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fast forward thinking

shhark®

Aluminum Low Noise Gear Pump Group 2 | Technical Information

shhark
when less is more

History of revisions

Date	Page	Changed	Rev.
March 2016	ALL	First release	A

Reference documents

Title	Type	Order number
Hydraulic Fluids and Lubricants	Technical Information	L1021414
Group 2 Gear Pumps	Technical Information	L1016341

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shhark® Low Noise technology

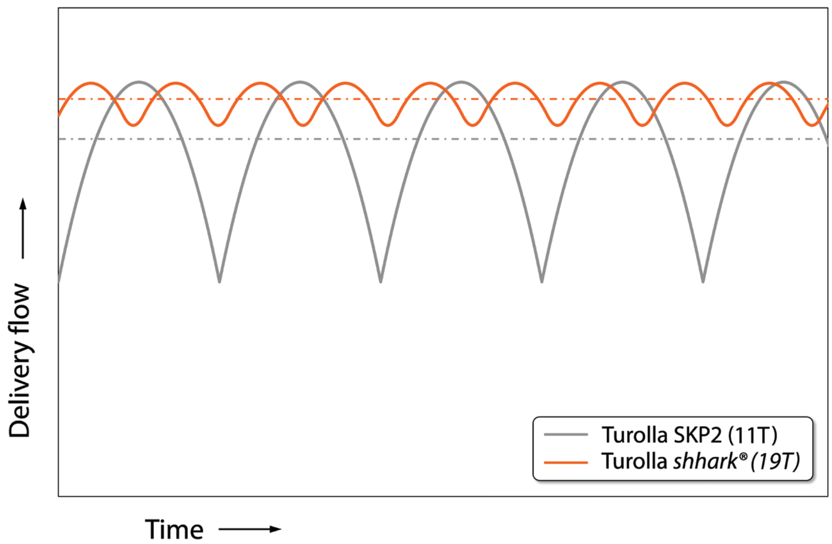
The standard technology currently used in low noise gear pumps is based on double-flank contact. This solution reduces the peak-to-peak flow pulsation by 75% compared to a single-flank contact gear pump with the same number of teeth.

Turolla *shhark*® aims to the same reduction of flow pulsation, but in a totally different way. As illustrated below, for the same outer diameter, *shhark*® gear features almost twice as many teeth of a standard pump gear, thanks to a revolutionary design of asymmetric tooth profile. Moreover, the *shhark*® teeth are also slightly helical; the small helix angle does not generate any additional axial load but makes the flow characteristic smoother, further reducing the flow pulsation.

Standard Gear Pump (11T) | Turolla *shhark*®

standard gears vs *shhark*®

The comparison between the flow characteristic of Turolla SKP2 (11-teeth) and *shhark*® (19-teeth) is illustrated in the plot below: the reduction of peak-to-peak flow pulsation is 78%. In addition, the average flow per unit width of *shhark*® is approximately 2.7% higher than SKP2; this means that for the exact same pump's dimensions, *shhark*® delivers more flow.



Flow characteristics of Turolla *shhark*® vs SKP2

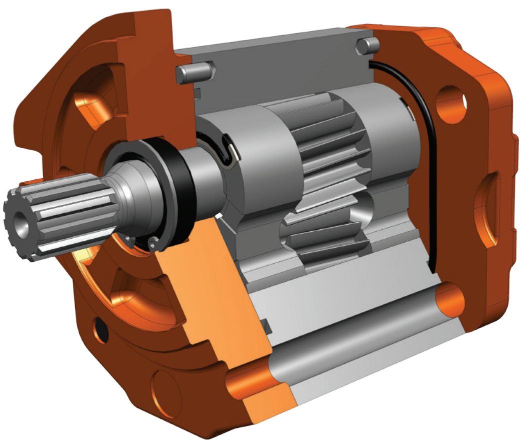
Advantage of *shhark*® vs the "double-flank contact" technology

The effectiveness of double-flank contact is very likely to decrease throughout the pump's life, because external gear units often work at high pressure with high level of contaminants in the hydraulic fluid. In such conditions the critical components of the rotating kit slowly wear out, with a progressive loss of the double-flank contact condition and with it, the low noise performance.

shhark® does not rely on any short-lived condition as double-flank contact, because the reduction of flow pulsation is achieved through the increased number of teeth. The clearances associated with the meshing of *shhark*® gears are of the same order of magnitude of standard gear pumps. Therefore **the noise performance of *shhark*® remains constant throughout the pump's life**.

Pump design

In terms of rated **operating range** (speed, pressure and temperature), **overall dimensions** and **available configurations** *shhark*® has been design to be essentially a low noise version of SKP2. The 20 mm shaft can accommodate any type of drive end, such as SA(SAE 9T-16/32), SB(SAE 11T-16/32), AA (Taper 1:5), BA(Taper 1:8), GA(Parallel SAE Ø15.875), CA(Tang 8x17.8). As for SKP2, the hydrostatic compensation system is on the bearing blocks, to ensure high efficiency and also more compact tandem combinations and higher flexibility to distribution.



SHHP2NN 06SA - cutaway view

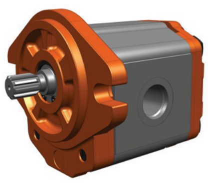
Features and benefits

- Wide range of displacements from 6.18cc/rev to 25.94cc/rev
- Rated pressure up to 250 bar
- Operating speed up to 4000 rpm
- SAE, DIN and European standard mounting flanges and shafts
- Compact and lightweight
- Multiple pump configurations, also available with standard gear products such as SNP1NN, SNP2NN, SKP2NN and SNP3NN
- Available with integral relief valve

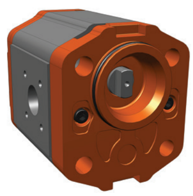
Many combinations of the pumps mentioned are available as multiple units made to fit any need.

shhark® gear pumps representatives:

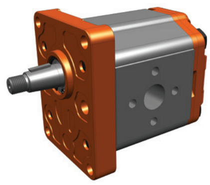
SHHP2NN 06SA



SHHP2NN 03CA



SHHP2NN 01BA



Technical Data

Technical Data

Frame size		8,0	011	014	017	019	022
Displacement	cm³/rev [in³/rev]	8.7 [0.53]	11.1 [0.68]	14.8 [0.90]	17.3 [1.06]	19.8 [1.21]	23.5 [1.43]
SHHP2NN							
Peak pressure	bar [psi]	280 [4060]	280 [4060]	280 [4060]	280 [4060]	260 [3770]	230 [3335]
Rated pressure	bar [psi]	250 [3625]	250 [3625]	250 [3625]	250 [3625]	240 [3480]	210 [3045]
Minimum speed at 0-100 bar	min^{-1} (rpm)	600	500	500	500	500	500
Minimum speed at 100-180 bar	min^{-1} (rpm)	1000	800	750	750	700	700
Min. speed at 180 bar to rated pressure	min^{-1} (rpm)	1400	1200	1000	1000	1000	800
Maximum speed	min^{-1} (rpm)	4000	4000	3500	3000	3000	3000

6,0 and 025 frame size are available upon request

1 kg•m² = 23.68 lb•ft²

Frame size		8,0	011	014	017	019	022
SHHP2							
Weight	Kg [lb]	2.5 [5.5]	2.7 [5.8]	2.9 [6.3]	3.0 [6.5]	3.1 [6.7]	3.2 [7.0]
Moment of inertia of rotating components	x 10^{-6} Kg•m² [x 10^{-6} lb•ft²]	32.4 [769]	38.4 [911]	47.3 [1122]	53.3 [1265]	59.2 [1405]	68.1 [1616]
Theoretical flow at maximum speed	l/min [US gal/min]	34.8 [9.2]	44.4 [11.7]	51.8 [13.7]	51.9 [13.7]	59.4 [15.7]	70.5 [18.6]

1 kg•m² = 23.68 lb•ft²

Caution

The rated and peak pressure mentioned are for pumps with flanged ports only. When threaded ports are required a de-rated performance has to be considered. To verify the compliance of an high pressure application with a threaded ports pump apply to a Turolla representative.

Product code single pumps
Model code

A / B C D E F G H I J K L / M N 0

A Family

SHHP2NN	Low Noise Group 2 Pump
SHHP2EN	Low Noise Group 2 Pump + Ext.Drain RV *
SHHP2IN	Low Noise Group 2 Pump + Int.Drain RV

*For this option please contact your Turolla representative

B Frame sizes and displacement

8,0	Displacement 8.7cc
011	Displacement 11.1cc
014	Displacement 14.8cc
017	Displacement 17.3cc
019	Displacement 19.8cc
022	Displacement 23.5cc

* Other frame sizes and displacements are available upon request

C Rotation

R	Right (Clockwise)
L	Left (Counterclockwise)

D Project version

N	Standard gear pump

A	B	C	D	E	F	G	H	I	J	K	L	M	N	0
/											/			

E Mounting flange

Code	Description (Type of flange • Type of drive gear • Preferred ports for configuration)
01	pilot Ø36,5+4 holes
02	pilot Ø80+4 holes
03	pilot Ø52+O-ring+4 holes through body
04	pilot Ø50+2 holes through body
A4	pilot Ø50+2 holes through body+seal on pilot
05	pilot Ø50+2 holes through body
06	SAE A pilot Ø82,55+2 holes
A6	SAE A pilot Ø82,55+2 holes+seal on pilot

F Drive gear

AA	Taper 1:5-M12x1,25-Key 3
BA	Taper 1:8-M12x1,25-Key 4
CA	Tang 8x Ø17,8xL6,5
GA	Parallel SAE Ø15,875-L23,8-Key 4x18
SA	Spline SAE J498-9T-16/32
SB	Spline SAE J498-11T-16/32

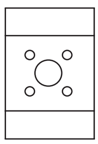
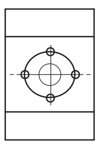
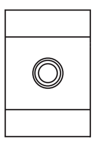
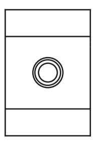
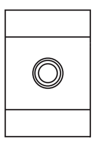
For options not listed here, please apply/refer to your Turolla representative.

A / B C D E F G H I J K L / M N 0

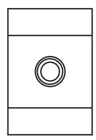
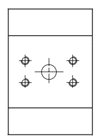
G	Rear cover

E1	Cover pump with relief valve with external drain 3/8 Gas
E3	Cover pump for RV with ext. drain 3/8 Gas with M5 Holes
I1	Cover pump for RV with int. drain
I3	Cover pump for RV with int. drain with M5 Holes
P1	Standard cover for pump
P3	Standard cover for pump with M5 Holes

H Inlet size

B5	15x35xM6	
B6	15x40xM6	
B7	20x40xM6	
C3	13,5x30xM6	
C5	13,5x40xM8	
C7	20x40xM8	
D5	M18x1,5	
D7	M22x1,5	
E4	3/4-16UNF	
E5	7/8-14UNF	
E6	1-1/16-12UN	
F3	3/8 GAS	
F4	1/2 GAS	
F5	3/4 GAS	
F6	1 GAS	

I Outlet size

H5	M18x1,5-ISO6149	
H7	M22x1,5-ISO6149	
H8	M27x2-ISO6149	
H9	M33x2-ISO6149	
MB	12x38,1x17,48xM8(=)	
MC	18,5x47,63x22,23xM6(=)	
MD	18,5x47,63x22,23xM8(=)	
ME	18,5x47,63x22,23xM10(=)	
MG	25/20x52,37x26,19xM10(=)	
NN	Without outlet port	

A	/	B	C	D	E	F	G	H	I	J	K	L	/	M	N	0
	/												/			

J Ports positions & Special body

NN	Std from catalogue
YY	Port Bx-Bx with flange SAE-A;off-set to rear cover to install fitting screws

K Seals

G	Viton shaft seal + HNBR preassure seals
N	Standard NBR seals
D	VITON shaft seal

L Screws

N	Std burnished screws
A	Zinc plated screws
B	Geomet screws

M Set valve

NNN	No valve
V**	Integral relief valve pressure setting

**For details go to page 30

N Type mark

N	Standard Turolla Marking
A	Standard Turolla Marking+Customer Code
Z	Without Marking

O Mark position

N	Std Marking position (on top)
A	Special Marking position on the bottom

Product code tandem pumps
Model code

A	/	B	B1	C	D	E	F	G	H	I	J	H1	I1	J1	K
	/														

L	/	M	N	0
	/			

A Family

PKK	SHHW2NN+SHHP2NN
PKL	SHHW2NN+SKP2NN
PLK	SKW2NN+SHHP2NN
EKK	SHHW2NN+SHHP2EN
EKL	SHHW2NN+SKP2EN
ELK	SKW2NN+SHHP2EN
IKK	SHHW2NN+SHHP2IN
IKL	SHHW2NN+SKP2IN
ILK	SKW2NN+SHHP2IN

B Available frame sizes and displacements for SHHP2*

017	Displacement 17.3cc
019	Displacement 19.8cc
022	Displacement 23.5cc

* Other frame sizes and displacements are available upon request

B1 Available frame sizes and displacements for SHHP2

8,0	Displacement 8.7cc
011	Displacement 11.1cc
014	Displacement 14.8cc
017	Displacement 17.3cc
019	Displacement 19.8cc
022	Displacement 23.5cc

* Other frame sizes and displacements are available upon request

C Rotation

R	Right (Clockwise)
L	Left (Counterclockwise)

D Project version

N	Standard gear pump

A	B	B1	C	D	E	F	G	H	I	J	H1	I1	J1	K
/														

L	M	N	0
/			

E Mounting flange

Code	Description (Type of flange • Type of drive gear • Preferred ports for configuration)
01	pilot Ø36,5+4 holes
02	pilot Ø80+4 holes
04	pilot Ø50+2 holes through body
A4	pilot Ø50+2 holes through body+seal on pilot
05	pilot Ø50+2 holes through body
06	SAE A pilot Ø82,55+2 holes
A6	SAE A pilot Ø82,55+2 holes+seal on pilot

F Drive gear

AG	Taper 1:5-M12x1,25-Key 3
BQ	Taper 1:8-M12x1,25-Key 4
SM	Spline SAE J498-9T-16/32
SS	Spline SAE J498-11T-16/32

For options not listed here, please apply/refer to your Turolla representative.

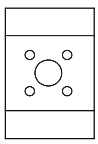
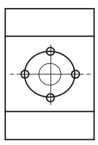
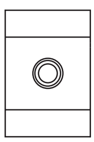
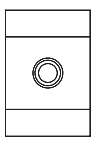
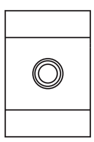
A	B	B1	C	D	E	F	G	H	I	J	H1	I1	J1	K
☐☐☐ /	☐☐☐	☐☐☐	☐	☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐☐	☐

L	M	N	0
☐ /	☐☐☐	☐	☐

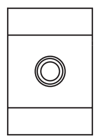
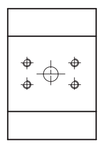
G Rear cover

E1	Cover pump with relief valve with external drain 3/8 Gas
E3	Cover pump for RV with ext. drain 3/8 Gas with M5 Holes
I1	Cover pump for RV with int. drain
I3	Cover pump for RV with int. drain with M5 Holes
P1	Standard cover for pump
P3	Standard cover for pump with M5 Holes

H H1 Inlet size

B5	15x35xM6	
B6	15x40xM6	
B7	20x40xM6	
C3	13,5x30xM6	
C5	13,5x40xM8	
C7	20x40xM8	
D5	M18x1,5	
D7	M22x1,5	
E4	3/4-16UNF	
E5	7/8-14UNF	
E6	1-1/16-12UN	
F3	3/8 GAS	
F4	1/2 GAS	
F5	3/4 GAS	
F6	1 GAS	

I I1 Outlet size

H5	M18x1,5-ISO6149	
H7	M22x1,5-ISO6149	
H8	M27x2-ISO6149	
H9	M33x2-ISO6149	
MB	12x38,1x17,48xM8(=)	
MC	18,5x47,63x22,23xM6(=)	
MD	18,5x47,63x22,23xM8(=)	
ME	18,5x47,63x22,23xM10(=)	
MG	25/20x52,37x26,19xM10(=)	
NN	Without outlet port	

A	B	B1	C	D	E	F	G	H	I	J	H1	I1	J1	K
||| /	|||													

L	M	N	0
/			

J J1 Ports positions & Special body

NN	Std from catalogue
YY	Port Bx-Bx with flange SAE-A;off-set to rear cover to install fitting screws

K Seals

G	Viton shaft seal + HNBR preassure seals
N	Standard NBR seals
D	VITON shaft seal

L Screws

N	Zinc kit studs

N Type mark

N	Standard Turolla Marking
A	Standard Turolla Marking+Customer Code
Z	Without Marking

M Set valve

NNN	No valve
V**	Integral relief valve pressure setting

**For details go to page 30

O Mark position

N	Std Marking position (on top)
A	Special Marking position on the bottom

Determination of nominal pump sizes

Based on SI units/based on US units

Use these formulae to determine the nominal pump size for a specific application.

	Based on SI units	Based on US units
Output flow	$Q = \frac{Vg \cdot n \cdot \eta_v}{1000}$ l/min	$Q = \frac{Vg \cdot n \cdot \eta_v}{231}$ [US gal/min]
Input torque	$M = \frac{Vg \cdot \Delta p}{20 \cdot \pi \cdot \eta_m}$ N•m	$M = \frac{Vg \cdot \Delta p}{2 \cdot \pi \cdot \eta_m}$ [lbf•in]
Input power	$P = \frac{M \cdot n}{9550} = \frac{Q \cdot \Delta p}{600 \cdot \eta_t}$ kW	$P = \frac{M \cdot n}{63.025} = \frac{Q \cdot \Delta p}{1714 \cdot \eta_t}$ [hp]

Variables: *SI units [US units]*

V_g	=	Displacement per rev.	cm^3/rev [in^3/rev]
p_{HD}	=	Outlet pressure	bar [psi]
p_{ND}	=	Inlet pressure	bar [psi]
Δp	=	$p_{HD} - p_{ND}$	bar [psi]
n	=	Speed	min^{-1} (rpm)
η_v	=	Volumetric efficiency	
η_m	=	Mechanical (torque) efficiency	
η_t	=	Overall efficiency ($\eta_v \cdot \eta_m$)	

System requirements

Inlet pressure

Inlet vacuum must be controlled in order to preserve expected pump's life and performance. The system design must meet inlet pressure requirements during all operation modes. Expected lower inlet pressures during cold start will be improved as soon as the fluid warms.

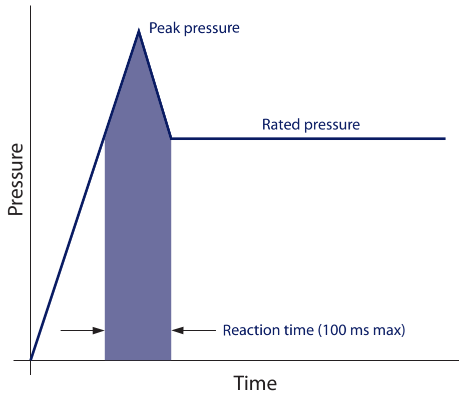
Peak pressure is the highest intermittent pressure allowed at the pump's outlet. Peak pressure depens on the relif valve over shoot (reaction time). The illustration to the right shows peak pressure in relation to rated pressure and reaction time (100 ms maximum).

Rated pressure is the max continous operating pressure.
The maximum machine load demand determines rated pressure.

Inlet pressure

Max. continuous vacuum	bar abs.	0.7 [20.7]
Max. pressure	[in. Hg]	4.0 [118.1]

Time versus pressure

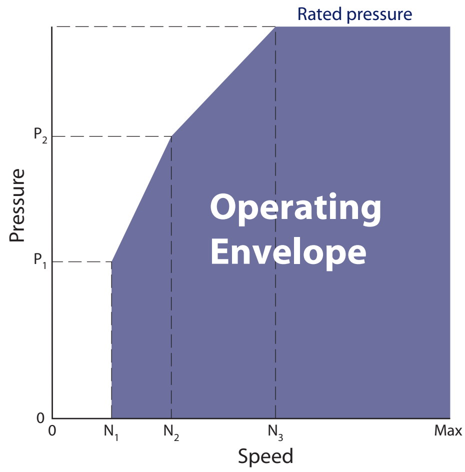


Speed

Maximum speed is the limit recommended by Turolla for a particular gear pump when operating at rated pressure. It is the highest speed at which normal life can be expected.

The lower limit of operating speed is the **minimum speed**. It is the lowest speed at which normal life can be expected. The minimum speed increases as operating pressure increases. When operating under higher pressures, a higher minimum speed must be maintained, as illustrated to the right.

Speed versus pressure



Where:
N_1 = Minimum speed at 100 bar
N_2 = Minimum speed at 180 bar
N_3 = Minimum speed at rated pressure

Hydraulic fluids

Ratings and data for *shhark*® are guaranteed when the hydraulic pump works with premium hydraulic fluids containing oxidation, rust, and foam inhibitors. These fluids have to work with good thermal and hydrolytic stability to prevent wear, erosion, and corrosion of internal components. They include:

- Hydraulic fluids following DIN 51524, part 2 (HLP) and part 3 (HVLP) specifications
- API CD engine oils conforming to SAE J183
- M2C33F or G automatic transmission fluids
- Certain agricultural tractor fluids

Please see Turolla publication Hydraulic Fluids and Lubricants Technical Information, **L1021414** for more information.

Caution

Never mix hydraulic fluids.

Temperature and viscosity

Temperature and viscosity requirements must be concurrently satisfied. Use petroleum / mineral-based fluids.

High temperature limit apply at the inlet port of the pump. The pump should run at or below the maximum continuous temperature. The peak temperature is based on material properties. Don't exceed it.

Cold oil, generally, doesn't affect the durability of pump components. It may affect the ability of oil to flow and transmit power. For this reason, keep the temperature at 16 °C [60 °F] above the pour point of the hydraulic fluid.

Minimum viscosity

It occurs only during brief occasions of maximum ambient temperature and severe duty cycle operation.

Maximum viscosity

It occurs only at cold start. During this condition, limit speeds until the system warms up.

Size heat exchangers to keep the fluid within these limits. Test regularly to verify that these temperatures and viscosity limits aren't exceeded. For maximum unit efficiency and bearing life, keep the fluid viscosity in the recommended viscosity range.

Fluid viscosity

Maximum (cold start)	mm^2/s [SUS]	1000 [4600]
Recommended range		12-60 [66-290]
Minimum		10 [60]

Temperature

Minimum (cold start)	°C [°F]	-20 [-4]
Maximum continuous		80 [176]
Peak (intermittent)		90 [194]

Filtration

Filters

Use a filter that conforms to Class 22/18/13 of ISO 4406 (or better). It may be on the pump outlet (pressure filtration), inlet (suction filtration), or reservoir return (return-line filtration).

Recommendations and remarks

When selecting a filter, please consider:

- Contaminant ingression rate
  (determined by factors such as the number of actuators used in the system)
- Generation of contaminants in the system
- Required fluid cleanliness
- Desired maintenance interval
- Filtration requirements of other system components

Measure filter efficiency with a Beta ratio (β_X). For:

- Suction filtration, with controlled reservoir ingression, use a $\beta_{35\text{-}45} = 75$ filter
- Return or pressure filtration, use a pressure filtration with an efficiency of $\beta_{10} = 75$.

βx ratio is a measure of filter efficiency defined by ISO 4572. It is 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 cleanliness level and βx ratio

Fluid cleanliness level (per ISO 4406)	Class 22/18/13 or better
β_x ratio (suction filtration)	$\beta_{35\text{-}45} = 75$ and $\beta_{10} = 2$
β_x ratio (pressure or return filtration)	$\beta_{10} = 75$
Recommended inlet screen size	100-125 µm [0.004-0.005 in]

The filtration requirements for each system are unique. Evaluate filtration system capacity by monitoring and testing prototypes.

Reservoir

The **reservoir** provides clean fluid, dissipates heat, removes entrained air, and allows fluid volume changes associated with fluid expansion and cylinder differential volumes. A correctly sized reservoir accommodates maximum volume changes during all system operating modes. It promotes de-aeration of the fluid as it passes through, and accommodates a fluid dwell-time between 60 and 180 seconds, allowing entrained air to escape.

Minimum reservoir capacity depends on the volume required to cool and hold the oil from all retracted cylinders, allowing for expansion due to temperature changes. A fluid volume of 1 to 3 times the pump output flow (per minute) is satisfactory. The minimum reservoir capacity is 125% of the fluid volume.

Install the suction line above the bottom of the reservoir to take advantage of gravity separation and prevent large foreign particles from entering the line. Cover the line with a 100-125 micron screen. The pump should be below the lowest expected fluid level.

Put the return-line below the lowest expected fluid level to allow discharge into the reservoir for maximum dwell and efficient deaeration. A baffle (or baffles) between the return and suction lines promotes deaeration and reduces fluid surges.

Line sizing

Choose line sizes that accommodate minimum fluid velocity to reduce system noise, pressure drops, and overheating. This maximizes system life and performance.
Design inlet piping that maintains continuous pump inlet pressure above 0.8 bar absolute during normal operation. The line velocity should not exceed the values in this table:

Maximum line speed

Inlet	m/s [ft/sec]	2.5 [8.2]
Outlet		5.0 [16.4]
Return		3.0 [9.8]

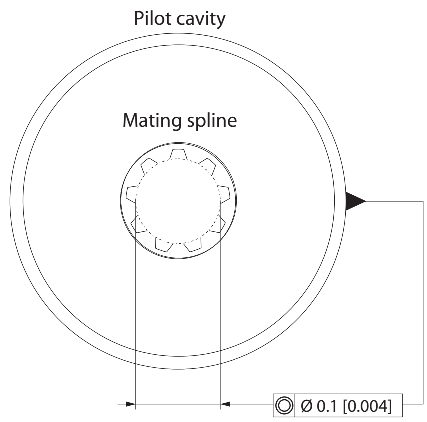
Most systems use hydraulic oil containing 10% dissolved air by volume. Under inlet vacuum conditions the oil releases the dissolved air. Moreover, when inlet vacuum is particularly severe, the hydraulic fluid may cavitate, causing adjacent metal surfaces to erode. **Over-aeration** is the result of air leaks on the inlet side of the pump, and flow-line restrictions. These include inadequate pipe sizes, sharp bends, or elbow fittings, causing a reduction of flow line cross sectional area. This problem will not occur if inlet vacuum and rated speed requirements are maintained, and reservoir size and location are adequate.

Pump drive

Shaft options for *shhark*® Group 2 gear pump include tapered, tang, splined, or parallel shafts. They are suitable for a wide range of direct and indirect drive applications for radial and thrust loads.

Plug-in drives, acceptable only with a splined shaft, can impose severe radial loads when the mating spline is rigidly supported. Increasing spline clearance does not alleviate this condition.

Use plug-in drives if the concentricity between the mating spline and pilot diameter is within 0.1 mm [0.004 in]. Lubricate the drive by flooding it with oil. A 3-piece coupling minimizes radial or thrust shaft loads.



Caution

In order to avoid spline shaft damages it is recommended to use carburized and hardened steel couplings with 80-82 HRA surface hardness.

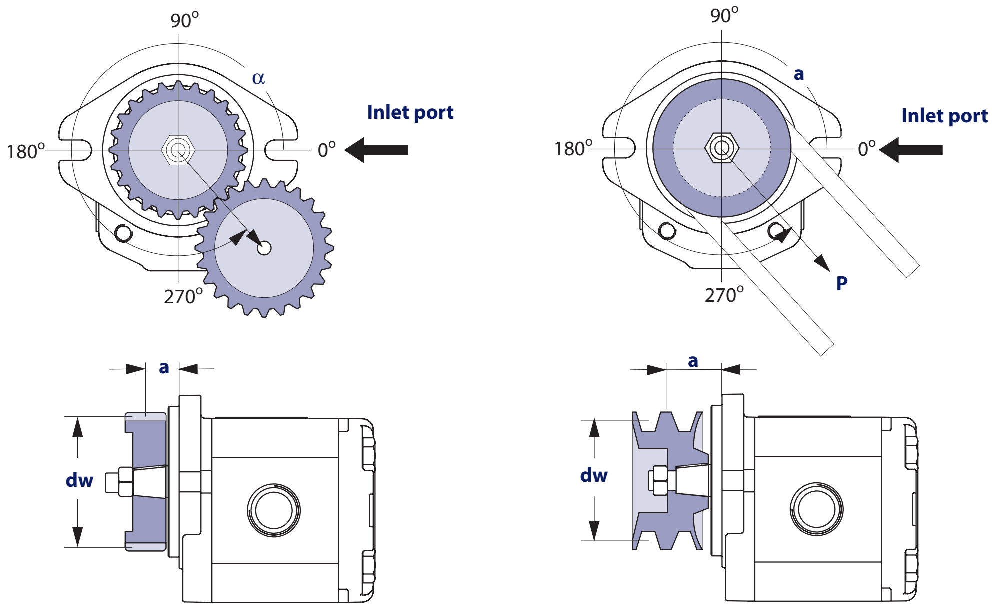
Allowable **radial shaft loads** are a function of the load position, load orientation, and operating pressure of the hydraulic pump. All external shaft loads have an effect on bearing life, and may affect pump performance.

In applications where external shaft loads can't be avoided, minimize the impact on the pump by optimizing the orientation and magnitude of the load. Use a tapered input shaft; don't use splined shafts for belt or gear drive applications. A spring-loaded belt tension-device is recommended for belt drive applications to avoid excessive tension. Avoid thrust loads in either direction. Contact Turolla if continuously applied external radial or thrust loads occur.

Fill in this page form and send it to your Turolla representative for an assistance in applying pumps with belt or gear drive. This illustration shows a pump with counterclockwise orientation:

Pump drive data form

Optimal radial load position



Application data

Item		Value	Unit
Pump displacement			cm³/rev [in³/rev]
Rated system pressure			❑ bar ❑ psi
Relief valve setting			
Pump shaft rotation			❑ left ❑ right
Pump minimum speed			min^{-1} (rpm)
Pump maximum speed			
Drive gear helix angle (gear drive only)			degree
Belt type (gear drive only)			❑ V ❑ notch
Belt tension (gear drive only)	**P**		❑ N ❑ lbf
Angular orientation of gear or belt to inlet port	α		degree
Pitch diameter of gear or pulley	$\mathbf{d}_w$		❑ mm ❑ in
Distance from flange to center of gear or pulley	**a**		

Pump life

Pump life is a function of speed, system pressure, and other system parameters (such as fluid quality and cleanliness).

All Turolla gear pumps use hydrodynamic journal bearings that have an oil film maintained between the gear/shaft and bearing surfaces at all times. If the oil film is sufficiently sustained through proper system maintenance and operating within recommended limits, long life can be expected.

B_{10} life expectancy number is generally associated with rolling element bearings. It does not exist for hydrodynamic bearings.

High pressure, resulting from high loads, impacts pump life. When submitting an application for review, provide machine duty cycle data that includes percentages of time at various loads and speeds. We strongly recommend a prototype testing program to verify operating parameters and their impact on life expectancy before finalizing any system design.

Sound levels

Fluid power systems are inherent generators of noise. As with many high power density devices, noise is an unwanted side effect. However, there are many techniques available to minimize noise associated with fluid power systems. To apply these methods effectively, it is necessary to understand how the noise is generated and how it reaches the listener. The noise energy can be transmitted away from its source as either fluid borne noise (pressure ripple) or as structure borne noise.

Pressure ripple is the result of the number of pumping elements (gear teeth) delivering oil to the outlet and the pump's ability to gradually change the volume of each pumping element from high to low pressure. In addition, the pressure ripple is affected by the compressibility of the oil as each pumping element discharges into the outlet of the pump. Pressure pulsations will travel along the hydraulic lines at the speed of sound (about 1400 m/s in oil) until affected by a change in the system such as an elbow fitting. Thus the pressure pulsation amplitude varies with overall line length and position.

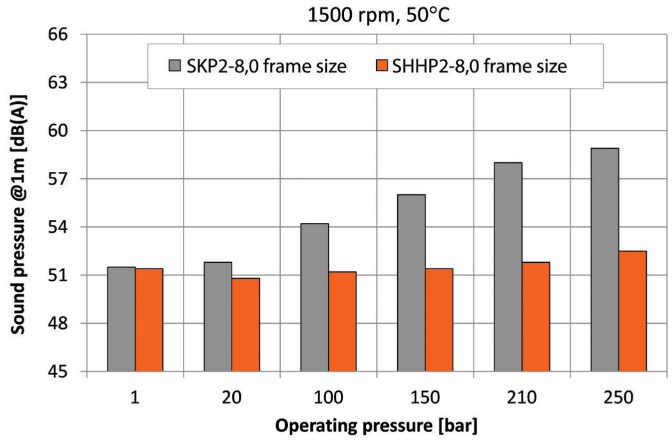
Structure borne noise may be transmitted wherever the pump casing is connected to the rest of the system. The response of one circuit component to excitation depends on its size, form, and manner in which it is mounted or supported. Because of this excitation, a system line may actually have a greater noise level than the pump. To reduce this excitation, use flexible hoses in place of steel plumbing. If steel plumbing must be used, clamping of lines is recommended. To minimize other structure borne noise, use flexible (rubber) mounts.

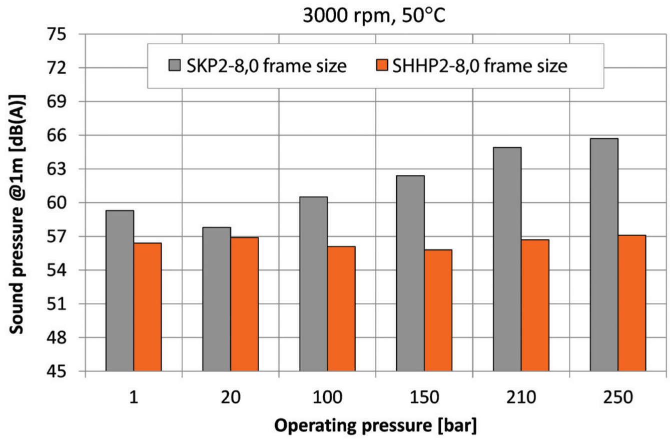
The accompanying graph shows typical sound pressure levels for SHHP2NN and SKP2NN pumps (with SAE A flange and spline shaft) expressed in dB(A) at 1 m [3.28 ft] from the unit.
Data were taken using ISO VG46 petroleum /mineral based fluid at 50°C (viscosity at 28 mm2/s [cSt]).

Contact your Turolla representative for assistance with system noise control.

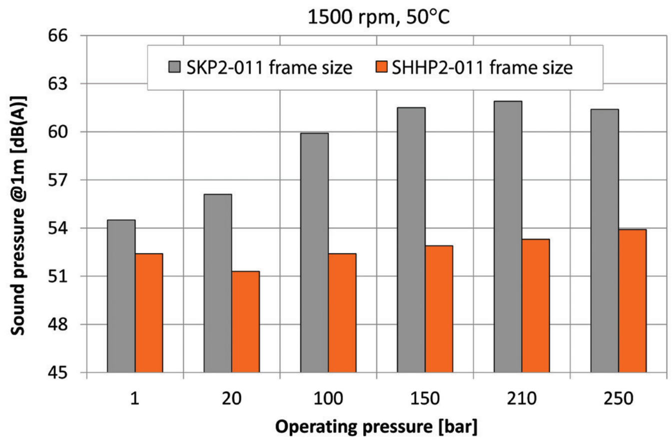
Sound level graphs

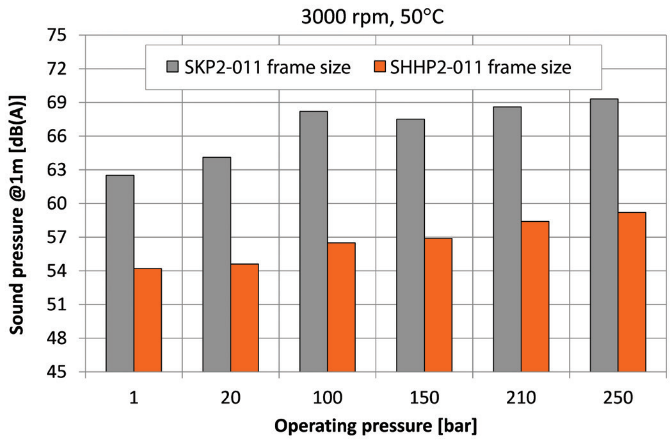
Sound levels graph 8,0 frame size



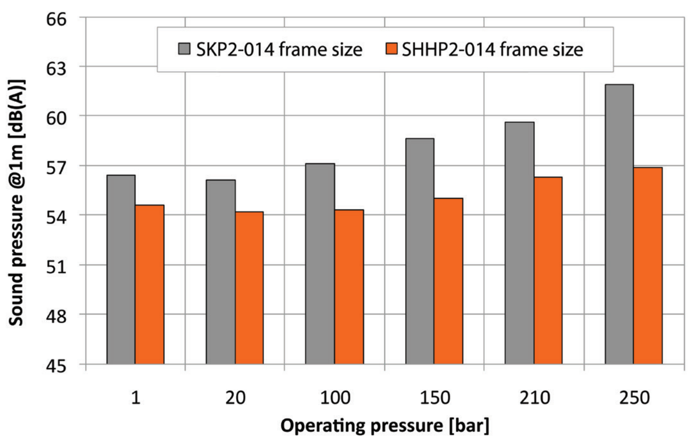


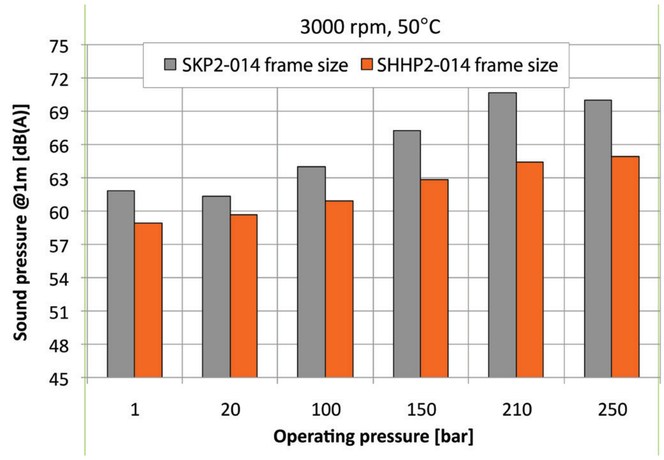
Sound levels graph 011 frame size



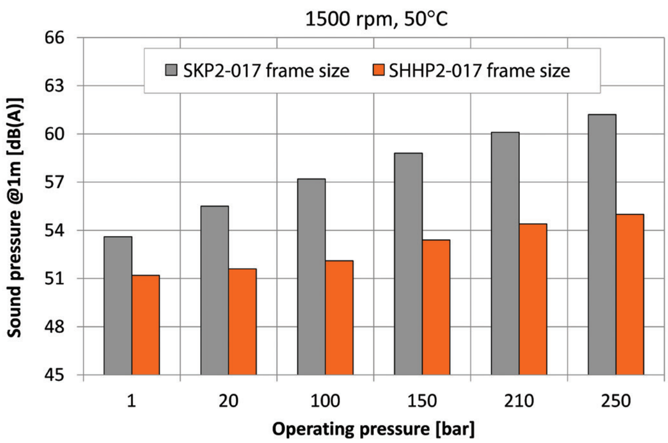


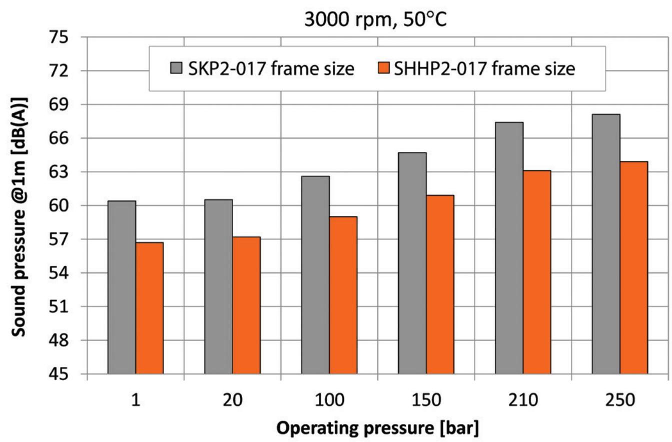
Sound levels graph 014 frame size



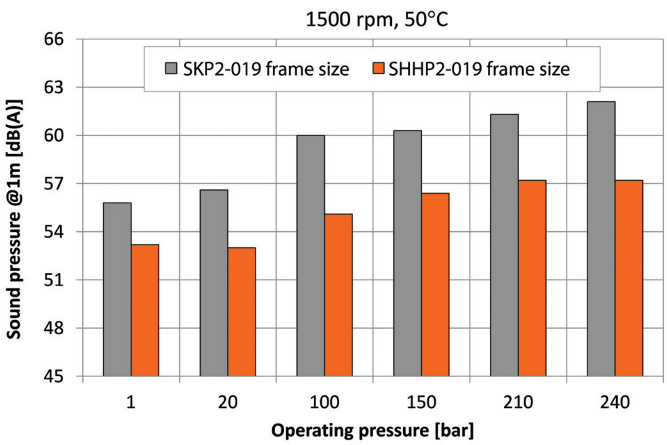


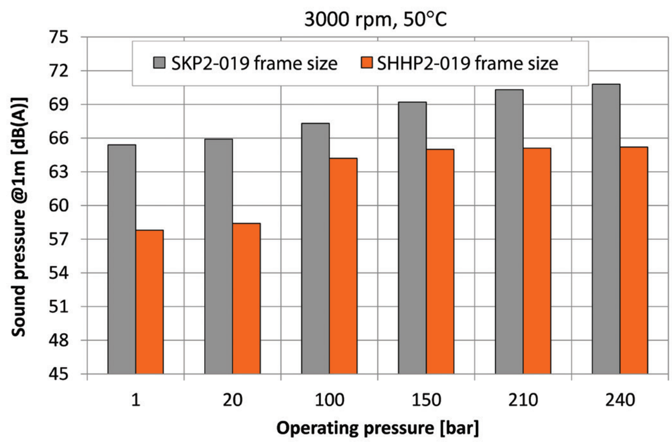
Sound levels graph 017 frame size



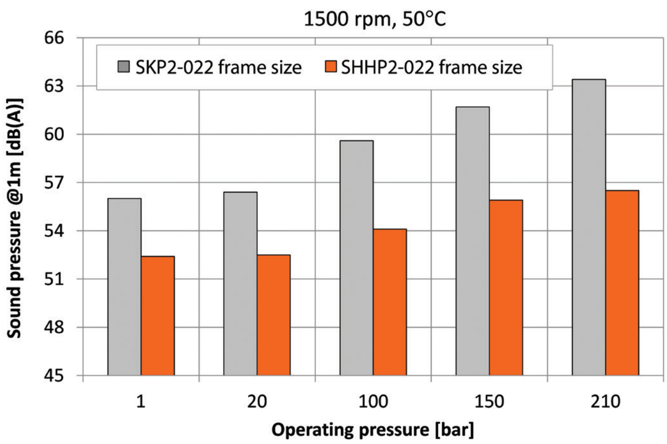


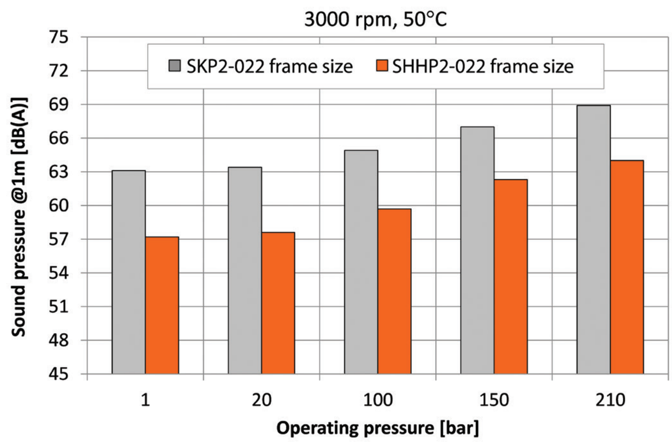
Sound levels graph 019 frame size





Sound levels graph 022 frame size



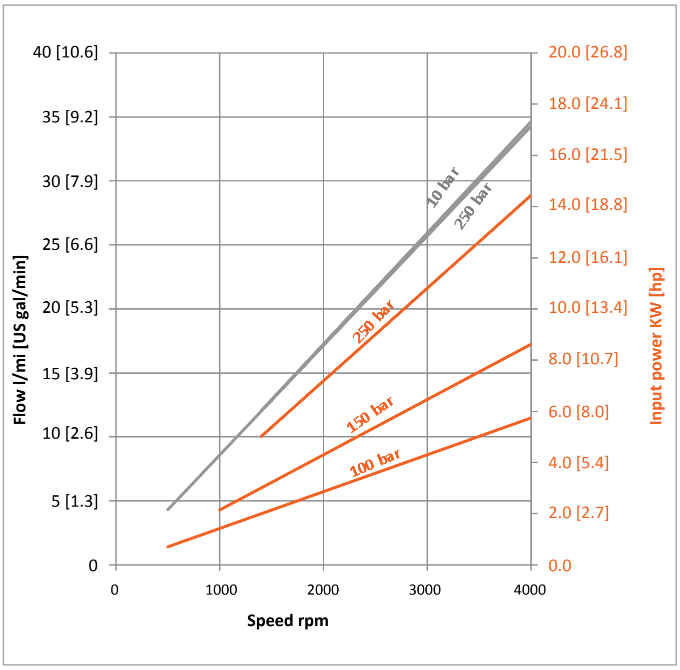


Pump Performance

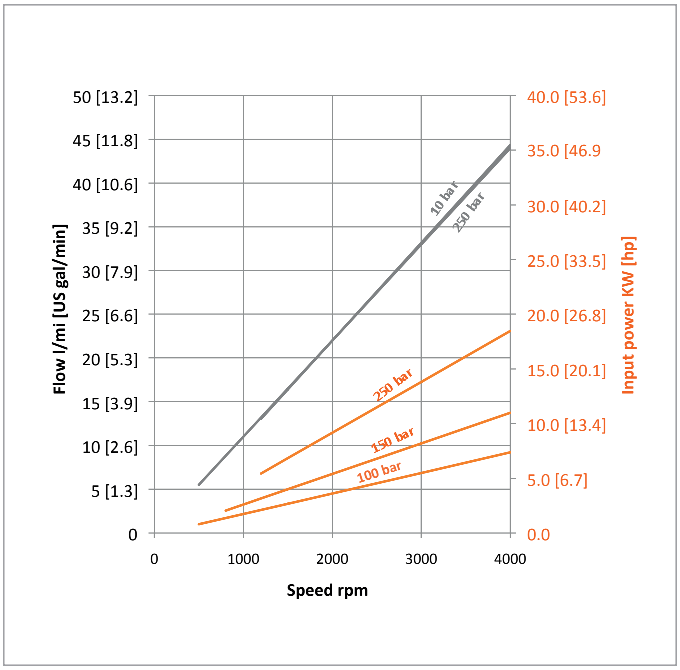
Performance graphs

The graphs on the next pages provide typical output flow and input power for *shhark*® pumps at various working pressures. Data were taken using ISO VG46 petroleum /mineral based fluid at 50 °C (viscosity at 28 mm²/s [cSt]).

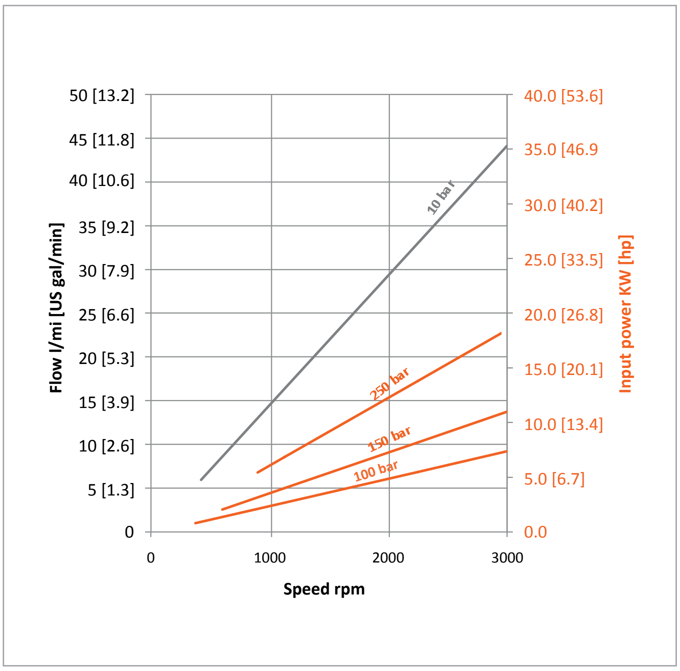
Performance graph for 8,0 frame size



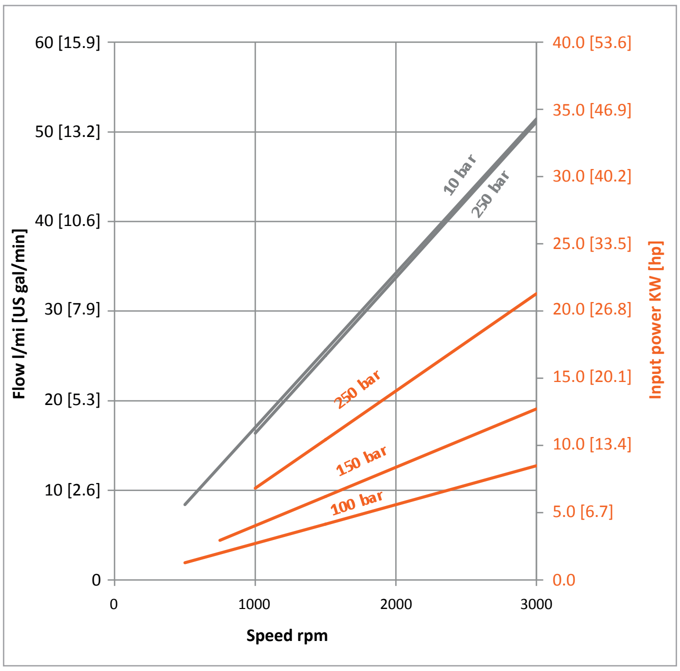
Performance graph for 011 frame size



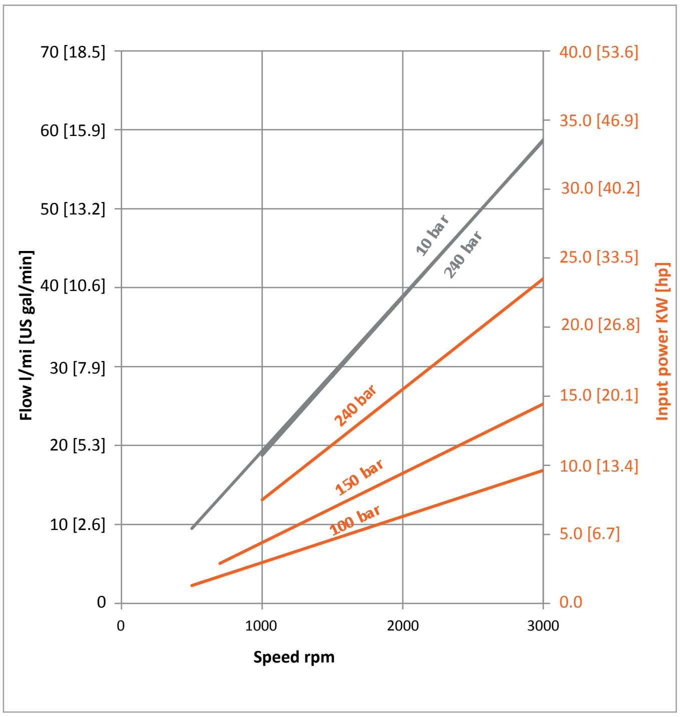
Performance graph for 014 frame size



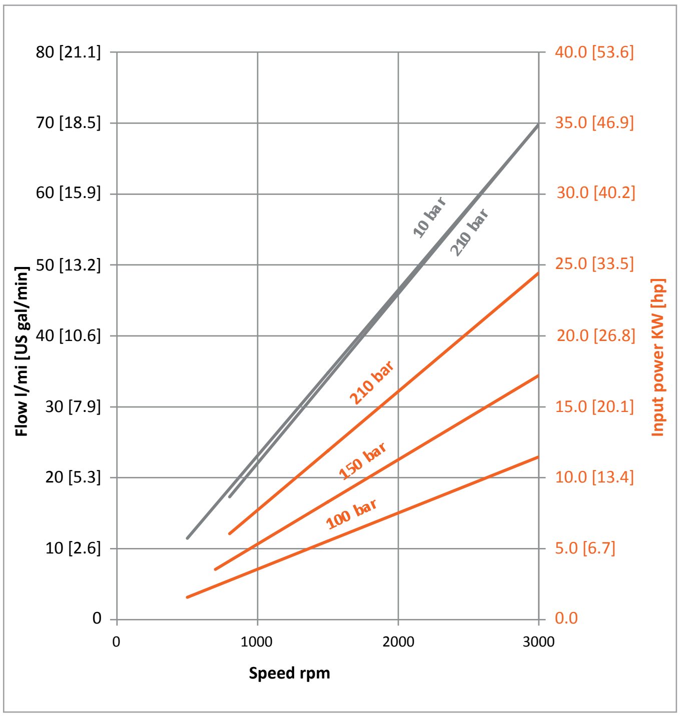
Performance graph for 017 frame size



Performance graph for 019 frame size



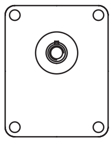
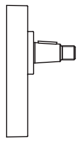
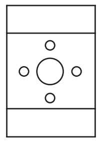
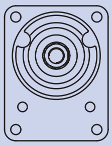
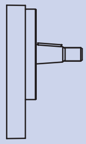
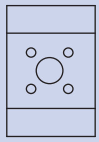
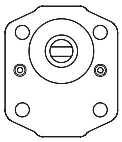
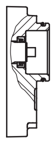
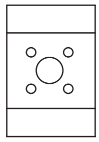
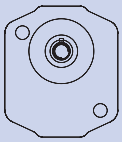
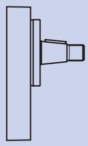
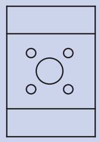
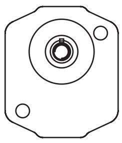
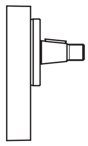
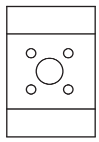
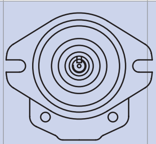
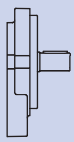
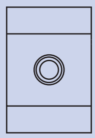
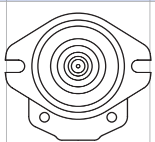
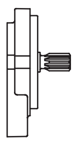
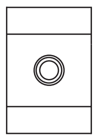
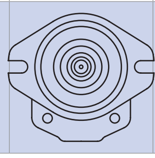
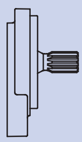
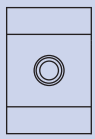
Performance graph for 022 frame size



Product Options

Flange, shaft and ports configurations

Available flange, shaft and ports configurations

Code single units	Code tandem units	Flange		Shaft		Ports	
01BA	**01BQ**	pilot Ø 36.5 mm [1.438 in] European 01, 4-bolt		1:8 tapered		European flanged, + pattern	
02AA	**02AG**	pilot Ø 80 mm [3.15 in] German PTO, 4-bolt		1:5 tapered		German std, × pattern	
03CA	**Not available**	Turolla 03		Turolla tang		German std, × pattern	
04AA	**04AG**	pilot Ø 50 mm [1.969 in] German PTO, 2-bolt		1:5 tapered		German std, × pattern	
05AA	**05AG**	pilot Ø 50 mm [1.969 in] German PTO, 2-bolt		1:5 tapered		German std, × pattern	
06GA	**Not available**	pilot Ø 82.55 mm [3.25 in] SAE A, 2-bolt		Ø 15.875 mm [0.625 in] parallel		Threaded SAE O-Ring boss	
06SA	**06SM**	pilot Ø 82.55 mm [3.25 in] SAE A, 2-bolt		9-teeth splined SAE spline J 498-9T-16/32DP		Threaded SAE O-Ring boss	
06SB	**06SS**	pilot Ø 82.55 mm [3.25 in] SAE A, 2-bolt		11-teeth splined SAE spline J		Threaded SAE O-Ring boss	

Shaft options

Direction is viewed facing the shaft. Group 2 pumps are available with a variety of tang, splined, parallel, and tapered shaft ends. Not all shaft styles are available with all flange styles.

Shaft versus flange availability and torque capability

A / B C D E F G H I J K L / M N 0

Single pump torque limit

Shaft		Mounting flange code with maximum torque in N•m [lbf•in]					
Description	*Code*	**01**	**02**	**03**	**04**	**05**	**06**
Taper 1:5	**AA**	–	140 [1239]	–	140 [1239]	140 [1239]	–
Taper 1:8	**BA**	150 [1328]	–	–	–	–	–
SAE spline 9T 16/32p	**SA**	–	–	–	–	–	90 [796]
SAE spline 11T 16/32p	**SB**	–	–	–	–	–	150 [1328]
Parallel 15.875 mm [0.625 in]	**GA**	–	–	–	–	–	80 [708]
Turolla Tang	**CA**	–	–	70 [620]	–	–	–

Other shaft options may exist. Contact your Turolla representative for availability.

Caution

Shaft torque capability may limit allowable pressure. Torque ratings assume no external radial loading. Applied torque must not exceed these limits, regardless of stated pressure parameters. Maximum torque ratings are based on shaft torsional fatigue strength.

The second section torque limit is equal to 70Nm. Other configuration with higher rated torque are available upon request.

Pumps with integral relief valve • SHHP2EN and SHHP2IN

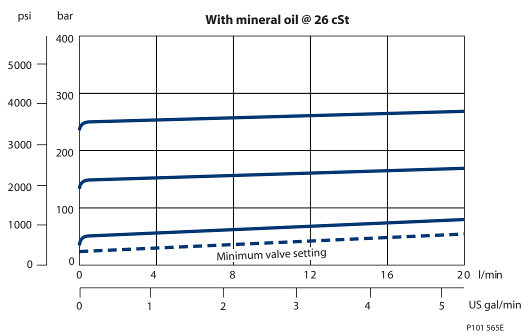
Group 2 pumps are offered with an optional **integral relief valve** in the rear cover . This valve can have an internal (SHHP2IN) or external (SHHP2EN) drain. This valve opens directing all flow from the pump outlet to the internal or external drain when the pressure at the outlet reaches the valve setting. This valve can be ordered preset to the pressures shown in the table below. Valve performance curve, rear cover cross-section and schematics are shown below.

Please contact Turolla Engineering Department for further information

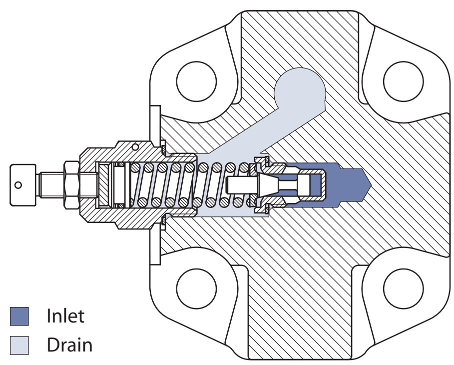
Caution

When the relief valve is operating in bypass condition, rapid heat generation occurs. If this bypass condition continues, the pump prematurely fails. The reason for this is that it is a rule, not an exception. When frequent operation is required, external drain option (SHHP2EN) must be used.

Valve performance graph

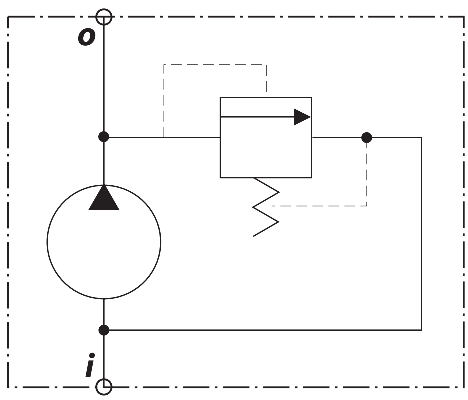


Integral relief valve cross-section

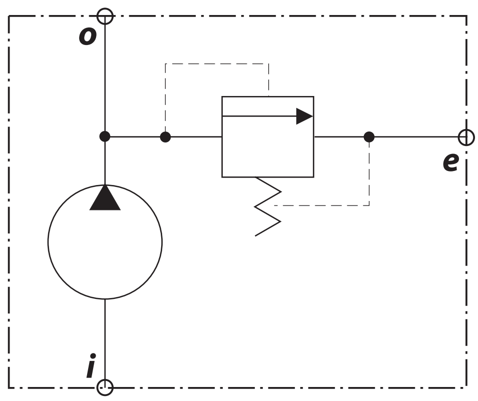


Integral relief valve schematics

Integral relief valve schematic
(internal drain)



Integral relief valve schematic
(external drain)



Where:
i = inlet
o = outlet
e = external drain

Variant codes for ordering integral relief valves

The tables below detail the various codes for ordering integral relief valves in **M** section of model code.

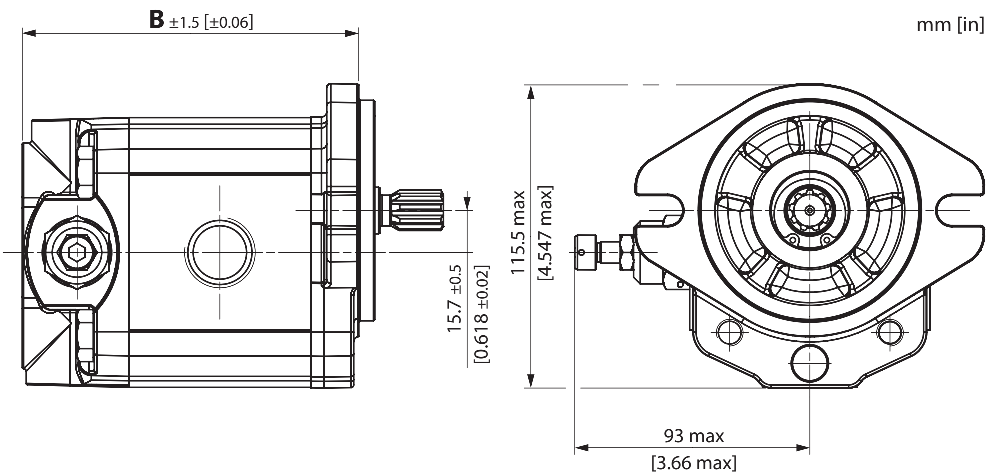
A	B	C	D	E	F	G	H	I	J	K	L	M	N	0
S H H P 2 E N /											/	V		
S H H P 2 I N														

Code	Pump speed for RV setting
A	Not defined
C	500 min^{-1} (rpm)
E	1000 min^{-1} (rpm)
F	1250 min^{-1} (rpm)
G	1500 min^{-1} (rpm)
K	2000 min^{-1} (rpm)
I	2250 min^{-1} (rpm)
L	2500 min^{-1} (rpm)
M	2800 min^{-1} (rpm)
N	3000 min^{-1} (rpm)
O	3250 min^{-1} (rpm)

Code	Pressure setting
A	No setting
B	No valve
C	18 bar [261 psi]
D	25 bar [363 psi]
E	30 bar [435 psi]
F	35 bar [508 psi]
G	40 bar [580 psi]
K	50 bar [725 psi]
L	60 bar [870 psi]
M	70 bar [1015 psi]
N	80 bar [1160 psi]
O	90 bar [1305 psi]
P	100 bar [1450 psi]
Q	110 bar [1595 psi]
R	120 bar [1740 psi]
S	130 bar [1885 psi]
T	140 bar [2030 psi]
U	160 bar [2320 psi]
V	170 bar [2465 psi]
W	180 bar [2611 psi]
X	210 bar [3046 psi]
Y	240 bar [3480 psi]
Z	250 bar [3626 psi]

For pressures higher than 210 bar [3046 psi] and lower than 40 bar [580 psi] apply to your Turolla representative.

Integral relief valve covers SHHP2EN and SHHP2IN



Dimensions of integral relief valve cover with SAE flange

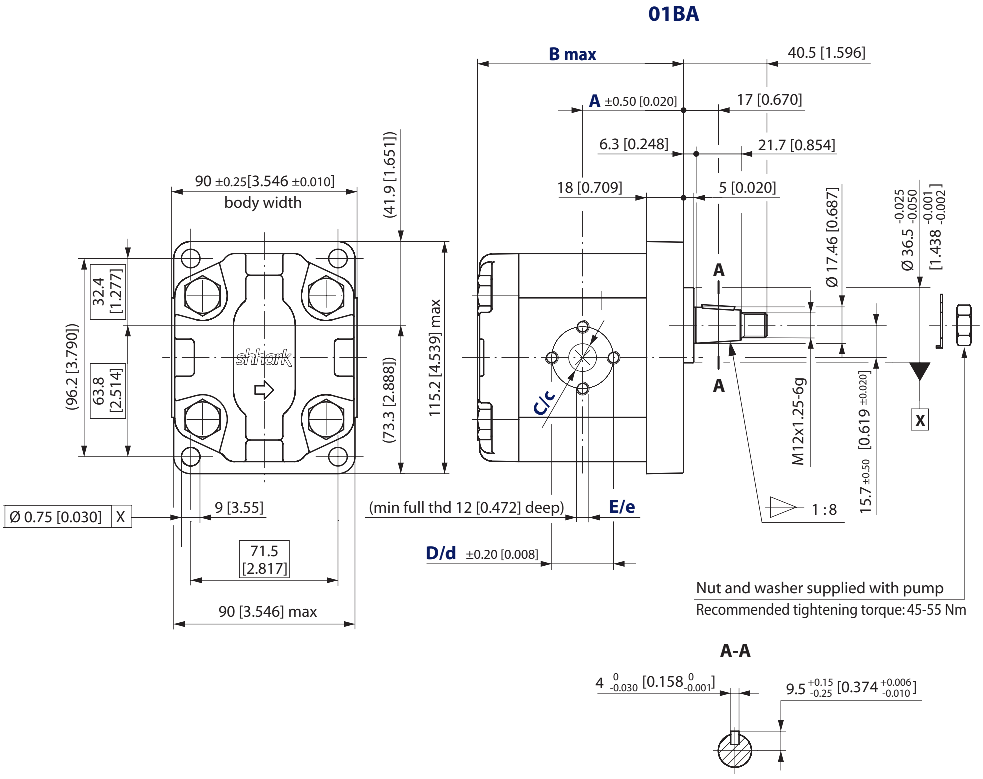
Type	8,0	011	014	017	019	022
B **mm [in]**	117.5 [4.63]	121.5 [4.78]	127.5 [5.02]	131.5 [5.18]	135.5 [5.33]	141.5 [5.57]

Dimensions

SHHP2NN – 01BA

Standard porting for 01BA

mm [in]



SHHP2NN – 01BA dimensions

Frame size		8,0	011	014	017	019	022
Dimension	A	45 [1.772]	49 [1.929]	52 [2.047]	52 [2.047]	56 [2.205]	59 [2.323]
	B	97.5 [3.839]	101.5 [3.996]	107.5 [4.232]	111.5 [4.390]	115.5 [4.574]	121.5 [4.783]
Inlet	C	13.5 [0.531]	13.5 [0.531]	20 [0.787]	20 [0.787]	20 [0.787]	20 [0.787]
	D	30 [1.181]	30 [1.181]	40 [1.575]	40 [1.575]	40 [1.575]	40 [1.575]
	E	M6		M8			
Outlet	c	13.5 [0.531]					
	d	30 [1.181]					
	e	M6					

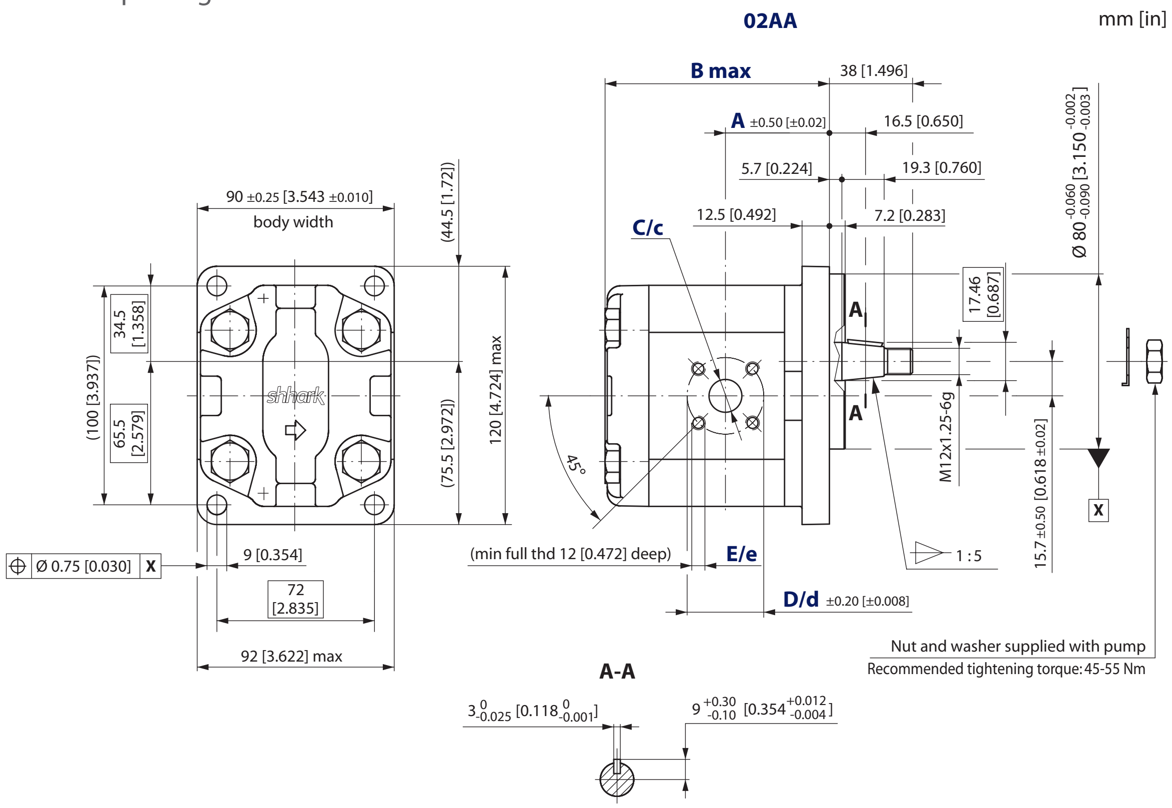
Model code examples and maximum shaft torque

Flange/drive gear	Model code example	Maximum shaft torque
01BA	SHHP2NN/8,0LN01BAP1C3C3NNNN/NNNNN	150 N•m [1328 lbf•in]

For further details on ordering, see Model Code, pages 8-15.

SHHP2NN – 02AA

Standard porting for 02AA



SHHP2NN – 02AA dimensions

Frame size		8,0	011	014	017	019	022
Dimension	A	43.1 [1.697]	47.5 [1.870]	47.5 [1.870]	47.5 [1.870]	47.5 [1.870]	55 [2.165]
	B	100 [3.937]	104 [4.094]	110 [4.331]	114 [4.488]	118 [4.646]	124 [4.882]
Inlet	C	20 [0.787]					
	D	40 [1.575]					
	E	M6					
Outlet	c	15 [0.591]					
	d	35 [1.378]					
	e	M6					

Model code examples and maximum shaft torque

Flange/drive gear	Model code example	Maximum shaft torque
02AA	SHHP2NN/017RN02AAP1B7B5NNNN/NNNNN	140 N•m [1239 lbf•in]

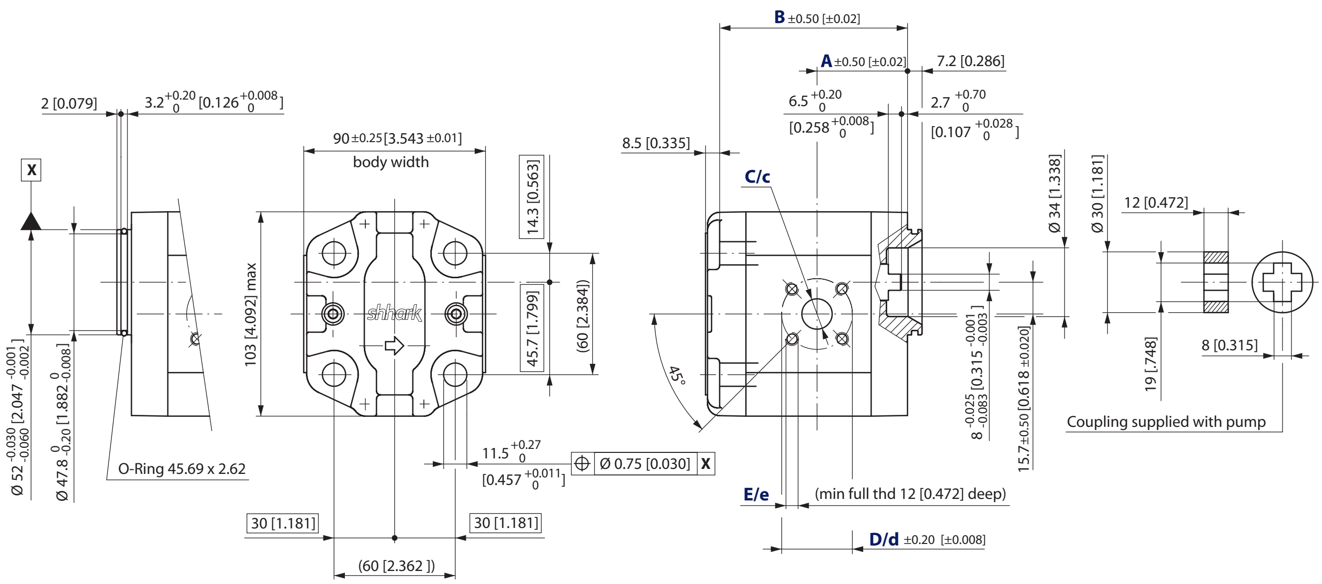
For further details on ordering, see Model Code, pages 8-15.

SHHP2NN – 03CA

Standard porting for 03CA

mm [in]

03CA



SHHP2NN – 03CA dimensions

Frame size		8,0	011	014	017	019	022
Dimension	**A**	40.6 [1.598]	45 [1.772]	45 [1.772]	45 [1.772]	45 [1.772]	52.5 [2.067]
	B	89 [3.504]	93 [3.661]	99 [3.897]	103 [4.055]	107 [4.212]	113 [4.448]
Inlet	**C**	20 [0.787]					
	D	40 [1.575]					
	E	M6					
Outlet	**c**	15 [0.591]					
	d	35 [1.378]					
	e	M6					

Model code example and maximum shaft torque

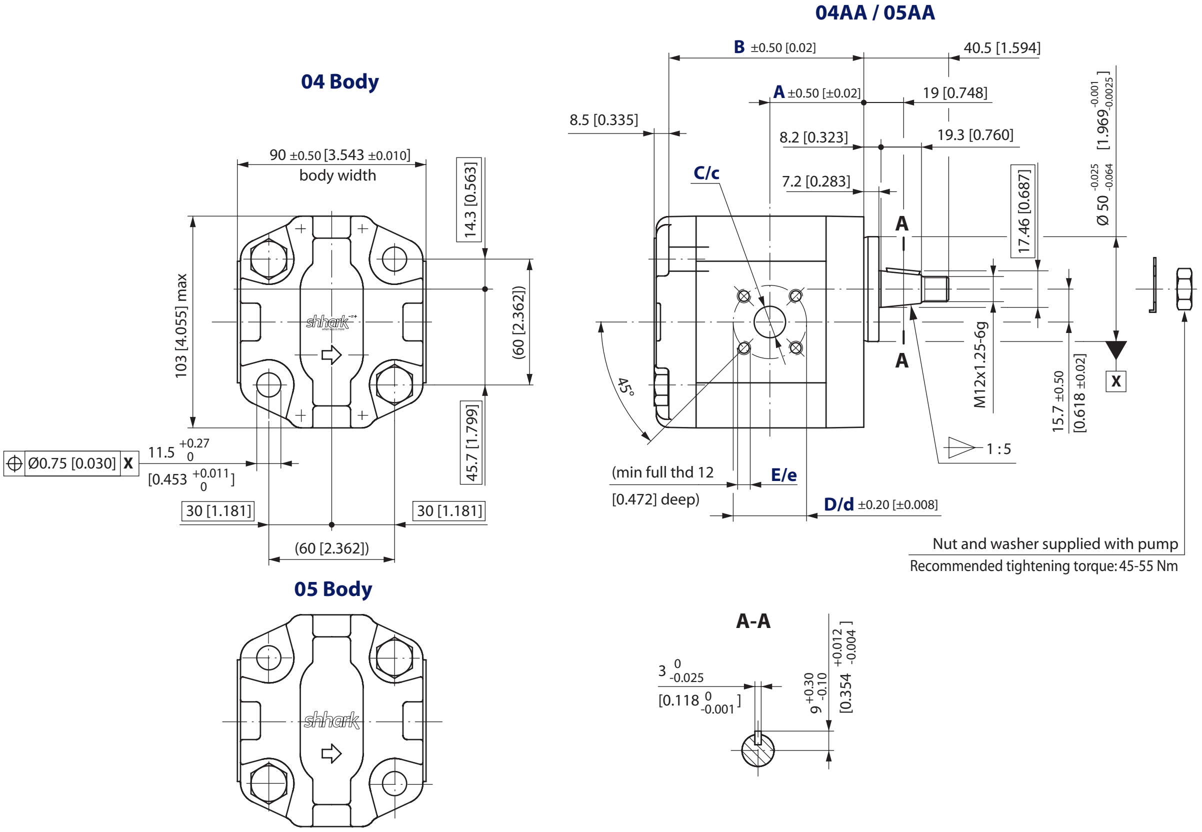
Flange/drive gear	Model code example	Maximum shaft torque
03CA	SHHP2NN/014RN03CAP3B7B5NNNN/NNNNN	70 N•m [620 lbf•in]

For further details on ordering, see Model Code, pages 8-15.

SHHP2NN – 04/05AA

Standard porting for 04/05AA

mm [in]



SHHP2NN – 04/05AA dimensions

Frame size		8,0	011	014	017	019	022
Dimension	A	40.6 [1.598]	45 [1.772]	45 [1.772]	45 [1.772]	45 [1.772]	52.5 [2.067]
	B	89 [3.503]	93 [3.661]	99 [3.897]	103 [4.055]	107 [4.212]	113 [4.448]
Inlet	C	20 [0.787]					
	D	40 [1.575]					
	E	M6					
Outlet	c	15 [0.591]					
	d	35 [1.378]					
	e	M6					

Model code examples and maximum shaft torque

Flange/drive gear	Model code example	Maximum shaft torque
04AA	SHHP2NN/6,0LN04AAP1B7B5NNNN/NNNNN	140 N•m [1239 lbf•in]
05AA	SHHP2NN/014RN05AAP1B7B5NNNN/NNNNN	

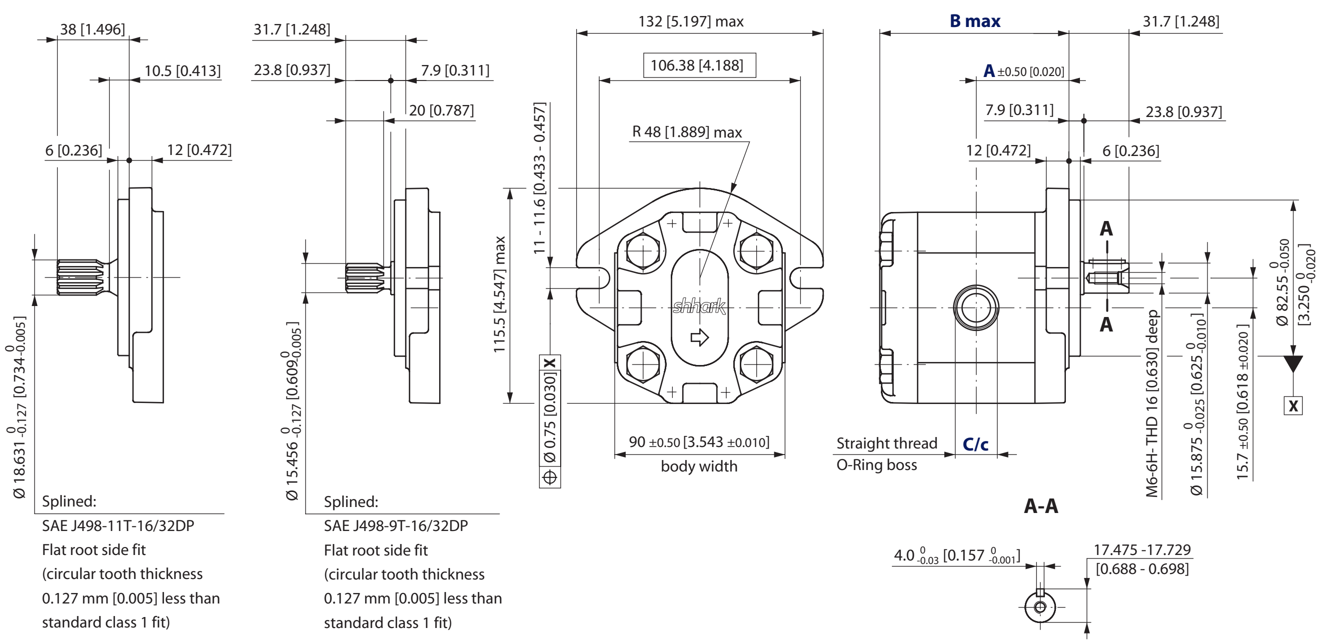
For further details on ordering, see Model Code, pages 8-15.

SHHP2NN – 06SB, 06SA and 06GA

Standard porting for 06SB, and 06SA, 06GA

mm [in]

06SB (SHHP2NN) **06SA (SHHP2NN)** **06GA**



SHHP2NN – 06SA, 06GA and 06SB dimensions

Frame size		8,0	011	014	017	019	022
Dimension	**A**	47 [1.850]	49 [1.920]	52 [2.047]	54 [2.205]	56 [2.205]	59 [2.323]
	B	97.5 [3.839]	101.5 [3.996]	107.5 [4.232]	111.5 [4.390]	115.5 [4.547]	121.5 [4.783]
Inlet	**C**	1 1⁄16–12UNF–2B, 18.0 [0.709] deep					
Outlet	**c**	7⁄8–14UNF–2B, 16.7 [0.658] deep					

Model code examples and maximum shaft torque

Flange/drive gear	Model code example	Maximum shaft torque
06GA	SHHP2NN/6,0RN06GAP1E6E5NNNN/NNNNN	80 N•m [708 lbf•in]
06SA	SHHP2NN/011LN06SAP1E6E5NNNN/NNNNN	90 Nm [796 lbf in]
06SB	SNNP2NN/022RN06SBP1E6E5NNNN/NNNNN	150 N•m [1328 lbf•in]

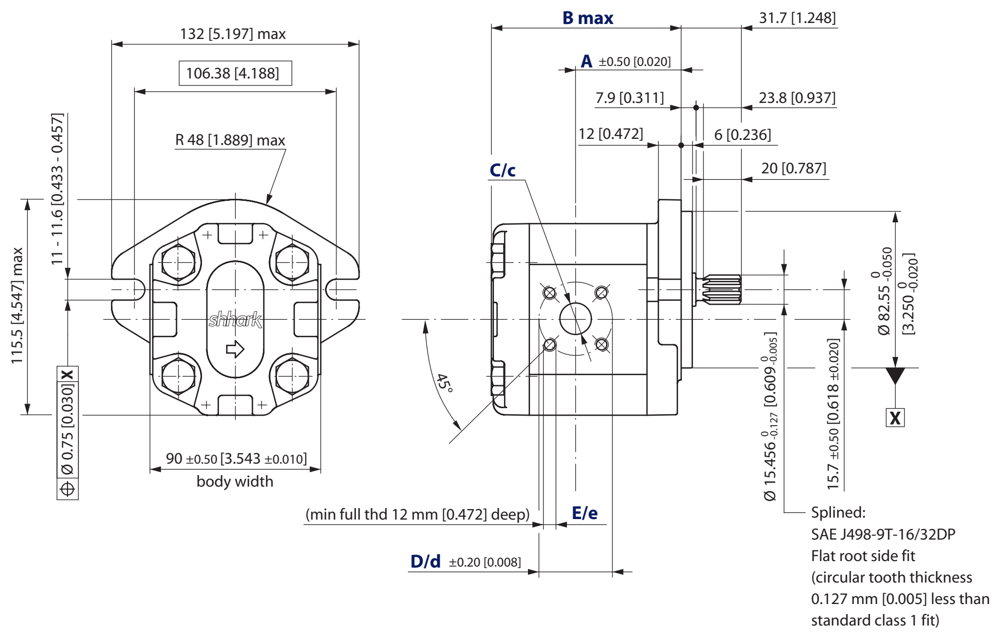
For further details on ordering, see Model Code, pages 8-15.

SHHP2NN – 06SA..BxBxYY../.....

Standard porting for 06SA with port type Bx offset from center of the body

mm [in]

06SA..BxBxYY../.....



SHHP2NN – 06SA..BxBxYY../..... dimensions

Frame size		8,0	011	014	017	019	022
Dimension	A	53.4 [2.102]	53.0 [2.087]	59.0 [2.322]	63.0 [2.480]	67.0 [2.637]	65.5 [2.579]
	B	97.5 [3.839]	101.5 [3.996]	107.5 [4.232]	111.5 [4.390]	115.5 [4.547]	121.5 [4.783]
Inlet	C	20 [0.787]					
	D	40 [1.575]					
	E	M6					
Outlet	c	15 [0.591]					
	d	35 [1.378]					
	e	M6					

Model code examples and maximum shaft torque

Flange/drive gear	Model code example	Maximum shaft torque
06SA..BxBxYY../.....	SHHP2NN/019RN06SAP1B7B5YYNN/NNNNN	90 Nm [796 lbf in]

For further details on ordering, see Model Code, pages 8-15.

Notes

Member of the Danfoss Group

TUROLLA

fast forward thinking

Italy
Via Natale Salieri, 33-35
40024 Castel San Pietro Terme,
Bologna, Italy
Phone: +39 051 6054411
Fax: +39 051 6053033

U.S.A.
2800 East 13th Street
Ames, IA 50010, USA
Phone: +1 515 239 6677
Fax: +1 515 239 6618

E-mail: turollaocg@turollaocg.com
www.turollaocg.com

Local address