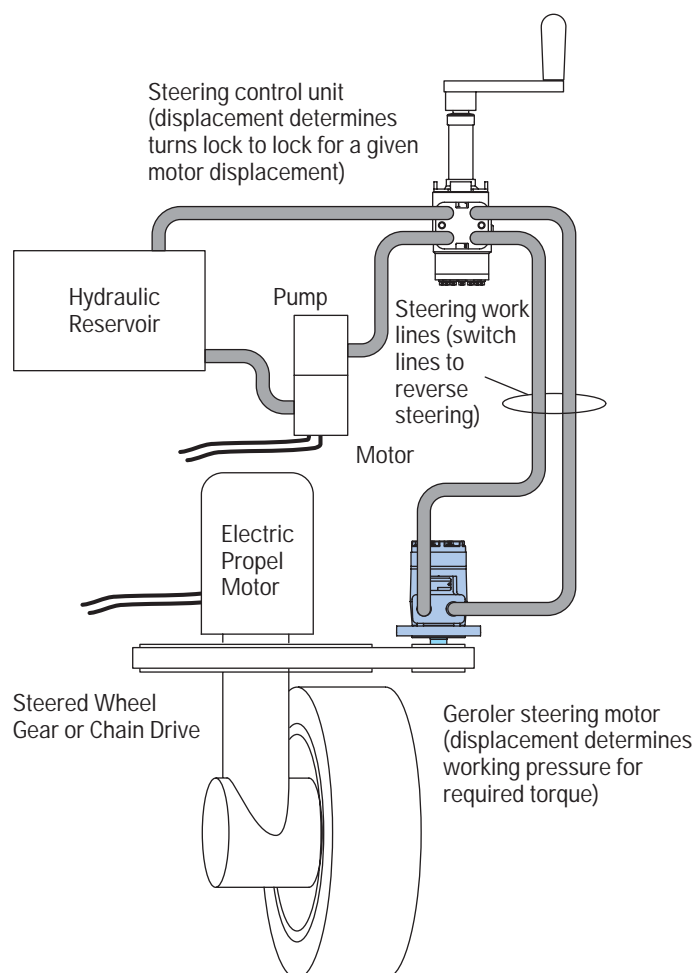
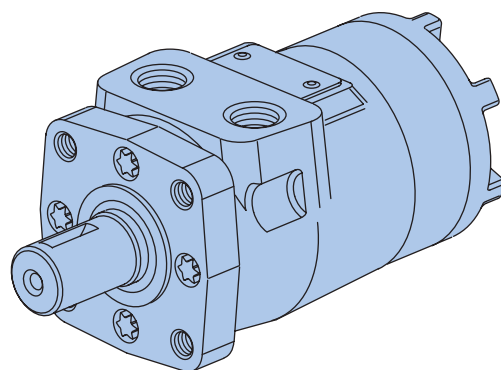
T Series Hydraulic Motors

Char-Lynn T Series low speed, high torque Geroler motor developed with low speed/low leakage valving specifically for steering applications (see Catalog E-MOLO-MC001-E2 Low Speed High Torque Motor page B-4-10 Code AB, Position 11-12).

Pressure Capability	
Continuous	155 bar [2250 PSI]
Intermittent	190 bar [2750 PSI]
Speeds	
	up to 1055 RPM
Torque	
Continuous	440 Nm [3905 lb-in]
Intermittent	510 Nm [4515 lb-in]
11 Displacements to	
	36 cm ³ /r [2.2 in ³ /r]
	370 cm ³ /r [22.6 in ³ /r]

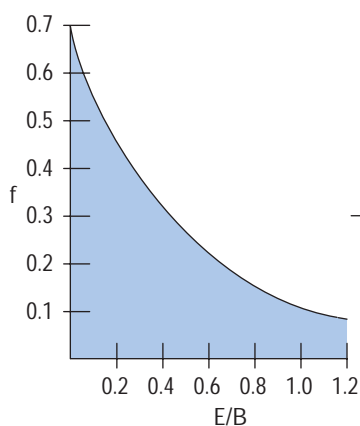
Comprehensive T Series Motor Description

(See Char-Lynn General Purpose Motors H, S, T Series Catalog E-MOLO-MC001-E2)



Sizing and Application—Ackermann Type Steering

Step One: Kingpin Torque



Typical values based
on rubber tired vehicles on
dry concrete.

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

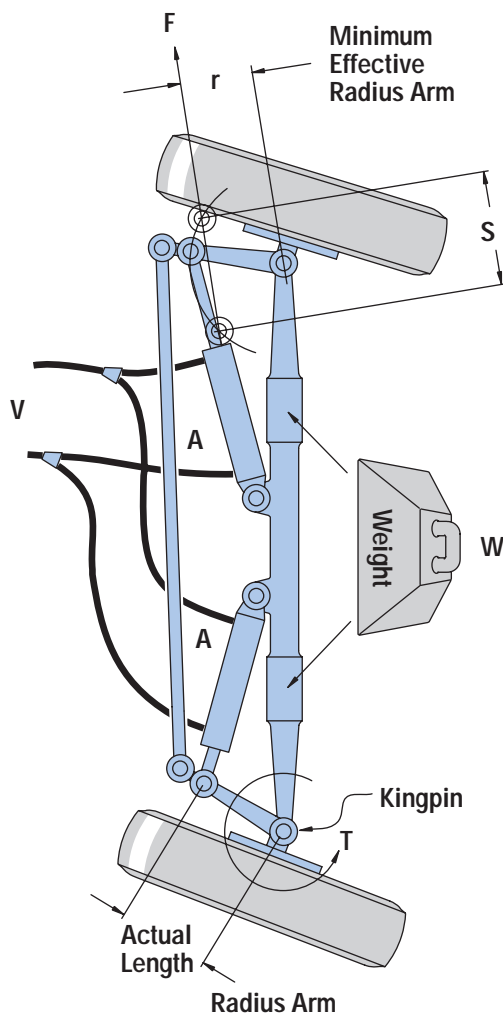
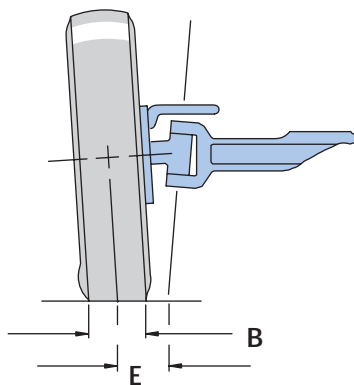
T = Total Kingpin Torque required to steer axle.

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).



Sizing and Application

Ackermann Type Steering Continued

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 approximate the additional dynamic loads.

r = Effective radius arm about the kingpin axis at which the cylinder force is applied. The effective radius is the minimum 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%.

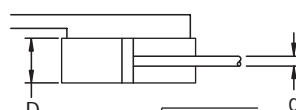
Cylinder Diameter

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

D = Inside diameter of cylinder.

d = Rod diameter as required.

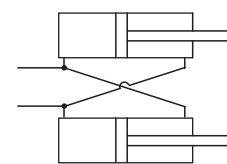
Differential Cylinder



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

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

Cross Connected Cylinder



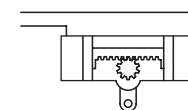
$$D = \sqrt{\frac{2A}{\pi} + \frac{d^2}{2}}$$

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)

$$V = S \times \frac{\pi}{4} (D^2 - d^2)$$

Cross Connected Cylinder

$$V = S \times \frac{\pi}{4} (2D^2 - d^2)$$

Cylinder Volume

$$V = \text{Volume} \quad V = S \times A$$

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

Sizing and Application

Ackermann Type Steering Continued

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.

$$Q_p = R_{\text{max.}} \times \text{displ.}$$

Q_p (L/min): Required pump flow.

R_{max} = 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 R_{max} .

- 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

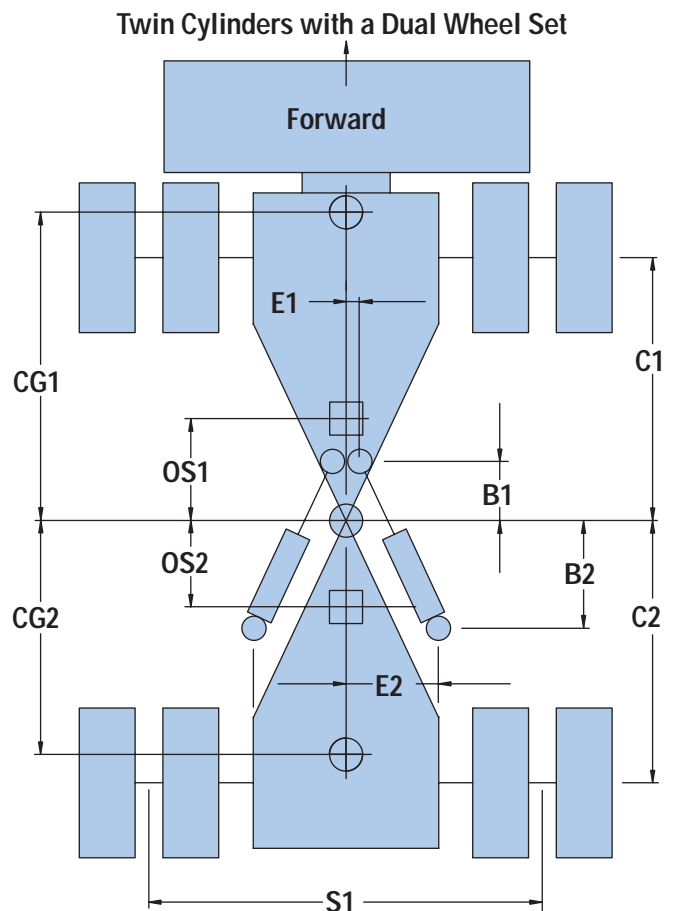
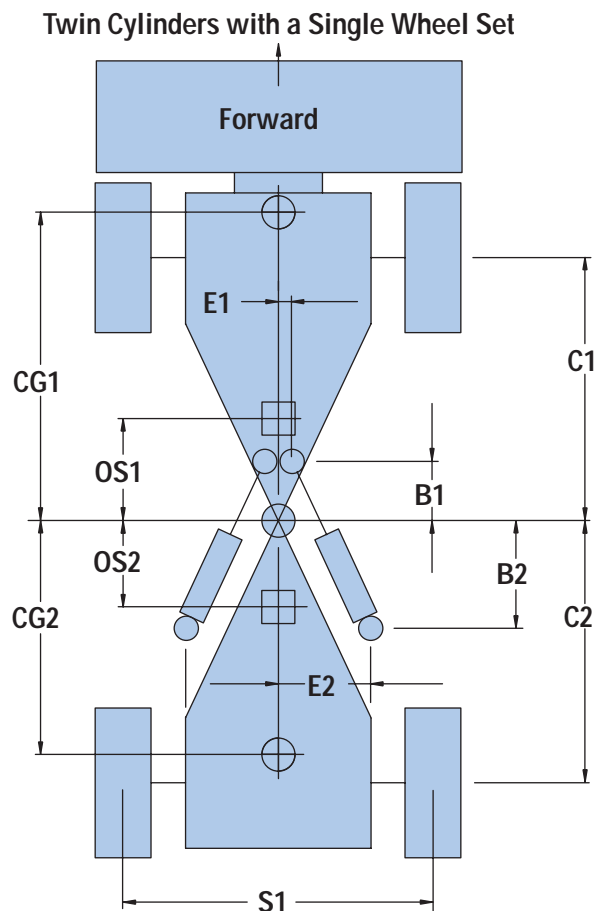
Eaton's Hydraulic Division has developed a computer program to assist articulated vehicle designers with a steering system analysis. This analysis can provide basic system sizing, pressure requirements or a complete system analysis including dynamic characteristics.

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 or send it to:

Marketing Product Manager—Steering
Eaton Hydraulics
14615 Lone Oak Rd.
Eden Prairie, MN 55344



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 _____ | 22. Articulation Angle (lock to lock) _____ |
| 2. Time Lock to Lock _____ | 23. Steering Circuit Line Size, Lengths, Type, Location (please note on schematic ref. 10.) _____ |
| 3. Max. Steering Wheel RPM _____ | 24. Is Steering Through Brakes Statically Required? _____ |
| 4. Cylinder Rod Diameter _____ | 25. Are Locking Differentials Used? Front _____ Rear _____ Both _____ |
| 5. Cylinder Bore Diameter _____ | 26. Is There A Differential Between the Front and Rear Differentials? Yes _____ No _____ |
| 6. Cylinder Stroke _____ | 27. CG1 (Center of Gravity) _____ |
| 7. Pump: GPM Hi Idle _____ | 28. CG2 (Center of Gravity) _____ |
| GPM Lo Idle _____ | 29. OS1 (Operator Seat) _____ |
| 8. Steering Relief Pressure _____ | 30. OS2 (Operator Seat) _____ |
| 9. Auxiliary Relief Pressure _____ | 31. Weight - Front Bogey _____ |
| 10. Hydraulic Schematic (attach) _____ | 32. Weight - Rear Bogey _____ |
| 11. B1 _____ | 33. I1 Mass Moment of Inertia (about CG1) Front _____ |
| 12. B2 _____ | 34. I2 Mass Moment of Inertia (about CG2) Rear _____ |
| 13. C1 _____ | 35. Tire Size _____ Pressure _____ |
| 14. C2 _____ | Width _____ Ballast _____ |
| 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 _____ | |

Note:

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

1-26 Needed for sizing and an analysis of steering pressure characteristics.

1-35 Needed for a full steering system analysis including dynamic characteristics.

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