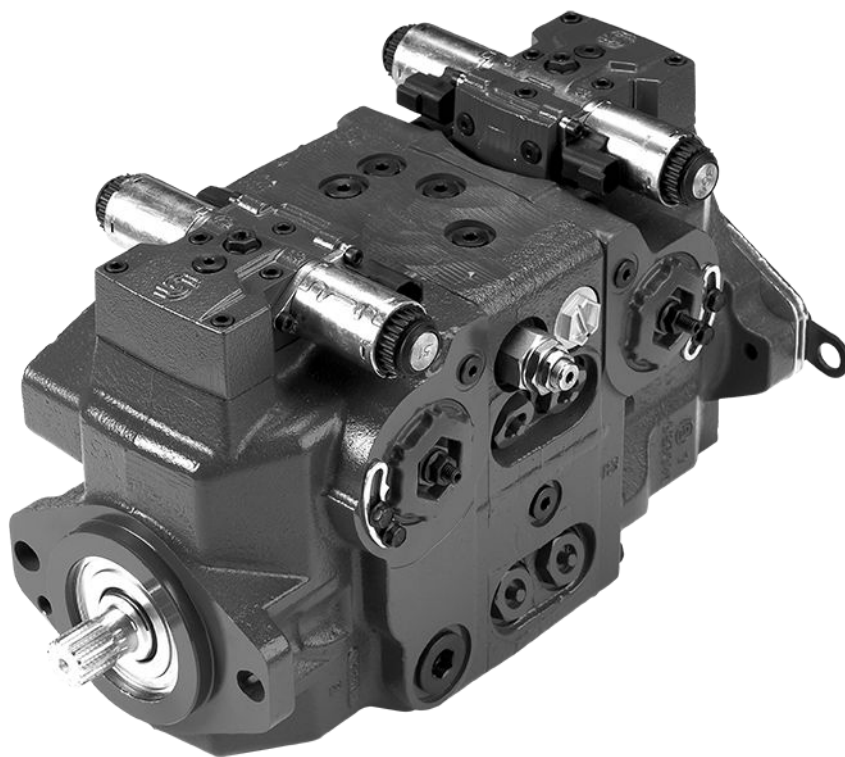


Technical Information

H1T 045/053/060/068

H1 Axial Piston Tandem Pumps



Revision history*Table of revisions*

Date	Changed	Rev
July 2018	Major revision.	0801
June 2018	Angle sensor chapters added.	0701
September 2017	add G6 option	0603
June 2017	minor edit page 40	0602
April 2017	add 60-68	0601
November 2015	Master Model Code changes	0501
2010-2014	Various changes.	BA-EA
Jul 2009	First edition	AA

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Master model code H1 Tandem

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Technical specifications

H1 Pumps General Specification

Axial piston closed circuit variable displacement pump of cradle swash-plate design with clockwise or counterclockwise direction of rotation.

Pipe connections

- Main pressure ports H1P 045/053: SAE straight thread O-ring boss
- Main pressure ports H1P 060/068: ISO split flange boss
- Remaining ports: SAE straight thread O-ring boss

Recommended installation position

Pump installation position is discretionary, however the recommended control position is on the top or at the side with the top position preferred. If the pump is installed with the control at the bottom, flushing flow must be provided through port M14 located on the EDC, FNR and NFPE control.

Vertical input shaft installation is acceptable. If input shaft is at the top, 1 bar case pressure must be maintained during operation.

The housing must always be filled with hydraulic fluid.

Recommended mounting for a multiple pump stack is to arrange the highest power flow towards the input source.

Consult Danfoss for nonconformance to these guidelines.

Auxiliary cavity pressure

Auxiliary cavity pressure will be inlet pressure with internal charge pump or case pressure with external charge supply. For reference see [Operating parameters H1 Tandem Pumps](#) on page 5. Please verify mating pump shaft seal capability.

Technical Data for H1 Tandem Pumps

Feature	Unit	Size 045	Size 053	Size 060	Size 068
Displacement	cm ³ [in ³]	45.0 [2.75]	53.8 [3.28]	60.4 [3.69]	68.0 [4.15]
Flow at rated (continuous) speed*	l/min [US gal/min]	153 [40]	183 [48]	210 [55.5]	238 [62.8]
Torque at maximum displacement (theoretical)	N•m/bar [lbf•in/1000 psi]	0.8 [488]	0.9 [549]	0.96 [590]	1.08 [610]
Mass moment of inertia of rotating components	kg•m ² [slug•ft ²]	0.0078 [0.00575]	0.0077 [0.00568]	0.01431 [0.01055]	0.01427 [0.01052]
Mass (weight dry, without charge pump or auxiliary flange)	kg [lb]	65 [143]		96.2 [212]	
Oil volume	l [US gal]	2.3 [0.61]		4.2 [1.1]	
Mounting flange per ISO 3019-1		Flange 101-2 (SAE B), Special bolt diameter		Flange 127-4 (SAE C)	
Input shaft outer diameter, splines per ISO 3019-1		Outer Ø25 mm - 4 (SAE B-B, 15 teeth) Outer Ø32 mm - 4 (SAE-C, 14 teeth) Outer Ø31 mm - 4 (19 teeth)		Outer Ø32 mm - 4 (SAE C, 14 teeth) Outer Ø35 mm - 4 (SAE-C, 21 teeth)	

Technical Information

H1 Axial Piston Tandem Pumps, Size 045/053/060/068

Technical specifications

Feature	Unit	Size 045	Size 053	Size 060	Size 068
Auxiliary mounting flange with metric fasteners, shaft outer diameter and splines per ISO 3019-1		Flange 82 - 2: outer Ø16 mm - 4 (SAE A, 9 teeth) outer Ø19 mm - 4 (SAE A, 11 teeth) Flange 101 - 2: outer Ø22 mm - 4 (SAE B, 13 teeth) outer Ø25 mm - 4 (SAE B-B, 15 teeth)		Flange 101 - 2: outer Ø22 mm - 4 (SAE B, 13 teeth) outer Ø25 mm - 4 (SAE B-B, 15 teeth)	
Charge inlet port per ISO 11926-1 (SAE O-ring boss)		7/8 -14		1 1/16 -14	
Main port configuration		ISO 11926-1: 1 5/16 -12 (SAE O-ring boss)		ISO 6162: M12 x 1.75 (Split flange)	
Case drain port L3 per ISO 11926-1 – 1 (use for cooling purposes)		1 1/16 -12 (SAE O-ring boss)		1 5/16 -12 (SAE O-ring boss)	
Other ports		SAE O-ring boss			
Customer interface threads		Metric fasteners			

* Applies for each rotating group.

Operating parameters H1 Tandem Pumps

Feature		Size 045	Size 053	Size 060	Size 068
Input speed (at minimum charge/control pressure)	Minimum for external charge supply ¹⁾	500 min ⁻¹ (rpm)			
	Rated	3400 min ⁻¹ (rpm)		3500 min ⁻¹ (rpm)	
	Maximum	3500 min ⁻¹ (rpm)		4000 min ⁻¹ (rpm)	
System pressure	Maximum working pressure	420 bar [6090 psi]	380 bar [5510 psi]	420 bar [6090 psi]	380 bar [5510 psi]
	Maximum pressure	450 bar [6527 psi]	400 bar [5800 psi]	450 bar [6527 psi]	400 bar [5800 psi]
	Maximum low loop	45 bar [650 psi]			
	Minimum low loop pressure	10 bar [145 psi]			
Charge pressure	Minimum without CCO valve	16 bar [232 psi]			
	Minimum with CCO valve	18 bar [265 psi]			
	Maximum	34 bar [435 psi]			
Control pressure	Min. at corner power (EDC, MDC, FNR)	21.5 bar [312 psi]		18.5 bar [268 psi]	
	Maximum	40 bar [580 psi]			
Case pressure	Rated	3 bar [44 psi]			
	Maximum	5 bar [73 psi]			
Lip seal external maximum pressure		0.4 [5.8 psi]			

¹⁾ Full performance (pressure and displacement) possible at minimum charge and control pressure supply.

Technical specifications

Fluid Specifications

Viscosity

Intermittent ¹⁾	Minimum	Recommended range	Maximum
5 mm ² /s [42 SUS]	7 mm ² /s [49 SUS]	12 – 80 mm ² /s [66 – 370 SUS]	1600 mm ² /s [7500 SUS]

¹⁾ Intermittent = Short term t < 1 min per incident and not exceeding 2 % of duty cycle based load-life

Temperature

Minimum (cold start)	Rated	Recommended range*	Maximum Intermittent
-40°C [-40°F]	104°C [220°F]	60 – 85°C [140 – 185°F]	115°C [240°F]

* At the hottest point, normally case drain port

Filtration, Cleanliness level and Efficiency β_x -ratio (Recommended Minimum)

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

External radial shaft loads H1 Tandem

External radial shaft loads

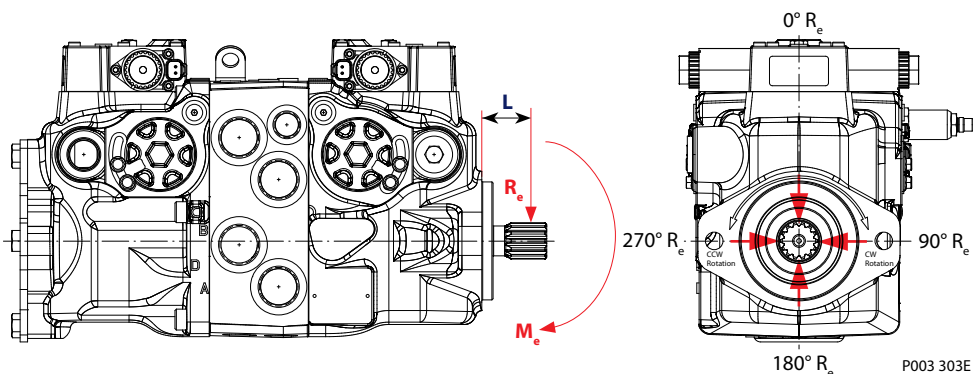
H1 pumps are designed with bearings that can accept some external radial loads. The external radial shaft load limits are a function of the load position and orientation, and the operating conditions of the unit. External radial shaft loads impact lifetime. For lifetime calculations please contact Danfoss representative.

The **maximum allowable radial load (R_e)** is based on the maximum external moment (M_e) and the distance (L) from the mounting flange to the load.

$$R_e = \frac{M_e}{L}$$

It may be determined using the following formula:

Radial load position (045/053 shown)



M_e = shaft moment

L = flange distance

R_e = external force to the shaft

Thrust loads should be avoided. Contact factory in the event thrust loads are anticipated.

Technical specifications

Bearing Life

Maximum external shaft load based on shaft deflection

External radial moment	Unit	Size 045 / 053	Size 060 / 068
M_e	N·m [lbf·in]	104 [920]	104 [920]

All external shaft loads affect bearing life. In applications with external shaft loads, minimize the impact by positioning the load at 0° or 180° as shown in the figure.

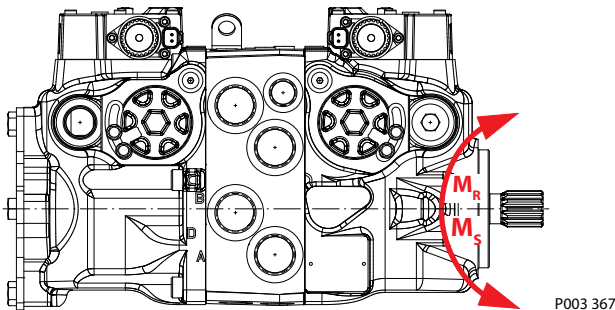
Danfoss recommends clamp-type couplings for applications with radial shaft loads.

Contact your Danfoss representative for an evaluation of unit bearing life if you have continuously applied external loads exceeding 25 % of the maximum allowable radial load (R_e) or the pump swashplate is positioned on one side of center all or most of the time.

Mounting flange loads H1T 045/053

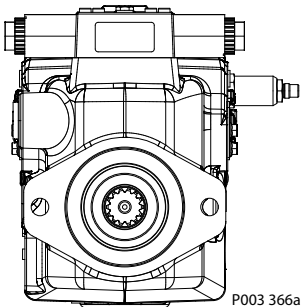
H1 tandem pump front flange load

Mounting flange loads H1T 045/053, Controls on top



The moments shown below apply for the control orientation on top or side.

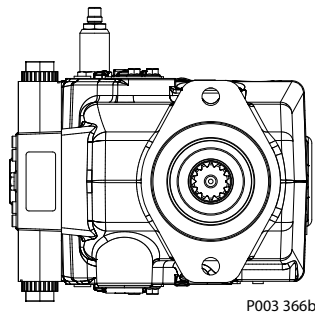
Mounting flange loads, Control on top



Rated moment:
 $M_R = 2020 \text{ N·m [17 880 lbf·in]}$

Shock load moment:
 $M_S = 4110 \text{ N·m [36 380 lbf·in]}$

Mounting flange loads, Control on side



Rated moment:
 $M_R = 1300 \text{ N·m [11 510 lbf·in]}$

Shock load moment:
 $M_S = 2930 \text{ N·m [25 935 lbf·in]}$

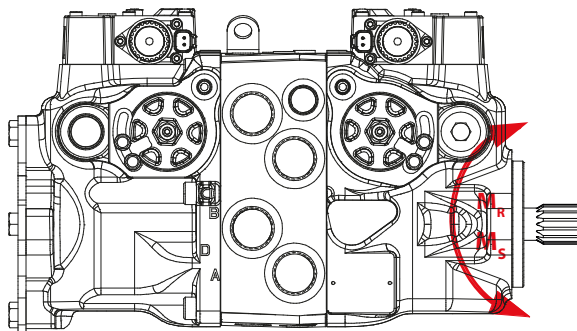
For more information, see *H1 Axial Piston Pumps, Basic Information*, **BC00000057**, the section "Mounting flange loads".

Technical specifications

Mounting flange loads H1T 060/068

H1 tandem pump front flange load

Mounting flange loads H1T 060/068, Controls on top



Rated moment:

$M_R = 2190 \text{ N}\cdot\text{m}$ [19 380 lbf·in]

Shock load moment:

$M_S = 6560 \text{ N}\cdot\text{m}$ [58 060 lbf·in]

P109515

The moments shown apply for the control orientation on top or side.

For more information, see *H1 Axial Piston Pumps, Basic Information*, **BC00000057**, the section "Mounting flange loads".

Case drain

The tandem housings are connected through the center section via a drilled hole. The charge relief valve discharges oil into the front housing. In order to provide positive flow through both housings, use of the rear housing case drain is required. The front housing case pressure ports should only be used if the pump is used as a common drain manifold for the vehicle where external drain flow is brought into the rear housing and discharged out the front.

The allowable case pressures must be met accordingly.

Master model code H1 Tandem

H1T Master Model Code

Displacement (Front pump, second pump see "C")

045	45 cm ³ [2.75 in ³]
053	53.8 cm ³ [3.28 in ³]
060	60 cm ³ [3.66 in ³]
068	68 cm ³ [4.15 in ³]

A – Rotation

L	Left hand (counter clockwise)
R	Right hand (clockwise)

B – Product version

A	Revision code
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Z – Port configuration

A	Inch, Customer O-ring port sealing according to ISO 11926-1
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C – Second pump size

N	Frame size of rear stage equal front stage (default)
A	Rear stage kit 45cc/rev (only use with 53cc/rev front stage)
B	Rear stage kit 60cc/rev (only use with 68cc/rev front stage)

D – Controls

Code	Control type	Voltage	Miscellaneous options	Connector
A2	EDC	12 V	—	DEUTSCH
A3	EDC	24 V	—	DEUTSCH
A4	EDC	12 V	MOR	DEUTSCH
A5	EDC	24 V	MOR	DEUTSCH
A9	FNR	12 V	MOR	DEUTSCH
H3	EDC	24 V	Angle sensor	DEUTSCH
H4	MDC front unit	—	Gain 0.52 with NSS	—
	FNR rear unit	12 V	Gain 0.52 with MOR	DEUTSCH
H6	EDC	12 V	Angle sensor + MOR	DEUTSCH
H7	EDC	24 V	Angle sensor + MOR	DEUTSCH
B1	FNR	24 V	MOR	DEUTSCH
B6	FNR front unit	12 V	—	DEUTSCH
	EDC rear unit	12 V	Gain 0.52	DEUTSCH
D7	EDC front unit	12 V	MOR	DEUTSCH
	FNR rear unit	12 V	MOR	DEUTSCH

Master model code H1 Tandem

D – Controls (continued)

Code	Control type	Voltage	Miscellaneous options	Connector
D9	MDC front unit	—	Gain 0.52 with NSS	—
	MDC rear unit	—	Gain 0.52	DEUTSCH
N1	NFPE¹⁾	12 V	MOR	DEUTSCH
N2	NFPE¹⁾	24 V	MOR	DEUTSCH
N5	NFPE¹⁾	12 V	Angle sensor + MOR	DEUTSCH
N6	NFPE¹⁾	24 V	Angle sensor + MOR	DEUTSCH
M1	MDC	—	—	—
M2	MDC	—	NSS	—

¹⁾ Align with options: **E**: Displacement limiters and **W**: Special hardware.

F – Orifices (mm)

Code	Tank (A+B)	P	A / B	Note
C3	No orifice			Not to be used for FDC controls and mobile applications.
C1	—	—	0.8	Not to be used for FDC controls.
C6	1	—	—	To be used for MDC controls only.
C7	1.3	—	—	
C8	0.6	0.8	—	
C9	0.6	1	—	
D1	0.8	1	—	
D2	0.8	1.3	—	
D3	1	1.3	—	
D4	1	1.3	1.3	
D5	0.6	0.6	0.8	

E – Displacement limiter

N	None
C	No limiters, with nested springs, required for NFPE
B	Adjustable externally
D	Adjustable externally with nested springs, required for NFPE

G – Endcap options

Code	Description	045/053	060/068
E7	Tandem same-sided SAE O-ring boss ports, (HPRV only) standard	●	—
D1	Tandem same-sided SAE O-ring boss ports with Control Cut Off (HPRV only), 12 V	●	—
F7	Tandem same-sided SAE O-ring boss ports with Control Cut Off (HPRV only), 24 V	●	—
H3	Tandem Opp. Port Code 62, 12V CCO & Brake	—	●
H4	Tandem Opp. Port Code 62, 24V CCO & Brake	—	●
H5	Tandem Opp. Port Code 62, 12V CCO	—	●
H6	Tandem Opp. Port Code 62, 24V CCO	—	●

Master model code H1 Tandem
G – Endcap options (continued)

Code	Description	045/053	060/068
H7	Tandem Opp. Port Code 62	—	●
H8	Tandem Opp Port Code 62, Opposite Charge Inlet	—	●

H – Mounting

F	ISO 3019-1, flange 101-2 SAE B (045/053)
H	ISO 3019-1, flange 127-4 SAE C (060/068)
J	ISO 3019-1, flange 101-2 SAE B and speed sensor (045/053)

J – Input shaft

Code	Description	045/053	060/068
G1	ISO 3019-1, outer Ø32 mm - 4 (SAE C, 14 teeth splined shaft 12/24 pitch)	●	●
G5	ISO 3019-1, outer Ø25 mm - 4 (SAE B-B, 15 teeth splined shaft 16/32 pitch)	●	—
G6	ISO 3019-1, outer Ø31 mm - 4 (19 teeth splined shaft 16/32 pitch) (45/53 only)	●	—
F1	ISO 3019-1 outer diameter 35mm -4 (SAE C, 21 teeth splined shaft 16/32 pitch) (60/68 only)	—	●

K – Auxiliary mounting pad ISO 3019-1 without charge pump, with shipping cover

Code	Description	045/053	060/068
NN	No auxiliary mounting pad, No shipping cover	●	—
H2	Flange 82 - 2, outer Ø16 mm - 4 (SAE A, 9 teeth 16/32 coupling) (45/53)	●	●
H1	Flange 82 - 2, outer Ø19 mm - 4 (SAE A, 11 teeth 16/32 coupling) (45/53)	●	●
H3	Flange 101 - 2, outer Ø22 mm - 4 (SAE B, 13 teeth 16/32 coupling)	●	●
H5	Flange 101 - 2, outer Ø25 mm - 4 (SAE B-B, 15 teeth 16/32 coupling)	●	●

Align with options: **S** – Charge pump and **Y** – Special settings.

M – High pressure relief valve setting, NO bypass, side “A” (front pump)

N – High pressure relief valve setting, NO bypass side “B” (front pump)

P – High pressure relief valve setting, NO bypass, side “C” (rear pump)

R – High pressure relief valve setting, NO bypass, side “D” (rear pump)

Code	Pressure setting (Use the selection for ports A, B, C and D)	045	053	60	68
13	130 bar [1885 psi]	●	●	—	—
15	150 bar [2175 psi]	●	●	—	—
18	180 bar [2610 psi]	●	●	●	●
20	200 bar [2900 psi]	●	●	●	●
23	230 bar [3336 psi]	●	●	●	●
25	250 bar [3630 psi]	●	●	●	●
28	280 bar [4061 psi]	●	●	●	●
30	300 bar [4350 psi]	●	●	●	●
33	330 bar [4786 psi]	●	●	●	●

Master model code H1 Tandem

M – High pressure relief valve setting, NO bypass, side “A” (front pump)

N – High pressure relief valve setting, NO bypass side “B” (front pump)

P – High pressure relief valve setting, NO bypass, side “C” (rear pump)

R – High pressure relief valve setting, NO bypass, side “D” (rear pump) (continued)

Code	Pressure setting (Use the selection for ports A, B, C and D)	045	053	60	68
35	350 bar [5080 psi]	●	●	●	●
38	380 bar [5510 psi]	●	●	●	●
40	400 bar [5800 psi]	●	—	●	—
41	410 bar [5946 psi]	●	—	—	—
42	420 bar [6090 psi]	●	—	●	—

● = available option,
— = not available option

Pressure limiter 060/068

Code	Pressure setting (Use the selection for ports A, B, C and D)	060	068
AE	150 bar PL / 200 bar HPRV	●	●
AH	180 bar PL / 250 bar HPRV	●	●
BK	200 bar PL / 250 bar HPRV	●	●
BC	230 bar PL / 280 bar HPRV	●	●
BE	250 bar PL / 300 bar HPRV	●	●
BH	280 bar PL / 330 bar HPRV	●	●
CK	300 bar PL / 350 bar HPRV	●	●
CC	330 bar PL / 380 bar HPRV	●	●
CE	350 bar PL / 400 bar HPRV	●	●
CH	380 bar PL / 430 bar HPRV	●	●
DK	400 bar PL / 450 bar HPRV	●	-
DA	410 bar PL / 450 bar HPRV	●	-
DB	420 bar PL / 450 bar HPRV	●	-

S – Charge pump

N	No charge pump, external charge supply (Align with options: T – Filtration)
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T – Filtration

P	Remote full charge flow filtration (045/053 only)
E	External charge filtration (060/068 only)

V – Charge pressure relief setting

18	18 bar [261 psi]	Not to be used for NFPE controls.
20	20 bar [290 psi]	
22	22 bar [319 psi]	
24	24 bar [348 psi]	

Master model code H1 Tandem
V – Charge pressure relief setting (continued)

26	26 bar [377 psi]
28	28 bar [406 psi]
30	30 bar [435 psi]
32	32 bar [464 psi]
34	34 bar [493 psi]

W – Special hardware features

PN	EDC/FNR/MDC valve plate (without a handle)
P1	NFPE valve plate (<i>Align with options: D – Control selection and E – Displacement limiters</i>)
P4	EDC/FNR/MDC Valve Plate and Speed Ring (045/053 only)
H1	EDC/FNR/MDC Valve Plate, included MDC Handle (All frames)
H2	EDC/FNR/MDC Valve Plate, MDC Handle Front, System Loop Bypass (045/053 only)

X – Paint and nametag

NNN	Black paint and Danfoss nametag
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Y – Special settings

NNN	None
M00	MDC (handle in standard position)

Control Options

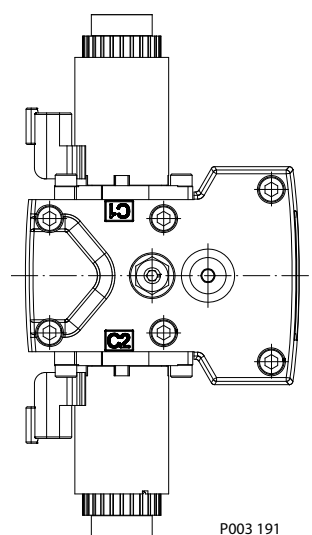
Electrical Displacement Control (EDC)

The Electrical Displacement Control (EDC) consists of a pair of proportional solenoids on each side of a three-position, four-way porting spool. The proportional solenoid applies a force input to the spool, which ports hydraulic pressure to either side of a double acting servo piston.

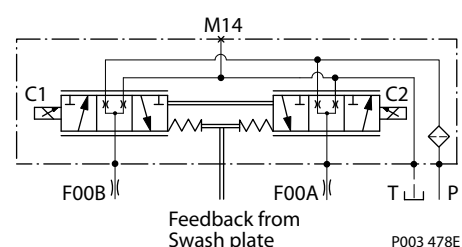
Differential pressure across the servo piston rotates the swash-plate, changing the pump's displacement from full displacement in one direction to full displacement in the opposite direction. A serviceable 125 μm screen is located in the supply line immediately before the control porting spool.

Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

Electrical Displacement Control

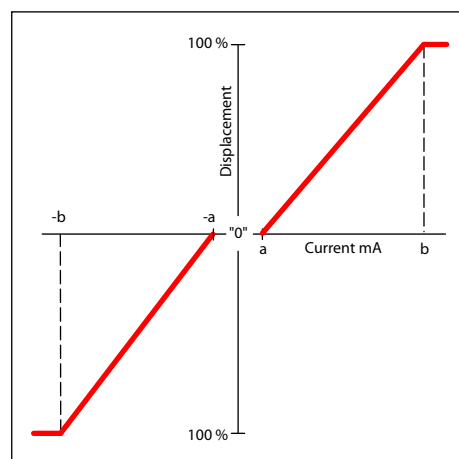


EDC schematic, feedback from swash-plate



EDC Control Signal Requirements

Pump displacement vs. control current



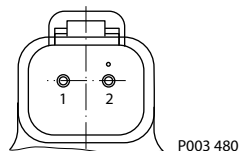
Control Options

EDC Control minimum current to stroke pump

Voltage	a*	b	Pin connections
12 V	640 mA	1640 mA	any order
24 V	330 mA	820 mA	

* Factory test current, for vehicle movement or application actuation expect higher or lower value.

Connector



Connector ordering data

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

EDC Solenoid Data

Description		12 V	24 V
Maximum current		1800 mA	920 mA
Nominal coil resistance	@ 20 °C [68 °F]	3.66 Ω	14.20 Ω
	@ 80 °C [176 °F]	4.52 Ω	17.52 Ω
Inductance		33 mH	140 mH
PWM signal frequency	Range	70 – 200 Hz	
	Recommended*	200 Hz	
IP Rating	IEC 60 529	IP 67	
	DIN 40 050, part 9	IP 69K with mating connector	
Connector color		Black	

* PWM signal required for optimum control performance.

Pump output flow direction vs. control signal

Shaft rotation	CW				CCW			
	Front		Rear		Front		Rear	
Coil energized*	C2	C1	C2	C1	C2	C1	C2	C1
Port A	in	out	—	—	out	in	—	—
Port B	out	in	—	—	in	out	—	—
Port C	—	—	in	out	—	—	out	in
Port D	—	—	out	in	—	—	in	out
Servo port pressurized	M5	M4	M5	M4	M5	M4	M5	M4

* For coil location see Installation drawings.

Control Options

Control Response

H1 controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements. The time required for the pump output flow to change from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure.

H1 pumps are limited in mechanical orifice combinations. Mechanical servo orifices are to be used only for fail-safe return to neutral in a case of an electrical failure.

A swash-plate response times table is available for each frame size. Testing should be conducted to verify the proper orifice selection for the desired response. Typical response times at the following conditions:

$\Delta p = 250 \text{ bar}$ [3626 psi]

Charge pressure = 20 bar [290 psi]

Viscosity and temperature = 30 mm²/s [141 SUS] and 50 °C [122 °F]

Speed = 1800 min⁻¹ (rpm)

Response time, EDC 045/053

Stroking direction	0.8 mm [0.03 in] orifice	1.3 mm [0.05 in] orifice	No orifice
Neutral to full flow	1.7 s	0.9 s	0.5 s
Full flow to neutral	1.1 s	0.6 s	0.3 s

Response time, EDC 060/068

Stroking direction	0.8 mm [0.03 in] Orifice	1.3 mm [0.05 in] Orifice	No orifice
Neutral to full flow	2.6 s	1.2 s	0.8 s
Full flow to neutral	1.7 s	0.8 s	0.4 s

Control Options

Manual Displacement Control (MDC)

A Manual proportional Displacement Control (**MDC**) consists of a handle on top of a rotary input shaft. The shaft provides an eccentric connection to a feedback link. This link is connected on its one end with a porting spool. On its other end the link is connected the pumps swash-plate.

This design provides a travel feedback without spring. When turning the shaft the spool moves thus providing hydraulic pressure to either side of a double acting servo piston of the pump.

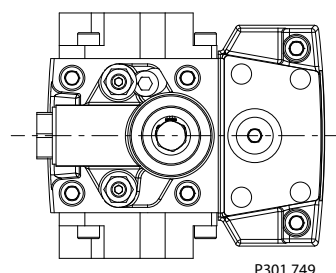
Differential pressure across the servo piston rotates the swash plate, changing the pump's displacement. Simultaneously the swash-plate movement is fed back to the control spool providing proportionality between shaft rotation on the control and swash-plate rotation.

The MDC changes the pump displacement between no flow and full flow into opposite directions. Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

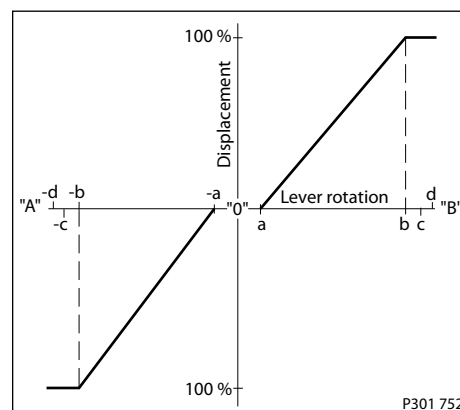
A serviceable 125 µm screen is located in the supply line immediately before the control porting spool.

The MDC is sealed by means of a static O-ring between the actuation system and the control block. Its shaft is sealed by means of a special O-ring which is applied for low friction. The special O-ring is protected from dust, water and aggressive liquids or gases by means of a special lip seal.

Manual Displacement Control



Pump displacement vs. control lever rotation



Legend:

Deadband on **B** side – **a** = $3^\circ \pm 1^\circ$

Maximum pump stroke – **b** = $30^\circ +2/-1^\circ$

Required customer end stop – **c** = $36^\circ \pm 3^\circ$

Internal end stop – **d** = 40°

MDC General Information

In difference to other controls the MDC provides a mechanical deadband. This is required to overcome the tolerances in the mechanical actuation.

The MDC contains an internal end stop to prevent over travel. The restoring moment is appropriate for turning the MDC input shaft back to neutral only. Any linkages or cables may prevent the MDC from returning to neutral.

The MDC is designed for a maximum case pressure of 5 bar and a rated case pressure of 3 bar. If the case pressure exceeds 5 bar there is a risk of an insufficient restoring moment. In addition a high case pressure can cause the NSS to indicate that the control is not in neutral. High case pressure may cause excessive wear.

Customers can apply their own handle design but they must care about a robust clamping connection between their handle and the control shaft and avoid overload of the shaft.

Control Options

Customers can connect two MDC's on a tandem unit in such a way that the actuation force will be transferred from the pilot control to the second control but the kinematic of the linkages must ensure that either control shaft is protected from torque overload. To avoid an overload of the MDC, customers must install any support to limit the setting range of the Bowden cable.

! Caution

Using the internal spring force on the input shaft is not an appropriate way to return the customer connection linkage to neutral.

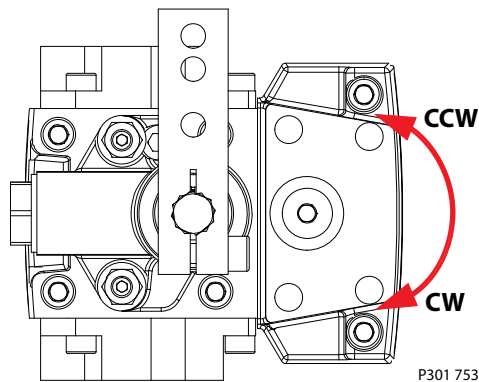
MDC Torque

Description	Value
Torque required to move handle to maximum displacement	1.4 N·m [12.39 lbf·in]
Torque required to hold handle at given displacement	0.6 N·m [5.31 lbf·in]
Maximum allowable input torque	20 N·m [177 lbf·in]

! Caution

Volumetric efficiencies of the system will have impacts on the start and end input commands.

MDC Shaft Rotation



MDC shaft rotation data

Pump shaft rotation*	Clock Wise (CW)		Counter Clock Wise (CCW)	
MDC shaft rotation	CW	CCW	CW	CCW
Port A	in (low)	out (high)	out (high)	in (low)
Port B	out (high)	in (low)	in (low)	out (high)
Servo port high pressure	M5	M4	M5	M4

* As seen from shaft side.

Control Response

H1 controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements. The time required for the pump output flow to change from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure.

H1 pumps are limited in mechanical orifice combinations. Mechanical servo orifices are to be used only for fail-safe return to neutral in a case of an electrical failure.

Control Options

A swash-plate response times table is available for each frame size. Testing should be conducted to verify the proper orifice selection for the desired response. Typical response times at the following conditions:

$\Delta p = 250 \text{ bar}$ [3626 psi]

Charge pressure = 20 bar [290 psi]

Viscosity and temperature = 30 mm²/s [141 SUS] and 50 °C [122 °F]

Speed = 1800 min⁻¹ (rpm)

Response time, MDC 045/053

Code	Orifice description (mm)				Stroking direction (sec)	
	P	A	B	Tank (A+B)	Neutral to full flow	Full flow to neutral
C3	–	–	–	–	0.3	0.4
C6	–	–	–	1	0.9	0.8
C7	–	–	–	1.3	0.6	0.6
C8	0.8	–	–	0.6	2.9	2.0
C9	1	–	–	0.6	2.7	1.9
D1	1	–	–	0.8	1.7	1.2
D2	1.3	–	–	0.8	1.5	1.1
D3	1.3	–	–	1	1.1	0.8
D4	1.3	1.3	1.3	1	1.3	1.0
D5	0.6	0.8	0.8	0.6	5.4	2.8

Response time, MDC 060/068

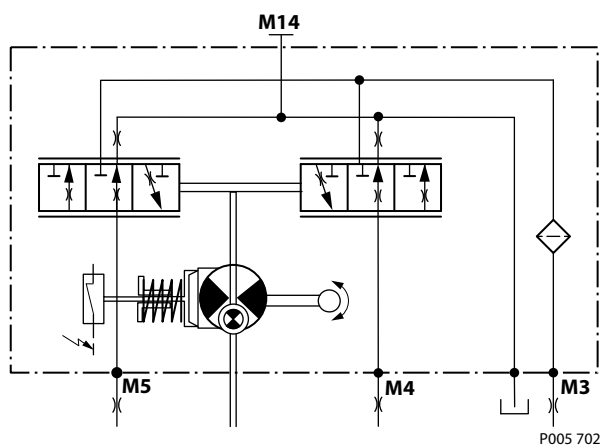
Code	Orifice description (mm)				Stroking direction (sec)	
	P	A	B	Tank (A+B)	Neutral to full flow	Full flow to neutral
C3	–	–	–	–	0.4	0.4
C6	–	–	–	1	1.1	1.0
C7	–	–	–	1.3	0.7	0.7
C8	0.8	–	–	0.6	3.6	2.6
C9	1	–	–	0.6	3.3	2.4
D1	1	–	–	0.8	2.1	1.5
D2	1.3	–	–	0.8	1.8	1.4
D3	1.3	–	–	1	1.3	1.0
D4	1.3	1.3	1.3	1	1.6	1.2
D5	0.6	0.8	0.8	0.6	6.5	3.6

Neutral Start Switch (NSS)

The Neutral Start Switch (**NSS**) contains an electrical switch that provides a signal of whether the control is in neutral. The signal in neutral is Normally Closed (**NC**).

Control Options

Neutral Start Switch schematic



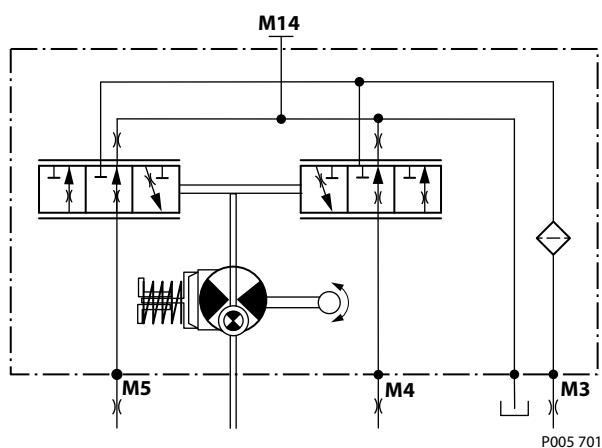
Neutral Start Switch data

Max. continuous current with switching	8.4 A
Max. continuous current without switching	20 A
Max. voltage	36 V _{DC}
Electrical protection class	IP67 / IP69K with mating connector

Case Gauge Port M14

The drain port should be used when the control is mounted on the unit's bottom side to flush residual contamination out of the control.

MDC schematic diagram

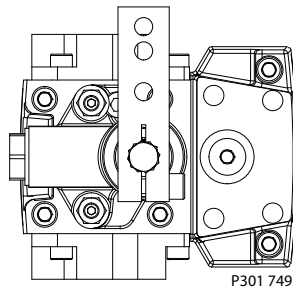


Control Options

Lever

MDC controls are available with optional lever/handle. Align with Settings: Y module in the model code.

Standard orientation 90° from input shaft

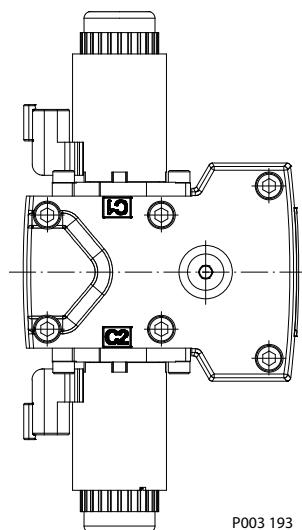


Control Options

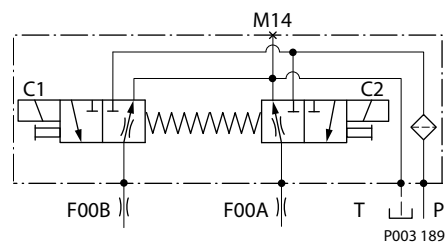
Forward-Neutral-Reverse Control (FNR)

The 3-position FNR control options **A9** (12 V) and **B1** (24 V) uses an electric input signal to switch the pump to a full stroke position. A serviceable 125 μ m screen is located in the supply line immediately before the control porting spool.

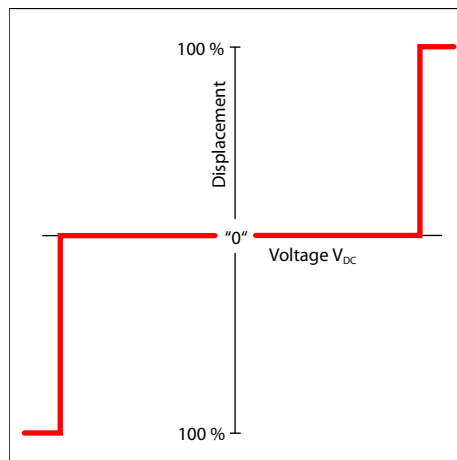
Forward-Neutral-Reverse electric control (FNR)



FNR hydraulic schematic



Pump displacement vs. electrical signal



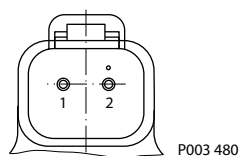
Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

Control current

Voltage	12 V _{DC}	24 V _{DC}
Min. current to stroke pump	750 mA	380 mA
Pin connections	any order	

Control Options

Connector



Connector ordering data

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

Solenoid data

Voltage	12 V _{DC}	24 V _{DC}
Minimum supply voltage	9.5 V _{DC}	19 V _{DC}
Maximum supply voltage (continuous)	14.6 V _{DC}	29 V _{DC}
Bi-directional diode cut off voltage	28 V _{DC}	53 V _{DC}
Maximum current	1050 mA	500 mA
Nominal coil resistance @ 20°C	8.4 Ω	34.5 Ω
PWM Range	70-200 Hz	
PWM Frequency (preferred)*	100 Hz	
IP Rating (IEC 60 529) + DIN 40 050	IP 67/IP 69K (part 9 with mating connector)	

* PWM signal required for optimum control performance.

Pump output flow direction vs. control signal

Shaft rotation	CW				CCW			
	Front		Rear		Front		Rear	
Coil energized*	C1	C2	C1	C2	C1	C2	C1	C2
Port A	in	out	—	—	out	in	—	—
Port B	out	in	—	—	in	out	—	—
Port C	—	—	in	out	—	—	out	in
Port D	—	—	out	in	—	—	in	out
Servo port pressurized	M5	M4	M5	M4	M5	M4	M5	M4

* For coil location see installation drawings.

Control Options

Control Response

H1 controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements. The time required for the pump output flow to change from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure.

H1 pumps are limited in mechanical orifice combinations. Mechanical servo orifices are to be used only for fail-safe return to neutral in a case of an electrical failure.

A swash-plate response times table is available for each frame size. Testing should be conducted to verify the proper orifice selection for the desired response. Typical response times at the following conditions:

$\Delta p = 250 \text{ bar}$ [3626 psi]

Charge pressure = 20 bar [290 psi]

Viscosity and temperature = 30 mm²/s [141 SUS] and 50 °C [122 °F]

Speed = 1800 min⁻¹ (rpm)

Response Time, FNR

Stroking direction	Size combo	0.8 [0.03] orifice	1.3 [0.05] orifice	No orifice
Neutral to full flow	045/053	1.8 s	0.9 s	0.5 s
	060/068	2.7 s	1.3 s	0.8 s
Full flow to neutral	045/053	1.6 s	0.8 s	0.4 s
	060/068	2.3 s	1.1 s	0.5 s

Control Options

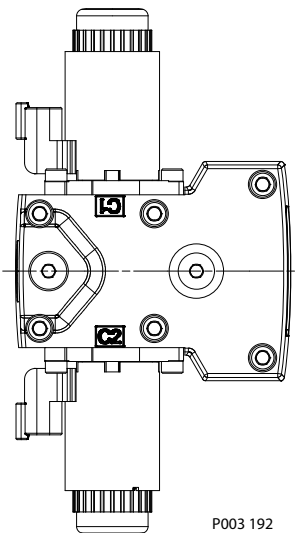
Non Feedback Proportional Electric Control (NFPE)

The Non Feedback Proportional Electric (**NFPE**) control is an electrical automotive control in which an electrical input signal activates one of two proportional solenoids that port charge pressure to either side of the pump servo cylinder. The NFPE control has no mechanical feedback mechanism.

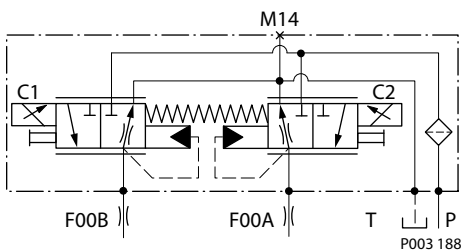
A serviceable 170 µm screen is located in the supply line immediately before the control porting spool.

Under some circumstances, such as contamination, the control spool could stick and cause the pump to stay at some displacement.

Non Feedback Proportional Electric Control



NFPE schematic



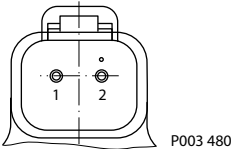
Control signal requirements, NFPE 045/053 Tandem

Control current

Voltage	a* mA	b mA	c mA	Pin connections
12 V	870	1290	1550	any order
24 V	440	670	775	

* Factory test current, for vehicle movement or application actuation expect higher or lower value.

Connector



Connector ordering data

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

Control Options

Description		12 V	24 V
Maximum current		1800 mA	920 mA
Nominal coil resistance	@ 20 °C [68 °F]	3.66 Ω	14.20 Ω
	@ 80 °C [176 °F]	4.52 Ω	17.52 Ω
Inductance		33 mH	140 mH
PWM signal frequency	Range	70 – 200 Hz	
	Recommended*	200 Hz	
IP Rating	IEC 60 529	IP 67	
	DIN 40 050, part 9	IP 69K with mating connector	
Connector color		Black	

* PWM signal required for optimum control performance.

Pump output flow direction vs. control signal

Shaft rotation	CW		CCW	
Coil energized*	C1	C2	C1	C2
Port A	in	out	out	in
Port B	out	in	in	out
Servo port pressurized	M5	M4	M5	M4

* For coil location see Installation drawings.

Control Response

H1 controls are available with optional control passage orifices to assist in matching the rate of swash-plate response to the application requirements. The time required for the pump output flow to change from zero to full flow (acceleration) or full flow to zero (deceleration) is a net function of spool porting, orifices, and charge pressure.

H1 pumps are limited in mechanical orifice combinations. Mechanical servo orifices are to be used only for fail-safe return to neutral in a case of an electrical failure.

A swash-plate response times table is available for each frame size. Testing should be conducted to verify the proper orifice selection for the desired response. Typical response times at the following conditions:

$\Delta p = 250$ bar [3626 psi]

Charge pressure = 20 bar [290 psi]

Viscosity and temperature = 30 mm²/s [141 SUS] and 50 °C [122 °F]

Speed = 1800 min⁻¹ (rpm)

Response Time, NFPE

Stroking direction	Size combo	0.8 [0.03] orifice	1.3 [0.05] orifice	No orifice
Neutral to full flow	045/053	2.2 s	1.2 s	0.8 s
	060/068	3.3 s	1.6 s	1.0 s
Full flow to neutral	045/053	1.5 s	0.7 s	0.4 s
	060/068	1.9 s	0.8 s	0.4 s

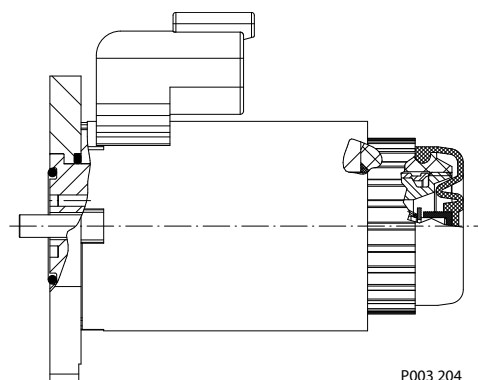
Control Options

Manual Over Ride (MOR)

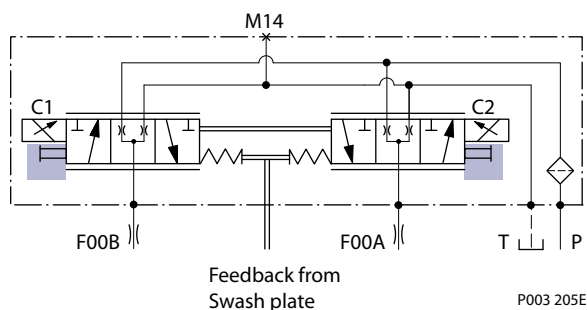
All controls are available with a Manual Over Ride (MOR) either standard or as an option for temporary actuation of the control to aid in diagnostics.

Forward-Neutral-Reverse (FNR) and Non Feedback Proportional Electric (NFPE) controls are always supplied with MOR functionality.

Manual Over Ride (MOR)



MOR schematic diagram (EDC shown)



Unintended MOR operation will cause the pump to go into stroke. The vehicle or device must always be in a „safe“ condition when using the MOR function. (Example: vehicle lifted off the ground)

The MOR plunger has a 4 mm diameter and must be manually depressed to be engaged. Depressing the plunger mechanically moves the control spool which allows the pump to go on stroke. The MOR should be engaged anticipating a full stroke response from the pump.

Warning

An o-ring seal is used to seal the MOR plunger where initial actuation of the function will require a force of 45 N to engage the plunger. Additional actuation typically require less force to engage the MOR plunger. Proportional control of the pump using the MOR should not be expected.

Refer to control flow table for the relationship of solenoid to direction of flow.

Control Options

Swash Plate Angle Sensor for EDC Controls

The angle sensor detects the swash plate position with an accuracy dependent upon the calibration effort done for the application and direction of rotation from the neutral position. At minimum the sensor can be used for forward, neutral and reverse (FNR) detection.

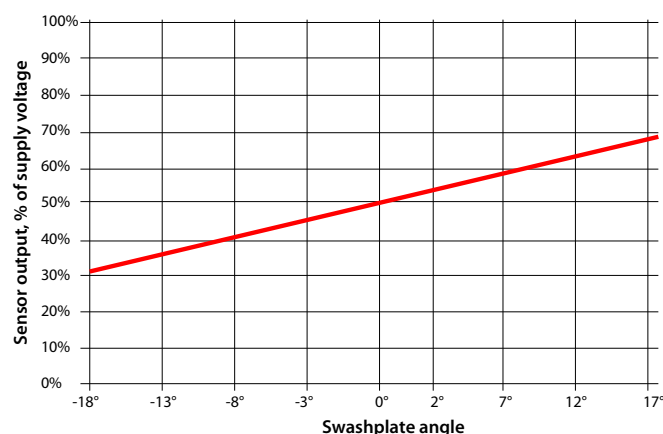
The sensor works on the hall-effect technology. The implemented technology is based on a measurement of the magnetic field direction in parallel to the chip surface. This field direction is converted to a voltage signal at the output.

Enhanced calibration of the non-linear behavior leads to more exact calculation of the pump swash plate angle.

The 4-pin DEUTSCH connector is part of the sensor housing.

The swash plate angle sensor is available for all EDC controls for 12 V and 24 V.

Swash plate angle vs. output of supply voltage



Strong magnetic fields in the proximity of the sensor can influence the sensor signal and must be avoided.

Contact your Danfoss representative in case the angle sensor will be used for safety functions.

Swash Plate Angle Sensor Parameters (EDC)

Parameter	Minimum	Typical	Maximum
Supply voltage range	4.5 V _{DC}	5 V _{DC}	5.5 V _{DC}
Supply protection	–	–	18 V _{DC}
Pump neutral output (% of supply voltage)	–	50%	–
Working range (swash plate angle)	–18°	–	18°
Required supply current	–	–	30 mA
Output current signal	–	9 mA	11 mA
Working temperature	–40°C	80°C	115°C

Protection	Class
IP rating IEC 60 529	IP 67
IP rating DIN 40050, part 9	IP 69K with mating connector
EMC Immunity (ISO 11452-2)	100 V/m

Control Options

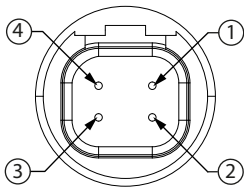
Calibration of the sensor output within the software is mandatory. Vehicle neutral thresholds in the software ($\pm 0.5^\circ$) are vehicle dependent and must consider different conditions, example: system temperature, system pressure and/or shaft speed.

For safety function: If the sensor fails (invalid signal $< 10\%$ or $> 90\%$ of supply voltage), it must be sure that the ECU will go into a diagnostic mode and shift into limited mode in order for the driver to take the full control or the mechanical breaks should be activated.

Strong magnetic fields in the proximity of the sensor can influence the sensor signal and must be avoided.

Swash Plate Angle Sensor Connector

DEUTSCH 4-pin connector



Legend:

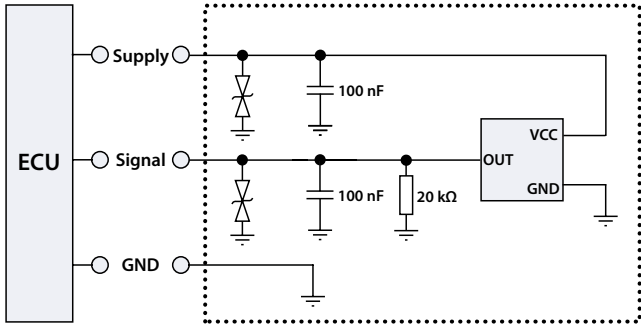
- 1. Ground (GND)
- 2. Not connected
- 3. Output signal 1 (SIG 1)
- 4. Supply (V+)

Connector order numbers

Description	Quantity	Order number
Mating connector DTM06-4S-E004	1	11105824
Wedge lock WM-4S	1	not available
Socket contact 0462-201-2031	3	

Interface with ECU

Interface with ECU diagram

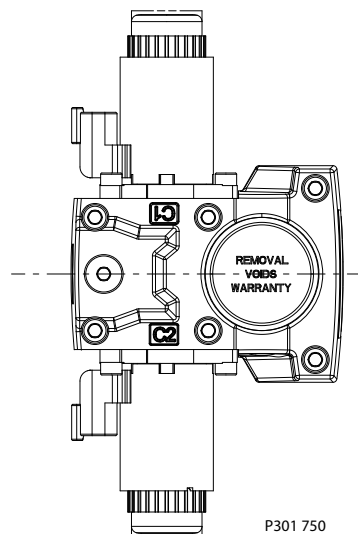


Control Options

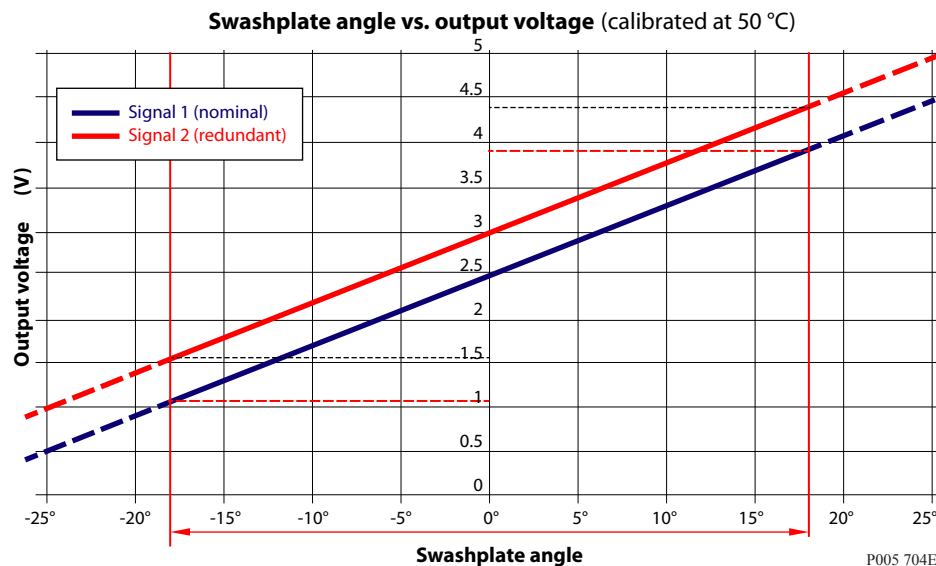
Swash plate angle sensor for NFPE and AC2 controls

The angle sensor detects the swash plate angle position and direction of rotation from the zero position. The swash angle sensor works on the AMR sensing technology. Under the saturated magnetic field, the resistance of the element varies with the magnetic field direction.

The output signal give a linear output voltage for the various magnet positions in the sensing range.



Swash plate angle vs. output voltage



Swash Plate Angle Sensor Parameters (NFPE/AC)

Parameter	Minimum	Typical	Maximum
Supply voltage range	4.75 V	5 V	5.25 V
Supply protection	–	–	28 V
Supply current	–	22 mA	25 mA
Output current (Signal 1, 2)	–	0.1 mA	–
Short circuit output current to supply or GND ¹⁾	–	–	7.5 mA

Control Options

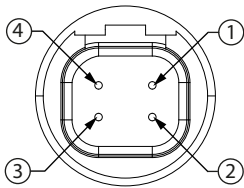
Parameter	Minimum	Typical	Maximum
Sensitivity	70.0 mV/deg	78.0 mV/deg	85.8 mV/deg
Working range (swash plate angle)	-18°	0°	18°
Correlation between signals 1 and 2²⁾	475 mV	500 mV	525 mV

¹⁾ Up to duration of 2.5 seconds at 25°C

²⁾ Signal 1 (nominal) is lower than signal 2 (redundant)

Swash Plate Angle Sensor Connector

DEUTSCH 4-pin connector



4-Pin Legend:

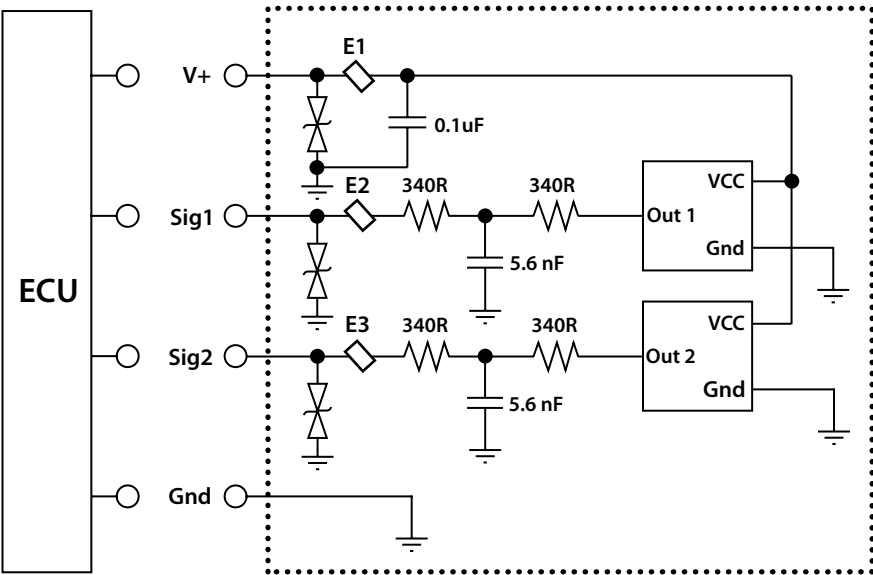
1. Ground (GND)
2. Output Signal 2 (SIG2) – Secondary (redundant)
3. Output Signal 1 (SIG1) – Primary (nominal)
4. Supply (V+)

Connector order numbers

Description	Quantity	Order number
Mating connector DTM06-4S-E004	1	11105824
Wedge lock W4S	1	11084558
Socket contact (16-18 AWG) 0462-201-16141	2	K02325

Interface with ECU

Interface with ECU schematic



Minimum recommended load resistance is 100 kΩ.

Control Options

Control-Cut-Off (CCO) and Brake Release Valves

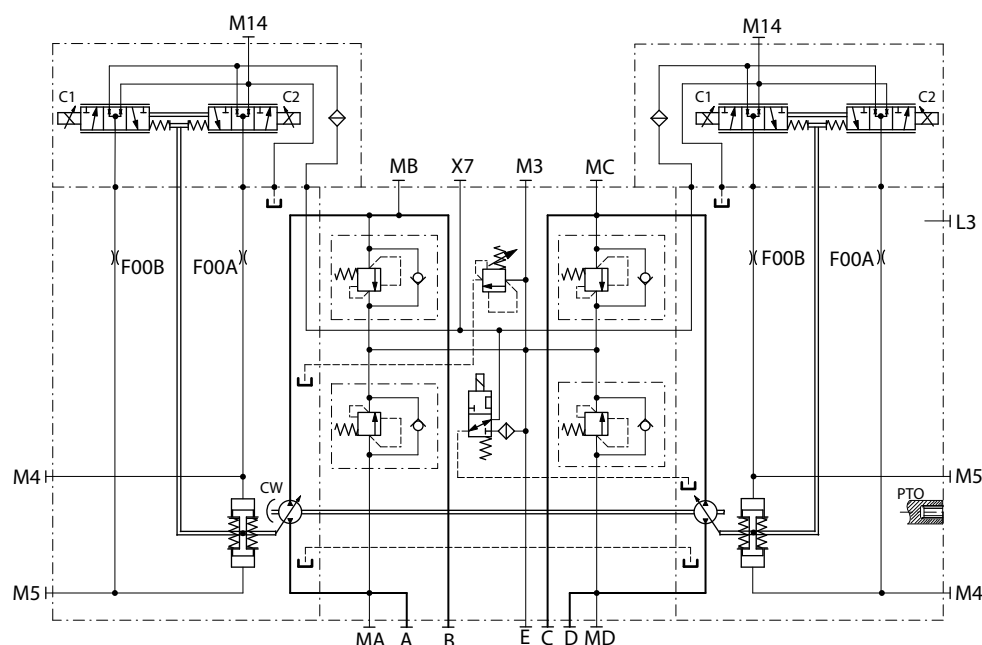
The H1 tandem pumps offer an optional **Control-Cut-Off** valve integrated into the pump center section and a separate brake release valve allowing the controls to be activated before activating any auxiliary functions.

The CCO valve shunts charge pressure from the pump controls allowing the servo springs to de-stroke both pumps. The valve is normally open for fail-safe operation. The solenoid must be energized for the pump to operate. When the machine control circuits energize the CCO solenoid, it connects charge supply from the charge gallery to the pump controls.

The 45/53cc tandem also supplies charge pressure to the port X7 for auxiliary operation of devices such as spring applied/pressure released brakes. The control cut off valve also shunts pressure away from port X7.

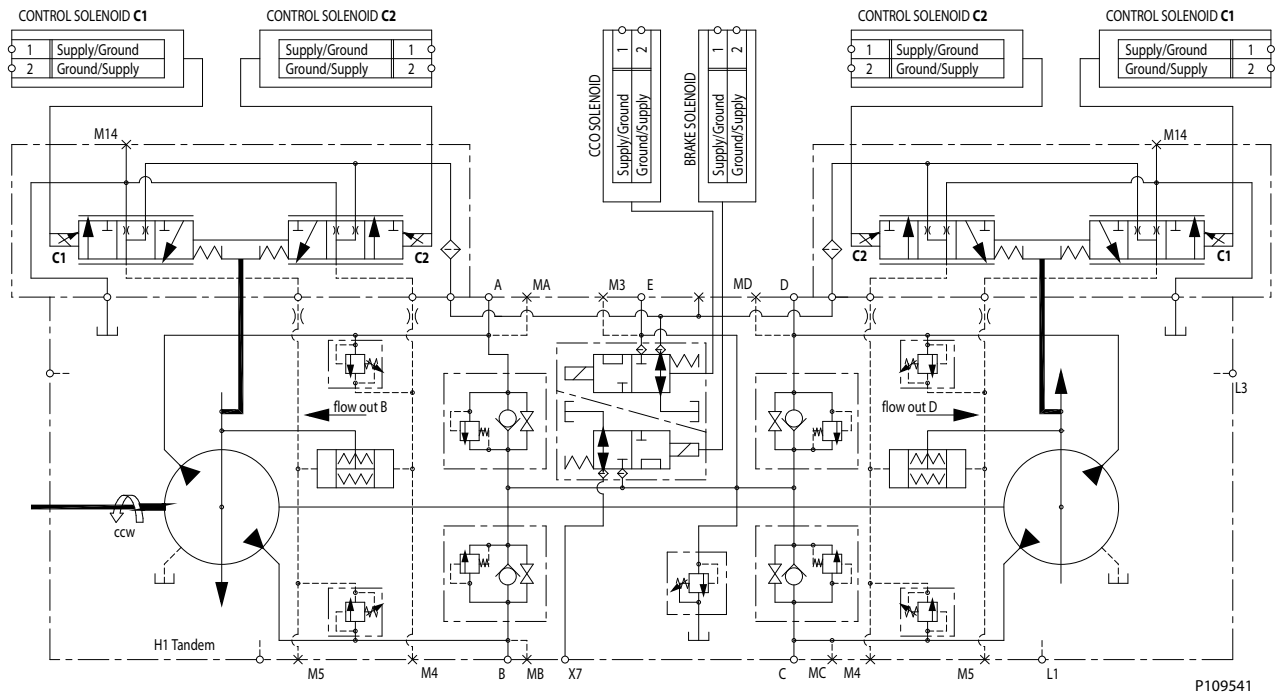
The 60/68 tandem offers a separate brake release valve that operates independently of the CCO valve allowing the controls to be activated before activating any auxiliary functions. When the 60/68 brake valve is deactivated the X7 port shunts to case.

CCO schematic 045/053 tandem



Control Options

CCO schematic 060/068 tandem

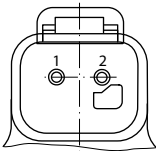


Solenoid data

Description		12 V	24 V
Minimum supply voltage		9 V _{DC}	18 V _{DC}
Maximum supply voltage (continuous)		16 V _{DC}	32 V _{DC}
IP Rating	IEC 60 529	IP 67	
	DIN 40 050, part 9	IP 69K with mating connector	
Pin connector		any order	

For additional information, please contact Danfoss.

CCO connector



Connector ordering data

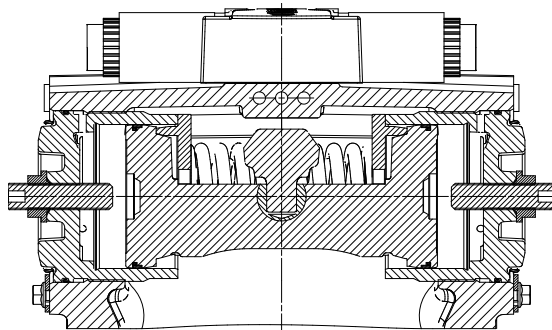
Description	Quantity	Ordering number
Mating connector	1	DEUTSCH DT06-2S
Wedge lock	1	DEUTSCH W2S
Socket contact (16 and 18 AWG)	2	DEUTSCH 0462-201-16141

Control Options

Displacement limiter

H1 pumps are designed with optional mechanical displacement (stroke) limiters factory set to max. displacement. The maximum displacement of the pump can be set independently for forward and reverse using the two adjustment screws to mechanically limit the travel of the servo piston down to 50 % displacement.

Adjustments under operating conditions may cause leakage. The adjustment screw can be completely removed from the threaded bore if backed out to far.



P003 266

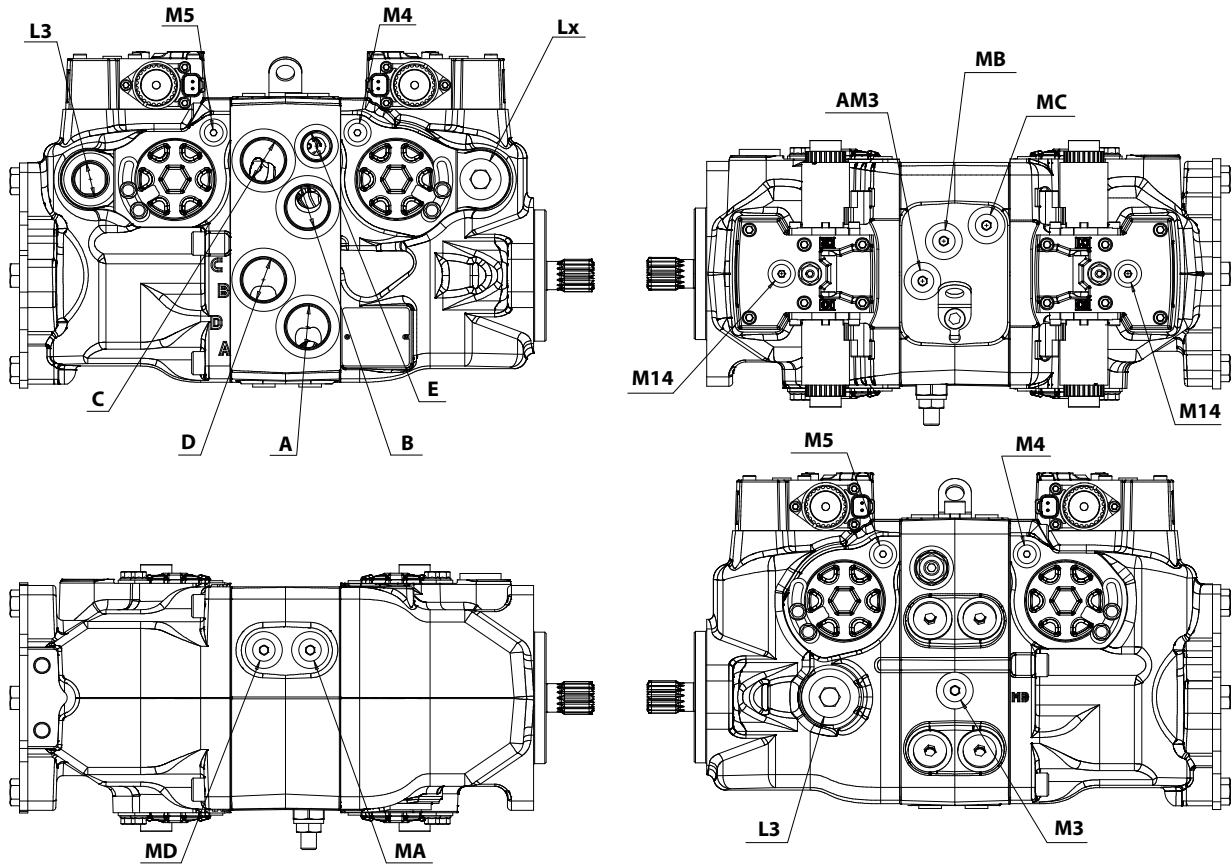
Displacement change (approximately)

Parameter	Size 045	Size 053	Size 060	Size 068
1 Turn of displacement limiter screw	5.1 cm ³ [0.31 in ³]	6.0 cm ³ [0.37 in ³]	5.9 cm ³ [0.36 in ³]	6.6 cm ³ [0.40 in ³]
Internal wrench size	4 mm			
External wrench size	13 mm			
Torque for external hex seal lock nut	23 N·m [204 lbf·in]			

For more information, see *H1 Axial Piston Pumps, Service Manual*, **AX00000087**, the section "Displacement Limiter Adjustment".

Port Locations

Port Locations H1P 045/053 Tandem



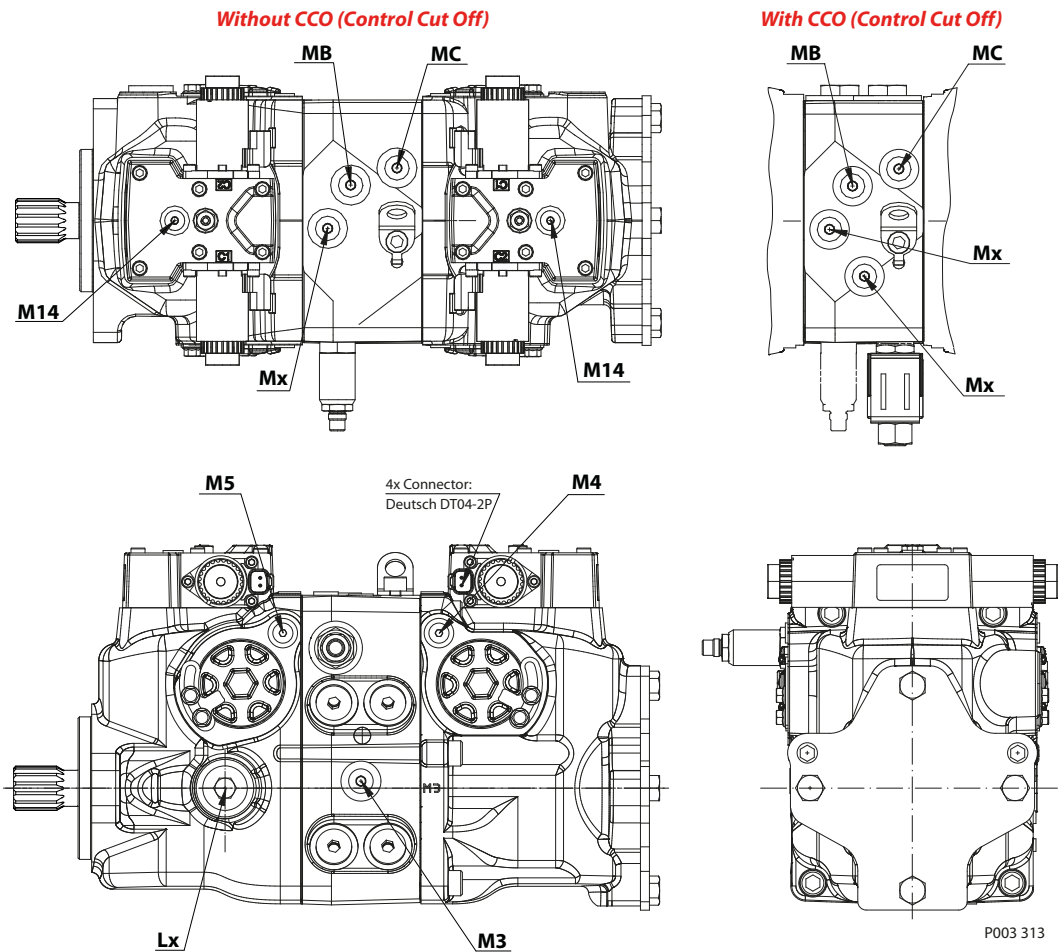
P109516

Mounting flange, shaft and connector surfaces to be paint free.

Ports description, ISO 11926-1

Ports	Description	Sizes
A, B, C, D	System ports: A, B, C and D; Ø48.5 max. clearance for fitting	1 ⁵ / ₁₆ – 12
MA, MB, MC, MD	System gauge ports A, B, C and D; Ø28 max. clearance for fitting	9/ ₁₆ – 18
E	Charge filtration inlet port from filter; Ø36 max. clearance for fitting	7/ ₈ – 14
L3, Lx	Case drain port; Ø48.5 max. clearance for fitting	1 ¹ / ₁₆ – 12
M3	Charge gauge / constr. port; Ø28 max. clearance for fitting	9/ ₁₆ – 18
M4, M5	Servo gauge ports; Ø24.5 max. clearance for fitting	7/ ₁₆ – 20
M14	Case gauge port; Ø21 max. clearance for fitting (EDC, MDC, FNR, NFPE)	7/ ₁₆ – 20
AM3	Alternate charge pressure port	9/ ₁₆ – 18

Port Locations



Mounting flange, shaft and connector surfaces to be paint free.

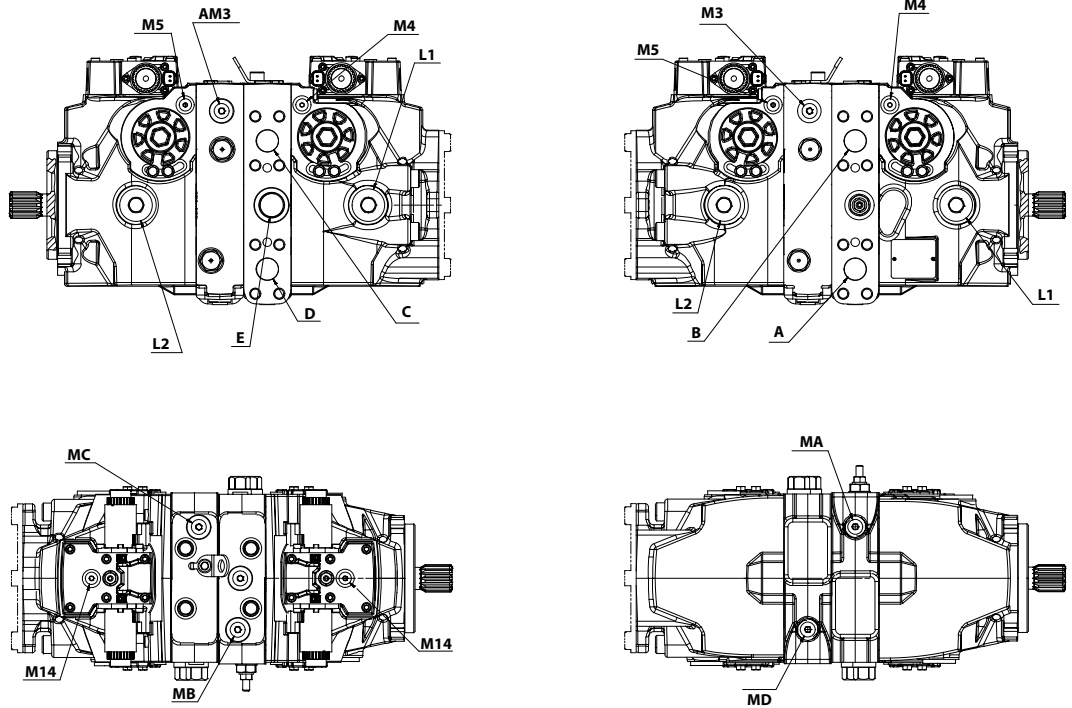
Ports description, ISO 11926-1

Ports	Description	Sizes
A, B, C, D	System ports: A, B, C and D ; Ø48.5 max. clearance for fitting	1 ⁵ / ₁₆ –12
MA, MB, MC, MD	System gauge ports A, B, C and D ; Ø28 max. clearance for fitting	9/ ₁₆ –18
E	Charge filtration inlet port from filter; Ø36 max. clearance for fitting	7/ ₈ –14
Lx	Case pressure port; Ø48.5 max. clearance for fitting	1 ¹ / ₁₆ –12
M3 / Mx	Charge gauge / constr. port; Ø28 max. clearance for fitting	9/ ₁₆ –18
M4, M5	Servo gauge ports; Ø24.5 max. clearance for fitting	7/ ₁₆ –20
M14	Case gauge port; Ø21 max. clearance for fitting (EDC, MDC, FNR, NFPE)	7/ ₁₆ –20
X7	Brake gauge port	9/ ₁₆ –18

Please contact Danfoss representative for specific installation drawings.

Port Locations

Port Locations H1P 060/068 Tandem



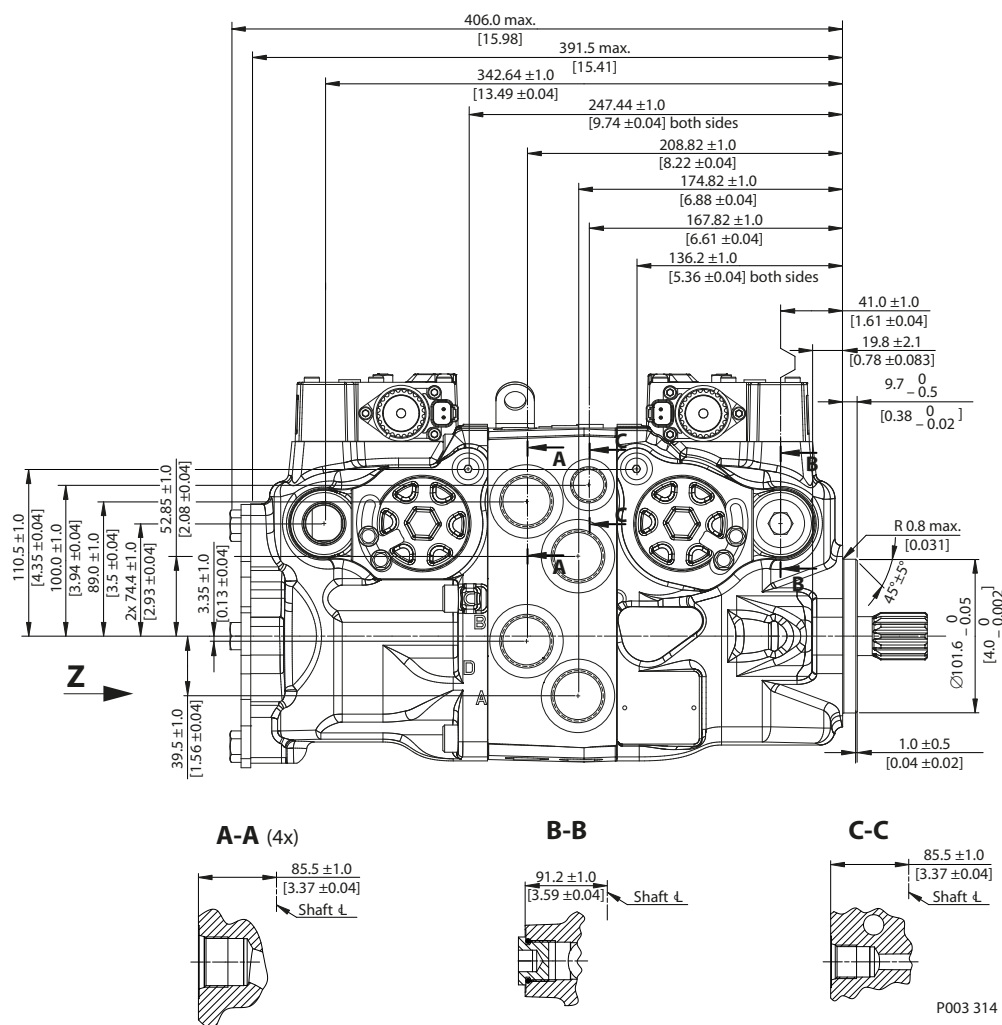
P109116

Ports description, ISO 11926-1

Ports	Description	Size
A, B, C, D	System ports: A, B, C and D	Split flange, M12 x 1.75
MA, MB, MC, MD	System gauge ports A, B, C and D	$\frac{9}{16}$ - 18
E	Charge filtration inlet port from filter	$1\frac{1}{16}$ - 12
L3	Case drain port	$1\frac{5}{16}$ - 12
M3 / Mx	Charge gauge / constr. port	$\frac{9}{16}$ - 18
M4, M5	Servo gauge ports	$\frac{7}{16}$ - 20
M14	Case gauge port; (EDC, MDC, FNR, NFPE)	$\frac{7}{16}$ - 20
X7	Brake gauge port	$\frac{3}{4}$ - 16

Dimensions

Dimensions H1T 045/053 Tandem

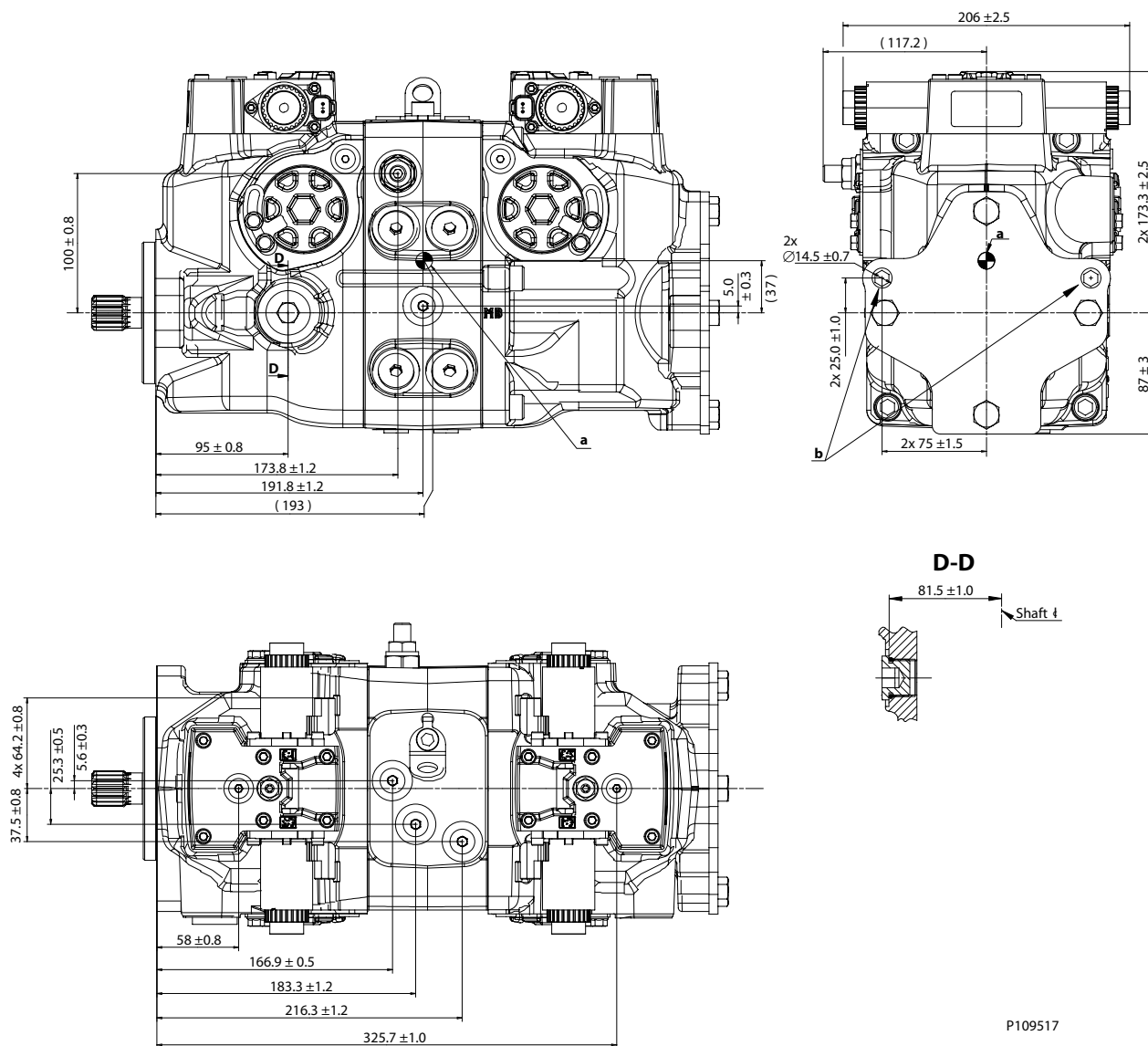


L3 case drain port must be used (see the section *Case drain* on page 8 for more details).

Please contact Danfoss representative for specific installation drawings.

Technical Information
H1 Axial Piston Tandem Pumps, Size 045/053/060/068

Dimensions

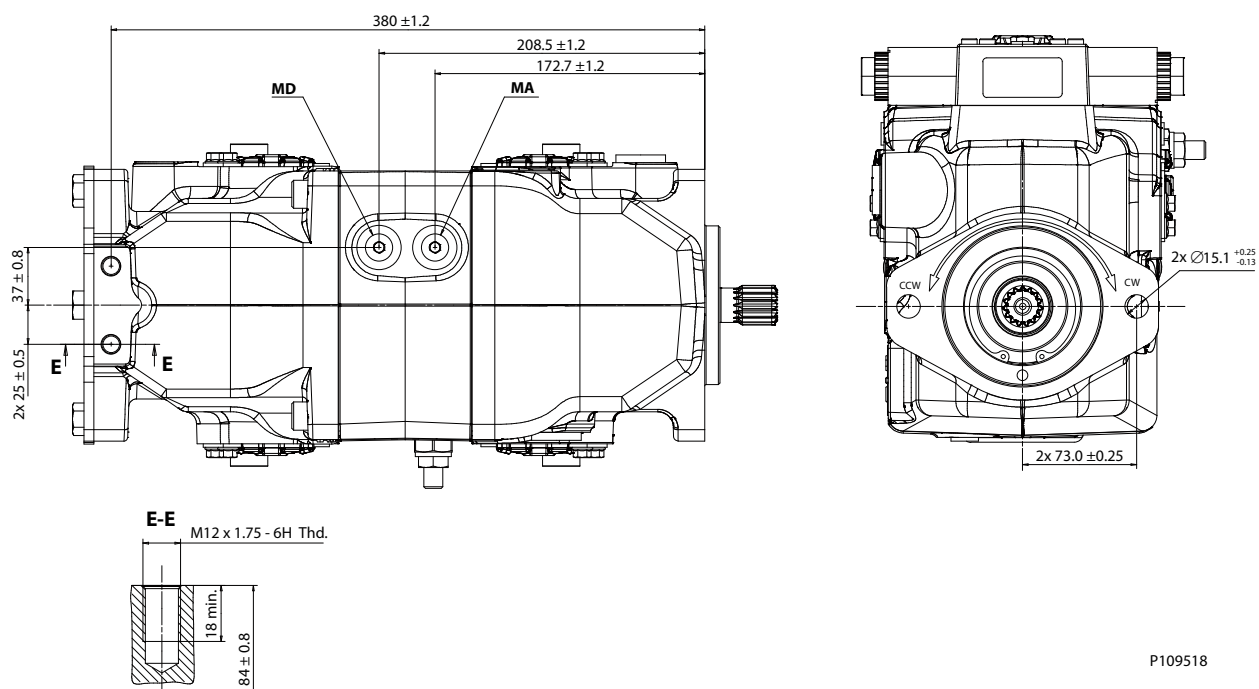


Notes in the drawing:

- a** – Approximate center of gravity
- b** – Lifting holes weight limit not to exceed 75 kg [165 lb]

Please contact Danfoss representative for specific installation drawings.

Dimensions



P109518

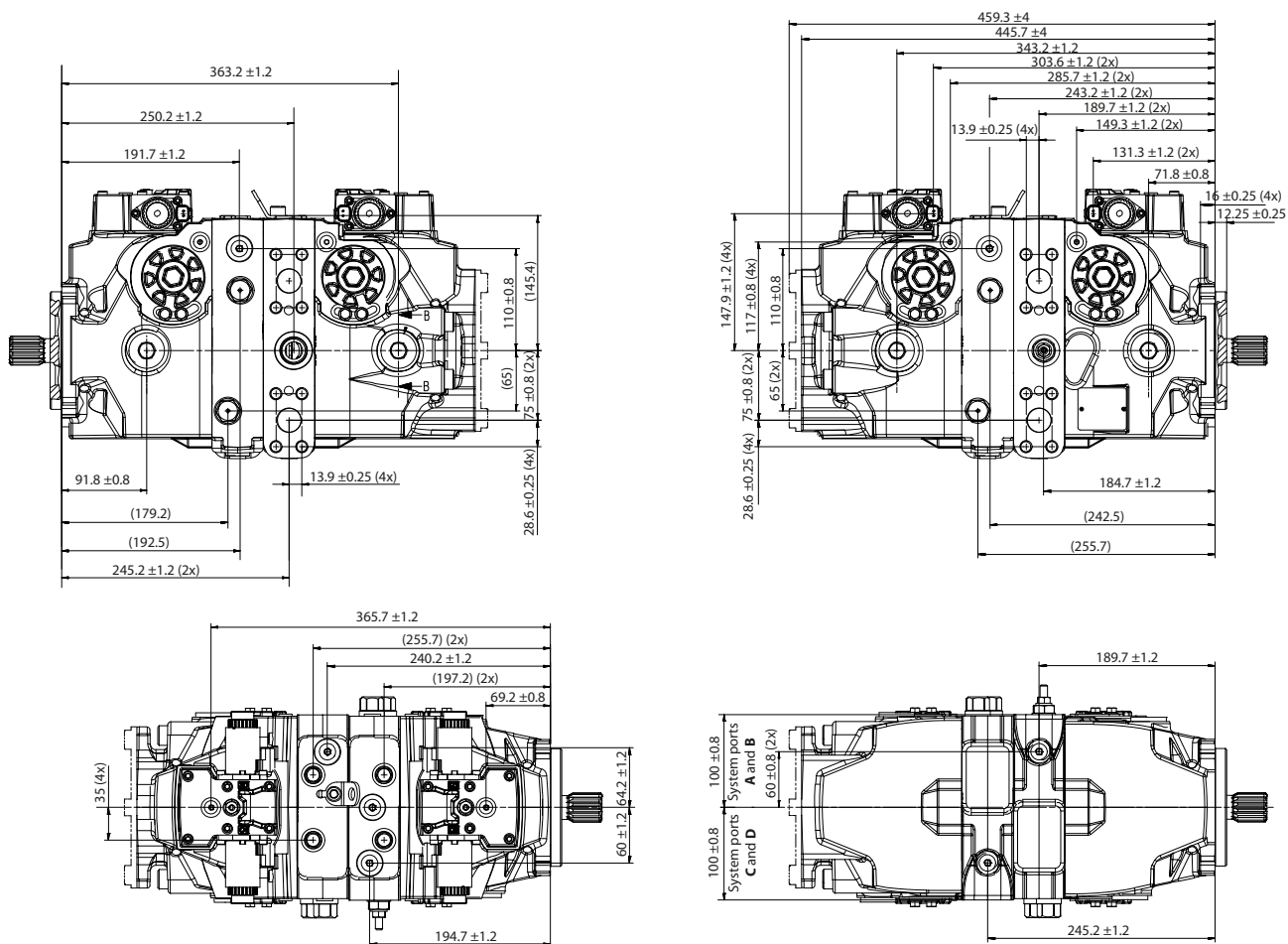
Mounting bolt holes are sized for 14 mm fasteners. M12 or ½ inch can be used, but require a hardened washer.

[Please contact Danfoss representative for specific installation drawings.](#)

Technical Information H1 Axial Piston Tandem Pumps, Size 045/053/060/068

Dimensions

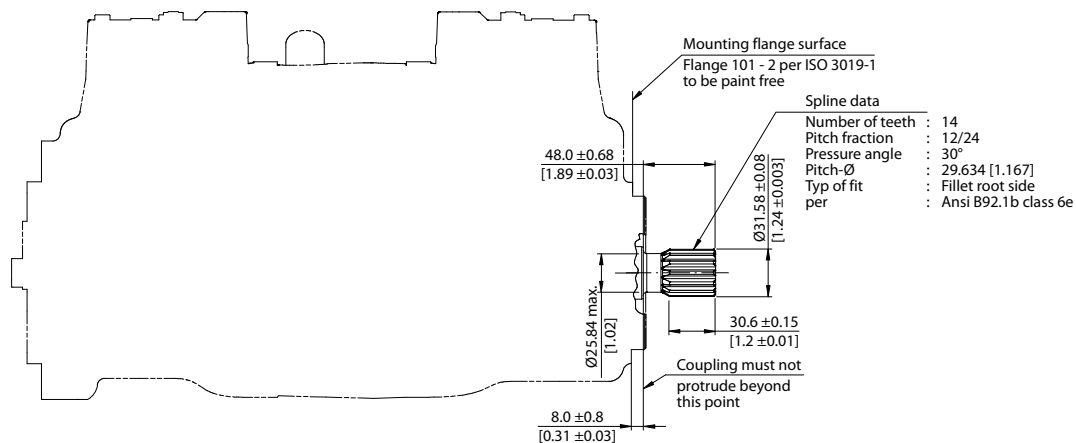
Dimensions H1T 060/068 Tandem



Dimensions

Input shaft, option G1 (SAE C, 14 teeth) (045/053/060/068)

Option G1



Specifications

Option		G1
Spline		14 teeth, 12/24 pitch
Min. active spline length ¹⁾		30.6 mm [1.205 in]
Torque rating ²⁾	Rated	534 N·m [4720 lbf·in]
	Maximum	592 N·m [5240 lbf·in]

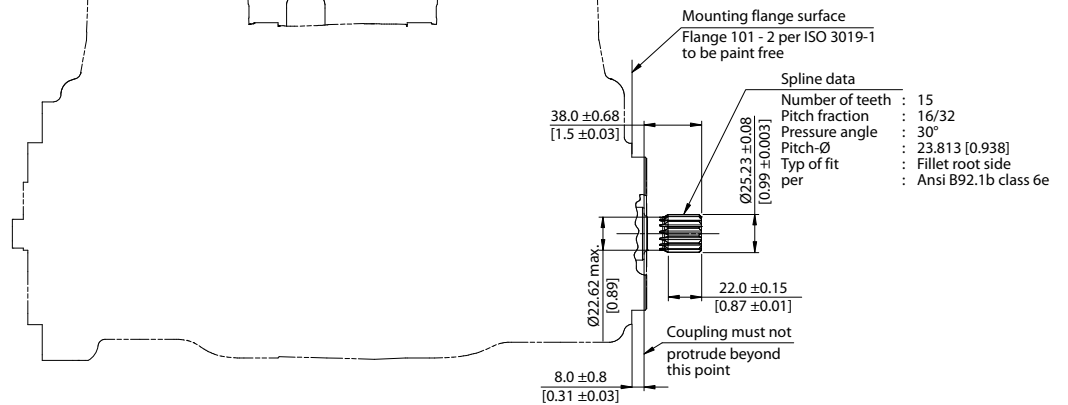
¹⁾ Minimum active spline length for the specified torque ratings.

²⁾ For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

Dimensions

Input shaft, option G5 (SAE B-B, 15 teeth) (045/053 only)

Option G5



Specifications

Option		G5
Spline		15 teeth, 16/32 pitch
Min. active spline length ¹⁾		22 mm [0.866 in]
Torque rating ²⁾	Rated	277 N•m [2450 lbf•in]
	Maximum	370 N•m [3270 lbf•in]

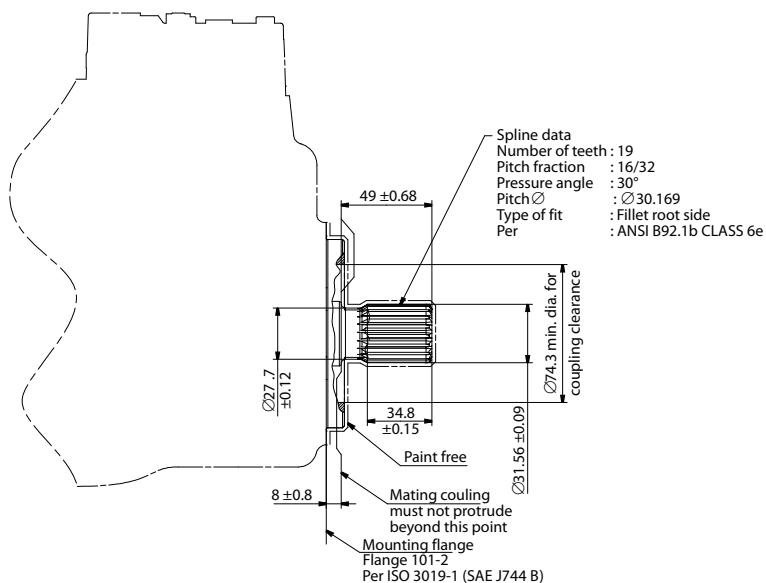
¹⁾ Minimum active spline length for the specified torque ratings.

²⁾ For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

Dimensions

Input shaft, option G6, (19 teeth-long) (045/053 only)

Option G6, 045/053



Specifications

Option		G6
Spline		19 teeth, 16/32 pitch
Min. active spline length ¹⁾		34.8 mm [1.370 in]
Torque rating ²⁾	Rated	563 N·m [4980 lbf·in]
	Maximum	732 N·m [6478 lbf·in]

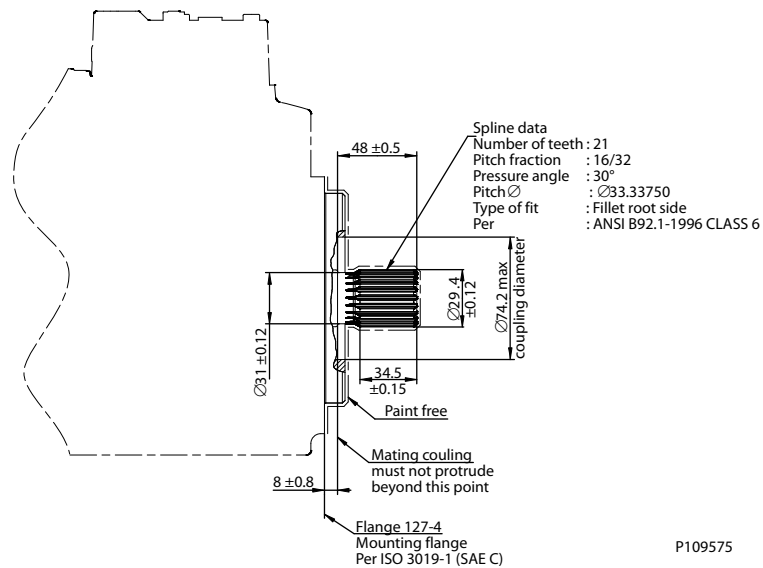
¹⁾ Minimum active spline length for the specified torque ratings.

²⁾ For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

Dimensions

Input shaft, option F1, (060/068 only)

Option F1, ISO 3019-1, outer dia 32 mm-4 (SAE C, 21 teeth)



Specifications

Option		F1
Spline		21 teeth, 16/32 pitch
Min. active spline length ¹⁾		31.5 mm [1.358 in]
Torque rating ²⁾	Rated	760 N·m [6730 lb·in]
	Maximum	1137 N·m [10060 lb·in]

¹⁾ Minimum active spline length for the specified torque ratings.

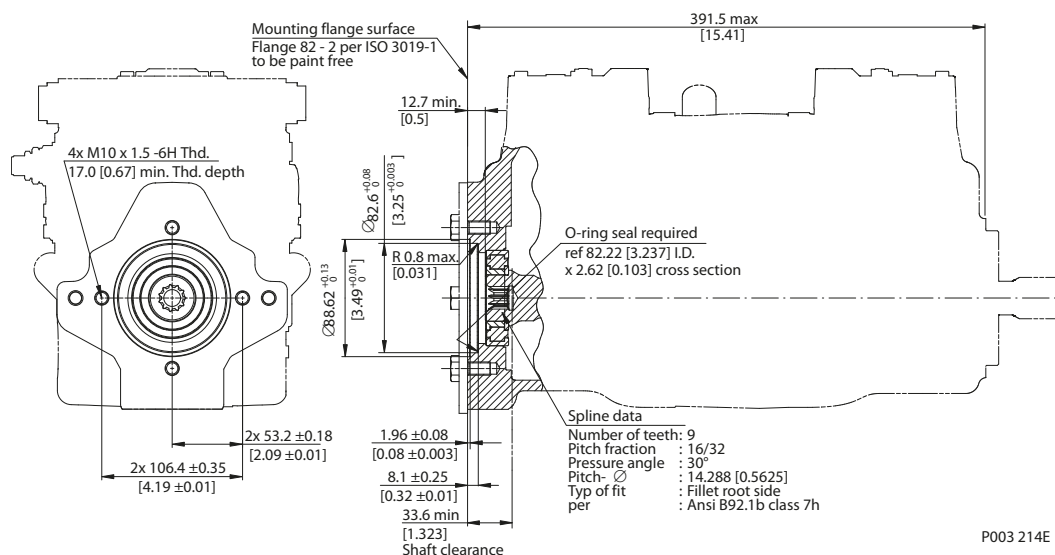
²⁾ For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

Dimensions

Auxiliary mounting pads

Option H2 (SAE A, 9 teeth) 045/053

Option H2, ISO 3019-1, flange 82-2 (SAE A, 9 teeth)



Specifications

Option	H2
Spline	9 teeth, 16/32 pitch
Maximum torque¹⁾	162 N•m [1430 lbf•in]

¹⁾ For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

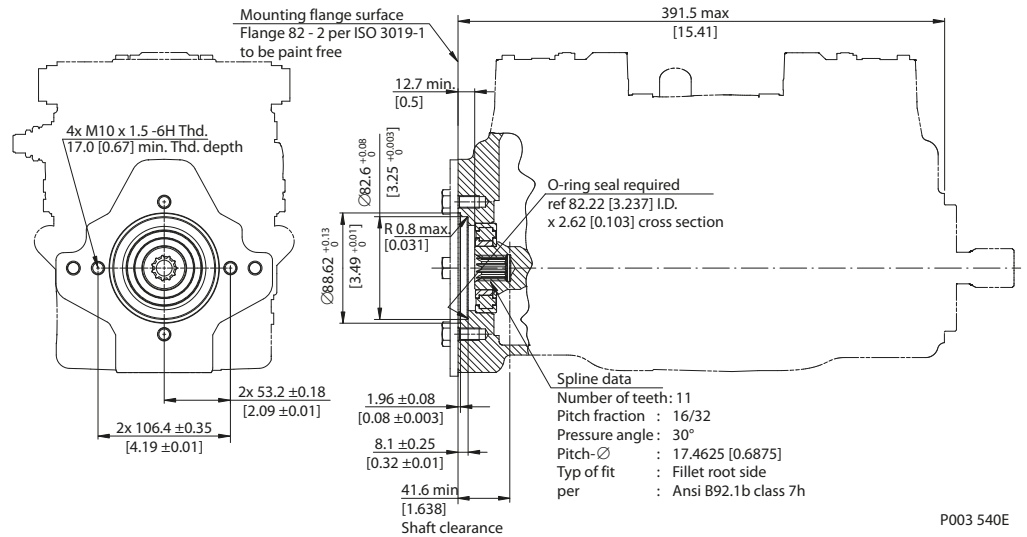
Caution

Standard pad cover is installed only to retain coupling during shipping. Do not operate pump without an auxiliary pump or running cover installed.

Dimensions

Option H1 (SAE A, 11 teeth) 045/053

Option H1, ISO 3019-1, Flange 82-2 (SAE A, 11 Teeth)



Specifications

Option	H1
Spline	11 teeth, 16/32 pitch
Maximum torque ¹⁾	296 N·m [2620 lbf·in]

¹⁾ For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

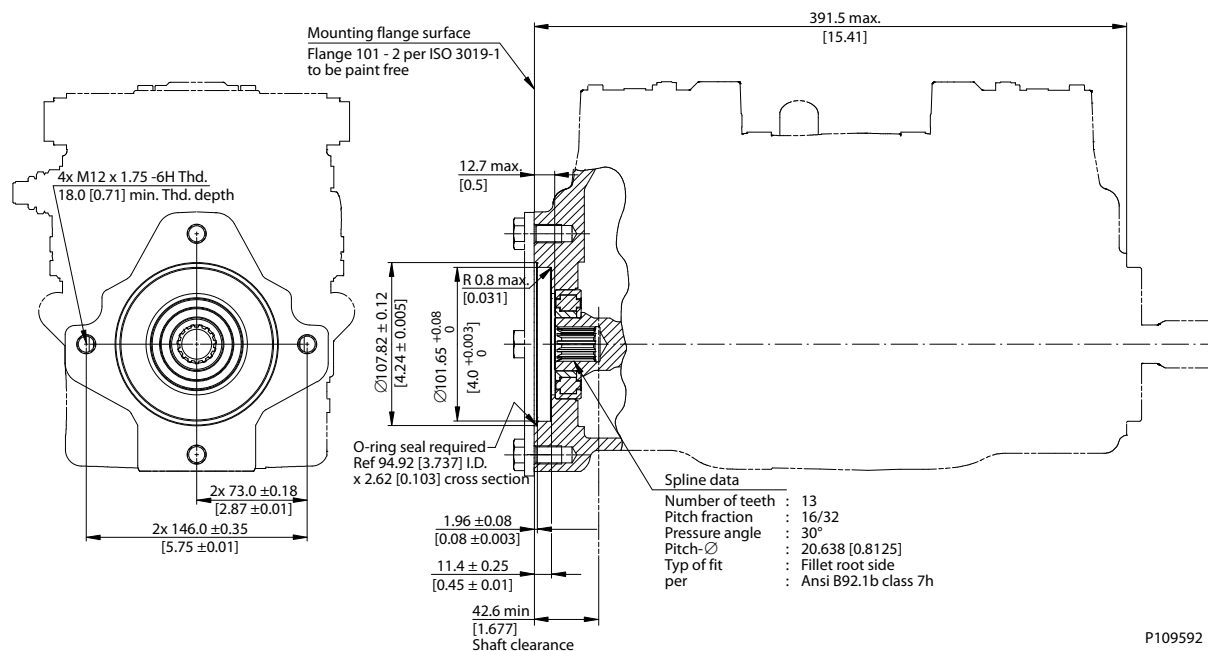
⚠ Caution

Standard pad cover is installed only to retain coupling during shipping. Do not operate pump without an auxiliary pump or running cover installed.

Dimensions

Option H3 (SAE B, 13 teeth) 045/053

Option H3, ISO 3019-1, Flange 101-2 (SAE B, 13 Teeth)



P109592

Specifications

Option	H3
Spline	13 teeth, 16/32 pitch
Maximum torque ¹⁾	395 N·m [3500 lbf·in]

¹⁾ For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

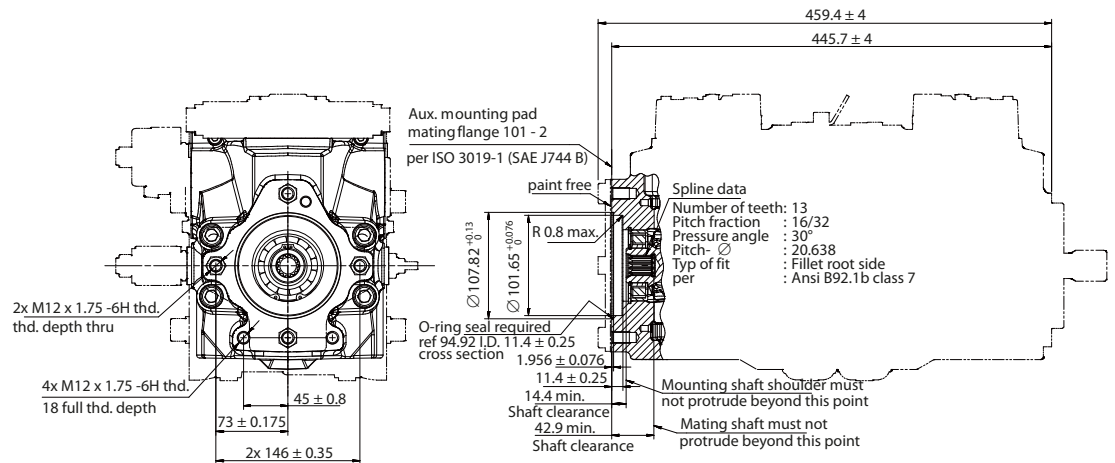
⚠ Caution

Standard pad cover is installed only to retain coupling during shipping. Do not operate pump without an auxiliary pump or running cover installed.

Dimensions

Option H3 (SAE B, 13 teeth) 060/068

Option H3, ISO 3019-1, Flange 101-2 (SAE B, 13 Teeth)



P109521

Specifications

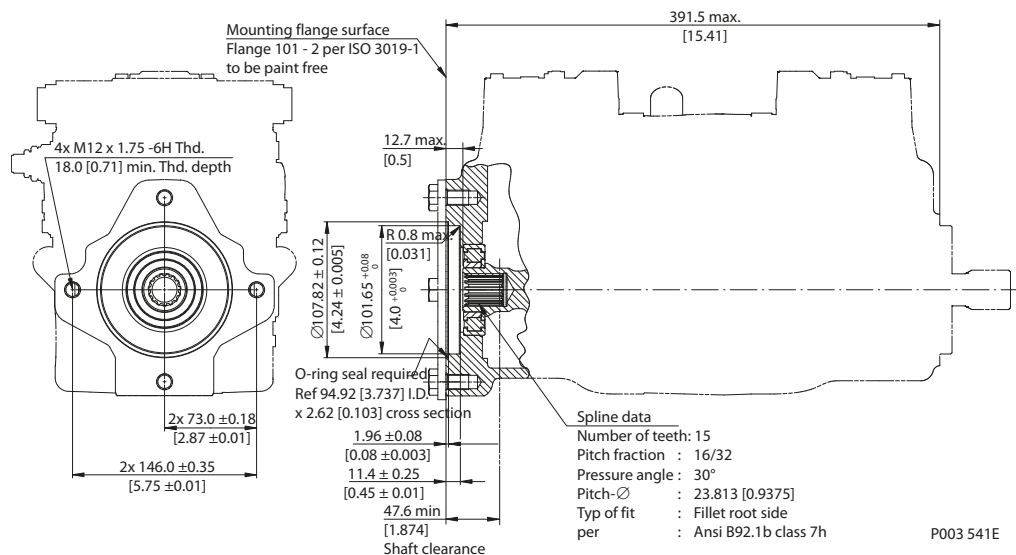
Option	H3
Spline	13 teeth, 16/32 pitch
Maximum torque ¹⁾	395 N·m [3500 lbf·in]

¹⁾ For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

Dimensions

Option H5 (SAE B-B, 15 teeth) 045/053

Option H5, ISO 3019-1, Flange 101-2 (SAE B-B, 15 Teeth)



Specifications

Option	H5
Spline	15 teeth, 16/32 pitch
Maximum torque ¹⁾	405 N·m [3580 lbf·in]

¹⁾ For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

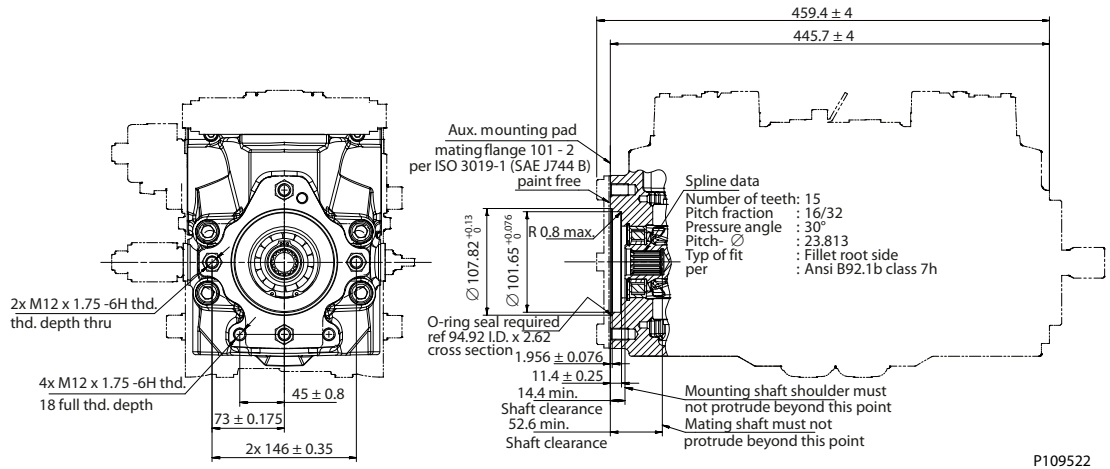
⚠ Caution

Standard pad cover is installed only to retain coupling during shipping. Do not operate pump without an auxiliary pump or running cover installed.

Dimensions

Option H5 (SAE B-B, 15 teeth) 060/068

Option H5, ISO 3019-1, Flange 101-2 (SAE B-B, 15 Teeth)



Specifications

Option	H5
Spline	15 teeth, 16/32 pitch
Maximum torque ¹⁾	592 N·m [5240 lbf·in]

¹⁾ For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section Shaft Torque Ratings and Spline Lubrication.

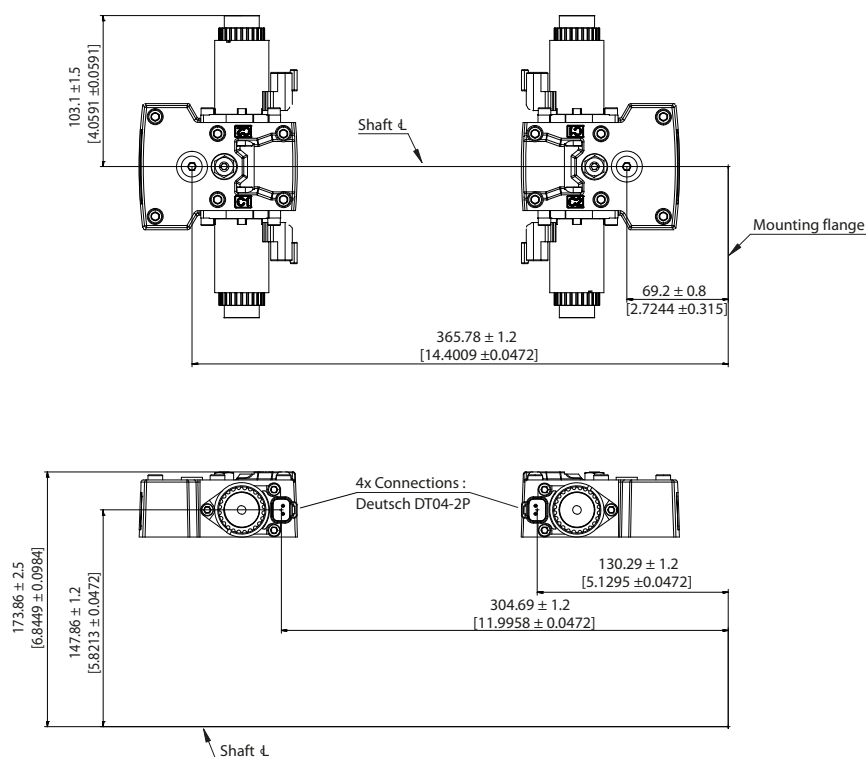
! Caution

Standard pad cover is installed only to retain coupling during shipping. Do not operate pump without an auxiliary pump or running cover installed.

Dimensions

060/068 Control dimensions

Electric Displacement Control (EDC), option A2 (12V) / A3 (24V) (060/068)



P109544

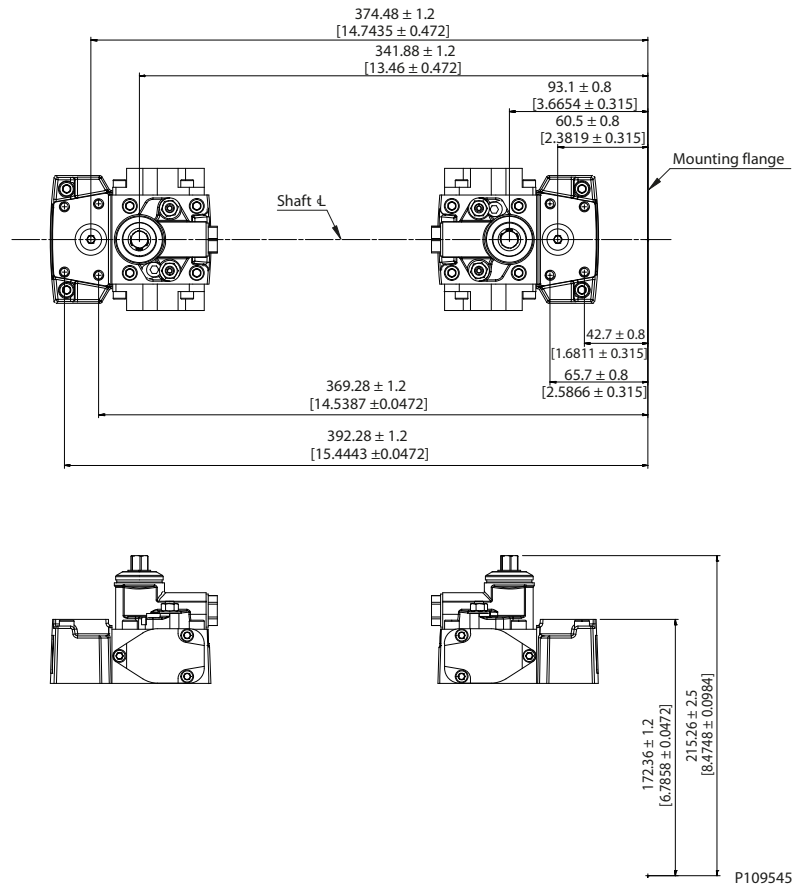
2x Case gauge port **M14**: ISO 11926-1 – 7/16 -20; Ø21.0 max clearance dia for fitting

4x Connectors Deutsch DT04-2P to be paint free

[Please contact Danfoss representative for specific installation drawings.](#)

Dimensions

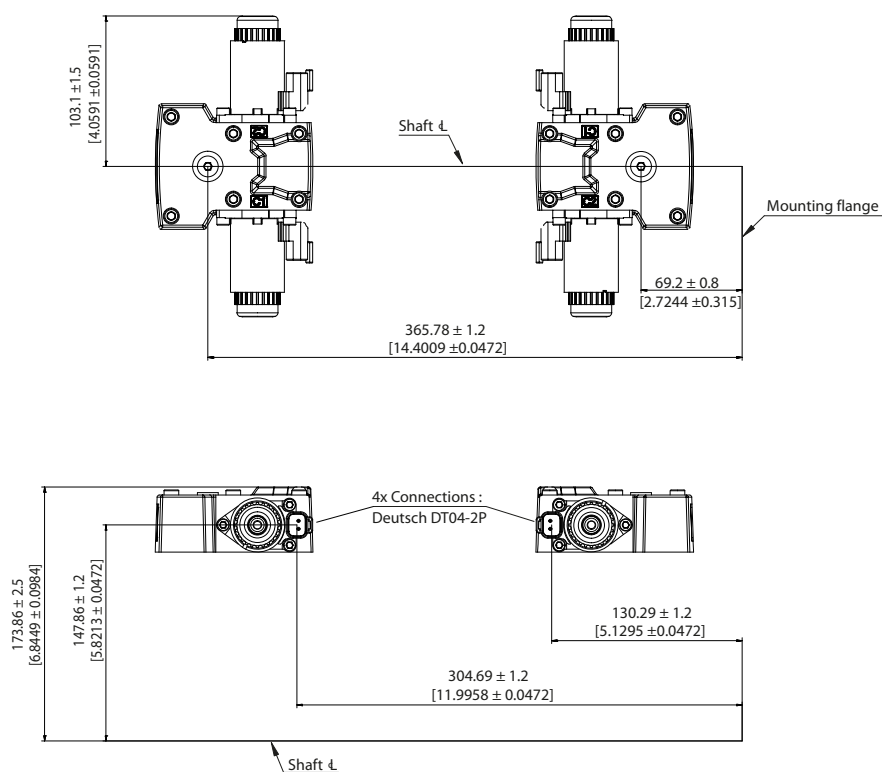
Manual Displacement Control (MDC), option M1 (060/068)



Please contact Danfoss representative for specific installation drawings.

Dimensions

Forward-Neutral-Reverse (FNR) with MOR, option A9 (12 V)/ B1 (24 V) (060/068)



P109546

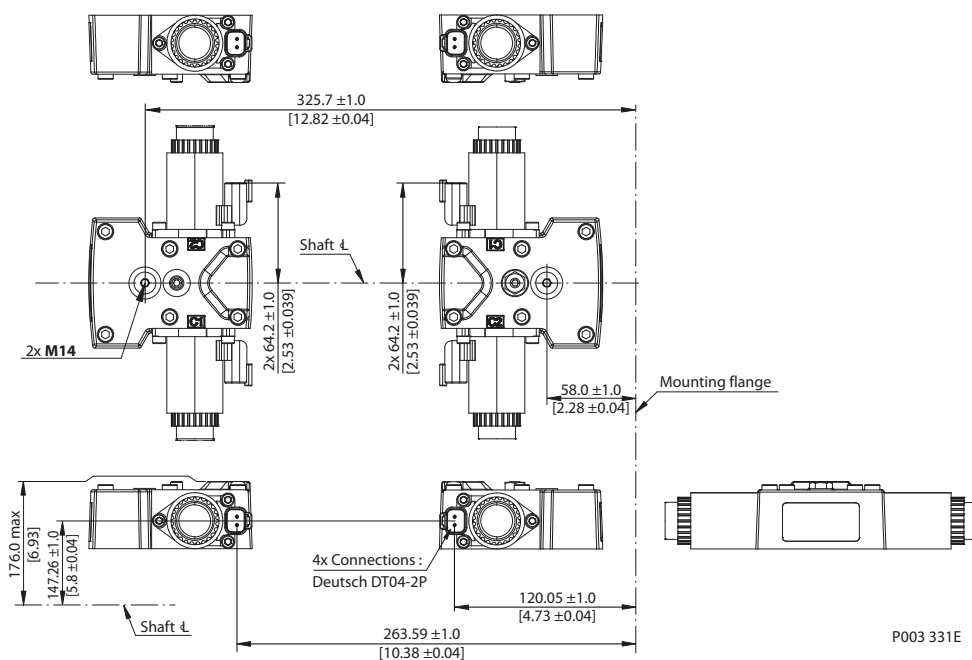
2x Case gauge port **M14**: ISO 11926-1; $\frac{7}{16}$ -20; Ø21.0 max clearance dia for fitting.
 4x Connectors Deutsch DT04-2P to be paint free.

Please contact Danfoss representative for specific installation drawings.

Dimensions

045/053 Control dimensions

Electric Displacement Control (EDC), option A2 (12V) / A3 (24V) H1T (045/053)



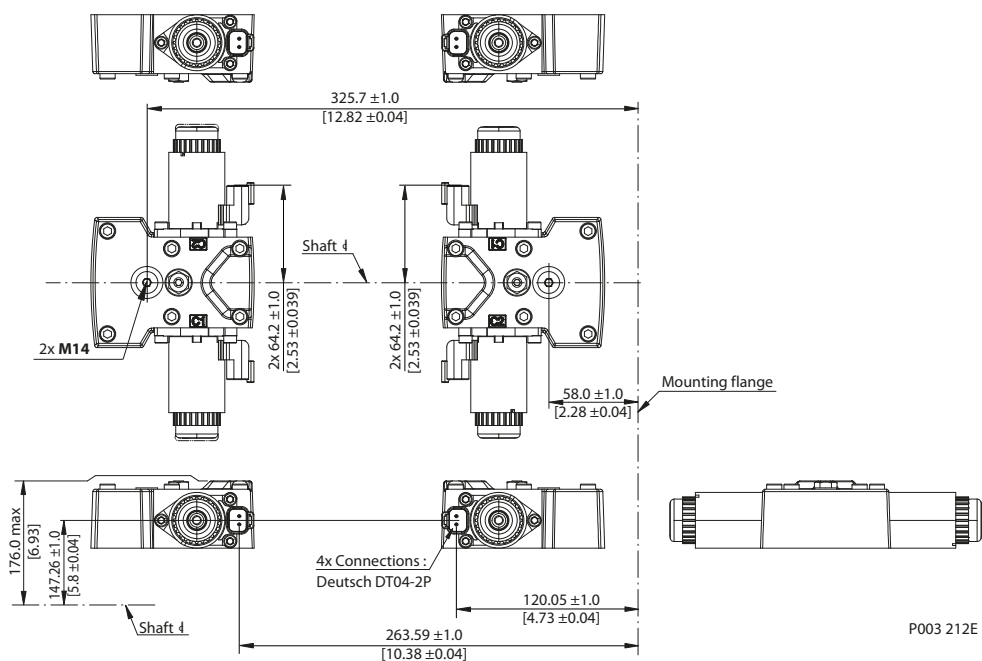
2x Case gauge port **M14**: ISO 11926-1 – 7/16 -20; $\varnothing 21.0$ max clearance dia for fitting

4x Connectors Deutsch DT04-2P to be paint free

[Please contact Danfoss representative for specific installation drawings.](#)

Dimensions

Electric Displacement Control (EDC) with MOR, option A4 (12 V) / A5 (24 V) H1T (045/053)



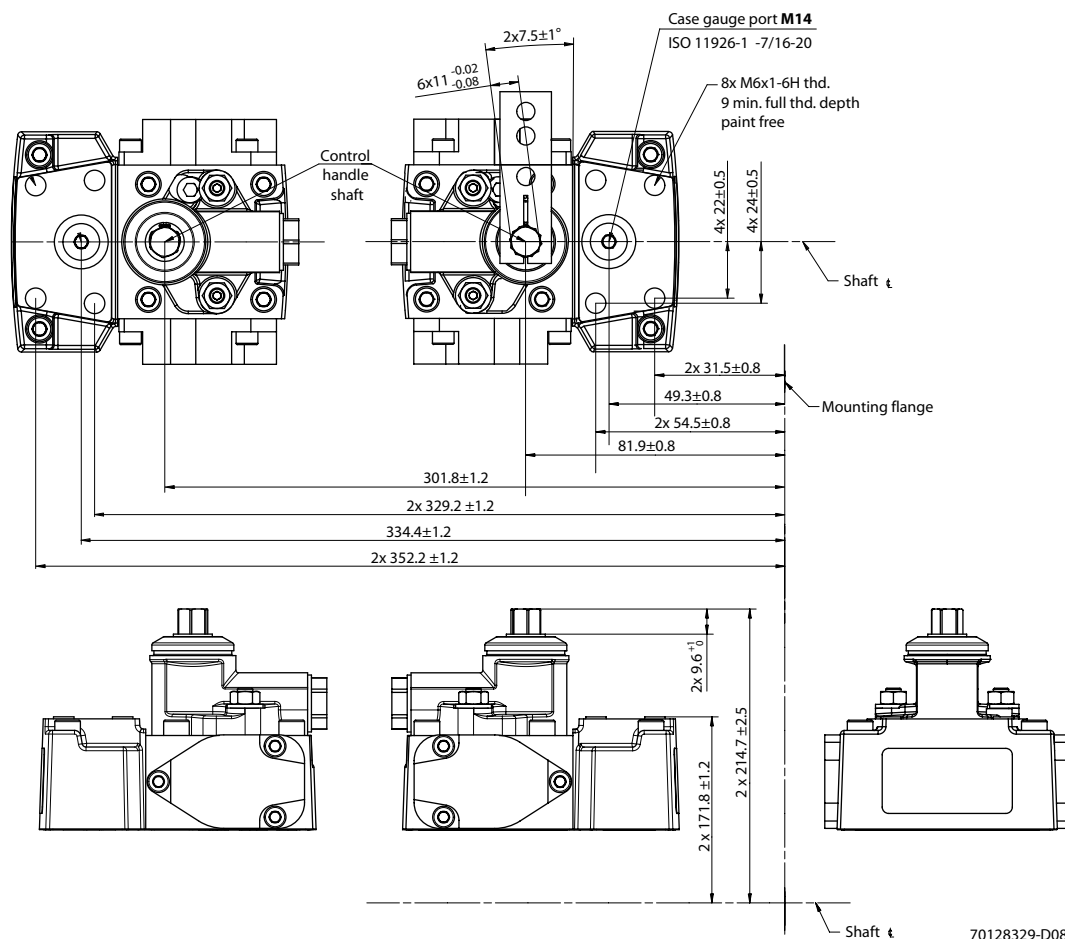
2x Case gauge port **M14**: ISO 11926-1 – 7/16 -20; Ø21.0 max clearance dia for fitting

4x Connectors Deutsch DT04-2P to be paint free

Please contact Danfoss representative for specific installation drawings.

Dimensions

Manual Displacement Control (MDC), option M1, H1T (045/053)

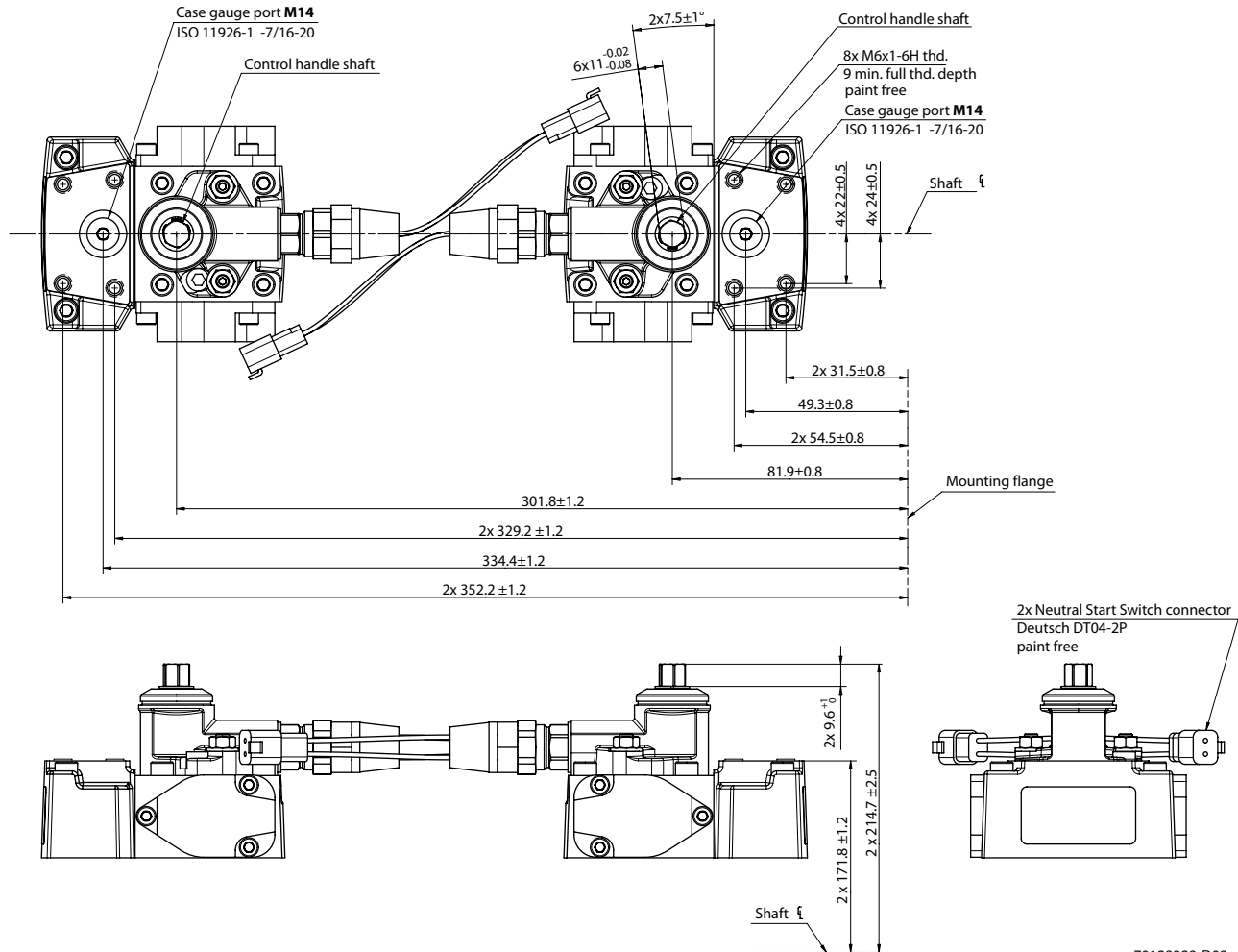


Please contact Danfoss representative for specific installation drawings.

Dimensions

Manual Displacement Control (MDC) with NSS, option M2, H1T (045/053)

H1 Tandem 045/053 Manual Displacement Control (MDC) with NSS, option M2



70128329-D09

Neutral Start Switch connector:

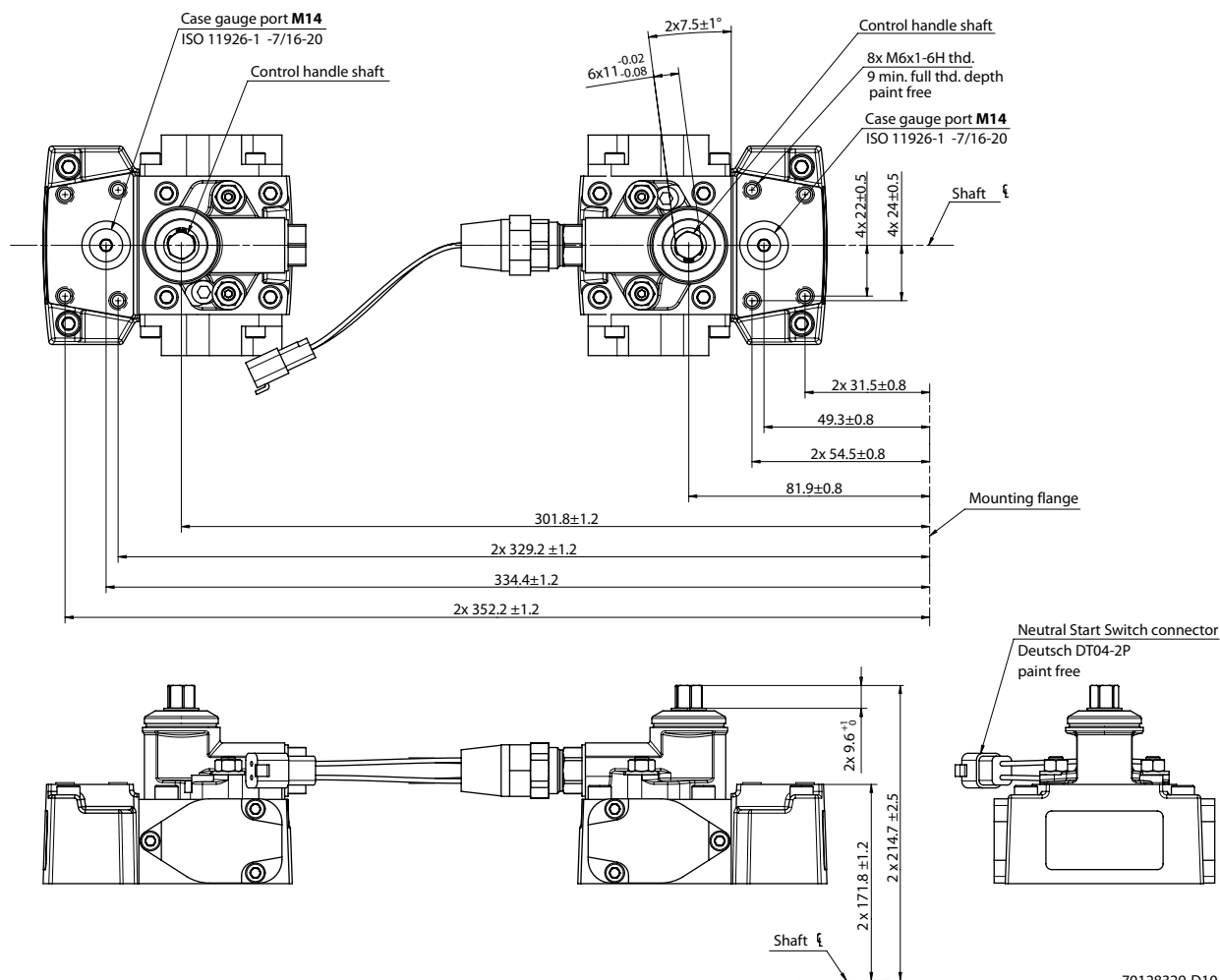
Pin	Assignment		Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions

Manual Displacement Control (MDC) with NSS, option D9, H1T (045/053)

H1 Tandem 045/053 Manual Displacement Control (MDC) with NSS, option D9



70128329-D10

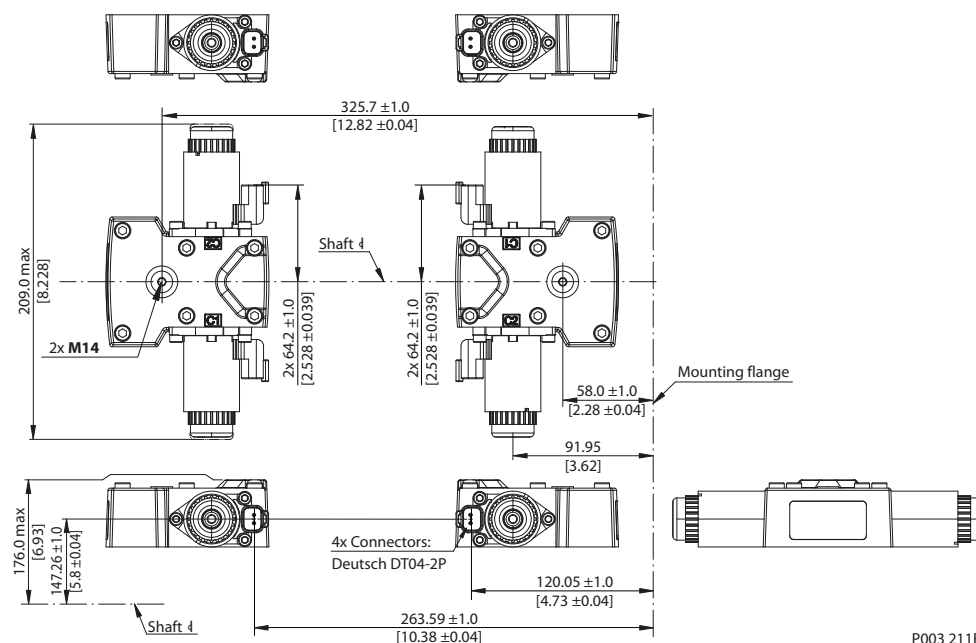
Neutral Start Switch connector:

Pin	Assignment		Pin	Assignment
1	Supply	OR	1	Ground
2	Ground		2	Supply

Please contact Danfoss representative for specific installation drawings.

Dimensions

Forward-Neutral-Reverse (FNR) with MOR, option A9 (12 V) / B1 (24 V) H1T (045/053)



P003 211E

2x Case gauge port **M14**: ISO 11926-1; $\frac{7}{16}$ -20; Ø21.0 max clearance dia for fitting.

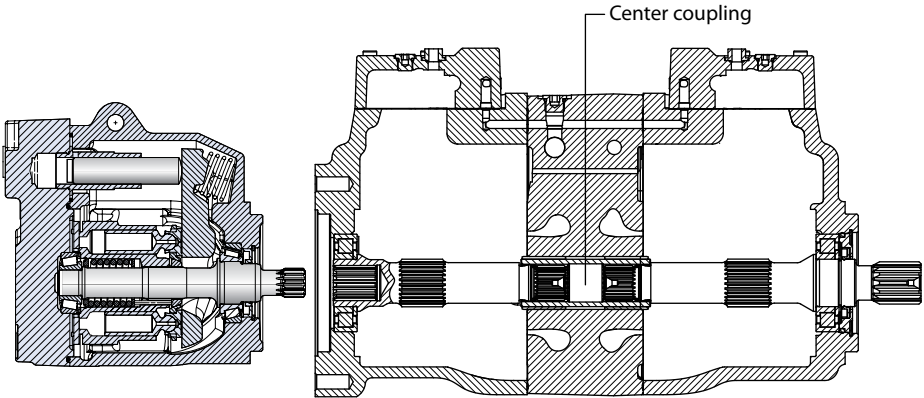
4x Connectors Deutsch DT04-2P to be paint free.

Please contact Danfoss representative for specific installation drawings.

Dimensions

Center section coupling, torque rating

Torque rating for center section coupling



P003 203E

Maximum torque for center coupling

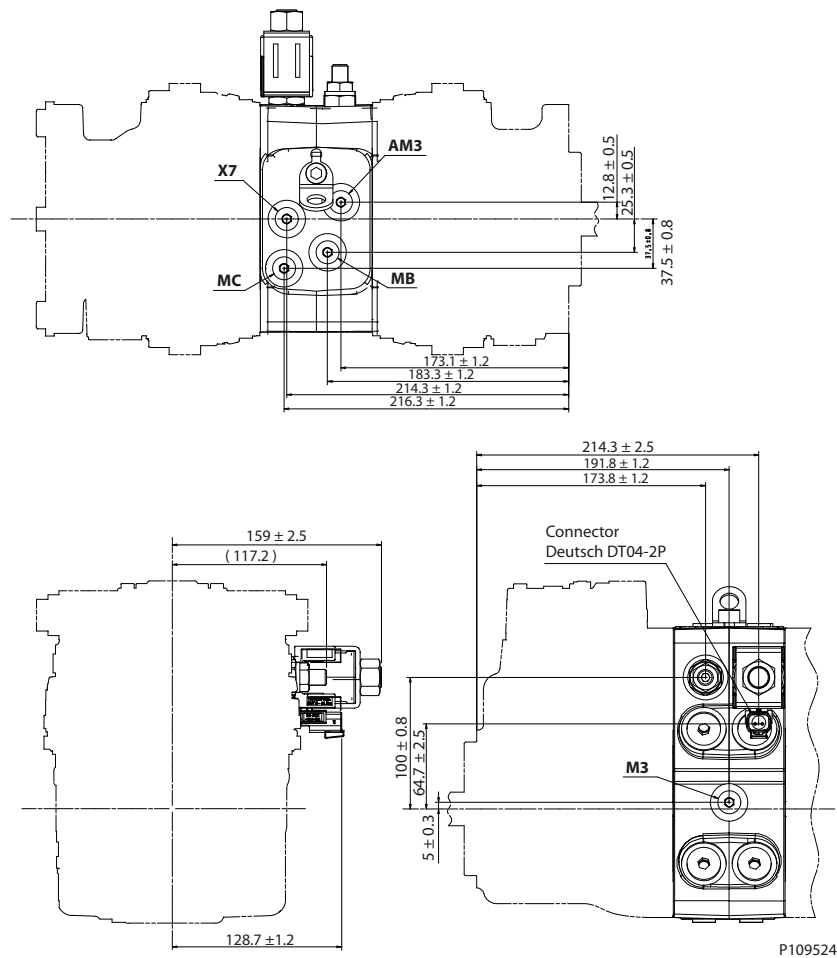
Model	Max. torque
045/053	405 N•m [3580 lbf•in]
060/068	592 N•m [5040 lbf•in]

For definitions of maximum and rated torque values, refer to *Basic Information 11062168*, section *Shaft Torque Ratings and Spline Lubrication*.

Dimensions

Control Cut Off (CCO)

045/053 CCO



Mounting flange, shaft and connector surfaces to be paint free.

Ports description, ISO 11926-1

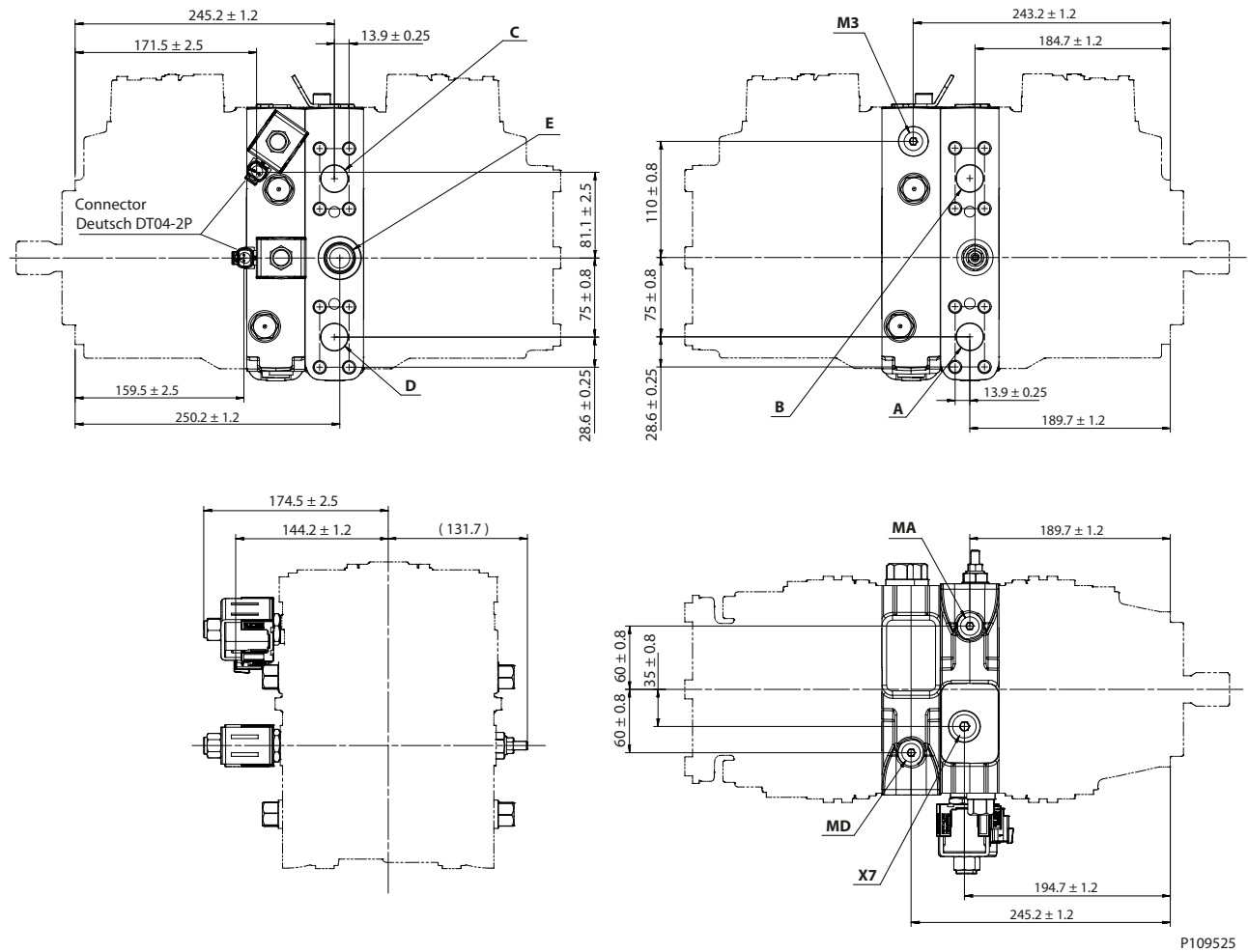
Ports	Description	Size
MB, MC	System gauge ports B, C ; Ø28 max. clearance for fitting	$\frac{9}{16}$ - 18
AM3	Charge constr. port; Ø28 max. clearance for fitting	$\frac{9}{16}$ - 18
X7	Brake gauge port	$\frac{9}{16}$ - 18
M3	Charge Gauge Port	$\frac{9}{16}$ - 18

Please contact Danfoss representative for specific installation drawings.

Technical Information
H1 Axial Piston Tandem Pumps, Size 045/053/060/068

Dimensions

060/068 CCO



P109525

Mounting flange, shaft and connector surfaces to be paint free.

Ports description, ISO 11926-1

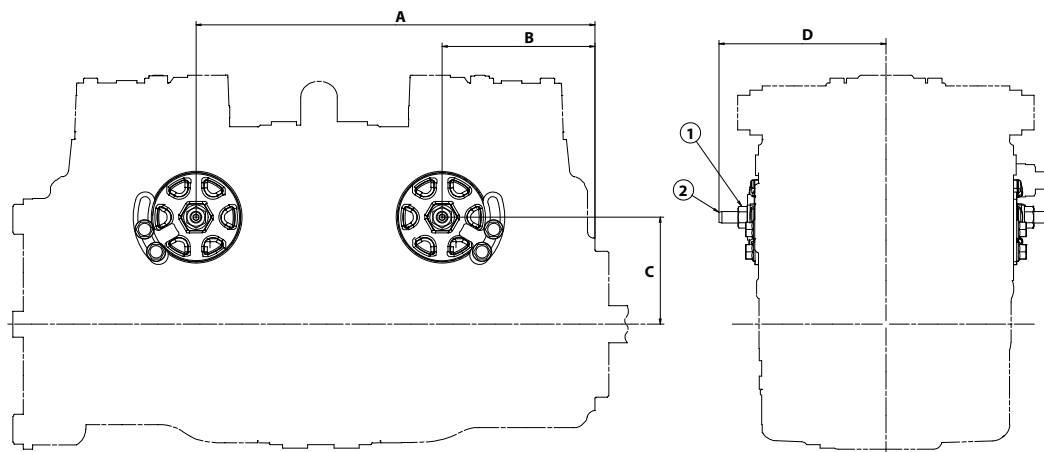
Ports	Description	Size
MA, MD	System gauge ports A, D	$\frac{9}{16}$ - 18
E	Charge inlet port	$1\frac{1}{16}$ - 12
X7	Brake gauge port	$\frac{3}{4}$ - 16
M3	Charge Gauge Port	$\frac{9}{16}$ - 18

Please contact Danfoss representative for specific installation drawings.

Dimensions

Displacement limiter, H1 Tandem, option B

045/053 shown



P109539

	Description	Wrench size	Torque
1	Seal nut	13 mm external hex	23 Nm [17 lbf·ft]
2	Adjustment screw	4 mm internal hex	-

Dimensions

	045/053	060/068
A	277.4 ± 1.2	314 ± 1.2
B	106.2 ± 0.8	120 ± 1.2
C	74.4 ± 0.8	79.5 ± 0.8
D	(116.1)	128.2

Please contact Danfoss representative for specific installation drawings.

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