



Literature Referenced in this Catalog:

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

Description and Advantages

Steering Control Units

The Danfoss 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 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

Danfoss 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.

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

Danfoss 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.

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

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

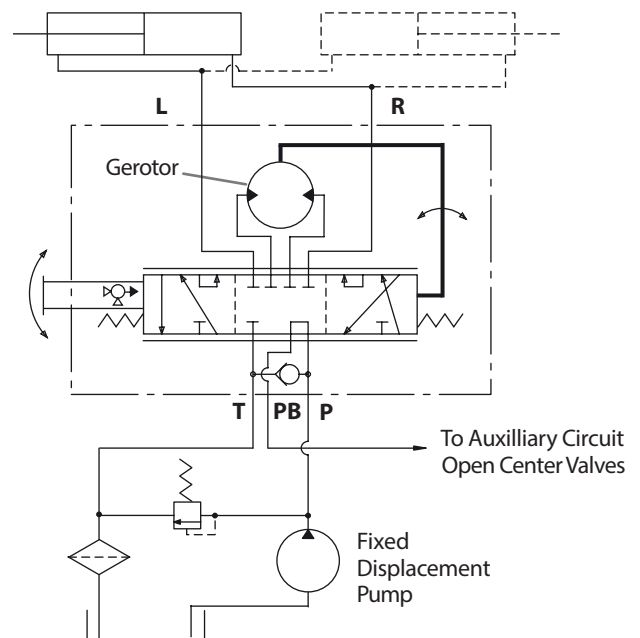
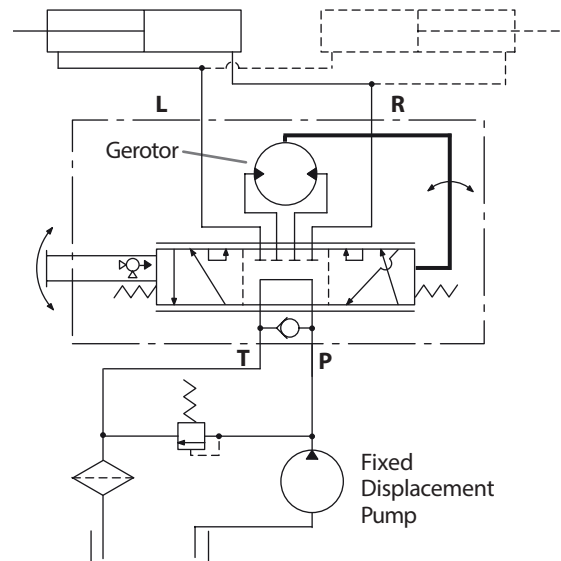
The power beyond steering control unit supplies steering and auxiliary valve functions. The power beyond unit is used on medium pressure, open center (fixed displacement pump) systems. When not steering, the power beyond unit directs all inlet flow to the auxiliary circuit. However, once steering is 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

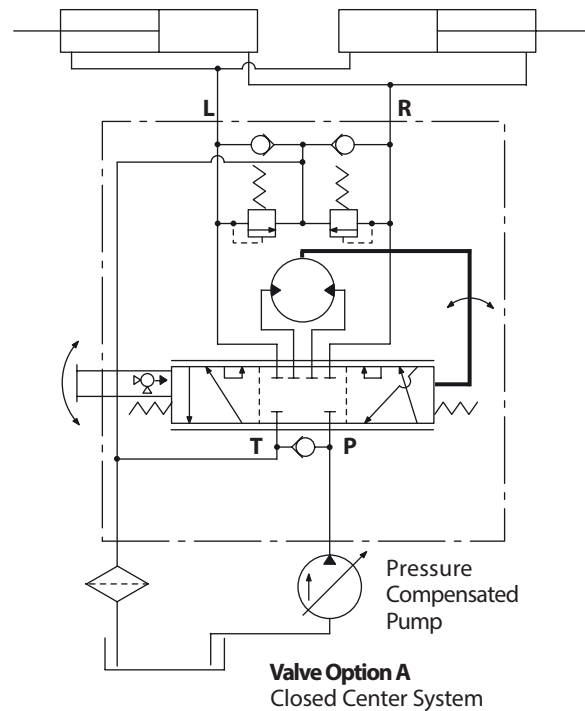


Hydraulic Circuit Explanation

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

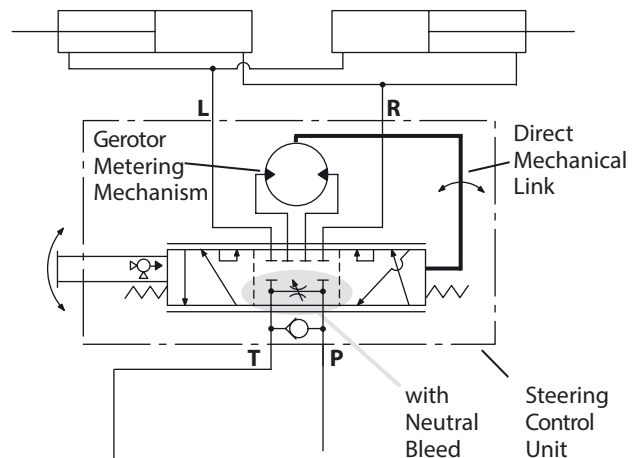
Closed Center Steering Control Units are available with and without neutral bleed feature. Most applications may not require the bleed feature, however, the maximum temperature differential between components within the steering circuit must not exceed specification (50° F or 28° C). Order unit with 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



Hydraulic Circuit Explanation

Neutral Circuits: Load Sensing

Load Sensing Circuits

Danfoss 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.

Danfoss 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.

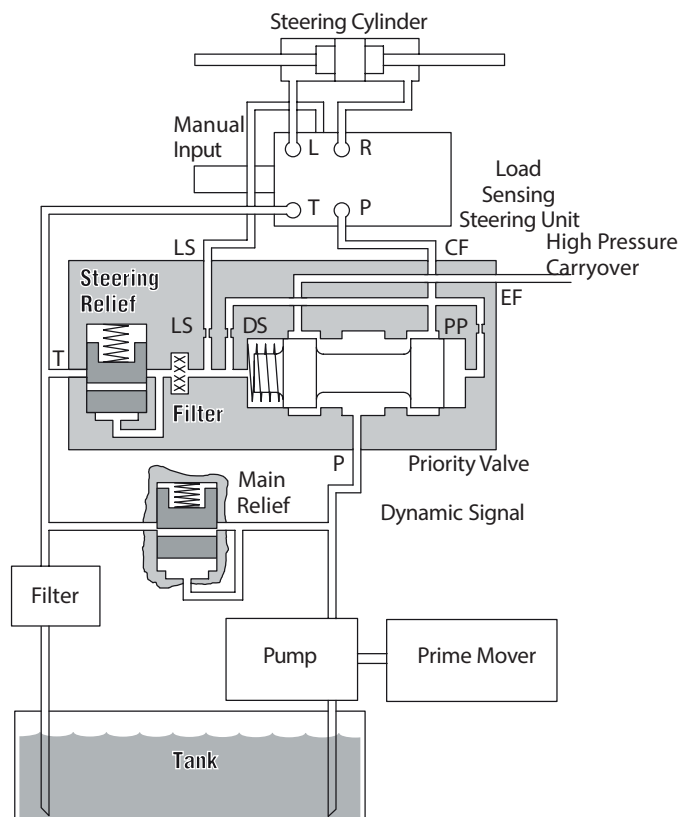
Priority Valve—Sized for design pressure drop at maximum pump output flow rate and priority flow requirements. The minimum control pressure must assure adequate steering flow rate and must be matched with the steering control unit. A dynamic signal priority valve must be used with a dynamic signal steering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

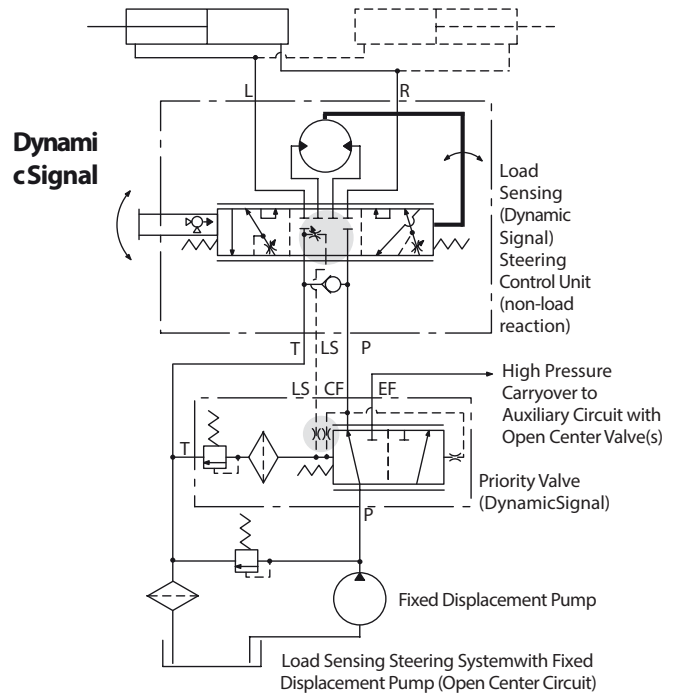
Load Sensing Circuits—Signal Systems

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

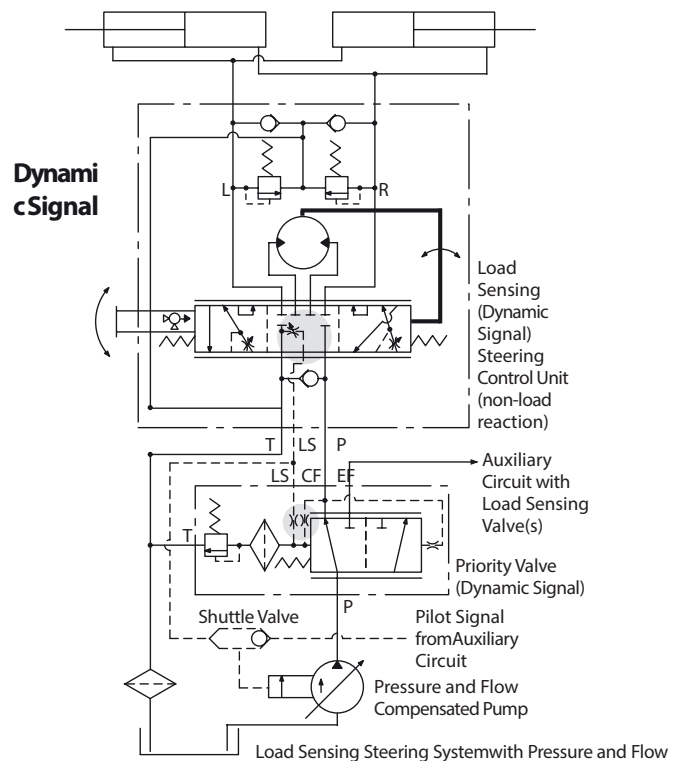
Dynamic Signal—Used for more difficult applications. The dynamic signal systems offer the following benefits:

- 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



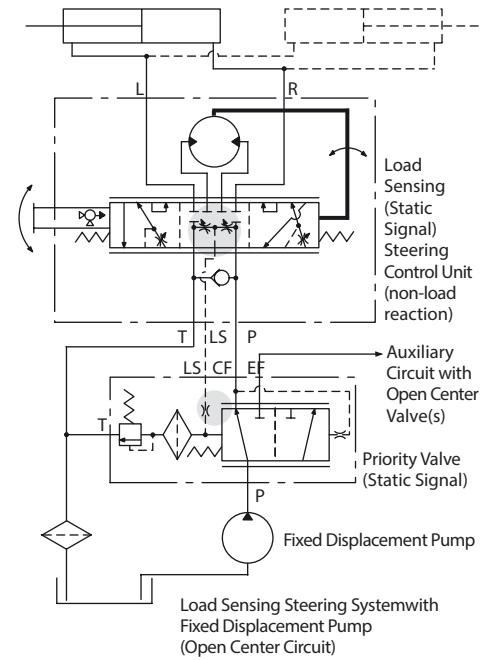
Hydraulic Circuit Explanation

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

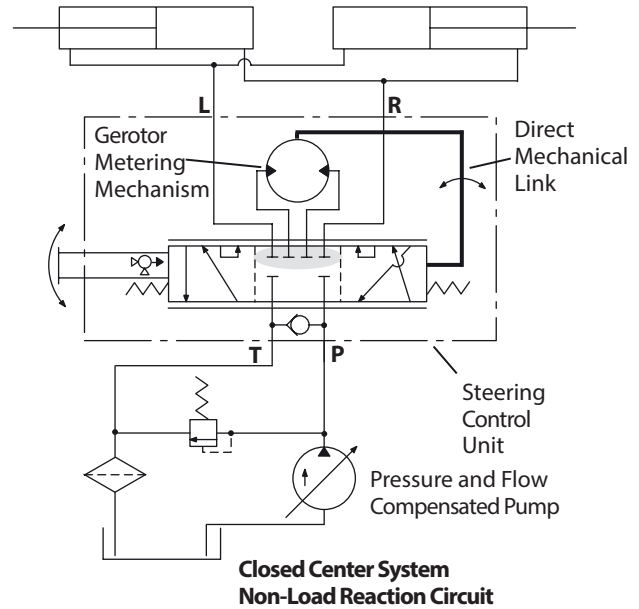


Hydraulic Circuit Explanation

Work Circuits: Non-Load Reaction and Load Reaction

Non-Load Reaction

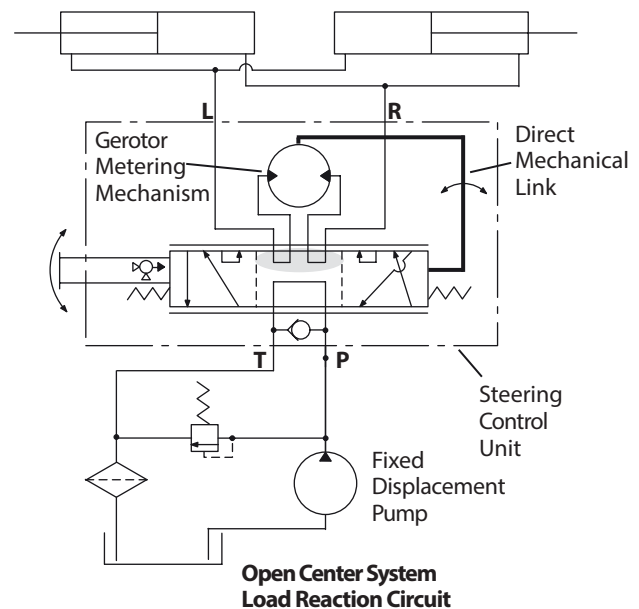
A non-load reaction steering unit blocks the cylinder ports in neutral, holding the axle position whenever the operator releases the steering wheel.



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.**



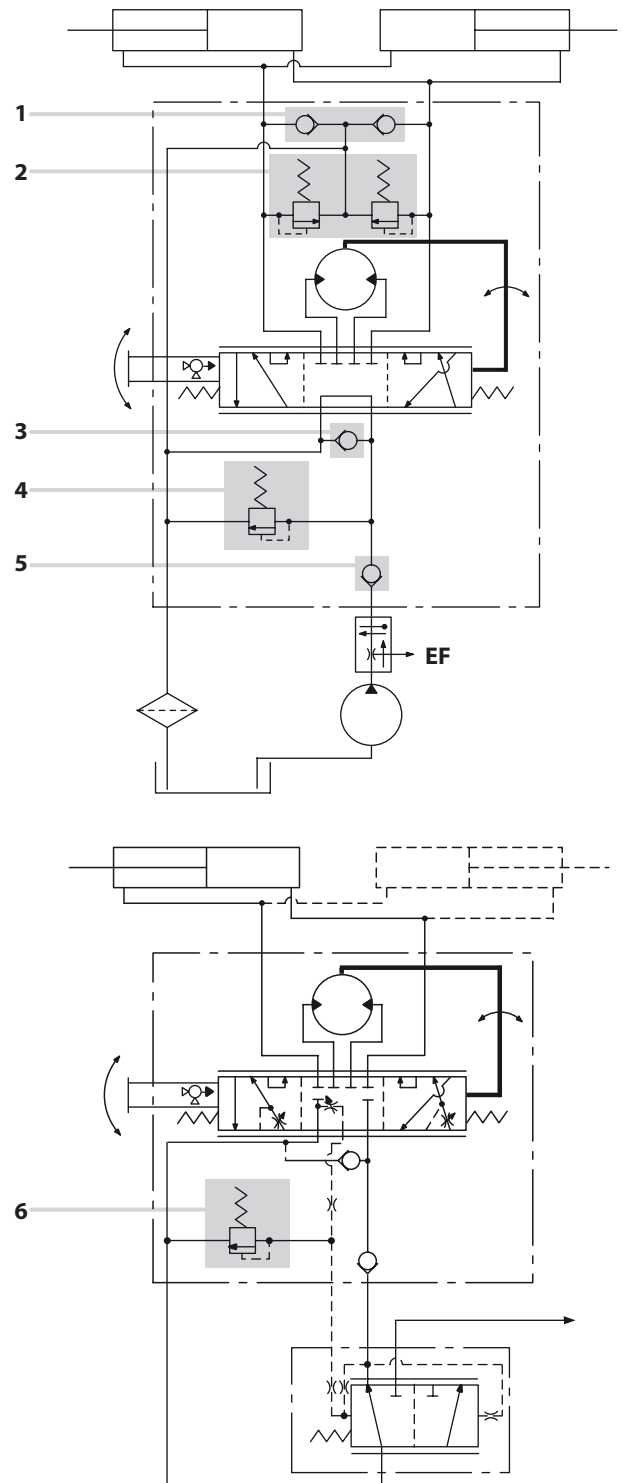
Steering Units with Integral Valves

Integral valves are available for the Danfoss 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 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

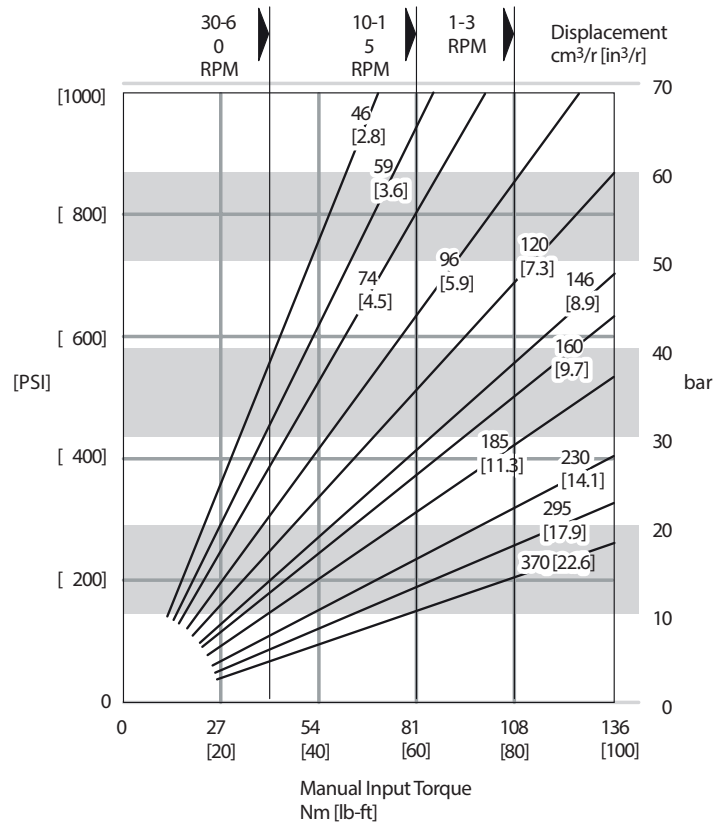
Description

The steering control unit can provide steering flow when the pump or engine fails. It will pump oil through the meter (generator) 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 perform 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.

Danfoss Technologies

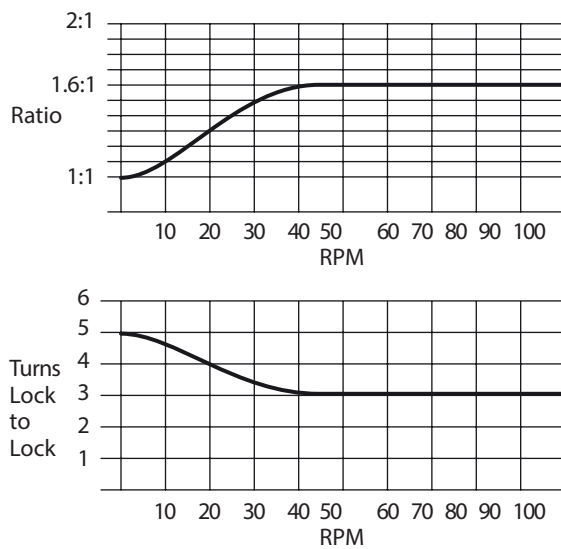
Q-Amp (Flow Amplification) for Load Sensing Circuits

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.)

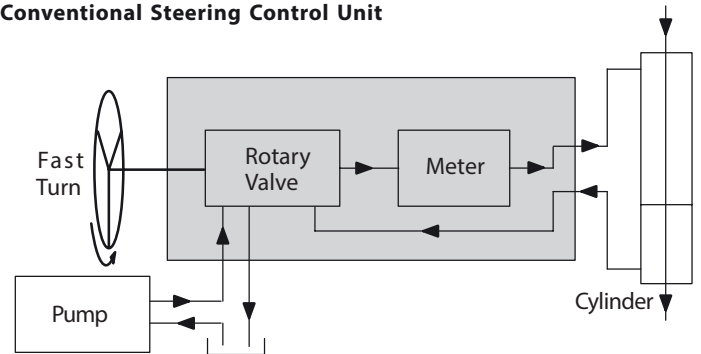
Features

- Variable Ratio

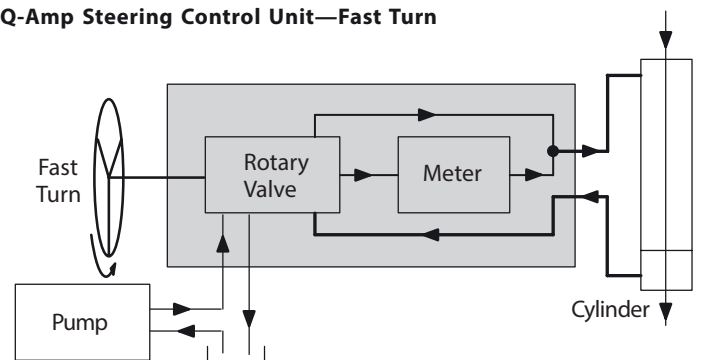


- Manual Steering
Steering a vehicle with loss of engine power may not be possible with a large displacement steering control unit (SCU). Q-Amp with manual feature has the smaller displacement required for manual steering and has the additional flow requirement of the larger displacement SCU for power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

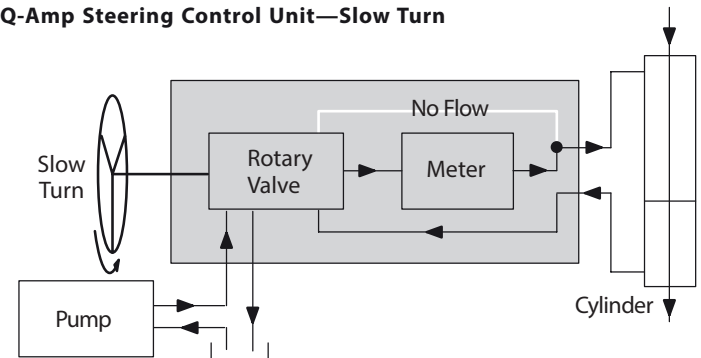
Conventional Steering Control Unit



Q-Amp Steering Control Unit—Fast Turn



Q-Amp Steering Control Unit—Slow Turn



Danfoss 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

Danfoss Technologies

Wide Angle

Description

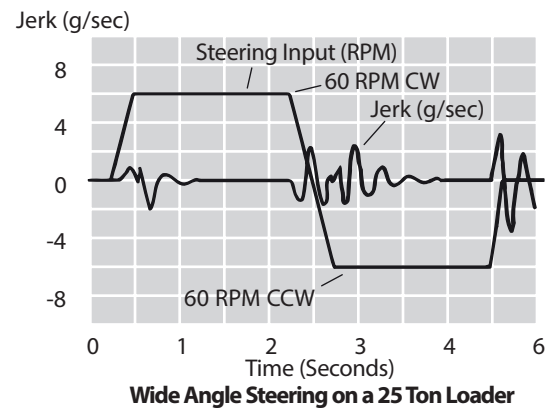
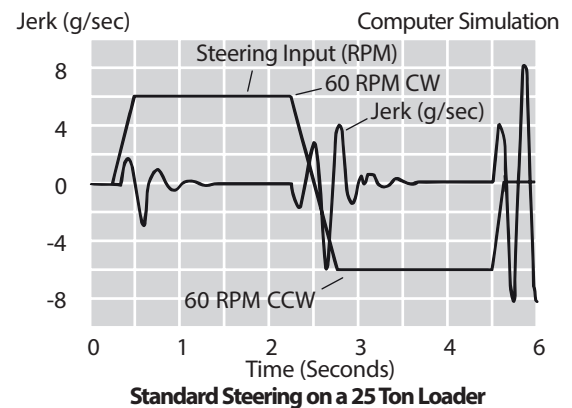
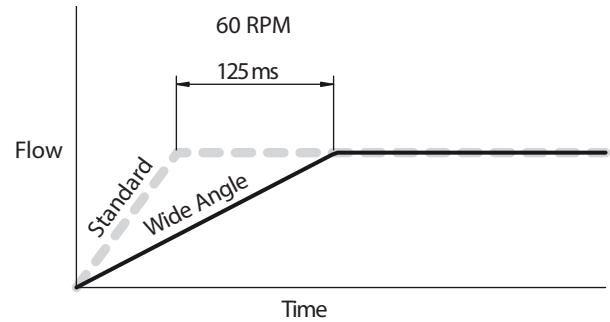
Steering units with wide angle features have been developed to significantly reduce or eliminate the jerky motion of vehicles with articulated steering systems. This has been accomplished by increasing the maximum deflection of the spool relative to the sleeve. Increasing the deflection reduces the gain. 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 Series25.
- 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.

Danfoss Technologies

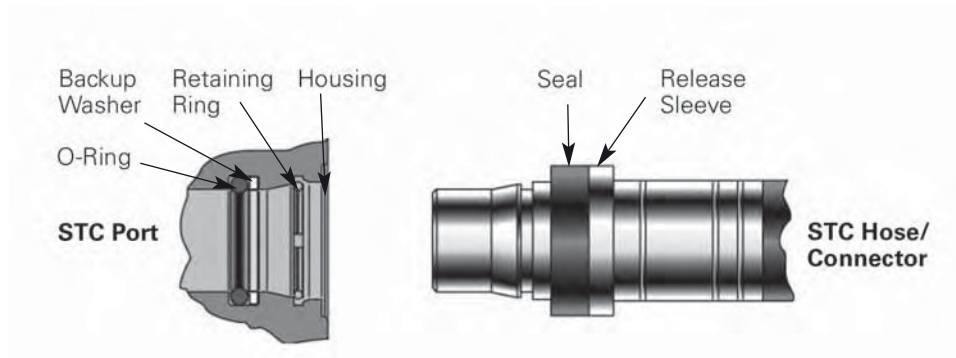
STC Direct Porting

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 porting technology provides leak-proof sealing and has operating pressure capability exceeding 4500PSI (310bar).

STC Direct Porting is available with Series5 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.

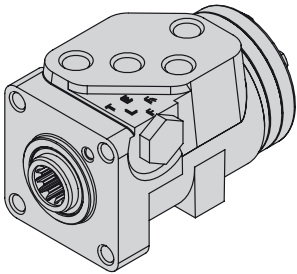
Power Beyond Models—Optional power beyond steering control units supply steering and flow to auxiliary valve functions. The power beyond unit is used in open center (fixed displacement pump) systems in the medium pressure range. When not steering, the power beyond unit directs all inlet flow to the excess 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

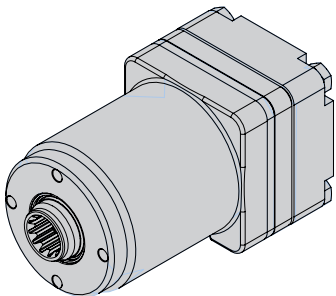
- Open Center
- Load Sensing
- Open Center
- Power Beyond Integral Column
- Manual Steering Check Valve
- Inlet Relief Valve
- Load Sense Relief Valve
- Cylinder Relief Valve
- Anti-Cavitation Valve

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 26



Option 2: Round Housing with End Ports
refer to Model Code, page 27

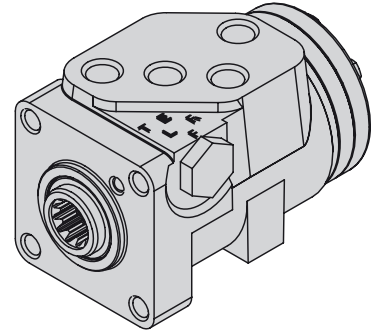
SPECIFICATIONS	
Max. System Pressure	140 bar [2030 PSI]
Max. Back Pressure	21 bar [300 PSI]
Max. Flow	19 l/min [5 GPM]
Max. Differential Between Steering Unit and System Temperature	28° C 50° F
Max.System Operating Temperature	93°C [200° F]
Input Torque	
Powered -Standard	1,7 - 2,8 Nm @ 6,9 bar tank 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			O		A								A	O			1	O			B
----------	----------	----------	--	----------	----------	--	--	----------	--	----------	--	--	--	--	--	--	--	----------	----------	--	--	----------	----------	--	--	----------

Nos	Feature	Code	Description
1,2,3	Product Series	ABR	Series 5 Steering Control Unit
4	Nominal Flow Rating	1 B	11 l/min [3 GPM] 19 l/min [5 GPM]
5	Inlet Pressure Rating	C	140 bar [2030 PSI]
6	Tank Pressure Rating	A B	10 bar [150 PSI] 21 bar [300 PSI]
7-8	Displacement	35 37 39 41 43 46 48	31.5 cm ³ /r [1.92 in ³ /r] 39.5 cm ³ /r [2.41 in ³ /r] 50.8 cm ³ /r [3.10 in ³ /r] 63.1 cm ³ /r [3.85 in ³ /r] 73.8 cm ³ /r [4.50 in ³ /r] 100 cm ³ /r [6.10 in ³ /r] 120 cm ³ /r [7.33 in ³ /r]
9	Flow Amplification	0	None
10	Neutral Circuit	A B F	Open Center Open Center, Power Beyond Load Sensing, Dynamic signal
11	Load Circuit	A	Non-Load Reaction
12,13	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
14,15	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]
16,17	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]

Nos	Feature	Code	Description
18,19,20,	Ports and Mounting Threads	4AAN 4AKN 4AEN UAAN UBNN UBPN YAAN YBRN	Square 4 x 9/16 SAE Ports, M10 x 1,5 Column Mounting Threads (Use with Open Center) Square 5 x 9/16 SAE Ports, M10 x 1,5 Column Mounting Threads (Use with Excess Flow) Square 5 x 9/16 SAE Ports, M10 x 1,5 Column Mounting Threads (Use with Load Sense) Square 4 x -06 STC Direct Ports, M10 x 1,5 Column Mounting Threads (Use with Open Center) Square 5 x -06 STC Direct Ports, M10 x 1,5 Column Mounting Threads (Use with Excess Flow) Square 5 x -06 STC Direct Ports, M10 x 1,5 Column Mounting Threads (Use with Load Sense) Square 4 x G .375 BSP Straight Thd. Ports, M10 x 1,5 Column Mounting Threads (Use with Open Center) Square 5 x G .375 BSP Striaight Thd. Ports, M10 x 1,5 Column Mounting Threads (Use with Load Sense)
22	Input Torque	1 3	Low* Standard
23	Fluid Type	A	See Danfoss Technical Bulletin 3-401
24	Special Application	0	None
25,26	Special Feature	AA	None
27	Paint	1	Black Primer
28	Identification	0	Danfoss Product Number on Nameplate
29	Mechanical Interface	A D	Tapered 17.919mm (.7055in) diameter, .083:1 and serrated 17.5 (.688) diameter, 40 tooth, M16x1.5-6g, Extension length 65.02 (2.56) Internal involute spline 12 tooth, 16/32 DP, 30 degree PA
30	Danfoss Assigned Design Code	B	Assigned Design Code

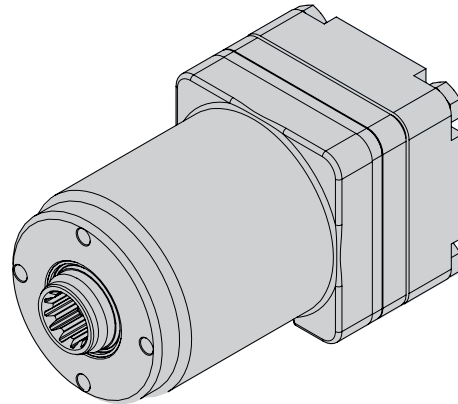
* All low torque units need approval from a Danfoss Steering Engineer.

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						O	O							A	O			1	O	B

Nos	Feature	Code	Description
1,2,3	Product Series	ABR	Series 5 Steering Control Unit
4	Nominal Flow Rating	1 B	11 l/min [3 GPM] 19 l/min [5 GPM]
5	Inlet Pressure Rating	C	140 bar [2030 PSI]
6	Tank Pressure Rating	A	10 bar [150 PSI]
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]
9	Flow Amplification	0	None
10	Neutral Circuit	A B C F	Open Center Open Center, Power Beyond Closed Center Load Sensing, Dynamic signal
11	Load Circuit	A	Non-Load Reaction
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.
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]
16,17	Cylinder Relief Setting	00	None

Nos	Feature	Code	Description
18,19, 20, 21	Ports and Mounting Threads	VAAH VAKH VAEH WAAH WBNH	Round 4 x 9/16 SAE Ports, M6 x 1,0 Column Mounting Threads (Use with Open Center) Round 5 x 9/16 SAE Ports, M6 x 1,0 Column Mounting Threads (Use with Excess Flow) Round 5 x 9/16 SAE Ports, M6 x 1,0 Column Mounting Round 4 x -06 STC Direct Ports, M6 x 1,0 Column Mounting Threads (Use with Open Center) Round 5 x -06 STC Direct Ports, M6 x 1,0 Column Mounting Threads (Use with Excess Flow)
		WBPH	Round 5 x -06 STC Direct Ports, M6 x 1,0 Column Mounting Threads (Use with Load Sense)
22	Input Torque	1 3	Low* Standard
23	Fluid Type	A	See Danfoss Technical Bulletin
24	Special Application	0	None
25,26	Special Feature	AA	None
27	Paint	1	Black Primer
28	Identification	0	Danfoss Product Number on Nameplate
29	Mechanical Interface	A	Tapered 17.919mm (.7055in) diameter, .083:1 and serrated 17.5 (.688) diameter, 40 tooth, M16x1.5-6g, Extension length 65.02 (2.56)
		D	Internal involute spline 12 tooth, 16/32 DP, 30 degree PA
30	Danfoss Assigned Design Code	B	Assigned Design Code

* All low torque units need approval from a Danfoss Steering Engineer.

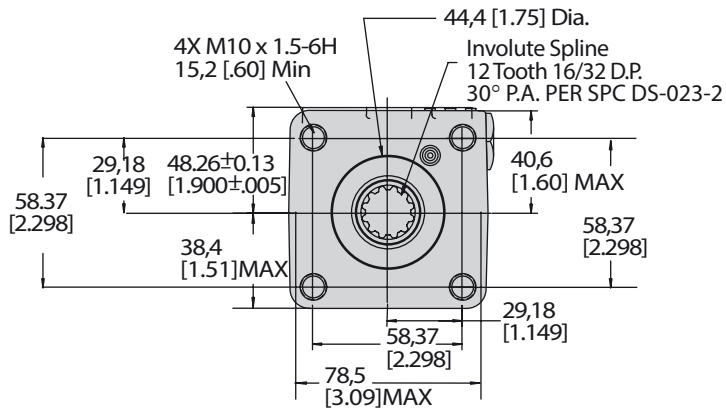
** Plug-O ports rated to 103 bar [1500PSI]

Steering Control Units—Series 5

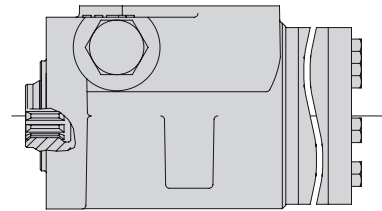
Installation Drawing

Option 1: Square Housing with Side Ports

refer to Model Code, page 26

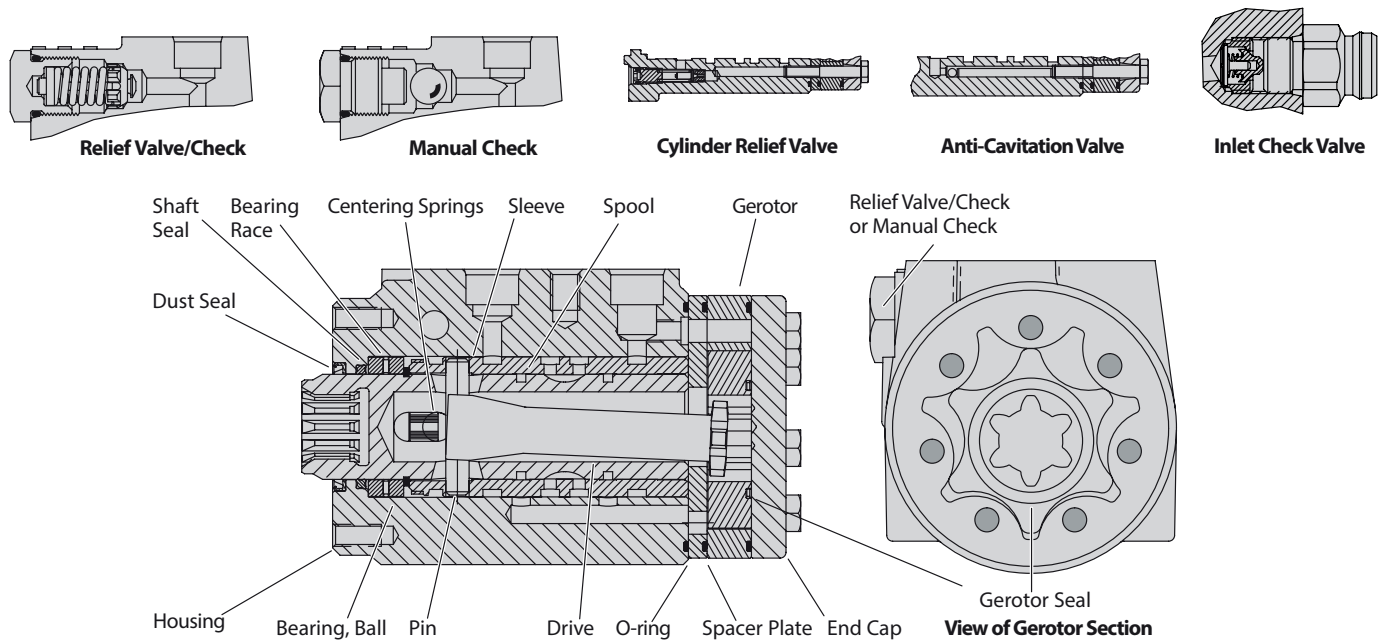


Side View



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]

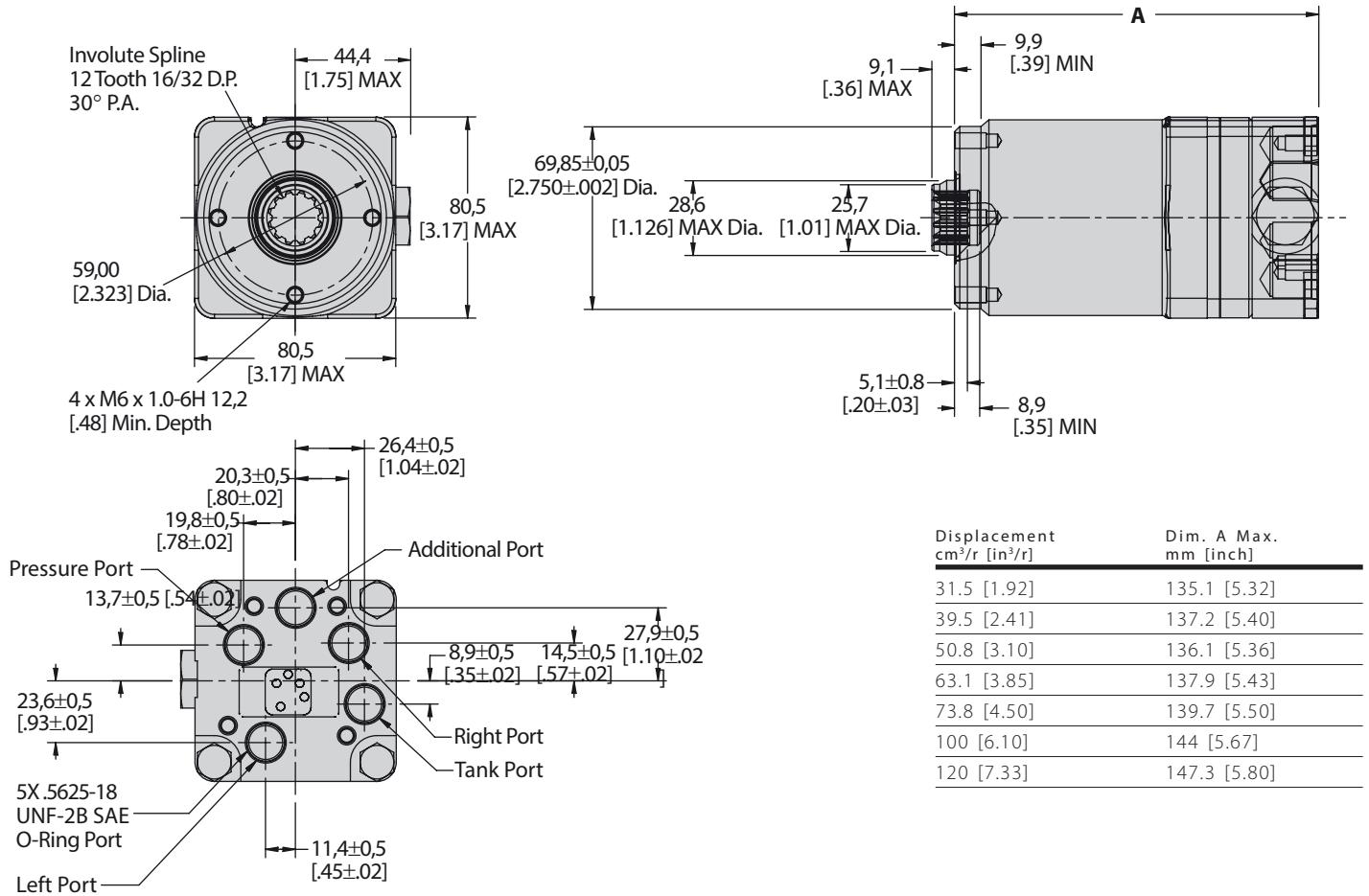
Sectional Drawing



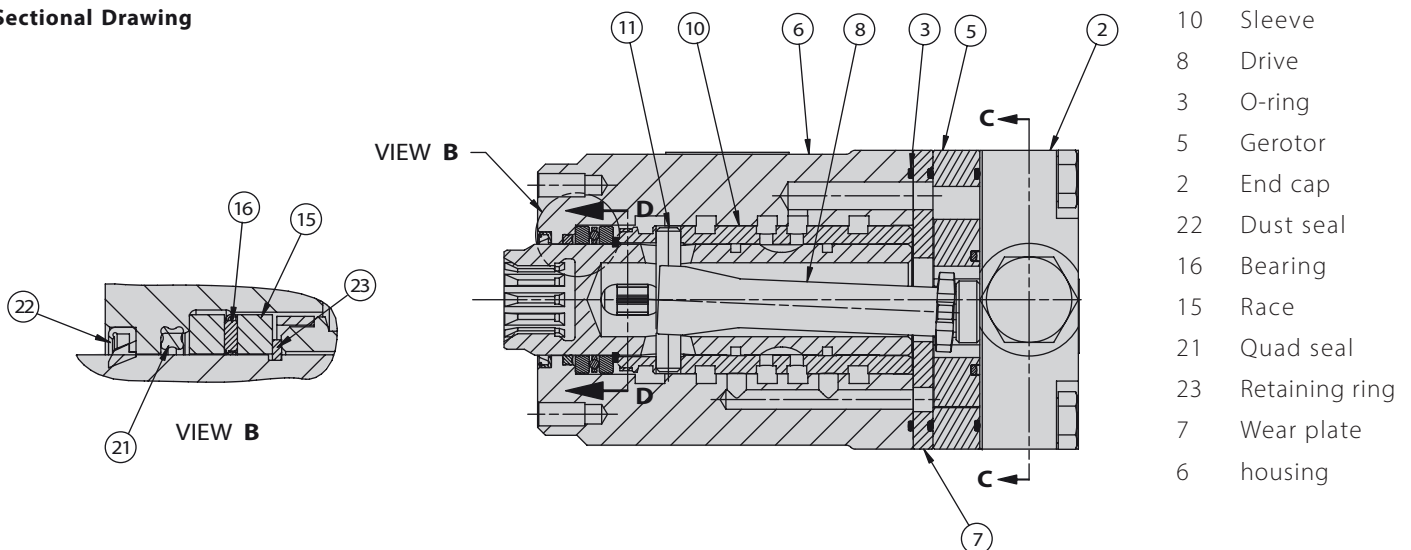
Steering Control Units—Series 5

Installation Drawing

Option 2: Round Housing with End Ports



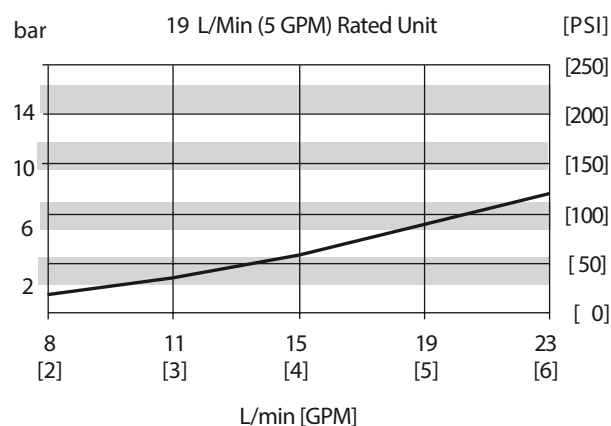
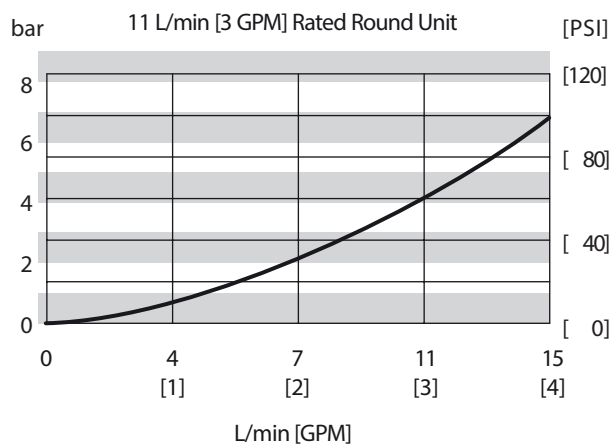
Sectional Drawing



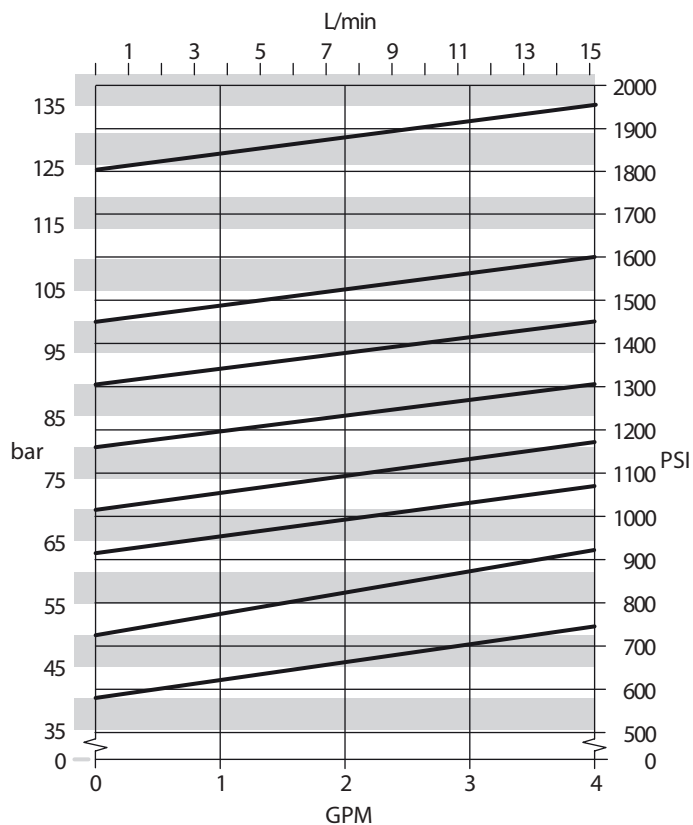
Steering Control Units—Series 5

Performance Data

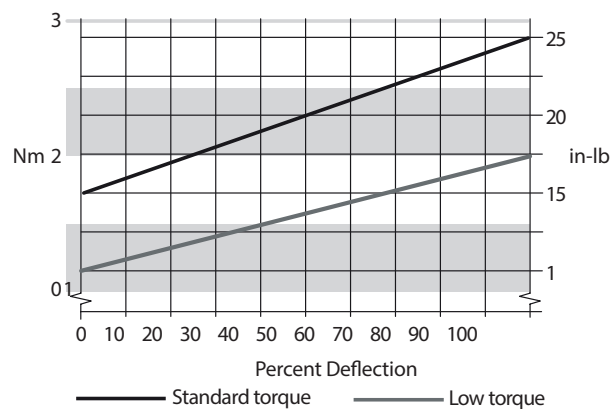
Neutral Pressure Drop Inlet to Auxiliary



Relief Valve Curve



Input Torque Curve

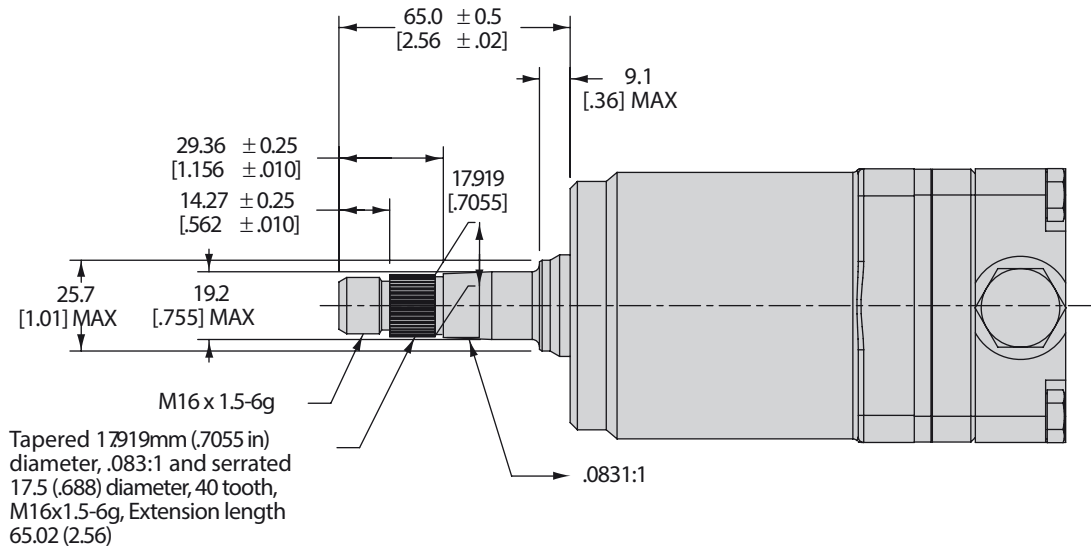


Steering Control Units—Series 5

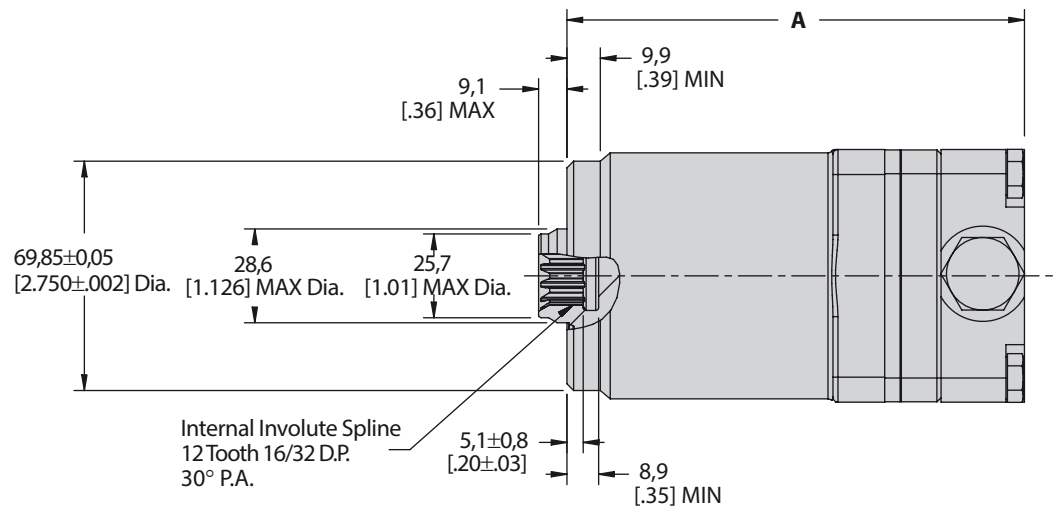
Integral Column Option

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

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



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



Steering Control Units—Series 25

Product Description

The Series 25 SCU includes two 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

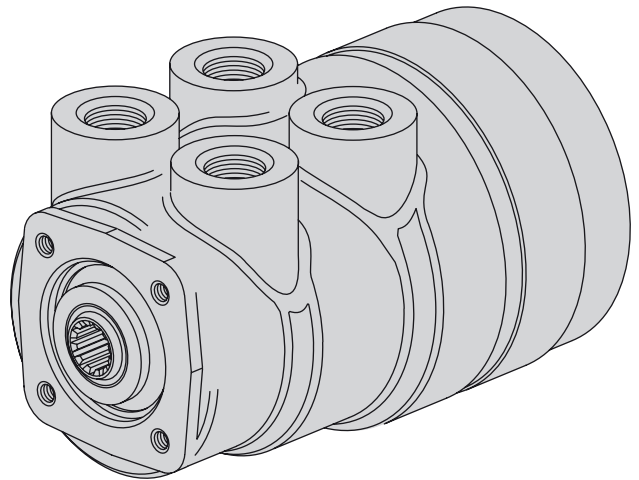
- Loaders
- Scrapers
- Skidders
- AG Tractors

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.
- Danfoss' **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

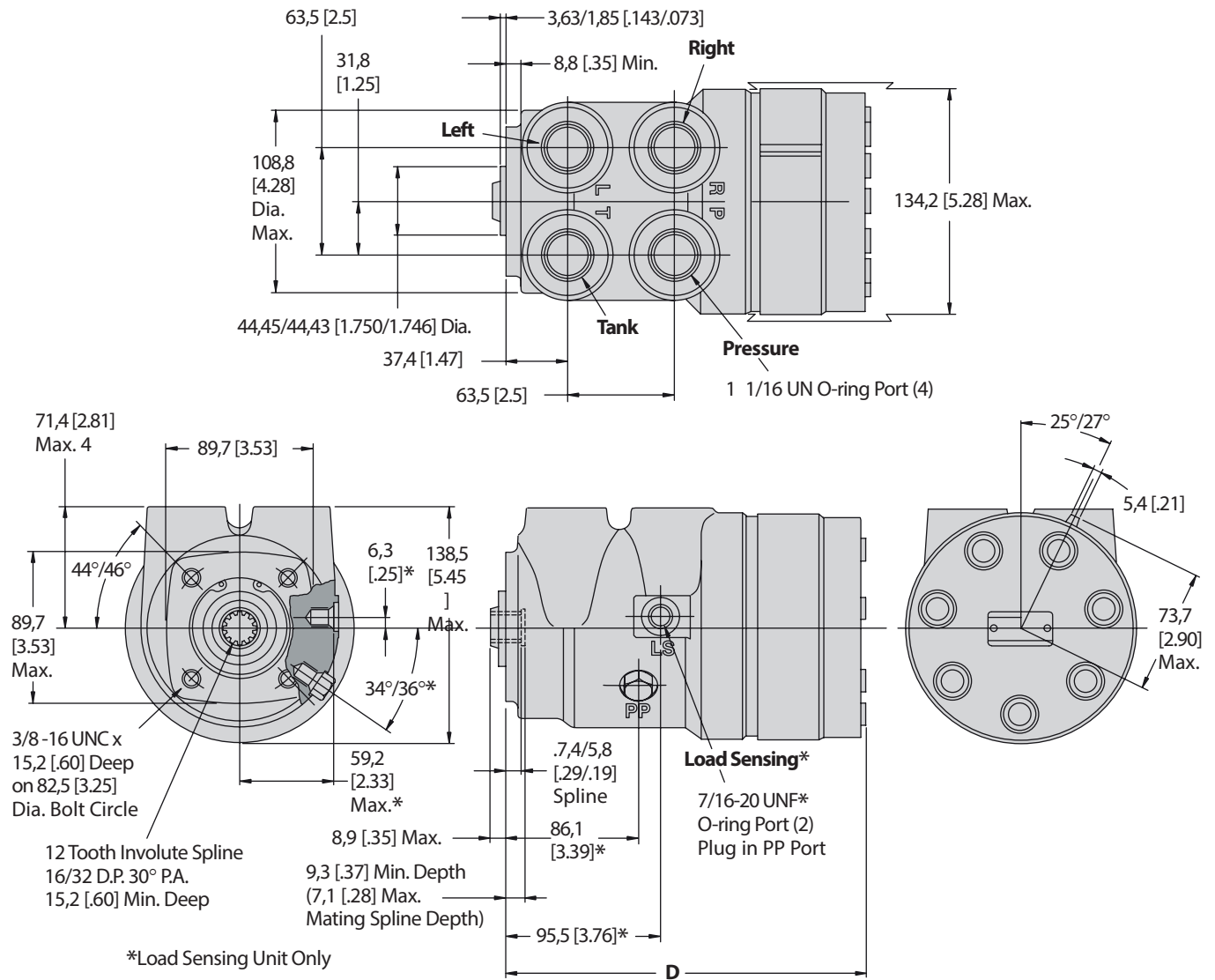
The following 29-digit coding system has been developed to identify all of the configuration options for the Series 25 steering control units. Use this model code to specify a unit with the desired features. All 29 digits of the code must be present when ordering. You may want to photocopy the matrix 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
1,2,3	Product Series	ABW	Series 25 Steering Control Unit
4	Nominal Flow Rating	7 8 E	95 l/min [25 GPM] 151 l/min [40 GPM] (Q-amp only) 189 l/min [50 GPM] (Q-amp only)
5	Inlet Pressure Rating	6	241 bar [3500 PSI]
6	Return Pressure Rating	A	10 bar [150 PSI]
7-8	Displacement cm ³ /r [in ³ /r]	62 65 67 69 71	490 [30] 625 [38] 795 [48] 985 [60] 1230 [75]
9	Flow Amplification	0 1	None 1.6 : 1.0 Ratio
10	Neutral Circuit	A C D F	Open Center Closed Center Closed Center with Neutral Bleed Load Sensing, Dynamic Signal
11	Load Circuit	A D	Non-Load Reaction Non-Load-Reaction, Cylinder Damping (Use with Flow Amp and Wide Angle Only)
12,13	Valve Options	00 02 21	None Anti-Cavitation Valve Anti-Cavitation Valve, Cylinder Relief Valves
14, 15	Load Sense Relief Valve Setting	00	None
16,17	Cylinder Relief Valve Setting	00	None
	Valve Setting	6F	207 bar [3000 PSI]
**Cylinder Relief Setting recommendation is 870 PSI (60 bar) above steering inlet/load sense pressure.		70 7H 83 8L 95	224 bar [3250 PSI] 241 bar [3500 PSI] 259 bar [3760 PSI] 276 bar [4000 PSI] 293 bar [4250 PSI]

Nos	Feature	Code	Description
18,19, 20, 21	Ports and Mounting Threads	EAAA EAGA	4 x 1—1/6 Ports with 3/8-16 UNC Column Mounting 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)
		NBDN	4 x M27 with M12—LS and M12 PP (Capped) M10 Mounting Threads (Use with Load Sensing Units Only)
		NAAN	4 x M27 with M10 Mounting Threads
22	Input Torque	3	Standard
23	Fluid Type	A	See Danfoss Technical Bulletin 3-401
24	Special Applications	0 1	None Wide Angle (Use with Load Sensing Units Only)
25, 26	Special Features AA		None
27	Paint	1	Black Paint
28	Identification	0	Danfoss Product Number on Nameplate
29	Danfoss Assigned D		Assigned Design Code Design Code

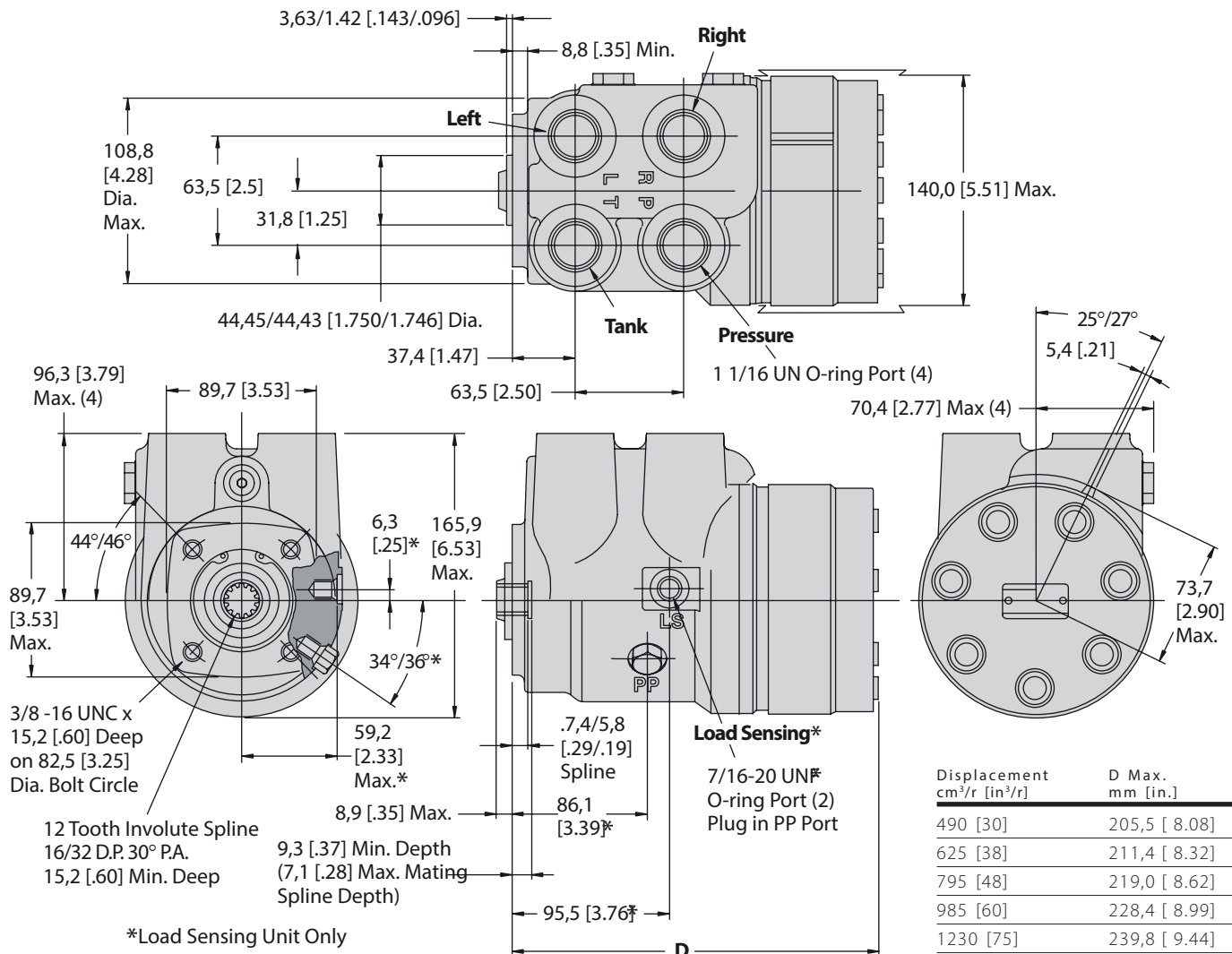
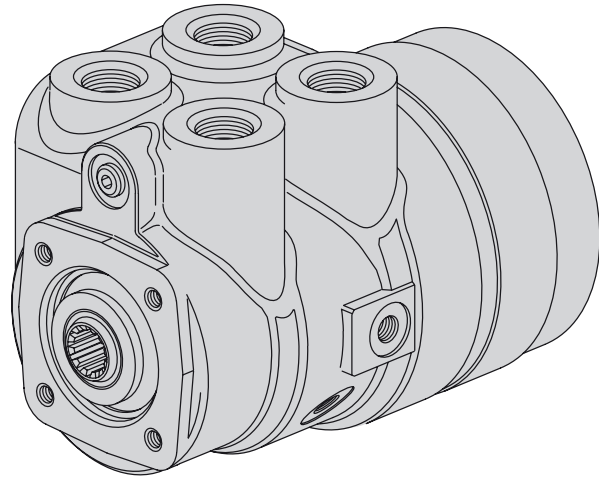
Installation Drawing



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

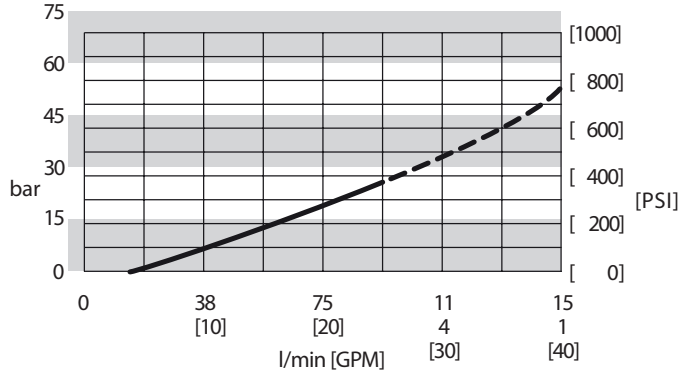
Installation Drawing with Cylinder Relief, Anti-Cavitation



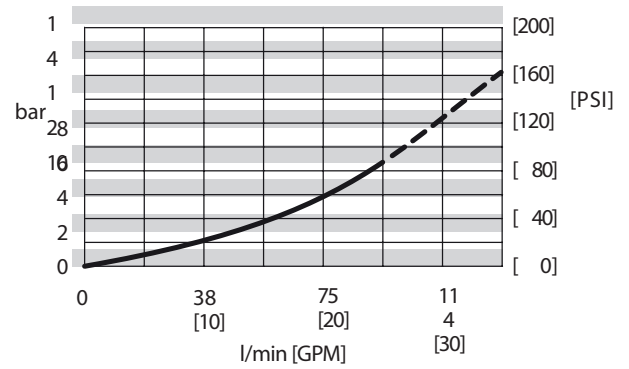
Steering Control Units—Series 25

Performance Data

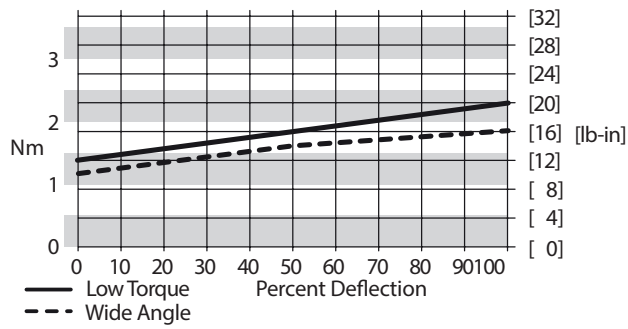
Average Pressure Drop at Full Valve Deflection



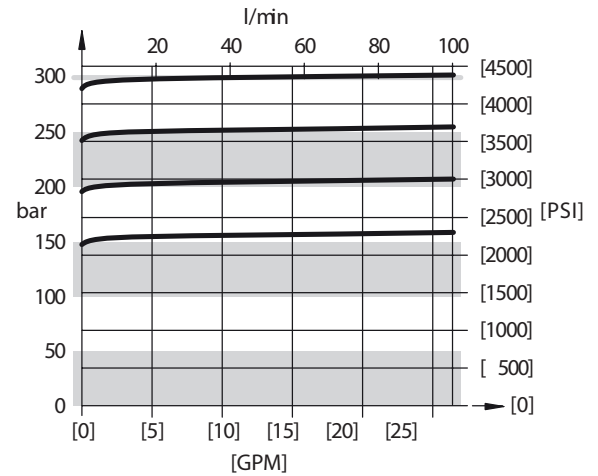
Neutral Pressure Drop - Open Center Fluid Viscosity 25 cSt [120 SUS]



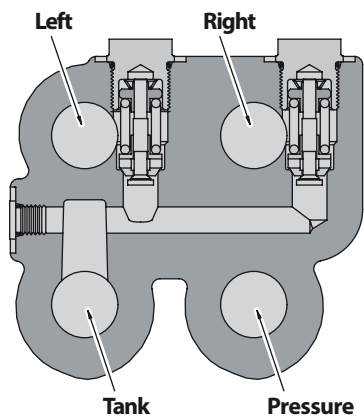
Input Torque



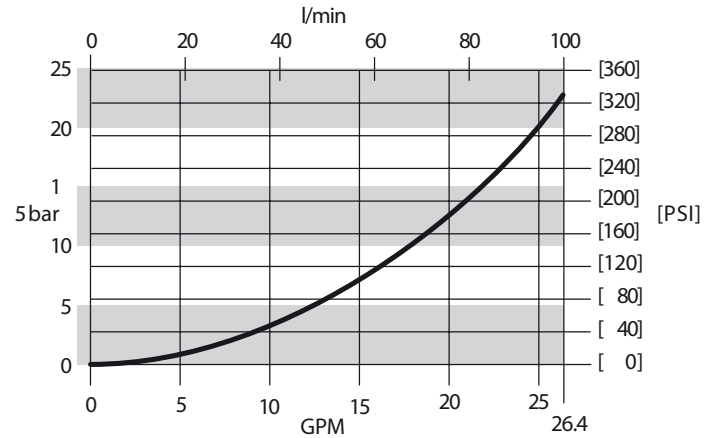
Pressure Relief Characteristics



SCU Valve Section



Check Valve Characteristics



Steering Control Units—Series 40

Product Description

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

Benefits

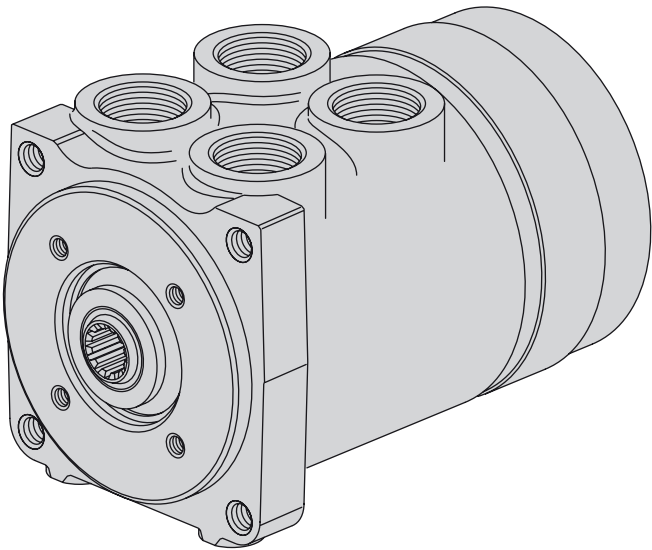
- Symmetrical valving provides passageways and valving that are equal in both directions and pressure areas that are staged for minimum leakage. This gives balance, precise servo response and uniform steering action in both directions.
- Progressive valving makes it possible to produce the spool/ sleeve valve in a way that assures reliability and reduces costs.
- Danfoss’ 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	28° C
and System Temperature	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.

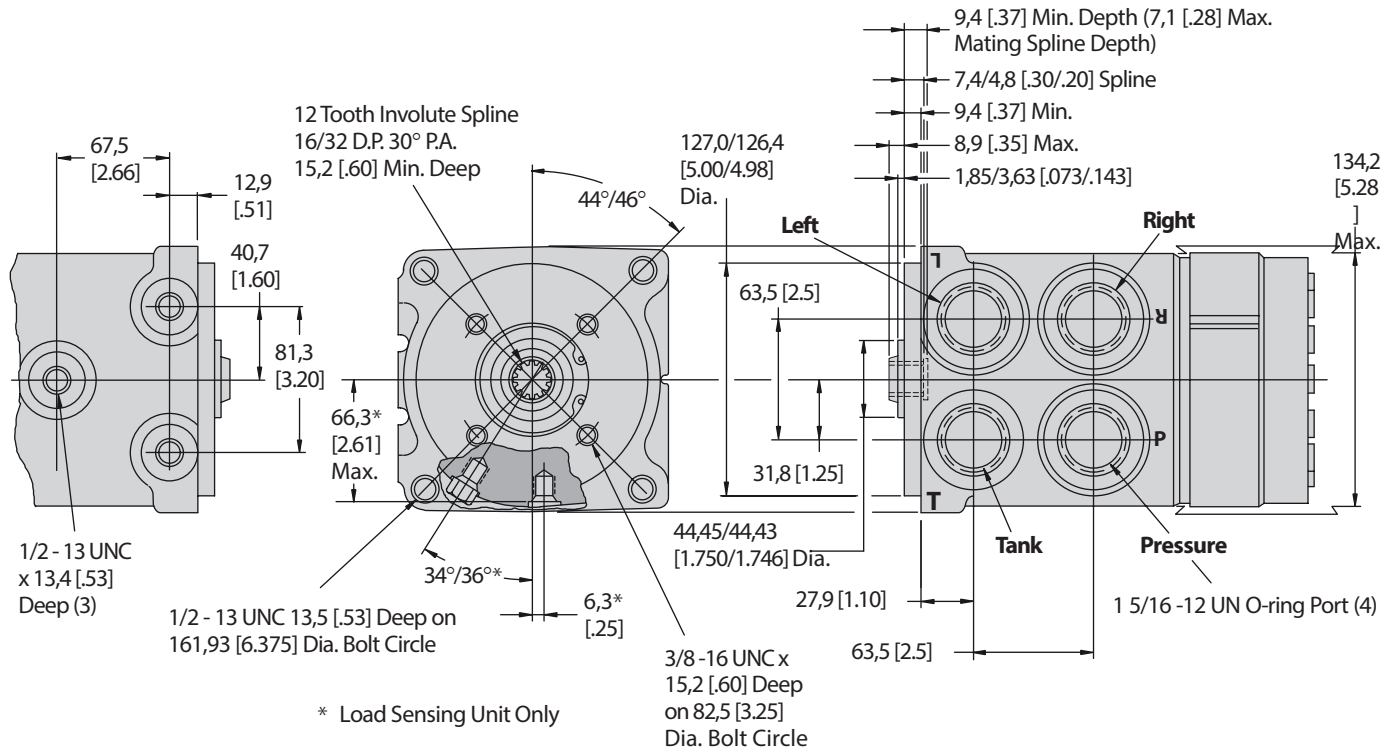
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
A	B	Y	6	B							0	0	0	0	0	0					3	A	0	A	A	0	0	C

Nos	Feature	Code	Description
1,2,3	Product Series	ABY	Series 40 Steering Control Unit
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]
6	Return Pressure Rating	B	21 bar [300 PSI]
7-8	Displacement cm ³ /r [in ³ /r]	71	1230 [75]
		74	1560 [95]
		76	1970 [120]
		78	2460 [150]
		80	3030 [185]
9	Flow Amplification	0	None
		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
		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

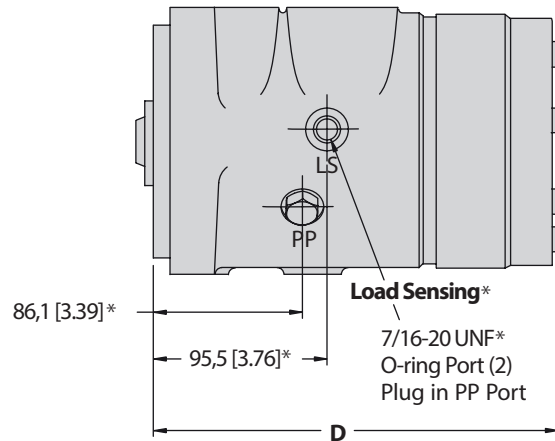
Nos	Feature	Code	Description
18,19, 20, 21	Ports and Mounting	GAAA	4 x 1 – 5/16 SAE Ports with 3/8-16 UNC Column Mounting Threads
		GAGA	4 x 1 – 5/16 SAE ports with 7/16 SAE Load Sensing Port and 7/16 SAE Pilot Pressure Port with 3/8-16 UNC Column Mounting Threads (Use with Load Sensing Only)
22	Input Torque	3	Standard
23	Fluid Type	A	See Danfoss Technical Bulletin 3-401
24	Special Applications	0	None
25,26	Special Features	AA	None
27	Paint	0	No Paint
28	Identification	0	Danfoss Product Number on Nameplate
29	Danfoss Assigned Design Code	C	Assigned Design Code

Steering Control Units—Series 40

Installation Drawing



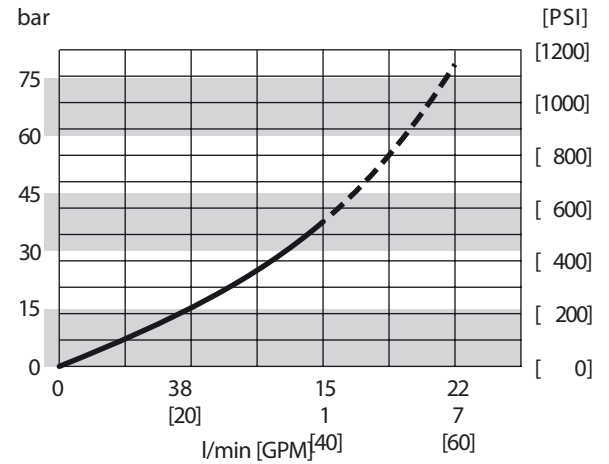
Displacement cm ³ /r [in ³ /r]	D Max. mm [in.]
1230 [75]	230,9 [9.09]
1555 [95]	245,9 [9.68]
1965 [120]	265,2 [10.44]
2460 [150]	288,3 [11.35]
3030 [185]	315,0 [12.40]



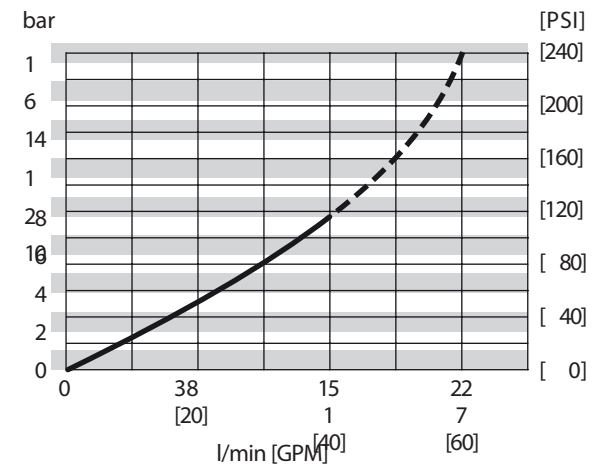
Steering Control Units—Series 40

Installation Drawing

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



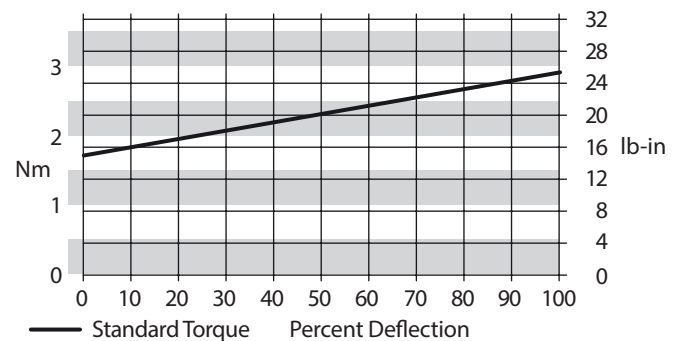
Open Center Neutral Pressure Drop
Fluid Viscosity 25 cSt [120 SUS]



Input Torque

Applications

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



Torque Generator

Product Description

Danfoss 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. Danfoss 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

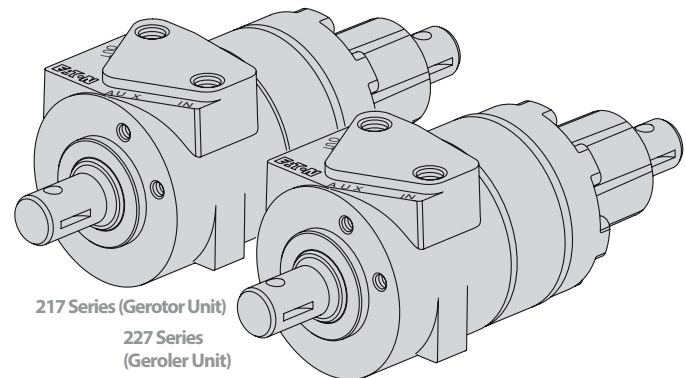
This version has three ports: Inlet (IN), Tank (OUT), and Excess Flow (EF). In the power beyond configuration, flow not used for priority steering exits the EF port and is available for the downstream reach function. Flow used for steering will exit the (OUT) port to tank, and cannot be used for auxiliary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

Load Sensing

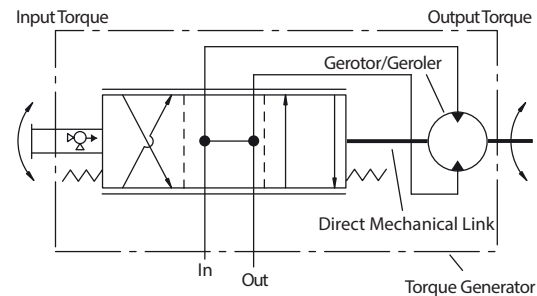
Danfoss load sensing torque generators use conventional or load sensing power supplies to achieve load sensing steering. The use of a load sensing torque generator and a priority valve in a normal power steering circuit offers the following advantages:

- 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.

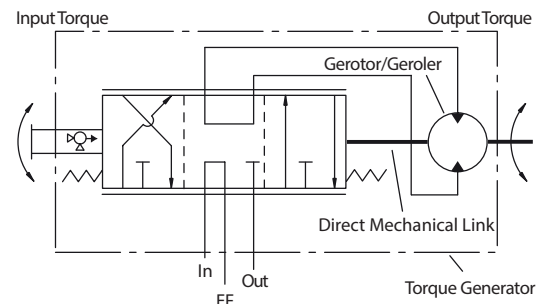
Danfoss load sensing torque generators and priority valves can be used with open center, closed center or load sensing systems. Used either in an open center system with a fixed displacement pump or a closed center system with a pressure compensated pump, these torque generators offer many of the features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



Standard Open Center



Power Beyond



Torque Generator

Product Description

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 recentering 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.

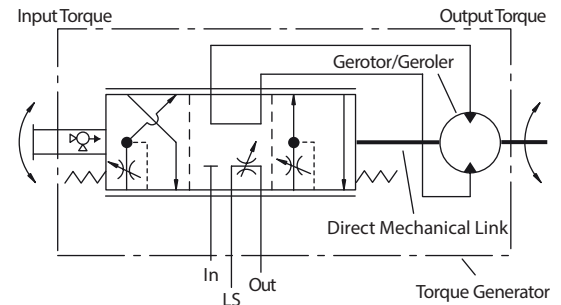
Limited Manual Steering

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.

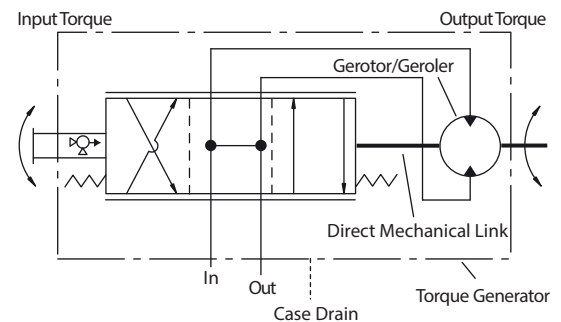
Reaction Torque Resistance

Customer supplied bracket is required for reaction torque resistance.

Load Sensing

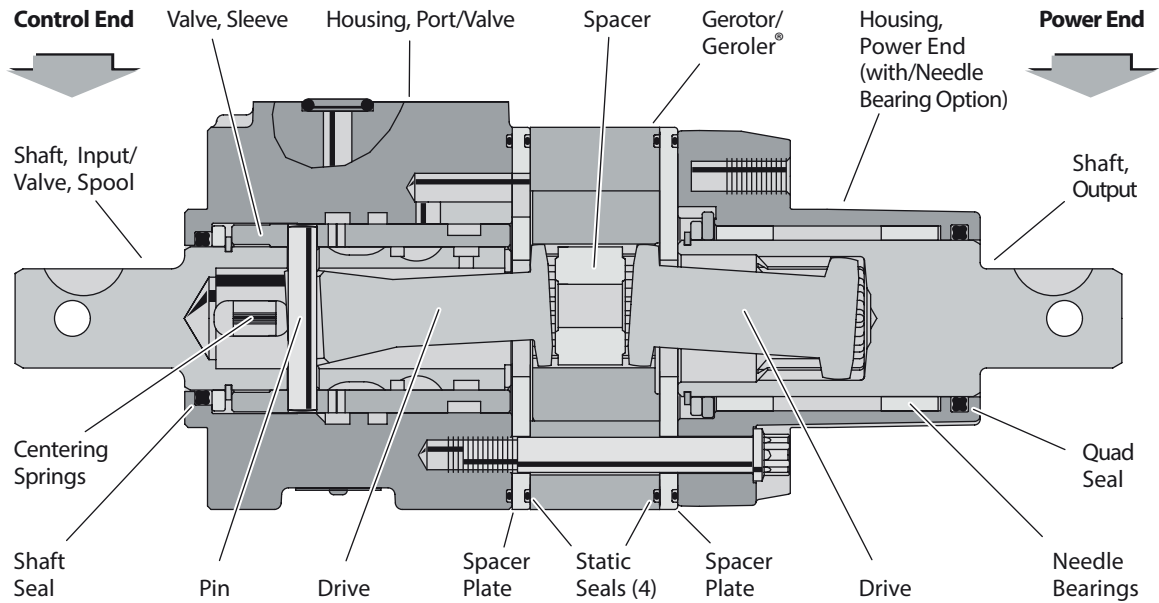


Open Center (with Case Drain)



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	23 kg [50 lb]
with Bearing	272 kg [600 lb]
Fluid	Most petroleum hydraulic fluids—see your Danfoss 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

CircuitType	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 [0 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
1,2,3	Product Series	ABP	Torque Generator
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]
		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] cm ³ /r [in ³ /r])
		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]
		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]
7,8	Displacement cm ³ /r [in ³ /r]	08	76 [4.7] Gerotor
		10	96 [5.9] Gerotor
		17	160 [9.7] Gerotor
		58	80 [4.9] Geroler
		60	102 [6.2] Geroler
		66	160 [9.6] Geroler

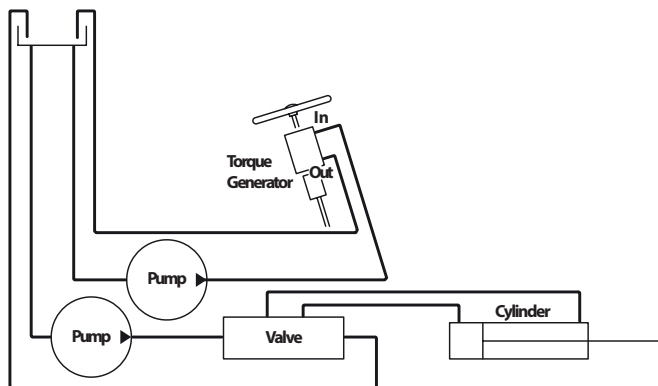
Nos	Feature	Code	Description
9	Ports	A	2 x .625 inch Dia. Manifold Ports with 2 x 5/16-18 UNC Mounting Holes (use with port block) - open center only
		B	3 x .625 inch Dia. Manifold Ports with 3 x 5/16 - 18 UNC Mounting Holes (use with port block)
		C	2 x 9/16 SAE Ports— open center only
		D	3 x 9/16 SAE Ports
		E	2 x G3/8 (BSP) Ports— open center only
		F	3 x G3/8 (BSP) Ports
10	Shaft Bearings	0	None
		1	Output Shaft Needle Bearings
11	Integral Valves	0	None
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
16,17	Special Feature	00	None
		01	Port Block Installed
18	Paint and Packaging	A	Black Primer
19	Identification	1	Danfoss Product Number on Nameplate
20	Danfoss Assigned Design Code	B	Assigned Design Code

Torque Generator

Conventional System Circuits

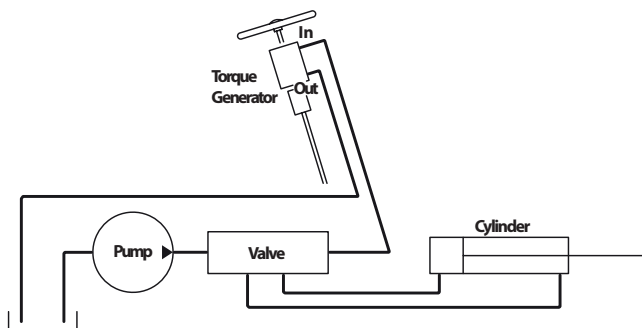
Conventional System with Two Pumps

- Extra cost of two separate circuits



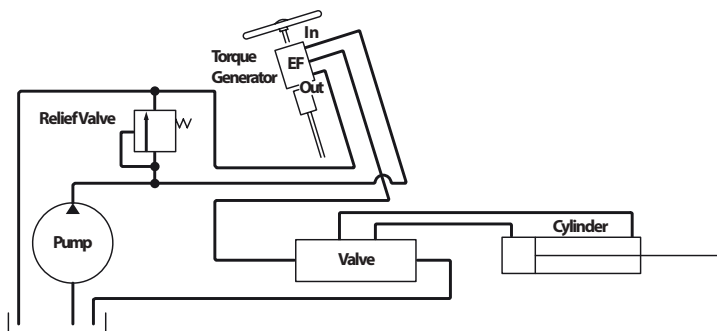
Conventional System with One Pump

- 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

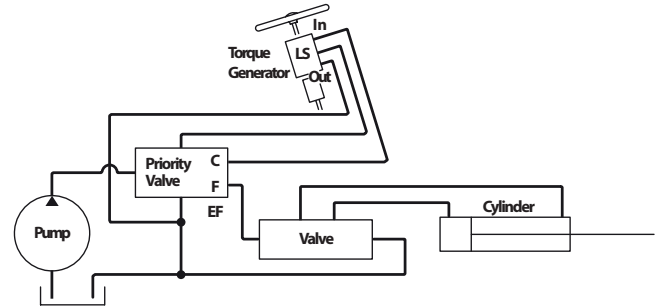


Torque Generator

Conventional System Circuits

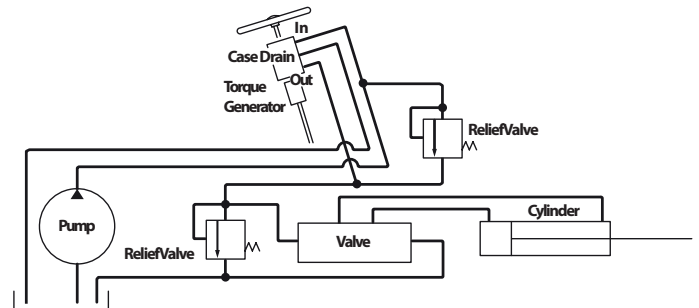
Load Sensing System

- 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

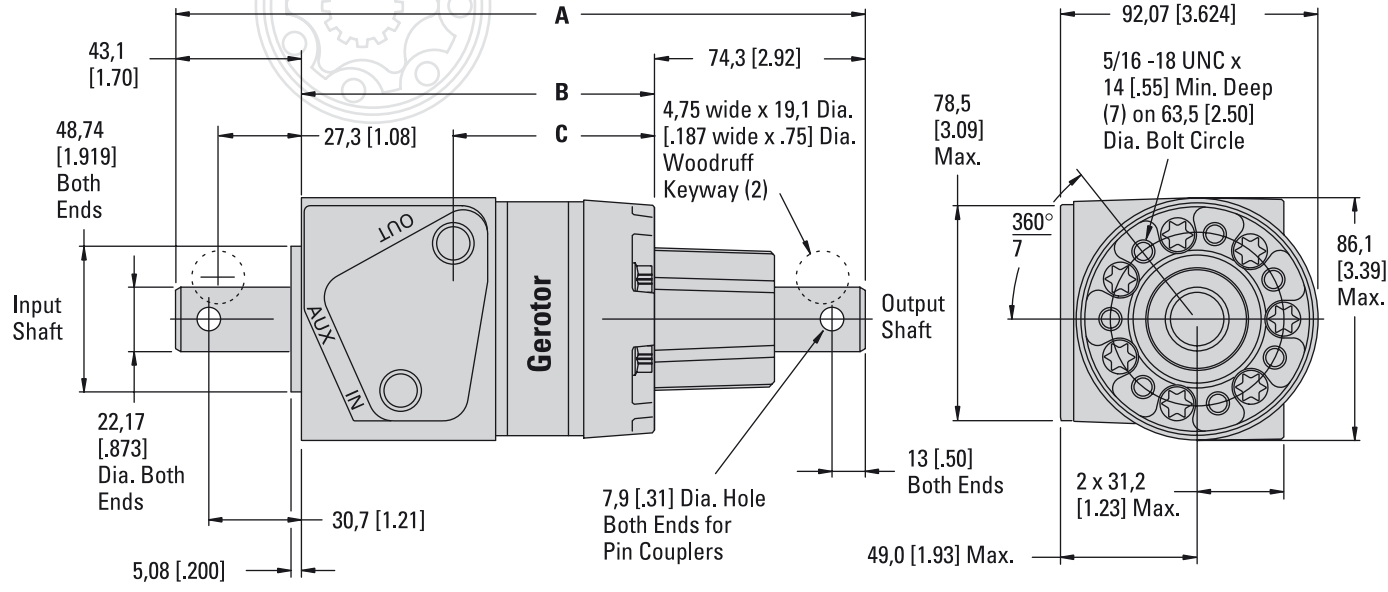
- Series circuit; auxiliary and steering pressures are additive
- All flow available to auxiliary function, even while steering
- Separate relief valves required for steering and auxiliary



Torque Generator

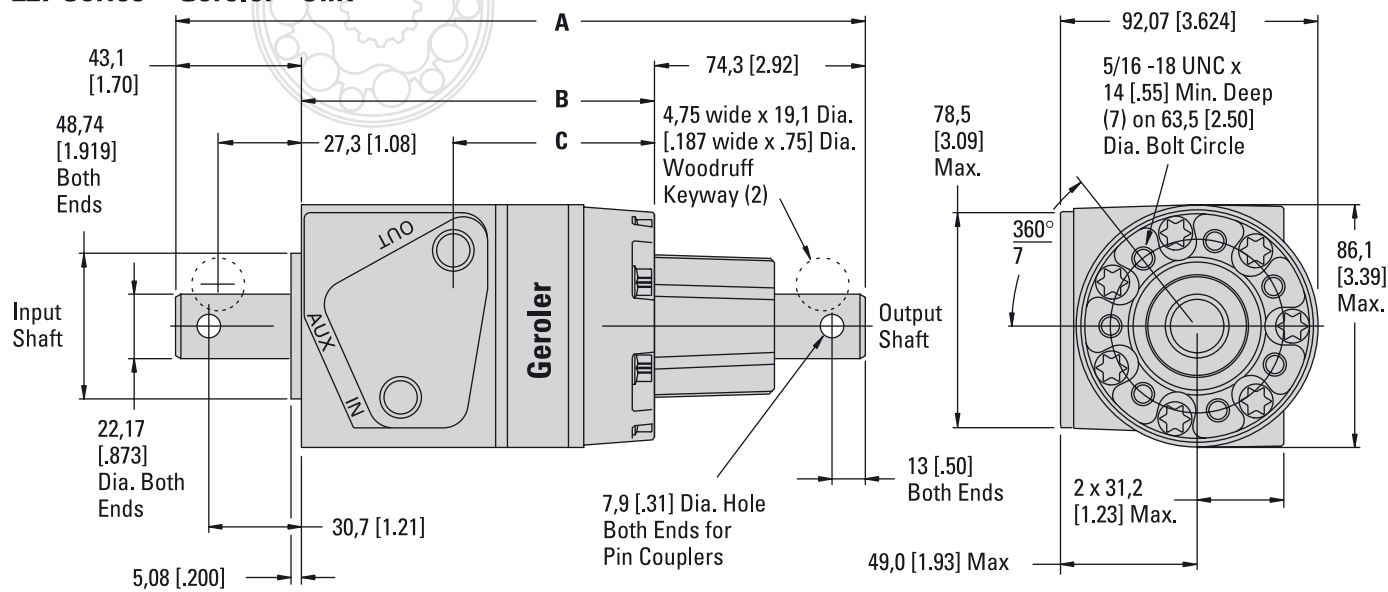
Installation Drawing

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]

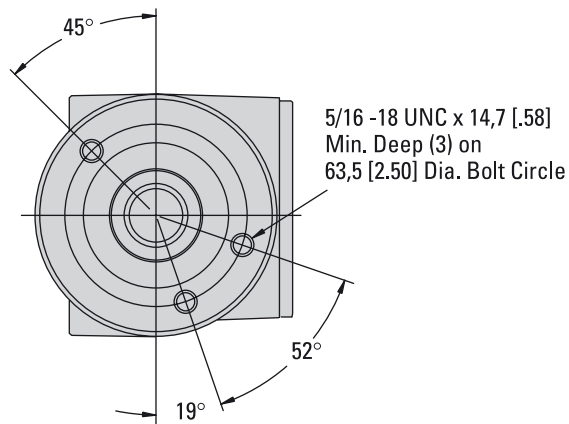
227 Series—Geroler® Unit



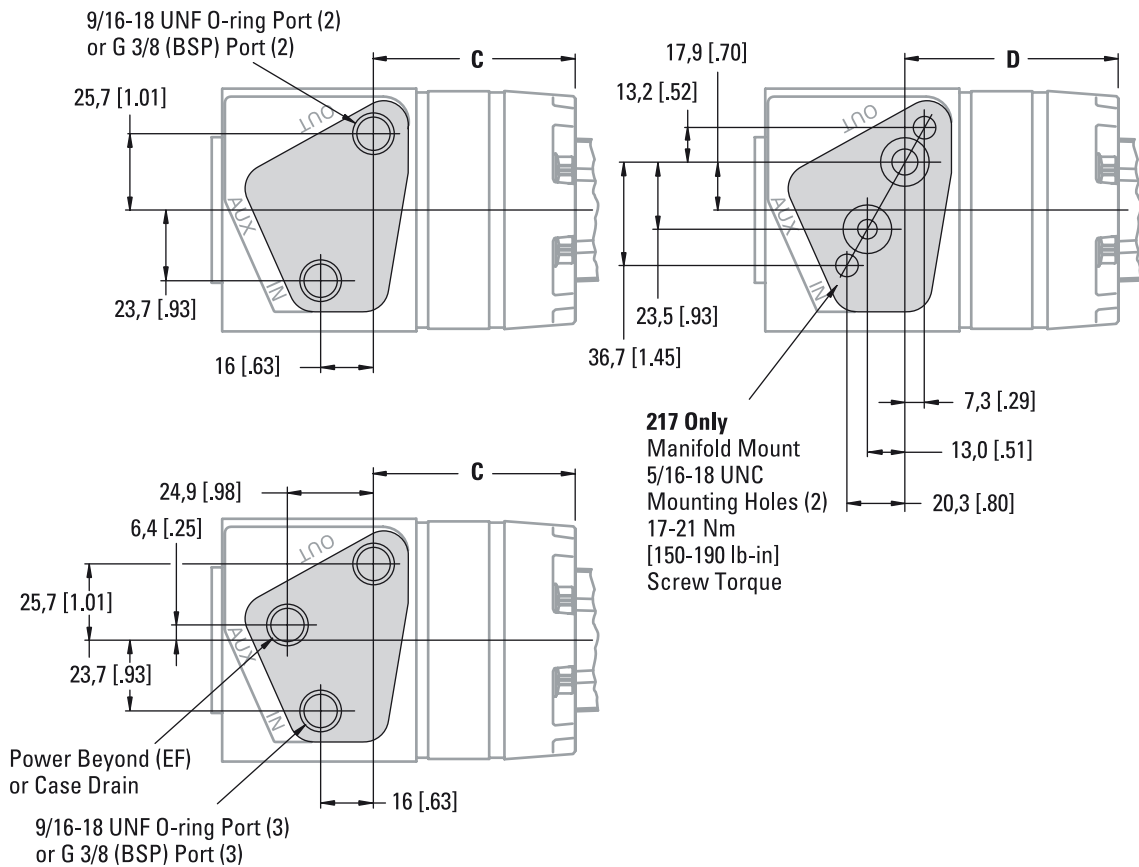
Torque Generator

Ports

Input End



Port Options



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

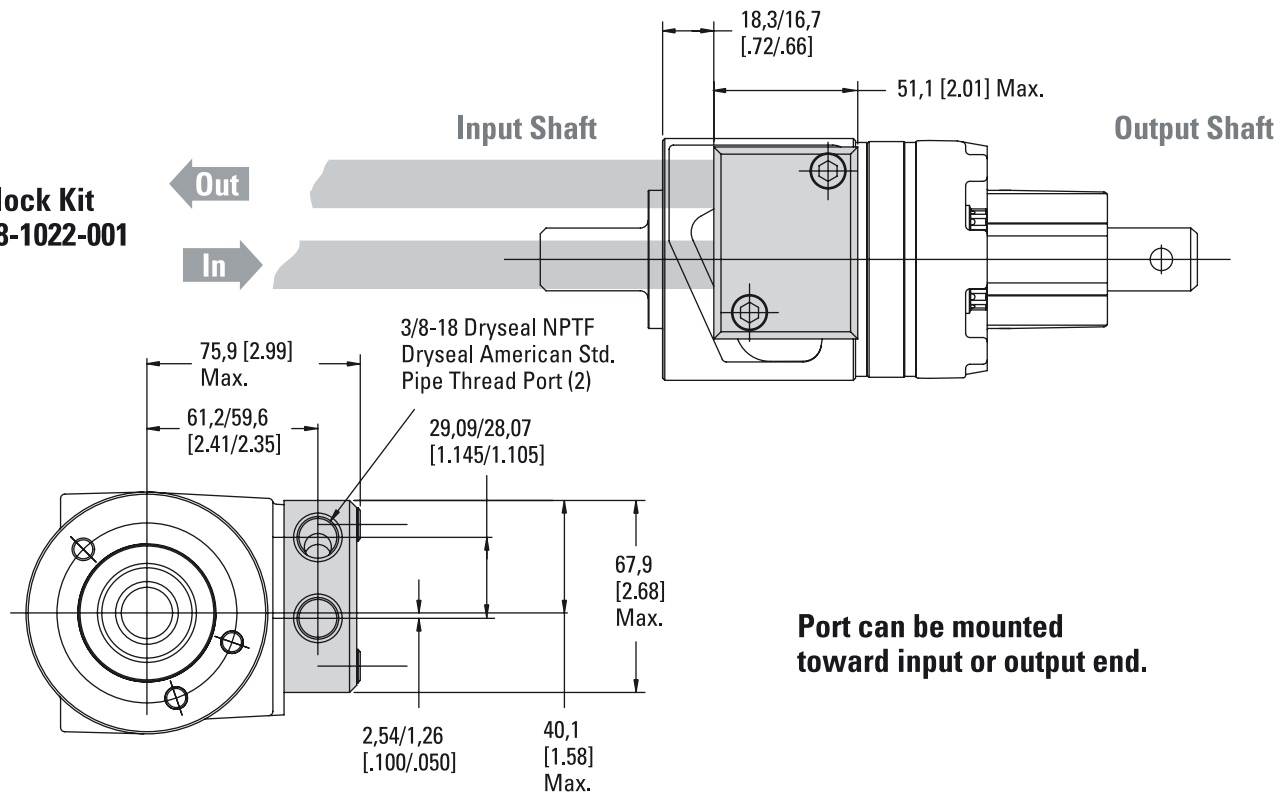
For proper operation it is recommended that the unit be installed so no radial load or thrust load is applied to either the input or output shafts. Misalignment of shafts will cause binding.

Torque Generator

217 Series Port Block

Installation Drawing Port Block with 3/8-18 Dryseal NPTF Ports

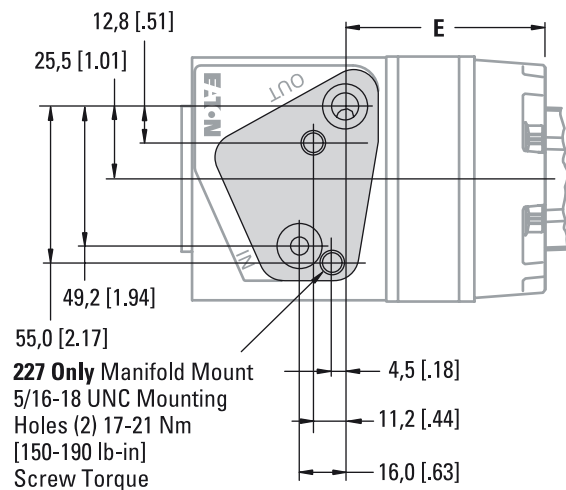
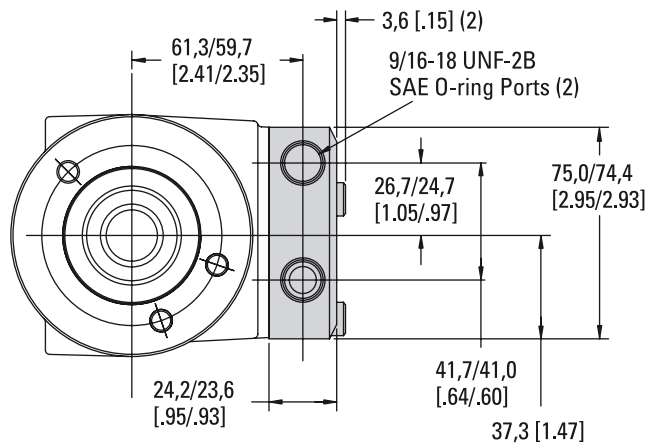
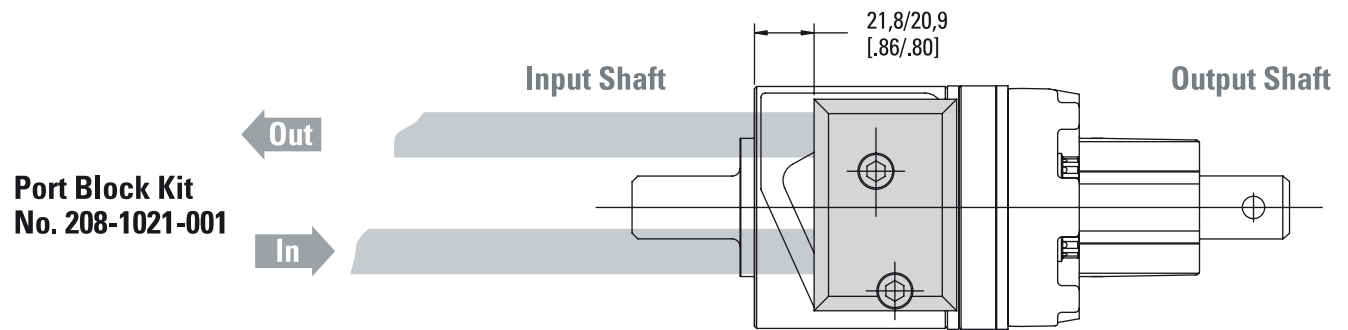
**Port Block Kit
No. 208-1022-001**



Torque Generator

227 Series Port Block

Installation Drawing 9/16-18 UNF SAE O-ring Port

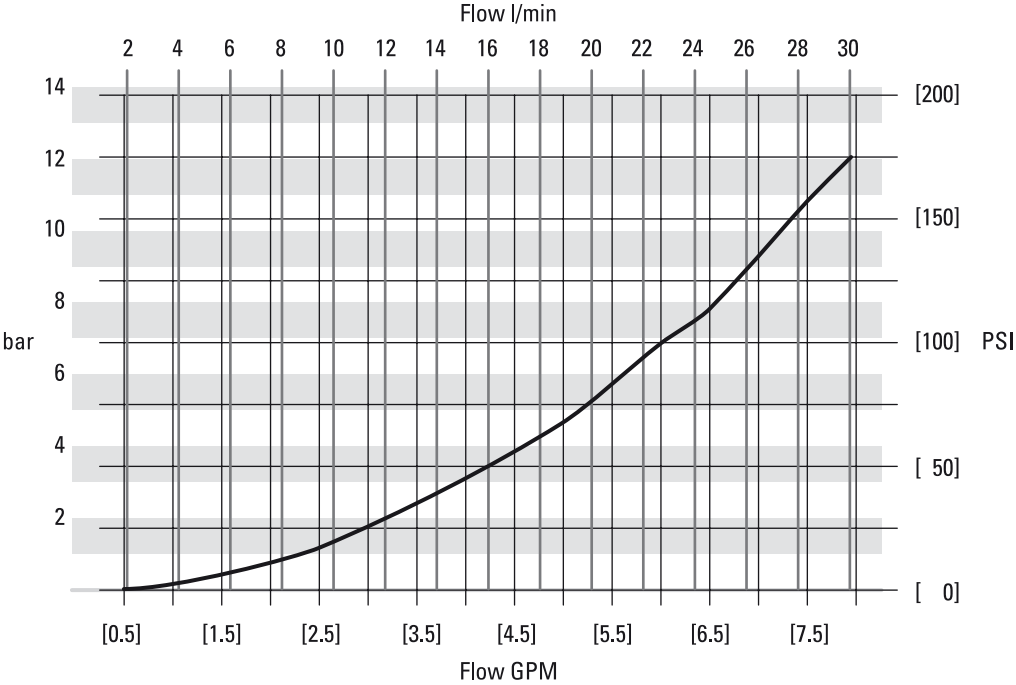


Displacement cm ³ /r [in ³ /r]	Dim. mm [inch] E	
227 Series	80,3 [4.90]	62,0 [2.44]
(Geroler® Unit)	101,6 [6.20]	71,2 [2.80]
	160,0 [9.64]	76,2 [3.00]

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. (For more information see Vickers® by Danfoss 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.

Ordering Information

1. Reference Part Number: 5991006-001

Ports:

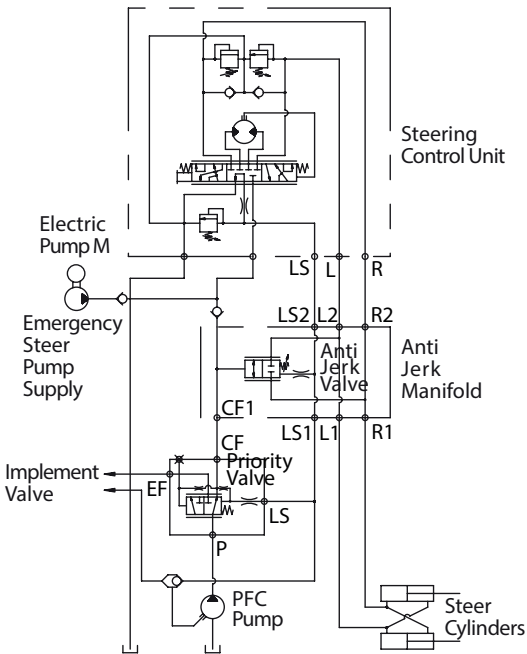
CF1, CF2	¾-16 UNF
L1, L2, R1, R2	¾-16 UNF
LS1, LS2	7/16-20 UNF

Pressure Setting Range: 100-600PSI

2. Specify Ports.

Ports	8 Size	12 Size		
Port Options	Option 1	Option 2	Option 3	Option 4
CF1, CF2	¾-16 UNF	M18	1 1/6-12UNF	M27
L1, L2, R1, R2	¾-16 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] |



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, SAE10, etc.
Filtration	Cleanliness code 18/16/13

Steering System Components

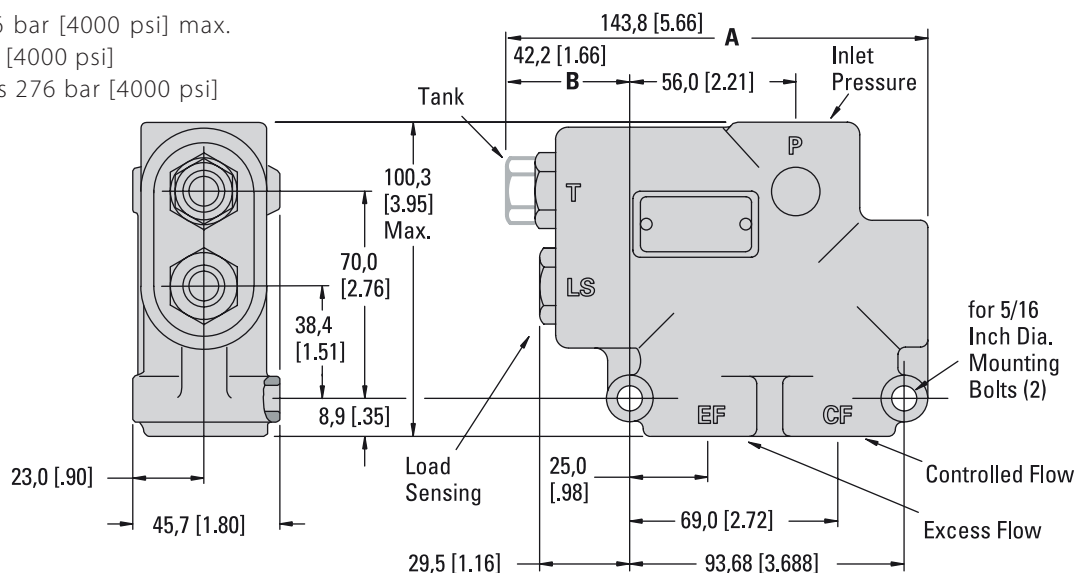
VLC In-Line Priority Valves

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 [5]	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

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

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.

Steering System Components

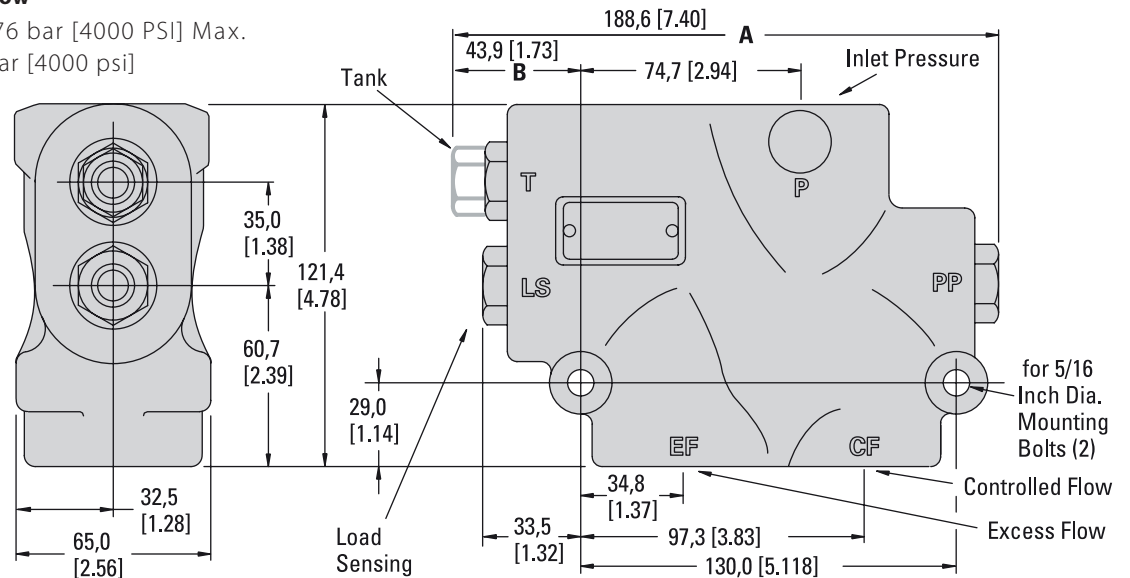
VLE In-Line Priority Valves

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 value 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	11/ 16 - 12						
CF	3/4 - 16	606-1093	606-1294	606-1094	606-1295	606-1095	606-1296
LS & T	7/16 - 20						
P & EF	11/ 16 - 12						
CF	7/8 - 14	606-1046	606-1341	606-1047	606-1342	606-1048	606-1343
LS & T	7/16 - 20						
P & EF	1 5/16 - 12						
CF	7/8 - 14	606-1058	606-1344	606-1059	606-1345	606-1060	606-1346
LS & T	7/16 - 20						
P & EF	1 5/16 - 12						
CF	1 5/16 - 12	606-1141	606-1347	606-1142	606-1348	606-1143	606-1349
LS & T	7/16 - 20						
P & EF	1 5/16 - 12						
CF	1 1/16 - 12	606-1350	606-1282	606-1351	606-1281	606-1352	606-1283
LS & T	7/16 - 20						
P & EF	M27 X 2						
CF	M18 X 1,5	606-1353	606-1354	606-1355	606-1356	606-1357	606-1358
LS & T	M12 X 1,5						
P & EF	R 3/4 - 14						
CF	R 1/2 - 14	606-1359	606-1360	606-1361	606-1362	606-1363	606-1364
LS & T	R 1/4 - 19						

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

Steering System Components

VLH In-Line Priority Valves

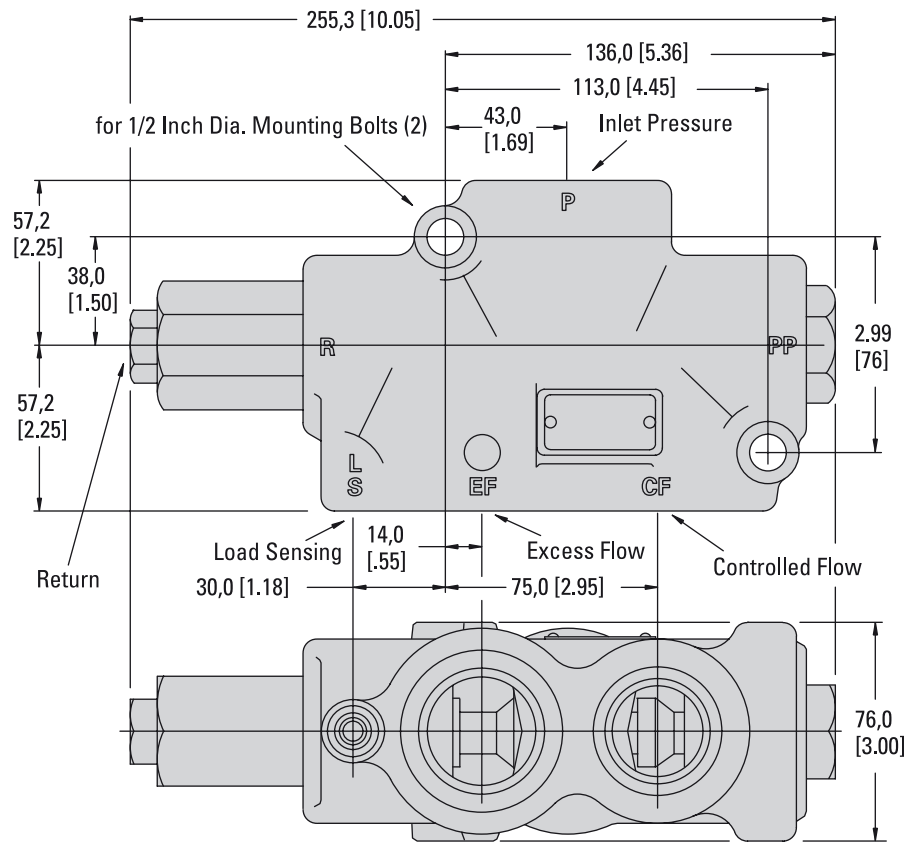
240 l/min [63 GPM] Rated Flow

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]

High Pressure

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 value setting.

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

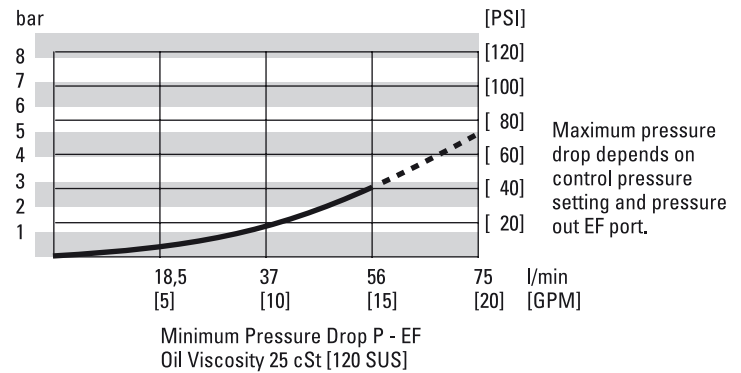
Control Pressure - bar [PSI] / Product Number

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	15/ 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	15/ 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	15/ 8 - 12						
CF	3/4 - 16	606-1189	606-1371	606-1190	606-1372	606-1191	606-1373
LS & R	7/16 - 20						

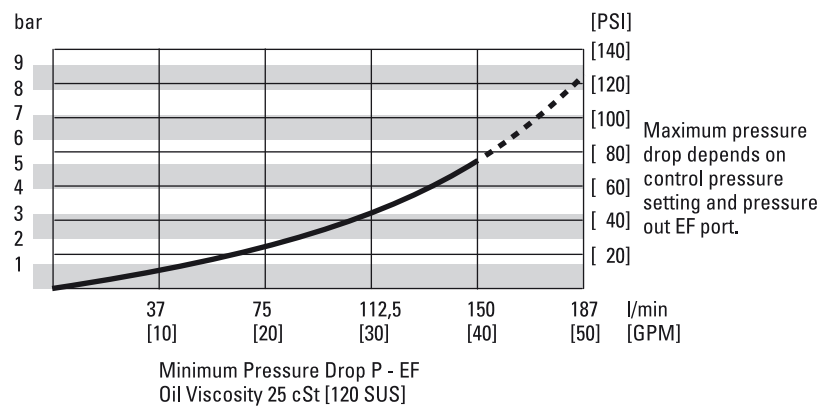
Steering System Components

VLC, VLE and VLH Priority Valves – Pressure Drop Curves

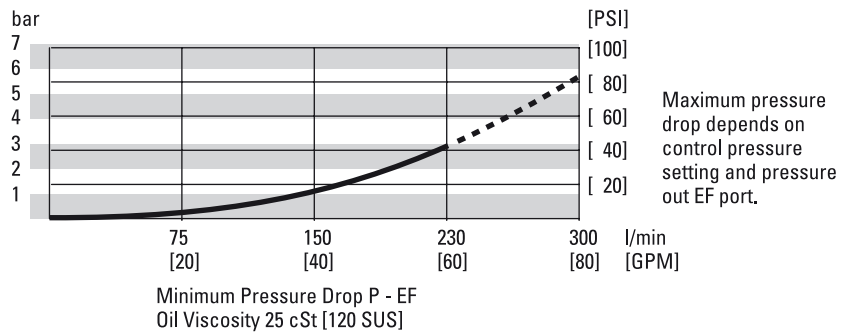
VLC Series



VLE Series

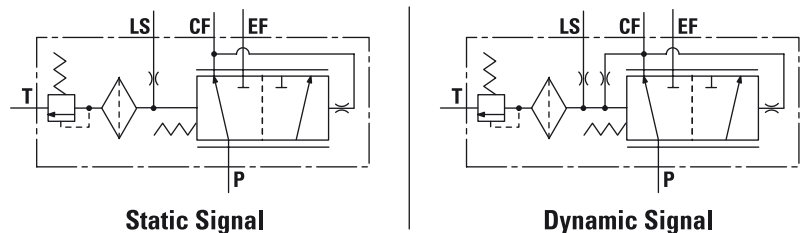


VLH Series



Symbols

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



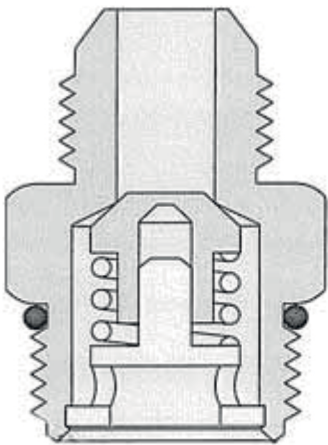
Steering System Components

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.

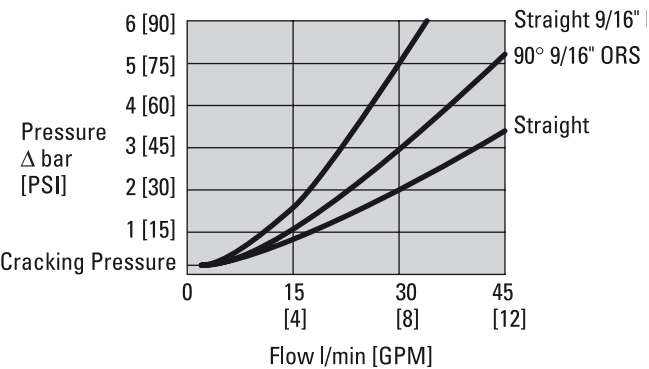
The check valve is installed directly into the pressure port of Danfoss steering control unit. Connection of the hose assembly is either a male 37°end or O-ring face seal (ORS).

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



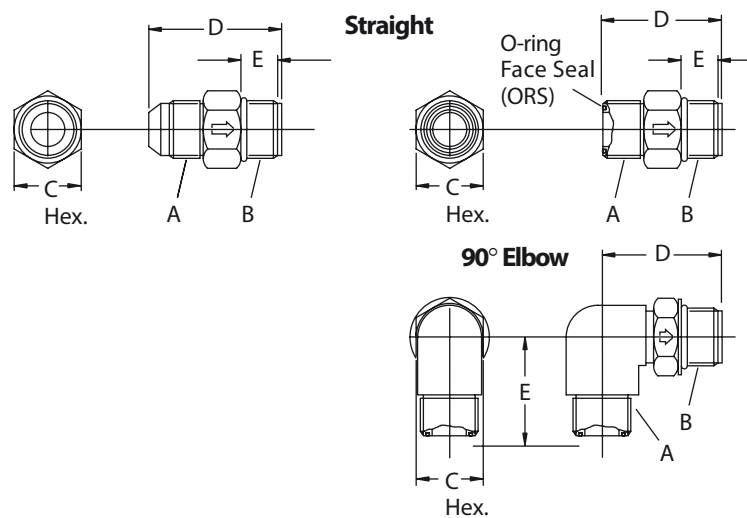
Performance Data

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]

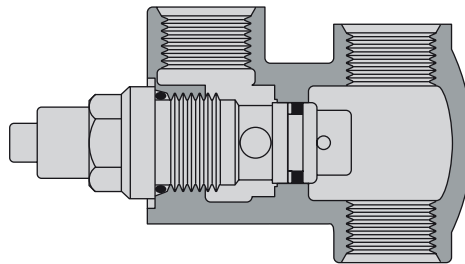
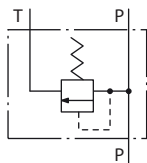
Steering System Components

Relief Valves

Model 32107 In-Line Relief Valve–Direct Acting Cartridge

Specifications

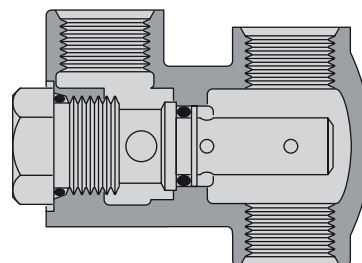
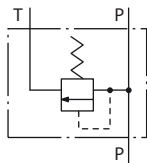
Max. Flow Through Relief Valve	57 l/min [15 GPM]
Relief Valve Setting Range	47–276 bar [675–4000 lbf/in ²]
Standard Relief Valve Setting	138 bar [2000 PSI]
Housing Rated Pressure	345 bar [5000 PSI]



Model 32107 In-Line Relief Valve–Pilot Operated Cartridge

Specifications

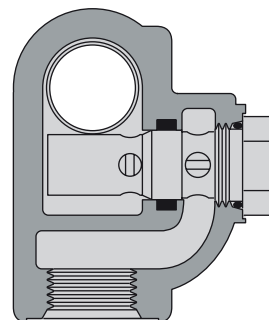
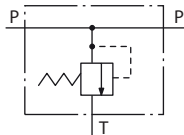
Max. Flow Through Relief Valve	75,7 l/min [20 GPM]
Relief Valve Setting Range	103–241 bar [1500–3500 lbf/in ²]
Housing Rated Pressure	345 bar [5000 PSI]



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 lbf/in ²]
Housing Rated Pressure	345 bar [5000 PSI]



Comprehensive Relief Valve Description

(see Danfoss Relief Valve Catalog 11-510)

Steering System Components

Columns Product Description

Danfoss 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

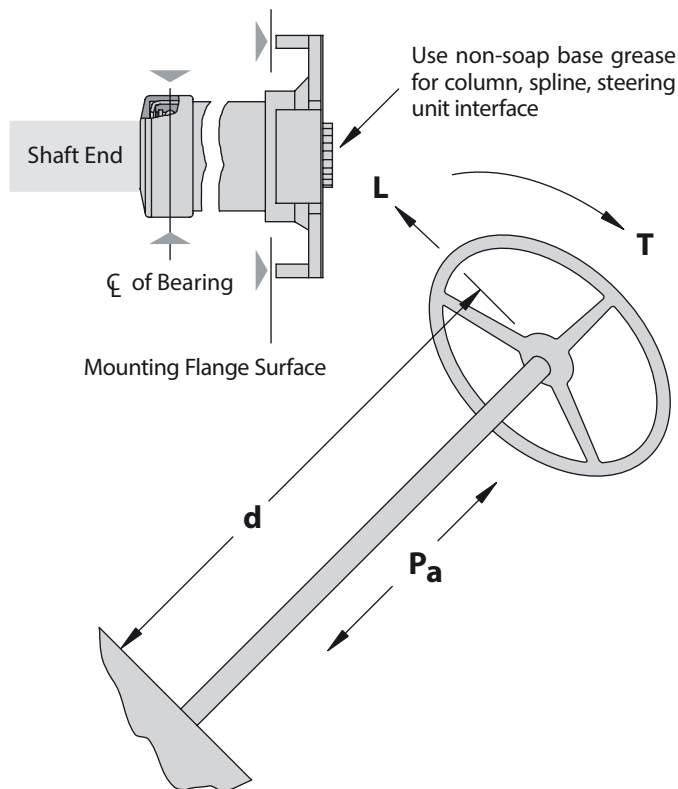
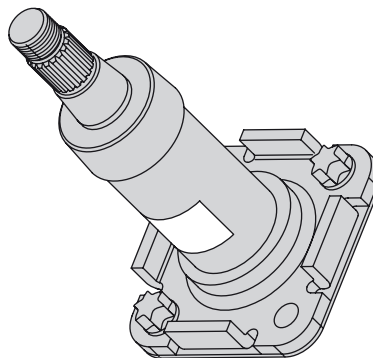
Rated Torsional	81Nm [60 lb-ft]
Rated Bending Moment*	136 Nm [100 lb-ft]
Rated Radial Load**	86 kg [150 lb]
Rated Axial Load	86 kg [150 lb]
Torsional Friction Drag	0,23 kg [2 lb-in]
Recommended Wheel Nut Torque	47 Nm [35 lb-ft]

*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 Danfoss 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
1,2,3	Product Series	ACK	Steering Column
4,5	Jacket/Base Type (page 74)	SJ	Standard (38 mm [1.50 inch] O.D.)
		MN	Round Series 5 (38mm [1.5 inch] O.D.)
		HG	Heavy Wall (41,4 [1.63 inch] O.D.)
			Tabbed Flange
		SH	Standard With flat Flange (38mm [1.50 inch] O.D.) (No Tabs)
		TJ	Tilt Column with Flat Flange, Mechanical Push Button
6	Lower Shaft End (see page 75)	1	12 Tooth Spline for Steering Unit
		3	3/4 inch "D" Section (for Noise Isolator)
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
		MJ	Available with or without Horn Wire
		DN	Not Available with Horn Wire
		EJ	Not Available with Horn Wire
		GC	Not Available with Horn Wire
		CL	Not Available with Horn Wire
		PT	Available with or without Horn Wire
		SV	Available with or without Horn Wire
		YM	Not Available with Horn Wire
9,10,11	Jacket Length mm [in.] (Suggested Std. Dim.)	022	56,6 [2.23]
		033	82,8 [3.26]
		058	147,8 [5.82]
		078	197,1 [7.76]
		099	250,7 [9.87]
		108	273,3 [10.76]
		118	298,7 [11.76]
		157	399,8 [15.74]
		178	451,6 [17.78]
		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]
		100	254,0 [10.00]
		120	304,8 [12.00]

Nos	Feature	Code	Description
		140	355,6 [14.00]
		160	406,4 [16.00]
		026	66,1 [2.60]
		036	92,3 [3.63]
		062	157,3 [6.19]
		081	206,6 [8.13]
		103	260,2 [10.24]
		111	282,8 [11.13]
		121	308,2 [12.13]
		162	409,3 [16.11]
		182	461,1 [18.15]
		257	651,6 [25.65]
		276	701,9 [27.63]
		302	765,9 [30.15]
		329	835,7 [32.90]
		AAA	190,5 [7.50] Above Pivot
			546,4 [21.51] Below Pivot
		AAB	190,5 [7.50] Above Pivot
			101,6 [4.00] Below Pivot
		AAC	127,0 [5.00] Above Pivot
			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
17	Horn Brush Wire Terminal End (page 79)	0	None—Select When No Horn Wire Used
		D	SAE J928 Pin and Double End Connector
		K	Blade Receptacle—Insulated (Compatible with SAEJ858a)
18,19	Shaft End Wire Terminal (page 79)	00	None
		01	One Horn Button (Only with One Horn Wire)
		02	One Horn Button with Wire Eyelet (Select with Two horn Wire)
		08	Tinned Bare Wire End
20,21	Special Feature	00	None
22	Danfoss Assigned Design Code	B	For Tilt columns

Tilt Column

BOLT & NUT KITS

Metric Cap Screw Kit	M10 x 1.5 Thread x 20mm Length (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

Separate kits are available for purchase to use with steering columns

Steering System Components

Columns Jacket/Base Type

Example—see model code page 76

Position 4-5

SH Standard with flat flange (No Tabs)

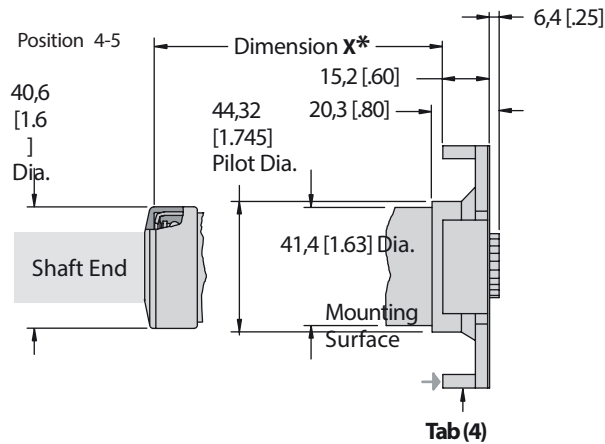
Position 9, 10, 11

026 66,1 [2.60] (Dimension X)

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

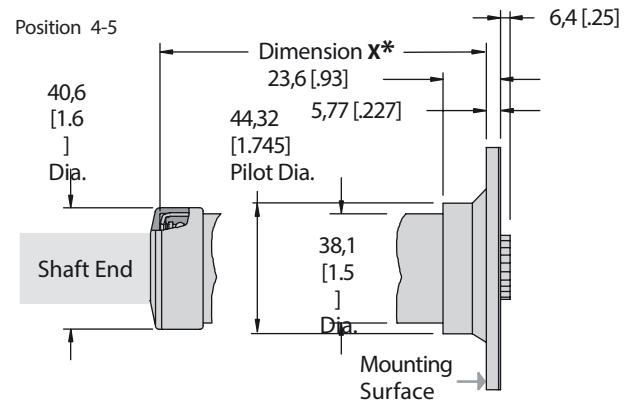
SJ Standard Wall

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



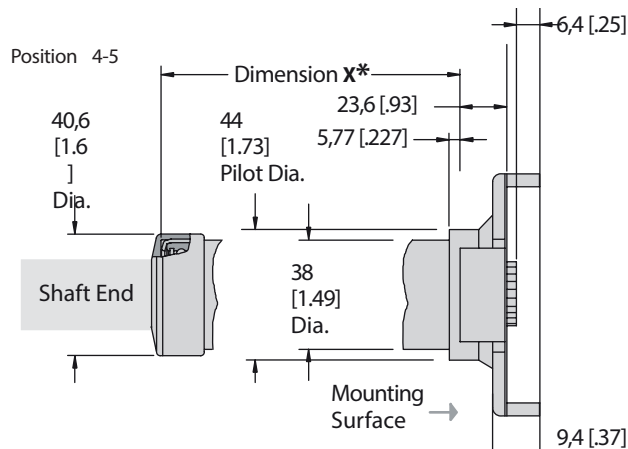
SH Standard Wall

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



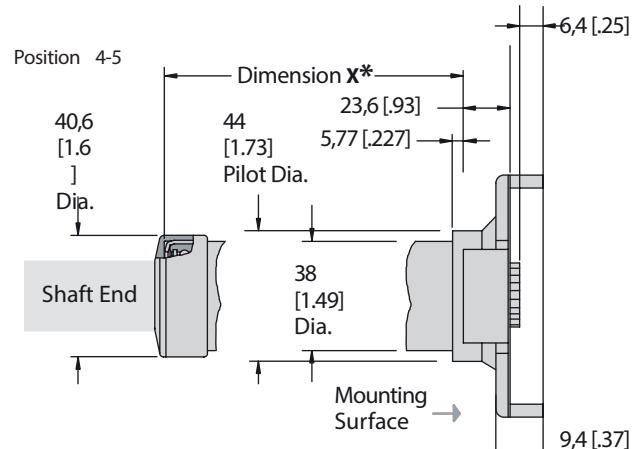
HG Heavy Wall

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



MN

(Round Series 5 with End Ports Only)



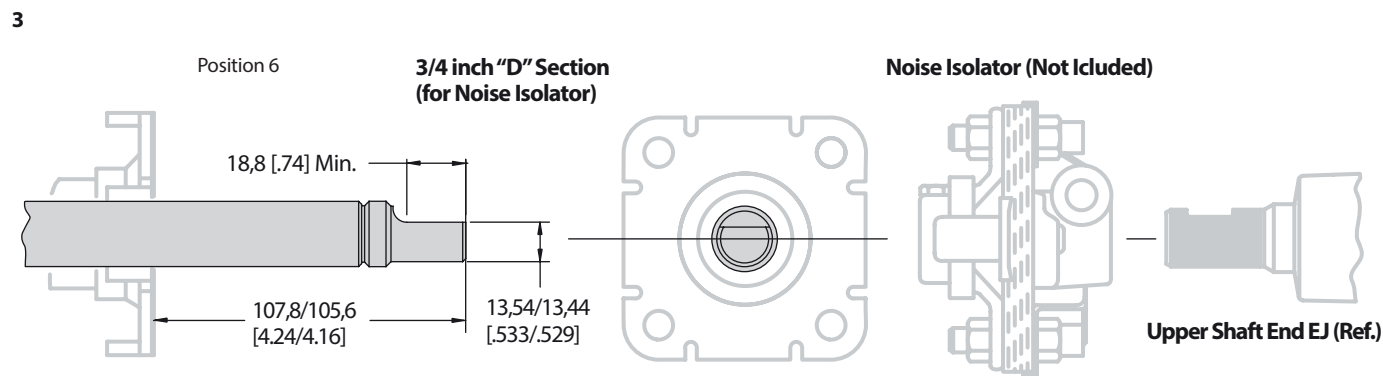
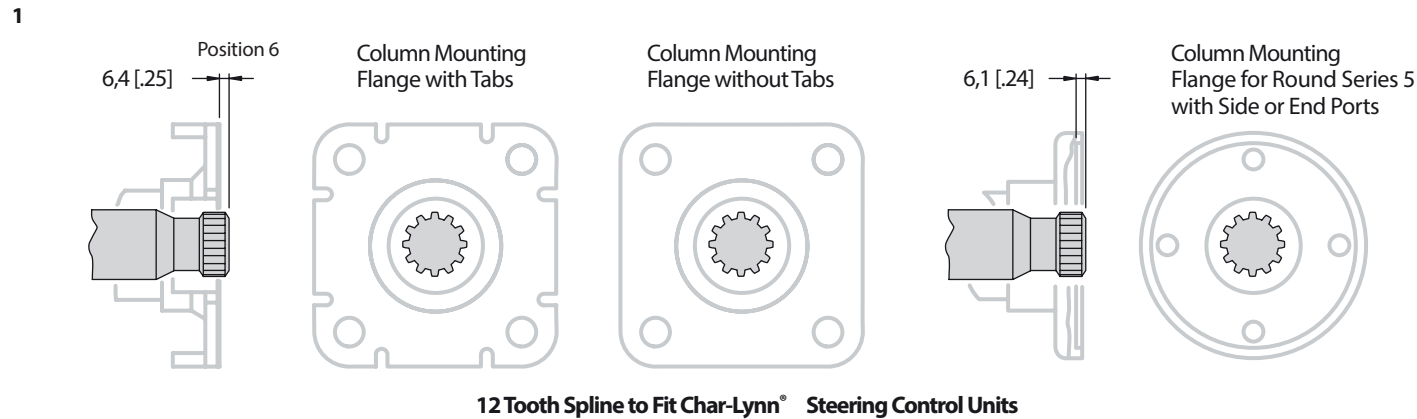
Steering System Components

Columns Lower End Type

Example—see model code page 76

Position 6

1 12 Tooth Spline for Steering Unit



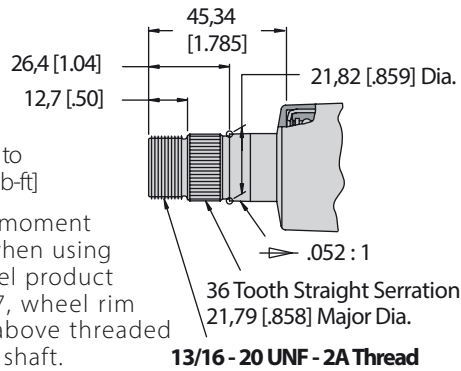
Steering System Components

Columns Upper Shaft End

AJ Position 7-8

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

For bending moment calculation when using Danfoss wheel product No. 209-1007, wheel rim is 22,1 [.87] above threaded end steering shaft.

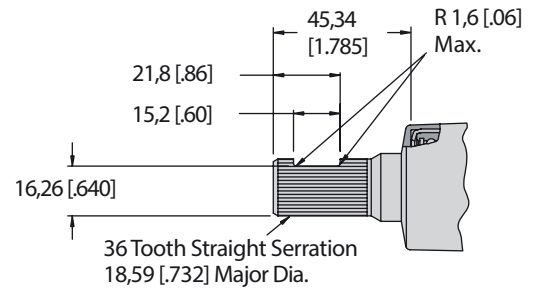


Example—see model code page 76

EJ Position 7-8

EJ (36 Tooth Straight Serration)

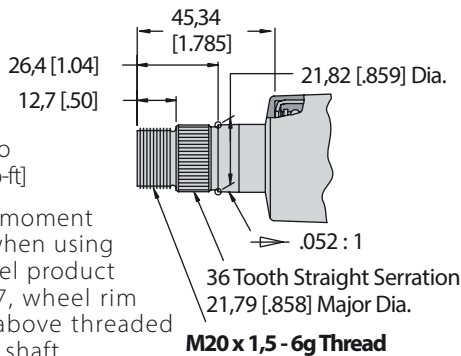
Not available with horn wire



MJ Position 7-8

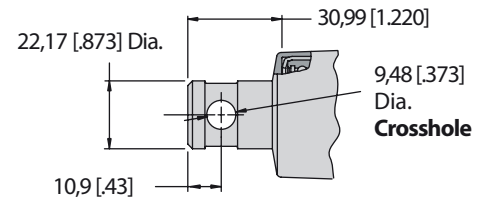
Note: Torque Nut to 41-54 Nm [30-40 lb-ft]

For bending moment calculation when using Danfoss wheel product No. 209-1007, wheel rim is 22,1 [.87] above threaded end steering shaft.



GC Position 7-8

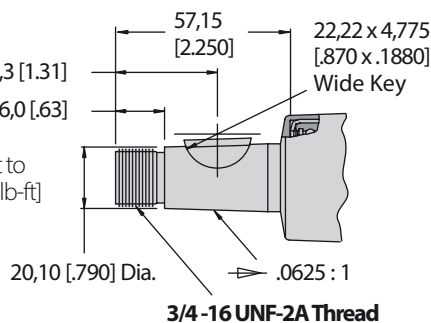
Not Available with Horn Wire



DN Position 7-8

Not Available with Horn Wire

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



Steering System Components

Columns Upper Shaft End Continued

Example—see model code page 76

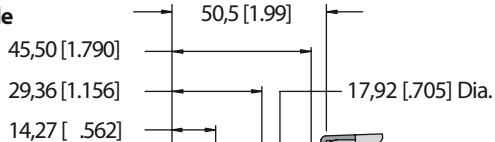
Position 7-8

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

Not available with horn wire

CL Position 7-8

**Not Available
with Horn
Wire**



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

M16 x 1,5 - 6g Thread

40 Tooth Straight Tooth Serration
17,48 [.688] Major Dia.

.083 : 1

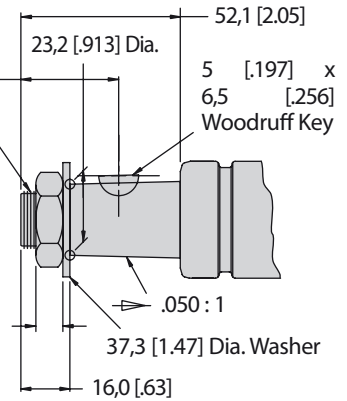
YM Position 7-8

**Not Available
with Horn
Wire or Tilt**

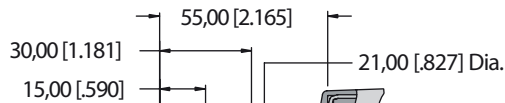
M18 x 1,5 - 6g Thread

32,0 [1.26]
26,9 [1.06]
M18 x 1,5 - 6H
Thread JamNut

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



PT Position 7-8



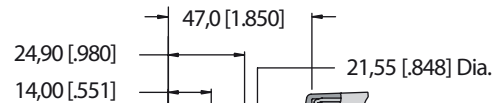
Note: Torque Nut to
41-54 Nm [30-40 lb-ft]

M18 x 1,5 - 6g Thread

36 Tooth Straight Serration
20,55 [.809] Major Dia.

.0625 : 1

SV Position 7-8



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

M18 x 1,5 - 6g Thread

36 Tooth Straight Serration
21,79 [.858] Major Dia.

.052 : 1

Columns Tilt Column

[illegible]

*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

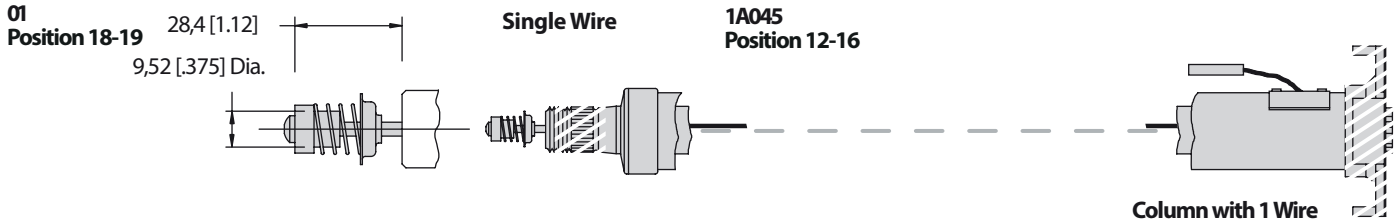
Columns Horn Wire Electrical

Example—see model code page 76

Position 12-16

1A045 Column with one horn wire

Single Wire

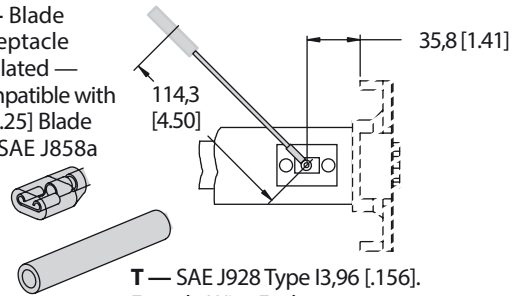


08
Position 18-19

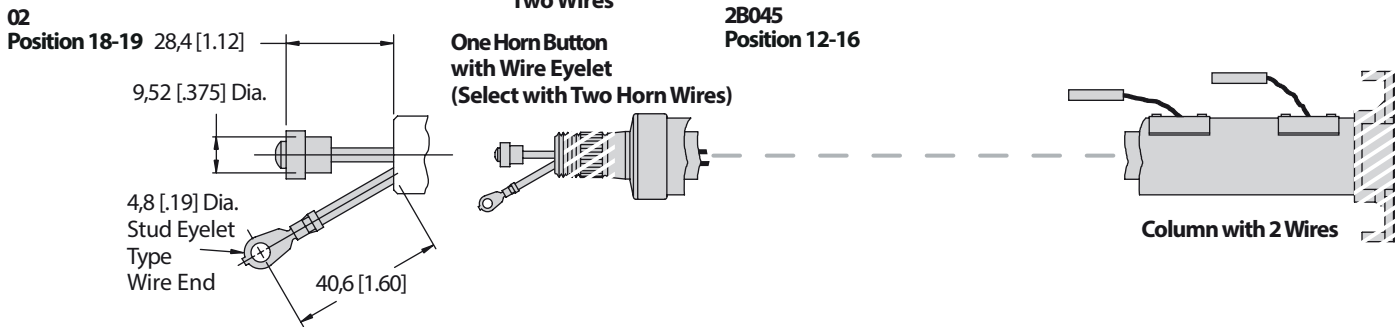


K or T
Position 17

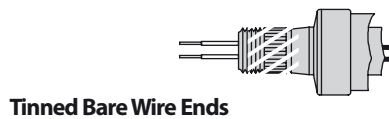
K — Blade
Receptacle
Insulated —
Compatible with
6,4 [.25] Blade
Per SAE J858a



Two Wire

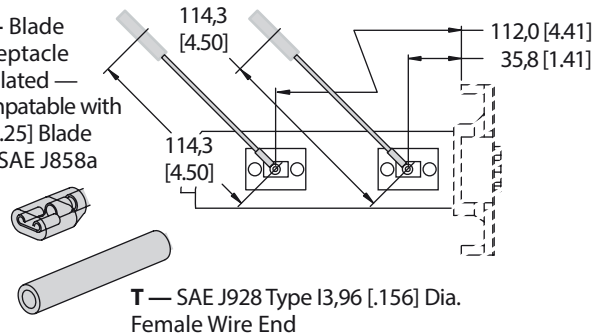


08
Position 18-19



K or T
Position 17

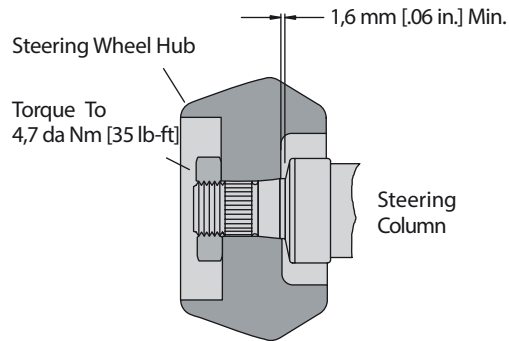
K — Blade
Receptacle
Insulated —
Compatible with
6,4 [.25] Blade
Per SAE J858a



Steering System Components

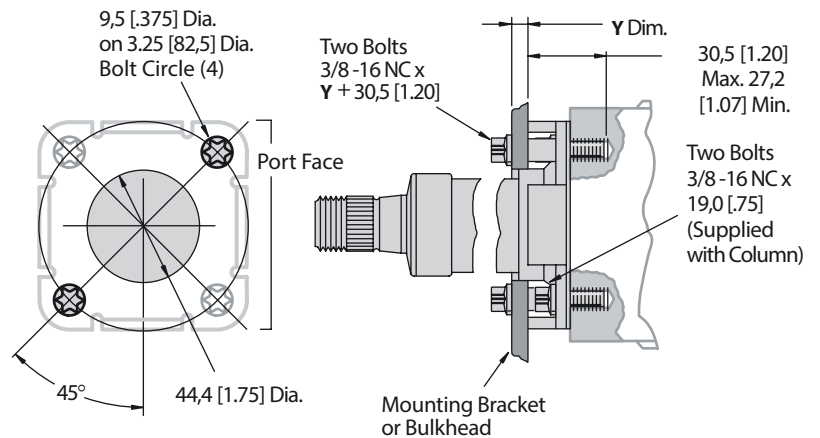
Columns and Wheel Mounting Product Information

Inspect for Minimum Clearance at Assembly



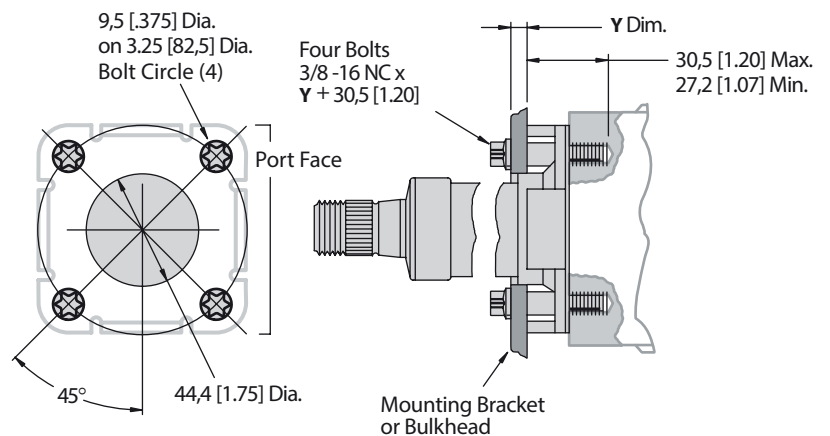
Square Series 5 and Series 10

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.

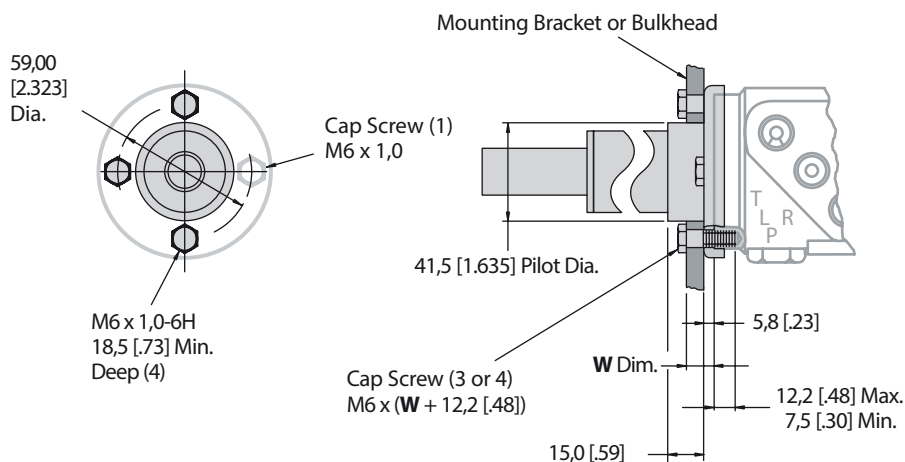


Steering System Components

Columns Product Information

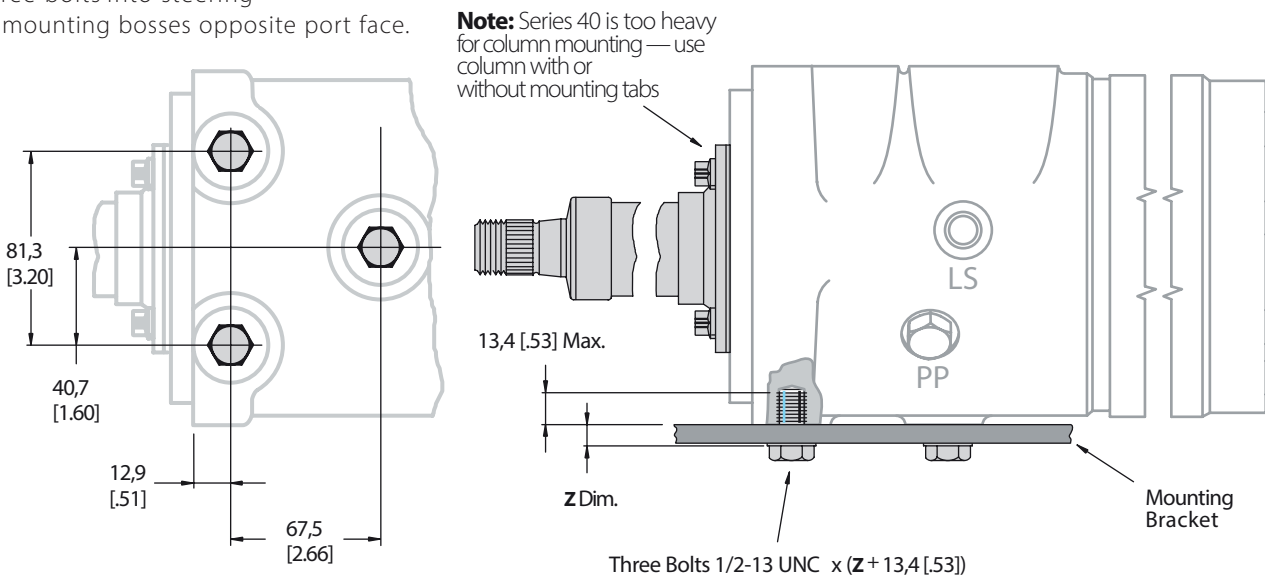
Round Series 5

Must use three bolts minimum.



Series 40

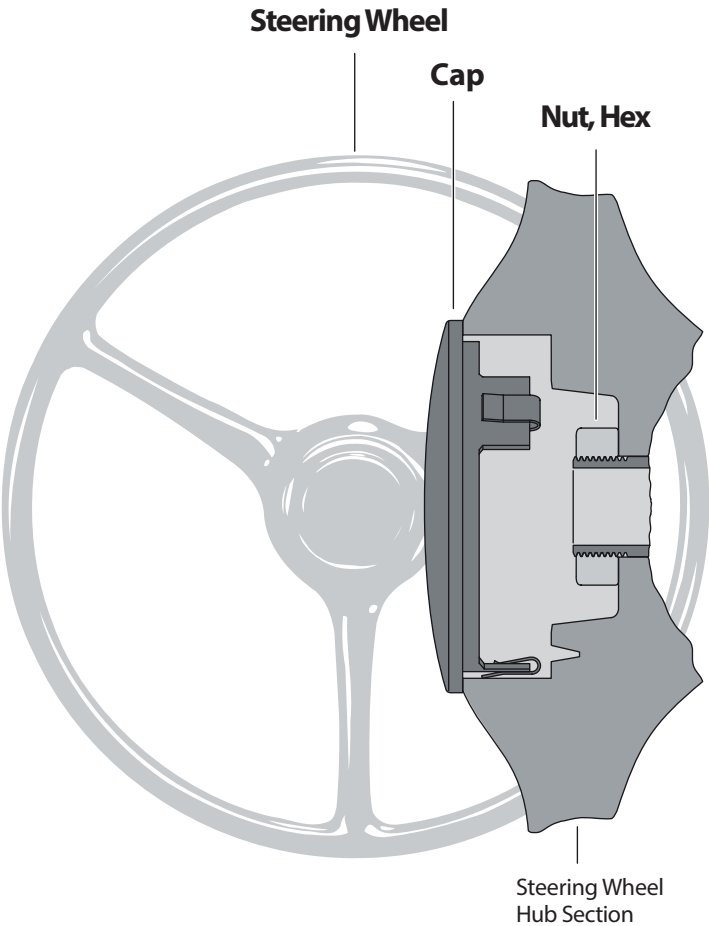
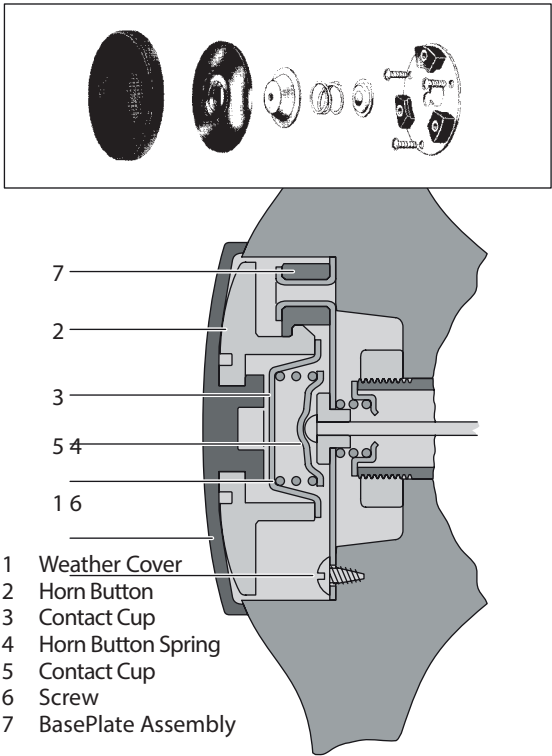
Must use three bolts into steering control unit mounting bosses opposite port face.



Steering System Components

Steering Wheels and Accessories

Horn Button Kit



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.

Horn Button Kit No. 208-1013

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

Cap No. 209-1005

Danfoss steering wheel hub cavity cap, for no horn installations used on steering wheel 209-1007

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

Steering System Components

Steering Wheels and Accessories

New Steering Wheels

Danfoss 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.

Horn Buttons

9900416

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

9900417

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



Caps

9900308

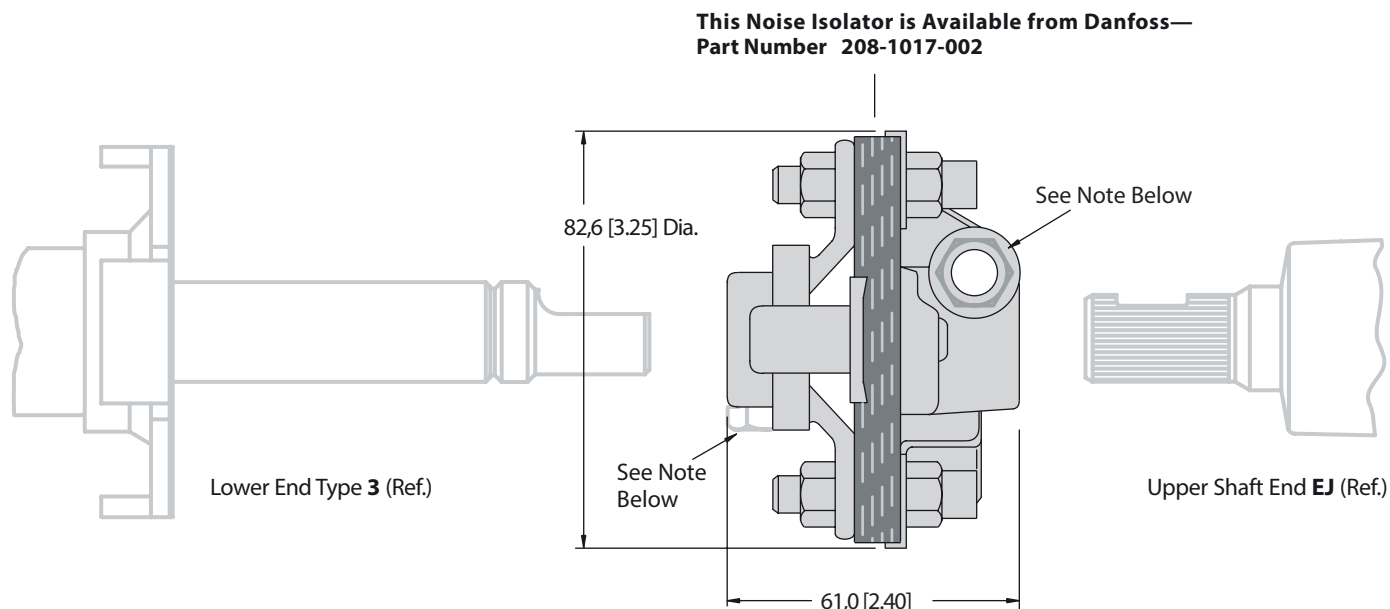
Danfoss, steering wheel hub cavity cap, for no horn installations. Used on steering wheel 209-1022 and 209-1023.

9900415

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

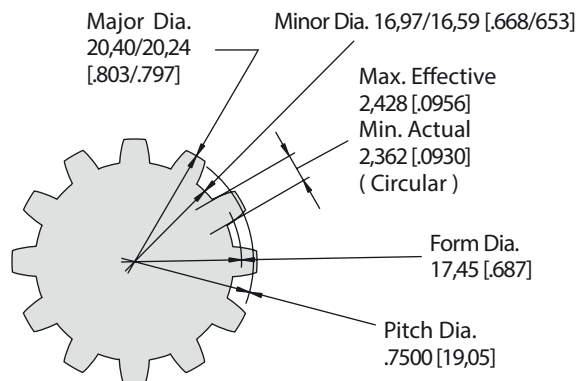
Steering System Components

Steering Wheels and Accessories



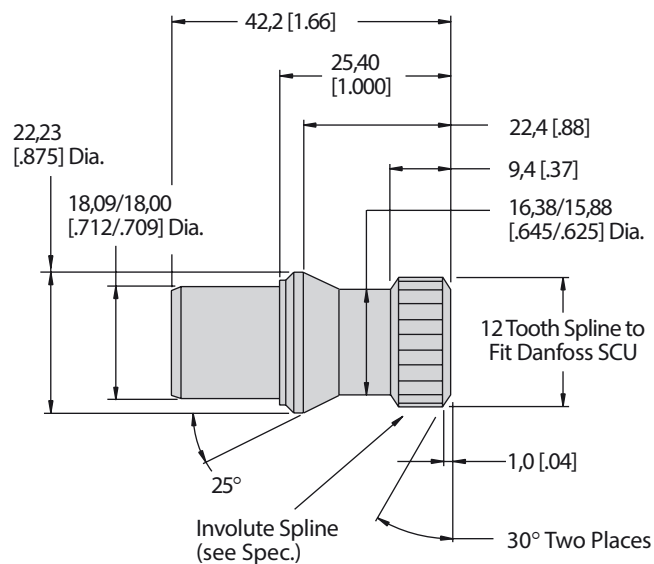
Note: Two screws (3/8-24 UNF x 31,8 [1.25] long — **not included**) are required to join isolator to mating steering columns. Torque screws to 41 Nm [360 lb-in].

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



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	

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



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 Loadsensing 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

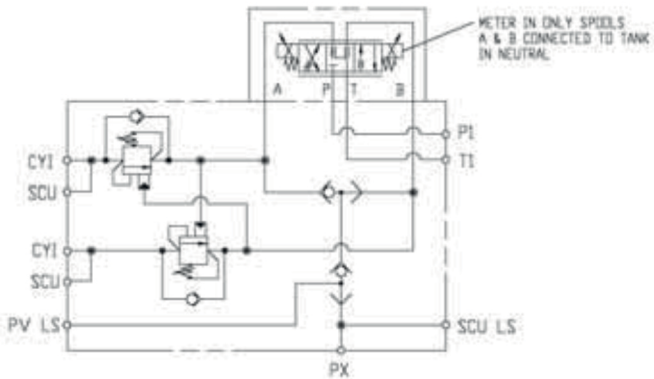
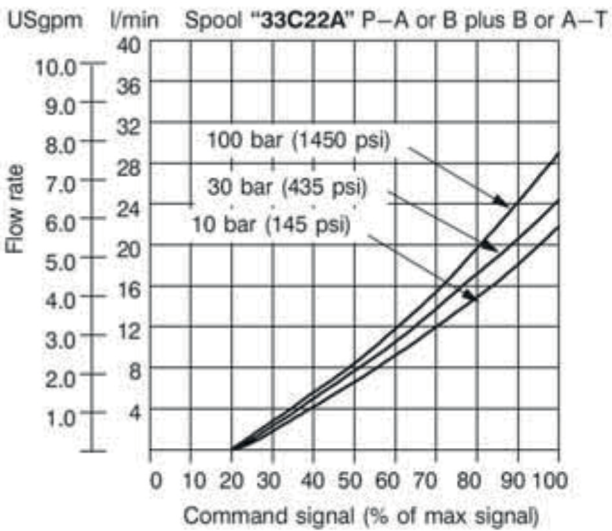
CBV2-10
Counterbalance Valve

KDG4V3S
Proportional Control Valve

(For more information see Vickers® by Danfoss Screw-in Cartridge Valves Cat. V-VLOV-MC001-E2 and Vickers by Danfoss 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 Orbital, 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

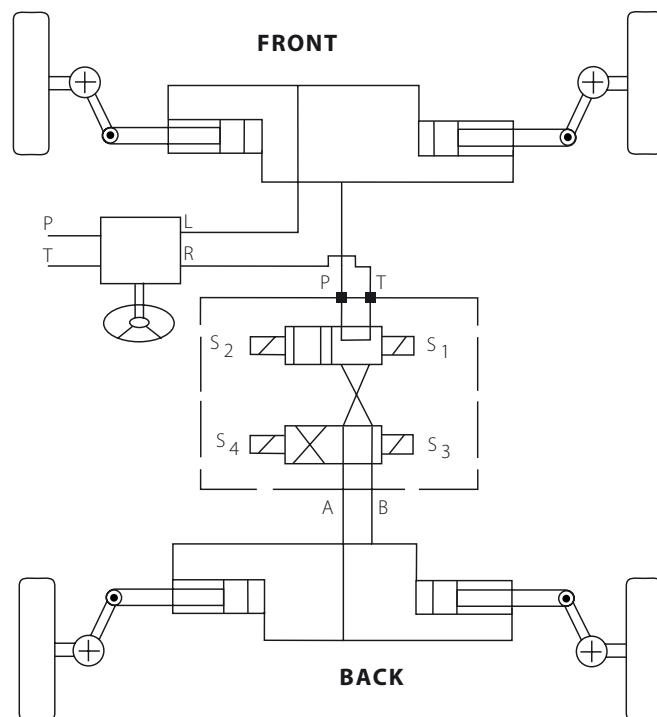
(For more information on these two valves, see Vickers® by Danfoss Solenoid Operated Directional Valves Cat. GB-C-2015.)

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 in³/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

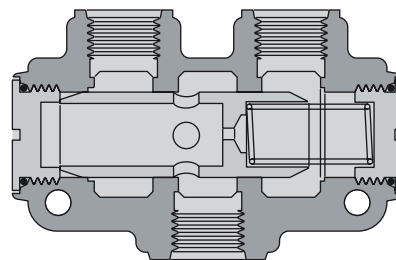
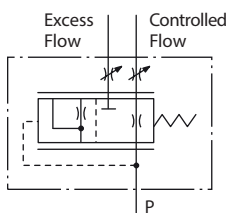
Model 32306 Priority Flow Divider

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]



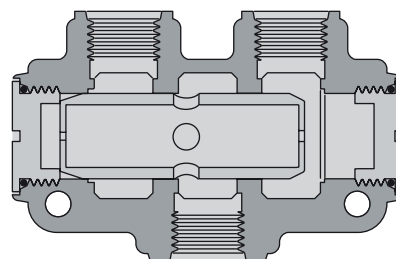
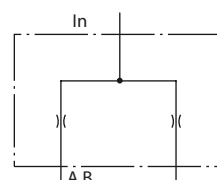
Model 32501 Proportional Flow Divider

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]

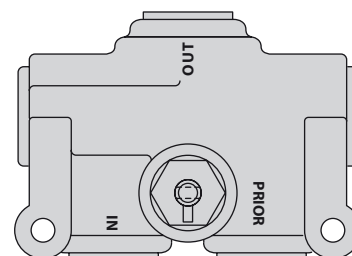
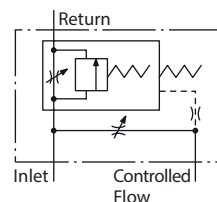
Rated Pressure 172,4 bar [2500 PSI]

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 Danfoss Flow Divider
Catalog E-VLFL-MC001-E)

Steering System Components

Brake Valve

Danfoss’ loadsensing brake valve makes power brakes an economical and efficient feature on lift trucks.

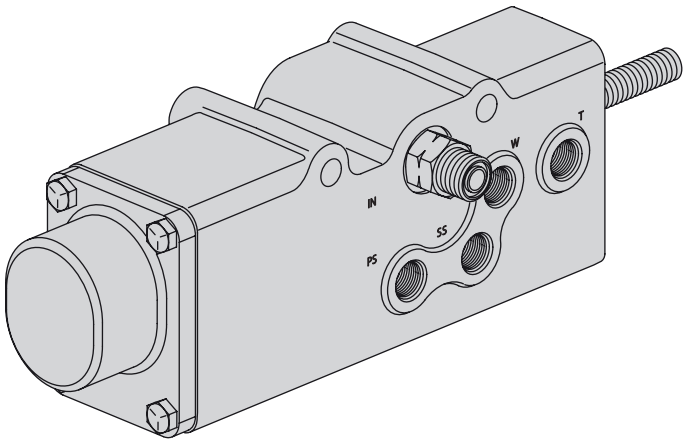
While power brakes in lift trucks can aid productivity, incorporating them into lift trucks has traditionally been expensive. The need for additional flow meant extra plumbing, plus the addition of a dedicated pump or a high pressure accumulator for the brake circuit. The increased system size also meant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

The Danfoss 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.

Danfoss’ 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 Danfoss 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 Danfoss 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 Danfoss Mobile Valves team.

Steering System Components

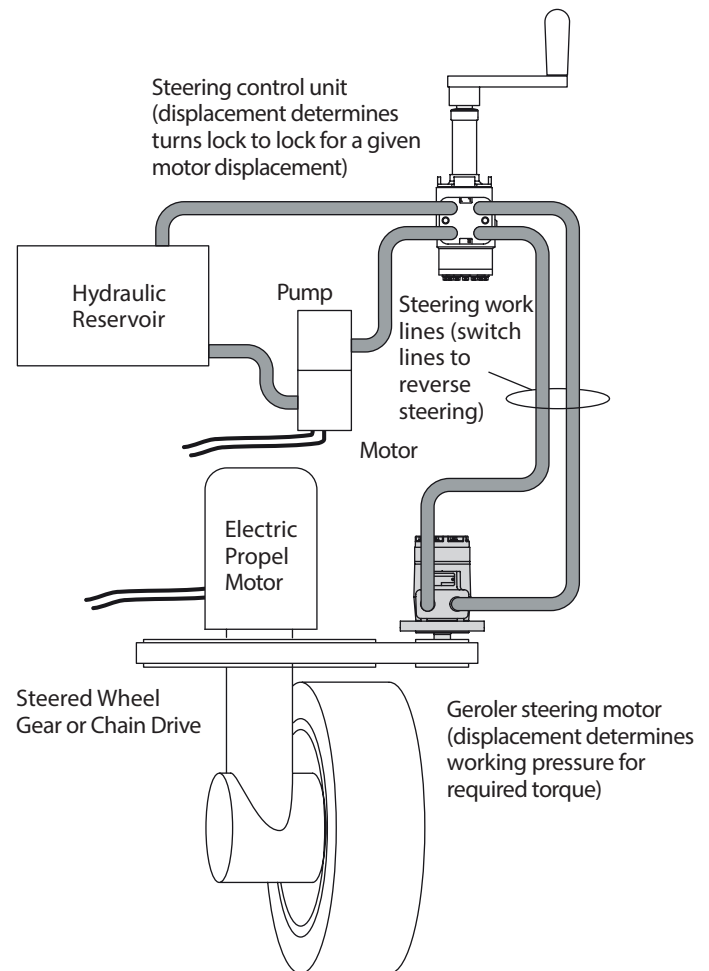
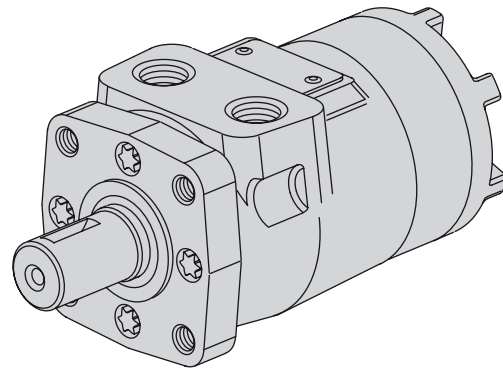
T Series Hydraulic Motors

Danfoss 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

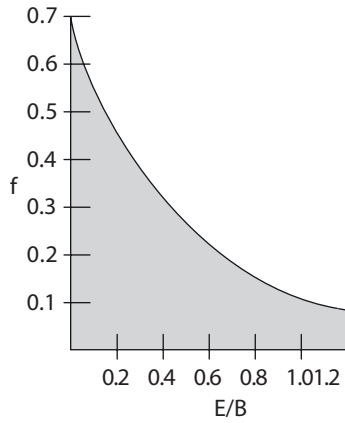
(See Danfoss General Purpose Motors H, S, T Series Catalog E-MOLO-MC001-E2)



Sizing and Application—

Ackermann Type Steering

Step One: Kingpin Torque



Typical values based on rubber tired vehicles on dry concrete.

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

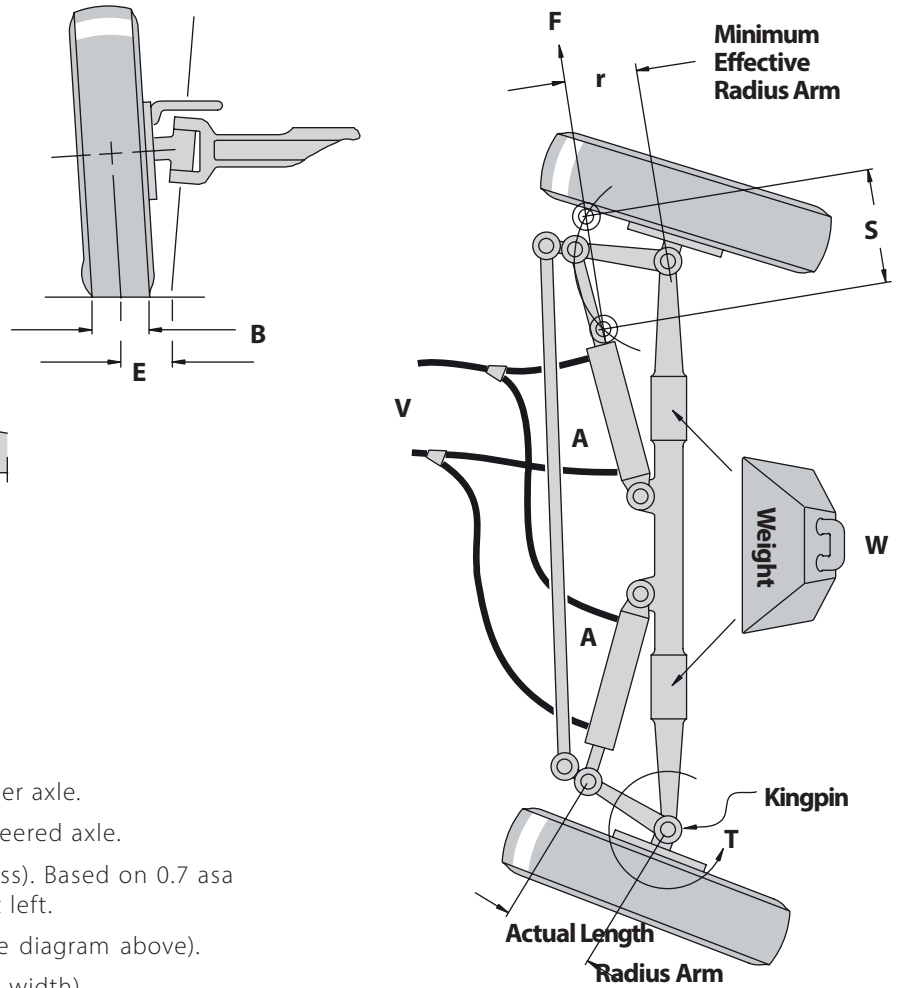
T = Total Kingpin Torque required to steer axle.

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

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

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%.

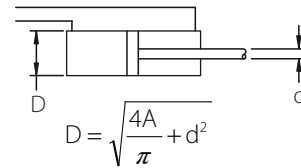
Cylinder Diameter

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

D = Inside diameter of cylinder.

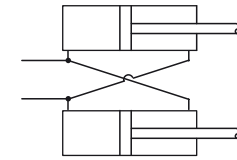
d = Rod diameter as required.

Differential Cylinder



Note: $\frac{d^2}{1D} \leq .5$

Cross Connected Cylinder



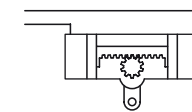
$$D = \sqrt{\frac{2A}{\pi} + \frac{d^2}{2}}$$

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.

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

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—

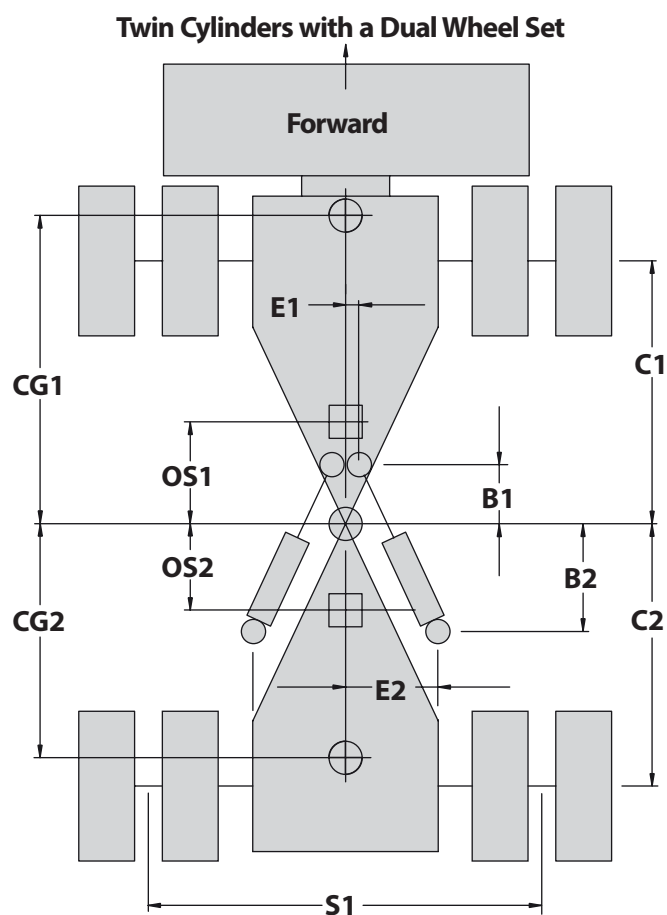
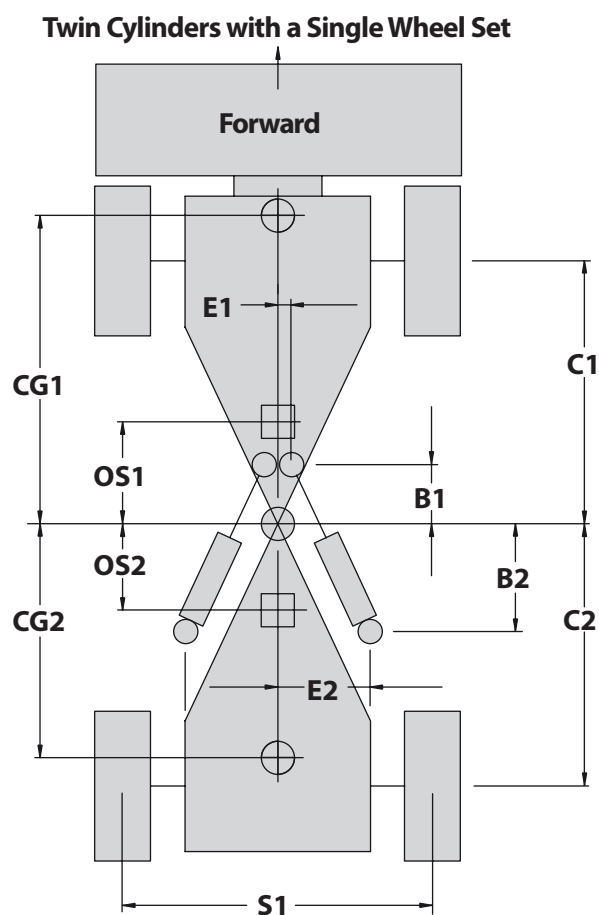
Articulated Type Steering

Danfoss 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 your Danfoss representative.



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 _____
GPM Lo Idle _____ | 28. CG2 (Center of Gravity) _____ |
| 8. Steering Relief Pressure _____ | 29. OS1 (Operator Seat) _____ |
| 9. Auxiliary Relief Pressure _____ | 30. OS2 (Operator Seat) _____ |
| 10. Hydraulic Schematic (attach) _____ | 31. Weight - Front Bogey _____ |
| 11. B1 _____ | 32. Weight - Rear Bogey
_____ |
| 12. B2 _____ | 33. I1 Mass Moment of Inertia (about CG1)
Front _____ |
| 13. C1 _____ | 34. I2 Mass Moment of Inertia (about CG2)
Rear _____ |
| 14. C2 _____ | 35. Tire Size _____ Pressure _____
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 systemsizing.

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

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

Products we offer:

- Cartridge valves
- DCV directional control valves
- Electric converters
- Electric machines
- Electric motors
- Gear motors
- Gear pumps
- Hydraulic integrated circuits (HICs)
- Hydrostatic motors
- Hydrostatic pumps
- Orbital motors
- PLUS+1® controllers
- PLUS+1® displays
- PLUS+1® joysticks and pedals
- PLUS+1® operator interfaces
- PLUS+1® sensors
- PLUS+1® software
- PLUS+1® software services, support and training
- Position controls and sensors
- PVG proportional valves
- Steering components and systems
- Telematics

Danfoss Power Solutions is a global manufacturer and supplier of high-quality hydraulic and electric components. We specialize in providing state-of-the-art technology and solutions that excel in the harsh operating conditions of the mobile off-highway market as well as the marine sector. Building on our extensive applications expertise, we work closely with you to ensure exceptional performance for a broad range of applications. We help you and other customers around the world speed up system development, reduce costs and bring vehicles and vessels to market faster.

Danfoss Power Solutions – your strongest partner in mobile hydraulics and mobile electrification.

Go to www.danfoss.com for further product information.

We offer you expert worldwide support for ensuring the best possible solutions for outstanding performance. And with an extensive network of Global Service Partners, we also provide you with comprehensive global service for all of our components.

Local address:

Hydro-Gear

www.hydro-gear.com

Daikin-Sauer-Danfoss

www.daikin-sauer-danfoss.com

**Danfoss
Power Solutions (US) Company**
2800 East 13th Street
Ames, IA 50010, USA
Phone: +1 515 239 6000

**Danfoss
Power Solutions GmbH & Co. OHG**
Krokamp 35
D-24539 Neumünster, Germany
Phone: +49 4321 871 0

**Danfoss
Power Solutions ApS**
Nordborgvej 81
DK-6430 Nordborg, Denmark
Phone: +45 7488 2222

**Danfoss
Power Solutions Trading
(Shanghai) Co., Ltd.**
Building #22, No. 1000 Jin Hai Rd
Jin Qiao, Pudong New District
Shanghai, China 201206
Phone: +86 21 2080 6201