DATORKER®

Strain wave gearbox

Note:
The technical data in this catalogue may
be changed without prior notice.

DATORKER® shaft gear unit

DATORKER® shaft gear unit

DATORKER® shaft gear units are characterised by high precision, high efficiency, high torsional rigidity and low starting torque. They are widely used in robotics, automation, semiconductor technology, machine tools and many other sectors of industry.

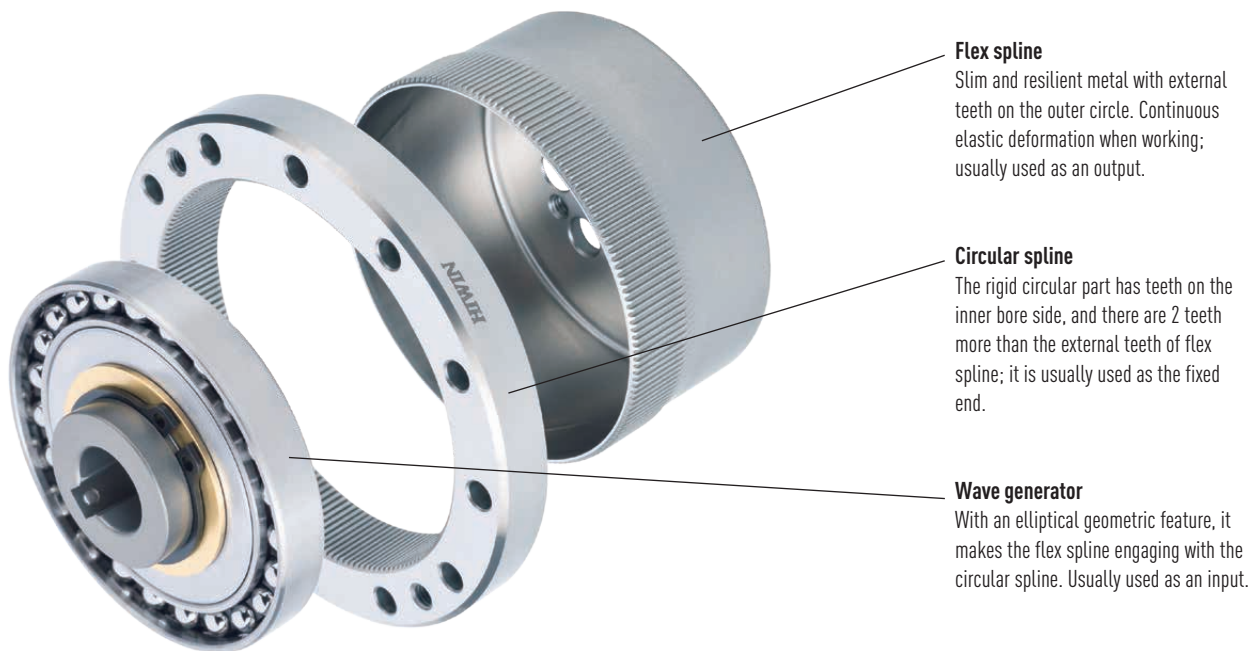# DATORKER® strain wave gearboxes

Contents

1. General information

1.1 Characteristics DATORKER® strain wave gearboxes

DATORKER® strain wave gearboxes has the characteristics of high precision, high efficiency, high torsional rigidity and low starting torque. It is widely used in robots, automation equipment, semiconductor equipment, machine tools and other industries.

Features DATORKER® strain wave gearboxes

- Compact and light weight – Easy for user to assemble and work with
- High accuracy – Provides stable repeatability and positioning
- Improved lubricating properties
- High torque – Widely use in automation and inspection equipment
- Wide reduction ratio – Various choices available under same model

Flex spline
Slim and resilient metal with external teeth on the outer circle. Continuous elastic deformation when working; usually used as an output.

Circular spline
The rigid circular part has teeth on the inner bore side, and there are 2 teeth more than the external teeth of flex spline; it is usually used as the fixed end.

Wave generator
With an elliptical geometric feature, it makes the flex spline engaging with the circular spline. Usually used as an input.

1.1.1 Backlash-free

In a mechanical system, maximum backlash describes the maximum displacement or rotation in a given direction while a part is held stationary. The backlash of the HIWIN DATORKER® shaft gear unit is damped to "0" due to the mechanical construction.
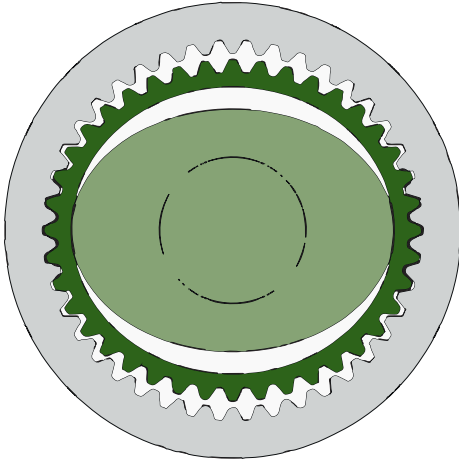

Fig. 1.1 **Mechanical engagement of the teeth of a DATORKER® shaft gear unit**
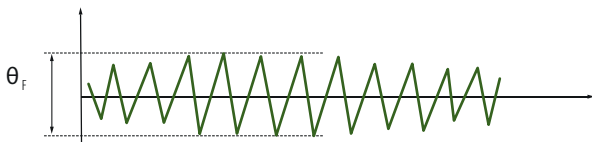
1.1.2 Positioning accuracy

The positioning accuracy depends on several factors. On the one hand, the accuracy of the angular transmission plays a role; this indicates the basic accuracy of the gear unit. In addition, there is angular displacement due to the torsional rigidity; this depends on the applied torque and the resulting angular displacement is subject to a hysteresis loss.

1.1.2.1 Accuracy of angular transmission

With an input angle of rotation (θ_1), a theoretical output angle of rotation (θ_2) results based on the reduction ratio. The difference between the theoretical output rotation angle (θ_2) and the actual output rotation angle (θ_3) indicates the accuracy of the angular transmission (θ_F).

$$\theta_2 = \frac{\theta_1}{\text{Reduction ratio}}$$

$$\theta_F = \theta_3 - \theta_2$$

DATORKER® strain wave gearboxes

General information

1.1.2.2 Torsional rigidity

The torsional rigidity indicates the factor of the change in angle of the gear unit output side as a function of the torque when the input side is stationary. The slope of the ¨torque torsion angle diagram¨ is expressed as a spring constant. The ¨torque torsion angle diagram¨ is divided into three parts and the spring constant of each section represents K_1, K_2 and K_3.

- K_1 refers to the spring constant from ¨0¨ to ¨T_1¨
- K_2 refers to the spring constant from ¨T_1¨ to ¨T_2¨
- K_3 refers to the spring constant with a torque over ¨T_2¨

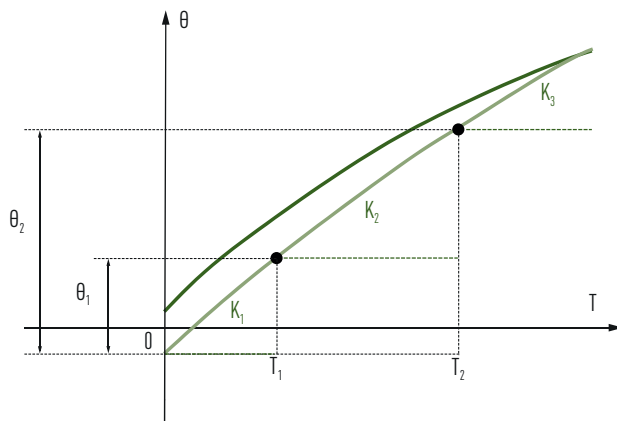Fig. 1.2 **Torque torsion angle diagram**

1.1.2.3 Hysteresis loss

After the torque is applied at the nominal value and reset to ¨0¨, the torsion angle is not completely ¨0¨ and has some displacement (B-B'), which is called hysteresis loss. The hysteresis loss is mainly caused by internal friction. When the torque is extremely small, it is almost non-existent.
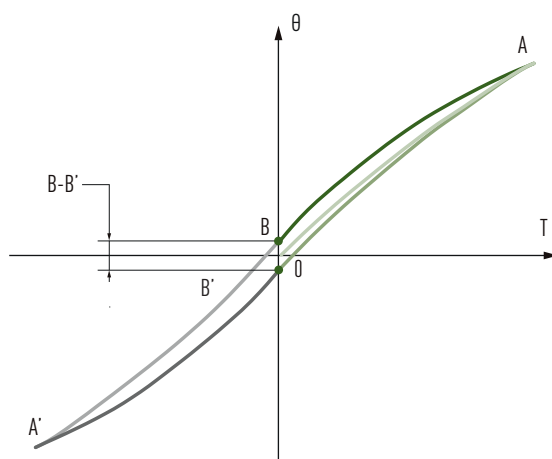
Fig. 1.3 **Hysteresis loss B-B'**

1.1.3 Low starting torque

The starting torque defines the torque required without load to set the gear unit in motion. Because the shaft generator is supported by balls, only the rolling friction has to be overcome, resulting in very low starting torques.

1.1.4.1 Starting torque

The starting torque defines the torque when the shaft generator is used as the drive side of the gear unit. It consists mainly of the rolling friction of the shaft generator and the radial bearings as well as the shaft sealing rings in the sealed series.
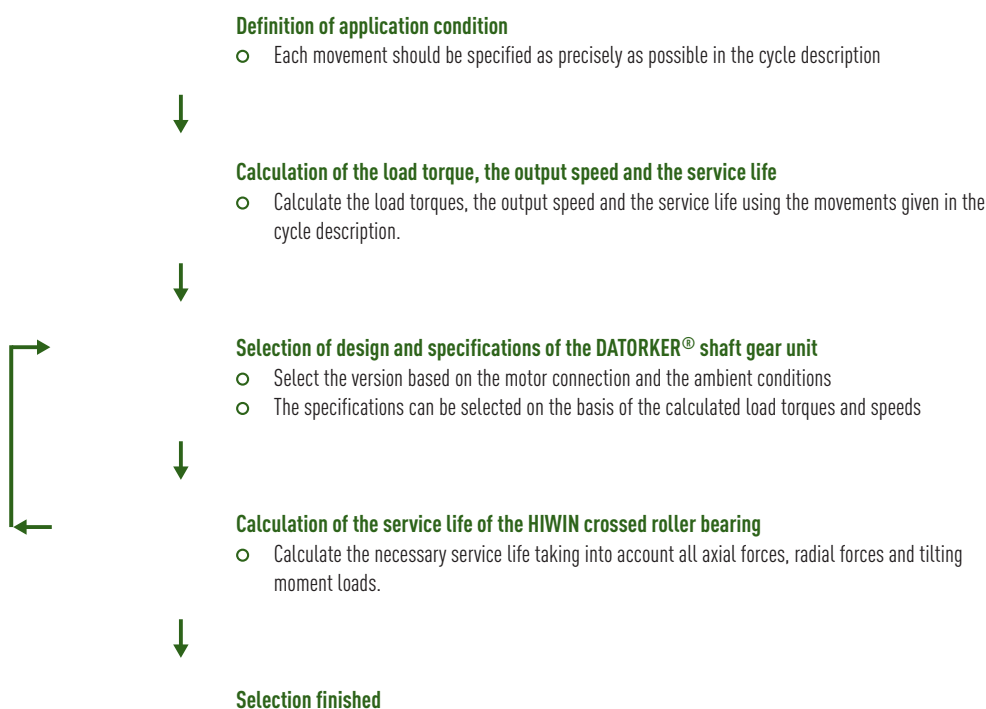
1.1.4.2 Reverse starting torque

The reverse starting torque defines the torque required when the shaft generator is used as the driven side. This is higher because the rotary movement is initiated via the tooth flanks, which creates additional sliding friction.

1.1.4 High tilting moments thanks to integrated crossed roller bearing

HIWIN crossed roller bearings consist of an inner ring, an outer ring, cylindrical rollers arranged at a 90° angle and spacers in between. Due to the cross arrangement of the cylindrical rollers, axial forces from both directions, radial forces, tilting moment loads and any load combinations can be absorbed with just one bearing. Thanks to the direct integration of the bearings into the gear units, DATORKER® shaft gear units are very compact.

2. Selection principle

2.1 Process for selecting a DATORKER® shaft gear unit

Definition of application condition

o   Each movement should be specified as precisely as possible in the cycle description

↓

Calculation of the load torque, the output speed and the service life

o   Calculate the load torques, the output speed and the service life using the movements given in the cycle description.

↓

Selection of design and specifications of the DATORKER® shaft gear unit

o   Select the version based on the motor connection and the ambient conditions
o   The specifications can be selected on the basis of the calculated load torques and speeds

↓

Calculation of the service life of the HIWIN crossed roller bearing

o   Calculate the necessary service life taking into account all axial forces, radial forces and tilting moment loads.

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Selection finished

DATORKER® strain wave gearboxes

Selection principle

2.2 Confirmation of application condition
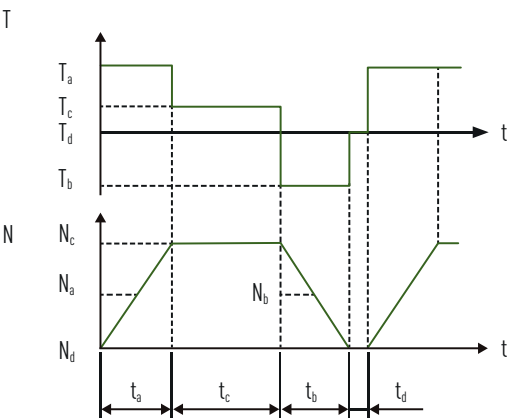
Table 2.1 **Confirmation of application condition**					
	Load torque	Time	Output speed	Maximum output speed	Maximum input speed
Start time (acceleration)	T_a	t_a	N_a	N_{max}	n_{max}
Operating time (constant)	T_c	t_c	N_c		
Stop time (deceleration)	T_b	t_b	N_b		
Switch-off time	T_d	t_d	N_d		
Impact effect	T_e	te	N_e		

2.3 Calculation of the load torque, the speed and the service life

Calculation of the load torque
- $T_{av} \leqslant$ Permissible maximum value of the average load torque

↓

Confirmation
- T_a, $T_b \leqslant$ Permissible peak torque during start/stop

↓

Confirmation
- $T_e \leqslant$ Permissible maximum instantaneous torque

↓

Calculation
- $n_{av} \leqslant$ Permissible average input speed
- $n_{max} \leqslant$ Permissible maximum input speed

↓

Calculation
- $L_{10} \leqslant$ Nominal service life of the gear unit 7,000 hours,
  Nominal service life of the gear unit at L_{50} 35,000 hours
- Determine the required service life, taking into account the load torque and the input speed

2.3.1 Maximum permissible value of the average load torque
When the input speed or load torque changes, please calculate the average load torque and confirm whether it is in accordance with the values in the nominal power table of each specification. Please note that a value exceeding the catalogue value may cause premature ageing of the lubricant and abnormal gear wheel wear due to heat.

F 2.1

$$T_{av} = \sqrt[3]{\frac{N_1 t_1 |T_1|^3 + N_2 t_2 |T_2|^3 + \cdots + N_n t_n |T_n|^3}{N_1 t_1 + N_2 t_2 + \cdots N_n t_n}}$$

2.3.2 Permissible peak torque during start/stop
During starting and stopping, a load greater than the average torque is applied to the gear unit due to the moment of inertia of the load.

2.3.3 Permissible maximum instantaneous torque
The permissible maximum instantaneous torque is the maximum permissible load torque in the event of an impact.

2.3.4 Permissible average input speed and permissible maximum input speed
When setting the operating conditions of the gear unit, do not exceed the value specified in the nominal power table.

DATORKER® strain wave gearboxes

Selection principle

Calculation of the average output speed

F 2.2

$$N_{av} = \frac{N_1 t_1 + N_2 t_2 + \cdots + N_n t_n}{t_1 + t_2 + \cdots + t_n}$$

Calculation of the average input speed

F 2.3

$$n_{av} = N_{av} \times R$$

R = Reduction ratio

Calculation of the maximum input speed

F 2.4

$$n_{max} = N_{max} \times R$$

2.3.5 Nominal service life of the gear unit

The service life of the gear unit depends on the flexible bearing of the shaft generator.
The nominal service life of the shaft generator is 35,000 hours. The calculation
formula is as follows:

F 2.5

$$L_{50} = 35.000 \times \left(\frac{T_r}{T_{av}}\right) \times \left(\frac{n_r}{n_{av}}\right)$$

T_r = Nominal torque
n_r = Nominal speed

F 2.6

$$L_{10} = \frac{L_{50}}{5}$$

2.4 Selection of DATORKER® shaft gear unit design and specification

Select the DATORKER® shaft gear unit design according to the operating requirements and
check the nominal power table of each unit according to the calculation results from the
previous step to confirm whether the selected model specifications match the application.
If the gear unit contains a crossed roller bearing, please proceed to the next step and
calculate the service life of the crossed roller bearing.

2.5 Calculation of the service life of the crossed roller bearing

Calculation

○ $M_{max} \leq$ Maximum static load torque

Select other size

← ↓

Selection of design and specifications of the DATORKER® shaft gear unit

Calculation of the service life of the crossed roller bearing

← ↓

or add an extra bearing support

Calculation of safety factor

← ↓

Completing the selection
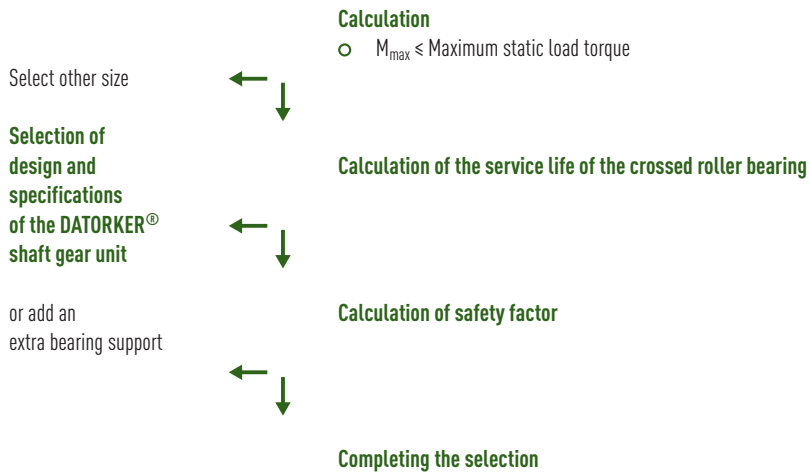
2.6 Calculation of efficiency

Due to the mechanical properties of the gear unit, the efficiency changes depending on various factors. These include, above all, the speed, the temperature and the load ratio under which the gear unit is used. To be sure that the motor is correctly dimensioned, always start from the most unfavourable conditions. The graphs for determining the efficiency can be found in the technical data of the respective series.

DATORKER® strain wave gearboxes

Selection principle

2.7 Order code DATORKER® strain wave gearboxes

W	T	I	S	25	80	P	O

DATORKER® strain wave gearbox

Type of flex spline :
U : Cup type
T : Hollow type

Type of circular :
I : Ring type
T : Flange type

Series :
S : Standard

Model :
14, 17, 20, 25, 32

Input type :
O : Hub with feather keyway
H : Hollow shaft

Module type :
C : Component type with gear without bearing
P : Combination type with gear and bearing
A : Sealed type with gear, bearing and seal

Reduction ratio :
50, 80, 100, 120
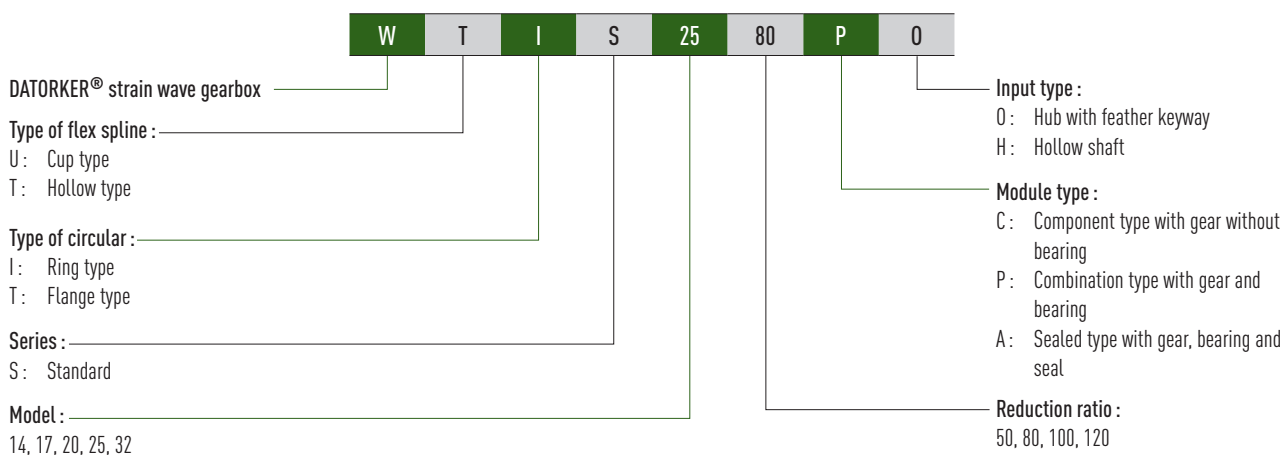
2.8 Type/Function

WUT Type
o Combination type (P) with gear and bearing
o Input shaft with fether keyway
o Whitstand axial and radial load

WUI Type
o Component type (C) with gear without bearing
o Input shaft with feather keyway
o Self-assembly of parts required: flex spline and circular spline ar not screwed together

WTI Type
o Combination type (P) with gear and bearing
o Input hollow shaft design
o Whitstand axial and radial load

WTI Type
o Sealed type (A) with gear, bearing and seal
o Input hollow shaft design
o Whitstand axial and radial load
o Completely sealed design
o User friendly design

2.9 Technical data

2.9.1 Specification Table

Table 2.2 **Specification Table**

| Model	Reduction Ratio	Rated torque at input 2000 r/min	Peak torque at start / stop	Permissible max. of value of average load torque	Permissible impact torque	Permissible maximum input speed	Permissible average input speed
		Nm	Nm	Nm	Nm	r/min	r/min
14	50	5.4	18.0	6.9	35.0	8,500	3,500
	80	7.8	23.0	11.0	47.0		
	100	7.8	28.0	11.0	54.0		
17	50	16.0	34.0	26.0	70.0	7,300	3,500
	80	22.0	43.0	27.0	87.0		
	100	24.0	54.0	39.0	108.0		
	120	24.0	54.0	39.0	86.0		
20	50	25.0	56.0	34.0	98.0	6,500	3,500
	80	34.0	74.0	47.0	127.0		
	100	40.0	82.0	49.0	147.0		
	120	40.0	87.0	49.0	147.0		
25	50	39.0	98.0	55.0	186.0	5,600	3,500
	80	63.0	137.0	87.0	255.0		
	100	67.0	157.0	108.0	284.0		
	120	67.0	167.0	108.0	304.0		
32	50	76.0	216.0	108.0	382.0	4,800	3,500
	80	118.0	304.0	167.0	568.0		
	100	137.0	333.0	216.0	647.0		
	120	137.0	353.0	216.0	686.0		

2.9.2 Reduction ratio and rotation direction
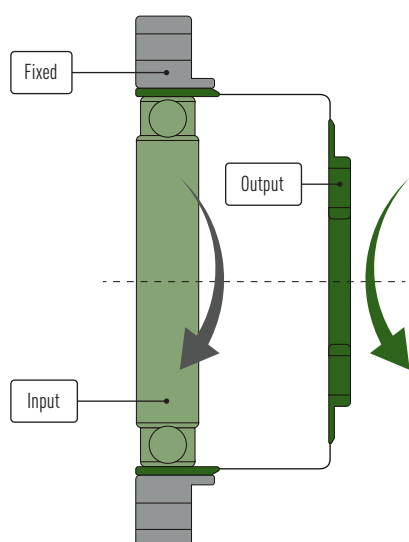
Input and Output with reverse direction rotation

Effective reduction ratio = (–1) × R

(R = Reduction ratio from Datasheet)
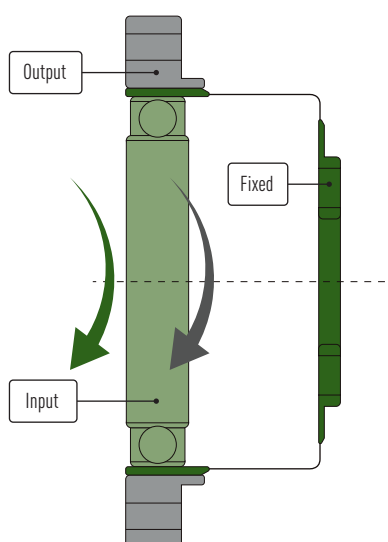
Input and Output with the same direction rotation

Effective reduction ratio = R + 1

3. WUI-CO

Model 14/17
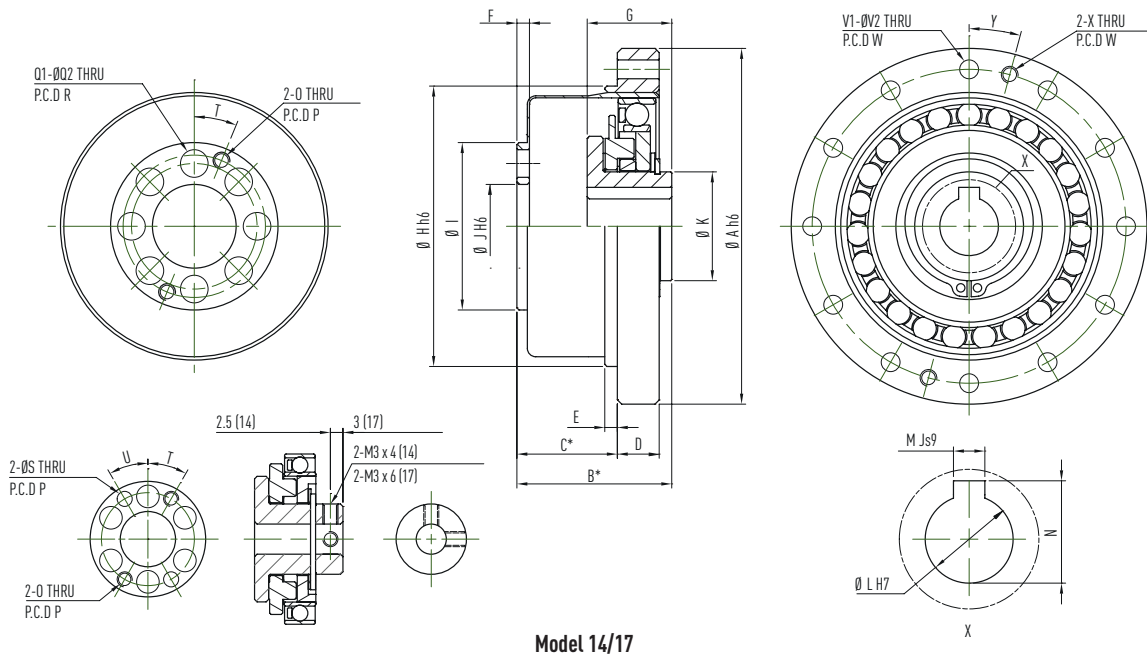
Table 3.1 **Dimensions of WUI-CO strain wave gearboxes**						
Model	Unit	14	17	20	25	32
ØA h6	mm	50.0	60.0	70.0	85.0	110.0
B [1]	mm	$28.5_{-0.8}$	$32.5_{-0.9}$	$33.5_{-1.0}$	$37.0_{-1.0}$	$44.0_{-1.1}$
C [1]	mm	$17.5^{+0.4}$	$20.0^{+0.5}$	$21.5^{+0.6}$	$24.0^{+0.6}$	$28.0^{+0.6}$
D	mm	6.0	6.5	7.5	10.0	14.0
E	mm	2.0	2.5	3.0	3.0	3.0
F	mm	2.4	3.0	3.0	3.0	3.2
G	mm	$17.6_{-0.1}$	$19.5_{-0.1}$	$20.1_{-0.1}$	$20.2_{-0.1}$	$22.0_{-0.1}$
ØH h6	mm	38.0	48.0	54.0	67.0	90.0
ØI	mm	23.0	27.2	32.0	40.0	52.0
J H6	mm	11.0	10.0	16.0	20.0	26.0
ØK	mm	14.0	18.0	21.0	26.0	26.0
ØL H7	mm	6.0	8.0	9.0	11.0	14.0
M Js9	mm	–	–	3.0	4.0	5.0
N	mm	–	–	$10.4^{+0.1}$	$12.8^{+0.1}$	$16.3^{+0.1}$
O	mm	M3	M3	M3	M4	M5
P (P.C.D)	mm	18.5	21.5	27.0	34.0	45.0
Q1	mm	6.0	6.0	8.0	8.0	8.0
ØQ2	mm	4.5	5.5	5.5	6.6	9.0
R (P.C.D)	mm	17.0	19.0	24.0	30.0	40.0
S	mm	$3.0^{+0.015}$	$3.0^{+0.015}$	–	–	–
T	Degree	30°	30°	22.5°	22.5°	22.5°
U	Degree	30°	30°	–	–	–
V1	mm	6.0	12.0	12.0	12.0	12.0
ØV2	mm	3.5	3.5	3.5	4.5	5.5
W (P.C.D)	mm	44.0	54.0	62.0	75.0	100.0
X	mm	M3	M3	M3	M4	M5
Y	Degree	30°	15°	15°	15°	15°
Moment of inertia	×10⁻⁴ kgm²	0.033	0.079	0.193	0.413	1.69
Weight	kg	0.09	0.15	0.28	0.45	0.89

[1] B and C is the tolerance and the matching position of axial direction

3.1 WUI-C0 design

3.1.1 Technical data

Table 3.2 **Accuracy of angular transmission**						
Reduction ratio		Model				
		14	17	20	25	32
50 – 120	×10⁻⁴ rad	4.4	4.4	2.9	2.9	2.9

Table 3.3 **Hysteresis loss**						
Reduction ratio		Model				
		14	17	20	25	32
50	×10⁻⁴ rad	5.8	5.8	5.8	5.8	5.8
80 – 120	×10⁻⁴ rad	2.9	2.9	2.9	2.9	2.9

Table 3.4 **Starting torque**					
Reduction ratio	Model				
	14	17	20	25	32
50	3.3	5.1	6.6	12.0	26
80	2.4	3.3	4.1	7.7	16
100	2.1	2.9	3.7	6.9	15
120	–	2.7	3.3	6.3	13

Unit: cNm
Note: The values in this table vary depending on the working conditions and are for reference purposes only. The upper limit is 20% above the value in this table.

Table 3.5 **Reverse starting torque**					
Reduction ratio	Model				
	14	17	20	25	32
50	1.4	2.5	4.0	7.5	16
80	1.4	2.5	4.2	7.7	16
100	1.7	2.8	4.5	8.4	18
120	–	3.1	4.9	9.2	19

Unit: Nm
Note: The values in this table vary depending on the working conditions and are for reference purposes only. The upper limit is 20% above the value in this table.

DATORKER® strain wave gearboxes

WUI-CO

Table 3.6 **Torsional rigidity**

Reduction ratio			Model				
			14	17	20	25	32
T1		Nm	2.0	3.9	7.0	14.0	29.0
T2		Nm	6.9	12.0	25.0	48.0	108..,0
50	K_1	×10⁴ Nm/rad	0.34	0.81	1.3	2.5	5.4
	K_2	×10⁴ Nm/rad	0.47	1.1	1.8	3.4	7.8
	K_3	×10⁴ Nm/rad	0.57	1.3	2.3	4.4	9.8
	θ_1	×10⁻⁴ rad	5.8	4.9	5.2	5.5	5.5
	θ_2	×10⁻⁴ rad	16.0	12.0	15.4	15.7	15.7
80 – 120	K_1	×10⁴ Nm/rad	0.47	1.0	1.6	3.1	6.7
	K_2	×10⁴ Nm/rad	0.61	1.4	2.5	5.0	11.0
	K_3	×10⁴ Nm/rad	0.71	1.6	2.9	5.7	12.0
	θ_1	×10⁻⁴ rad	4.1	3.9	4.4	4.4	4.4
	θ_2	×10⁻⁴ rad	12.0	9.7	11.3	11.1	11.6

The values are for reference purposes only. The lower limit is 20% below the value in this table.

3.1.2 Efficiency E_R

The efficiency of DATORKER® shaft gear units changes depending on the specification, load ratio, operating conditions (speed/load) and lubrication (lubricant type/amount).

E_R = Efficiency at nominal torque
T = Temperature
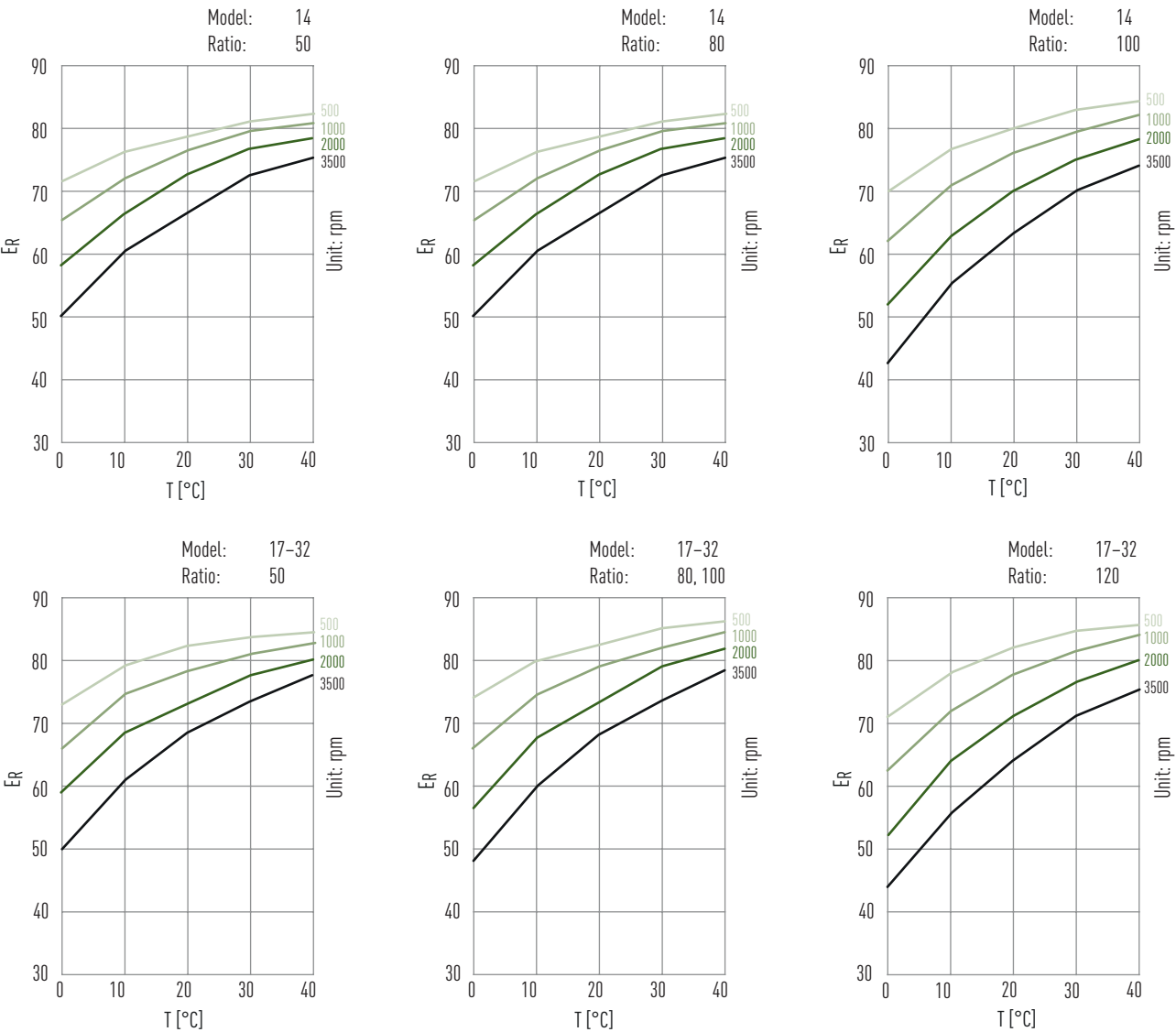
Correction coefficient α
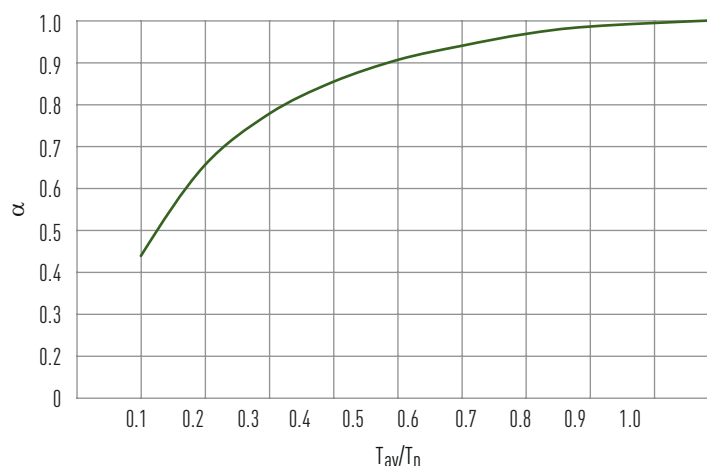
Efficiency = $\alpha \times E_R$

α = Correction coefficient

E_R = Efficiency at nominal torque

T_{av} = Average load torque

T_n = Rated torque

T_{av} / T_n = Torque ratio

3.1.3 Idling operating torque

The idling operating torque is the torque required to drive the DATORKER® shaft gear input (high speed end) after more than 2 hours at an input speed of 2,000 rpm at an average ambient temperature of 25 °C without load.

Table 3.7 **Idling operating torque**

Reduction ratio	Input speed	Model				
		14	17	20	25	32
50	500 rpm	1.8	3.4	5.1	9.7	21.2
	1,000 rpm	2.3	4.4	6.9	12.5	27.2
	2,000 rpm	3.1	5.8	9.4	18.5	37.2
	3,500 rpm	4.2	7.9	13.4	25.5	50.2
80	500 rpm	1.4	2.6	3.9	7.6	16.8
	1,000 rpm	1.9	3.6	5.7	10.4	22.8
	2,000 rpm	2.7	5.0	8.2	16.4	32.8
	3,500 rpm	3.8	7.1	12.2	23.4	45.8
100	500 rpm	1.3	2.5	3.7	7.2	16.0
	1,000 rpm	1.8	3.5	5.5	10.0	22.0
	2,000 rpm	2.6	4.9	8.0	16.0	32.0
	3,500 rpm	3.7	7.0	12.0	23.0	45.0
120	500 rpm	–	2.4	3.5	6.9	15.4
	1,000 rpm	–	3.4	5.2	9.7	21.4
	2,000 rpm	–	4.8	7.8	15.7	31.4
	3,500 rpm	–	6.9	11.8	22.7	44.4

Unit: cNm

Note: The values in this table vary depending on the working conditions and are for reference purposes only. The upper limit is 20% above the value in this table.

4. WUT-PO

Model 14/17
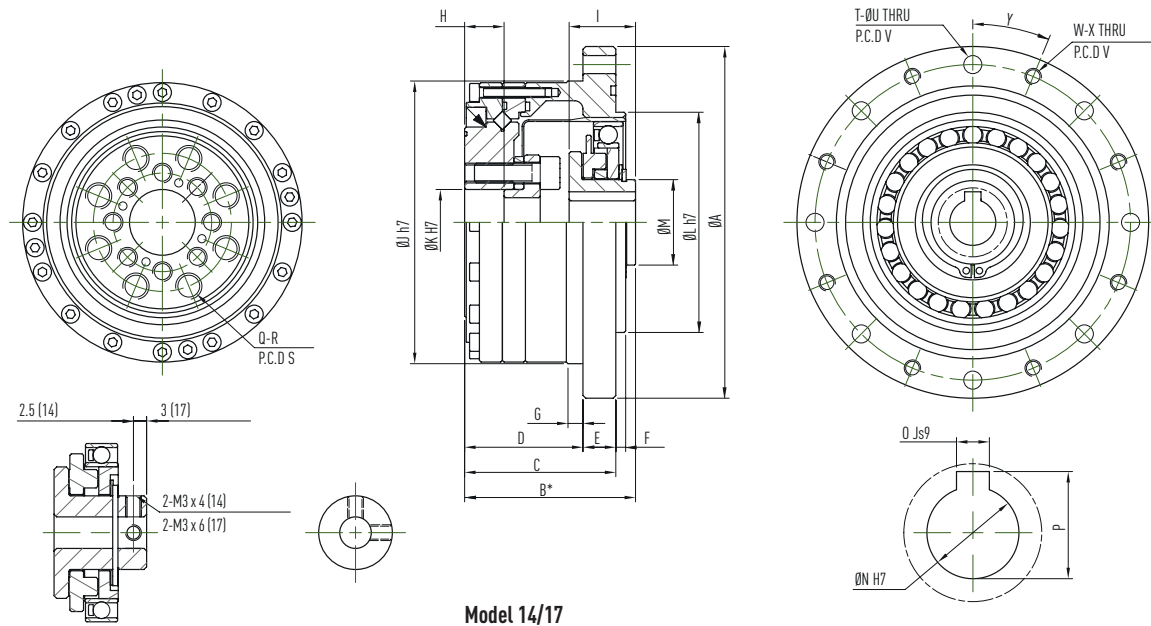
Table 4.1 **Dimensions of WUT-PO strain wave gearboxes**						
Model	Unit	14	17	20	25	32
ØA	mm	73.0	79.0	93.0	107.0	138.0
B [1]	mm	$41.0_{-0.9}$	$45.0_{-0.9}$	$45.5_{-1.0}$	$52.0_{-1.0}$	$62.0_{-1.1}$
C	mm	34.0	37.0	38.0	46.0	57.0
D	mm	27.0	29.0	28.0	36.0	45.0
E	mm	7.0	8.0	10.0	10.0	12.0
F	mm	2.0	2.0	3.0	3.0	3.0
G	mm	3.5	4.0	5.0	5.0	5.0
H	mm	9.4	9.5	9.0	12.0	15.0
I	mm	$17.6_{-0.1}$	$19.5_{-0.1}$	$20.1_{-0.1}$	$20.2_{-0.1}$	$22.0_{-0.1}$
ØJ h7	mm	56.0	63.0	72.0	86.0	113.0
ØK H7	mm	11.0	10.0	14.0	20.0	26.0
ØL h7	mm	38.0	48.0	56.0	67.0	90.0
ØM	mm	14.0	18.0	21.0	26.0	26.0
ØN H7	mm	6.0	8.0	12.0	14.0	14.0
O Js9	mm	–	–	4.0	5.0	5.0
P	mm	–	–	$13.8^{+0.1}$	$16.3^{+0.1}$	$16.3^{+0.1}$
Q	mm	6.0	6.0	8.0	8.0	8.0
R	mm	M4 x 8DP	M5 x 10DP	M6 x 9DP	M8 x 12DP	M10 x 15DP
S (P.C.D)	mm	23.0	27.0	32.0	42.0	55.0
T	mm	6.0	6.0	6.0	8.0	12.0
ØU	mm	4.5	4.5	5.5	5.5	6.6
V (P.C.D)	mm	65.0	71.0	82.0	96.0	125.0
W	mm	6.0	6.0	6.0	8.0	12.0
X	mm	M4	M4	M5	M5	M6
Y	Degree	30°	30°	30°	22.5°	15°
Moment of inertia	×10⁻⁴ kgm²	0.033	0.079	0.193	0.413	1.69
Weight	kg	0.52	0.68	0.98	1.5	3.2

[1] B is the tolerance and the matching position of axial direction.

4.1 WUT-PO design

4.1.1 Technical data

Table 4.2 **Crossed roller bearing specifications**						
Model	Centre circle diameter of the rollers	Offset	Basic load ratings		Permitted torque	Moment rigidity
	Dpw	R	Dynamic load C_{dyn}	Static load C_0		
	m	m	kN	kN	Nm	$\times 10^4$ Nm/rad
14	0.0350	0.0095	4.7	6.1	41	4.38
17	0.0425	0.0095	5.3	7.6	64	7.75
20	0.0500	0.0095	5.8	9.0	91	12.80
25	0.0620	0.0115	9.6	15.1	156	24.20
32	0.0800	0.0130	15.0	25.0	313	53.90

Table 4.3 **Accuracy of angular transmission**						
Reduction ratio		Model				
		14	17	20	25	32
50 – 120	$\times 10^{-4}$ rad	4.4	4.4	2.9	2.9	2.9

Table 4.4 **Hysteresis loss**						
Reduction ratio		Model				
		14	17	20	25	32
50	$\times 10^{-4}$ rad	5.8	5.8	5.8	5.8	5.8
80 – 120	$\times 10^{-4}$ rad	2.9	2.9	2.9	2.9	2.9

Table 4.5 **Starting torque**					
Reduction ratio	Model				
	14	17	20	25	32
50	4.1	6.1	7.8	15.0	31
80	2.8	4.0	4.9	9.2	19
100	2.5	3.4	4.3	8.0	18
120	–	3.1	3.8	7.3	15

Unit: cNm
Note: The values in this table vary depending on the working conditions and are for reference purposes only. The upper limit is 20% above the value in this table.

Table 4.6 **Reverse starting torque**					
Reduction ratio	Model				
	14	17	20	25	32
50	1.6	3.0	4.7	9.0	18
80	1.6	3.0	4.8	9.1	19
100	1.8	3.3	5.1	9.8	20
120	–	3.5	5.5	11.0	22

Unit: Nm
Note: The values in this table vary depending on the working conditions and are for reference purposes only. The upper limit is 20% above the value in this table.

DATORKER® strain wave gearboxes

WUT-PO

Table 4.7 **Torsional rigidity**							
Reduction ratio		Model				
		14	17	20	25	32
T1	Nm	2.0	3.9	7.0	14.0	29.0
T2	Nm	6.9	12.0	25.0	48.0	108.0
50	K_1 ×10⁴ Nm/rad	0.34	0.81	1.3	2.5	5.4
	K_2 ×10⁴ Nm/rad	0.47	1.1	1.8	3.4	7.8
	K_3 ×10⁴ Nm/rad	0.57	1.3	2.3	4.4	9.8
	θ_1 ×10⁻⁴ rad	5.8	4.9	5.2	5.5	5.5
	θ_2 ×10⁻⁴ rad	16.0	12.0	15.4	15.7	15.7
80 – 120	K_1 ×10⁴ Nm/rad	0.47	1.0	1.6	3.1	6.7
	K_2 ×10⁴ Nm/rad	0.61	1.4	2.5	5.0	11.0
	K_3 ×10⁴ Nm/rad	0.71	1.6	2.9	5.7	12.0
	θ_1 ×10⁻⁴ rad	4.1	3.9	4.4	4.4	4.4
	θ_2 ×10⁻⁴ rad	12.0	9.7	11.3	11.1	11.6

The values are for reference purposes only. The lower limit is 20% below the value in this table.

4.1.2 Efficiency E_R

The efficiency of DATORKER® shaft gear units changes depending on the specification, load ratio, operating conditions (speed/load) and lubrication (lubricant type/amount).

E_R = Efficiency at nominal torque
T = Temperature
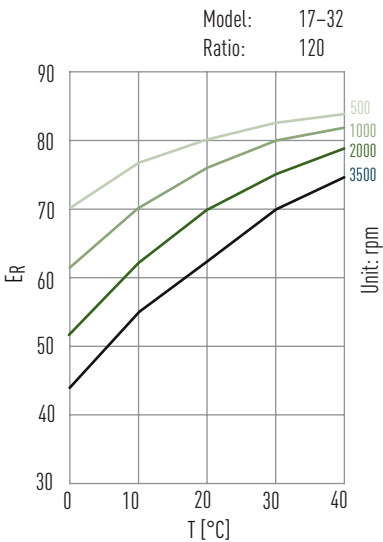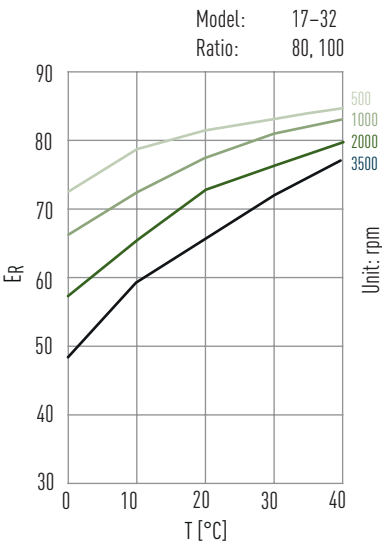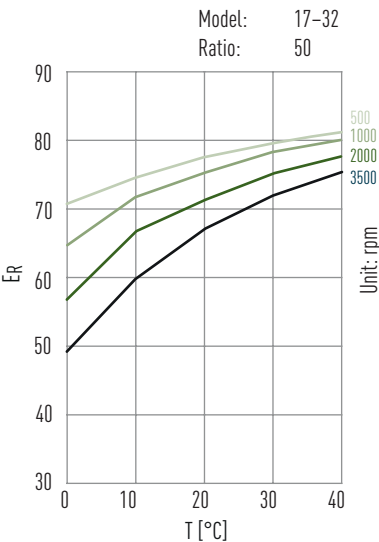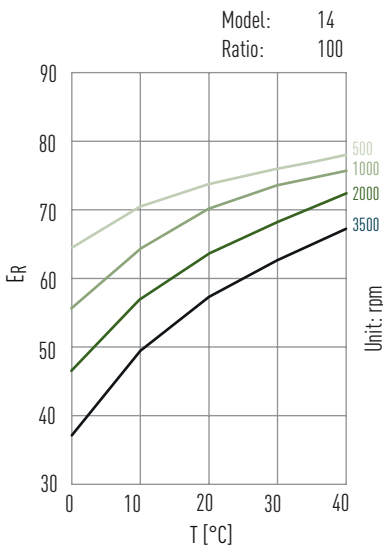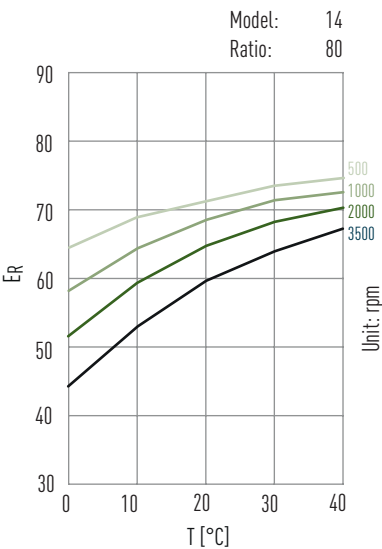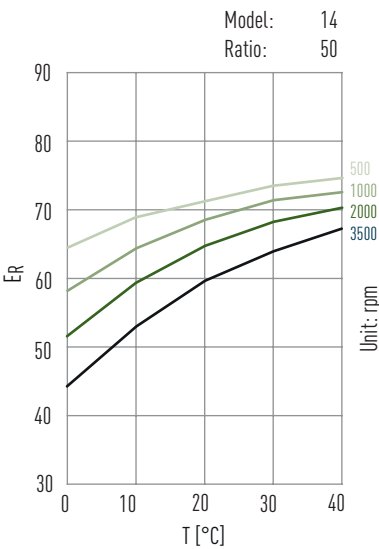
Correction coefficient α

Efficiency = $\alpha \times E_R$

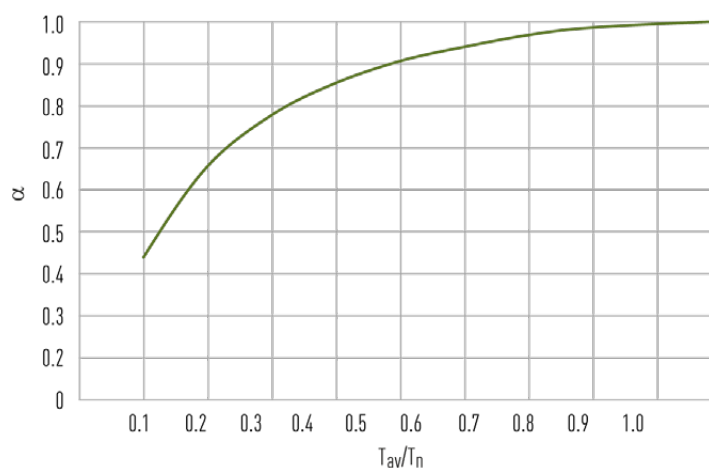α = Correction coefficient

E_R = Efficiency at nominal torque

T_{av} = Average load torque

T_n = Rated torque

T_{av} / T_n = Torque ratio

4.1.3 Idling operating torque

The idling operating torque is the torque required to drive the DATORKER® shaft gear input (high speed end) after more than 2 hours at an input speed of 2,000 rpm at an average ambient temperature of 25 °C without load.

Table 4.8 **Idling operating torque**

| Reduction ratio	Input speed	Model				
		14	17	20	25	32
50	500 rpm	3.2	5.1	7.3	12.8	26.1
	1,000 rpm	3.9	6.1	9.1	17.8	33.1
	2,000 rpm	4.6	7.6	11.8	21.8	44.1
	3,500 rpm	5.9	9.6	12.7	28.8	57.1
80	500 rpm	2.3	3.8	5.5	9.7	20.3
	1,000 rpm	3.0	4.8	7.3	14.7	27.3
	2,000 rpm	3.7	6.3	10.0	18.7	38.3
	3,500 rpm	5.0	8.3	10.9	25.7	51.3
100	500 rpm	2.1	3.5	5.0	9.0	19.0
	1,000 rpm	2.8	4.5	6.8	14.0	26.0
	2,000 rpm	3.5	6.0	9.5	18.0	37.0
	3,500 rpm	4.8	8.0	10.4	25.0	50.0
120	500 rpm	–	3.3	4.7	8.5	18.1
	1,000 rpm	–	4.3	6.5	13.5	25.1
	2,000 rpm	–	5.8	9.2	17.5	36.1
	3,500 rpm	–	7.8	10.1	24.5	17.2

Unit: cNm

Note: The values in this table vary depending on the working conditions and are for reference purposes only. The upper limit is 20% above the value in this table.

5. WTI-PH

Model 14/17

Table 5.1 **Dimensions of WTI-PH strain wave gearboxes**
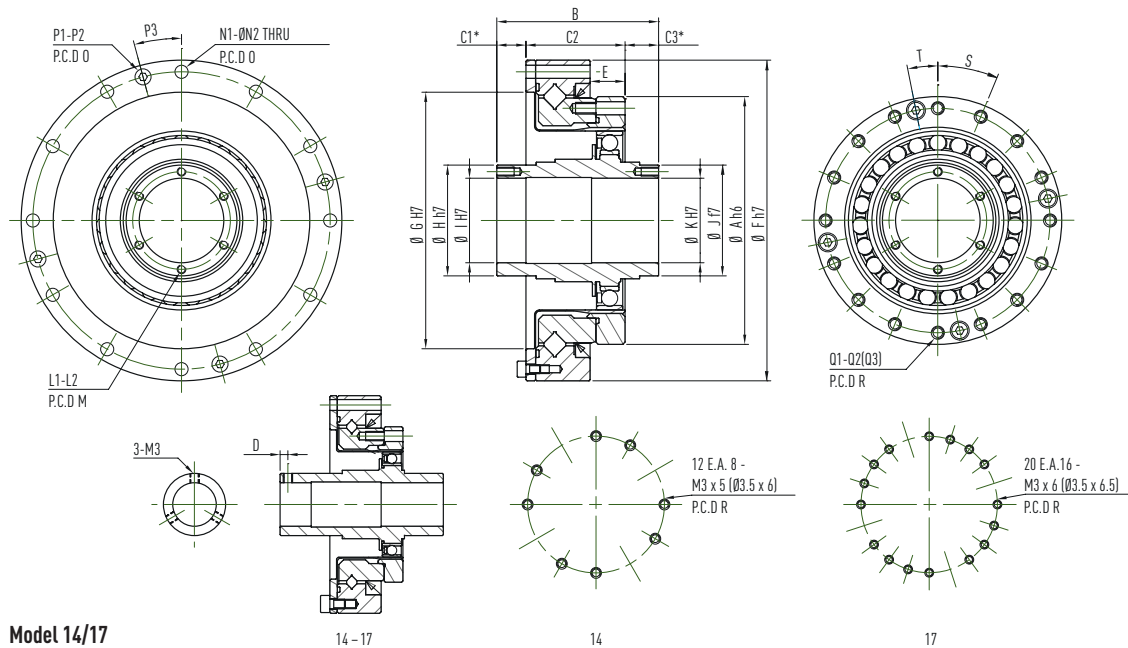
Model	Unit	14	17	20	25	32
ØA h6	mm	50.0	60.0	70.0	85.0	110.0
B	mm	52.5 -0.1	56.5 -0.1	51.5 -0.1	52.0 -1.0	62.0 -1.1
C1 [1]	mm	16.0 +0.8	16.0 +0.9	9.5 +1.0	10.0 +1.1	12.0 +1.1
C2	mm	23.5	26.5	29.0	34.0	42.0
C3 [1]	mm	13.0	14.0	13.0	11.5	11.5
D	mm	2.5	2.5	–	–	–
E	mm	7.0	7.5	8.5	12.0	15.0
ØF h7	mm	70.0	80.0	90.0	110.0	142.0
ØG H7	mm	48.0	60.0	70.0	88.0	114.0
ØH h7	mm	20.0	25.0	30.0	38.0	45.0
ØI H7	mm	14.0	19.0	21.0	29.0	36.0
ØJ f7	mm	20.0	25.0	30.0	38.0	45.0
ØK H7	mm	14.0	19.0	21.0	29.0	36.0
L1	mm	3.0	3.0	2x6	2x6	2x6
L2	mm	M3	M3	M3 x DP6	M3 x DP6	M3 x DP6
M (P.C.D)	mm	–	–	25.5	33.5	40.5
N1	mm	8.0	12.0	12.0	12.0	12.0
ØN2	mm	3.5	3.5	3.5	4.5	5.5
O (P.C.D)	mm	64.0	74.0	84.0	102.0	132.0
P1	mm	2.0	4.0	4.0	4.0	4.0
P2	mm	M3	M3	M3	M3	M4
P3	Degree	22.5°	15°	15°	15°	15°
Q1	mm	12 E.A. 8	20 E.A. 16	16.0	16.0	16.0
Q2	mm	M3 x 5DP	M3 x 6DP	M3 x 6DP	M4 x 7DP	M5 x 8DP
Q3	mm	Ø3.5 x 6DP	Ø3.5 x 6.5DP	Ø3.5 x 7.5DP	Ø4.5 x 10DP	Ø5.5 x 14DP
ØR	mm	44.0	54.0	62.0	77.0	100.0
S	Degree	30°	18°	22.5°	22.5°	22.5°
T	Degree	30°	18°	11.25°	11.25°	11.25°
Moment of inertia	×10^{-4} kgm^2	0.033	0.079	0.193	0.413	1.69
Weight	kg	0.45	0.63	0.89	1.44	3.1

[1] C1, C3 is the tolerance and the matching position of axial direction.

5.1 WTI-PH design

5.1.1 Technical data

Table 5.2 **Crossed roller bearing specifications**						
Model	Centre circle diameter of the rollers	Offset	Basic load ratings		Permitted torque	Moment rigidity
	Dpw	R	Dynamische Traglast C_{dyn}	Statische Traglast C_0		
	m	m	kN	kN	Nm	×10⁴ Nm/rad
14	0.050	0.0217	5.8	8.6	74	8.5
17	0.060	0.0239	10.4	16.3	124	15.4
20	0.070	0.0255	14.6	22.0	187	25.2
25	0.085	0.0296	21.8	35.8	258	39.2
32	0.111	0.0364	38.2	65.4	580	100.0

Table 5.3 **Accuracy of angular transmission**						
Reduction ratio		Model				
		14	17	20	25	32
50 – 120	×10⁻⁴ rad	4.4	4.4	2.9	2.,9	2.9

Table 5.4 **Hysteresis loss**						
Reduction ratio		Model				
		14	17	20	25	32
50	×10⁻⁴ rad	5.8	5.8	5.8	5.8	5.8
80 – 120	×10⁻⁴ rad	2.9	2.9	2.9	2.9	2.9

Table 5.5 **Starting torque**					
Reduction ratio	Model				
	14	17	20	25	32
50	4.1	6.1	7.8	15.0	31
80	2.8	4.0	4.9	9.2	19
100	2.5	3.4	4.3	8.0	18
120	–	3.1	3.8	7.3	15

Unit: cNm
Note: The values in this table vary depending on the working conditions and are for reference purposes only. The upper limit is 20% above the value in this table.

Table 5.6 **Reverse starting torque**					
Reduction ratio	Model				
	14	17	20	25	32
50	1.6	3.0	4.7	9.0	18
80	1.6	3.0	4.8	9.1	19
100	1.8	3.3	5.1	9.8	20
120	–	3.5	5.5	11.0	22

Unit: Nm
Note: The values in this table vary depending on the working conditions and are for reference purposes only. The upper limit is 20% above the value in this table.

DATORKER® strain wave gearboxes

WTI-PH

Table 5.7 **Torsional rigidity**							
Reduction ratio			Model				
			14	17	20	25	32
T1		Nm	2.0	3.9	7.0	14.0	29.0
T2		Nm	6.9	12.0	25.0	48.0	108.0
50	K_1	$\times 10^4$ Nm/rad	0.34	0.81	1.3	2.5	5.4
	K_2	$\times 10^4$ Nm/rad	0.47	1.1	1.8	3.4	7.8
	K_3	$\times 10^4$ Nm/rad	0.57	1.3	2.3	4.4	9.8
	θ_1	$\times 10^{-4}$ rad	5.8	4.9	5.2	5.5	5.5
	θ_2	$\times 10^{-4}$ rad	16.0	12.0	15.4	15.7	15.7
80 – 120	K_1	$\times 10^4$ Nm/rad	0.47	1.0	1.6	3.1	6.7
	K_2	$\times 10^4$ Nm/rad	0.61	1.4	2.5	5.0	11.0
	K_3	$\times 10^4$ Nm/rad	0.71	1.6	2.9	5.7	12.0
	θ_1	$\times 10^{-4}$ rad	4.1	3.9	4.4	4.4	4.4
	θ_2	$\times 10^{-4}$ rad	12.0	9.7	11.3	11.1	11.6

The values are for reference purposes only. The lower limit is 20% below the value in this table.

6. WTI-AH

Model 14/17

Table 6.1 **Dimensions of WTI-AH strain wave gearboxes**

Model	Unit	14	17	20	25	32
ØA h7	mm	70.0	80.0	90.0	110.0	142.0
ØB	mm	54.0	64.0	75.0	90.0	115.0
ØC h7	mm	36.0	45.0	50.0	60.0	85.0
ØD h7	mm	74.0	84.0	95.0	115.0	147.0
ØE h7	mm	20.0	25.0	30.0	38.0	45.0
ØF H7	mm	14.0	19.0	21.0	29.0	36.0
G	mm	52.5	56.5	51.5	55.5	65.5
H	mm	12.0	12.0	5.0	6.0	7.0
I	mm	20.5	23.0	25.0	26.0	32.0
J	mm	20.0	21.5	21.5	23.5	26.5
K	mm	5.5	5.5	–	–	–
L	mm	9.0	10.0	10.5	10.5	12.0
M	mm	8.0	8.5	9.0	8.5	9.5
N	mm	7.5	8.5	7.0	6.0	5.0
O	mm	2.5	2.5	–	–	–
P	mm	36.0	45.0	–	–	–
Q	mm	3.0	3.0	2x6	2x6	2x6
R	mm	M3	M3	M3 x DP6	M3 x DP6	M3 x DP6
S (P.C.D)	mm	–	–	25.5	33.5	40.5
T	mm	8.0	12.0	12.0	12.0	12.0
ØU	mm	3.5	3.5	3.5	4.5	5.5
V (P.C.D)	mm	64.0	74.0	84.0	102.0	132.0
W1	mm	12 E.A. 8	20 E.A. 16	16.0	16.0	16.0
W2	mm	M3 x 5DP	M3 x 6DP	M3 x 6DP	M4 x 7DP	M5 x 8DP
W3	mm	Ø3.5 x 11.5DP	Ø3.5 x 12DP	Ø3.5 x 13.5DP	Ø4.5 x 15.5DP	Ø5.5 x 20.5DP
X (P.C.D)	mm	44.0	54.0	62.0	77.0	100.0
Y	Degree	30°	18°	22.5°	22.5°	22.5°
Z	Degree	30°	18°	11.25°	11.25°	11.25°
Moment of inertia	×10⁻⁴ kgm²	0.091	0.193	0.404	1.07	2.85
Weight	kg	0.71	1.0	1.38	2.1	4.5

DATORKER® strain wave gearboxes

WTI-AH

6.1 WTI-AH design

6.1.1 Technical data

Table 6.2 **Crossed roller bearing specifications**						
Model	Centre circle diameter of the rollers	Offset	Basic load ratings		Permitted torque	Moment rigidity
	D_{pw}	R	Dynamic load C_{dyn}	Static load C_0		
	m	m	kN	kN	Nm	$\times 10^4$ Nm/rad
14	0.050	0.0217	5.8	8.6	74	8.5
17	0.060	0.0239	10.4	16.3	124	15.4
20	0.070	0.0255	14.6	22.0	187	25.2
25	0.085	0.0296	21.8	35.8	258	39.2
32	0.111	0.0364	38.2	65.4	580	100.0

Table 6.3 **Accuracy of angular transmission**						
Reduction ratio		Model				
		14	17	20	25	32
50 – 120	$\times 10^{-4}$ rad	4.4	4.4	2.9	2.9	2.9

Table 6.4 **Hysteresis loss**						
Reduction ratio		Model				
		14	17	20	25	32
50	$\times 10^{-4}$ rad	5.8	5.8	5.8	5.8	5.8
80 – 120	$\times 10^{-4}$ rad	2.9	2.9	2.9	2.9	2.9

Table 6.5 **Starting torque**					
Reduction ratio	Model				
	14	17	20	25	32
50	8.8	27	36	56	85
80	7.5	25	33	50	74
100	6.9	24	32	49	72
120	–	24	31	48	68

Unit: cNm

Note: The values in this table vary depending on the working conditions and are for reference purposes only. The upper limit is 20% above the value in this table.

Table 6.6 **Reverse starting torque**					
Reduction ratio	Model				
	14	17	20	25	32
50	5.3	16	22	34	51
80	7.2	24	31	48	70
100	8.2	29	38	59	86
120	–	34	45	69	97

Unit: Nm

Note: The values in this table vary depending on the working conditions and are for reference purposes only. The upper limit is 20% above the value in this table.

Table 6.7 **Torsional rigidity**							
Reduction ratio			Model				
			14	17	20	25	32
T1		Nm	2.0	3.9	7.0	14.0	29.0
T2		Nm	6.9	12.0	25.0	48.0	108.0
50	K_1	×10⁴ Nm/rad	0.34	0.81	1.3	2.5	5.4
	K_2	×10⁴ Nm/rad	0.47	1.1	1.8	3.4	7.8
	K_3	×10⁴ Nm/rad	0.57	1.3	2.3	4.4	9.8
	θ_1	×10⁻⁴ rad	5.8	4.9	5.2	5.5	5.5
	θ_2	×10⁻⁴ rad	16.0	12.0	15.4	15.7	15.7
80 – 120	K_1	×10⁴ Nm/rad	0.47	1.0	1.6	3.1	6.7
	K_2	×10⁴ Nm/rad	0.61	1.4	2.5	5.0	11.0
	K_3	×10⁴ Nm/rad	0.71	1.6	2.9	5.7	12.0
	θ_1	×10⁻⁴ rad	4.1	3.9	4.4	4.4	4.4
	θ_2	×10⁻⁴ rad	12.0	9.7	11.3	11.1	11.6

The values are for reference purposes only. The lower limit is 20% below the value in this table.

6.1.2 Efficiency E_R

The efficiency of DATORKER® shaft gear units changes depending on the specification, load ratio, operating conditions (speed/load) and lubrication (lubricant type/amount).

E_R = Efficiency at nominal torque
T = Temperature

Model: 14–32
Ratio: 50, 80, 100, 120
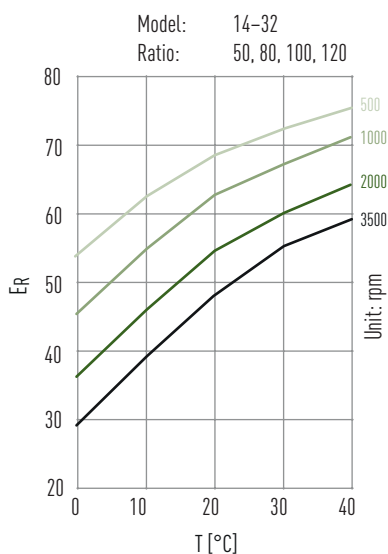
DATORKER® strain wave gearboxes

WTI-AH

Correction coefficient α

Coefficient for correcting the efficiency α according to torque ratio T_{av}/T_n
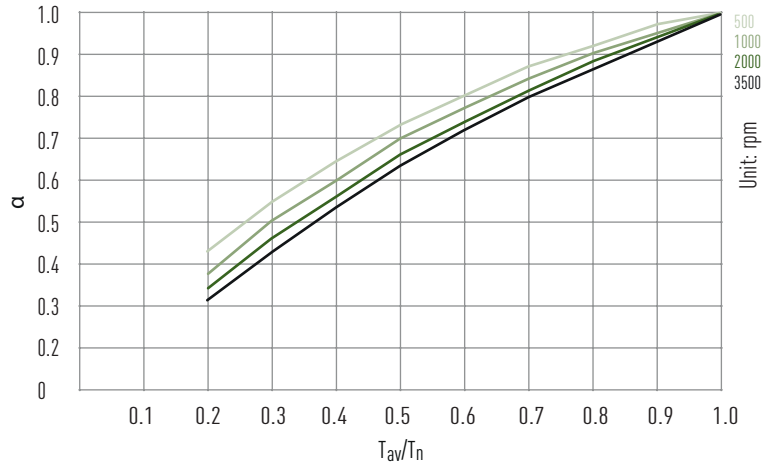
Correction coefficient β

Coefficient for correcting the efficiency β according to specification
Efficiency = $\alpha \times (E_R + \beta)$
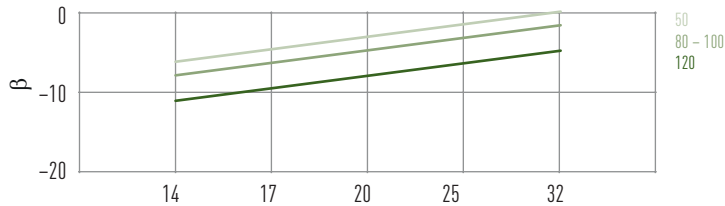
6.1.3 Idling operating torque

The idling operating torque is the torque required to drive the DATORKER® shaft gear input (high speed end) after more than 2 hours at an input speed of 2,000 rpm at an average ambient temperature of 25 °C without load.

Reduction ratio	Input speed	Model				
		14	17	20	25	32
50	500 rpm	6.3	17.8	23.6	37.2	58.0
	1.000 rpm	7.8	21.8	28.6	49.2	76.0
	2.000 rpm	10.1	27.8	37.6	62.2	98.0
	3.500 rpm	14.1	36.8	48.6	89.2	138.0
80	500 rpm	5.4	16.4	21.5	33.8	51.5
	1.000 rpm	6.9	20.4	26.5	45.8	69.5
	2.000 rpm	9.2	26.4	35.5	58.8	91.5
	3.500 rpm	13.2	35.4	46.5	85.8	131.5
100	500 rpm	5.2	16.0	21.0	33.0	50.0
	1.000 rpm	6.7	20.0	26.0	45.0	68.0
	2.000 rpm	9.0	26.0	35.0	58.0	90.0
	3.500 rpm	13.0	35.0	46.0	85.0	130.0
120	500 rpm	–	15.8	20.6	32.4	48.9
	1.000 rpm	–	19.8	25.6	44.4	66.9
	2.000 rpm	–	25.8	34.6	57.4	88.9
	3.500 rpm	–	34.8	45.6	84.4	128.9

Table 6.8 **Idling operating torque**

Unit: cNm

Note: The values in this table vary depending on the working conditions and are for reference purposes only. The upper limit is 20% above the value in this table.

6.1.4 Permissible input load

The hollow shaft is supported by two deep groove bearings. To ensure proper
performance of the gear unit, please confirm the load capacity on the hollow shaft. As
shown below:
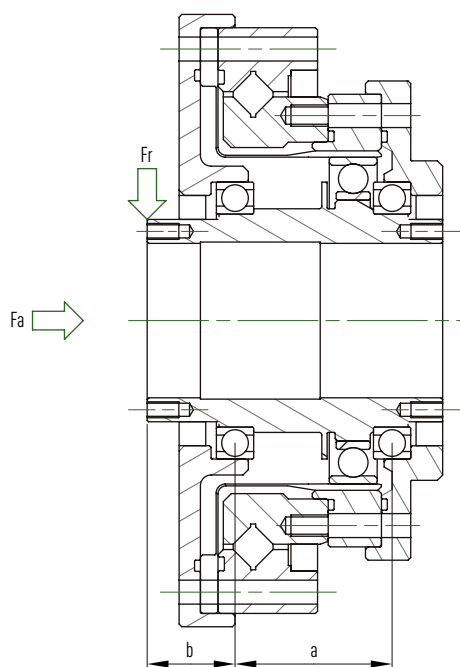
The following figure shows the average input speed of 2,000 rpm and the basic
nominal service life L_{10} = 7,000 hours.
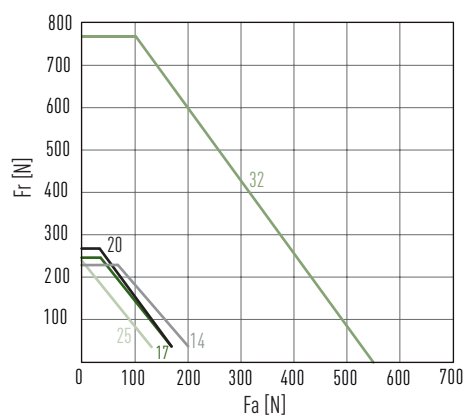
Table 6.9 **Specifications of the deep groove ball bearings**							
Element	Bearing A		Bearing B		a (mm)	b (mm)	Maximum radial load Fr (N) ×10⁴ Nm/rad
Model	Dynamic load C_{dyn} (kN)	Static load C_0 (kN)	Dynamic load C_{dyn} (kN)	Static load C_0 (kN)			
14	4.00	2.47	4.00	2.47	27.0	16.5	230
17	4.30	2.95	4.30	2.95	29.0	17.5	250
20	4.50	3.45	4.50	3.45	27.0	15.5	275
25	4.90	4.35	4.90	4.35	29.5	16.5	250
32	14.10	10.90	5.35	5.25	33.0	23.0	770

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Notes

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Notes

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