![PSL logo]

worm drives

production programme

BASIC INFORMATION

* PSL, a. s., is a bearing and slewing ring manufacturer with many years of tradition and experience.

* PSL, a. s., has a developed, utilized and certified system of the quality assurance programme according to the standard DIN EN ISO 9001.

* This publication contains basic information on PSL worm drives and their mounting and maintenance.

* The PSL worm drive system is a compact unit (slewing ring + base plate + worm) suitable for slow rotation with a continuous/cyclical movement capable of handling combined loads.

* Solutions to complex applications involving PSL worm drives can be provided by the experts of the PSL Technical Department.

* The contents of this publication have been carefully reviewed, however due to continuous technical development, PSL reserves the right to make technical changes and/or amendments without prior notice.

PSL WORM DRIVES

The universal design of PSL worm drive allows:

– continuous or cyclical rotation of the connected superstructure
– various connections with the driving motor
  (right or left side per customer's request)
– simple installation
– rational space utilization
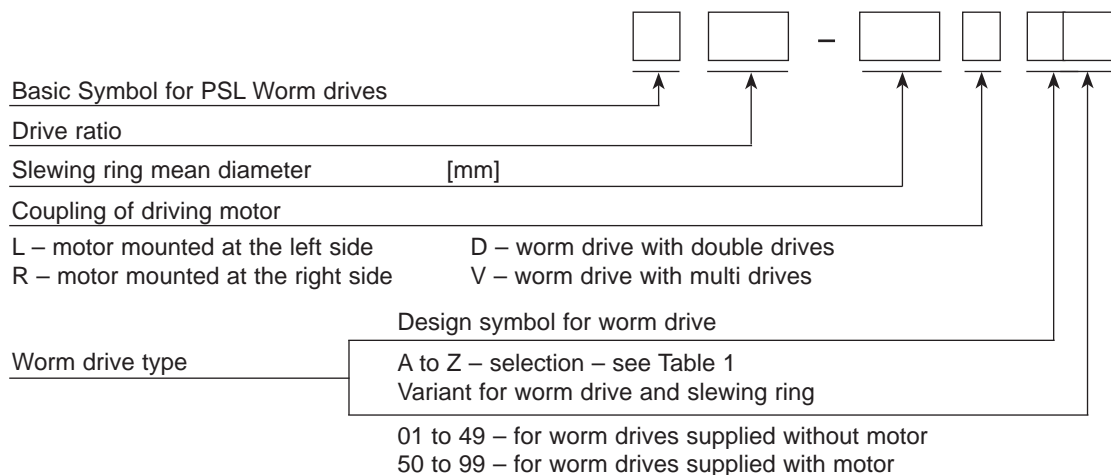– reliable operation with low maintenance requirements

The gear is self–locking, therefore a break is not necessary.

PSL open/covered worm drive systems are produced with multiple combinations suitable for most common applications, such as aerial platforms, positioners and cranes etc.

PART NUMBER DESIGNATION OF PSL WORM DRIVE SYSTEMS

□□ – □ □ □□

Basic Symbol for PSL Worm drives

Drive ratio

Slewing ring mean diameter   [mm]

Coupling of driving motor

L – motor mounted at the left side   D – worm drive with double drives
R – motor mounted at the right side   V – worm drive with multi drives

Design symbol for worm drive

Worm drive type   A to Z – selection – see Table 1
Variant for worm drive and slewing ring

01 to 49 – for worm drives supplied without motor
50 to 99 – for worm drives supplied with motor

Example of designation:

IP107-422LD01   **IP**   – PSL worm drive
                         107 – drive ratio 107
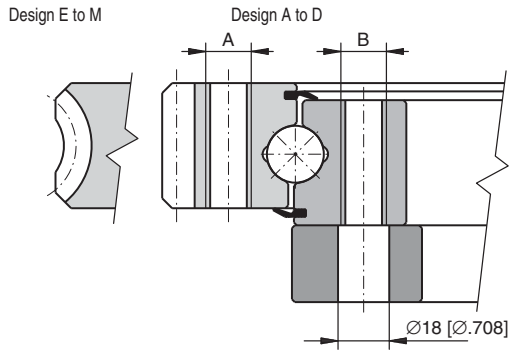   **422** – slewing ring mean diameter 422
                         L   – motor at the left side
                         D01 – worm drive and slewing ring type D01
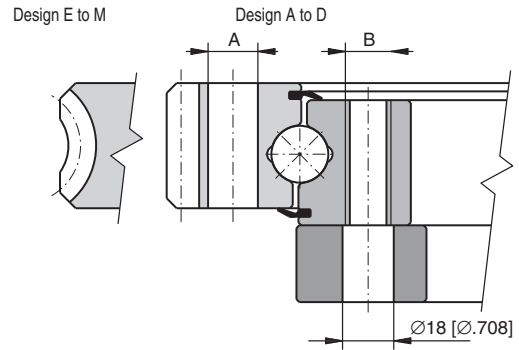   (helical gear – covered – welded – worm drive supplied without motor)

Table 1

Design Symbol	Type of slewing ring gear					Type of worm drive				
	Helical	Globoidal		Straight	Other	Open	Covered	Casting	Welded	Other
		Steel	Bronze							
A	*					*		*		
B	*					*			*	
C	*						*	*		
D	*						*		*	
E		*				*		*		
F		*				*			*	
G		*					*	*		
H		*					*		*	
J			*			*		*		
K			*			*			*	
L			*				*	*		
M			*				*		*	
N				*		*		*		
O				*		*			*	
P				*			*	*		
R				*			*		*	
S										
T										
U										
V										
W										
X										
Y										
Z										

BASIC TYPES OF WORM DRIVES AND SLEWING RINGS

| TYPE 01: | A;B=M16 |
| TYPE 05: | A;B=5/8"-11UNC-2B |

Design E to M   Design A to D

A   B

∅18 [∅.708]

TYPE 02:	A=∅17.5 [∅.69]; B=M16
TYPE 06:	A=∅17.5 [∅.69]
	B=5/8"-11UNC-2B

Design E to M   Design A to D

A   B

∅18 [∅.708]

| TYPE 03: | A;B=∅17.5 [∅.69] |
| TYPE 07: | A;B=∅17.5 [∅.69] |

Design E to M   Design A to D

A   B

∅18 [∅.708]

TYPE 04:	A=M16; B=∅17.5 [∅.69]
TYPE 08:	A=5/8"-11UNC-2B
	B=∅17.5 [∅.69]

Design E to M   Design A to D

A   B

∅18 [∅.708]
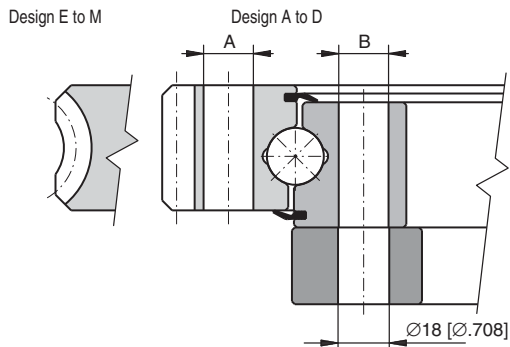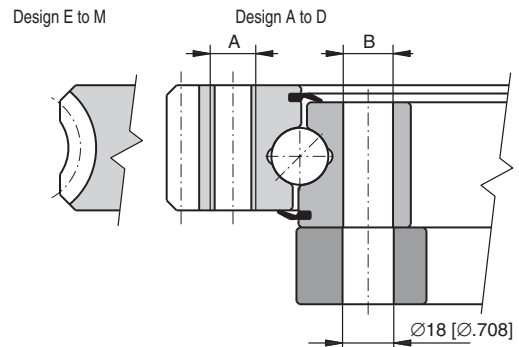
OPEN WORM DRIVES

TYPES 01 TO 08

AM8x1   BM10x1

DIN 71412

LITHIUM GREASE EP2

COVERED WORM DRIVES

BM10x1   DIN 71412

LITHIUM GREASE EP2

OPEN WORM DRIVES

Small worm drive
IP60-223L/R
Design A
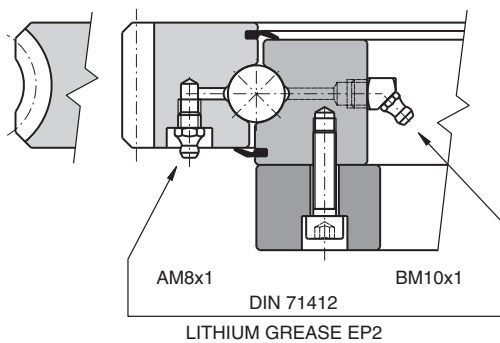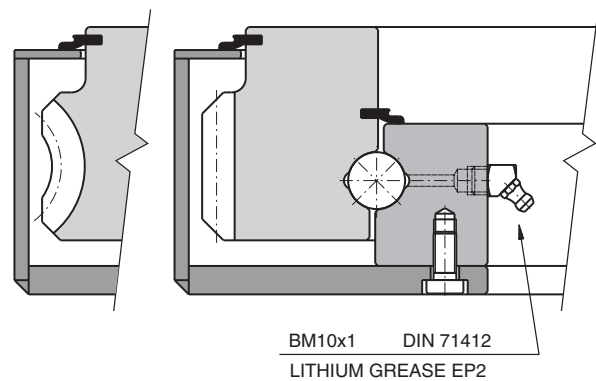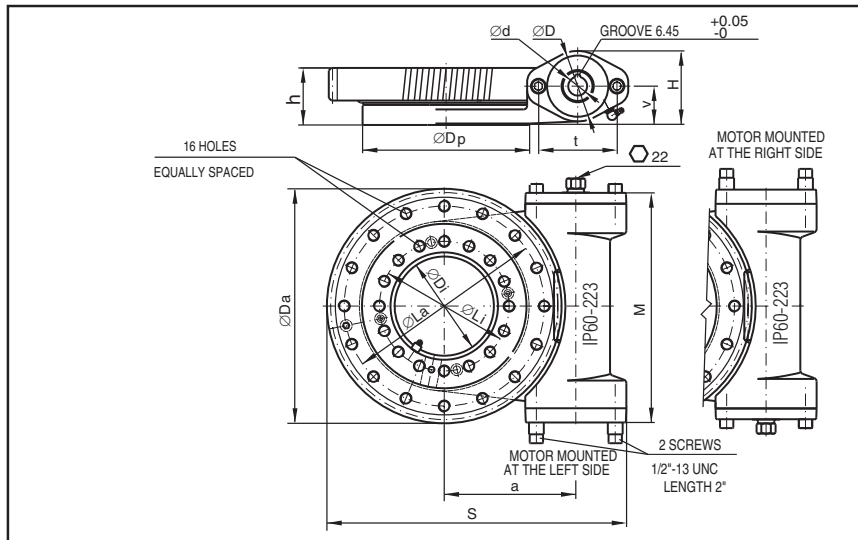
Medium worm drive
IP85-343L/R
Design A

Heavy duty worm drive
IP103-422L/R
Design A
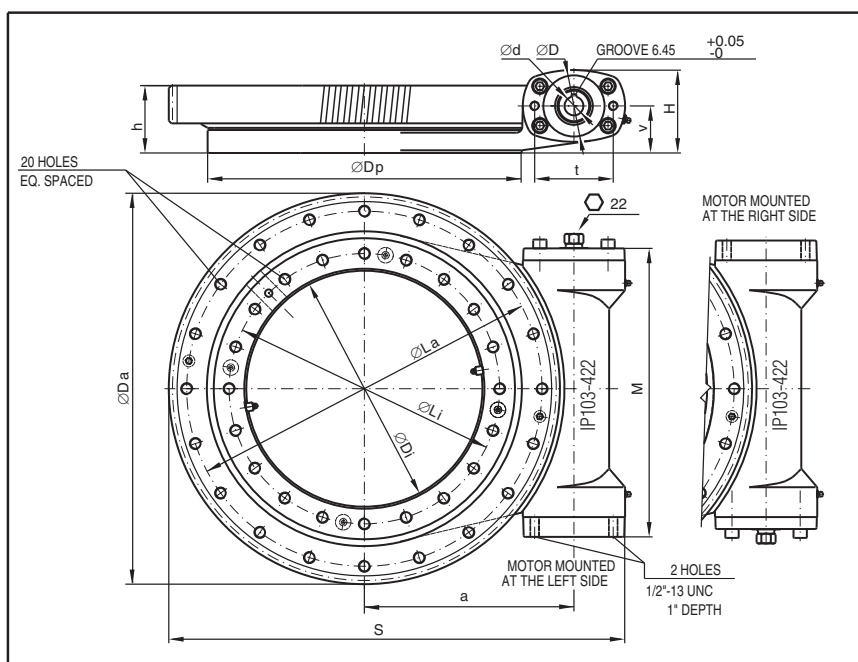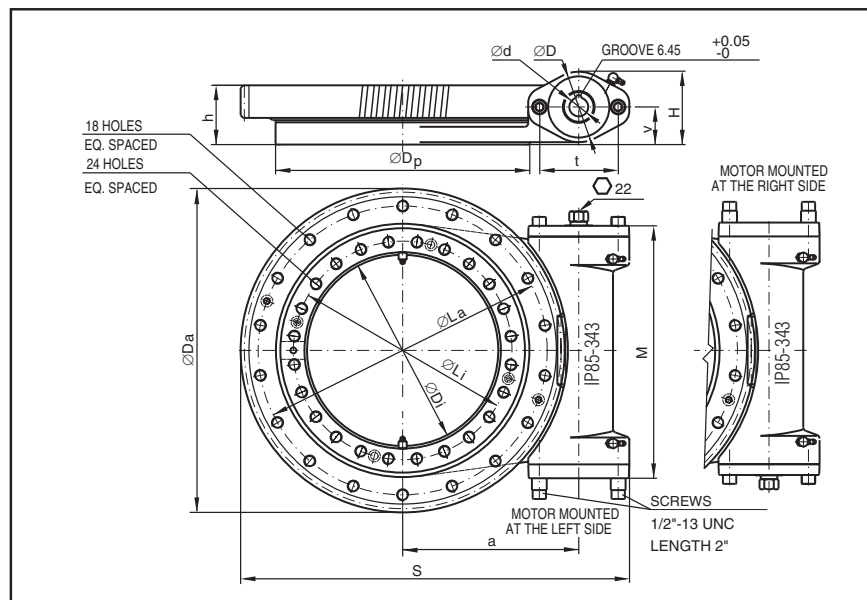
Boundary dimensions for worm drives, design A — Table 2

Designation	IP 60-223 [mm]	IP 60-223 [inch]	IP 85-343 [mm]	IP 85-343 [inch]	IP 103-422 [mm]	IP 103-422 [inch]
ød	25.5	1.004"	25.5	1.004"	25.5	1.004"
øD	82.6	3.25"	82.6	3.25"	82.6	3.25"
øLi	175	6.89"	295	11.614"	365	14.37"
øLa	270	10.63"	390	15.354"	479.4	18.874
øDi	134	5.276"	258	10.157"	300	11.811"
øDa	316.6	12.465"	437.3	17.217"	527.8	20.78"
øDp	225	8.86"	343	13.5"	425	16.7"
h	77	3.031"	80	3.15"	91	3.58"
H	98.5	3.88"	98.5	3.88"	111	4.37"
v	52.4	2.063"	50.8	2"	63.5	2.5"
t	106.4	4.189"	106.4	4.189"	106.4	4.189"
a	177.539	6.9897"	237.6	9.3543"	282.8	11.13"
S	405	15.95"	527	20.75"	617.5	24.3"
M	312	12.3"	343	13.5"	389	15.31"

Diagram for limiting static load worm drives, design A — Table 3
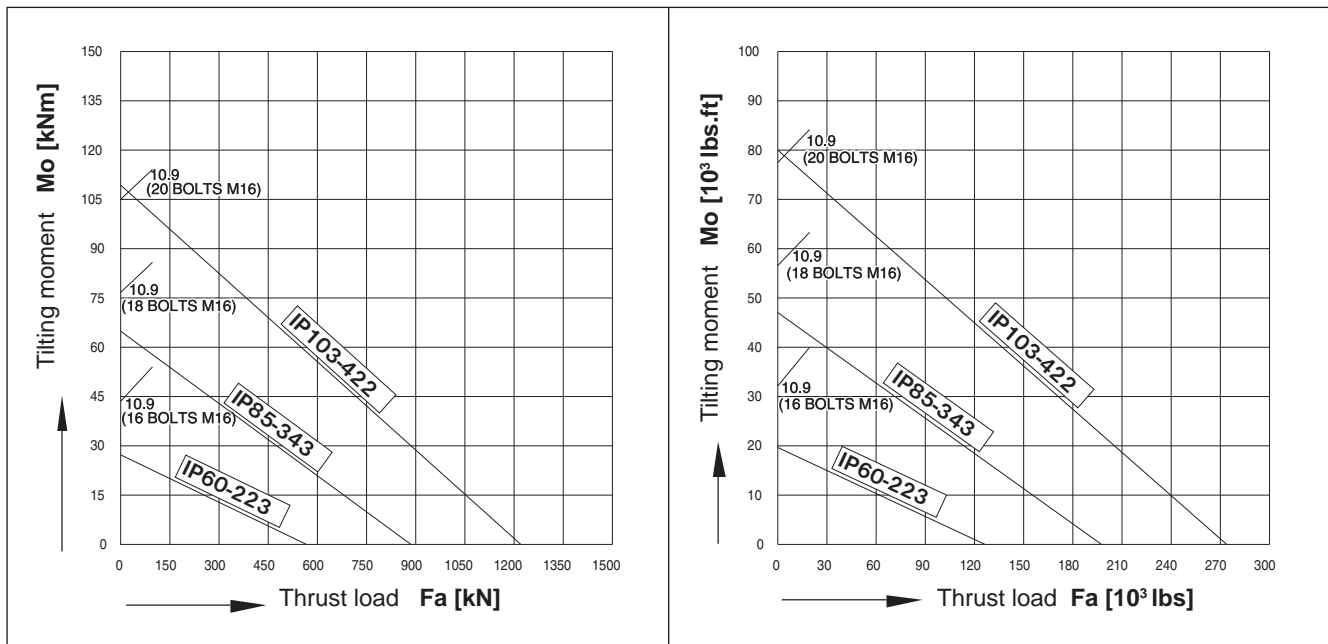
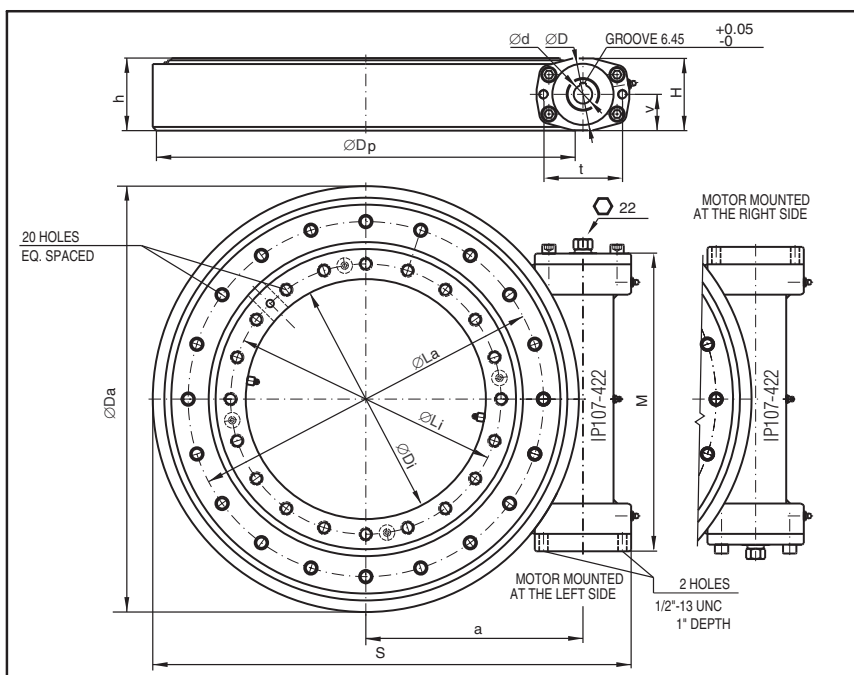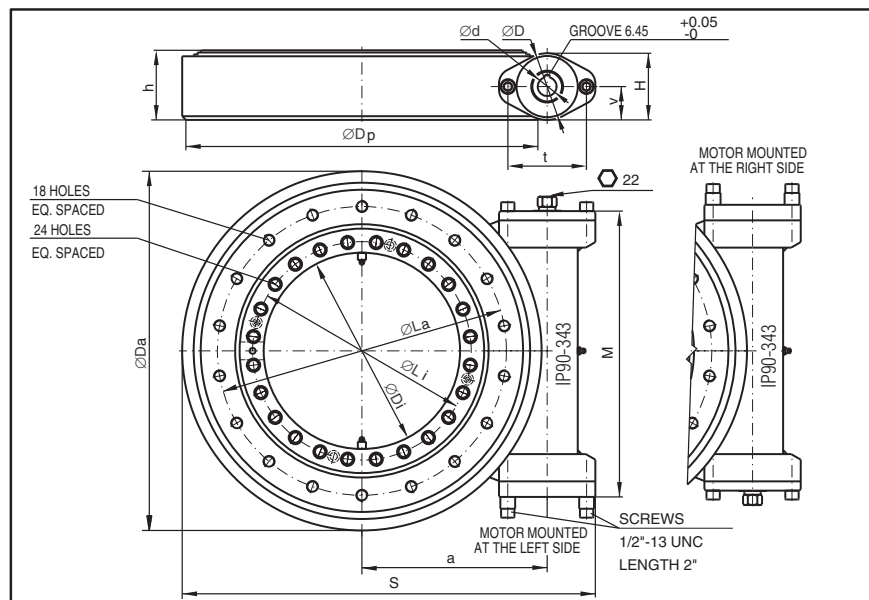

General parameters for worm drives, design A — Table 4

Specification	Unit	IP60-223	IP85-343	IP103-422
Weight	[kg]	37	51	86
	[lb]	82	112	190
Input torque	[Nm]	58	54	108
	[lb.ft]	43	40	80
Output torque	[Nm]	2800	3640	8900
	[lb.ft]	2065	2685	6564
Max. output rotation	[rpm]	13	10	8

COVERED WORM DRIVES
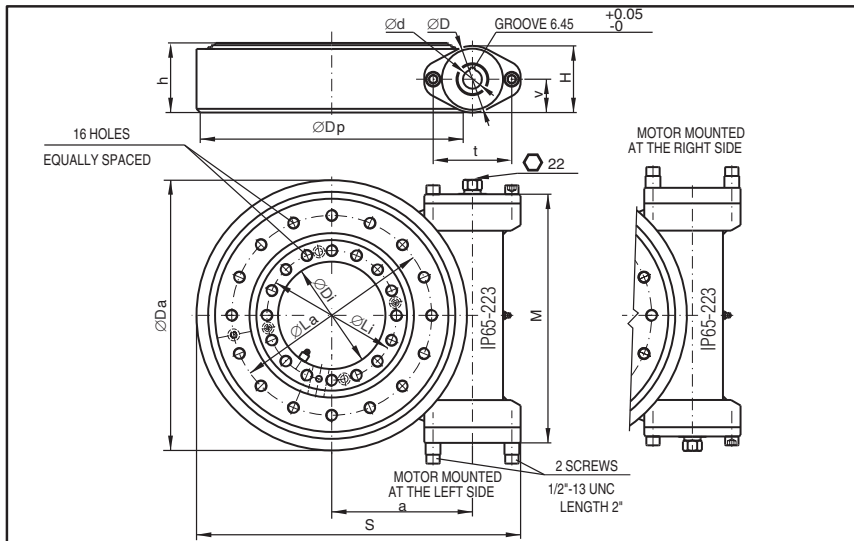
Small worm drive
IP65-223L/R
Design D, H, M

Medium worm drive
IP90-343L/R
Design D, H, M


Heavy duty worm drive
IP107-422L/R
Design D, H, M

Boundary dimensions for worm drives, design D, H, M — Table 5

Designation	IP65-223 [mm]	IP65-223 [inch]	IP90-343 [mm]	IP90-343 [inch]	IP107-422 [mm]	IP107-422 [inch]
ød	25.5	1.004"	25.5	1.004"	25.5	1.004""
øD	82.6	3.25"	82.6	3.25"	82.6	3.25"
øLi	175	6.89"	295	11.614"	365	14.37"
øLa	270	10.63"	390	15.354"	479.4	18.874"
øDi	145	5.708"	265	10.433"	324	12.754"
øDa	365	14.370"	485	19.094"	575	22.64"
øDp	355	13.796"	475	18.700"	565	22.25"
h	94	3.70"	94	3.70"	98	3.86"
H	90	3.54"	90	3.54"	97	3.81"
v	45	1.772"	45	1.772"	49	1.93"
t	106.4	4.189"	106.4	4.189"	106.4	4.189"
a	190	7.480"	250	9.842"	293	11.54"
S	438	17.05"	558	21.97"	645.5	24.51"
M	336	13.3"	386	15.2"	402	15.83"

Diagram for limiting static load worm drives, design D, H, M — Table 6
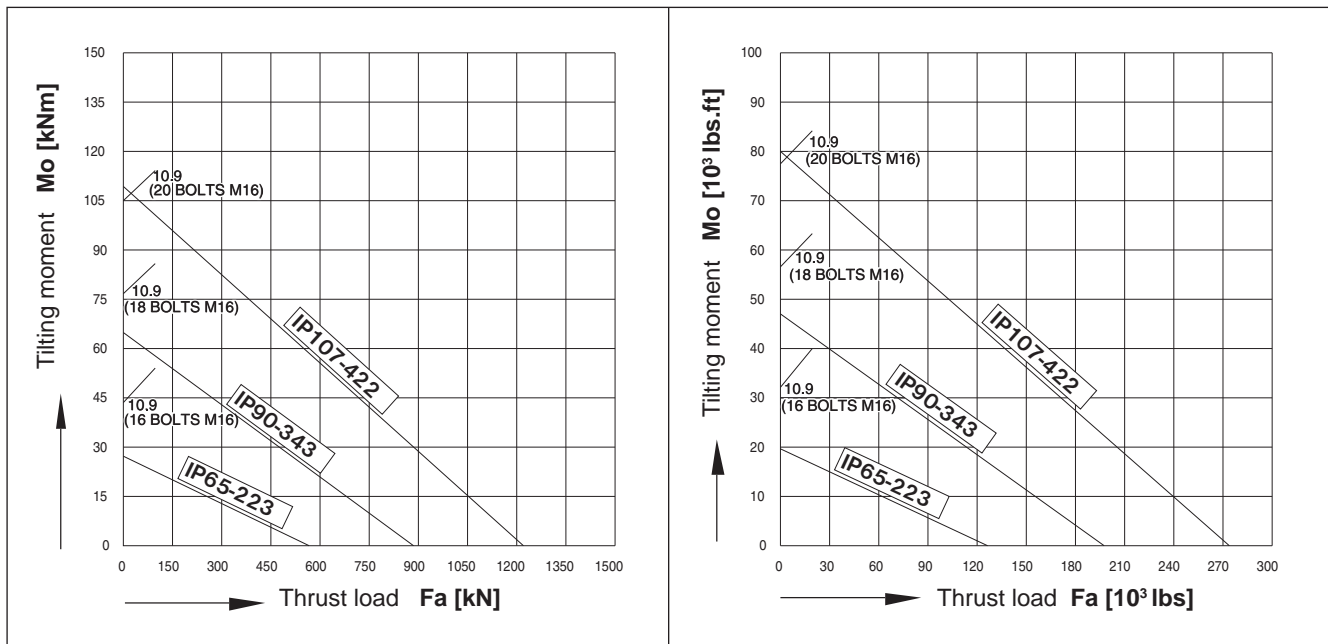
General parameters for worm drives, design D, H, M — Table 7

Specification	Unit	IP65-223	IP90-343	IP107-422
Weight	[kg]	51	74	110
	[lb]	112	163	243
Input torque	[Nm]	92	83	175
	[lb.ft]	68	61	129
Output torque	[Nm]	2980	3740	9350
	[lb.ft]	2198	2758	6896
Max. output rotation	[rpm]	13	10	8

WORM DRIVE SELECTION

In order to decide on which worm drive size is applicable, the following data is needed:

– size, direction and time utilization of the operating load
– required life
– operating rotational speed, or number of work cycles/working angle
  (1 work cycle = 2 working angles)
– work environment requirements
– mounting and maintenance requirements

The priority criterion is a reliable load transmission, i. e. adequacy of the raceways, gear and fixing bolts.

Calculation of equivalent axial and moment static load	Table 8
Formula	**Conditions of validity**
$F'_{OA} = (F_{OA} + 5{,}05 . F_{OR}) . s_O$ $M'_{OK} = M_{OK} . s_O$	$0{,}1 < \dfrac{F_{OR}}{F_{OA}} < 8$ $e > 2$
$F'_{OA} = (1{,}23 . F_{OA} + 2{,}68 . F_{OR}) . s_O$ $M'_{OK} = 1{,}23 . M_{OK} . s_O$	$0{,}1 < \dfrac{F_{OR}}{F_{OA}} < 8$ $e \leq 2$

F_{OA} – Σ axial static forces on the slewing ring   [kN]
F_{OR} – Σ radial static forces on the slewing ring   [kN]
M_{OK} – Σ tilting static moments on the slewing ring   [kNm]
s_o – static safety factor   [–]
     $s_o = 1$ for normal operating conditions
     $s_o = 1.1$ to 1.5 – according to operating conditions
e $= \dfrac{2000 . M_{0K}}{F_{OA} . D_s}$ – load eccentricity parameter   [–]
D_s – mean diameter of slewing ring   [mm]

Note: – if $\dfrac{F_{OR}}{F_{OA}} < 0{,}1$ – it is not necessary to take into account the radial force when calculating the equivalent load

How to proceed when selecting a suitable worm drive:
The calculated values of the equivalent axial and moment static loads are defined in their respective coordinates system marked by the operating point in the diagram of a limiting static load (tables 3 and 6). The calculated operating point must lie under the curve for the limiting static loads of raceways and bolts.

FASTENING BOLTS

For fastening of the worm drives, bolts class 10.9 (according to ISO) or grade 8 (according to SAE) must be used.
The fastening bolt length has to be l = 5 x d.
Bolt tightening torque: Threaded bolt M16 . . . . 279 Nm (206 lb.ft)
                       Threaded bolt 5/8" - 11 UNC. . . . . 260 Nm (192 lb.ft)

MOUNTING AND MAINTENANCE OF WORM DRIVES

Mounting is based upon gradual tightening of the bolts, while alternating opposite one another. First, gently tighten all bolts with half the prescribed moment, then second proceed with full prescribed tightening moment.
When completed final inspection of the prescribed tightening moment should be performed.

After mounting, it is necessary to:
– check the lubrication of all worm drive functional parts (especially of the gear).
– measure the initial tilting clearance under minimum and maximum loads.
– record measured data in the machine operation diary.

The maitenance is based upon the regular relubrication of the slewing ring raceways, gear and worm bearings. Inspection of wear should be completed as well.

Open/Uncovered Worm Drives:
In a presumed constant cyclical operation (application such as an assembling platform) it is sufficient for functional parts to be lubricated once per year.

The recommended lubricants are:
– lithium lubricants of the consistency 2 with EP additives for the raceways of the slewing ring and worm bearings.
– grease for open drives for the gear.

The relubrication of the slewing ring raceway, worm bearing and gear must be performed so that all functional surfaces are lubricated to approximately 70 per cent (the filling factor 70 %).
When more frequent use of the equipment is applicable (more than 8 hours/day) or at a small swing angle it is suitable to relubricate more often, i. e. approximately once every 4 months.

Covered Worm Drives:
– they are filled with fully synthetic grease with a long life period "Klübersynth GE 14-151" or its equivalent.
– they require the relubrication of the slewing ring raceway and gear. The relubrication interval depends on operation frequency.The worm bearings relubrication is not needed, for the initial lubrication lasts the entire period of the presumed life (6 000 operating hours).

The Inspection of Wear
The indicator of the wear of the slewing ring raceway is an increase in the tilting clearance.
The permissible increase in the tilting clearance may be max. app. 1.5 mm. The signal of the gear wear is an increased backlash. The permissible magnitude of the backlash depends on the swing drive type applied.
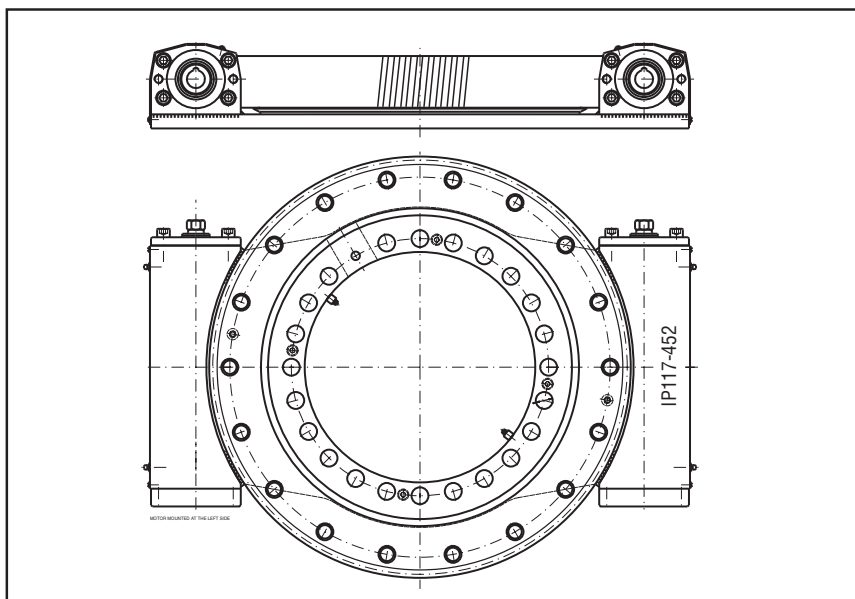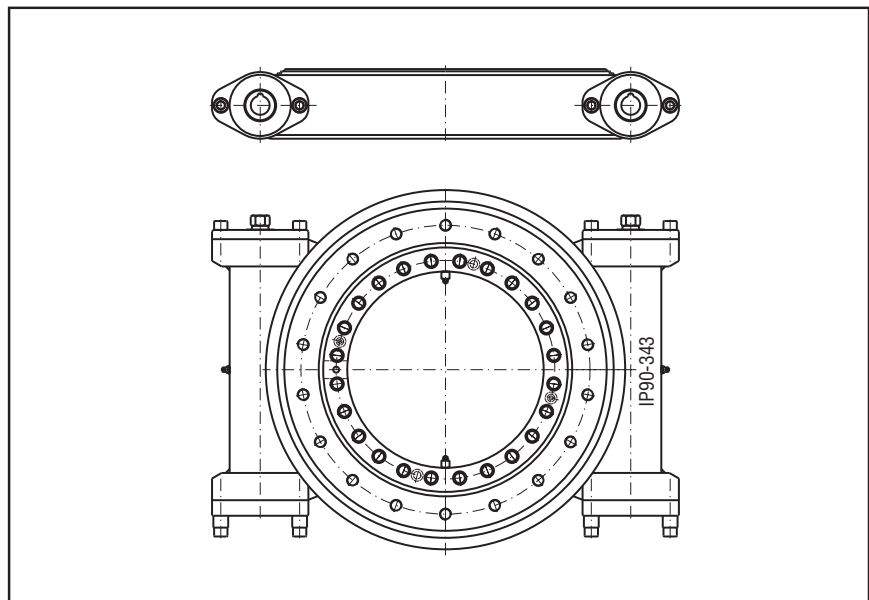
Note:
In the event of an excessive wear or an increase in the slewing ring tilting clearance or backlash of the gear engaged, it is necessarry to consult the PSL, a. s., Technical Department for permissible values.

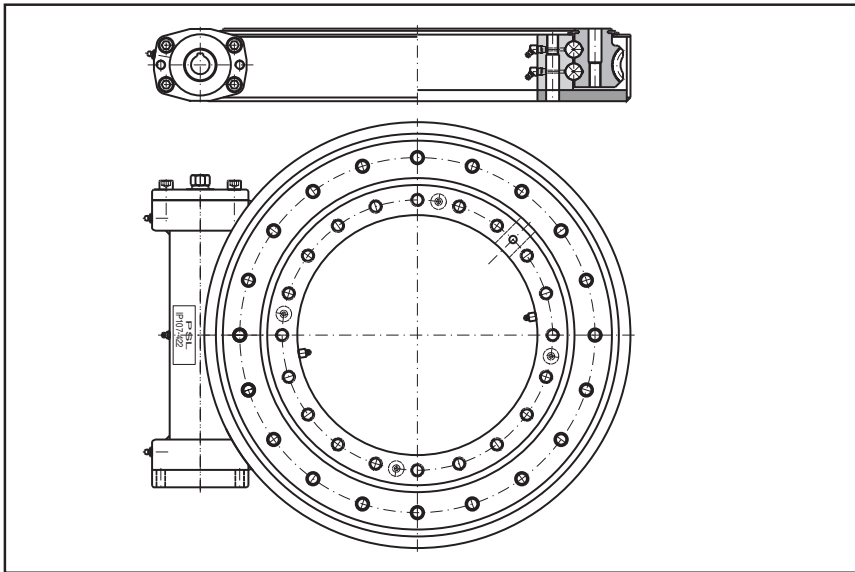# OTHER PSL WORM DRIVE DESIGNS
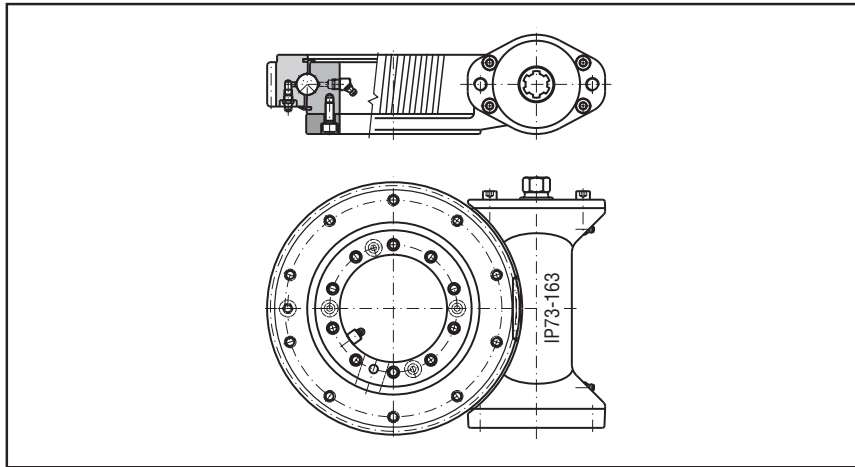
Mini worm drive
IP73-163L/R
Design A

**Medium worm drive
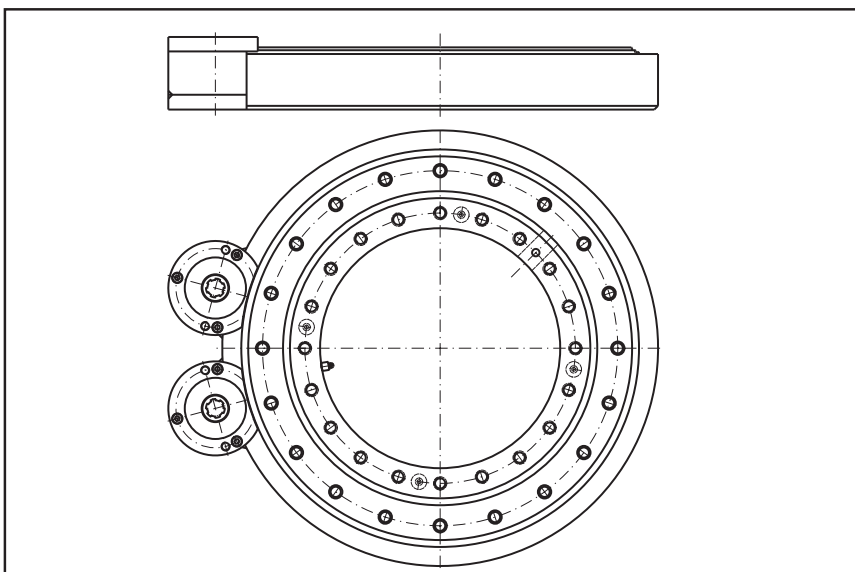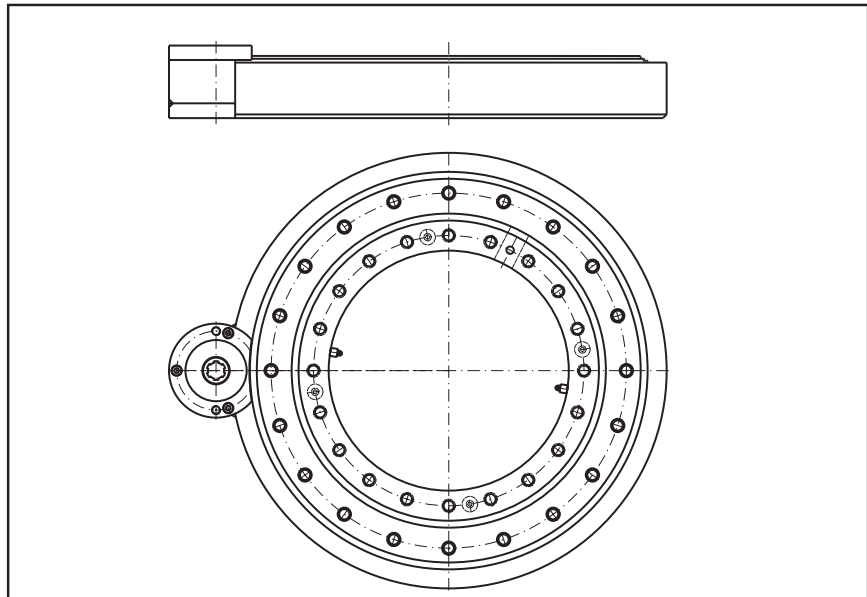with 2 worms**
IP90-343D
Design D

**Heavy duty worm drive
with 2 worms**
IP117-452D
Design B

OTHER PSL WORM DRIVE DESIGNS

**Heavy duty worm drive
with double row
slewing ring**
IP107-422L/R
Design H

**Heavy duty drive
with pinion**
IP8,6-422
Design R

**Heavy duty drive
with 2 pinions**
IP8,6-422D
Design R

PSL, a. s.
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PSL

Quality For Heavy Duty

WORM DRIVE – DESIGN WORKSHEET

Company:	Name:
Address:	Department
	Tel:
	Fax:
	E-mail:

Application/Type of machine:	Axis of rotation*:	Rotation mode*:
	– vertical ☐	– continuous rotation ☐
	– horizontal ☐	– intermittent rotation ☐
	– angular ☐ .... °	– cyclic or positioning only ☐
	– variable ☐	

Load characteristics*
Bearing under   compression ☐   shocks ☐
                tension ☐   vibrations ☐

Load		working load average	working load maximum	test	extreme
axial	[kN]				
	lb				
radial	[kN]				
	lb				
tilting moment	[kNm]				
	[10^3.lb.ft]				
torque	[kNm]				
	[10^3.lb.ft]				

Drive ratio*
60 ☐   85 ☐   103 ☐
65 ☐   90 ☐   107 ☐   other ....

Rotational speed
average................................. min^{-1} maximum .... min^{-1}
cyclic operation: number of cycles/hour   .... cycles/hour
                     working angle   ± ....

Operating conditions
number of operating hours   .... hours/day   thereof rotational (oscillatory) time   .... %
number of operating hours   .... hours/year   required life   .... hours

Operating temperature
outer ring   .... °C   .... °C   inner ring   .... °C

Driving motor
type ....   torque ....
coupling of driving motor*   at the left side ☐   at the right side ☐

Remarks: (environmental conditions, dustiness, humidity, aggressive properties, etc.)

Necessary data
Required date of offer   ....   Quoted quantity   .... pcs
Required date of delivery   ....   Annual requirements   .... pcs/year

Please fully complete this form. Incomplete information will delay our proposal.
Individual consultation required. Please call for appointment.*   ☐
*Please check appropriate

Date:	Signature:

NOTES

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