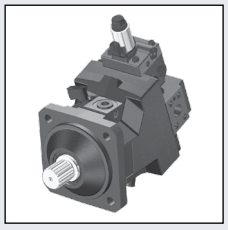
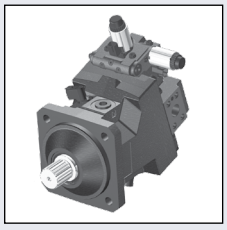
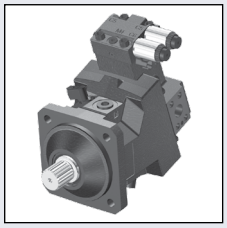
SAUER DANFOSS

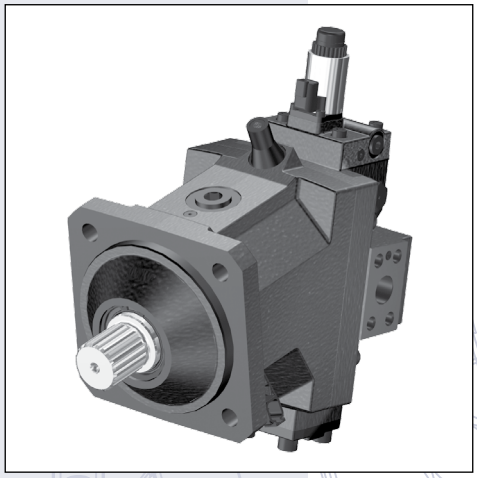
H1
Bent Axis Variable Displacement Motors
Size 060
Size 080
Size 110
Size 160

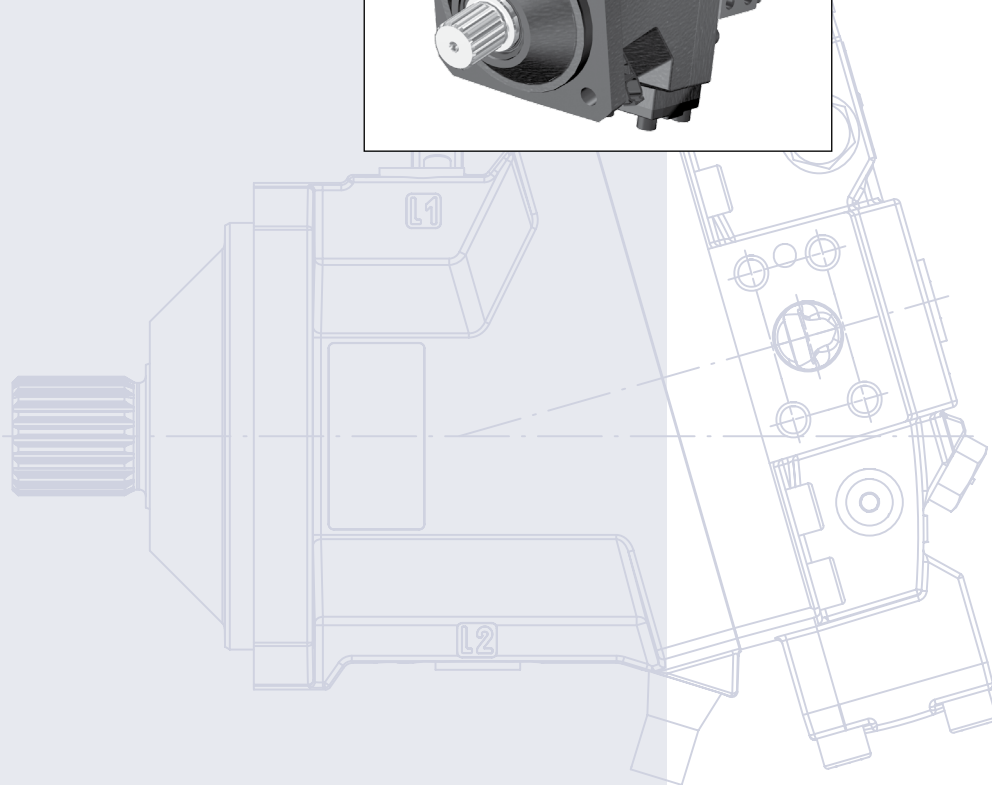
Technical Information











History of Revisions

Table of revisions

Date	Page	Changed	Rev.
21 May, 2008	—	First edition	AA
1 Dec, 2008	Different pages	New size (080)	BA
27 Jul, 2009	—	New size (060)	CA
30 Jul, 2009	47,49,51,55,57,59,63,65,67 15 68	Changed Split flange boss A/B: Full thread depth from 16.5 to 18.0 (size 060) Changed Metric system, Output Torque Added O-ring dimension (size 060)	CB
Dec 2, 2009	13-14	30 bar, and 35 bar deleted in diagram	CC
Jun, 2010	47, 49, 51, 55, 57, 59	Flange dimension (CJ) changed for SAE and DIN	CD
Sep 2010	76	New back cover	CE
Mar 2011	Various	New size (160)	DA
Jul 2011	27, 40, 62	New shaft option	DB
Aug 2011	5, 88-89	Headline corected	DC
Sep 2011	65, 73, 79	AC measurement, Introduction dates added	DD
Dec 2011	78	Dimension typo	DE
Jan 2012	36, 39		DF
Mar 2012	27	LN and LS ontions corrected	DG

Front cover illustrations: P003 427, P003 454, P003 434, P003 425, P003 420

H1 Bent Axis Variable Displacement Motors
Technical Information
Contents

H1 General Information

Design 6
- Cross section H1 Electric proportional control 6
- Cross section H1 Electric two-position control 7

General Description 8
The H1 Range of Products 8
System Diagram 9
- H1 Pump and H1 Motor with Electric proportional control 9

System Schematic 10

Technical Specifications

Technical Specifications 11
- General specifications 11
- Physical properties 11
- Operating parameters 12

Speed Range 12
Open Circuit Requirements 13
- Fluid specifications 15

Determination of Nominal Motor Sizes 15

Operating

Shaft Rotation Direction 16
Loop Flushing Shuttle Spool 17
Loop Flushing Relief Valve 17
Speed Sensor 18
Speed Sensor Connector 18
Sensor Position 18
Target Ring 18
Minimum Displacement Limiter 18

Operating Parameters

Overview 19
Output Speed 19
System Pressure 19
Case Pressure 20
External Shaft Seal Pressure 20
Temperature and Viscosity 20

System Design Parameters

Filtration System 22
Fluid Selection 22
Reservoir 23
Case Drain 23
Independent Braking System 23
Bearing Loads & Life 24
Shaft Torque 24

Model Code

Model Code 26

Control Operation and Description

Electric Controls 29
Electric Proportional Controls 29
Electric Two-Position Controls 29
Servo Supply 29

Contents

Controls Options Operation and Description

Control Options 30
PCOR 30
Proportional with PCOR 30
Two Position with PCOR 30
Two Position with Proportional PCOR 30
Hydraulic Two-Position Control 31
Control Options BPD 33
Electric Solenoid Connector 33
Applications-related Controls 33

Controls Circuit Diagram – Nomenclature – Description

Electric Proportional Control Options L1BA, L2BA 34
Electric Proportional Control with (PCOR) Options D1MA, D2MA 36
Electric Proportional Control with (PCOR) and (BPD) Options D1M1, D2M2 38
Electric Proportional Control Options M1CA, M2CA 40
Electric Proportional Control with (PCOR) and (BPD) Options K1K1, K2K2 42
Electric Two-Position Control Options E1AA, E2AA 44
Electric Two-Position Control with (PCOR) Options T1DA, T2DA 45
Electric Two-Position Control with (PPCOR) Options P1DA, P2DA 46
Electric Two-Position Control with (PCOR) and (BPD) Options T1D1, T2D2 48
Electric Two-Position Control with (PPCOR) and (BPD) Options P1D1, P2D2 49
Hydraulic Two-Position Control Option HEHE 51
Control Pressure X1 51
Hydraulic Two-Position Control Option HFHF 52
Control Pressure X1 52
Pressure Compensator OverRide (PCOR) 53
Pressure Compensator OverRide (PCOR) and Electric Brake Pressure Defeat (BPD) 54
Control Response 55

General Dimensions

SAE Flange Design, Proportional Control, Option L* 56
- Axial Ports 56
- Radial Ports 56

SAE Flange Design, Proportional Control, Option M* 58
- Axial Ports 58
- Radial Ports 58

SAE Flange Design, Two Position Control, Pressure Compensator Override, Electric Brake Pressure Defeat, Option T* D* and P* D* 60
- Axial Ports 60
- Radial Ports 60
- SAE Flange Design 62

DIN Flange Design, Proportional Control, Option L* 64
- Axial Ports 64
- Radial Ports 64

DIN Flange Design, Proportional Control, Option M* 66
- Axial Ports 66
- Radial Ports 66

DIN Flange Design, Two Position Control, Pressure Compensator Override,

Contents

General Dimensions (continued)

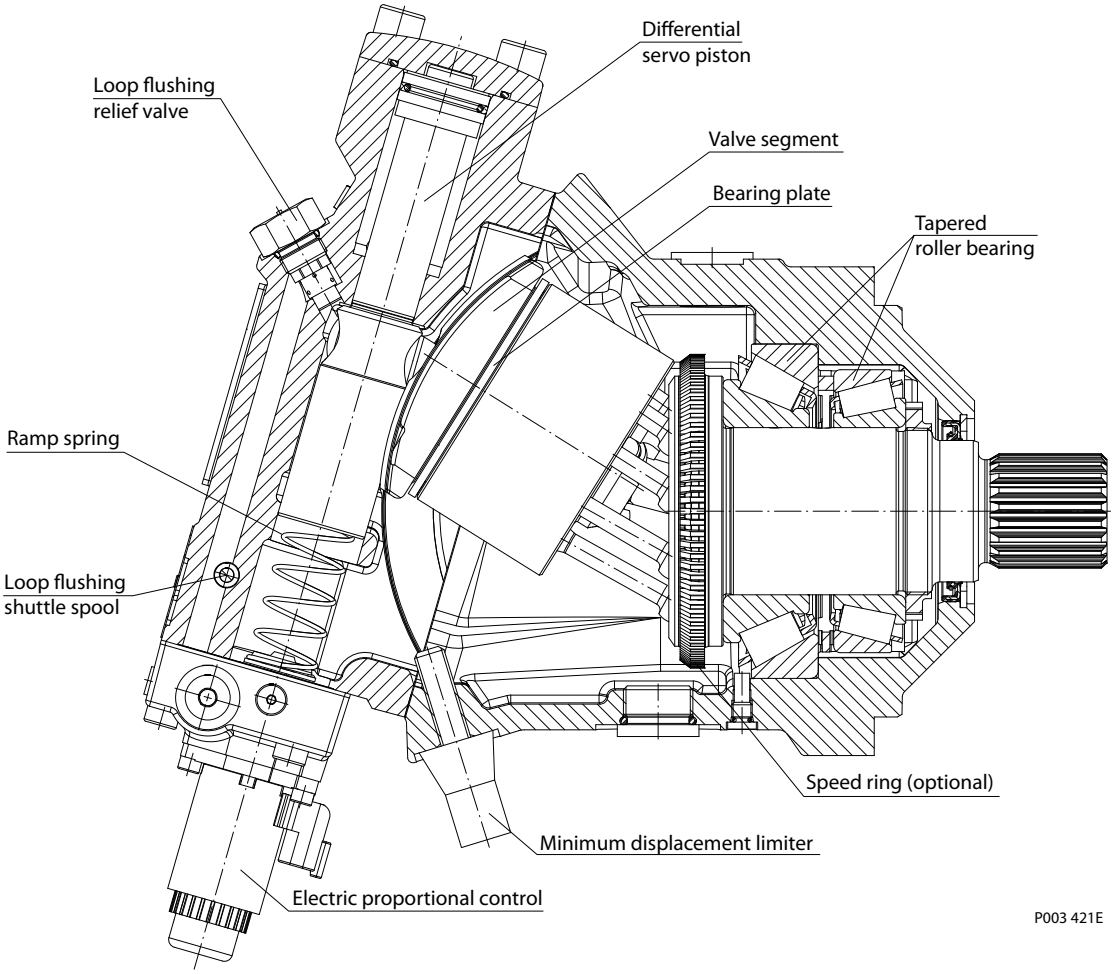
Electric Brake Pressure Defeat, Option T* D* and P* D* 68
Axial Ports 68
Radial Ports 68
Flange Design per ISO 3019/2, (DIN Flange) 70
Cartridge Flange Design, Proportional Control, Option L* 72
Axial Ports 72
Radial Ports 72
Cartridge Flange Design, Proportional Control, Option M* 74
Axial Ports 74
Radial Ports 74
Cartridge Flange Design, Two Position Control, Pressure Compensator Override, Electric Brake Pressure Defeat, Option T* D* and P* D* 76
Axial Ports 76
Radial Ports 76
Cartridge Flange Design 78

General Dimensions – Controls

Electric Proportional Control Options L1BA, L2BA 80
Electric Proportional Control Options M1CA, M2CA 81
Electric Proportional Control with (PCOR) and (BPD) Options K1K1, K2K2 82
Electric Two-Position Control Options E1AA, E2AA 83
Electric Two-Position Control with (PCOR) Options T1DA, T2DA and Electric Two-Position Control with (PPCOR) Options P1DA, P2DA 84
Electric Two-Position Control with (PCOR) and (BPD) Options T1D1, T2D2 and Electric Two-Position Control with (PPCOR) and (BPD) Options P1D1, P2D2 85
Hydraulic Two-Position Control Option HEHE 86
Hydraulic Two-Position Control Option HFHF 87
Electric Proportional Control Option D*M* 88
Electric Proportional Control Option D*MA 89
Hydraulic Two-Position Control Option TADA 90
Hydraulic Two-Position Control Option TAD* 91

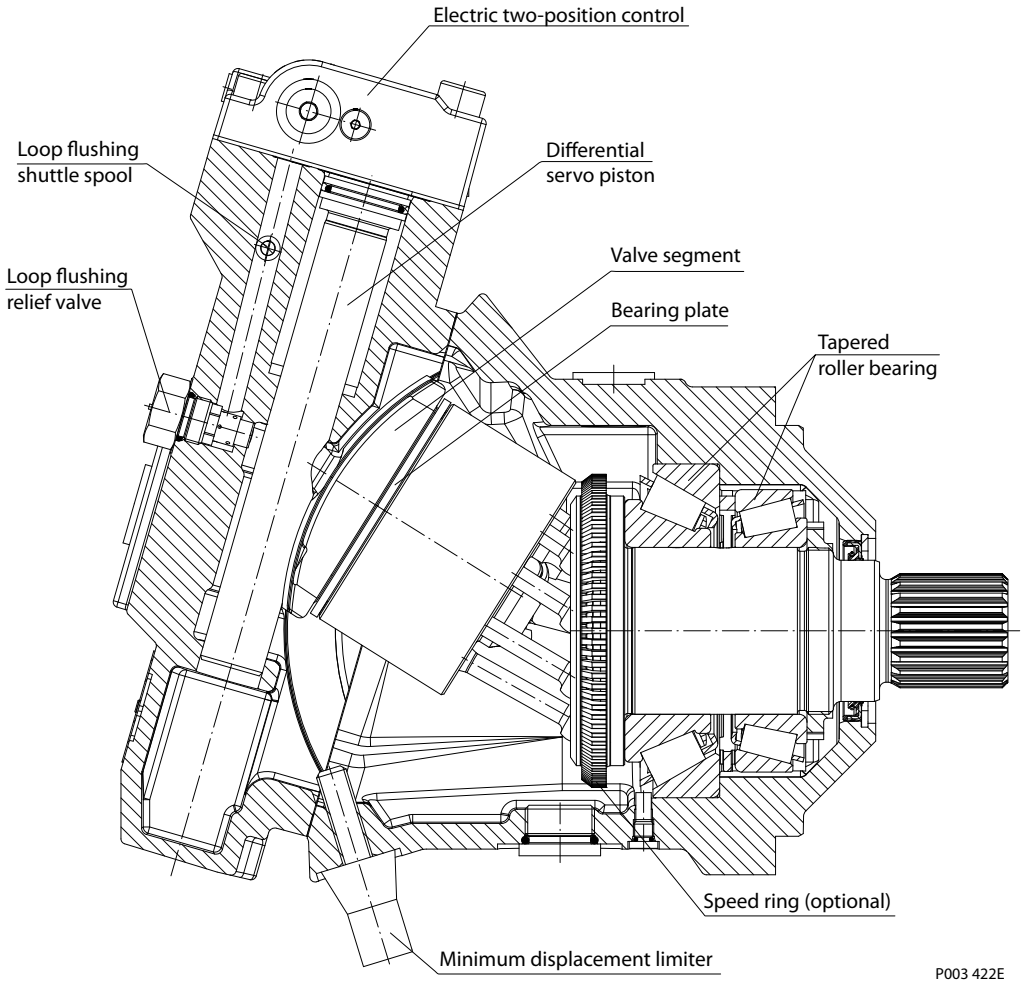
Design

Cross section H1 Electric proportional control



Design

Cross section H1 Electric two-position control



General Description

Series H1 variable displacement motors are bent axis design, incorporating spherical pistons.

These motors are designed primarily to be combined with other products in closed circuit systems to transfer and control hydraulic power. Series H1 motors have a large maximum/minimum displacement ratio of 5:1 and high output speed capabilities.

The expanded function of zero degree capability, coupled with a high performance 32 degree maximum angle, creates opportunities to easily improve the machine performance for:

- wheel assist on the steering axle of high inertia machines (i.e. combines) and could include Anti Slip Control
- off highway machines requiring Anti Slip (i.e. Ag sprayer)
- multi-motor applications requiring optimized work and transport modes (i.e. wheel loader, Ag sprayer) utilizing the zero degree position for maximum transport speed
- improved machine (i.e. Single Drum Roller) gradeability through precise Anti Slip Control

The Anti Slip Control reduces ground damage, increases traction control and improves machine controllability for the operator.

SAE, Cartridge and DIN flange with radial or axial high pressure port configurations are available including the loop flushing device.

A complete family of controls and regulators are available to fulfill the requirements of a wide range of applications.

Motors normally start at maximum displacement. This provides maximum starting torque for high acceleration.

All controls utilize internally supplied servo pressure. This may be overridden by a pressure compensator which functions when the motor is operating in motor and pump modes. A defeat option is available to disable the pressure compensator override when the motor is running in pump mode during deceleration/braking.

The pressure compensator option features a low pressure rise to ensure optimal power utilization throughout the entire displacement range of the motor.

Speed sensor options are available to cover all frame sizes and flange styles.
They are capable of sensing the following, all in one package;

- Speed
- Direction
- Temperature

The electric controls are specifically designed for the Sauer-Danfoss family of Plus+1™ micro controllers for easy Plug-and Perform ™ installation.

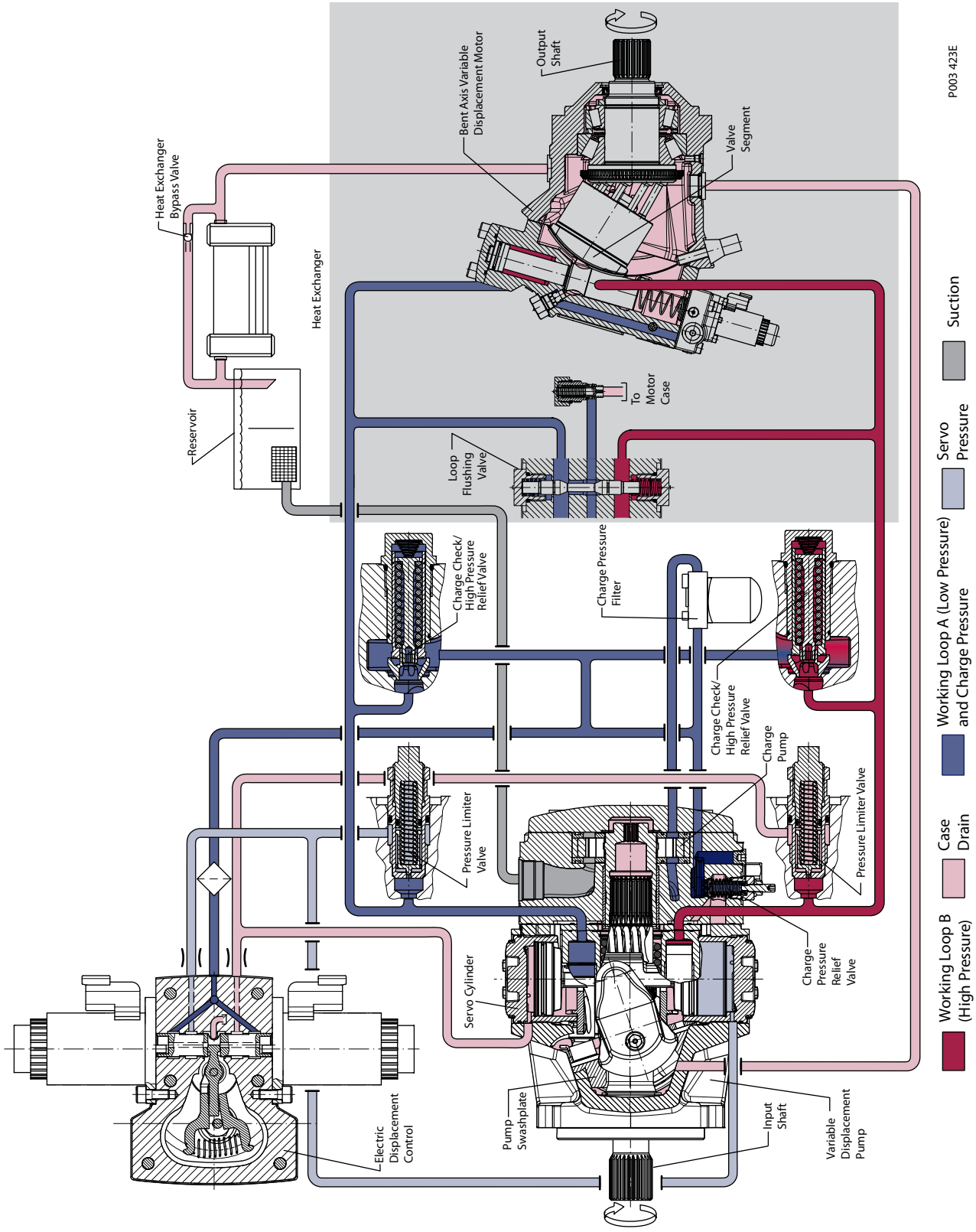
The H1 Range of Products

A growing family based on the success of the Series 51 product family

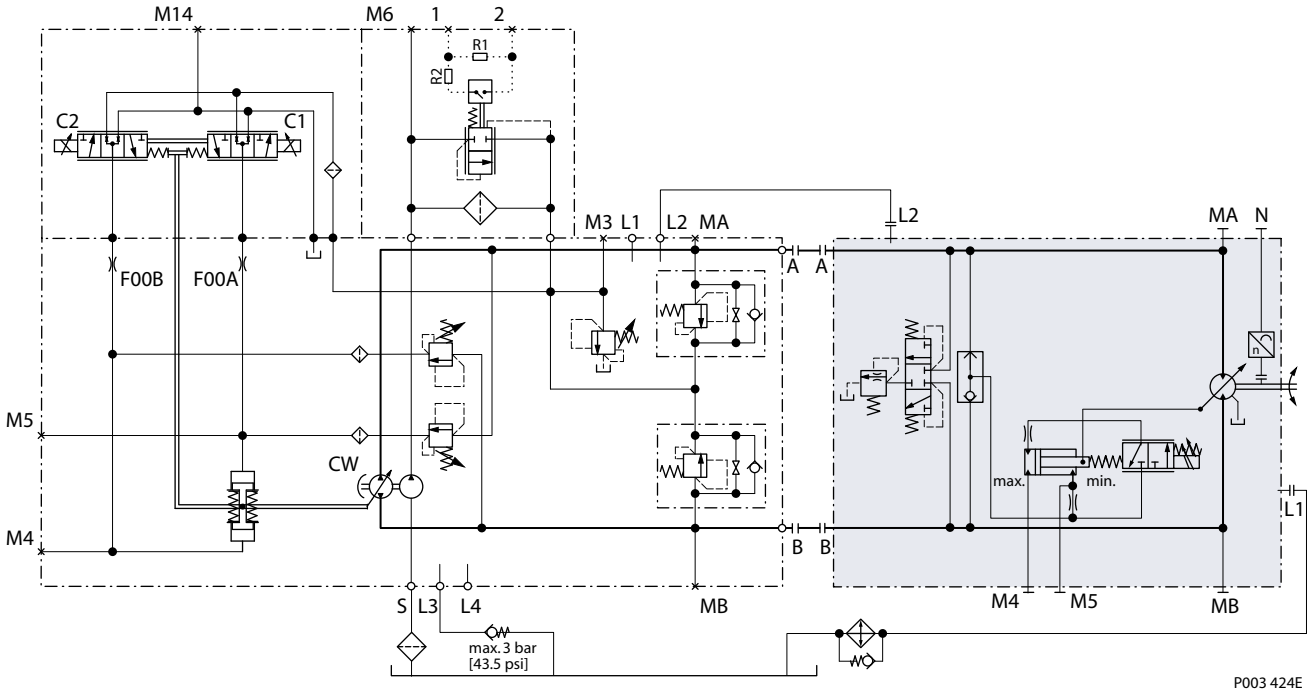
- Initial release of 060cc, 080cc, 110cc and 160 cc displacement size.
- Development plans include additional displacement sizes.

System Diagram

H1 Pump and H1 Motor with Electric proportional control



System Schematic



The schematic above shows the function of a hydrostatic transmission using an H1 Axial variable displacement pump with electric proportional displacement control (EDC) and an H1 Bent axis variable displacement motor with electric proportional control (L*) and integrated loop flushing device.

Technical Specifications

General specifications

Design	Piston motor with variable displacement bent axis design
Direction of rotation	Bi-directional
Pipe connections	Main pressure ports: ISO split flange boss
	Remaining ports: SAE straight thread O-ring boss
Recommended installation position	Discretionary, the housing must always be filled with hydraulic fluid

Physical properties

Features	**Unit**	**Size**			
		060	**080**	**110**	**160**
Displacement maximum	cm^3 [in^3]	60 [3.66]	80 [4.88]	110 [6.71]	160 [9.76]
Displacement minimum	cm^3 [in^3]	12 [0.73]	16 [0.98]	22 [1.34]	32 [1.95]
Flow at rated speed (theoretical)	l/min [US gal/min]	216 [57]	256 [67]	319 [84]	416 [110]
Flow at maximum speed (theoretical)	l/min [US gal/min]	270 [71]	328 [86]	407 [107]	528 [139]
Torque at maximum displacement (theoretical)	N•m/bar [lbf•in/1000 psi]	0.95 [583]	1.28 [784]	1.75 [1064]	2.55 [1563]
Theoretical corner power at rated speed and maximum working pressure (Δp = 450 bar [6527 psi])	kW [hp]	266 [356]	321 [430]	396 [531]	513 [688]
Mass moment of inertia of rotating components	kg•m^2 [slug•ft^2]	0.0042 [0.0031]	0.0064 [0.0047]	0.0114 [0.0084]	0.0204 [0.0150]
Weight dry (Electric proportional control)					
SAE configuration	kg [lb]	29.8 [65.8]	34.8 [76.9]	48.8 [107.8]	61.9 [136.5]
DIN configuration	kg [lb]	28.3 [62.5]	34.4 [76.0]	45.0 [99.4]	59.3 [130.7]
Cartridge configuration	kg [lb]	26.9 [58.4]	33.0 [72.8]	41.8 [92.3]	54.7 [120.6]
Case volume	liter [US gal]	0.9 [0.24]	1.0 [0.26]	1.4 [0.37]	2.7 [0.71]
Mounting flange					
SAE ISO 3019/1		Flange 127-4 (SAE C) 4-bolt		Flange 152-4 (SAE-D)	
DIN ISO 3019/2		Flange 125 B4 HL 4-bolt	Flange 140 B4 HL 4-bolt	Flange 160 B4 HL 4-bolt	Flange 180 B4 HL 4-bolt
Cartridge		Pilot dia 160 mm 2-bolt (200 dist.) M16	Pilot dia 190 mm 2-bolt (224 dist.) M20	Pilot dia 200 mm 2-bolt (250 dist.) M20	
Customer ports					
Radial split flange boss		DN19 typ I 40Mpa series ISO 6162	DN25 typ I 40Mpa series ISO 6162		DN32 typ I 40Mpa series ISO 6162
Axial SAE O-ring boss (Gage port)		0.875-14UN-2B [$^7/_8$-14UN-2B]	1.0625-12UN-2B [1 $^1/_{16}$-12UN-2B]		
Axial split flange boss		DN19 typ I 40Mpa series ISO 6162	DN25 typ I 40Mpa series ISO 6162		DN32 typ I 40Mpa series ISO 6162
Gage port SAE-O-ring boss		0.5625-18UNF-2B [$^9/_{16}$-18UNF-2B]			
Case drain ports	SAE O-ring boss	0.875-14UN-2B [$^7/_8$-14UN-2B]		1.0625-12UN-2B [1 $^1/_{16}$-12UN-2B]	
Gage ports	SAE O-ring boss	0.5625-18UNF-2B [$^9/_{16}$-18UNF-2B]			

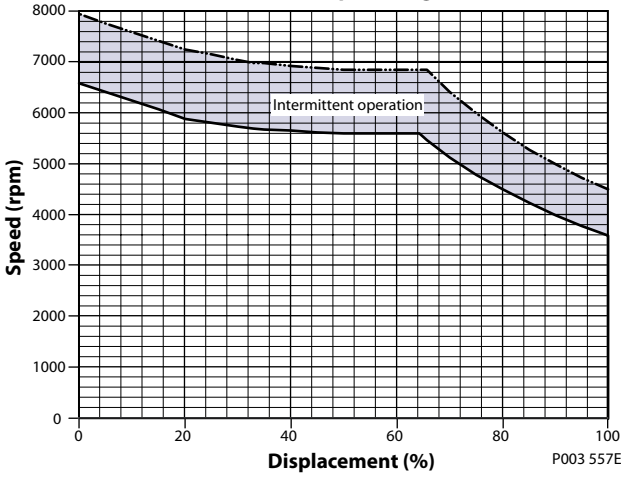
Technical Specifications (continued)

Operating parameters

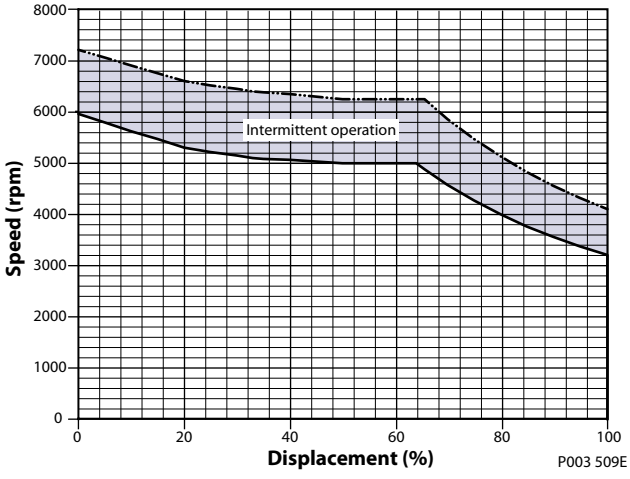
Features			Unit	Size			
				060	080	110	160
Output speed	Rated	maximum displacement 32°	min-1 (rpm)	3600	3200	2900	2600
		minimum displacement 6°		5900	5300	4800	4250
		zero displacement 0°		6600	5950	5350	4750
	Maximum	maximum displacement 32°		4500	4100	3700	3300
		minimum displacement 6°		7250	6600	5950	5250
		zero displacement 0°		7950	7200	6500	5750
System pressure	Max. working pressure		bar [psi]	450 [6527]			
	Maximum pressure			480 [6960]			
	Minimum pressure			7.5 [109]			
Case pressure	Rated		bar [psi]	3 [44]			
	Maximum			5 [73]			
	Minimum			0.3 [4]			

Speed Range

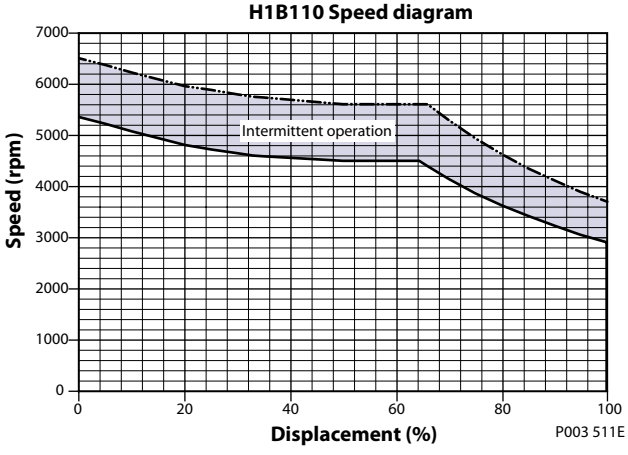
H1B060 Speed diagram



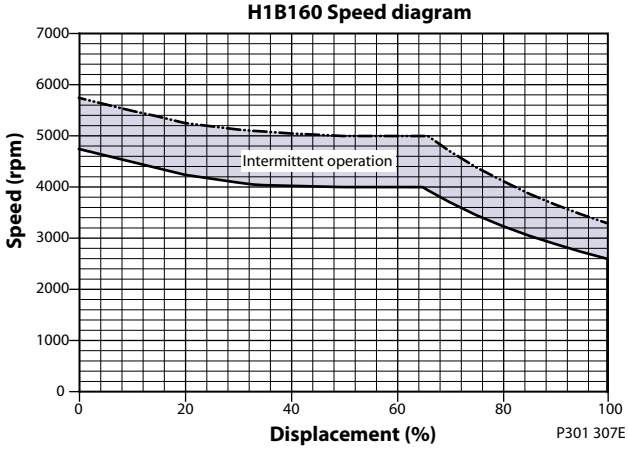
H1B080 Speed diagram



H1B110 Speed diagram



H1B160 Speed diagram



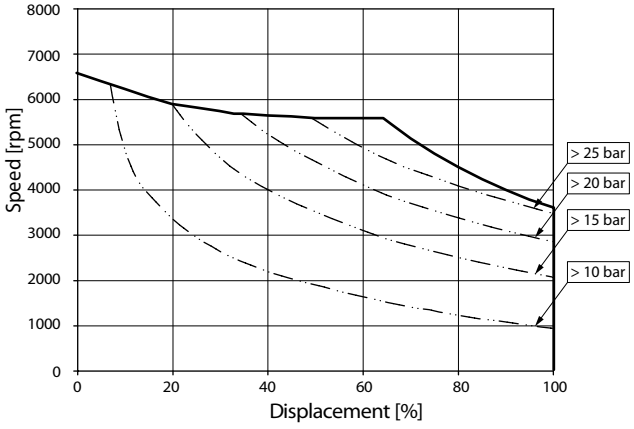
Open Circuit Requirements

The H1 Bent Axis Motor can be used in Open Circuit Applications if the following conditions are met:

- The application must ensure that the motor will operate in motoring mode under all conditions encountered.
- A counter-balance valve must be installed in-line with the working pressure line to ensure continuous motoring mode.
- A counter-balance valve must have sufficient flow capability in regards to the maximum flow of the motor.
- Ensure sufficient cooling capacity since the counter-balance valve converts the energy to heat.
- At no time shall the motor be allowed to operate above the rated speed limits. If flow limiter valves are used, they must be selected accordingly.
- The internal loop flushing is nonfunctional in open circuit applications. Cross flushing flow of the motor is required to prevent overheating.
- Motor controls should be selected that use the high loop system pressure to shift the servo piston. This will ensure proper function under all conditions.
- Valve blocks, attached to the high pressure ports must not interfere with any parts of the motor. A review of the outline drawings or appropriate 3D models must be completed.
- Sauer-Danfoss doesn't offer a counter-balance valve.
- The system and motor case must be kept full of oil at all times, whether in a dynamic or static condition. The plumbing must not allow the oil to drain down and be replaced with air in the control or rotating group.
- The minimum pressure in the high side and the low side of the loop, as measured at gage ports MA and MB, must be within the limits in the following graphs.
- A minimum summing pressure is required to prevent tipping of the cylinder block or valve segment and to avoid cavitation. The graphs below show the minimum pressures for the high and low side loops.

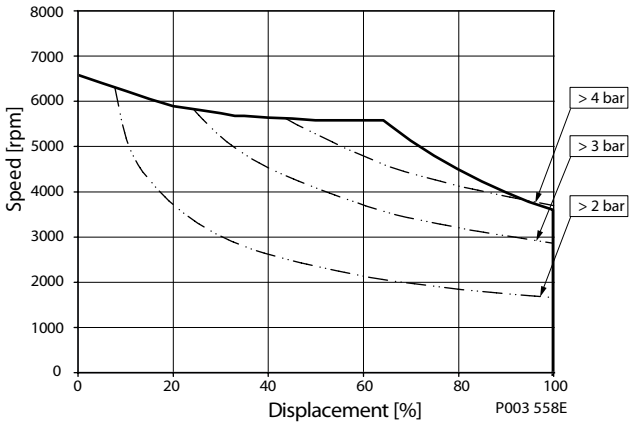
H1B060

Minimum Pressure on the High Loop Side versus Speed and Displacment



H1B060

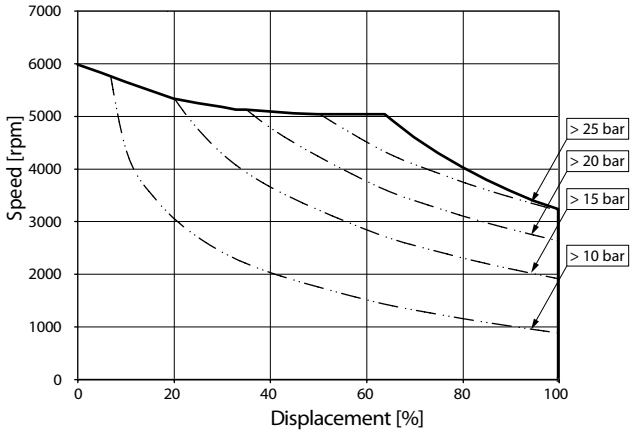
Required Low Pressure above Case Pressure versus Speed and Displacement



Open Circuit Requirements (continued)

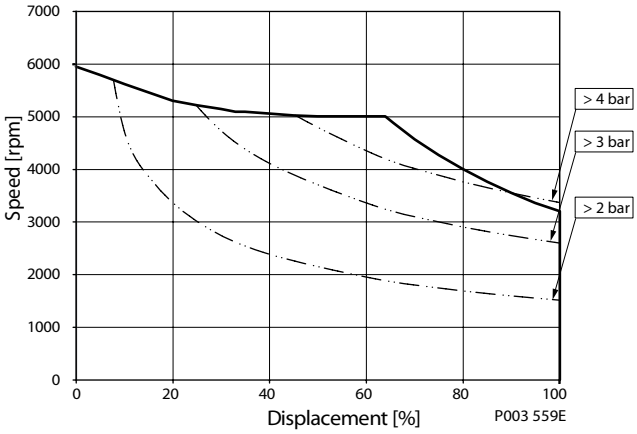
H1B080

Minimum Pressure on the High Loop Side versus Speed and Displacment



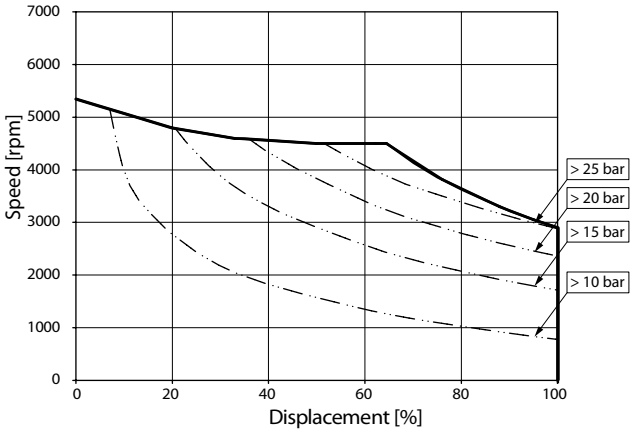
H1B080

Required Low Pressure above Case Pressure versus Speed and Displacement



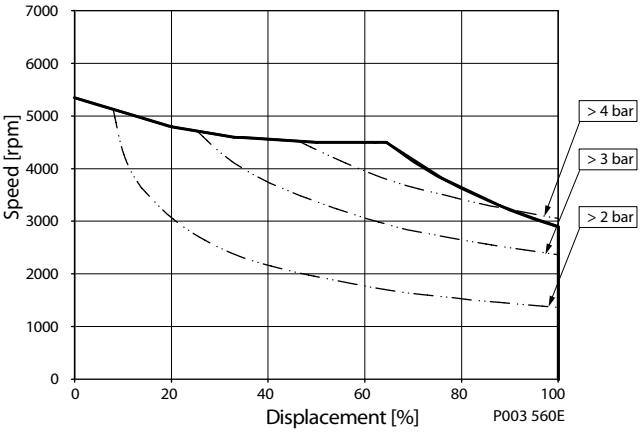
H1B110

Minimum Pressure on the High Loop Side versus Speed and Displacment



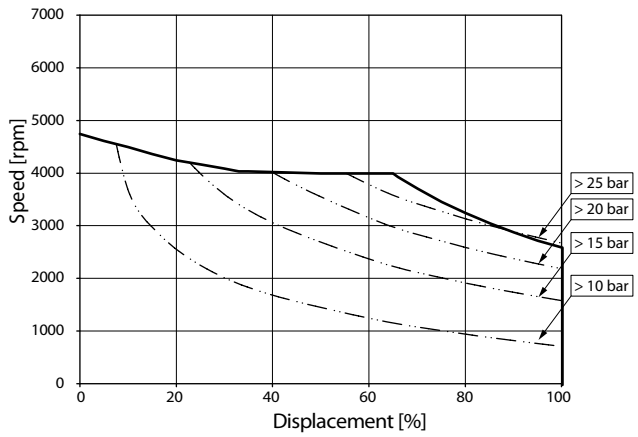
H1B110

Required Low Pressure above Case Pressure versus Speed and Displacement



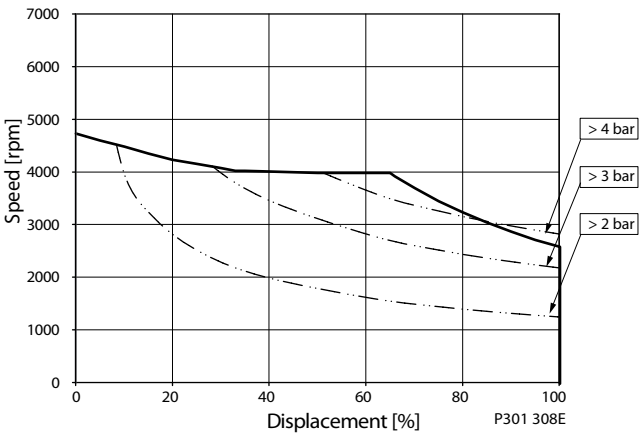
H1B160

Minimum Pressure on the High Loop Side versus Speed and Displacment



H1B160

Required Low Pressure above Case Pressure versus Speed and Displacement



Fluid specifications

Features		Unit	
Viscosity	Minimum	mm^2/s [SUS]	7 [49]
	Recommended range		12-80 [66-370]
	Maximum		1600 [7500]
Temperature range [1)]	Minimum	°C [°F]	-40 [-40]
	Rated		104 [220]
	Maximum intermittent		115 [240]
Filtration (recommended minimum)	Cleanliness per ISO 4406		22/18/13
	Efficiency (charge pressure filtration)	β-ratio	$\beta_{15-20} = 75$ ($\beta_{10} \geq 10$)
	Efficiency (suction and return line filtration)		$\beta_{35-45} = 75$ ($\beta_{10} \geq 2$)
	Recommended inlet screen mesh size	µm	100 – 125

[1)] At the hottest point, normally case drain port.

Determination of Nominal Motor Sizes

	Metric system		Inch system	
Input flow	$Q_e = \frac{V_g \cdot n}{1000 \cdot \eta_v}$	l/min	$Q_e = \frac{V_g \cdot n}{231 \cdot \eta_v}$	[US gal/min]
Output torque	$M_e = \frac{V_g \cdot \Delta p \cdot \eta_{mh}}{20 \cdot \pi}$	Nm	$M_e = \frac{V_g \cdot \Delta p \cdot \eta_{mh}}{2 \cdot \pi}$	[lbf•in]
Output power	$P_e = \frac{M_e \cdot n}{9550} = \frac{Qe \cdot \Delta p \cdot \eta_t}{600}$	kW	$P_e = \frac{V_g \cdot n \cdot \eta_t}{396\,000}$	[hp]
Speed	$n = \frac{Q_e \cdot 1000 \cdot \eta_v}{V_g}$	min^{-1}	$n = \frac{Q_e \cdot 231 \cdot \eta_v}{V_g}$	min^{-1}(rpm)

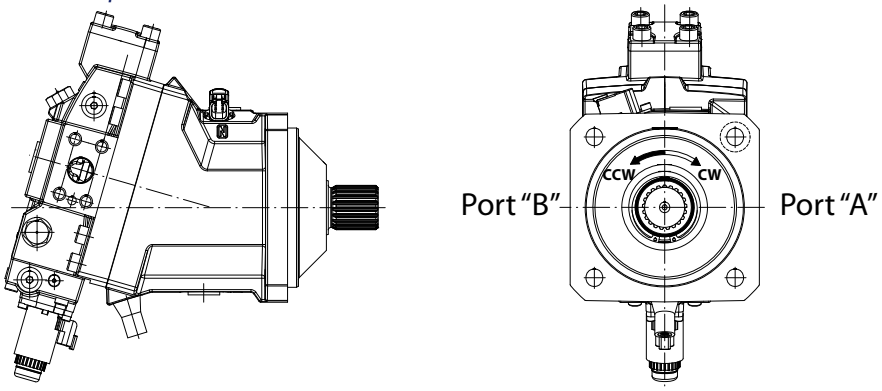
Where:

V_g	=	Motor displacement per rev.	cm^3 [in^3]
Δp	=	$p_{high} - p_{low}$	bar [psi]
p_{high}	=	High pressure	bar [psi]
p_{low}	=	Low pressure	bar [psi]
M_e	=	Output torque	Nm [lbf•in]
η_v	=	Motor volumetric efficiency	
η_{mh}	=	Motor mechanical-hydraulic efficiency	
η_t	=	Motor total efficiency	

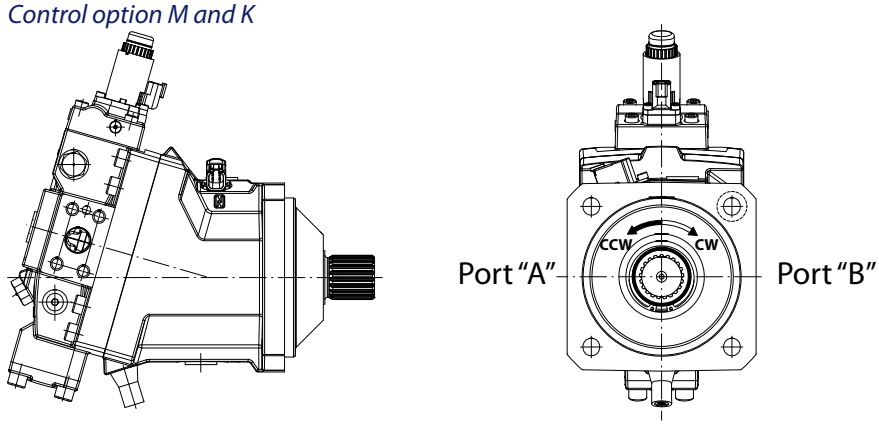
Shaft Rotation Direction

Shaft rotation direction is determined with a view to the shaft end.
Rotation direction of the motor will be dependent on the control option used as illustrated below and summarized in the table.

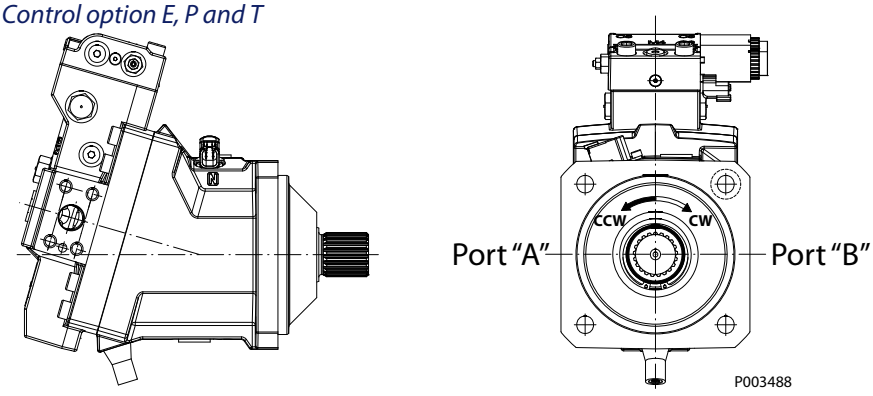
Control option L and D



Control option M and K



Control option E, P and T

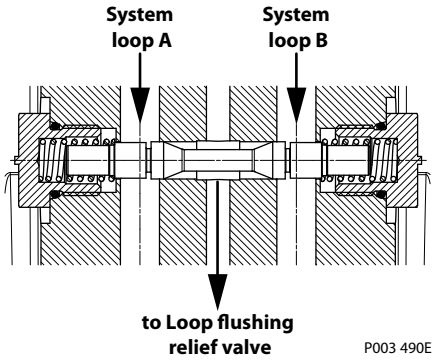


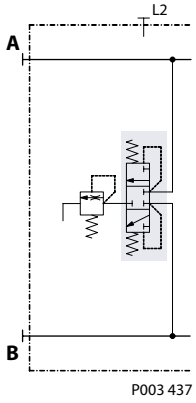
Position of control	**Flow into port**	**Direction of rotation** (view from the shaft end)
Control options L* and D*	A	CW
	B	CCW
Control Option M*,K*,E*P*,T*,TA, HE and HF	A	CCW
	B	CW

*) 1 = 12 Vdc
2 = 24 Vdc

Loop Flushing Shuttle Spool

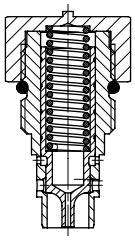
An integral loop flushing shuttle spool is used to separate system A and system B pressures. System delta pressure will cause the shuttle spool to shift, allowing the low side system pressure to flow to the loop flushing relief valve.

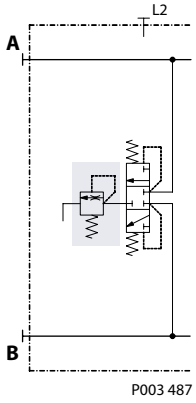




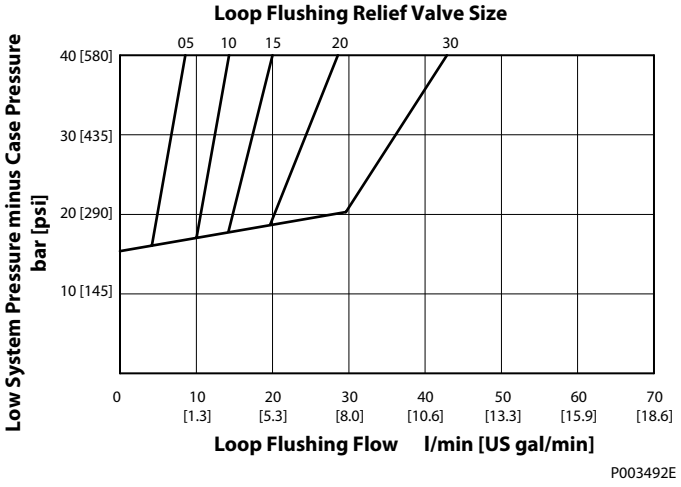
Loop Flushing Relief Valve

The loop flushing relief valve is incorporated into all H1 motors. Use the loop flushing option in Installations that require fluid to be removed from the low pressure side of the system circuit due to cooling requirements and also used to facilitate the removal of contaminants from the loop.





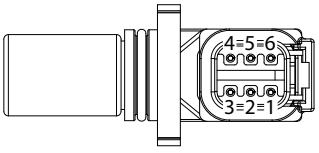
The loop flushing valve is equipped with an orificed charge pressure relief valve designed with a cracking pressure of 16 bar [232 psi]. Valves are available with several orifice sizes to meet the flushing flow requirements of all system operating conditions.



Speed Sensor

An optional, non-adjustable speed sensor is available. It is capable of measuring speed, direction of rotation and case oil temperature. The temperature sensor can not be used for dynamic measurement. The temperature sensor can be used for diagnostic purposes and other uses not requiring instantaneous temperature updates.

Speed sensor technical data

	Min.	Nom.	Max.	Units	
Supply	4.75	5	5.25	Vdc	
Supply protection	–	–	30	Vdc	
Max. required supply current			25	mA	
Output mode	NPN & PNP				
Connector	DEUTSCH DTM-Series 6-Pin DTM 04 – 6P				
Connector terminals					Sensor pinout 1 Speed signal 2 2 Direction signal 3 Speed signal 1 4 Supply 5 Ground 6 Temperature
Protection code IP-class	IP 67 and IP 69k according to IEC 60529 & DIN 40050				

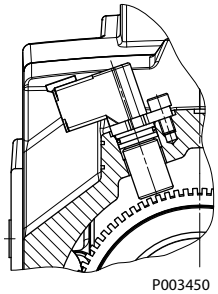
Please see *Speed and Temperature Sensor, Technical Information 11046759*

Speed Sensor Connector

Description	Quantity	Ordering number
Mating connector kit	1	11033865

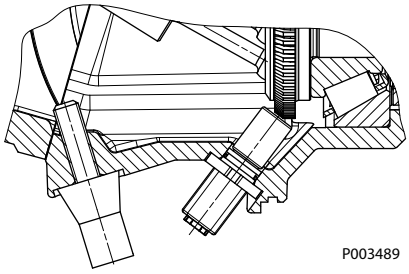
Sensor Position

SAE and DIN housing



P003450

Cartridge housing



P003489

Target Ring

Target ring size	H1B 060	H1B 080	H1B 110	H1B 160
Number of teeth	71	78	86	95

Minimum Displacement Limiter

All Series H1 Motors incorporate mechanical displacement limiters. The minimum displacement of the motor is preset at the factory with a set screw in the motor housing. A tamper-proof cap is provided.

Overview

This section defines the operating parameters and limitation for H1 motors with regard to output speeds and pressures. For actual parameters, refer to the operating parameters for each displacement.

Output Speed

Start Speed and Low Speed Stability

The motor produces maximum starting torque at maximum displacement. Stable operation can be achieved at 15-34 pm, ± 5 %, depending on system pressure, in applications that require low speed stability. Motor output rpm becomes more stable as speed increases.

Rated Speed is the highest output speed recommended at full power condition. Operating at or below this speed will yield satisfactory product life.

Maximum Speed is the highest operating speed permitted. Exceeding maximum speed reduces the product life and can cause loss of hydrostatic power and dynamic braking capacity. Never exceed the maximum speed limit under any operating conditions.

Operation between Rated Speed and Maximum is reserved for **Intermittent Operation** (see page 12) not to exceed 5 minute durations. Speed above Rated are anticipated to occur during downhill braking (negative power).

Contact factory for any operation above Rated speed when negative power is not involved.

⚠ Warning

Unintended vehicle or machine movement hazard.

Exceeding maximum speed may cause a loss of hydrostatic drive line power and dynamic braking capacity. In all propel systems, a braking system must be provided, redundant to the hydrostatic transmission, and sufficient to stop and hold the vehicle or machine in the event of hydrostatic drive power loss.

System Pressure

System pressure is the differential pressure between high pressure system ports. It is the dominant operating variable affecting hydraulic unit life. High system pressure, which results from high load, reduces expected life. Hydraulic unit life depends on the speed and normal operating, or weighted average, pressure that can only be determined from a duty cycle analysis.

Application pressure - is the high pressure relief or pressure limiter setting normally defined within the order code of the pump. This is the applied system pressure at which the driveline generates the maximum calculated pull or torque in the application.

Maximum Working Pressure - is the highest recommended application pressure. Maximum working pressure is not intended to be a continuous pressure. Propel systems with application pressures at, or below, this pressure should yield satisfactory unit life given proper component sizing.

Maximum pressure is the highest allowable application pressure under any circumstance.
For applications which are above the maximum working pressure, please contact Sauer-Danfoss

System Pressure (continued)

Minimum pressure must be maintained under all operating conditions to avoid cavitation.

All pressure limits are differential pressures referenced to low loop (charge) pressure. Subtract the low loop gage pressure from the high loop gage pressure readings to compute the differential.

Summing Pressure is the sum of both the low and high loop pressures. Summing pressure above 30 bar [435 psi] guarantees reliable use within the rated speed.

Servo Pressure is the pressure in the servo system and is supplied from the high side of the loop to keep the motor at the required displacement.

Case Pressure

Under normal operating conditions, the **rated case pressure** must not be exceeded. During cold start, case pressure must be kept below maximum intermittent case pressure. Size drain plumbing accordingly.

Caution

Possible component damage or leakage.

Operation with case pressure in excess of stated limits may damage seals, gaskets, and/or housings, causing external leakage. Performance may also be affected since charge and system pressures are referenced to case pressure.

External Shaft Seal Pressure

In certain applications, the output shaft seal may be exposed to external pressures. The shaft seal is designed to withstand an external pressure up to 0.25 bar [3.6 psi] above the case pressure. The case pressure limits must also be followed to ensure the shaft seal is not damaged.

Temperature and Viscosity

Temperature

The high temperature limits apply at the hottest point in the transmission, which is normally the motor case drain. The system should generally be run at or below the published **rated temperature**.

The **maximum intermittent temperature** is based on material properties and should never be exceeded.

Cold oil will generally not affect the durability of the transmission components, but it may affect the ability of oil to flow and transmit power. Therefore, temperatures should remain 16 °C [30 °F] above the pour point of the hydraulic fluid.

The **minimum temperature** relates to the physical properties of component materials.

Size heat exchangers too keep the fluid within these limits. Sauer-Danfoss recommends testing to verify that these temperature limits are not exceeded.

Viscosity

For maximum efficiency and bearing life, ensure that the fluid viscosity remains in the **recommended range**.

Temperature and Viscosity (continued)

The **minimum viscosity** should be encountered only during brief periods of maximum ambient temperature and severe duty cycle operation.

The **maximum viscosity** should be encountered only at cold start.

Filtration System

To prevent premature wear, ensure that only clean fluid enters the hydrostatic transmission circuit. A filter capable of controlling the fluid cleanliness to ISO 4406, class 22/18/13 (SAE J1165) or better, under normal operating conditions, is recommended. These cleanliness levels can not be applied for hydraulic fluid residing in the component housing/case or any other cavity upon delivery from the factory.

The filter may be located on the pump (integral) or in another location (remote or suction). The integral filter has a filter bypass sensor to signal the machine operator when the filter requires changing. Filtration strategies include suction or pressure filtration. The selection of the filter strategy depends on a number of factors including the contaminant ingression rate, the generation of contaminants in the system, the required fluid cleanliness, and the desired maintenance interval. Filters are selected to meet the above requirements using rating parameters of efficiency and capacity.

Filter efficiency can be measured with a Beta ratio[1] (β_x). For simple suction-filtered closed circuit transmissions and open circuit transmissions with return line filtration, a filter with a β-ratio within the range of $\beta_{35-45} = 75$ ($\beta_{10} \geq 2$) or better has been found to be satisfactory. For some open circuit systems, and closed circuits with cylinders being supplied from the same reservoir, a higher filter efficiency is recommended. This also applies to systems with gears or clutches using a common reservoir.
For these systems, a charge pressure or return filtration system with a filter β-ratio in the range of $\beta_{15-20} = 75$ ($\beta_{10} \geq 10$) or better is typically required.

Because each system is unique, only a thorough testing and evaluation program can fully validate the filtration system. Please see *Design Guidelines for Hydraulic Fluid Cleanliness Technical Information,* 520L0467 for more information.

Cleanliness level and β_x-ratio			
Filtration (recommended minimum)	Cleanliness per ISO 4406		22/18/13
	Efficiency (charge pressure filtration)	β-ratio	$\beta_{15-20} = 75$ ($\beta_{10} \geq 10$)
	Efficiency (suction and return line filtration)		$\beta_{35-45} = 75$ ($\beta_{10} \geq 2$)
	Recommended inlet screen mesh size	µm	100 – 125

Fluid Selection

Ratings and performance data are based on operating with hydraulic fluids containing oxidation, rust and foam inhibitors. These fluids must possess good thermal and hydrolytic stability to prevent wear, erosion, and corrosion of motor components. Never mix hydraulic fluids of different types.

Fire resistant fluids are also suitable at modified operating conditions. Please see *Hydraulic Fluids and Lubricants Technical Information,* 520L0463**,** for more information. Refer to *Experience with Biodegradable Hydraulic Fluids Technical Information,* 520L0465**,** for information relating to biodegradable fluids. Contact Sauer-Danfoss for fluids not mentioned below.

[1] Filter β_x-ratio is a measure of filter efficiency defined by ISO 4572. It is defined as the ratio of the number of particles greater than a given diameter ("x" in microns) upstream of the filter to the number of these particles downstream of the filter.

Fluid Selection (continued)

The following hydraulic fluids are suitable:

- Hydraulic Oil ISO 11 158 - HM (Seal compatibility and vane pump wear resistance per DIN 51 524-2 must be met)
- Hydraulic Oil ISO 11 158 - HV (Seal compatibility and vane pump wear resistance per DIN 51 524-3 must be met)
- Hydraulic Oil DIN 51 524-2 - HLP
- Hydraulic Oil DIN 51 524-3 - HVLP
- Automatic Transmission Fluid ATF A Suffix A (GM)
- Automatic Transmission Fluid Dexron II (GM), which meets Allison C-3 and Caterpillar TO-2 test
- Automatic Transmission Fluid M2C33F and G (Ford)
- Engine oils API Classification SL, SJ (for gasoline engines) and CI-4, CH-4, CG-4, CF-4 and CF (for diesel engines)
- Super Tractor Oil Universal (STOU) special agricultural tractor fluid

Reservoir

Proper sizing of the hydrostatic system reservoir will allow maximum volume changes during all system operating modes and increase de-aeration of the fluid as it passes through the tank. A suggested minimum total reservoir volume is ⅝ of the maximum charge pump flow per minute with a minimum fluid volume equal to ½ of the maximum charge pump flow per minute. This allows 30 seconds of fluid dwell time for removing entrained air at the maximum return flow. This is usually adequate to allow for a closed reservoir having no breather in most applications.

Locate the reservoir outlet to the charge pump inlet above the bottom of the reservoir to take advantage of gravity separation and prevent large foreign particles from entering the charge inlet line. A 100-125 mesh screen over the reservoir outlet port is recommended. Position the reservoir inlet for the fluid return to discharge below the normal fluid level and toward the interior of the tank. A baffle or baffles, between the inlet and outlet of the reservoir will further increase de-aeration and reduce surging of the fluid.

Case Drain

A case drain line must be connected to the case outlets of each motor to return the internal leakage oil to the system reservoir. When filling the case before start up, use the highest case drain outlet to promote complete filling of the case. The case drain fluid is typically the hottest fluid in the system. It is highly recommended to route the case drain flow through a heat exchanger before it is returned to the reservoir.

In some applications, it may be required the use of additional cross-flushing of the motor. If the motor is used mainly in a high speed application, higher cooling requirements may be needed for the rotating kit and tapered roller bearings.
Use the lowest case drain port as the inlet port and the highest case drain port as the outlet port. This will ensure that the case is full of oil at all times.
Apply unit case pressure ratings to case drain routing and design.

Independent Braking System

⚠ Warning

Unintended vehicle or machine movement hazard.

The loss of hydrostatic drive line power, in any mode of operation (forward, neutral, or reverse) may cause the system to lose hydrostatic braking capacity. A braking system must be provided, redundant to the hydrostatic transmission, and sufficient to stop and hold the vehicle or machine in the event of hydrostatic drive power loss.

Bearing Loads & Life

Bearing life is a function of speed, system pressure, motor angle and any external side or thrust loads. The influence of motor angle includes displacement as well as direction. External side loads are found in some applications such as a helical gear without its own support bearings, installed directly on to the motor shaft. All external side loads will act to reduce the normal bearing life of the motor. Other life factors include oil type and viscosity.

When external side loads are present, the allowable radial shaft loads are a function of the load position relative to the mounting flange, the load orientation relative to the internal loads and the operating pressures of the hydraulic unit. In applications where external shaft loads can not be avoided, the impact on bearing life can be minimized by proper orientation of the load. Optimal motor orientation is a consideration of the net loading on the shaft from the external load and the motor rotating kit.

Contact Sauer-Danfoss for a bearing life review if external side loads and thrust loads are present.

Shaft Torque

Available shafts are capable to transmit the maximum torque capability at maximum working pressure.

Notes

Model Code

	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
H1 B	A			N								N	N			N N N

Displacement

060	**060** cm³ [3.66 in³]
080	**080** cm³ [4.88 in³]
110	**110** cm³ [6.71 in³]
160	**160** cm³ [9.76 in³]

A Product version

A	Revision code

B Control

L1	Electr. Proport. 12 V, Deutsch DT 04-2P connector, de-energized = max. displacement, no PCOR
L2	Electr. Proport. 24 V, Deutsch DT 04-2P connector, de-energized = max. displacement, no PCOR
D1	Electr. Proport. 12 V, Deutsch DT 04-2P connector, de-energized = max. displacement, with PCOR
D2	Electr. Proport. 24 V, Deutsch DT 04-2P connector, de-energized = max. displacement, with PCOR
M1	Electr. Proport. 12 V, Deutsch DT 04-2P connector, de-energized = min. displacement, no PCOR
M2	Electr. Proport. 24 V, Deutsch DT 04-2P connector, de-energized = min. displacement, no PCOR
K1	Electr. Proport. 12 V, Deutsch DT 04-2P connector, de-energized = min. displacement, with PCOR
K2	Electr. Proport. 24 V, Deutsch DT 04-2P connector, de-energized = min. displacement, with PCOR
E1	Electr. 2 Pos. 12 V, Deutsch DT 04-2P connector, de-energized = max. displacement, no PCOR
E2	Electr. 2 Pos. 24 V, Deutsch DT 04-2P connector, de-energized = max. displacement, no PCOR
TA	PCOR, default (high pressure below PCOR pressure) = min. displacement
T1	Electr. 2 Pos. 12 V, Deutsch DT 04-2P connector, de-energized = min. displacement, with PCOR
T2	Electr. 2 Pos. 24 V, Deutsch DT 04-2P connector, de-energized = min. displacement, with PCOR
P1	Electr. 2 Pos. 12 V, Deutsch DT 04-2P connector, de-energized = min. displacement, with Electric Proportional PCOR
P2	Electr. 2 Pos. 24 V, Deutsch DT 04-2P connector, de-energized = min. displacement, with Electric Proportional PCOR
HE	Hydraulic 2 Position, external control pressure supply, default (w/o control pressure) = max. displacement
HF	Hydraulic 2 Position, external control pressure supply, default (w/o control pressure) = min. displacement

C PCOR, BPD

BA	Without PCOR & without BPD, use with "**L***" controls
CA	Without PCOR & without BPD, use with "**M***" controls
K1	With PCOR & electr. 12 V BPD (de-energized BPD = PCOR activ at port A) Deutsch DT 04-2P connector, use with "**K1**" controls
K2	With PCOR & electr. 24 V BPD (de-energized BPD = PCOR activ at port A) Deutsch DT 04-2P connector, use with "**K2**" controls
KA	With PCOR & without BPD, use with "**K***" controls
AA	Without PCOR & without BPD, use with "**E***" controls
M1	With PCOR & electr. 12V BPD (de-energized BPD = PCOR activ at port B), Deutsch DT 04-2P, ("**D1**" controls)
M2	With PCOR & electr. 24V BPD (de-energized BPD = PCOR activ at port B), Deutsch DT 04-2P, ("**D2**" controls)
MA	With PCOR & without BPD, ("**D***" controls)
D1	With PCOR & electr. 12 V BPD (de-energized BPD = PCOR activ at port A) Deutsch DT 04-2P connector, use with "**P1**" and "**T1**" controls
D2	With PCOR & electr. 24 V BPD (de-energized BPD = PCOR activ at port A) Deutsch DT 04-2P connector, use with "**P2**" and "**T2**" controls
DA	With PCOR & without BPD, use with "**P***" and "**T***" controls
HE	Internal servo pressure supply, without PCOR, without BPD, internal servo pressure supply, use with "HE" control
HF	Internal servo pressure supply, without PCOR, without BPD, internal servo pressure supply, use with "HF" control

D Default

N	Not applicable

E Orifices

A	1.2 mm [0.047 in] diameter orifices M4 and M5
B	0.8 mm [0.032 in] diameter orifices M4 and M5
C	0.6 mm [0.024 in] diameter orifices M4 and M5

Model Code (continued)

	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
H1 B	A			N								N N				N N N

F Endcap type and ports

PA	Endcap for prop. controls, axial ports ISO 6162 type 1 (metric), use with "**L***" and "**D***"controls
PB	Endcap for prop. controls, side ports ISO 6162 type 1 (metric), use with "**L***" and "**D***"controls
RA	Endcap for prop. controls, axial ports ISO 6162 type 1 (metric), use with "**M***" and "**K***" controls
RB	Endcap for prop. controls, side ports ISO 6162 type 1 (metric), use with "**M***" and "**K***" controls
TA	Endcap for 2 Pos. and Pressure Compensator controls, axial ports ISO 6162 type 1 (metric), use with "**E***", "**T***" and "**P***" controls
TB	Endcap for 2 Pos. and Pressure Compensator controls, side ports ISO 6162 type 1 (metric), use with "**E***", "**T***" and "**P***" controls

G Flange and housing

VN	SAE Flange motor housing (ISO 3019/1), no speed sensor port
DN	DIN Flange motor housing (ISO 3019/2), no speed sensor port
CN	Cartridge Flange motor housing, no speed sensor port
VS	SAE Flange motor housing (ISO 3019/1), with speed sensor port
DS	DIN Flange motor housing (ISO 3019/2), with speed sensor port
CS	Cartridge Flange motor housing, with speed sensor port

H Shaft and speed ring

	Size	060	080	110	160
AN	14 teeth 12/24 pitch ANSI 92.1 1970 class 5, no speed ring, use with SAE flange ("VN") only	●	●		
DN	27 teeth 16/32 pitch ANSI 92.1 1970 class 5, no speed ring, use with SAE flange ("VN") only			●	●
EN	13 teeth 8/16 pitch ANSI 92.1 1970 class 5, no speed ring, use with SAE flange ("VN") only			●	●
FN	15 teeth 8/16 pitch ANSI 92.1 1970 class 5, no speed ring, use with SAE flange ("VN") only				●
GN	W30x2x30x14x9g DIN 5480, no speed ring, use with DIN ("DN") or Cartridge ("CN") flange only	●			
HN	W35x2x30x16x9g DIN 5480, no speed ring, use with DIN ("DN") or Cartridge ("CN") flange only		●		
JN	W40x2x30x18x9g DIN 5480, no speed ring, use with DIN ("DN") or Cartridge ("CN") flange only		●	●	
KN	W45x2x30x21x9g DIN 5480, no speed ring, use with DIN ("DN") or Cartridge ("CN") flange only			●	●
LN	W50x2x30x24x9g DIN 5480, no speed ring, use with DIN ("DN") or Cartridge ("CN") flange only				●
AS	14 teeth 12/24 pitch ANSI 92.1 1970 class 5, with speed ring, use with SAE flange ("VS") only	●	●		
DS	27 teeth 16/32 pitch ANSI 92.1 1970 class 5, with speed ring, use with SAE flange ("VS") only			●	●
ES	13 teeth 8/16 pitch ANSI 92.1 1970 class 5, with speed ring, use with SAE flange ("VS") only			●	●
FS	15 teeth 8/16 pitch ANSI 92.1 1970 class 5, with speed ring, use with SAE flange ("VS") only				●
GS	W30x2x30x14x9g DIN 5480, with speed ring, use with DIN ("DS") or Cartridge ("CS") flange only	●			
HS	W35x2x30x16x9g DIN 5480, with speed ring, use with DIN ("DS") or Cartridge ("CS") flange only		●		
JS	W40x2x30x18x9g DIN 5480, with speed ring, use with DIN ("DS") or Cartridge ("CS") flange only		●	●	
KS	W45x2x30x21x9g DIN 5480, with speed ring, use with DIN ("DS") or Cartridge ("CS") flange only			●	●
LS	W50x2x30x24x9g DIN 5480, with speed ring, use with DIN ("DS") or Cartridge ("CS") flange only				●

● = Available options

J Sensor

N	No speed sensor
S	Speed sensor, DEUTSCH DTM 04-6P connector

Model Code (continued)

		A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R
H1 B		A			N								N N				N N N

K Loop flushing shuttle system

A	Standard 6.5 bar [94 psi] shift pressure
N	No loop flushing function

L Loop flushing relief valve

		Size	060	080	110	160
05	5 l/min [1.321 US gal/min], non adjustable, 16 bar [232 psi] cracking pressure		●	●		
10	10 l/min [2.642 US gal/min], non adjustable, 16 bar [232 psi] cracking pressure		●	●	●	
15	15 l/min [3.963 US gal/min], non adjustable, 16 bar [232 psi] cracking pressure				●	●
20	20 l/min [5.283 US gal/min], non adjustable, 16 bar [232 psi] cracking pressure					●
30	30 l/min [7.925 US gal/min], non adjustable, 16 bar [232 psi] cracking pressure					●
NN	No loop flushing function		●	●	●	●

M Special hardware feature

NN	Standard hardware

N Minimum displacement

XXX	000 or 012 to 040 cm^3/rev minimum displacement setting for frame size 060 cm^3/rev 000 or 016 to 054 cm^3/rev minimum displacement setting for frame size 080 cm^3/rev 000 or 022 to 074 cm^3/rev minimum displacement setting for frame size 110 cm^3/rev 000 or 032 to 108 cm^3/rev minimum displacement setting for frame size 160 cm^3/rev

P Maximum displacement

N	100 % maximum displacement for all "**L***", "**M***", "**K***" and "**D***" control options, non adjustable
Z	100 % maximum displacement for all "**E***", "**H***" , "**T***" , "**P***" , "**TA**" , "**HE**" and "**HF**"control options, non adjustable

Q PCOR setting

00	For all controls without PCOR function
16	PCOR pressure setting 160 bar [2320 psi]
17	PCOR pressure setting 170 bar [2465 psi]
18	PCOR pressure setting 180 bar [2610 psi]
19	PCOR pressure setting 190 bar [2755 psi]
20	PCOR pressure setting 200 bar [2900 psi]
21	PCOR pressure setting 210 bar [3050 psi]
22	PCOR pressure setting 220 bar [3190 psi]
23	PCOR pressure setting 230 bar [3340 psi]
24	PCOR pressure setting 240 bar [3480 psi]. Standard setting at production test for P* controls • 800 mA for P1 • 400mA for P2
25	PCOR pressure setting 250 bar [3630 psi]
26	PCOR pressure setting 260 bar [3770 psi]
27	PCOR pressure setting 270 bar [3920 psi]
28	PCOR pressure setting 280 bar [4060 psi]
29	PCOR pressure setting 290 bar [4210 psi]
30	PCOR pressure setting 300 bar [4350 psi]

R Paint and nametag

NNN	Black paint and S-D Nametag

Electric Controls

Motor displacement can be changed electro hydraulically under load in response to an electrical signal from maximum displacement to minimum displacement and vice versa.

Electric Proportional Controls

The electric proportional control consists of a proportional solenoid which acts directly on a two-position, three-way porting spool. When activated, the solenoid pushes on the spool which then ports high pressure to the larger diameter of the servo piston. The servo piston and rotating group move to change the displacement to the point where the pressures on the servo are in balance with the force from the feedback spring.

De-energized = maximum displacement

With a de-energized to maximum displacement control, the de-energized proportional valve keeps the motor at maximum displacement. When energized, the solenoid pushes on the porting spool which moves to port high system pressure to the larger diameter end of the servo piston. Depending on the current supplied to the proportional valve, the motor will stroke between maximum displacement at zero current and minimum displacement at maximum current.

De-energized = minimum displacement

With a de-energized to minimum displacement control, the de-energized proportional valve keeps the motor at minimum displacement. When energized, the solenoid pushes on the porting spool which moves to port high system pressure to the larger diameter end of the servo piston. Depending on the current supplied to the proportional valve, the motor will stroke between minimum displacement at zero current and maximum displacement at maximum current.

Electric Two-Position Controls

The electric two-position control consists of an off/on-solenoid which acts on a two position, three-way porting spool. Servo pressure is internally supplied to the two-position porting spool by an integral system pressure shuttle.

De-energized = maximum displacement

When the solenoid is de-energized, the motor runs at maximum displacement. When energized, the solenoid applies a force on the spool which ports high pressure to the larger diameter of the servo piston and strokes the motor to minimum displacement. When the solenoid is de-energized, the motor strokes back to maximum displacement.

De-energized = minimum displacement

When the solenoid is de-energized, the motor runs at minimum displacement. When energized, the solenoid applies a force on the spool which ports the larger diameter of the servo piston to tank, and strokes the motor to maximum displacement. When the solenoid is de-energized, the motor strokes back to minimum displacement.
Available in conjunction with PCOR only.

Servo Supply

The system shuttle check valve supplies the control system with high system pressure.

Control Options

To enhance the performance of our motors, several options are available to augment the performance of the control system. These control enhancements include, **P**ressure **C**ompensator **O**ver **R**ide (**PCOR**), **P**roportional **P**ressure **C**ompensator **O**ver **R**ide (**PPCOR**), and **B**rake **P**ressure **D**efeat (**BPD**) are available for the proportional and two-position controls.

PCOR

The de-energized electric control keeps the motor at minimum displacement. The electric control can be overridden by the PCOR using high loop system pressure. When the system pressure rises above the PCOR setting, the PCOR override will be activated. The motor then increases to maximum displacement. The motor displacement is regulated automatically between minimum and maximum in response to the high loop pressure. This ensures optimal power throughout the entire displacement range of the motor.

The pressure compensator control can also be overridden with an electric off/on-solenoid option. When the solenoid is energized, the motor strokes to maximum displacement and stays at that position until the solenoid is de-energized.

Proportional with PCOR

In the de-energized state, the electric proportional control keeps the motor at minimum displacement until system pressure rises above the PCOR setting. When the PCOR activates, it ports high system pressure to the larger end of the servo piston, increasing the motor displacement to maximum.

Two Position with PCOR

In the de-energized state, the electric two-position control supplies both sides of the servo piston and keeps the motor at minimum displacement as long as the high loop pressure remains below the pressure compensator setting. If the high loop pressure rises above the pressure compensator setting, the porting spool ports the larger diameter of the servo piston to tank. The motor strokes in the direction of maximum displacement.

Two Position with Proportional PCOR

The PPCOR valve consists of an electric proportional solenoid and a two-position, three-way porting spool with an adjustable spring force on the opposite end of the spool. Maximum signal current to the proportional solenoid overrides the pressure compensator and strokes the motor to maximum displacement. The proportional solenoid changes the pressure compensator setting to allow different, on the go, settings. The solenoid and the high system pressure work against the spring on the end of the two-position, three-way porting spool. With decreased signal current on the proportional solenoid, the reduction of the forces from the proportional solenoid cause an increased pressure compensator setting for the high system pressure and consequently provides a proportional pressure compensator. During production test, the PPCOR setting is adjusted to 240 bar with the adjusting screw on the control housing in reference to input current of:

- 800 mA for P1 (12 V)
- 400 mA for P2 (24 V)

Hydraulic Two-Position Control

Motor displacement can be changed hydraulically, under load, from maximum to minimum displacement and vice versa in response to an external hydraulic signal.

The hydraulic two-position control uses an external source for control pressure supply (e. g. charge pressure). This control pressure acts on a two position, three-way porting spool. Servo pressure is internally supplied to the two-position porting spool by an integral system shuttle check valve.

Default (without control pressure) = maximum displacement

With no control pressure applied, the motor operates at maximum displacement. When control pressure is applied, the spool shifts, porting high system pressure to the large diameter end of the servo piston, shifting the motor to minimum displacement. When the control pressure is removed, spring forces move the spool, allowing the large diameter end of the servo piston to drain to tank, shifting the motor to maximum displacement.

Default (without control pressure) = minimum displacement

With no control pressure applied, the motor operates at minimum displacement. When control pressure is applied, the spool shifts, porting the large diameter end of the servo piston to tank, shifting the motor to maximum displacement. When the control pressure is removed, spring forces move the spool, porting high pressure to the large diameter end of the servo piston, shifting the motor to minimum displacement.

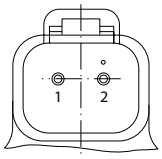
Notes

Control Options BPD

For propel applications, use the electric BPD option in conjunction with the PCOR option. The BPD shuttle valve is located ahead of the pressure compensator control valve. The BPD defeat consists of an electric off/on-solenoid and a two-position, three-way porting spool. The applied logic allows the pressure compensator control to operate normally with high loop system pressure during acceleration and cuts off the supply pressure during deceleration if the motor is running in pump mode. This prevents rapid or uncontrolled deceleration while the machine is slowing down. With the BPD solenoid de-energized, the porting spool is centered by spring force. The BPD solenoid must be controlled by a direction lever switch or an output signal from a micro controller.

Electric Solenoid Connector

Solenoid connector



P003 480

Description	Quantity	Ordering number
Mating connector	1	Deutsch® DT06-2S
Wedge lock	1	Deutsch® W2S
Socket contact (16 and 18 AWG)	2	Deutsch® 0462-201-16141
Sauer-Danfoss mating connector kit	1	K29657

Applications-related Controls

The following table is provided to assist in selecting controls for various applications. The recommendation is based on experience with a wide range of applications.

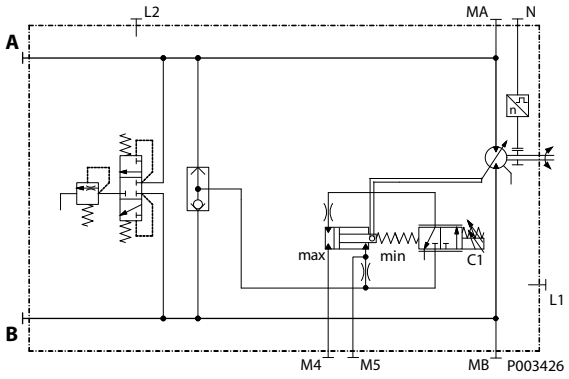
Machine	Function	Controls														
		L*BA	D*MA	D*M*	M*CA	K*K*	K*KA	E*AA	TADA	TAD*	T*D*	P*D*	T*DA	P*DA	HEHE	HFHF
Wheel loader	Propel			●		●					●	●			●	
Roller compactor	Propel							●							●	
Paver-Wheeled	Propel							●								
Paver-Tracked	Propel							●								
Crawler	Propel	●														
Sweeper	Propel					●					●	●				
Trencher	Propel	●														
Fork lift truck	Propel			●		●				●		●				
Agricultural machine	Propel	●				●			●							●
Wheel assist	Propel			●	●					●						●
Forestry machines	Propel					●										
Telescopic handler	Propel					●						●				
Railroad machines	Propel			●				●		●	●					
Snow groomer	Propel	●														
Snow blower	Blow drive						●						●	●		
Crane	Winch	●						●								
Crusher / Shredder	Roll		●				●		●				●	●		

*) 1 = 12 Vdc
2 = 24 Vdc

Electric Proportional Control Options L1BA, L2BA

L1 (Electric Proportional 12 V /**de-energized = max. displacement**)
BA (without Pressure Compensator Over Ride / without Brake Pressure Defeat)

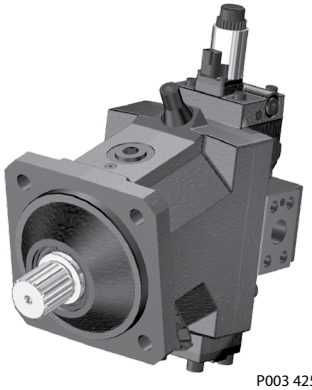
L2 (Electric Proportional 24 V /**de-energized = max. displacement**)
BA (without Pressure Compensator Over Ride / without Brake Pressure Defeat)

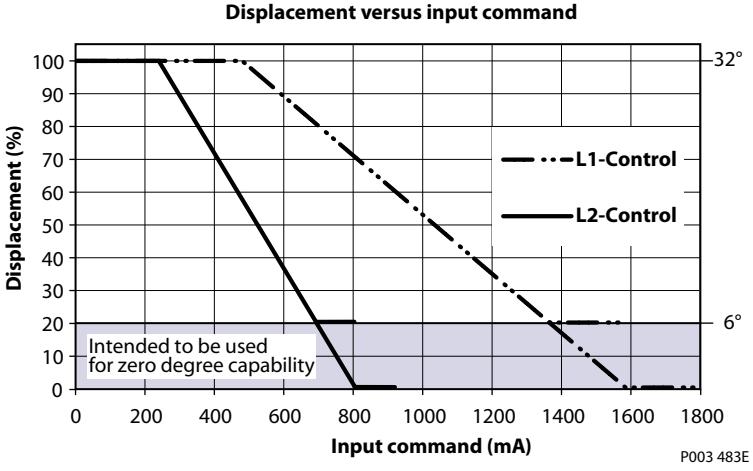


Ports:
A, B = Main pressure lines
L1, L2 = Drain lines
M4, M5 = Gage port servo pressure
N = Speed sensor (optional)
MA, MB = Gage port system pressure

Solenoid C1

De-energized = maximum displacement
Full-energized = minimum displacement


P003 425



P003 483E

Below are formulas to calculate start and end input command dependent on displacements:

Control type		All sizes
L1	Start input command (mA) from 100 % displacement	480 ± 10
L1	Start input command (mA) from y % max displacement	(1 - Vgy/Vgmax) x 1110 + 480
L1	End input command (mA) at 0 % displacement	1590 ± 130
L1	End input command (mA) at x % min displacement	(1 - Vgx/Vgmax) x 1110 + 480
L2	Start input command (mA) from 100 % displacement	240 ± 5
L2	Start input command (mA) from y % max displacement	(1 - Vgy/Vgmax) x 570 + 240
L2	End input command (mA) at 0 % displacement	810 ± 67
L2	End input command (mA) at x % min displacement	(1 - Vgx/Vgmax) x 570 + 240
L1	Max allowed current (mA)	1800
L2	Max allowed current (mA)	920

Electric Proportional Control Options L1BA, L2BA (continued)

Proportional solenoid data ***C1***

Description	Voltage	
	12 V	**24 V**
Maximum current	1800 mA	920 mA
Nominal coil resistance @ 20 °C [70 °F]	3.66 Ω	14.20 Ω
Nominal coil resistance @ 80 °C [176 °F]	4.52 Ω	17.52 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
Inductance	33 mH	140 mH
IP Rating (DIN 40 050)	IP 67	
IP Rating (DIN 40 050) with mating connector	IP 69K	

* PWM signal required for optimum control performance.

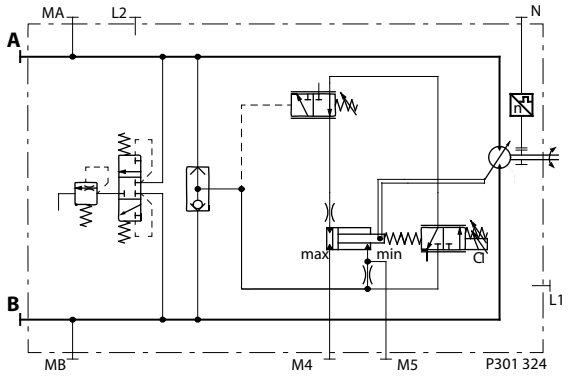
Electric Proportional Control with Pressure Compensator OverRide (PCOR) Options D1MA, D2MA

D1 (Electric Proportional 12 V/ **de-energized = max. displacement / with PCOR**)
MA (with PCOR / without BPD)

D2 (Electric Proportional 24 V/ **de-energized = max. displacement / with PCOR**)
MA (with PCOR / without BPD)

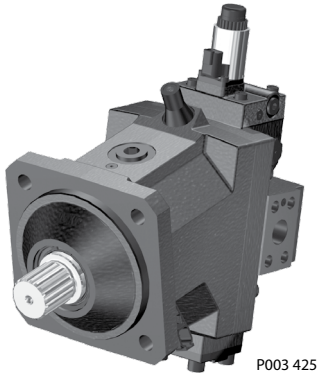
Caution

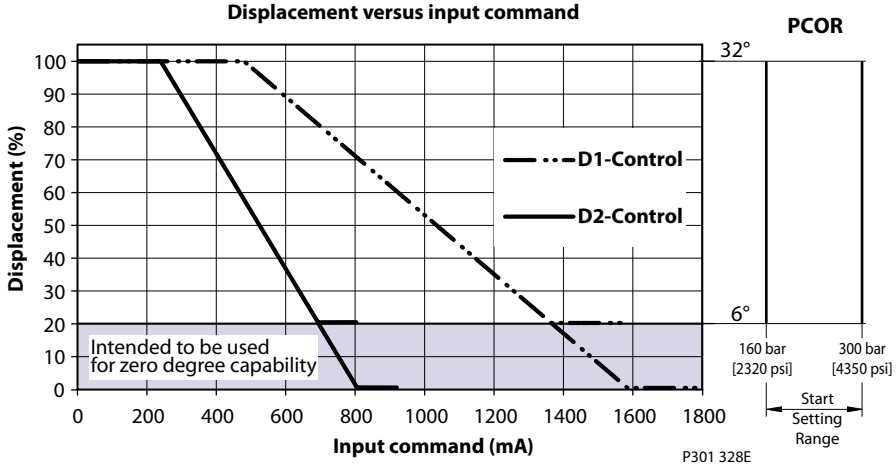
This control is not for use in Propel Applications.



Ports:

A, B	= Main pressure lines
L1, L2	= Drain lines
M4, M5	= Gage port servo pressure
N	= Speed sensor (optional)
MA, MB	= Gage port system pressure





Below are formulas to calculate start and end input command dependent on displacements:

Control type		All sizes
D1	Start input command (mA) from 100 % displacement	480 ± 10
D1	Start input command (mA) from y % max displacement	(1 - Vgy/Vgmax) x 1110 + 480
D1	End input command (mA) at 0 % displacement	1590 ± 130
D1	End input command (mA) at x % min displacement	(1 - Vgx/Vgmax) x 1110 + 480
D2	Start input command (mA) from 100 % displacement	240 ± 5
D2	Start input command (mA) from y % max displacement	(1 - Vgy/Vgmax) x 570 + 240
D2	End input command (mA) at 0 % displacement	810 ± 67
D2	End input command (mA) at x % min displacement	(1 - Vgx/Vgmax) x 570 + 240
D1	Max allowed current (mA)	1800
D2	Max allowed current (mA)	920

Electric Proportional Control with Pressure Compensator OverRide (PCOR) Options D1MA, D2MA

*Proportional solenoid data **C1***

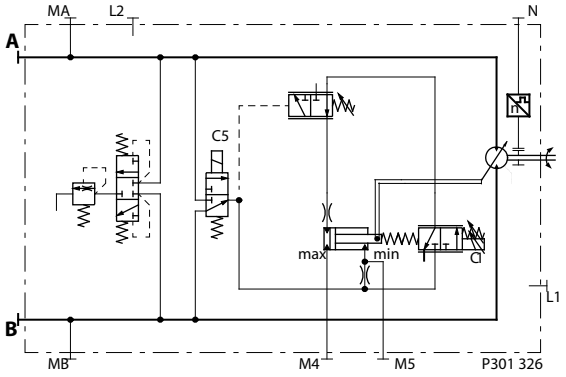
Description	Voltage	
	12 V	**24 V**
Maximum current	1800 mA	920 mA
Nominal coil resistance @ 20 °C [70 °F]	3.66 Ω	14.20 Ω
Nominal coil resistance @ 80 °C [176 °F]	4.52 Ω	17.52 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
Inductance	33 mH	140 mH
IP Rating (DIN 40 050)	IP 67	
IP Rating (DIN 40 050) with mating connector	IP 69K	

* PWM signal required for optimum control performance.

Electric Proportional Control with Pressure Compensator OverRide (PCOR) and Electric Brake Pressure Defeat (BPD) Options D1M1, D2M2

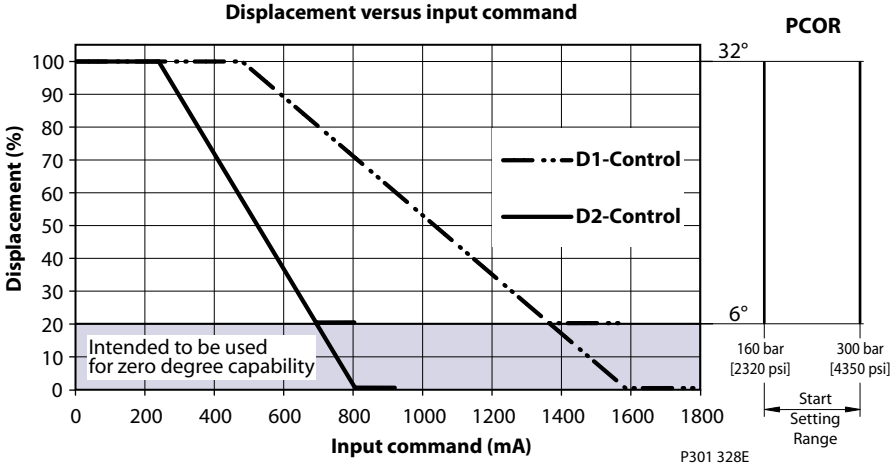
D1 (Electric Proportional 12 V/ **de-energized = max. displacement / with PCOR)**
M1 (with PCOR / with BPD)

D2 (Electric Proportional 24 V/ **de-energized = max. displacement / with PCOR)**
M2 (with PCOR / with Electric BPD)



Ports:
A, B = Main pressure lines
L1, L2 = Drain lines
M4, M5 = Gage port servo pressure
N = Speed sensor (optional)
MA, MB = Gage port system pressure


F301 776



Below are formulas to calculate start and end input command dependent on displacements:

Control type		All sizes
D1	Start input command (mA) from 100 % displacement	480 ± 10
D1	Start input command (mA) from y % max displacement	(1 - Vgy/Vgmax) x 1110 + 480
D1	End input command (mA) at 0 % displacement	1590 ± 130
D1	End input command (mA) at x % min displacement	(1 - Vgx/Vgmax) x 1110 + 480
D2	Start input command (mA) from 100 % displacement	240 ± 5
D2	Start input command (mA) from y % max displacement	(1 - Vgy/Vgmax) x 570 + 240
D2	End input command (mA) at 0 % displacement	810 ± 67
D2	End input command (mA) at x % min displacement	(1 - Vgx/Vgmax) x 570 + 240
D1	Max allowed current (mA)	1800
D2	Max allowed current (mA)	920

Electric Proportional Control with Pressure Compensator OverRide (PCOR) and Electric Brake Pressure Defeat (BPD) Options D1M1, D2M2

*Proportional solenoid data **C1***

Description	Voltage	
	12 V	**24 V**
Maximum current	1800 mA	920 mA
Nominal coil resistance @ 20 °C [70 °F]	3.66 Ω	14.20 Ω
Nominal coil resistance @ 80 °C [176 °F]	4.52 Ω	17.52 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
Inductance	33 mH	140 mH
IP Rating (DIN 40 050)	IP 67	
IP Rating (DIN 40 050) with mating connector	IP 69K	

* PWM signal required for optimum control performance.

*Two-position solenoid data **C5** (Brake pressure defeat)*

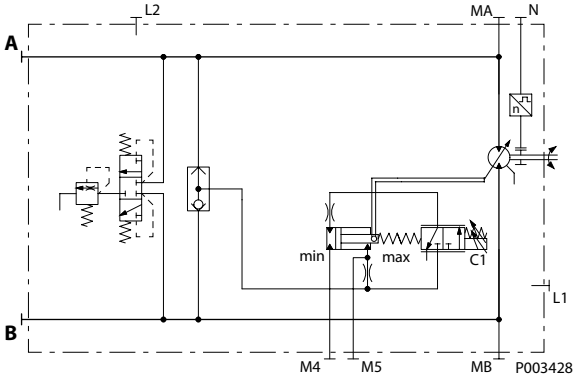
Min. supply voltage	9.5 Vdc	21.1 Vdc
Max. supply voltage (continuous)	14.6 Vdc	29.0 Vdc
Nominal coil resistance @ 20 °C [70 °F]	8.4 Ω	34.5 Ω
Recommended input current	1050 mA	500 mA
IP Rating (IEC 60 529)	IP 67	
IP Rating (IEC 60 529) with mating connector	IP 69K	

* PWM signal required for optimum control performance.

Electric Proportional Control Options M1CA, M2CA

M1 (Electric Proportional 12 V /**de-energized = min. displacement**)
CA (without Pressure Compensator Over Ride / without Brake Pressure Defeat)

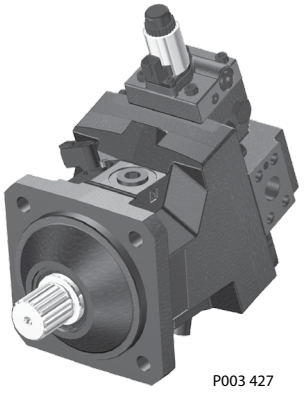
M2 (Electric Proportional 24 V /**de-energized = min. displacement**)
CA (without Pressure Compensator Over Ride / without Brake Pressure Defeat)

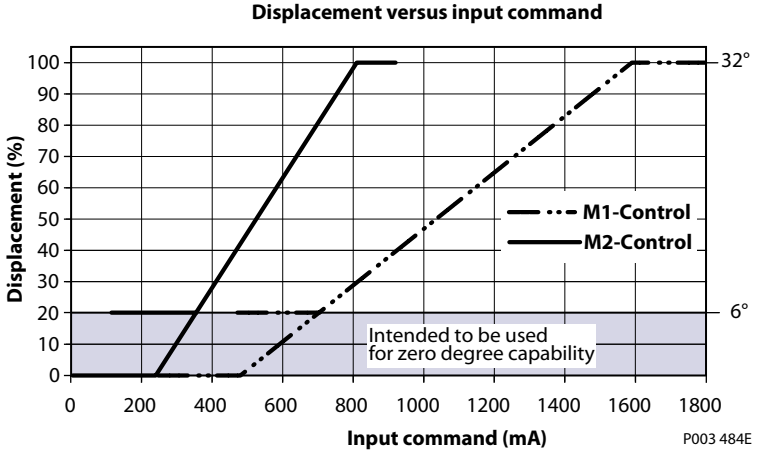


Ports:
A, B = Main pressure lines
L1, L2 = Drain lines
M4, M5 = Gage port servo pressure
N = Speed sensor (optional)
MA, MB = Gage port system pressure

Solenoid C1

De-energized = minimum displacement
Full-energized = maximum displacement


P003 427



Below are formulas to calculate start and end input command dependent on displacements:

Control type		All sizes
M1	Start input command (mA) from 0 % displacement	480 ± 10
M1	Start input command (mA) from x % min displacement	(Vgx/Vgmax) x 1110 + 480
M1	End input command (mA) at 100 % displacement	1590 ± 130
M1	End input command (mA) at y % max displacement	(Vgy/Vgmax) x 1110 + 480
M2	Start input command (mA) from 0 % displacement	240 ± 5
M2	Start input command (mA) from x % min displacement	(Vgx/Vgmax) x 570 + 240
M2	End input command (mA) at 100 % displacement	810 ± 67
M2	End input command (mA) at y % max displacement	(Vgy/Vgmax) x 570 + 240
M1	Max allowed current (mA)	1800
M2	Max allowed current (mA)	920

Electric Proportional Control Options M1CA, M2CA (continued)

Proportional solenoid data ***C1***

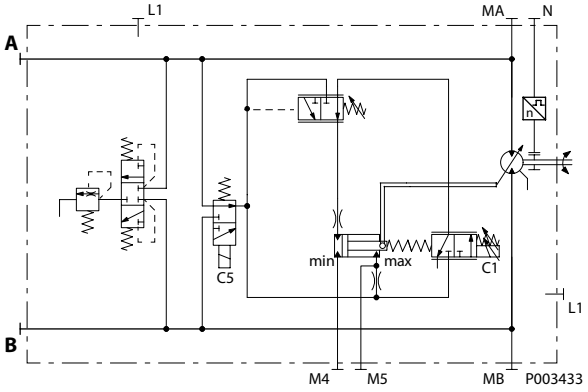
Description	Voltage	
	12 V	**24 V**
Maximum current	1800 mA	920 mA
Nominal coil resistance @ 20 °C [70 °F]	3.66 Ω	14.20 Ω
Nominal coil resistance @ 80 °C [176 °F]	4.52 Ω	17.52 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
Inductance	33 mH	140 mH
IP Rating (DIN 40 050)	IP 67	
IP Rating (DIN 40 050) with mating connector	IP 69K	

* PWM signal required for optimum control performance.

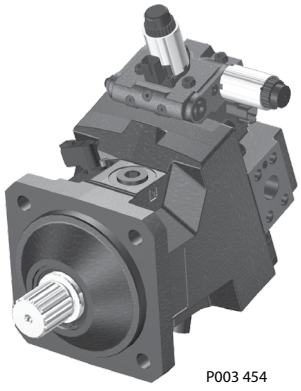
Electric Proportional Control with Pressure Compensator OverRide (PCOR) and Electric Brake Pressure Defeat (BPD) Options K1K1, K2K2

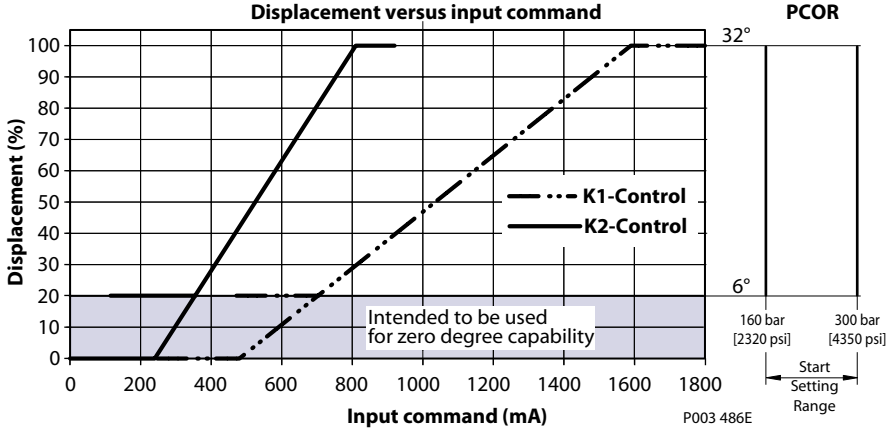
K1 (Electric Proportional 12 V /**de-energized = min. displacement** / with PCOR)
K1 (Electric BPD 12 V /de-energized BPD = PCOR active at Port A)

K2 (Electric Proportional 24 V /**de-energized = min. displacement** / with PCOR)
K2 (Electric BPD 24 V /de-energized BPD = PCOR active at Port A)



Ports:
A, B = Main pressure lines
L1, L2 = Drain lines
M4, M5 = Gage port servo pressure
N = Speed sensor (optional)
MA, MB = Gage port system pressure


P003 454



Below are formulas to calculate start and end input command dependent on displacements:

Control type		All sizes
K1	Start input command (mA) from 0 % displacement	480 ± 10
K1	Start input command (mA) from x % max displacement	(Vgx/Vgmax) x 1110 + 480
K1	End input command (mA) at 100 % displacement	1590 ± 130
K1	End input command (mA) at y % max displacement	(Vgy/Vgmax) x 1110 + 480
K2	Start input command (mA) from 0 % displacement	240 ± 5
K2	Start input command (mA) from x % min displacement	(Vgx/Vgmax) x 570 + 240
K2	End input command (mA) at 100 % displacement	810 ± 67
K2	End input command (mA) at y % max displacement	(Vgy/Vgmax) x 570 + 240
K1	Max allowed current (mA)	1800
K2	Max allowed current (mA)	920

Electric Proportional Control with Pressure Compensator OverRide (PCOR) and Electric Brake Pressure Defeat (BPD) Options K1K1, K2K2 (continued)

*Proportional solenoid data **C1** (Proportional control)*

Description	Voltage	
	12 V	**24 V**
Maximum current	1800 mA	920 mA
Nominal coil resistance @ 20 °C [70 °F]	3.66 Ω	14.20 Ω
Nominal coil resistance @ 80 °C [176 °F]	4.52 Ω	17.52 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
Inductance	33 mH	140 mH
IP Rating (DIN 40 050)	IP 67	
IP Rating (DIN 40 050) with mating connector	IP 69K	

*Two-position solenoid data **C5** (Brake pressure defeat)*

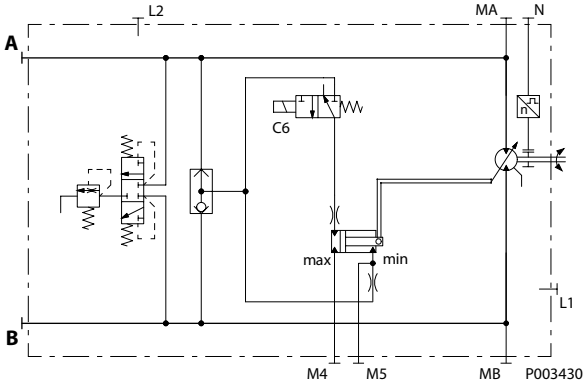
Min. supply voltage	9.5 Vdc	21.1 Vdc
Max. supply voltage (continuous)	14.6 Vdc	29.0 Vdc
Nominal coil resistance @ 20 °C [70 °F]	8.4 Ω	34.5 Ω
Recommended input current	1050 mA	500 mA
IP Rating (IEC 60 529)	IP 67	
IP Rating (IEC 60 529) with mating connector	IP 69K	

* PWM signal required for optimum control performance.

Electric Two-Position Control Options E1AA, E2AA

E1 (Electric Two-Position Control 12 V /**de-energized = max. displacement**)
AA (without Pressure Compensator Over Ride / without Brake Pressure Defeat)

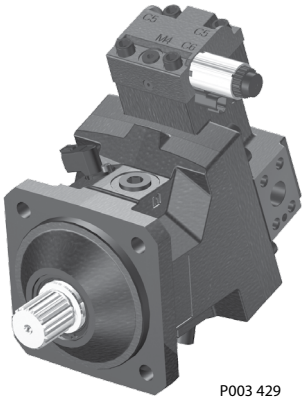
E2 (Electric Two-Position Control 24 V /**de-energized = max. displacement**)
AA (without Pressure Compensator Over Ride / without Brake Pressure Defeat)

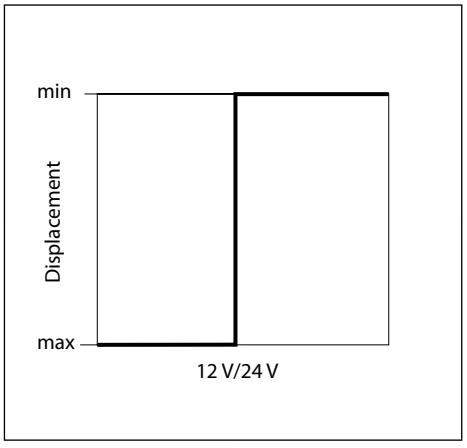


Ports:
A, B = Main pressure lines
L1, L2 = Drain lines
M4, M5 = Gage port servo pressure
N = Speed sensor (optional)
MA, MB = Gage port system pressure

Solenoid C6

De-energized = maximum displacement
Energized = minimum displacement


P003 429



P003 408

Two-position solenoid data ***C6***

Description	Voltage	
	12 V	24 V
Min. supply voltage	9.5 Vdc	21.1 Vdc
Max. supply voltage (continuous)	14.6 Vdc	29.0 Vdc
Nominal coil resistance @ 20 °C [70 °F]	8.4 Ω	34.5 Ω
Recommended input current	1050 mA	500 mA
IP Rating (IEC 60 529)	IP 67	
IP Rating (IEC 60 529) with mating connector	IP 69K	

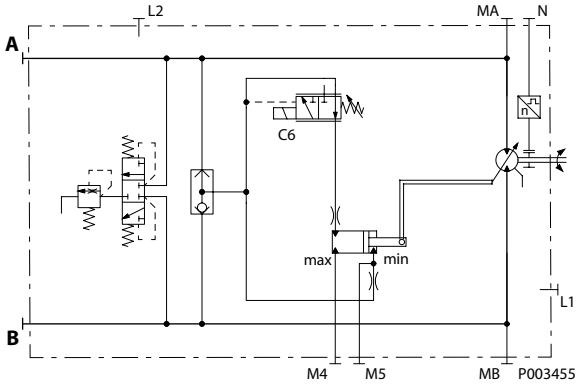
Electric Two-Position Control with Pressure Compensator OverRide (PCOR) Options T1DA, T2DA

T1 (Electric Two-Position Control 12 V /**de-energized = min. displacement** / with PCOR)
DA (without Brake Pressure Defeat)

T2 (Electric Two-Position Control 24 V /**de-energized = min. displacement** / with PCOR)
DA (without Brake Pressure Defeat)

Caution

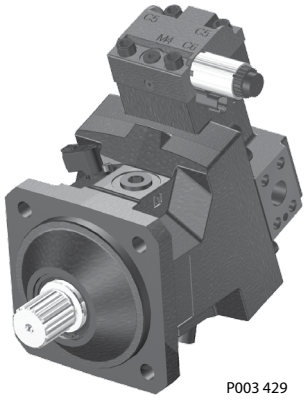
This control is not for use in Propel Applications.

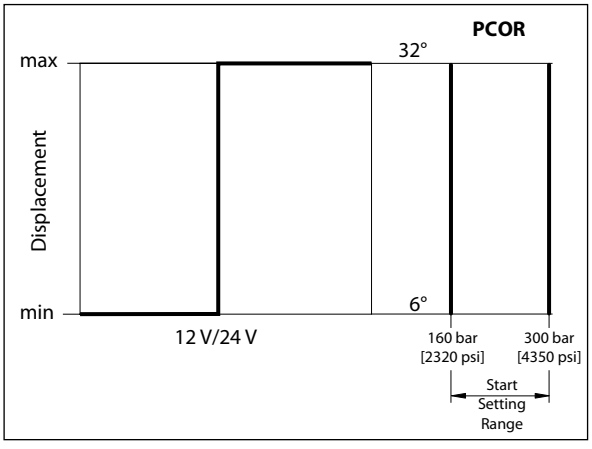


Ports:
A, B = Main pressure lines
L1, L2 = Drain lines
M4, M5 = Gage port servo pressure
N = Speed sensor (optional)
MA, MB = Gage port system pressure

Solenoid C6

De-energized = minimum displacement
Energized = maximum displacement


P003 429



P003 409E

Two-position solenoid data ***C6***

Description	Voltage	
	12 V	**24 V**
Min. supply voltage	9.5 Vdc	21.1 Vdc
Max. supply voltage (continuous)	14.6 Vdc	29.0 Vdc
Nominal coil resistance @ 20 °C [70 °F]	8.4 Ω	34.5 Ω
Recommended input current	1050 mA	500 mA
IP Rating (IEC 60 529)	IP 67	
IP Rating (IEC 60 529) with mating connector	IP 69K	

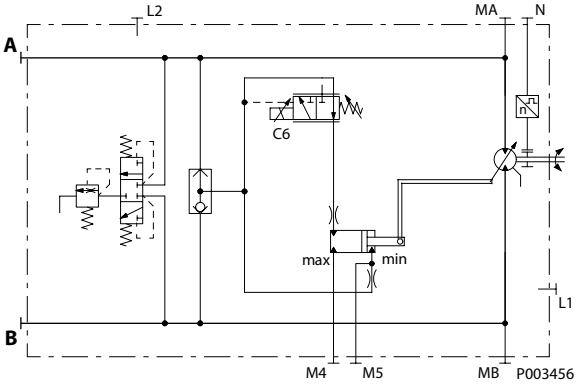
Electric Two-Position Control with Electric Proportional Pressure Compensator OverRide (PPCOR) Options P1DA, P2DA

P1 (Electric Two-Position Control 12 V /**de-energized = min. displacement** / with Electric Proportional PCOR)
DA (without Brake Pressure Defeat)

P2 (Electric Two-Position Control 24 V /**de-energized = min. displacement** / with Electric Proportional PCOR)
DA (without Brake Pressure Defeat)

Caution

This control is not for use in Propel Applications.

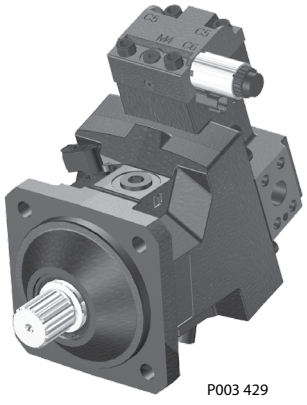


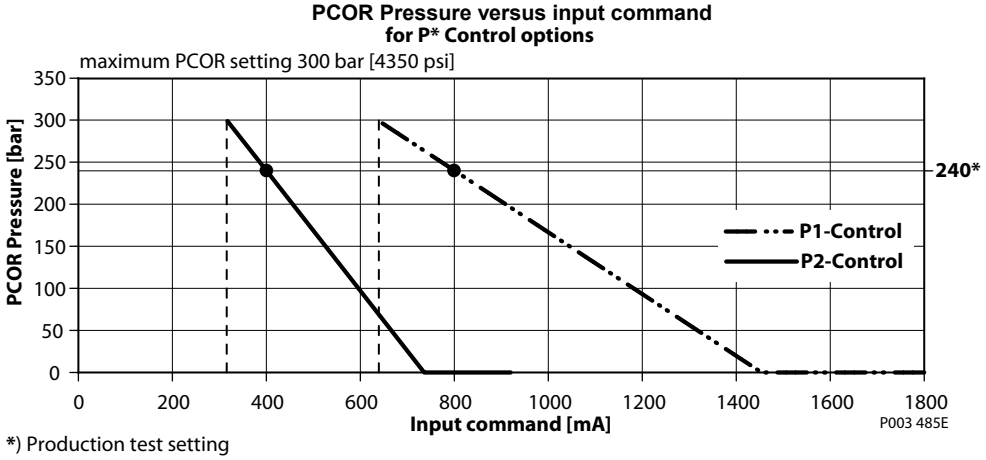
Ports:

A, B	=	Main pressure lines
L1, L2	=	Drain lines
M4, M5	=	Gage port servo pressure
N	=	Speed sensor (optional)
MA, MB	=	Gage port system pressure

Caution

If the signal to the PPCOR is lost or drops below the range shown in the chart below, the PCOR setting will potentially increase to pressure levels above the recommended application limits or the regulated pressure control of the pump, and in effect, disable the PCOR function.


P003 429



*) Production test setting

Electric Two-Position Control with Electric Proportional Pressure Compensator OverRide (PPCOR) Options P1DA, P2DA (continued)

The PCOR pressure level can be proportionally changed with the input current to the solenoid. The pressure level versus input current can be calculated by the formula below:

12 V: $I_{PCOR} = -2.724 \times P_{PCOR} + 1453.8$

24 V: $I_{PCOR} = -1.399 \times P_{PCOR} + 735.7$

P_{PCOR} = PCOR pressure level [bar]
I_{PCOR} = Current input to proportional PCOR solenoid [mA]

*Proportional solenoid data **C6** (Proportional PCOR)*

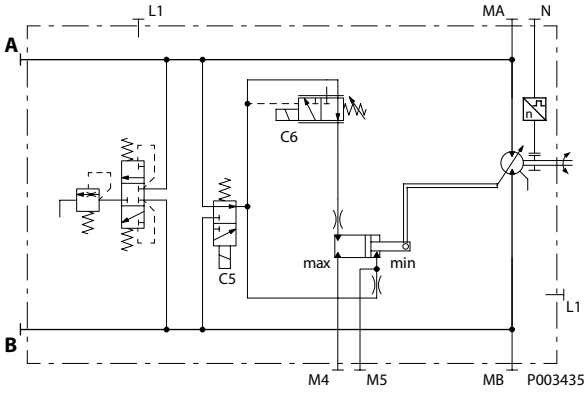
Description	Voltage	
	12 V	24 V
Maximum current	1800 mA	920 mA
Nominal coil resistance @ 20 °C [70 °F]	3.66 Ω	14.20 Ω
Nominal coil resistance @ 80 °C [176 °F]	4.52 Ω	17.52 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
Inductance	33 mH	140 mH
IP Rating (DIN 40 050)	IP 67	
IP Rating (DIN 40 050) with mating connector	IP 69K	

* PWM signal required for optimum control performance.

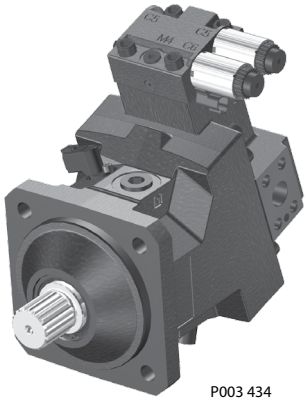
Electric Two-Position Control with Pressure Compensator OverRide (PCOR) and Electric Brake Pressure Defeat (BPD) Options T1D1, T2D2

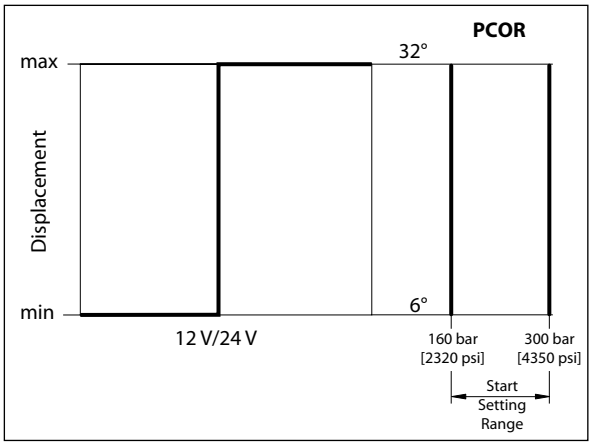
T1 (Electric Two-Position Control 12 V / **de-energized = min. displacement** / with PCOR)
D1 (with Electric BPD 12 V /de-energized BPD = PCOR active at Port A)

T2 (Electric Two-Position Control 24 V / **de-energized = min. displacement** / with PCOR)
D2 (with Electric BPD 24 V /de-energized BPD = PCOR active at Port A)



Ports:
A, B = Main pressure lines
L1, L2 = Drain lines
M4, M5 = Gage port servo pressure
N = Speed sensor (optional)
MA, MB = Gage port system pressure


P003 434



P003 409E

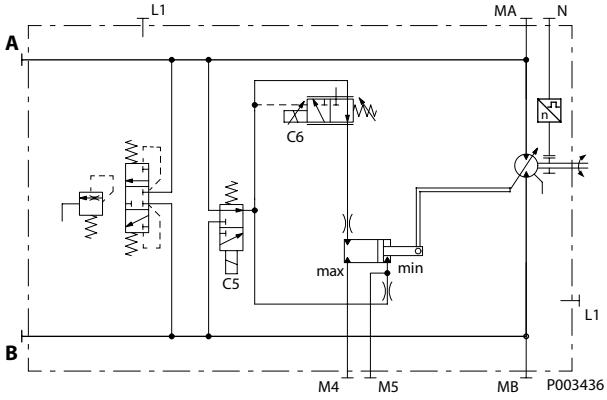
*Solenoid data **C5** (BPD) and **C6** (Two-position control)*

Description	Voltage	
	12 V	24 V
Min. supply voltage	9.5 Vdc	21.1 Vdc
Max. supply voltage (continuous)	14.6 Vdc	29.0 Vdc
Nominal coil resistance @ 20 °C [70 °F]	8.4 Ω	34.5 Ω
Recommended input current	1050 mA	500 mA
IP Rating (IEC 60 529)	IP 67	
IP Rating (IEC 60 529) with mating connector	IP 69K	

Electric Two-Position Control with Electric Proportional Pressure Compensator OverRide (PPCOR) and Electric Brake Pressure Defeat (BPD) Options P1D1, P2D2

P1 (Electric Two-Position Control 12 V / **de-energized = min. displacement** / with Electric Proportional PCOR)
D1 (with BPD 12 V /de-energized BPD = PCOR active at Port A)

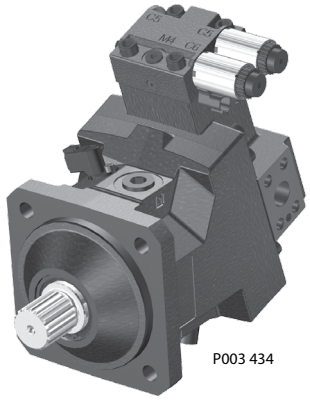
P2 (Electric Two-Position Control 24 V / **de-energized = min. displacement** / with Electric Proportional PCOR)
D2 (with BPD 24 V /de-energized BPD = PCOR active at Port A)

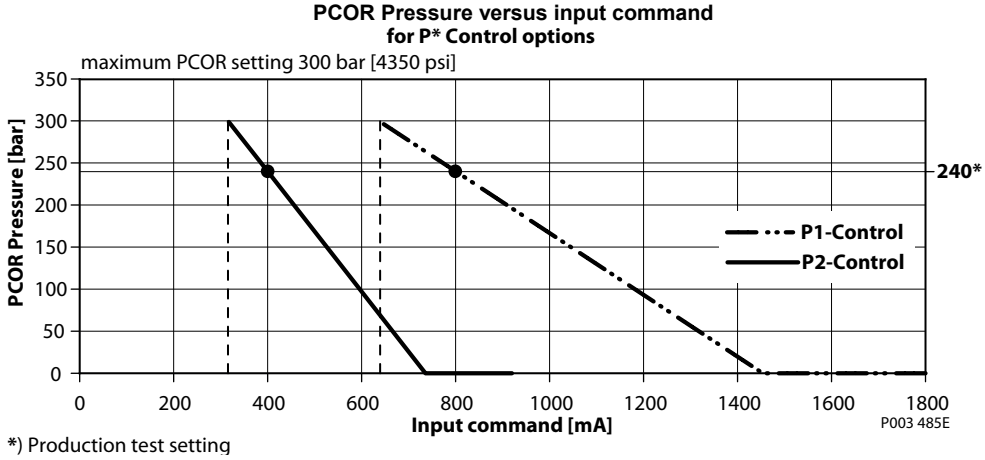


Ports:
A, B = Main pressure lines
L1, L2 = Drain lines
M4, M5 = Gage port servo pressure
N = Speed sensor (optional)
MA, MB = Gage port system pressure

Caution

If the signal to the PPCOR is lost or drops below the range shown in the chart below, the PCOR setting will potentially increase to pressure levels above the recommended application limits or the regulated pressure control of the pump, and in effect, disable the PCOR function.





*) Production test setting

Electric Two-Position Control with Electric Proportional Pressure Compensator OverRide (PPCOR) and Electric Brake Pressure Defeat (BPD) Options P1D1, P2D2 (continued)

The PCOR pressure level can be proportionally changed with the input current to the solenoid. The pressure level versus input current can be calculated by the formula below:

12 V: $I_{PCOR} = -2.724 \times P_{PCOR} + 1453.8$

24 V: $I_{PCOR} = -1.399 \times P_{PCOR} + 735.7$

P_{PCOR} = PCOR pressure level [bar]
I_{PCOR} = Current input to proportional PCOR solenoid [mA]

*Proportional solenoid data **C6** (PPCOR)*

Description	Voltage	
	12 V	24 V
Maximum current	1800 mA	920 mA
Nominal coil resistance @ 20 °C [70 °F]	3.66 Ω	14.20 Ω
Nominal coil resistance @ 80 °C [176 °F]	4.52 Ω	17.52 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
Inductance	33 mH	140 mH
IP Rating (DIN 40 050)	IP 67	
IP Rating (DIN 40 050) with mating connector	IP 69K	

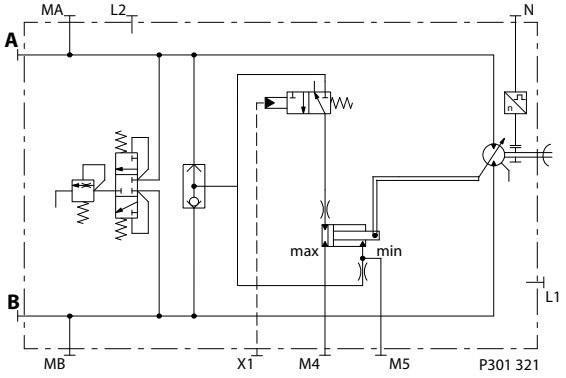
*Two-position solenoid data **C5** (BPD)*

Min. supply voltage	9.5 Vdc	21.1 Vdc
Max. supply voltage (continuous)	14.6 Vdc	29.0 Vdc
Nominal coil resistance @ 20 °C [70 °F]	8.4 Ω	34.5 Ω
Recommended input current	1050 mA	500 mA
IP Rating (IEC 60 529)	IP 67	
IP Rating (IEC 60 529) with mating connector	IP 69K	

* PWM signal required for optimum control performance.

Hydraulic Two-Position Control Option HEHE

HE (Hydraulic Two-Position Control / external control pressure supply / default (without control pressure) = maximum displacement)
HE (internal servo pressure supply / without PCOR / without BPD)



Ports:

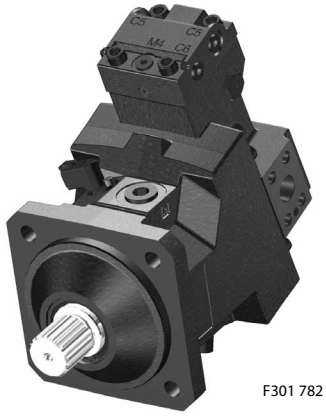
A, B	=	Main pressure lines
L1, L2	=	Drain lines
M4, M5	=	Gage port servo pressure
N	=	Speed sensor (optional)
MA, MB	=	Gage port system pressure

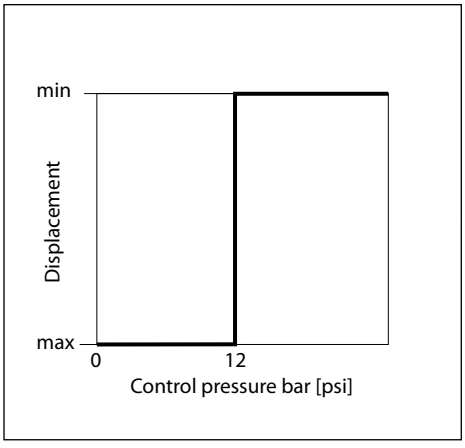
Control Pressure X1

Without control pressure on Port X1 = maximum displacement
With control pressure on Port X1 = minimum displacement

Control pressure: > 12 bar [175 psi] to ensure minimum displacement

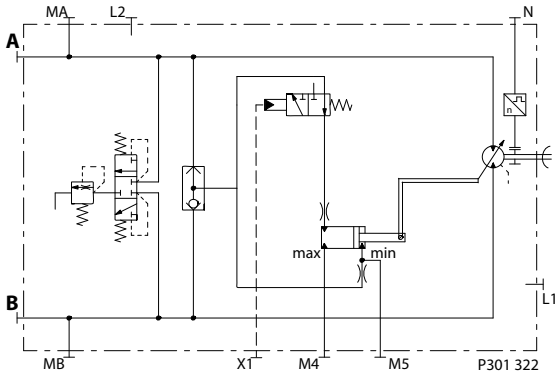
Maximum control pressure: 100 bar [1450 psi]





Hydraulic Two-Position Control Option HFHF

HF (Hydraulic Two-Position Control / external control pressure supply / default (without control pressure) = minimum displacement)
HF (internal servo pressure supply / without PCOR / without BPD)



Ports:

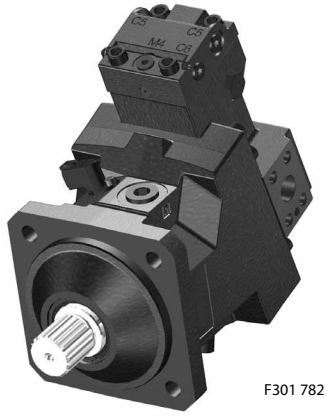
A, B	=	Main pressure lines
L1, L2	=	Drain lines
M4, M5	=	Gage port servo pressure
N	=	Speed sensor (optional)
MA, MB	=	Gage port system pressure

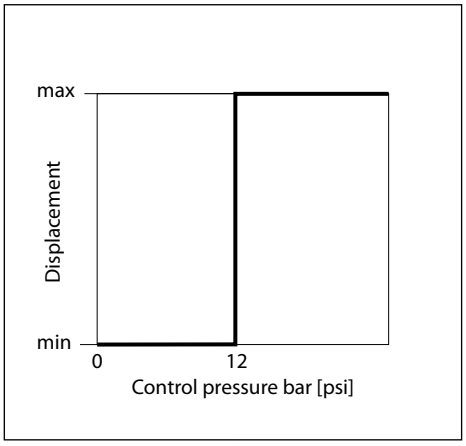
Control Pressure X1

Without control pressure on Port X1 = minimum displacement
With control pressure on Port X1 = maximum displacement

Control pressure: > 12 bar [175 psi] to ensure maximum displacement

Maximum control pressure: 100 bar [1450 psi]





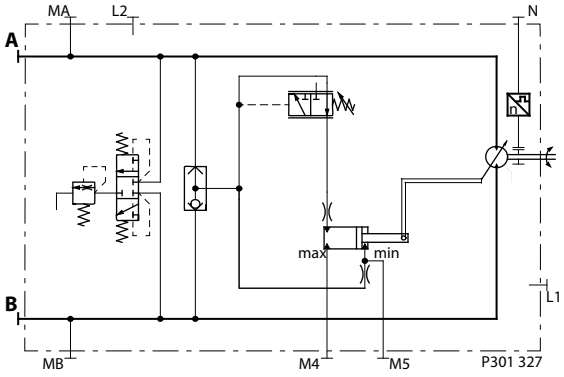
Pressure Compensator OverRide (PCOR)

TA (PCOR,Default: High Pressure below PCOR Pressure=min. displacement)

DA (with PCOR / without BPD)

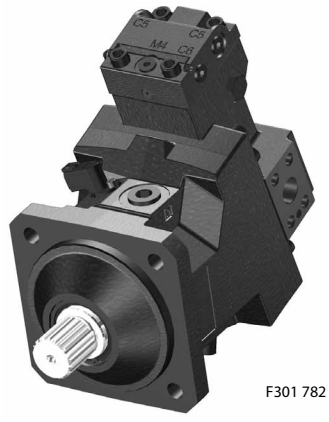
Caution

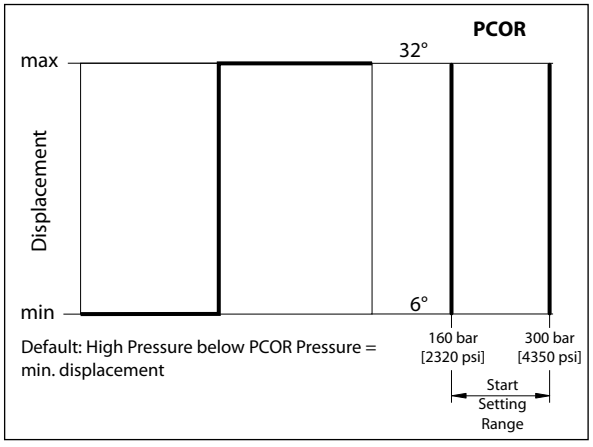
This control is not for use in Propel Applications.



Ports:

A, B	= Main pressure lines
L1, L2	= Drain lines
M4, M5	= Gage port servo pressure
N	= Speed sensor (optional)
MA, MB	= Gage port system pressure

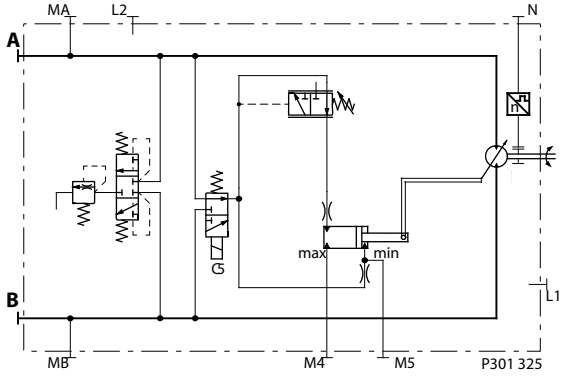




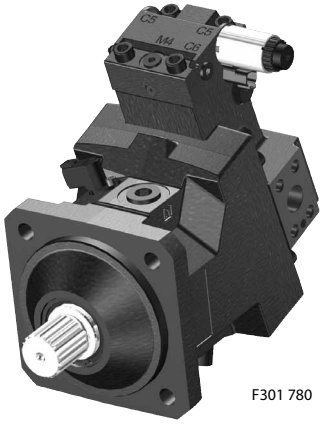
Pressure Compensator OverRide (PCOR) and Electric Brake Pressure Defeat (BPD)

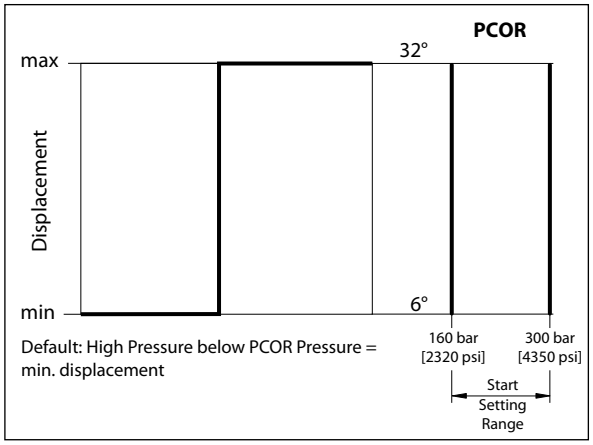
TA (PCOR,Default: High Pressure below PCOR Pressure = min. displacement)
D1 (with Electric BPD / 12 V)

TA (PCOR,Default: High Pressure below PCOR Pressure = min. displacement)
D2 (with Electric BPD / 24 V)



Ports:
A, B = Main pressure lines
L1, L2 = Drain lines
M4, M5 = Gage port servo pressure
N = Speed sensor (optional)
MA, MB = Gage port system pressure


F301 780



P301 329E

*Two-position solenoid data **C5** (Brake pressure defeat)*

Min. supply voltage	9.5 Vdc	21.1 Vdc
Max. supply voltage (continuous)	14.6 Vdc	29.0 Vdc
Nominal coil resistance @ 20 °C [70 °F]	8.4 Ω	34.5 Ω
Recommended input current	1050 mA	500 mA
IP Rating (IEC 60 529)	IP 67	
IP Rating (IEC 60 529) with mating connector	IP 69K	

* PWM signal required for optimum control performance.

Control Response

H1 controls are available with orifices to assist in matching the rate of stroking time from maximum displacement (100 %) to minimum displacement (20 %) and vice versa to application requirements. Stroking times for other pressure levels could be calculated at simulation model of request.

Typical response times shown below at the following conditions:

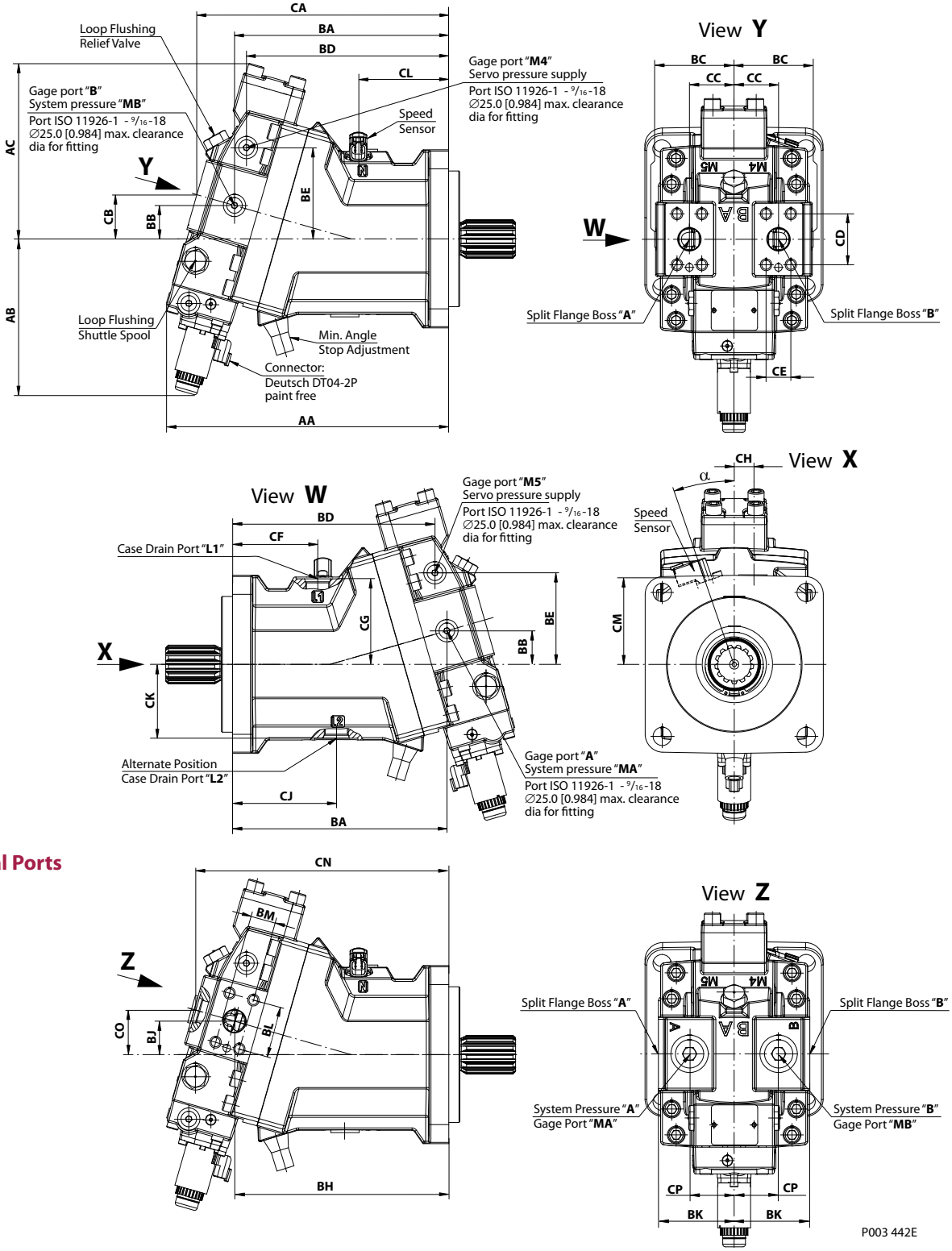
Differential pressure:	210 bar	[3045 psi]
Viscosity and temperature:	30 mm/s^2 (50 °C)	[141 SUS (122 F°)]
Charge pressure:	20 bar	[290 psi]
Motor speed:	1.500 min-1 (rpm)	

Stroking direction	Orifice	Size			
		060	080	110	160
Maximum to minimum	0.6 mm [0.02 in]	0.7 s	1.0 s	1.2 s	1.6 s
Minimum to maximum		0.8 s	1.1 s	1.4 s	1.7 s
Maximum to minimum	0.8 mm [0.03 in]	0.5 s	0.6 s	0.7 s	1.1 s
Minimum to maximum		0.5 s	0.7 s	0.8 s	1.2 s
Maximum to minimum	1.2 mm [0.05 in]	0.3 s	0.4 s	0.4 s	0.6 s
Minimum to maximum		0.3 s	0.4 s	0.4 s	0.6 s

SAE Flange Design, Proportional Control, Option L*

mm
[in]

Axial Ports



Radial Ports

SAE Flange Design, Proportional Control, Option L*

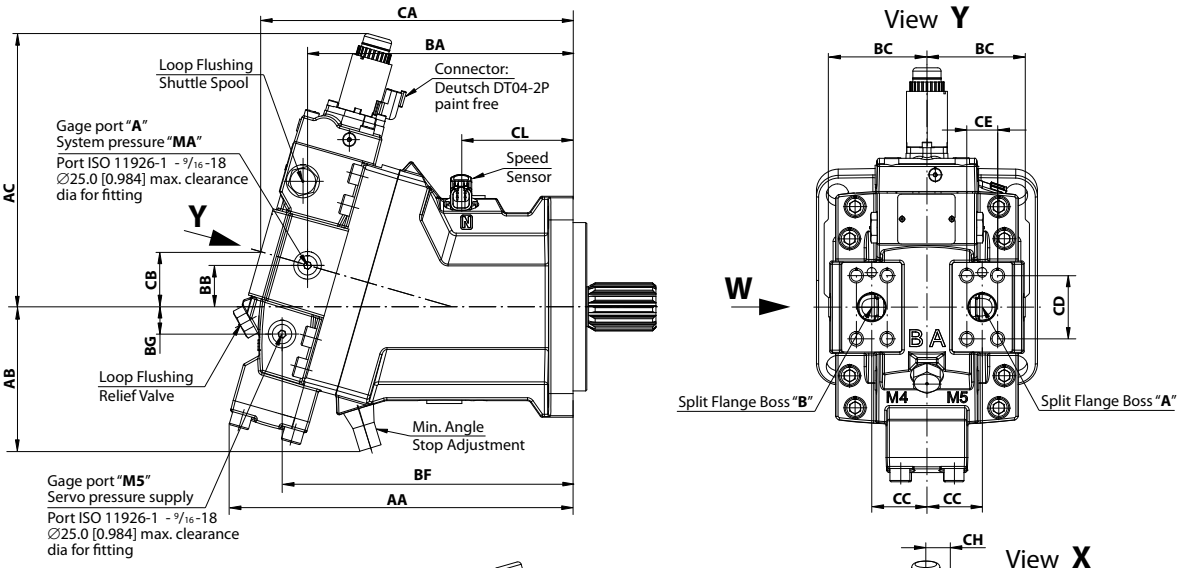
Dimensions mm [in]

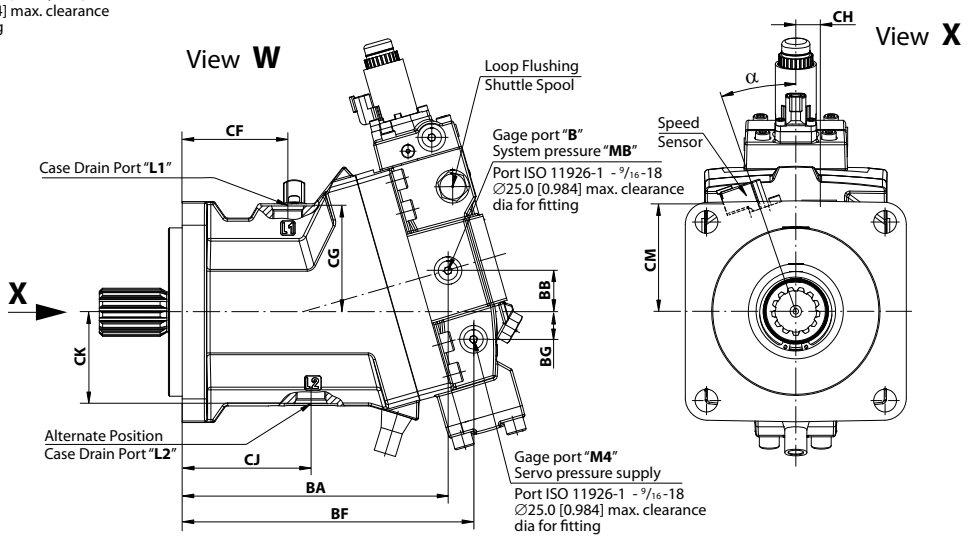
Frame size	060		080		110		160	
Axial and radial ports								
AA	272.0	[10.72]	290.0	[11.42]	316.0	[12.44]	344.0	[13.54]
AB	165.0	[6.49]	171.0	[6.73]	175.0	[6.89]	184.0	[7.24]
AC	168.0	[6.60]	180.0	[7.09]	197.0	[7.76]	220.0	[8.66]
BA	205.0	[8.06]	219.0	[8.62]	240.0	[9.45]	264.0	[10.39]
BB	32.0	[1.27]	35.0	[1.38]	37.5	[1.48]	42.0	[1.65]
BC	74.0	[2.90]	78.0	[3.07]	89.0	[3.50]	97.0	[3.82]
BD	191.0	[7.52]	204.0	[8.03]	227.0	[8.94]	248.0	[9.76]
BE	84.0	[3.30]	92.0	[3.62]	102.5	[4.04]	115.0	[4.53]
CA	244.0	[9.60]	258.0	[10.16]	283.0	[11.14]	307.0	[12.08]
CB	43.0	[1.71]	46.0	[1.81]	50.0	[1.97]	54.0	[2.13]
CC	48.0	[1.89]	50.0	[1.97]	50.0	[1.97]	60.0	[2.36]
CD	50.8	[2.00]	57.2	[2.25]	57.2	[2.25]	66.6	[2.62]
CE	23.8	[0.94]	27.8	[1.09]	27.8	[1.09]	31.8	[1.25]
CF	69.5	[2.74]	68.0	[2.68]	95.5	[3.76]	86.0	[3.39]
CG	86.0	[3.38]	90.0	[3.54]	96.0	[3.78]	102.0	[4.02]
CH	18.0	[0.71]	17.0	[0.67]	21.0	[0.83]	23.0	[0.91]
CJ	92.5	[3.64]	104.0	[4.09]	119.5	[4.70]	123.0	[4.84]
CK	70.0	[2.76]	75.0	[2.95]	83.0	[3.27]	93.0	[3.66]
CL	83.0	[3.28]	89.0	[3.50]	101.0	[3.98]	108.0	[4.25]
CM	89.0	[3.50]	94.0	[3.70]	97.0	[3.82]	100.0	[3.39]
α	17°		17°		19°		17°	
Case drain port "L1"/"L2"	Port ISO 11926-1 – 7/8 -14 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 7/8 -14 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅48.5 [1.91] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅48.5 [1.91] max. clearance DIA for fitting	
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	
Radial ports								
BH	205.0	[8.06]	219.0	[8.62]	240.0	[9.45]	264.0	[10.39]
BJ	32.0	[1.27]	35.0	[1.38]	37.5	[1.48]	42.0	[1.65]
BK	69.5	[2.74]	75.0	[2.95]	85.0	[3.35]	96.0	[3.78]
BL	50.8	[2.00]	57.2	[2.25]	57.2	[2.25]	66.6	[2.62]
BM	23.8	[0.94]	27.8	[1.09]	27.8	[1.09]	31.8	[1.25]
CN	245.0	[9.64]	258.0	[10.16]	284.0	[11.18]	308.0	[12.13]
CO	44.0	[1.72]	46.0	[1.81]	50.0	[1.97]	55.0	[2.17]
CP	48.0	[1.89]	50.0	[1.97]	50.0	[1.97]	60.0	[2.36]
System pressure "A"/"B" Gage port "MA"/"MB"	Port ISO 11926-1 – 7/8 -14 ∅34.0 [1.34] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅42.0 [1.65] max. clearance DIA for fitting	
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	

SAE Flange Design, Proportional Control, Option M*

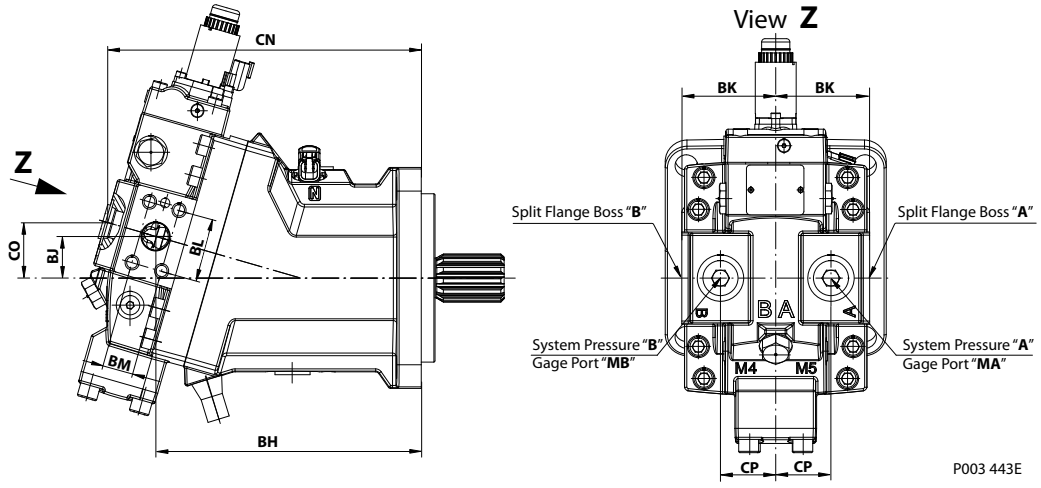
mm
[in]

Axial Ports





Radial Ports



SAE Flange Design, Proportional Control, Option M*

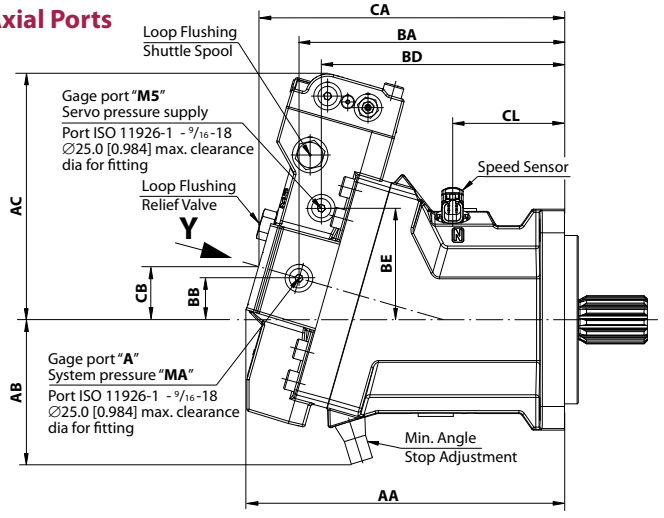
Dimensions mm [in]

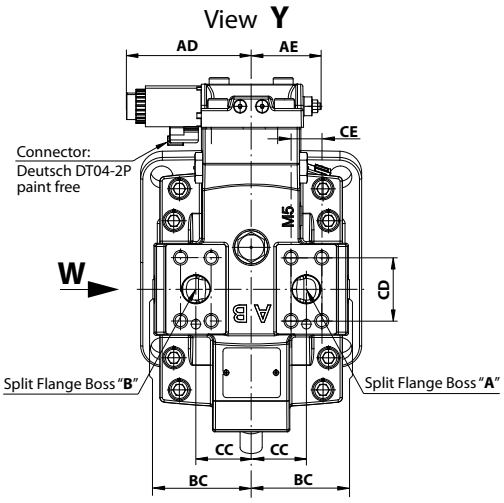
Frame size	060	080	110	160
Axial and radial ports				
AA	265.0 [10.43]	283.0 [11.14]	311.0 [12.24]	340.0 [13.39]
AB	115.0 [4.52]	119.0 [4.69]	131.0 [5.16]	138.0 [5.43]
AC	224.0 [8.83]	236.0 [9.29]	247.0 [9.72]	265.0 [10.43]
BA	205.0 [8.06]	219.0 [8.62]	240.0 [9.45]	264.0 [10.39]
BB	32.0 [1.27]	35.0 [1.38]	37.5 [1.48]	42.0 [1.65]
BC	74.0 [2.90]	78.0 [3.07]	89.0 [3.5]	97.0 [3.82]
BF	221.0 [8.68]	237.0 [9.33]	263.0 [10.35]	289.0 [11.38]
BG	19.0 [0.75]	22.0 [0.87]	25.0 [0.98]	29.0 [1.14]
CA	244.0 [9.60]	258.0 [10.16]	283.0 [11.14]	307.0 [12.08]
CB	43.0 [1.71]	46.0 [1.81]	50.0 [1.97]	54.0 [2.13]
CC	48.0 [1.89]	50.0 [1.97]	50.0 [1.97]	60.0 [2.36]
CD	50.8 [2.00]	57.2 [2.25]	57.2 [2.25]	66.6 [2.62]
CE	23.8 [0.94]	27.8 [1.09]	27.8 [1.09]	31.8 [1.25]
CF	69.5 [2.74]	68.0 [2.68]	95.5 [3.76]	86.0 [3.39]
CG	86.0 [3.38]	90.0 [3.54]	96.0 [3.78]	102.0 [4.02]
CH	18.0 [0.71]	17.0 [0.67]	21.0 [0.83]	23.0 [0.91]
CJ	92.5 [3.64]	104.0 [4.09]	119.5 [4.70]	123.0 [4.84]
CK	70.0 [2.76]	75.0 [2.95]	83.0 [3.27]	93.0 [3.66]
CL	83.0 [3.28]	89.0 [3.50]	101.0 [3.98]	108.0 [4.25]
CM	89.0 [3.50]	94.0 [3.70]	97.0 [3.82]	100.0 [3.39]
α	17°	17°	19°	17°
Case drain port "L1"/"L2"	Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅42.0 [1.65] max. clearance DIA for fitting	Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅42.0 [1.65] max. clearance DIA for fitting	Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting	Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth	DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth
Radial ports				
BH	205.0 [8.06]	219.0 [8.62]	240.0 [9.45]	264.0 [10.39]
BJ	32.0 [1.27]	35.0 [1.38]	37.5 [1.48]	42.0 [1.65]
BK	69.5 [2.74]	75.0 [2.95]	85.0 [3.35]	96.0 [3.78]
BL	50.8 [2.00]	57.2 [2.25]	57.2 [2.25]	66.6 [2.62]
BM	23.8 [0.94]	27.8 [1.09]	27.8 [1.09]	31.8 [1.25]
CN	245.0 [9.64]	258.0 [10.16]	284.0 [11.18]	308.0 [12.13]
CO	44.0 [1.72]	46.0 [1.81]	50.0 [1.97]	55.0 [2.17]
CP	48.0 [1.89]	50.0 [1.97]	50.0 [1.97]	60.0 [2.36]
System pressure "A"/"B" Gage port "MA"/"MB"	Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅34.0 [1.34] max. clearance DIA for fitting	Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅42.0 [1.65] max. clearance DIA for fitting	Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅42.0 [1.65] max. clearance DIA for fitting	Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅42.0 [1.65] max. clearance DIA for fitting
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth	DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth

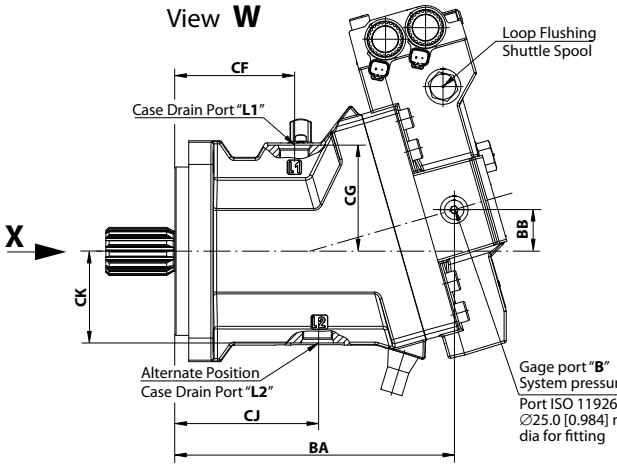
SAE Flange Design, Two Position Control, Pressure Compensator Override, Electric Brake Pressure Defeat, Option T* D* and P* D*

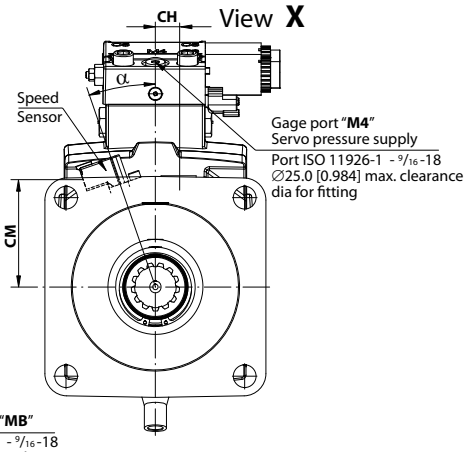
mm
[in]

Axial Ports

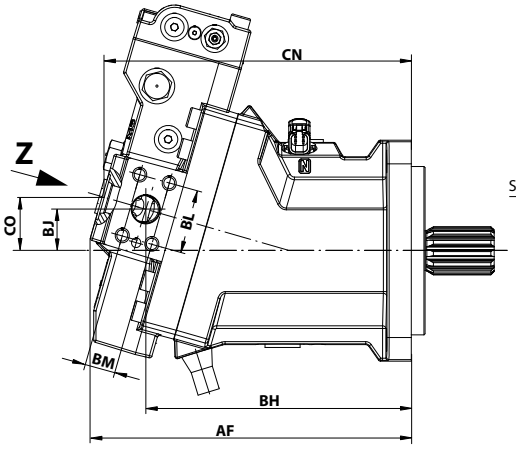


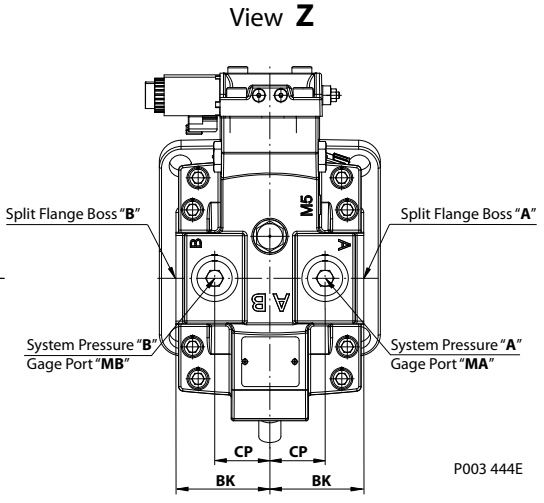






Radial Ports





P003 444E

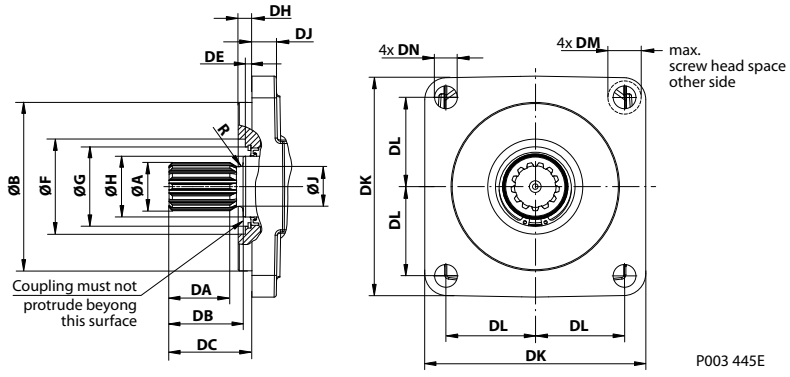
General Dimensions

**SAE Flange Design,
Two Position Control,
Pressure Compensator Override,
Electric Brake Pressure Defeat,
Option T* D* and P* D***

Dimensions mm [in]

Frame size	060		080		110		160	
Axial and radial ports								
AA	243.0	[9.57]	261.0	[10.28]	288.0	[11.34]	315.0	[12.40]
AB	115.0	[4.52]	119.0	[4.69]	131.0	[5.16]	138.0	[5.43]
AC	192.0	[7.55]	205.0	[8.07]	222.0	[8.74]	243.0	[9.57]
AD	113.0	[4.45]	113.0	[4.45]	113.0	[4.45]	113.0	[4.45]
AE	68.5 max.	[2.70 max.]	68.5 max.	[2.70 max.]	68.5 max.	[2.70 max.]	68.5 max.	[2.70 max.]
BA	205.0	[8.06]	219.0	[8.62]	240.0	[9.45]	264.0	[10.39]
BB	32.0	[1.27]	35.0	[1.38]	37.5	[1.48]	42.0	[1.65]
BC	74.0	[2.90]	78.0	[3.07]	89.0	[3.5]	100.0	[3.94]
BD	190.0	[7.47]	198.0	[7.80]	220.0	[8.66]	244.0	[9.60]
BE	84.0	[3.30]	90.0	[3.54]	101.0	[3.98]	112.0	[4.41]
CA	234.0	[9.21]	250.0	[9.71]	277.0	[10.90]	299.0	[11.77]
CB	41.0	[1.60]	44.0	[1.73]	48.0	[1.89]	52.0	[2.05]
CC	48.0	[1.89]	50.0	[1.97]	50.0	[1.97]	60.0	[2.36]
CD	50.8	[2.00]	57.2	[2.25]	57.2	[2.25]	66.6	[2.62]
CE	23.8	[0.94]	27.8	[1.09]	27.8	[1.09]	31.8	[1.25]
CF	69.5	[2.74]	68.0	[2.68]	95.5	[3.76]	86.0	[3.38]
CG	86.0	[3.38]	90.0	[3.54]	96.0	[3.78]	102.0	[4.02]
CH	18.0	[0.71]	17.0	[0.67]	21.0	[0.83]	23.0	0.91]
CJ	92.5	[3.64]	104.0	[4.09]	119.5	[4.70]	123.0	[4.84]
CK	70.0	[2.76]	75.0	[2.95]	83.0	[3.27]	97.0	[3.82]
CL	83.0	[3.28]	89.0	[3.50]	101.0	[3.98]	108.0	[4.25]
CM	89.0	[3.50]	94.0	[3.70]	97.0	[3.82]	106.0	[4.17]
α	17°		17°		19°		17°	
Case drain port "L1"/"L2"	Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting	
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	
Radial ports								
AF	245.0	[9.66]	264.0	[10.39]	290.0	[11.42]	315.0	[12.40]
BH	205.0	[8.08]	219.0	[8.62]	240.0	[9.45]	264.0	[10.39]
BJ	32.0	[1.27]	35.0	[1.38]	37.5	[1.48]	42.0	[1.65]
BK	69.5	[2.74]	75.0	[2.95]	85.0	[3.35]	96.0	[3.78]
BL	50.8	[2.00]	57.2	[2.25]	57.2	[2.25]	66.6	[2.62]
BM	23.8	[0.94]	27.8	[1.09]	27.8	[1.09]	31.8	[1.25]
CN	234.0	[9.22]	251.0	[9.88]	278.0	[10.95]	300.0	[11.81]
CO	41.0	[1.60]	44.0	[1.73]	48.0	[1.89]	52.0	[2.05]
CP	48.0	[1.89]	50.0	[1.97]	50.0	[1.97]	60.0	[2.36]
System pressure "A"/"B" Gage port "MA"/"MB"	Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅34.0 [1.34] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting	
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	

SAE Flange Design



Shaft and flange dimensions mm [in]

Frame size	060	080	110		160		
Shaft opt.	AN/AS	AN/AS	DN/DS	EN/ES	EN/ES	FN/FS	DN/DS
Shaft Dimensions							
Teeth	14	14	27	13	13	15	27
Module	12/24	12/24	16/32	8/16	8/16	8/16	16/32
Pressure angle	30°						
Pitch-Ø	29.633 [1.167]	29.633 [1.167]	42.862 [1.687]	41.275 [1.625]	41.275 [1.625]	47.625 [1.875]	42.862 [1.687]
Spline	ANSI B92.1-1970 Class 5 flat rood side fit	ANSI B92.1-1970 Class 5 flat rood side fit	ANSI B92.1-1970 Class 5 flat rood side fit		ANSI B92.1-1970 Class 5 flat rood side fit		
ØA	31.15 [1.226]	31.15 [1.226]	43.96 [1.730]	43.64 [1.72]	43.64 [1.72]	49.96 [1.966]	43.96 [1.731]
ØH	44.45 [1.750]	44.45 [1.750]	55.0 [2.165]		55.0 [2.165]		
ØJ	25.80 [1.016]	25.80 [1.016]	39.6 [1.559]	36.0 [1.417]	36.0 [1.417]	36.0 [1.417]	39.6 [1.559]
DA	37.50 [1.476]	37.50 [1.476]	55.0 [2.165]	55.0 [2.165]	55.0 [2.165]	53.0 [2.087]	55.0 [2.165]
DB	47.50 [1.870]	47.50 [1.870]	67.0 [2.638]		67.0 [2.638]		
DC	55.50 [2.185]	55.50 [2.185]	75.0 [2.953]	75.0 [2.953]	75.0 [2.953]	75.0 [2.953]	75.0 [2.953]
R	3.0 [0.118]	3.0 [0.118]	3.0 [0.118]		3.0 [0.118]		

Flange dimensions

Size	Mounting flange surface flange 127-4 per ISO 3019/1	Mounting flange surface flange 127-4 per ISO 3019/1	Mounting flange surface flange 152-4 per ISO 3019/1	Mounting flange surface flange 152-4 per ISO 3019/1
ØB	126.975 [4.999]	126.975 [4.999]	152.375 [6.00]	152.375 [6.00]
ØF	80.0 [3.150]	80.0 [3.150]	86.0 [3.39]	100.0 [3.94]
ØG	62.0 [2.441]	62.0 [2.441]	72.0 [2.84]	72.0 [2.84]
DE	6.40 [0.252]	6.40 [0.252]	6.00 [0.24]	6.40 [0.252]
DH	12.45 [0.490]	12.45 [0.490]	12.45 [0.49]	12.45 [0.49]
DJ	18.0 [0.71]	19.0 [0.748]	22.0 [0.88]	22.0 [0.88]
DK	142.5 [5.61]	142.5 [5.61]	200.0 [7.84]	200.0 [7.84]
DL	57.25 [2.254]	57.25 [2.254]	80.8 [3.18]	80.8 [3.18]
DM	19.5 [0.770]	19.5 [0.770]	30.0 [1.18]	30.0 [1.18]
DN	14.3 [0.563]	14.3 [0.563]	20.6 [0.81]	20.6 [0.81]

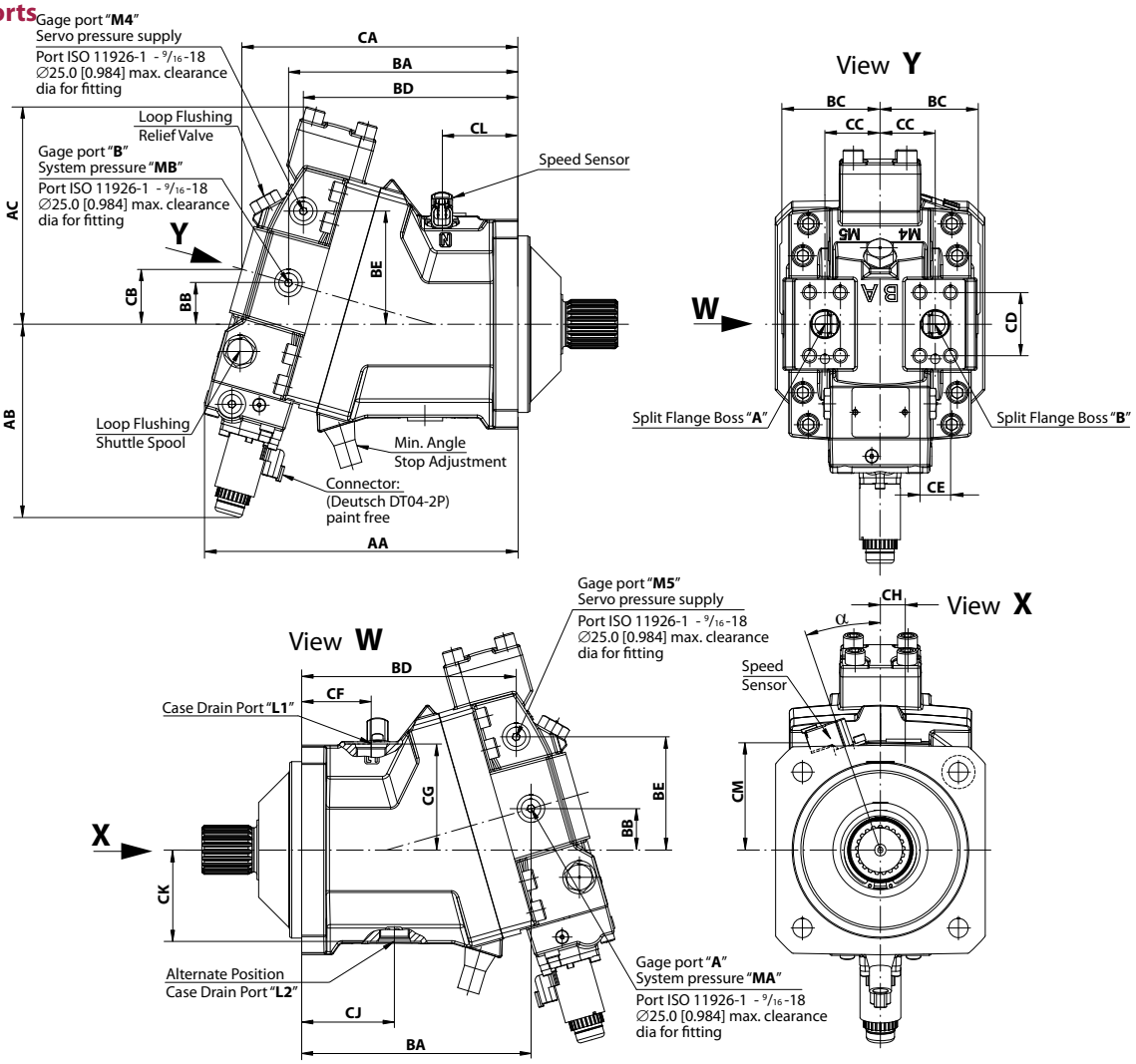
Notes

General Dimensions

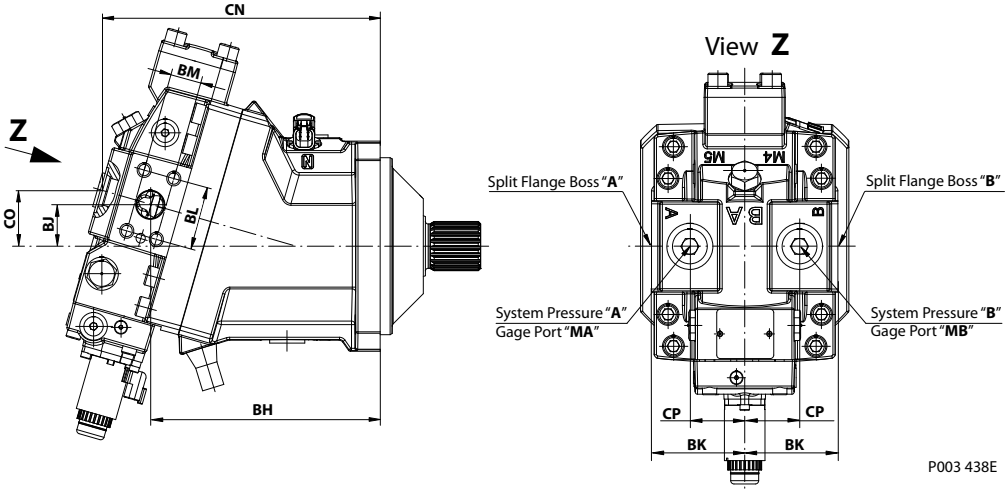
DIN Flange Design, Proportional Control, Option L*

mm
[in]

Axial Ports



Radial Ports



DIN Flange Design, Proportional Control, Option L*

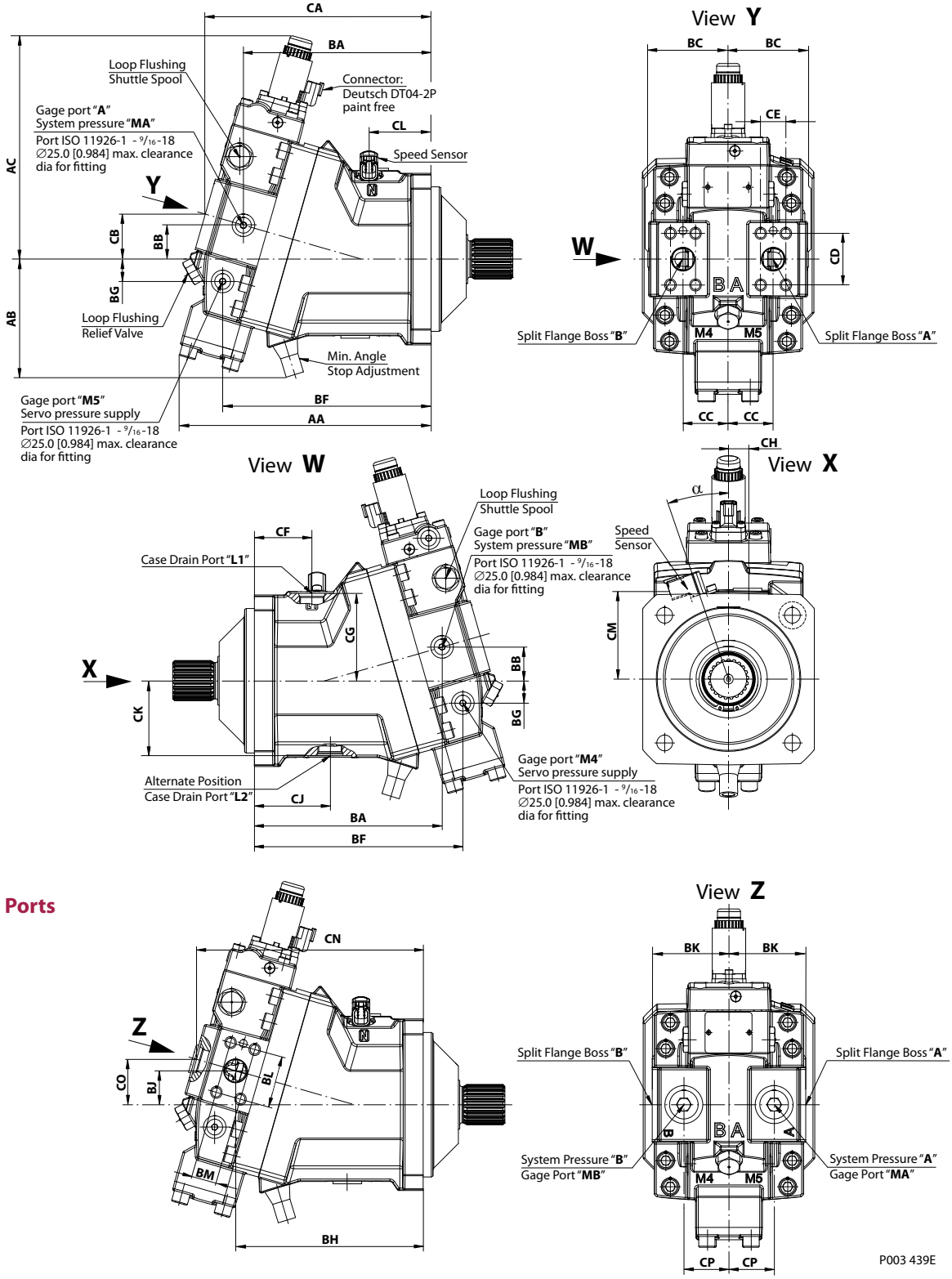
Dimensions mm [in]

Frame size	060		080		110		160	
Axial and radial ports								
AA	248.0	[9.76]	266.0	[10.47]	284.0	[11.20]	311.0	[12.24]
AB	165.0	[6.49]	171.0	[6.73]	175.0	[6.89]	184.0	[7.24]
AC	168.0	[6.60]	180.0	[7.09]	197.0	[7.76]	220.0	[8.66]
BA	180.0	180.0	195.0	[7.68]	208.0	[8.19]	232.0	[9.13]
BB	32.0	[1.27]	35.0	[1.38]	37.5	[1.48]	42.0	[1.65]
BC	74.0	[2.90]	78.0	[3.07]	89.0	[3.5]	97.0	[3.82]
BD	167.0	[6.56]	180.0	[7.09]	194.0	[7.64]	216.0	[8.50]
BE	84.0	[3.30]	92.0	[3.62]	102.5	[4.04]	115.0	[4.53]
CA	219.0	[8.63]	234.0	[9.21]	250.0	[9.84]	275.0	[10.83]
CB	43.0	[1.71]	46.0	[1.81]	50.0	[1.97]	54.0	[2.13]
CC	48.0	[1.89]	50.0	[1.97]	50.0	[1.97]	60.0	[2.36]
CD	50.8	[2.00]	57.2	[2.25]	57.2	[2.25]	66.6	[2.62]
CE	23.8	[0.94]	27.8	[1.09]	27.8	[1.09]	31.8	[1.25]
CF	45.0	[1.76]	46.0	[1.81]	63.0	[2.48]	55.5	[2.19]
CG	86.0	[3.38]	90.0	[3.54]	96.0	[3.78]	102.6	[4.02]
CH	18.0	[0.71]	22.0	[0.87]	21.0	[0.83]	23.0	[0.91]
CJ	68.0	[2.68]	80.0	[3.15]	87.0	[3.43]	91.0	[3.58]
CK	70.0	[2.76]	75.0	[2.95]	83.0	[3.27]	93.0	[3.66]
CL	59.0	[2.32]	65.0	[2.56]	69.0	[2.72]	76.0	[10.87]
CM	89.0		94.0	[3.70]	97.0	[3.82]	100.0	[3.39]
α	17°		17°		19°		17°	
Case drain port "L1"/"L2"	Port ISO 11926-1 – 7/8 -14 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 7/8 -14 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅48.5 [1.91] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅48.5 [1.91] max. clearance DIA for fitting	
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	
Radial ports								
BH	180.0	[7.10]	195.0	[7.68]	208.0	[8.19]	232.0	[9.13]
BJ	32.0	[1.27]	35.0	[1.38]	37.5	[1.48]	42.0	[1.65]
BK	69.5	[2.74]	75.0	[2.95]	85.0	[3.35]	96.0	[3.78]
BL	50.8	[2.00]	57.2	[2.25]	57.2	[2.25]	66.6	[2.62]
BM	23.8	[0.94]	27.8	[1.09]	27.8	[1.09]	31.8	[1.25]
CN	220.0	[8.67]	234.0	[9.21]	251.0	[9.88]	276.0	[10.87]
CO	44.0	[1.72]	46.0	[1.81]	50.0	[1.97]	55.0	[2.17]
CP	48.0	[1.89]	50.0	[1.97]	50.0	[1.97]	60.0	[2.36]
System pressure "A"/"B" Gage port "MA"/"MB"	Port ISO 11926-1 – 7/8 -14 ∅34.0 [1.34] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅42.0 [1.91] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅42.0 [1.91] max. clearance DIA for fitting	
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	

DIN Flange Design, Proportional Control, Option M*

mm
[in]

Axial Ports



Radial Ports

DIN Flange Design, Proportional Control, Option M*

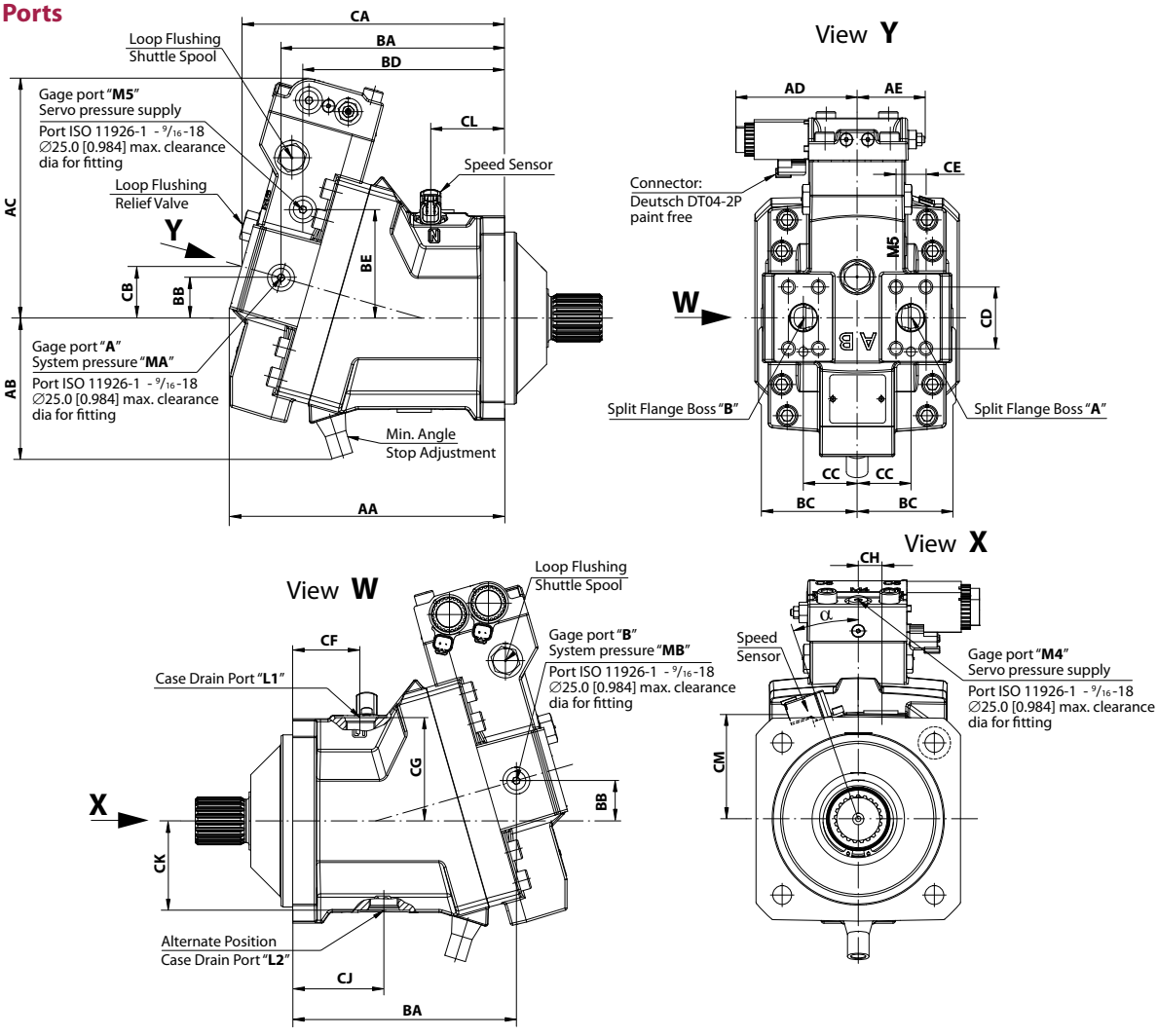
Dimensions mm [in]

Frame size	060	080	110	160
Axial and radial ports				
AA	240.0 [9.47]	259.0 [10.20]	278.0 [10.95]	308.0 [12.13]
AB	115.0 [4.52]	119.0 [4.69]	131.0 [5.16]	138.0 [5.43]
AC	224.0 [8.83]	236.0 [9.29]	247.0 [9.72]	265.0 [10.43]
BA	180.0 [7.09]	195.0 [7.68]	208.0 [8.19]	232.0 [9.13]
BB	32.0 [1.27]	35.0 [1.38]	37.5 [1.48]	42.0 [1.65]
BC	74.0 [2.90]	78.0 [3.07]	89.0 [3.5]	97.0 [3.82]
BF	196.0 [7.72]	213.0 [8.39]	231.0 [9.10]	257.0 [10.12]
BG	19.0 [0.75]	22.0 [0.87]	25.0 [0.98]	29.0 [1.14]
CA	219.0 [8.63]	234.0 [9.21]	250.0 [9.84]	275.0 [10.83]
CB	43.0 [1.71]	46.0 [1.81]	50.0 [1.97]	54.0 [2.13]
CC	48.0 [1.89]	50.0 [1.97]	50.0 [1.97]	60.0 [2.36]
CD	50.8 [2.00]	57.2 [2.25]	57.2 [2.25]	66.6 [2.62]
CE	23.8 [0.94]	27.8 [1.09]	27.8 [1.09]	31.8 [1.25]
CF	45.0 [1.76]	46.0 [1.81]	63.0 [2.48]	55.0 [2.17]
CG	86.0 [3.38]	90.0 [3.54]	96.0 [3.78]	102.0 [4.02]
CH	18.0 [0.71]	22.0 [0.87]	21.0 [0.83]	23.0 [0.91]
CJ	68.0 [2.68]	80.0 [3.15]	87.0 [3.43]	91.0 [3.58]
CK	70.0 [2.76]	75.0 [2.95]	83.0 [3.27]	93.0 [3.66]
CL	59.0 [2.56]	65.0 [2.56]	69.0 [2.72]	76.0 [2.99]
CM	89.0 [3.50]	94.0 [3.70]	97.0 [3.82]	100.0 [3.39]
α	17°	17°	19°	17°
Case drain port "L1"/"L2"	Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅42.0 [1.65] max. clearance DIA for fitting	Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅42.0 [1.65] max. clearance DIA for fitting	Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting	Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth	DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth
Radial ports				
BH	180.0 [7.10]	195.0 [7.68]	208.0 [8.19]	232.0 [9.13]
BJ	32.0 [1.27]	35.0 [1.38]	37.5 [1.48]	42.0 [1.65]
BK	69.5 [2.74]	75.0 [2.95]	85.0 [3.35]	96.0 [3.78]
BL	50.8 [2.00]	57.2 [2.25]	57.2 [2.25]	66.6 [2.62]
BM	23.8 [0.94]	27.8 [1.09]	27.8 [1.09]	31.8 [1.25]
CN	220.0 [8.67]	234.0 [9.21]	251.0 [9.88]	276.0 [10.87]
CO	44.0 [1.72]	46.0 [1.81]	50.0 [1.97]	55.0 [2.17]
CP	48.0 [1.89]	50.0 [1.97]	50.0 [1.97]	60.0 [2.36]
System pressure "A"/"B" Gage port "MA"/"MB"	Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅34.0 [1.34] max. clearance DIA for fitting	Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅42.0 [1.65] max. clearance DIA for fitting	Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅42.0 [1.91] max. clearance DIA for fitting	Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅42.0 [1.91] max. clearance DIA for fitting
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth	DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth

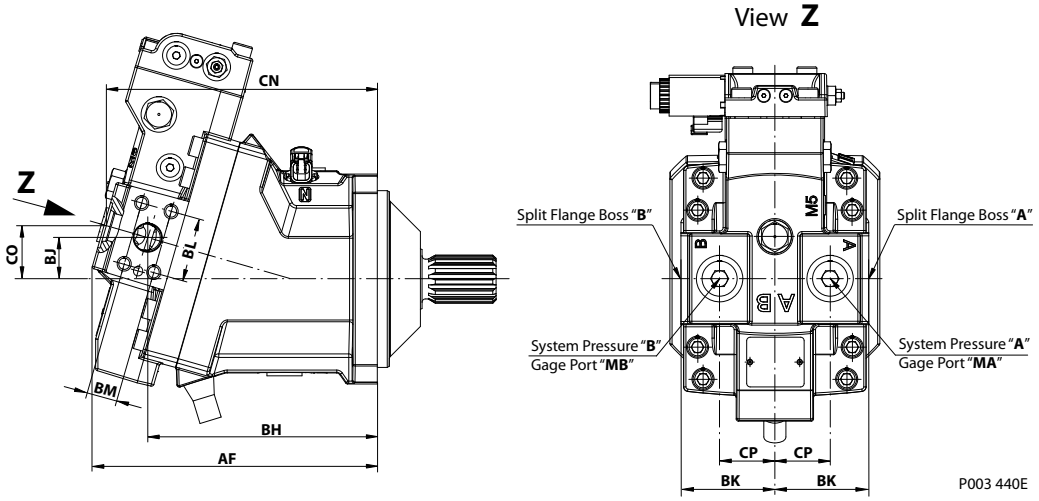
DIN Flange Design, Two Position Control, Pressure Compensator Override, Electric Brake Pressure Defeat, Option T* D* and P* D*

mm
[in]

Axial Ports



Radial Ports



P003 440E

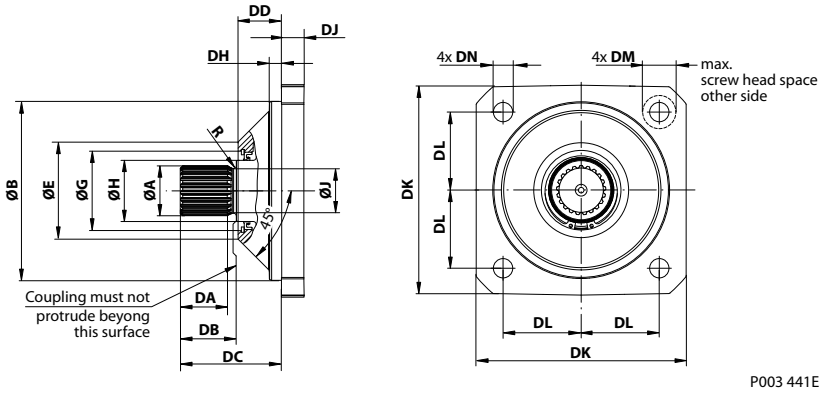
General Dimensions

**DIN Flange Design,
Two Position Control,
Pressure Compensator Override,
Electric Brake Pressure Defeat,
Option T* D* and P* D***

Dimensions mm [in]

Frame size	060		080		110		160	
Axial and radial ports								
AA	219.0	[8.63]	237.0	[9.33]	256.0	[10.08]	283.0	[11.14]
AB	115.0	[4.52]	119.0	[4.69]	131.0	[5.16]	138.0	[5.43]
AC	192.0	[7.55]	205.0	[8.07]	222.0	[8.74]	243.0	[9.57]
AD	113.0	[4.45]	113.0	[4.45]	113.0	[4.45]	113.0	[4.45]
AE	68.5 max.	[2.70 max.]	68.5 max.	[2.70 max.]	68.5 max.	[2.70 max.]	68.5 max.	[2.70 max.]
BA	181.0	[7.11]	195.0	[7.68]	208.0	[8.19]	232.0	[9.13]
BB	32.0	[1.27]	35.0	[1.38]	37.5	[1.48]	42.0	[1.65]
BC	74.0	[2.90]	78.0	[3.07]	89.0	[3.5]	100.0	[3.94]
BD	165.0	[6.51]	174.0	[6.85]	188.0	[7.40]	212.0	[8.35]
BE	84.0	[3.30]	90.0	[3.54]	101.0	[3.98]	112.0	[4.41]
CA	209.0	[8.24]	226.0	[8.90]	244.0	[9.60]	267.0	[10.51]
CB	41.0	[1.60]	44.0	[1.73]	48.0	[1.89]	52.0	[2.05]
CC	48.0	[1.89]	50.0	[1.97]	50.0	[1.97]	60.0	[2.36]
CD	50.8	[2.00]	57.2	[2.25]	57.2	[2.25]	66.6	[2.62]
CE	23.8	[0.94]	27.8	[1.09]	27.8	[1.09]	31.8	[1.25]
CF	45.0	[1.76]	46.0	[1.81]	63.0	[2.48]	54.0	[2.13]
CG	86.0	[3.38]	90.0	[3.54]	96.0	[3.78]	102.0	[4.02]
CH	18.0	[0.71]	22.0	[0.87]	21.0	[0.83]	23.0	[0.91]
CJ	68.0	[2.68]	80.0	[3.15]	87.0	[3.43]	91.0	[3.58]
CK	70.0	[2.76]	75.0	[2.95]	83.0	[3.27]	97.0	[3.82]
CL	59.0	[2.56]	65.0	[2.56]	69.0	[2.72]	55.0	[2.17]
CM	89.0		94.0	[3.70]	97.0	[3.82]	106.0	[4.17]
α	17°		17°		19°		17°	
Case drain port "L1"/"L2"	Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting	
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	
Radial ports								
AF	221.0	[8.69]	240.0	[9.45]	258.0	[10.16]	283.0	[11.14]
BH	181.0	[7.11]	195.0	[7.68]	208.0	[8.19]	232.0	[9.13]
BJ	32.0	[1.27]	35.0	[1.38]	37.5	[1.48]	42.0	[1.65]
BK	69.5	[2.74]	75.0	[2.95]	85.0	[3.35]	96.0	[3.78]
BL	50.8	[2.00]	57.2	[2.25]	57.2	[2.25]	66.6	[2.62]
BM	23.8	[0.94]	27.8	[1.09]	27.8	[1.09]	31.8	[1.25]
CN	210.0	[8.25]	227.0	[8.94]	245.0	[9.65]	268.0	[10.55]
CO	41.0	[1.60]	44.0	[1.81]	48.0	[1.89]	52.0	[2.05]
CP	48.0	[1.89]	50.0	[1.97]	50.0	[1.97]	60.0	[2.36]
System pressure "A"/"B" Gage port "MA"/"MB"	Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅34.0 [1.34] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting	
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	

Flange Design per ISO 3019/2, (DIN Flange)



Shaft and flange dimensions mm [in]

Frame size	060	080		110		160	
Shaft opt.	GN/GS	HN/HS	JN/JS	JN/JS	KN/KS	KN/KS	LN/LS
Shaft dimensions							
Teeth	14	16	18	18	21	21	24
Pressure angle	30°						
Pitch-Ø	28.000 [1.102]	32.000 [1.260]	36.000 [1.417]	36.000 [1.417]	42.000 [1.654]	42.000 [1.654]	48.000 [1.889]
Spline	W30x2x30x14x9g side fit DIN 5480	W35x2x30x 16x9g side fit DIN 5480	W40x2x30x 18x9g side fit DIN 5480	W40x2x30x 18x9g side fit DIN 5480	W45x2x30x 21x9g side fit DIN 5480	W45x2x30x 21x9g side fit DIN 5480	W50x2x30x 24x9g side fit DIN 5480
ØA	29.6 [1.165]	34.6 [1.362]	39.6 [1.559]	39.6 [1.559]	44.6 [1.756]	44.6 [1.756]	49.6 [1.953]
ØH	44.45 [1.750]	44.45 [1.750]		55.0 [2.165]		55.0 [2.165]	
ØJ	25.0 [0.984]	30.0 [1.181]	35.0 [1.378]	35.0 [1.378]	40.0 [1.757]	40.0 [1.757]	45.0 [1.772]
DA	27.0 [1.063]	32.0 [1.260]	37.0 [1.457]	37.0 [1.457]	42.0 [1.654]	42.0 [1.654]	47.0 [1.850]
DB	35.0 [1.378]	40.0 [1.575]	45.0 [1.772]	45.0 [1.772]	50.0 [1.969]	50.0 [1.969]	55.0 [2.165]
DC	67.5 [2.657]	72.0 [2.835]	77.0 [3.031]	85.5 [3.366]	90.5 [3.563]	90.5 [3.563]	95.5 [3.760]
R	1.6 [0.063]	1.6 [0.063]		2.5 [0.098]		2.5 [0.098]	1.6 [0.063]

Flange dimensions

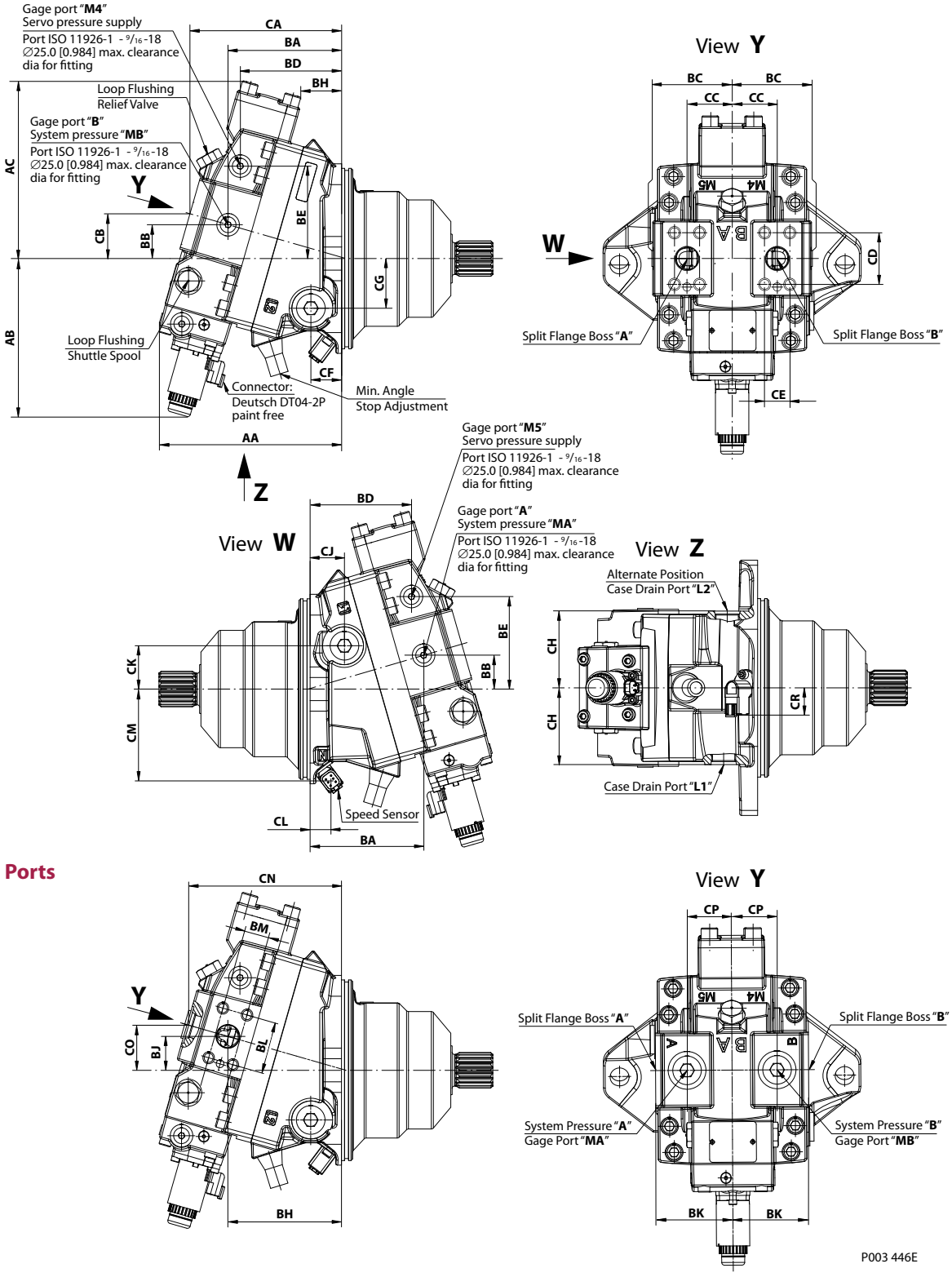
Size	Mounting flange surface flange 125 B4 HL per ISO 3019/2	Mounting flange surface flange 140 B4 HL per ISO 3019/2	Mounting flange surface flange 160 B4 HL per ISO 3019/2	Mounting flange surface flange 180 B4 HL per ISO 3019/2
ØB	125.0 [4.921]	140.0 [5.512]	160.0 [6.299]	180.0 [7.087]
ØE	72.0 [2.835]	76.6 [3.016]	86.0 [3.4]	99.0 [3.898]
ØG	62.0 [2.441]	62.0 [2.441]	72.0 [2.835]	72.0 [2.835]
DD	30.0 [1.181]	31.2 [1.228]	39.0 [1.54]	39.0 [1.54]
DH	11.0 [0.43]	11.0 [0.43]	11.0 [0.43]	11.0 [0.43]
DJ	17.0 [0.671]	19.0 [0.748]	22.0 [0.87]	22.0 [0.87]
DK	150.0 [5.906]	165.0 [6.496]	190.0 [7.84]	212.0 [8.346]
DL	56.6 [2.228]	63.65 [2.506]	70.7 [2.78]	79.2 [3.118]
DM	19.5 [0.770]	19.5 [0.770]	30.0 [1.18]	30.0 [1.18]
DN	13.5 [0.532]	13.5 [0.532]	17.5 [0.689]	17.5 [0.689]

Notes

Cartridge Flange Design, Proportional Control, Option L*

mm
[in]

Axial Ports



Radial Ports

Cartridge Flange Design, Proportional Control, Option L*

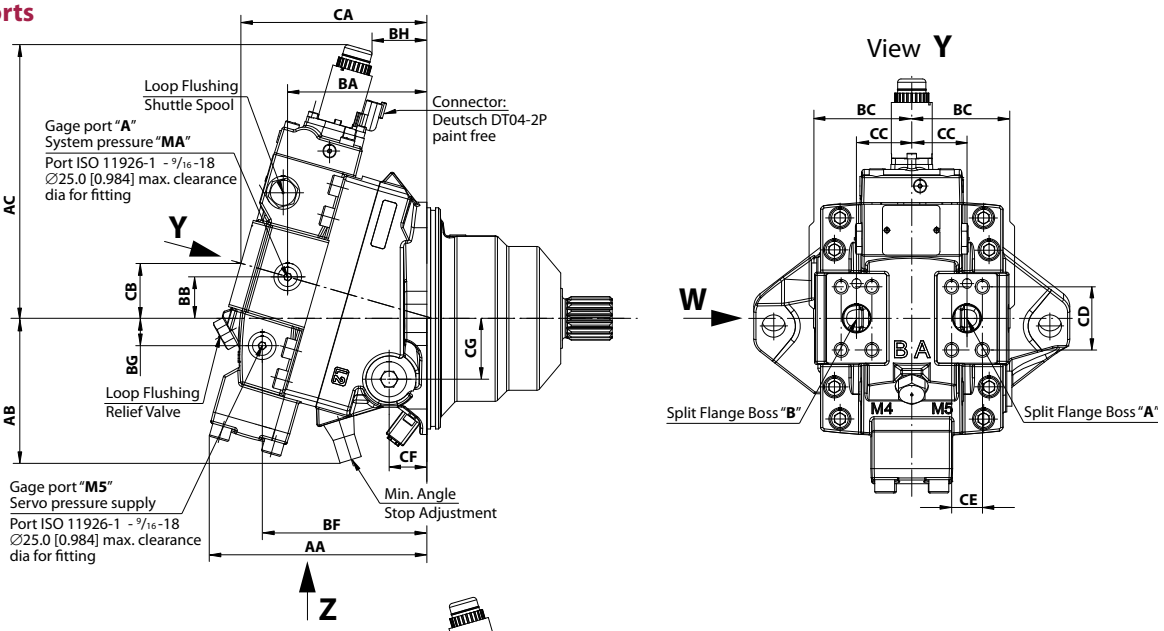
Dimensions mm [in]

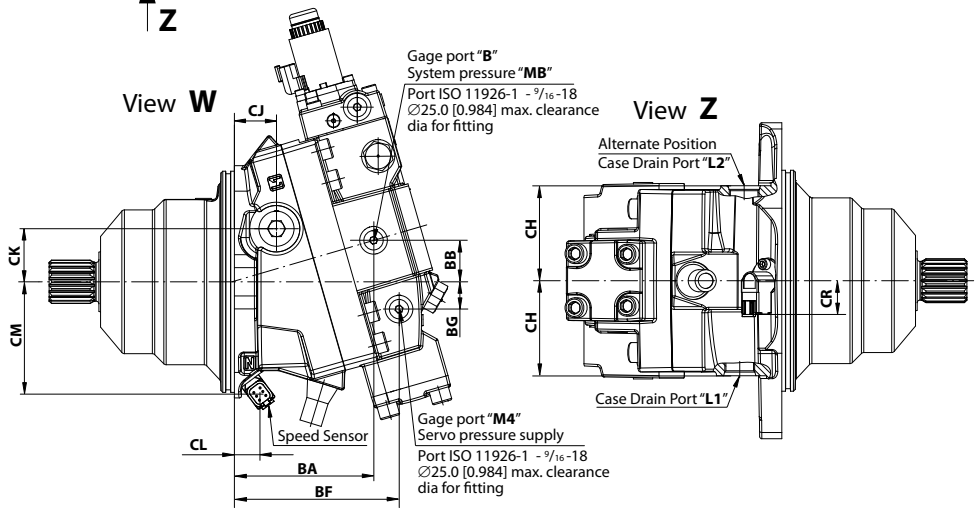
Frame size	060		080		110		160	
Axial and radial ports								
AA	188.0	[7.41]	188.0	[7.41]	202.0	[7.95]	229.0	[9.02]
AB	165.0	[6.49]	171.0	[6.73]	175.0	[6.89]	184.0	[7.24]
AC	168.0	[6.60]	180.0	[7.09]	197.0	[7.76]	220.0	[8.66]
BA	121.0	[4.75]	116.0	[4.57]	126.0	[4.96]	150.0	[5.91]
BB	32.0	[1.27]	35.0	[1.38]	37.5	[1.48]	42.0	[1.65]
BC	74.0	[2.90]	78.0	[3.07]	89.0	[3.5]	97.0	[3.82]
BD	107.0	[4.21]	102.0	[4.02]	112.0	[4.41]	134.0	[5.28]
BE	84.0	[3.30]	92.0	[3.62]	102.5	[4.04]	115.0	[4.53]
BH	43.0	[1.69]	37.0	[1.46]	46.0	[1.81]	64.0	[2.52]
CA	160.0	[6.28]	155.0	[6.10]	168.0	[6.60]	193.0	[7.60]
CB	43.0	[1.71]	46.0	[1.81]	50.0	[1.97]	54.0	[2.13]
CC	48.0	[1.89]	50.0	[1.97]	50.0	[1.97]	60.0	[2.36]
CD	50.8	[2.00]	57.2	[2.25]	57.2	[2.25]	66.6	[2.62]
CE	23.8	[0.94]	27.8	[1.09]	27.8	[1.09]	31.8	[1.25]
CF	33.0	[1.31]	31.0	[1.22]	34.0	[1.34]	52.0	[2.05]
CG	44.0	[1.73]	57.0	[2.24]	55.0	[2.17]	50.0	[1.97]
CH	75.0	[2.95]	78.0	[3.07]	86.0	[3.39]	97.0	[3.82]
CJ	44.0	[1.74]	36.0	[1.42]	38.0	[1.50]	53.0	[2.09]
CK	35.0	[1.38]	46.0	[1.81]	48.0	[1.89]	51.0	[2.01]
CL	26.0	[1.02]	22.0	[0.87]	23.0	[0.91]		
CM	97.0	[3.81]	96.0	[3.78]	101.0	[3.98]		
CR	30.0	[1.18]	30.0	[1.18]	30.0	[1.18]	30.0	[1.18]
Case drain port "L1"/"L2"	Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting	
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	
Radial ports								
BH	121.0	[4.75]	116.0	[4.57]	126.0	[4.96]	150.0	[5.91]
BJ	32.0	[1.27]	35.0	[1.38]	37.5	[1.48]	42.0	[1.65]
BK	69.5	[2.74]	75.0	[2.95]	85.0	[3.35]	96.0	[3.78]
BL	50.8	[2.00]	57.2	[2.25]	57.2	[2.25]	66.6	[2.62]
BM	23.8	[0.94]	27.8	[1.09]	27.8	[1.09]	31.8	[1.25]
CN	161.0	[6.32]	155.0	[6.10]	169.0	[6.65]	194.0	[7.64]
CO	44.0	[1.72]	46.0	[1.81]	50.0	[1.97]	55.0	[2.17]
CP	48.0	[1.89]	50.0	[1.97]	50.0	[1.97]	60.0	[2.36]
System pressure "A"/"B" Gage port "MA"/"MB"	Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅34.0 [1.34] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅42.0 [1.91] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅42.0 [1.91] max. clearance DIA for fitting	
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	

Cartridge Flange Design, Proportional Control, Option M*

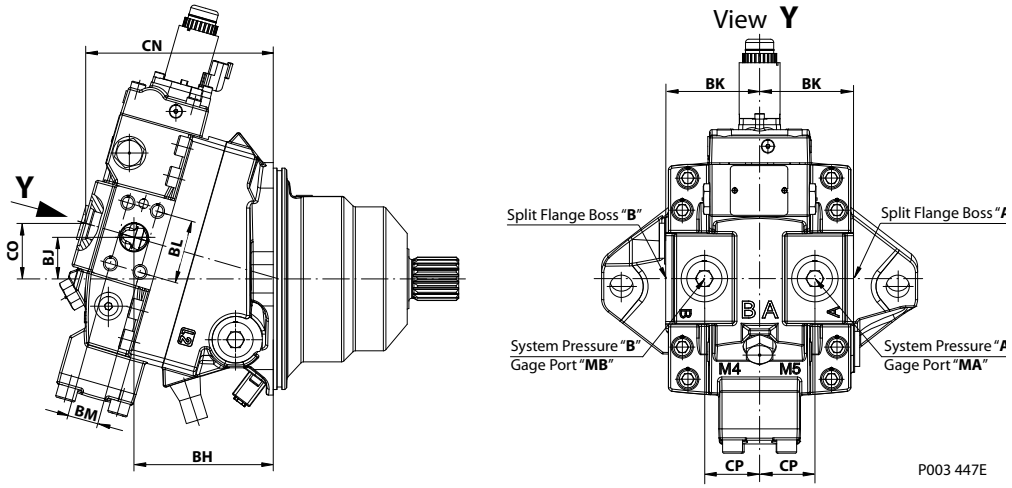
mm
[in]

Axial Ports





Radial Ports



Cartridge Flange Design, Proportional Control, Option M*

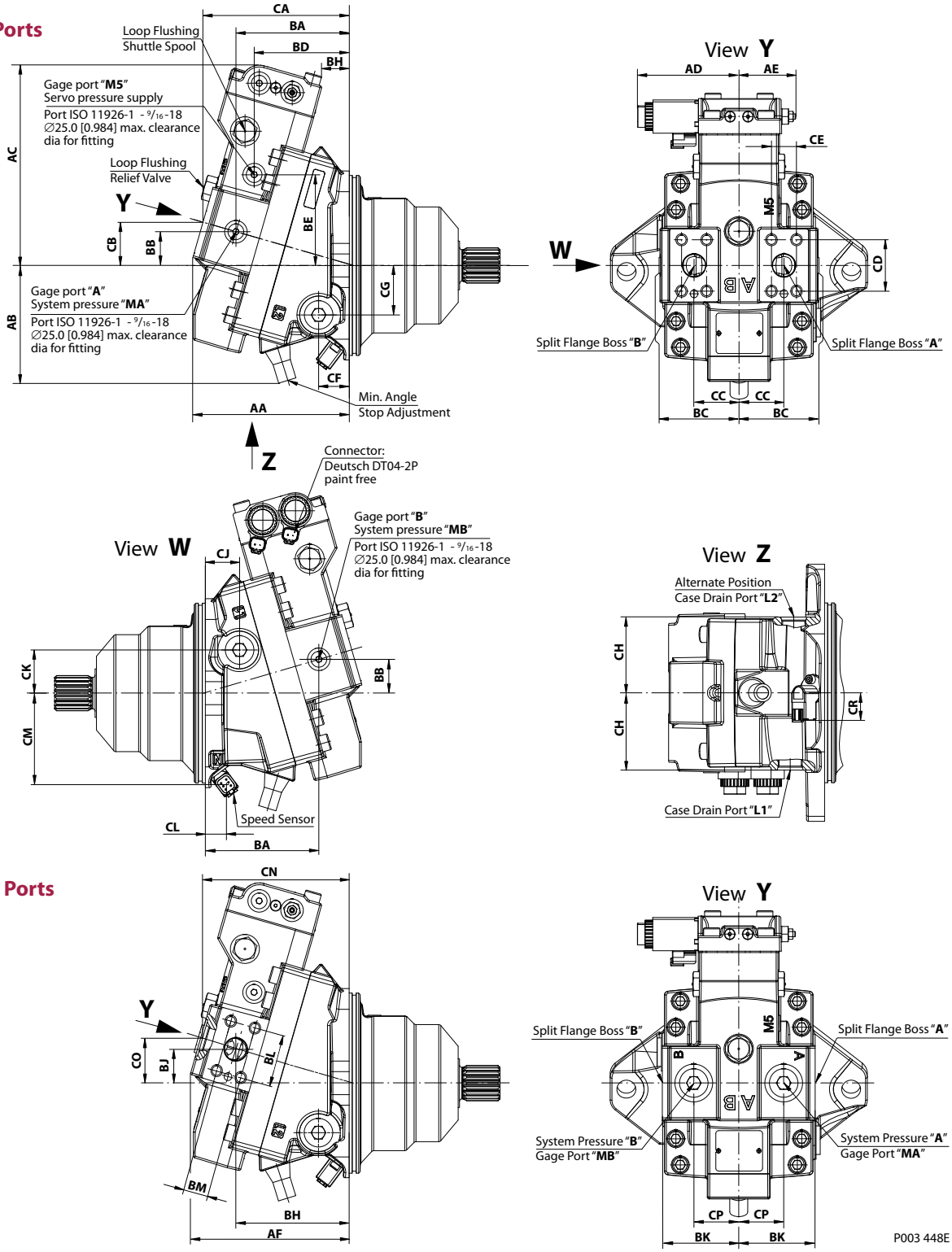
Dimensions mm [in]

Frame size	060		080		110		160	
Axial and radial ports								
AA	181.0	[7.13]	181.0	[7.13]	196.0	[7.72]	225.0	[8.86]
AB	115.0	[4.52]	119.0	[4.69]	131.0	[5.16]	138.0	[5.43]
AC	224.0	[8.83]	236.0	[9.29]	247.0	[9.72]	265.0	[10.43]
BA	121.0	[4.75]	116.0	[4.57]	126.0	[4.96]	150.0	[5.91]
BB	32.0	[1.27]	35.0	[1.38]	37.5	[1.48]	42.0	[1.65]
BC	74.0	[2.90]	78.0	[3.07]	89.0	[3.5]	97.0	[3.82]
BF	136.0	[5.37]	134.0	[5.28]	149.0	[5.87]	175.0	[6.89]
BG	19.0	[0.75]	22.0	[0.87]	25.0	[0.98]	29.0	[1.14]
BH	32.0	[1.26]	27.0	[	36.0		56.0	
CA	160.0	[6.28]	155.0	[6.10]	168.0	[6.60]	193.0	[7.60]
CB	43.0	[1.71]	46.0	[1.81]	50.0	[1.97]	54.0	[2.13]
CC	48.0	[1.89]	50.0	[1.97]	50.0	[1.97]	60.0	[2.36]
CD	50.8	[2.00]	57.2	[2.25]	57.2	[2.25]	66.6	[2.62]
CE	23.8	[0.94]	27.8	[1.09]	27.8	[1.09]	31.8	[1.25]
CF	33.0	[1.31]	31.0	[1.22]	34.0	[1.34]	55.0	[2.17]
CG	44.0	[1.73]	57.0	[2.24]	55.0	[2.17]	50.0	[1.97]
CH	75.0	[2.95]	78.0	[3.07]	86.0	[3.39]	97.0	[3.82]
CJ	44.0	[1.74]	36.0	[1.42]	38.0	[1.50]	53.0	[2.09]
CK	35.0	[1.38]	46.0	[1.81]	48.0	[1.89]	51.0	[2.01]
CL	26.0	[1.02]	22.0	[0.87]	23.0	[0.91]		
CM	97.0	[3.81]	96.0	[3.78]	101.0	[3.98]		
CR	30.0	[1.18]	30.0	[1.18]	30.0	[1.18]		
Case drain port "L1"/"L2"	Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅48.5 [1.91] max. clearance DIA for fitting	
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	
Radial Ports								
BH	121.0	[4.75]	116.0	[4.57]	126.0	[4.96]	150.0	[5.91]
BJ	32.0	[1.27]	35.0	[1.38]	37.5	[1.48]	42.0	[1.65]
BK	69.5	[2.74]	75.0	[2.95]	85.0	[3.35]	96.0	[3.78]
BL	50.8	[2.00]	57.2	[2.25]	57.2	[2.25]	66.6	[2.62]
BM	23.8	[0.94]	27.8	[1.09]	27.8	[1.09]	31.8	[1.25]
CN	161.0	[6.32]	155.0	[6.10]	169.0	[6.65]	194.0	[7.64]
CO	44.0	[1.72]	46.0	[1.81]	50.0	[1.97]	55.0	[2.17]
CP	48.0	[1.89]	50.0	[1.97]	50.0	[1.97]	60.0	[2.36]
System pressure "A"/"B" Gage port "MA"/"MB"	Port ISO 11926-1 – $^{7}/_{8}$ -14 ∅34.0 [1.34] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅42.0 [1.91] max. clearance DIA for fitting		Port ISO 11926-1 – 1 $^{1}/_{16}$-12 ∅42.0 [1.91] max. clearance DIA for fitting	
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	

Cartridge Flange Design, Two Position Control, Pressure Compensator Override, Electric Brake Pressure Defeat, Option T* D* and P* D*

mm
[in]

Axial Ports



Radial Ports

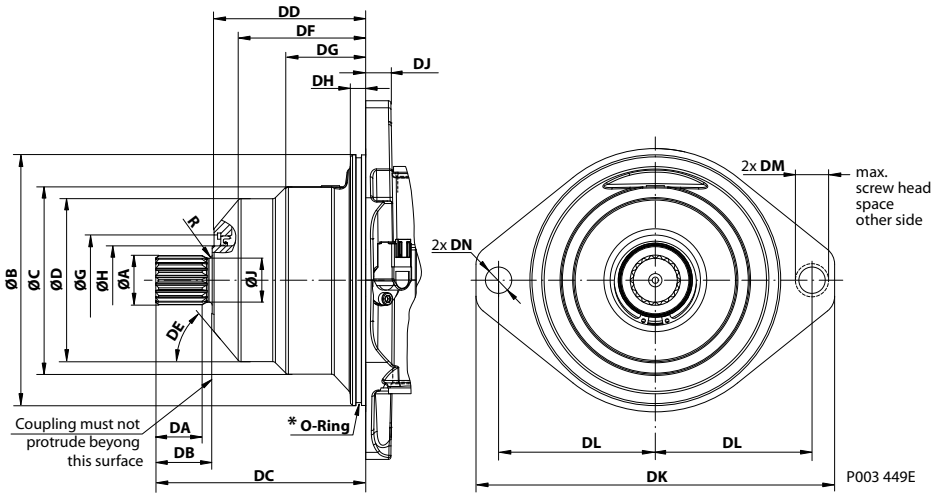
P003 448E

**Cartridge Flange Design,
Two Position Control,
Pressure Compensator Override,
Electric Brake Pressure Defeat,
Option T* D* and P* D***

Dimensions mm [in]

Frame size	060		080		110		160	
Axial and radial ports								
AA	159.0	[6.26]	159.0	[6.26]	174.0	[6.85]	201.0	[7.91]
AB	115.0	[4.52]	119.0	[4.69]	131.0	[5.16]	138.0	[5.43]
AC	192.0	[7.55]	205.0	[8.07]	222.0	[8.74]	243.0	[9.57]
AD	113.0	[4.45]	113.0	[4.45]	113.0	[4.45]	113.0	[4.45]
AE	68.5 max.	[2.70 max.]	68.5 max.	[2.70 max.]	68.5 max.	[2.70 max.]	68.5 max.	[2.70 max.]
BA	121.0	[4.75]	116.0	[4.57]	126.0	[4.96]	150.0	[5.90]
BB	32.0	[1.27]	35.0	[1.38]	37.5	[1.48]	42.0	[1.65]
BC	74.0	[2.90]	78.0	[3.07]	89.0	[3.5]	100.0	[3.94]
BD	106.0	[4.16]	96.0	[3.78]	106.0	[4.17]	130.0	[5.12]
BE	84.0	[3.30]	90.0	[3.54]	101.0	[3.98]	112.0	[4.41]
BH	29.0	[1.14]	20.0	[0.79]	31.0	[1.22]	50.0	[1.97]
CA	150.0	[5.90]	148.0	[5.83]	162.0	[6.38]	185.0	[7.28]
CB	41.0	[1.60]	44.0	[1.73]	48.0	[1.89]	52.0	[2.05]
CC	48.0	[1.89]	50.0	[1.97]	50.0	[1.97]	60.0	[2.36]
CD	50.8	[2.00]	57.2	[2.25]	57.2	[2.25]	66.6	[2.62]
CE	23.8	[0.94]	27.8	[1.09]	27.8	[1.09]	31.8	[1.25]
CF	33.0	[1.31]	31.0	[1.22]	34.0	[1.34]	52.0	[2.05]
CG	44.0	[1.73]	57.0	[2.24]	55.0	[2.17]	50.0	[1.97]
CH	75.0	[2.95]	78.0	[3.07]	86.0	[3.39]	97.0	[3.82]
CJ	44.0	[1.74]	36.0	[1.42]	38.0	[1.50]	53.0	[2.09]
CK	35.0	[1.38]	46.0	[1.81]	48.0	[1.89]	51.0	[2.00]
CL	26.0	[1.02]	22.0	[0.87]	23.0	[0.91]		
CM	97.0	[3.81]	96.0	[3.78]	101.0	[3.98]		
CR	30.0	[1.18]	30.0	[1.18]	30.0	[1.18]		
Case drain port "L1"/"L2"	Port ISO 11926-1 – 7/8 -14 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 7/8 -14 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅48.5 [1.91] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅48.5 [1.91] max. clearance DIA for fitting	
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	
Radial ports								
AF	161.0	[6.34]	161.0	[6.34]	176.0	[6.93]	201.0	[7.91]
BH	121.0	[4.76]	116.0	[4.57]	126.0	[4.96]	150.0	[5.90]
BJ	32.0	[1.27]	35.0	[1.38]	37.5	[1.48]	42.0	[1.65]
BK	69.5	[2.74]	75.0	[2.95]	85.0	[3.35]	96.0	[3.78]
BL	50.8	[2.00]	57.2	[2.25]	57.2	[2.25]	66.6	[2.62]
BM	23.8	[0.94]	27.8	[1.09]	27.8	[1.09]	31.8	[1.25]
CN	150.0	[5.90]	148.0	[5.83]	163.0	[6.42]	186.0	[7.32]
CO	41.0	[1.60]	44.0	[1.73]	48.0	[1.89]	52.0	[2.05]
CP	48.0	[1.89]	50.0	[1.97]	50.0	[1.97]	60.0	[2.36]
System pressure "A"/"B" Gage port "MA"/"MB"	Port ISO 11926-1 – 7/8 -14 ∅34.0 [1.34] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅42.0 [1.65] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅48.5 [1.91] max. clearance DIA for fitting		Port ISO 11926-1 – 1 1/16-12 ∅48.5 [1.91] max. clearance DIA for fitting	
Split flange boss "A"/"B"	DN 19 typ I 40MPa series per ISO 6162 thread: M10x1.5 18.0 [0.71] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 25 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth		DN 32 typ I 40MPa series per ISO 6162 thread: M12x1.75 23.0 [0.91] full thread depth	

Cartridge Flange Design



Shaft and flange dimensions mm [in]

Frame size	060	080		110		160	
Shaft opt.	GN/GS	HN/HS	JN/JS	JN/JS	KN/KS	KN/KS	LN/LS
Shaft dimensions							
Teeth	14	16	18	18	21	21	24
Pressure angle	30°						
Pitch-Ø	28.000 [1.102]	32.000 [1.260]	36.000 [1.417]	36.000 [1.417]	42.000 [1.654]	42.000 [1.654]	48.000 [1.889]
Spline	W30x2x30x14x9g side fit DIN 5480	W35x2x 30x16x9g side fit DIN 5480	W40x2x 30x18x9g side fit DIN 5480	W40x2x 30x18x9g side fit DIN 5480	W45x2x 30x21x9g side fit DIN 5480	W45x2x 30x21x9g side fit DIN 5480	W50x2x 30x24x9g side fit DIN 5480
ØA	29.6 [1.165]	34.6 [1.362]	39.6 [1.559]	39.6 [1.559]	44.6 [1.756]	44.6 [1.756]	49.6 [1.953]
ØH	44.45 [1.750]	44.45 [1.750]		55.0 [2.165]		55.0 [2.165]	
ØJ	25.0 [0.984]	30.0 [1.181]	35.0 [1.378]	35.0 [1.378]	40.0 [1.757]	40.0 [1.757]	45.0 [1.772]
DA	27.0 [1.063]	32.0 [1.260]	37.0 [1.457]	37.0 [1.457]	42.0 [1.654]	42.0 [1.654]	47.0 [1.850]
DB	35.0 [1.378]	40.0 [1.575]	45.0 [1.772]	45.0 [1.772]	50.0 [1.969]	50.0 [1.969]	55.0 [2.165]
DC	127.2 [5.008]	150.4 [5.921]	155.4 [6.118]	167.5 [6.594]	172.5 [6.791]	172.5 [6.791]	177.7 [7.0]
R	1.6 [0.063]	1.6 [0.063]		2.5 [0.098]		2.5 [0.098]	1.6 [0.063]

Flange dimensions

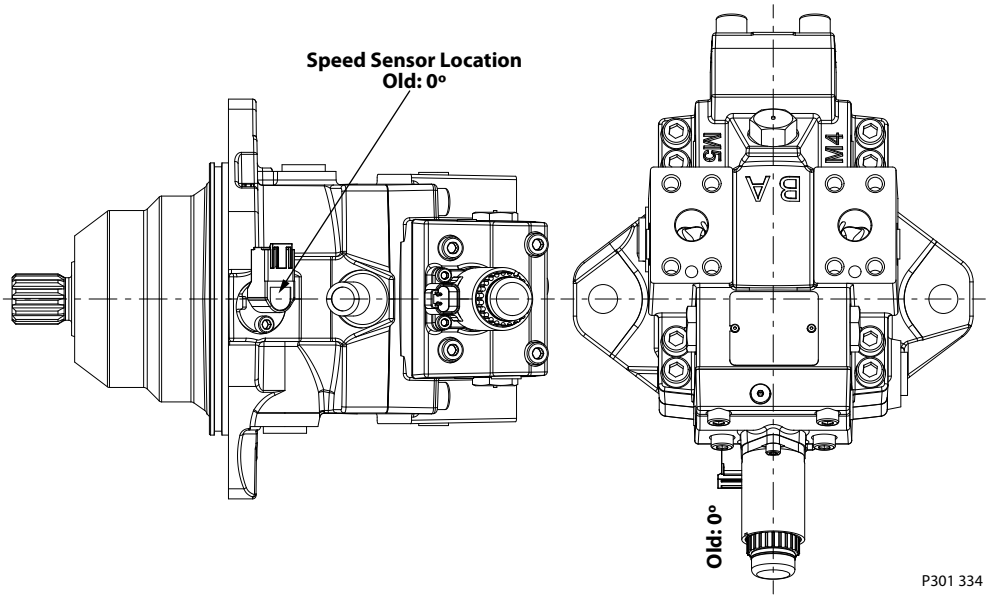
Size	Mounting flange surface Cartridge flange	Mounting flange surface Cartridge flange	Mounting flange surface Cartridge flange	Mounting flange surface Cartridge flange
ØB	160.0 [6.299]	190.0 [7.480]	200.0 [7.874]	200.0 [7.874]
ØC	121.0 [4.764]	134.0 [5.276]	150.0 [5.906]	170.0 [6.693]
ØD	104.0 [4.094]	116.0 [4.567]	130.0 [5.118]	146.0 [5.748]
ØG	62.0 [2.441]	62.0 [2.441]	72.0 [2.835]	72.0 [2.835]
DE	53°	50°	54°	45°
DD	90.4 [3.559]	109.2 [4.299]	121.0 [4.764]	121.0 [4.764]
DF	71.0 [2.801]	81.0 [3.189]	102.0 [4.0]	98.0 [3.858]
DG	41.0 [1.602]	57.0 [2.244]	64.0 [2.5]	62.0 [2.449]
DH	11.0 [0.441]	11.0 [0.441]	11.0 [0.441]	11.0 [0.441]
DJ	16.0 [0.638]	18.0 [0.709]	20.0 [0.79]	20.0 [0.79]
DK	235.0 [9.25]	260.0 [10.24]	286.0 [11.3]	286.0 [11.3]
DL	100.0 [3.937]	112.0 [4.409]	125.0 [4.92]	125.0 [4.92]
DM	30.0 [1.18]	30.0 [1.18]	30.0 [1.18]	30.0 [1.18]
DN	17.0 [0.67]	21.0 [0.83]	21.0 [0.83]	21.0 [0.83]
*** O-Ring**	3.00x150.00 [0.12x 5.90]	3.00x179.00 [0.12x 7.05]	3.00x192.00 [0.12x 7.563]	3.00x192.00 [0.12x 7.563]

* Is not part of the shipment

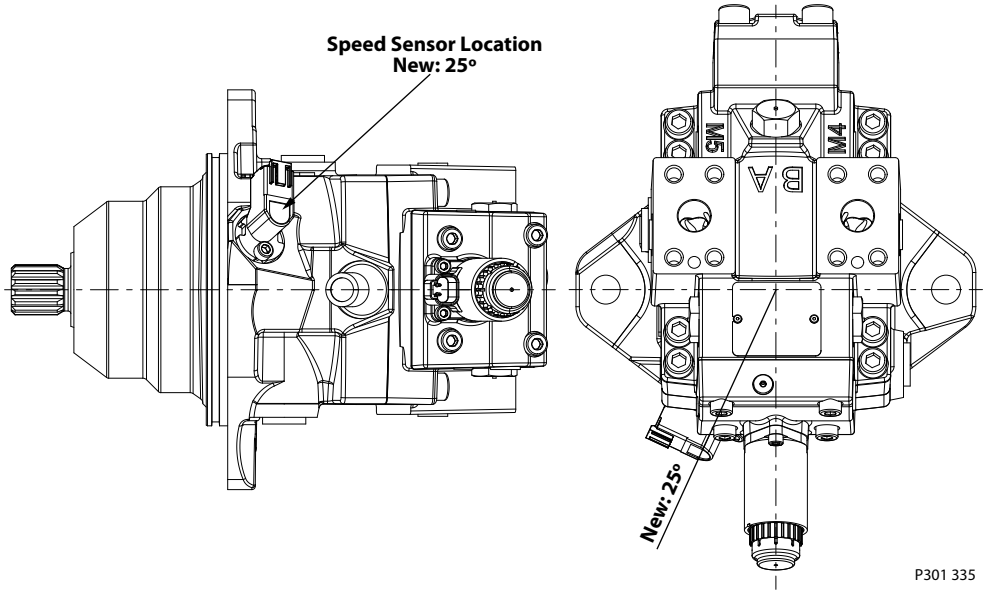
H1B Cartridge Motors with Speed Sensor

To eliminate potential interference of the speed sensor and some gearbox parking brakeports, we have made/will make a slight modification to the speed sensor location. The speed sensor location is rotated by 25° to eliminate the potential interference.

Size	*Date of introduction*
060cc	May 15, 2011
080cc	August 1, 2011
110cc	June 1, 2011
160cc	March 30, 2011

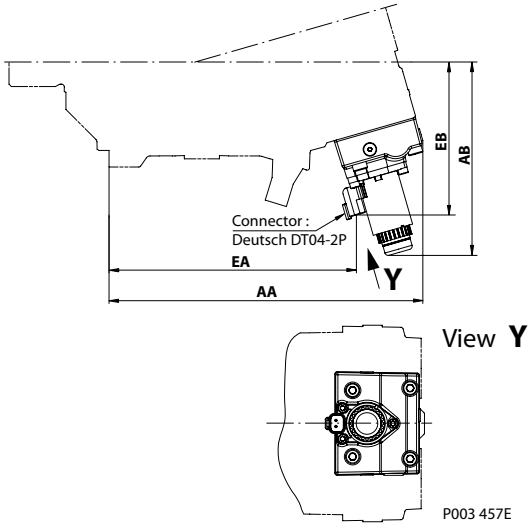


P301 334



P301 335

Electric Proportional Control Options L1BA, L2BA

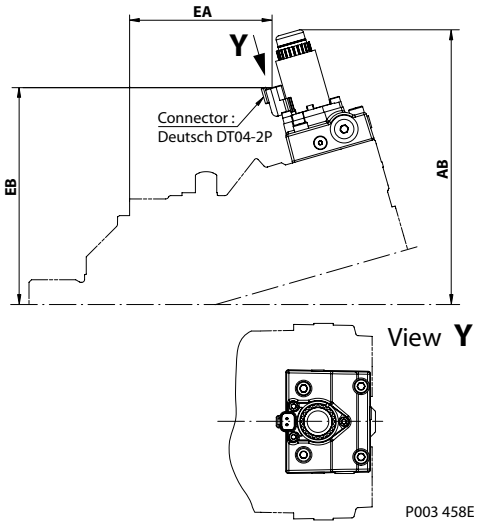


Dimensions mm [in]

Size 060	Flange style					
	DIN 125 B4 HL per ISO 3019/2		SAE 127-4 per ISO 3019/1		Cartridge 160	
AA	248.0	[9.76]	272.0	[10.72]	188.0	[7.41]
AB	165.0	[6.49]	165.0	[6.49]	165.0	[6.49]
EA	188.0	[7.41]	212.0	[8.35]	128.0	[5.04]
EB	128.0	[5.04]	128.0	[5.04]	128.0	[5.04]
Size 080	**DIN 140 B4 HL per ISO 3019/2**		**SAE 127-4 per ISO 3019/1**		**Cartridge 190**	
AA	266.0	[10.47]	290.0	[11.42]	188.0	[7.41]
AB	171.0	[6.73]	171.0	[6.73]	171.0	[6.73]
EA	206.0	[8.11]	230.0	[9.06]	127.0	[5.00]
EB	134.0	[5.28]	134.0	[5.28]	134.0	[5.28]
Size 110	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AA	284.0	[11.18]	316.0	[12.44]	202.0	[7.95]
AB	175.0	[6.89]	175.0	[6.89]	175.0	[6.89]
EA	224.0	[8.82]	256.0	[10.08]	142.0	[5.59]
EB	138.0	[5.43]	138.0	[5.43]	138.0	[5.43]
Size 160	**DIN 180 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AA	311.0	[12.24]	344.0	[13.54]	229.0	[9.02]
AB	184.0	[7.24]	184.0	[7.24]	184.0	[7.24]
EA	251.0	[9.88]	284.0	[11.18]	169.0	[6.65]
EB	147.0	[5.79]	147.0	[5.79]	147.0	[5.79]

General Dimensions – Controls

Electric Proportional Control Options M1CA, M2CA

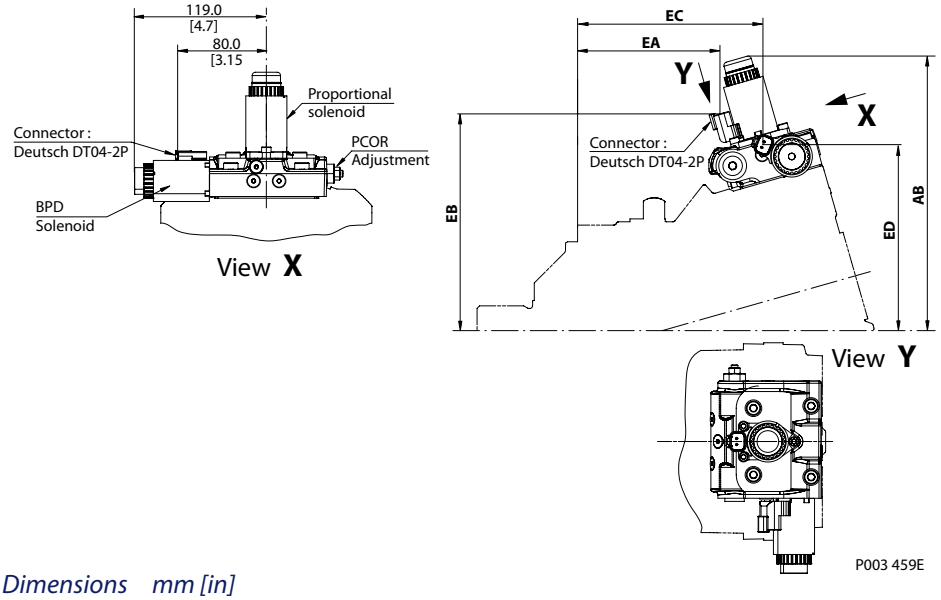


Dimensions mm [in]

Size 060	Flange style					
	DIN 125 B4 HL per ISO 3019/2		SAE 127-4 per ISO 3019/1		Cartridge 160	
AB	224.0	[8.83]	224.0	[8.83]	224.0	[8.83]
EA	102.0	[4.00]	126.0	[4.96]	42.0	[1.65]
EB	172.0	[6.78]	172.0	[6.78]	172.0	[6.78]
Size 080	**DIN 140 B4 HL per ISO 3019/2**		**SAE 127-4 per ISO 3019/1**		**Cartridge 190**	
AB	236.0	[9.29]	236.0	[9.29]	236.0	[9.29]
EA	115.0	[4.53]	139.0	[5.47]	36.0	[1.42]
EB	184.0	[7.24]	184.0	[7.24]	184.0	[7.24]
Size 110	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AB	247.0	[9.72]	247.0	[9.72]	247.0	[9.72]
EA	128.0	[5.04]	161.0	[6.34]	46.0	[1.81]
EB	195.0	[7.68]	195.0	[7.68]	195.0	[7.68]
Size 160	**DIN 180 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AB	265.0	[10.43]	265.0	[10.43]	265.0	[10.43]
EA	149.0	[5.87]	181.0	[7.13]	67.0	[2.64]
EB	213.0	[8.39]	213.0	[8.39]	213.0	[8.39]

General Dimensions – Controls

Electric Proportional Control with Pressure Compensator OverRide (PCOR) and Electric Brake Pressure Defeat (BPD) Options K1K1, K2K2

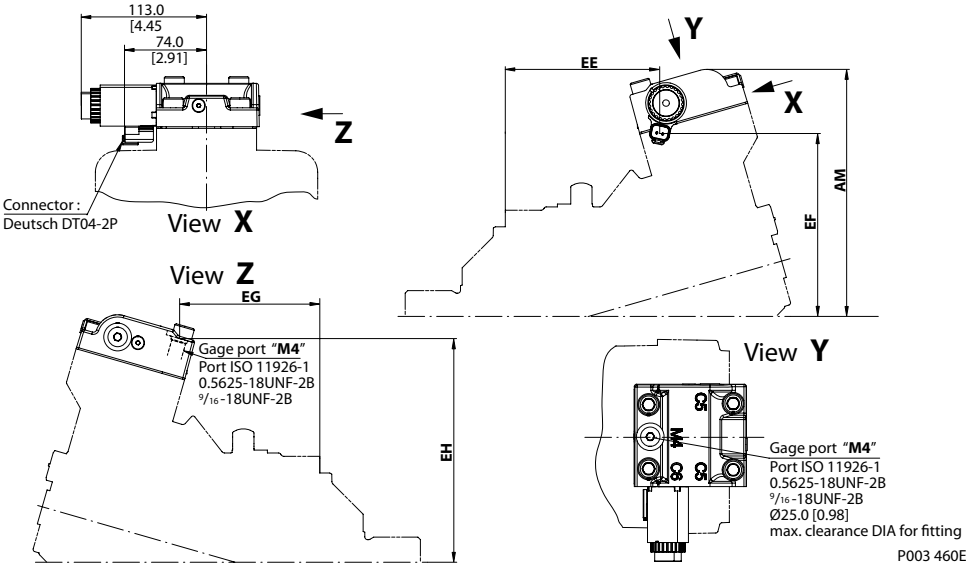


Dimensions mm [in]

Size 060	Flange style					
	DIN 125 B4 HL per ISO 3019/2		SAE 127-4 per ISO 3019/1		Cartridge 160	
AB	224.0	[8.83]	224.0	[8.83]	224.0	[8.83]
EA	102.0	[4.00]	126.0	[4.96]	42.0	[1.65]
EB	172.0	[6.78]	172.0	[6.78]	172.0	[6.78]
EC	140.0	[5.52]	165.0	[6.49]	81.0	[2.95]
ED	145.0	[5.69]	145.0	[5.69]	145.0	[5.69]
Size 080	**DIN 140 B4 HL per ISO 3019/2**		**SAE 127-4 per ISO 3019/1**		**Cartridge 190**	
AB	236.0	[9.29]	236.0	[9.29]	236.0	[9.29]
EA	115.0	[4.53]	139.0	[5.47]	36.0	[1.42]
EB	184.0	[7.24]	184.0	[7.24]	184.0	[7.24]
EC	153.0	[6.02]	177.0	[6.97]	75.0	[2.95]
ED	156.0	[6.14]	156.0	[6.14]	156.0	[6.14]
Size 110	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AB	247.0	[9.72]	247.0	[9.72]	247.0	[9.72]
EA	128.0	[5.04]	161.0	[6.34]	46.0	[1.81]
EB	195.0	[7.68]	195.0	[7.68]	195.0	[7.68]
EC	167.0	[6.58]	199.0	[7.84]	85.0	[3.35]
ED	167.5	[6.59]	167.5	[6.59]	167.5	[6.59]
Size 160	**DIN 180 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AB	265.0	[10.43]	265.0	[10.43]	265.0	[10.43]
EA	149.0	[5.87]	181.0	[7.13]	67.0	[2.64]
EB	213.0	[8.39]	213.0	[8.39]	213.0	[8.39]
EC	187.0	[7.36]	219.0	[8.62]	105.0	[4.13]
ED	185.0	[7.28]	185.0	[7.28]	185.0	[7.28]

General Dimensions – Controls

Electric Two-Position Control Options E1AA, E2AA



Dimensions mm [in]

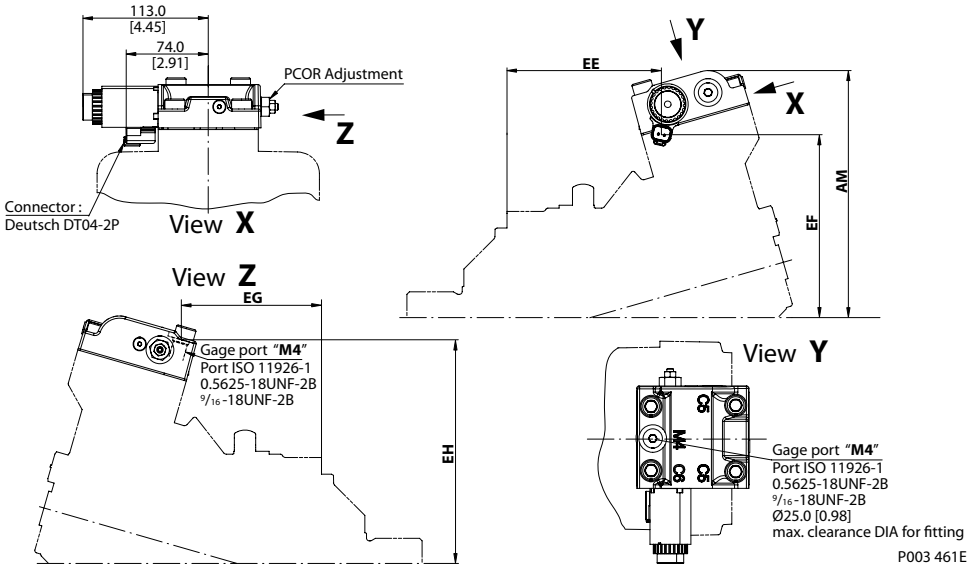
Size 060	Flange style					
	DIN 125 B4 HL per ISO 3019/2		SAE 127-4 per ISO 3019/1		Cartridge 160	
AM	192.0	[7.55]	192.0	[7.55]	192.0	[7.55]
EE	115.0	[4.54]	140.0	[5.50]	56.0	[2.19]
EF	134.0	[5.28]	134.0	[5.28]	134.0	[5.28]
EG	102.0	[4.01]	126.0	[4.97]	42.0	[1.66]
EH	171.0	[6.71]	171.0	[6.71]	171.0	[6.71]
Size 080	**DIN 140 B4 HL per ISO 3019/2**		**SAE 127-4 per ISO 3019/1**		**Cartridge 190**	
AM	205.0	[8.07]	205.0	[8.07]	205.0	[8.07]
EE	126.0	[4.96]	150.0	[5.79]	47.0	[1.85]
EF	147.0	[5.79]	147.0	[5.91]	147.0	[5.79]
EG	112.0	[4.41]	136.0	[5.35]	34.0	[1.34]
EH	183.0	[7.21]	183.0	[7.21]	183.0	[7.21]
Size 110	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AM	222.0	[8.74]	222.0	[8.74]	222.0	[8.74]
EE	140.0	[5.51]	172.0	[6.77]	58.0	[2.28]
EF	164.0	[6.46]	164.0	[6.46]	164.0	[6.46]
EG	126.0	[4.96]	159.0	[6.26]	44.0	[1.73]
EH	201.0	[7.91]	201.0	[7.91]	201.0	[7.91]
Size 160	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AM	243.0	[9.57]	243.0	[9.57]	243.0	[9.57]
EE	159.0	[6.26]	191.0	[7.52]	77.0	[3.03]
EF	183.0	[7.20]	183.0	[7.20]	183.0	[7.20]
EG	145.0	[5.71]	177.0	[6.97]	63.0	[2.48]
EH	222.0	[8.74]	222.0	[8.74]	222.0	[8.74]

General Dimensions – Controls

Electric Two-Position Control with Pressure Compensator OverRide (PCOR) Options T1DA, T2DA

and

Electric Two-Position Control with Electric Proportional Pressure Compensator OverRide (PPCOR) Options P1DA, P2DA



Dimensions mm [in]

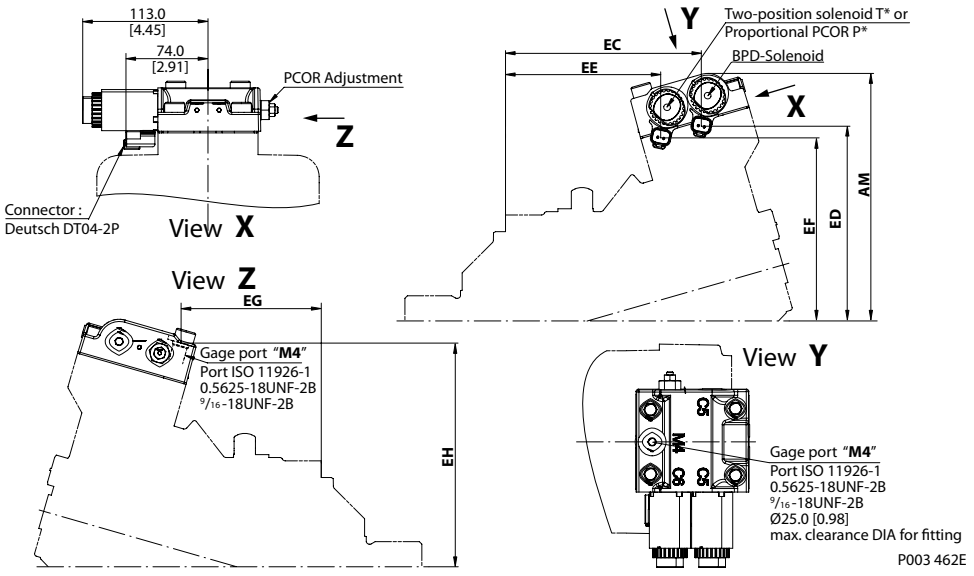
Size 060	Flange style					
	DIN 125 B4 HL per ISO 3019/2		SAE 127-4 per ISO 3019/1		Cartridge 160	
AM	192.0	[7.55]	192.0	[7.55]	192.0	[7.55]
EE	115.0	[4.54]	140.0	[550]	56.0	[2.19]
EF	134.0	[5.28]	134.0	[5.28]	134.0	[5.28]
EG	102.0	[4.01]	126.0	[4.97]	42.0	[1.66]
EH	171.0	[6.71]	171.0	[6.71]	171.0	[6.71]
Size 080	**DIN 140 B4 HL per ISO 3019/2**		**SAE 127-4 per ISO 3019/1**		**Cartridge 190**	
AM	205.0	[8.07]	205.0	[8.07]	205.0	[8.07]
EE	126.0	[4.96]	150.0	[5.79]	47.0	[1.85]
EF	147.0	[5.79]	147.0	[5.79]	147.0	[5.79]
EG	112.0	[4.41]	136.0	[5.35]	34.0	[1.34]
EH	183.0	[7.21]	183.0	[7.21]	183.0	[7.21]
Size 110	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AM	222.0	[8.74]	222.0	[8.74]	222.0	[8.74]
EE	140.0	[5.51]	172.0	[6.77]	58.0	[2.28]
EF	164.0	[6.46]	164.0	[6.46]	164.0	[6.46]
EG	126.0	[4.96]	159.0	[6.26]	44.0	[1.73]
EH	201.0	[7.91]	201.0	[7.91]	201.0	[7.91]
Size 160	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AM	243.0	[9.57]	243.0	[9.57]	243.0	[9.57]
EE	159.0	[6.26]	191.0	[7.52]	77.0	[3.03]
EF	183.0	[7.20]	183.0	[7.20]	183.0	[7.20]
EG	145.0	[5.71]	177.0	[6.97]	63.0	[2.48]
EH	222.0	[8.74]	222.0	[8.74]	222.0	[8.74]

General Dimensions – Controls

Electric Two-Position Control with Pressure Compensator OverRide (PCOR) and Electric Brake Pressure Defeat (BPD) Options T1D1, T2D2

and

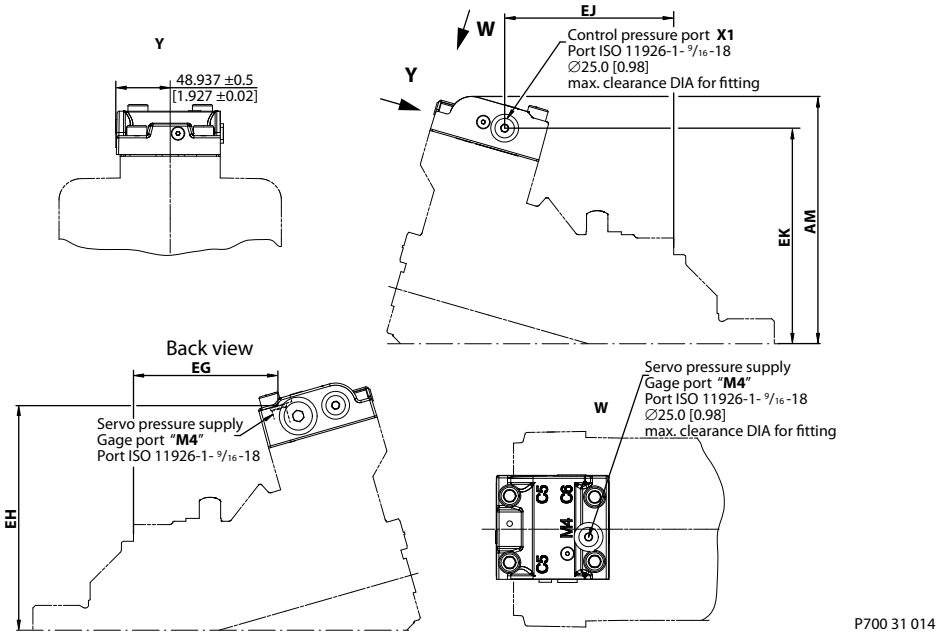
Electric Two-Position Control with Electric Proportional Pressure Compensator OverRide (PPCOR) and Electric Brake Pressure Defeat (BPD) Options P1D1, P2D2



Dimensions mm [in]

Size 060	Flange style					
	DIN 125 B4 HL per ISO 3019/2		SAE 127-4 per ISO 3019/1		Cartridge 160	
AM	192.0	[7.55]	192.0	[7.55]	192.0	[7.55]
EC	152.0	[5.98]	176.0	[6.94]	92.0	[3.63]
ED	144.0	[5.68]	144.0	[5.68]	144.0	[5.68]
EE	115.0	[4.54]	140.0	[5.50]	56.0	[2.19]
EF	134.0	[5.28]	134.0	[5.28]	134.0	[5.28]
EG	102.0	[4.01]	126.0	[4.97]	42.0	[1.66]
EH	171.0	[6.71]	171.0	[6.71]	171.0	[6.71]
Size 080	**DIN 140 B4 HL per ISO 3019/2**		**SAE 127-4 per ISO 3019/1**		**Cartridge 190**	
AM	205.0	[8.07]	205.0	[8.07]	205.0	[8.07]
EC	162.0	[6.38]	186.0	[7.32]	84.0	[3.31]
ED	157.0	[6.18]	157.0	[6.18]	157.0	[6.18]
EE	126.0	[4.96]	150.0	[5.91]	47.0	[1.85]
EF	147.0	[5.79]	147.0	[5.79]	147.0	[5.79]
EG	112.0	[4.41]	136.0	[5.35]	34.0	[1.34]
EH	183.0	[7.21]	183.0	[7.21]	183.0	[7.21]
Size 110	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AM	222.0	[8.74]	222.0	[8.74]	222.0	[8.74]
EC	176.0	[6.93]	209.0	[8.23]	94.0	[3.70]
ED	175.0	[6.89]	175.0	[6.89]	175.0	[6.89]
EE	140.0	[5.51]	172.0	[6.77]	58.0	[2.28]
EF	164.0	[6.46]	164.0	[6.46]	164.0	[6.46]
EG	126.0	[4.96]	159.0	[6.26]	44.0	[1.73]
EH	201.0	[7.91]	201.0	[7.91]	201.0	[7.91]
Size 160	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AM	243.0	[9.57]	243.0	[9.57]	243.0	[9.57]
EC	195.0	[7.68]	227.0	[8.94]	113.0	[4.45]
ED	194.0	[7.64]	194.0	[7.64]	194.0	[7.64]
EE	159.0	[6.26]	191.0	[7.52]	77.0	[3.03]
EF	183.0	[7.20]	183.0	[7.20]	183.0	[7.20]
EG	145.0	[5.71]	177.0	[6.97]	63.0	[2.48]
EH	222.0	[8.74]	222.0	[8.74]	222.0	[8.74]

Hydraulic Two-Position Control Option HEHE

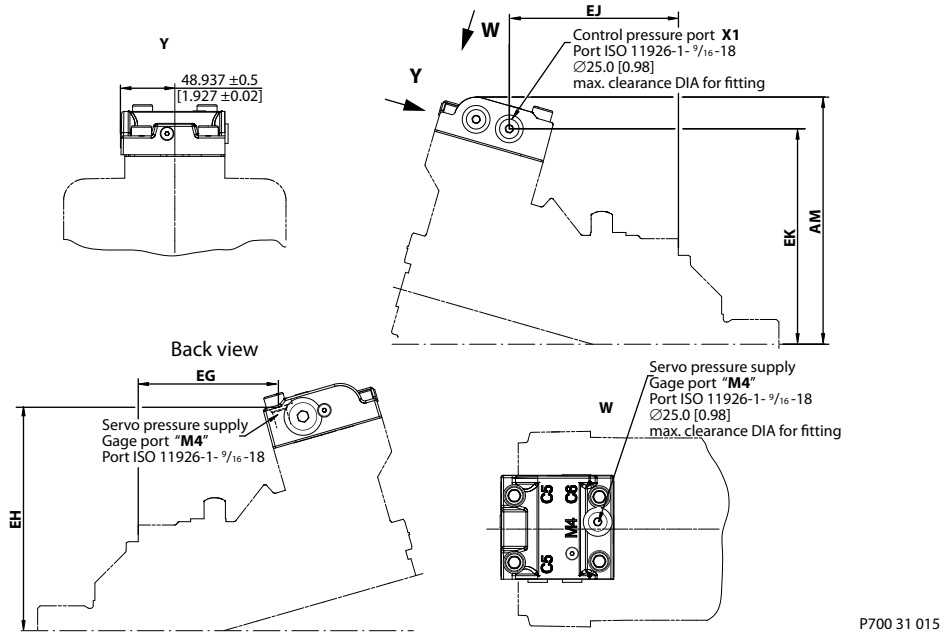


Dimensions mm [in]

Size 060	Flange style					
	DIN 125 B4 HL per ISO 3019/2		SAE 127-4 per ISO 3019/1		Cartridge 160	
AM	192.0	[7.56]	192.0	[7.56]	192.0	[7.56]
EG	106.0	[4.16]	130.0	[5.12]	46.0	[1.81]
EH	171.0	[6.71]	171.0	[6.71]	171.0	[6.71]
EJ	128.0	[5.03]	152.0	[5.98]	68.0	[2.68]
EK	163.0	[6.42]	163.0	[6.42]	163.0	[6.42]
Size 080	**DIN 140 B4 HL per ISO 3019/2**		**SAE 127-4 per ISO 3019/1**		**Cartridge 190**	
AM	205.0	[8.07]	205.0	[8.07]	205.0	[8.07]
EG	116.0	[4.57]	140.0	[5.51]	38.0	[1.48]
EH	185.0	[7.28]	185.0	[7.28]	185.0	[7.28]
EJ	138.0	[5.44]	162.0	[6.39]	60.0	[2.35]
EK	176.0	[6.94]	176.0	[6.94]	176.0	[6.94]
Size 110	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AM	222.0	[8.74]	222.0	[8.74]	222.0	[8.74]
EG	130.0	[5.12]	162.0	[6.40]	48.0	[1.89]
EH	202.0	[7.95]	202.0	[7.95]	202.0	[7.95]
EJ	152.0	[5.98]	185.0	[7.28]	70.0	[2.76]
EK	194.0	[7.64]	194.0	[7.64]	194.0	[7.64]
Size 160	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AM	243.0	[9.55]	243.0	[9.55]	243.0	[9.55]
EG	184.0	[7.24]	213.0	[8.39]	99.0	[3.90]
EH	234.0	[9.21]	234.0	[9.21]	234.0	[9.21]
EJ	172.0	[6.77]	204.0	[8.03]	90.0	[3.54]
EK	212.0	[8.35]	212.0	[8.35]	212.0	[8.35]

General Dimensions – Controls

Hydraulic Two-Position Control Option HFHF

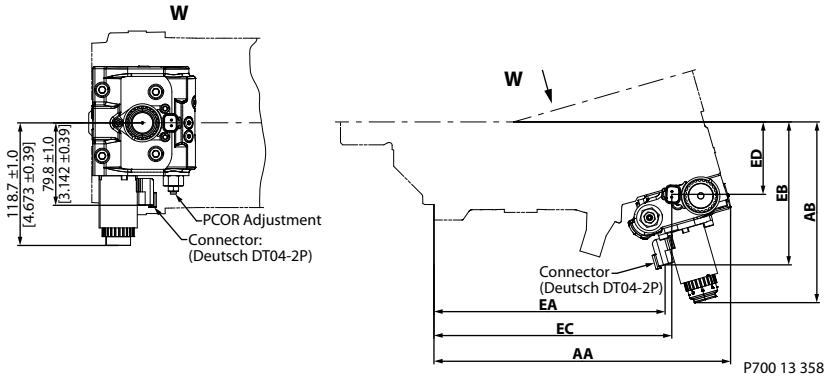


Dimensions mm [in]

Size 060	Flange style					
	DIN 125 B4 HL per ISO 3019/2		SAE 127-4 per ISO 3019/1		Cartridge 160	
AM	192.0	[7.56]	192.0	[7.56]	192.0	[7.56]
EG	106.0	[4.16]	130.0	[5.12]	46.0	[1.81]
EH	171.0	[6.71]	171.0	[6.71]	171.0	[6.71]
EJ	128.0	[5.03]	152.0	[5.98]	68.0	[2.68]
EK	163.0	[6.42]	163.0	[6.42]	163.0	[6.42]
Size 080	**DIN 140 B4 HL per ISO 3019/2**		**SAE 127-4 per ISO 3019/1**		**Cartridge 190**	
AM	205.0	[8.07]	205.0	[8.07]	205.0	[8.07]
EG	116.0	[4.57]	140.0	[5.51]	38.0	[1.48]
EH	185.0	[7.28]	185.0	[7.28]	185.0	[7.28]
EJ	138.0	[5.44]	162.0	[6.39]	60.0	[2.35]
EK	176.0	[6.94]	176.0	[6.94]	176.0	[6.94]
Size 110	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AM	222.0	[8.74]	222.0	[8.74]	222.0	[8.74]
EG	130.0	[5.12]	162.0	[6.40]	48.0	[1.89]
EH	202.0	[7.95]	202.0	[7.95]	202.0	[7.95]
EJ	152.0	[5.98]	185.0	[7.28]	70.0	[2.76]
EK	194.0	[7.64]	194.0	[7.64]	194.0	[7.64]
Size 160	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AM	243.0	[9.55]	243.0	[9.55]	243.0	[9.55]
EG	184.0	[7.24]	216.0	[8.50]	101.0	[3.98]
EH	234.0	[9.21]	234.0	[9.21]	234.0	[9.21]
EJ	172.0	[6.77]	204.0	[8.03]	90.0	[3.54]
EK	212.0	[8.35]	212.0	[8.35]	212.0	[8.35]

General Dimensions – Controls

Electric Proportional Control Option D*M*

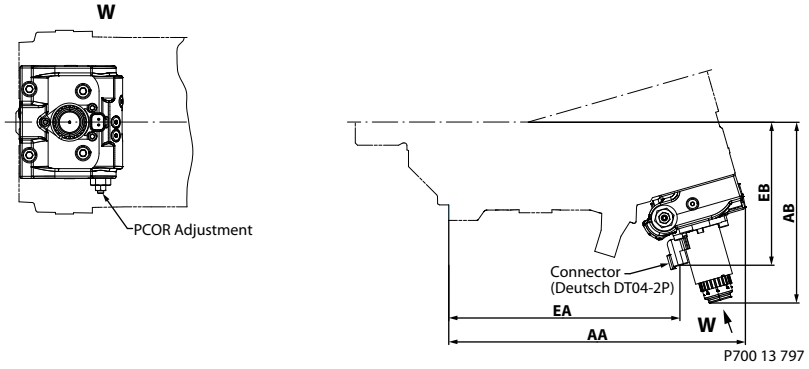


Dimensions mm [in]

Size 060	Flange style					
	DIN 125 B4 HL per ISO 3019/2		SAE 127-4 per ISO 3019/1		Cartridge 160	
AA	251.0	[9.88]	276.0	[10.85]	191.0	[7.53]
AB	165.0	[6.49]	165.0	[6.49]	165.0	[6.49]
EA	188.0	[7.39]	212.0	[8.35]	127.0	[5.03]
EB	128.0	[5.04]	128.0	[5.04]	128.0	[5.04]
EC	194.0	[7.64]	219.0	[8.61]	134.0	[5.29]
ED	60.0	[2.34]	60.0	[2.34]	60.0	[2.34]
Size 080	**DIN 140 B4 HL per ISO 3019/2**		**SAE 127-4 per ISO 3019/1**		**Cartridge 190**	
AA	269.0	[10.60]	293.0	[11.54]	191.0	[7.51]
AB	171.0	[6.71]	171.0	[6.71]	171.0	[6.72]
EA	206.0	[8.10]	230.0	[9.05]	127.0	[5.02]
EB	134.0	[5.27]	134.0	[5.27]	134.0	[5.27]
EC	212.0	[8.34]	236.0	[9.30]	134.0	[5.27]
ED	66.0	[2.59]	66.0	[2.59]	66.0	[2.59]
Size 110	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AA	287.0	[11.31]	320.0	[12.59]	205.0	[8.08]
AB	175.0	[6.89]	175.0	[6.89]	175.0	[6.89]
EA	224.0	[8.81]	256.0	[10.09]	142.0	[5.58]
EB	138.0	[5.45]	138.0	[5.45]	138.0	[5.45]
EC	230.0	[9.07]	263.0	[10.35]	148.0	[5.84]
ED	70.0	[2.76]	70.0	[2.76]	70.0	[2.76]
Size 160	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AA	315.0	[12.40]	347.0	[13.66]	232.0	[9.13]
AB	184.0	[7.24]	184.0	[7.24]	184.0	[7.24]
EA	252.0	[9.92]	284.0	[11.18]	169.0	[6.65]
EB	147.0	[5.79]	147.0	[3.79]	147.0	[5.79]
EC	259.0	[10.20]	290.0	[11.42]	176.0	[6.93]
ED	79.0	[3.11]	79.0	[3.11]	79.0	[3.11]

General Dimensions – Controls

Electric Proportional Control Option D*MA

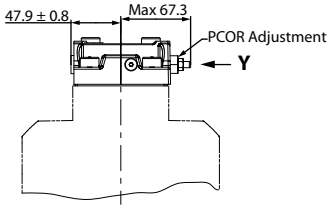


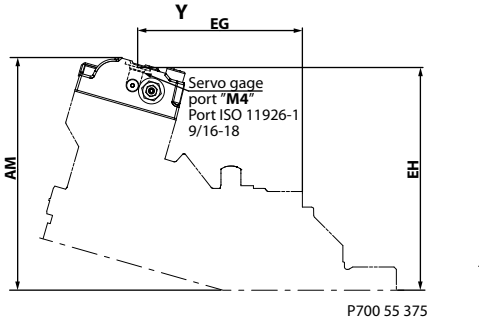
Dimensions mm [in]

Size 060	Flange style					
	DIN 125 B4 HL per ISO 3019/2		SAE 127-4 per ISO 3019/1		Cartridge 160	
AA	251.0	[9.88]	276.0	[10.85]	191.0	[7.53]
AB	165.0	[6.49]	165.0	[6.49]	165.0	[6.49]
EA	188.0	[7.39]	212.0	[8.35]	127.0	[5.03]
EB	128.0	[5.04]	128.0	[5.04]	128.0	[5.04]
Size 080	DIN 140 B4 HL per ISO 3019/2		SAE 127-4 per ISO 3019/1		Cartridge 190	
AA	269.0	[10.60]	293.0	[11.54]	191.0	[7.51]
AB	171.0	[6.71]	171.0	[6.71]	171.0	[6.72]
EA	206.0	[8.10]	230.0	[9.05]	127.0	[5.02]
EB	134.0	[5.27]	134.0	[5.27]	134.0	[5.27]
Size 110	DIN 160 B4 HL per ISO 3019/2		SAE 152-4 per ISO 3019/1		Cartridge 200	
AA	287.0	[11.31]	320.0	[12.59]	205.0	[8.08]
AB	175.0	[6.89]	175.0	[6.89]	175.0	[6.89]
EA	224.0	[8.81]	256.0	[10.09]	142.0	[5.58]
EB	138.0	[5.45]	138.0	[5.45]	138.0	[5.45]
Size 160	DIN 160 B4 HL per ISO 3019/2		SAE 152-4 per ISO 3019/1		Cartridge 200	
AA	315.0	12.40]	347.0	[13.66]	232.0	[9.13]
AB	184.0	[7.24]	184.0	[7.24]	184.0	[7.24]
EA	252.0	[9.92]	284.0	[11.18]	169.0	[6.65]
EB	147.0	[5.79]	147.0	[5.79]	147.0	[5.79]

General Dimensions – Controls

Hydraulic Two-Position Control Option TADA



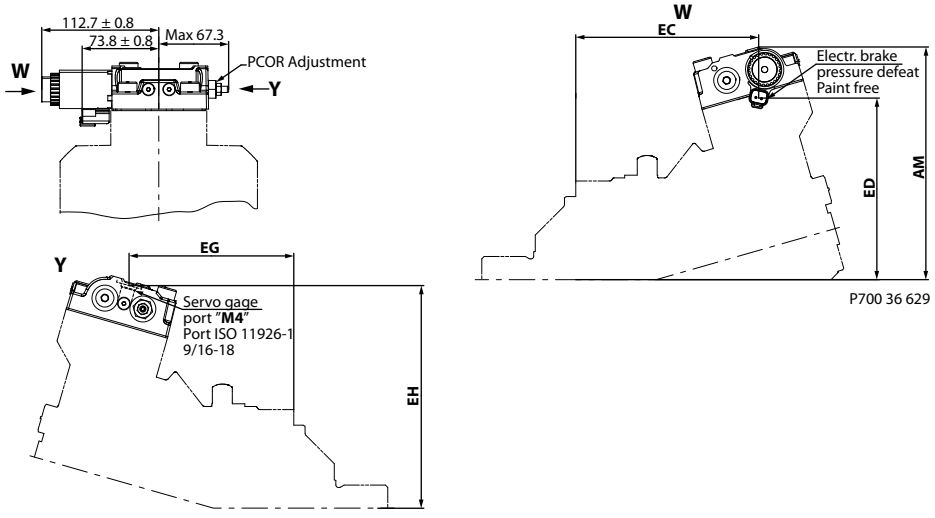


Dimensions mm [in]

Size 060	Flange style					
	DIN 125 B4 HL per ISO 3019/2		SAE 127-4 per ISO 3019/1		Cartridge 160	
AM	194.0	[7.62]	194.0	[7.62]	194.0	[7.62]
EG	134.0	[5.29]	159.0	[6.25]	75.0	[2.94]
EH	184.0	[7.24]	184.0	[7.24]	184.0	[7.24]
Size 080	**DIN 140 B4 HL per ISO 3019/2**		**SAE 127-4 per ISO 3019/1**		**Cartridge 190**	
AM	207.0	[8.13]	207.0	[8.13]	207.0	[8.13]
EG	145.0	[5.70]	169.0	[6.64]	66.0	[3.61]
EH	197.0	[7.75]	197.0	[7.75]	197.0	[7.75]
Size 110	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AM	224.0	[8.82]	244.0	[8.82]	224.0	[8.82]
EG	159.0	[6.25]	191.0	[7.33]	77.0	[3.02]
EH	214.0	[8.22]	214.0	[8.22]	214.0	[8.22]
Size 160	**DIN 160 B4 HL per ISO 3019/2**		**SAE 152-4 per ISO 3019/1**		**Cartridge 200**	
AM	243.0	[9.55]	243.0	[9.55]	243.0	[9.55]
EG	178.0	[7.03]	210.0	[8.28]	96.0	[3.78]
EH	233.0	[9.17]	233.0	[9.17]	233.0	[9.17]

General Dimensions – Controls

Hydraulic Two-Position Control Option TAD*



Dimensions mm [in]

Size 060	Flange style					
	DIN 125 B4 HL per ISO 3019/2		SAE 127-4 per ISO 3019/1		Cartridge 160	
AM	194.0	[7.62]	194.0	[7.62]	194.0	[7.62]
EC	152.0	[5.98]	176.0	[6.94]	92.0	[3.63]
ED	144.0	[5.68]	144.0	[5.68]	144.0	[5.68]
EG	134.0	[5.29]	159.0	[6.25]	75.0	[2.94]
EH	184.0	[7.24]	184.0	[7.24]	184.0	[7.24]
Size 080	DIN 140 B4 HL per ISO 3019/2		SAE 127-4 per ISO 3019/1		Cartridge 190	
AM	207.0	[8.13]	207.0	[8.13]	207.0	[8.13]
EC	162.0	[6.39]	186.0	[7.33]	84.0	[3.30]
ED	157.0	[6.19]	157.0	[6.19]	157.0	[6.19]
EG	145.0	[5.70]	169.0	[6.64]	66.0	[3.61]
EH	197.0	[7.75]	197.0	[7.75]	197.0	[7.75]
Size 110	DIN 160 B4 HL per ISO 3019/2		SAE 152-4 per ISO 3019/1		Cartridge 200	
AM	224.0	[8.82]	244.0	[8.82]	224.0	[8.82]
EC	176.0	[6.93]	209.0	[8.21]	94.0	[3.71]
ED	175.0	[6.88]	175.0	[6.88]	175.0	[6.88]
EG	159.0	[6.25]	191.0	[7.33]	77.0	[3.02]
EH	214.0	[8.22]	214.0	[8.22]	214.0	[8.22]
Size 160	DIN 160 B4 HL per ISO 3019/2		SAE 152-4 per ISO 3019/1		Cartridge 200	
AM	243.0	[9.55]	243.0	[9.55]	243.0	[9.55]
EC	196.0	[7.72]	228.0	[8.97]	114.0	[4.47]
ED	193.0	[7.61]	193.0	[7.61]	193.0	[7.61]
EG	178.0	[7.03]	210.0	[8.28]	96.0	[3.78]
EH	233.0	[9.17]	233.0	[9.17]	233.0	[9.17]

SAUER DANFOSS

Products we offer:

- Bent Axis Motors
- Closed Circuit Axial Piston Pumps and Motors
- Displays
- Electrohydraulic Power Steering
- Electrohydraulics
- Hydraulic Power Steering
- Integrated Systems
- Joysticks and Control Handles
- Microcontrollers and Software
- Open Circuit Axial Piston Pumps
- Orbital Motors
- PLUS+1™ GUIDE
- Proportional Valves
- Sensors
- Steering
- Transit Mixer Drives

Members of the Sauer-Danfoss Group:

Comatrol
www.comatrol.com

Schwarzmüller-Inverter
www.schwarzmueller-inverter.com

Turolla
www.turollaocg.com

Valmova
www.valmova.com

Hydro-Gear
www.hydro-gear.com

Sauer-Danfoss-Daikin
www.sauer-danfoss-daikin.com

11037153 • Rev EA • Apr 2012

Sauer-Danfoss is a global manufacturer and supplier of high-quality hydraulic and electronic 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. Building on our extensive applications expertise, we work closely with our customers to ensure exceptional performance for a broad range of off-highway vehicles.

We help OEMs around the world speed up system development, reduce costs and bring vehicles to market faster.
Sauer-Danfoss – Your Strongest Partner in Mobile Hydraulics.

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

Wherever off-highway vehicles are at work, so is Sauer-Danfoss.

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

Please contact the Sauer-Danfoss representative nearest you.

Local address:

Sauer-Danfoss (US) Company
2800 East 13th Street
Ames, IA 50010, USA
Phone: +1 515 239 6000
Fax: +1 515 239 6618

Sauer-Danfoss ApS
DK-6430 Nordborg, Denmark
Phone: +45 7488 4444
Fax: +45 7488 4400

Sauer-Danfoss GmbH & Co. OHG
Postfach 2460, D-24531 Neumünster
Krokamp 35, D-24539 Neumünster, Germany
Phone: +49 4321 871 0
Fax: +49 4321 871 122

Sauer-Danfoss-Daikin LTD.
Shin-Osaka TERASAKI 3rd Bldg. 6F
1-5-28 Nishimiyahara, Yodogawa-ku
Osaka 532-0004, Japan
Phone: +81 6 6395 6066
Fax: +81 6 6395 8585

www.sauer-danfoss.com