Sumitomo Drive Technologies

Fine Cyclo®

Zero Backlash Precision Gearboxes

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Fine Cyclo series

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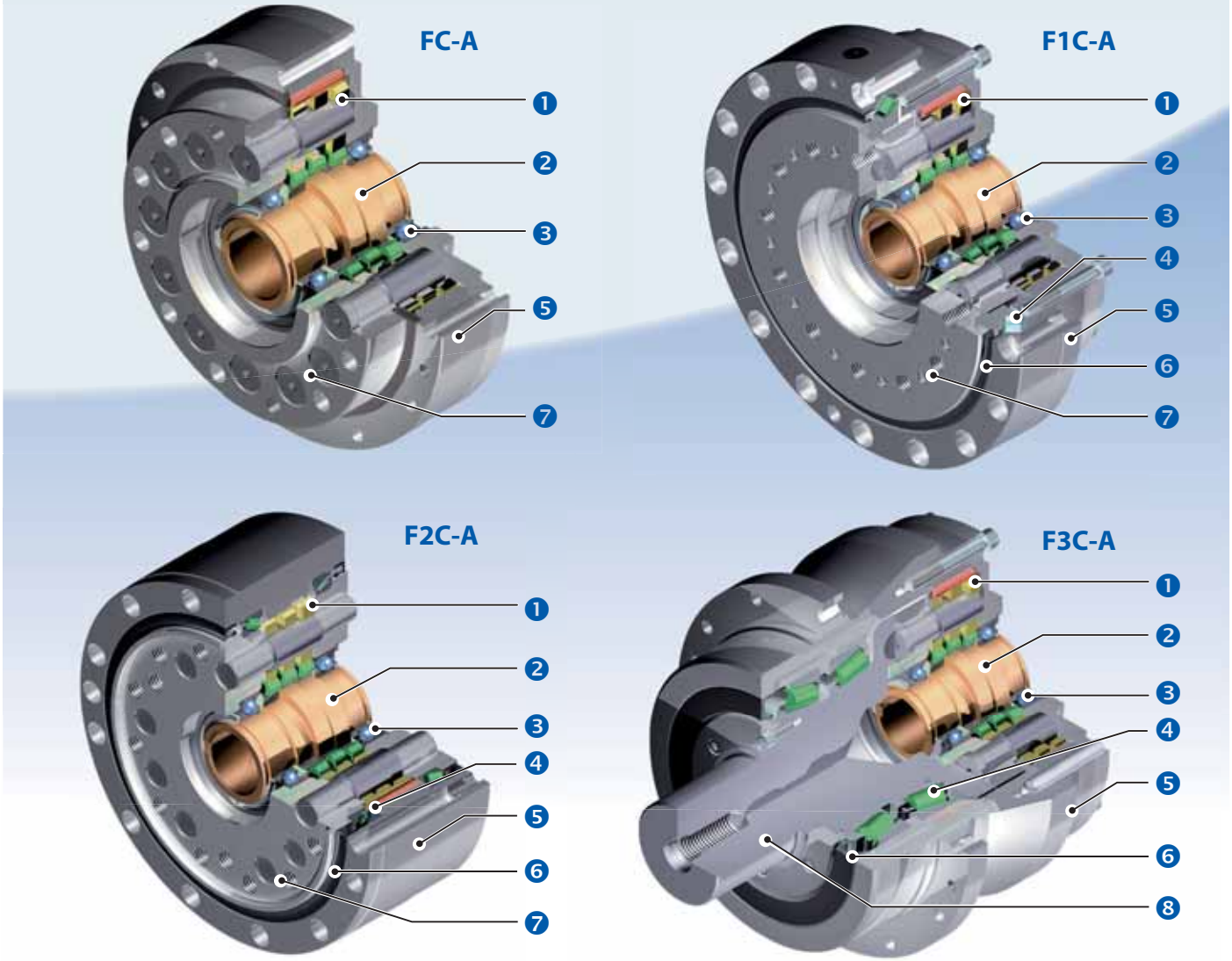
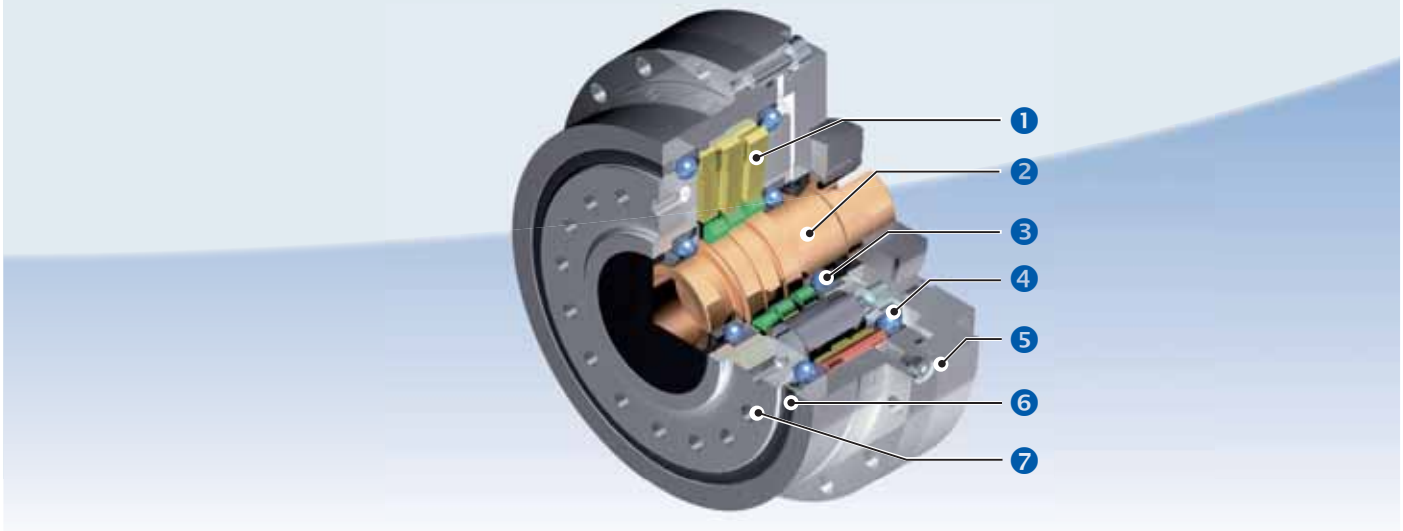
1 The Fine Cyclo reducer

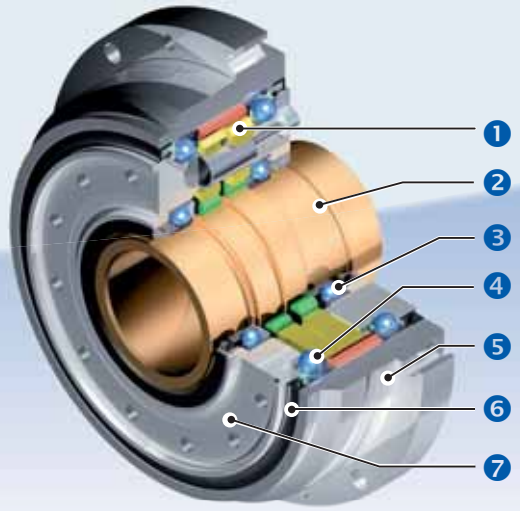
Inner design Series A



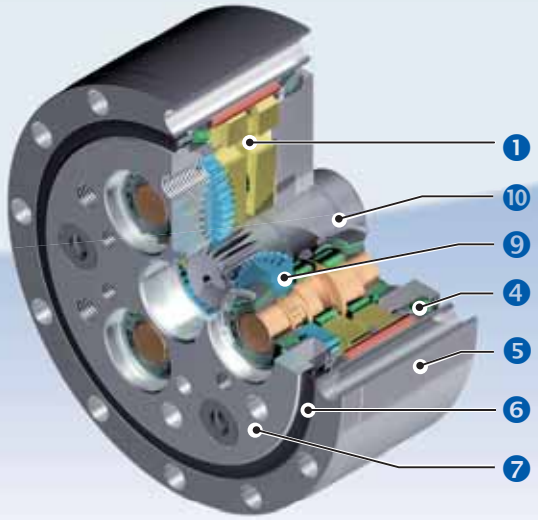
Inner design Series D



Inner design Series C



Inner design Series T



1. Cycloid disc
2. Eccentric high speed shaft
3. Input shaft bearing
4. Main Bearings
5. Ring gear (housing)
6. Radial shaft seal output side
7. Output flange
8. Output shaft
9. Planet gears
10. Input shaft with helical gear

1.1 Operating principle - Series A, D, and C

The gearbox of the Fine Cyclo series is fundamentally different in principle and mechanism from the helical gearing mechanism of competitors' gear motors. The unique reduction gearbox is an ingenious combination of the following two mechanisms:

- A planet gear and a fixed internal sun gear (hollow gear). On the Fine Cyclo the planet gear has cycloidal cam motion (cycloid disc) and the fixed sun gear has a circular arrangement of ring gear pins. The fixed sun gear has one or two "teeth" more than the "planet gear" (cycloid disc).
- A spline for constant speed.

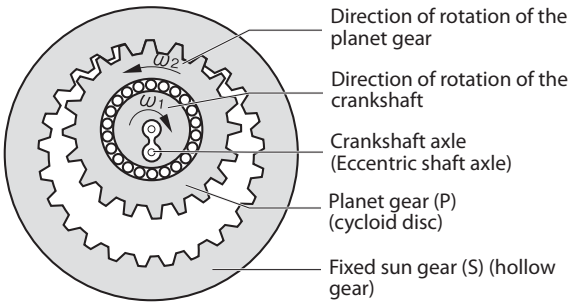


Fig. 1 Principle of the internal planetgearbox

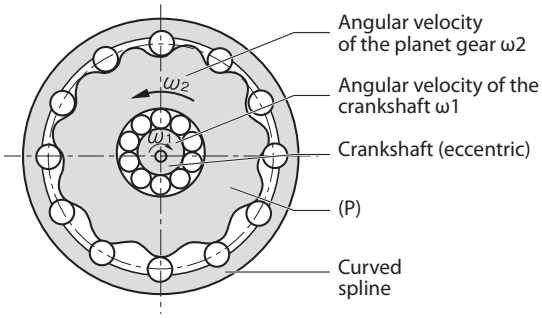


Fig. 2 Epitrochoidal planet gear, circular arrangement of ring gear pins (PIN) combination

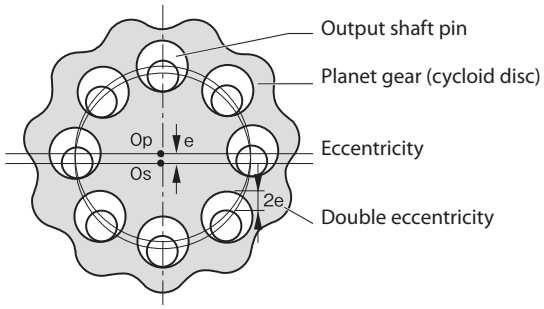


Fig. 3 Internal gearing for constant speed

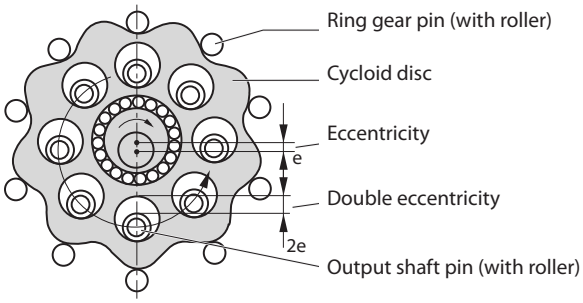


Fig. 4 Planet sun gear combination and internal gearing for constant speed

In equation 1, below, P identifies the number of the planet gear teeth, S that of the sun gear, and ω2 the angular velocity of the planet gear around its own axis (see Fig. 1). The speed ratio of ω2 to ω1 is represented as follows:

$$\text{Equation 1} \quad \frac{\omega 2}{\omega 1} = 1 - \frac{S}{P} = -\frac{S-P}{P}$$

The highest velocity ratio is obtained with S greater than P by one or two in this equation.

That is to say, if S−P=1 is applied to Equation 1, the velocity ratio may be calculated using the following equation:

$$\text{Equation 2} \quad \frac{\omega 2}{\omega 1} = -\frac{1}{P}$$

If, on the other hand, S−P=2 is applied to Equation 1, the velocity ratio may be calculated using the following equation:

$$\text{Equation 3} \quad \frac{\omega 2}{\omega 1} = -\frac{2}{P}$$

As the crankshaft rotates at the angular velocity ω1 around the axis of the sun gear, the planet gear also rotates at the angular velocity:

$$-\frac{1\omega 1}{P} \text{ or } -\frac{2\omega 1}{P}$$

P indicates the number of teeth of the planet gear and the symbol indicates that the planet gear rotates in a reverse direction to that of the crankshaft (eccentric).

As shown in Fig. 2, the Fine Cyclo circular teeth (pins) are adapted to the sun gear and the trochoidal teeth to the planet gear, thereby avoiding mutual obstruction of the spline.

The rotation of the planet gear around its own axis is caused by a constant speed internal gearing mechanism as shown (see Fig. 4).

In this mechanism, shown in Fig. 4 the pins of the output shaft are evenly spaced on a circle that is concentric to the axis of the sun gear. The pins transmit the rotation of the planet gear by rolling internally around the circumference of the bores of each planet gear or cycloid disc.

The diameter of the bores minus the diameter of the output shaft pins is equal to twice the eccentricity value of the crankshaft (eccentric).

This mechanism smoothly transmits only the rotation of the planet gear around its own axis to the output shaft.

1.2 Operating principle Series T

The Series T gearboxes are double stage and differ from the single stage series in having 3 eccentrics, driven by the input shaft with spur teeth. The cycloid discs are driven via 3 eccentric shafts and not directly by one eccentric input shaft. The pins and the eccentric shafts in the output shaft are evenly spaced on a circle, which is concentric to the axis of the sun gear. The pins transmit the rotation of the planet gear by rolling internally around the circumference of the bores of each planet gear or cycloid disc.

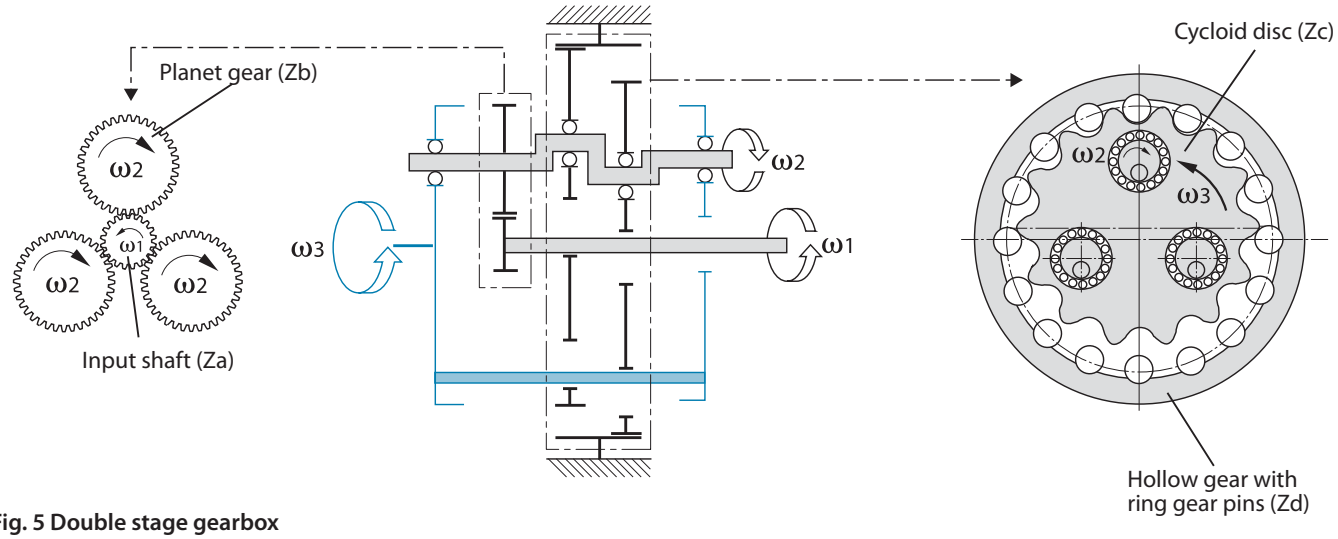


Fig. 5 Double stage gearbox

If the input shaft rotates with a speed ω1, then the angular velocity of the planet gear around its own axis is ω2.
If the eccentric shaft rotates with a rotational speed ω2 and the hollow gear is fixed, then the angular velocity of the cycloid discs around their own axis is ω3. Z is the number of teeth or the number of curve traces or ring gear pins.

Equation 1 $$\omega 2 = \frac{Za}{Zb}(\omega 3 - \omega 1) + \omega 3$$

Equation 2 $$\omega 3 = \left(1 - \frac{Zd}{Zc}\right) \cdot \omega 2$$

Partial reduction ratio when the angular velocity of the eccentric shaft gear around the input shaft is equal to 0:

Equation 3 $$i1 = \frac{Zb}{Za}$$

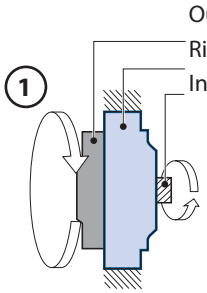
Partial reduction ratio of the trochoid gearing:

Equation 4 $$i2 = \frac{Zc}{(Zc - Zd)}$$

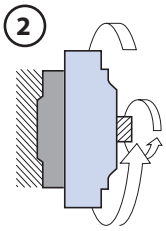
Equation 5 $$i = 1 + i1 \cdot (1 - i2)$$

Total reduction ratio $$i = \omega 1 / \omega 3$$

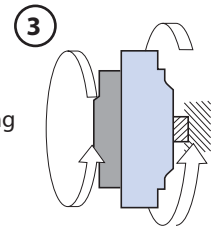
1.3 Speed ratio and rotation direction - Series A, D, and C



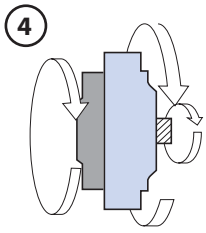
Gear reduction
Input: Input shaft
Output: Output shaft
Fixed:
Ring gear housing
n = –1/i



Gear reduction
Input: Input shaft
Output: Ring gear housing
Fixed:
Output shaft
n = 1/(i+1)



Gear reduction
Input: Output shaft
Output: Ring gear housing
Fixed:
Output shaft
n=i/(i+1)

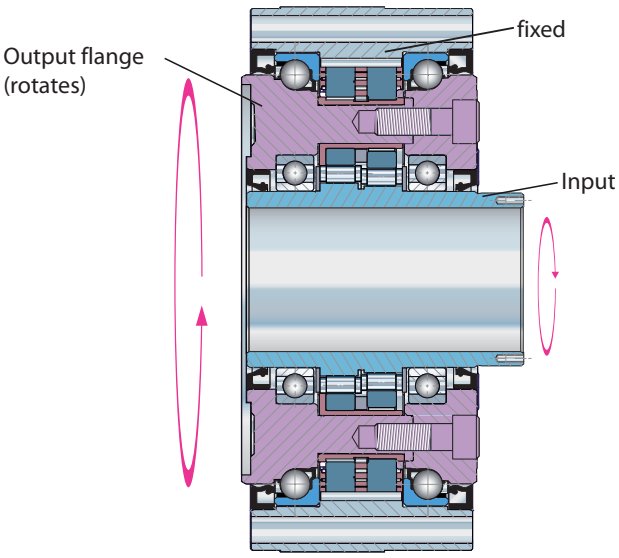


When all elements rotate at the same time, the speed ratio consists of a combination of the representation ① to ③.

n = Speed ratio = (output speed/input speed)
("–" indicates the possible opposite direction)

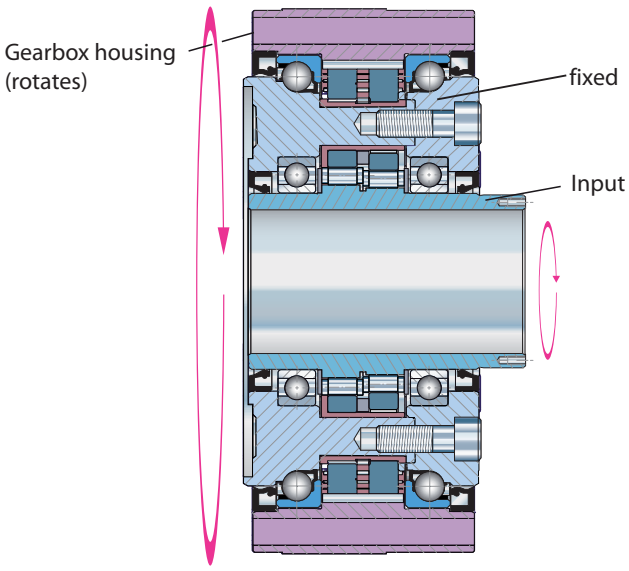
i = reduction ratio

Output flange rotates



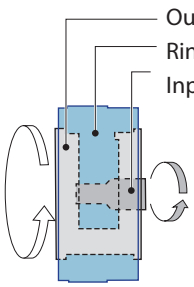
Catalogue reduction

Gearbox housing rotates

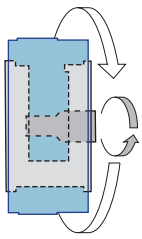


Catalogue gear reduction +1

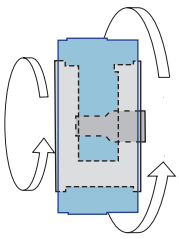
1.4 Speed ratio and rotation direction Series T



Gearbox
Input: Input shaft
Output: Output shaft
Fixed: Ring gear housing
n = –1/i



Gearbox
Input: Input shaft
Output: Ring gear housing
Fixed: Output shaft
n = -1/(i+1)



Speed increase ratio
Input: Output shaft
Output: Ring gear housing
Fixed: Input shaft
n = i/(i–1)

1.5 Features and advantages

Compact design

The high reduction ratios, in one or a maximum of two stages, allow for extremely compact designs with a long lifetime. Moreover, due to the different versions available, these gearboxes can be optimally integrated into the machine environment.

Simple installation

The Series A, C, and D gearboxes are lubricated for life, fully sealed and maintenance-free.

Precise positioning

In more and more applications, fast cycle speeds and precise positioning are required in order to increase the efficiency of machines or to open up new fields of application.

Precision gearbox with large hollow shaft bore and high capacity bearing

The C-Series gearbox was specifically developed for applications that require a large hollow shaft bore through which supply lines, shafts, and pipelines can be passed. The integrated bearing can handle high loads on the output side that could occur while using machine tools, positioning or during robotics applications.

The right size for every application

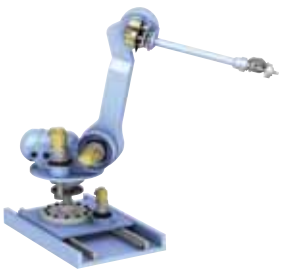
The wide range of gearbox series and the numerous sizes available within each series enable selection of the right gearbox for any precision application.

Gearboxes with outer diameters ranging from 115 mm to 570 mm are available. With these, a range of acceleration torques from below 100 Nm up to 30,000 Nm can be covered.
In the event of an emergency stop, this precision gearbox can even be safely subjected to a load of 60,000 Nm.

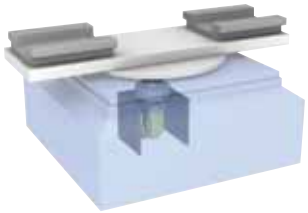
High torsional stiffness and low moments of inertia

For these application areas, Sumitomo Drive Technologies has developed a highly accurate series of backlash-free precision gearboxes. Compared with conventional gearboxes, the construction principle offers the highest torsional stiffness as well as low moments of inertia - ideal for highly dynamic tasks.

1.6 Application Examples



Axle drive for industrial robot



Pallet changer drive

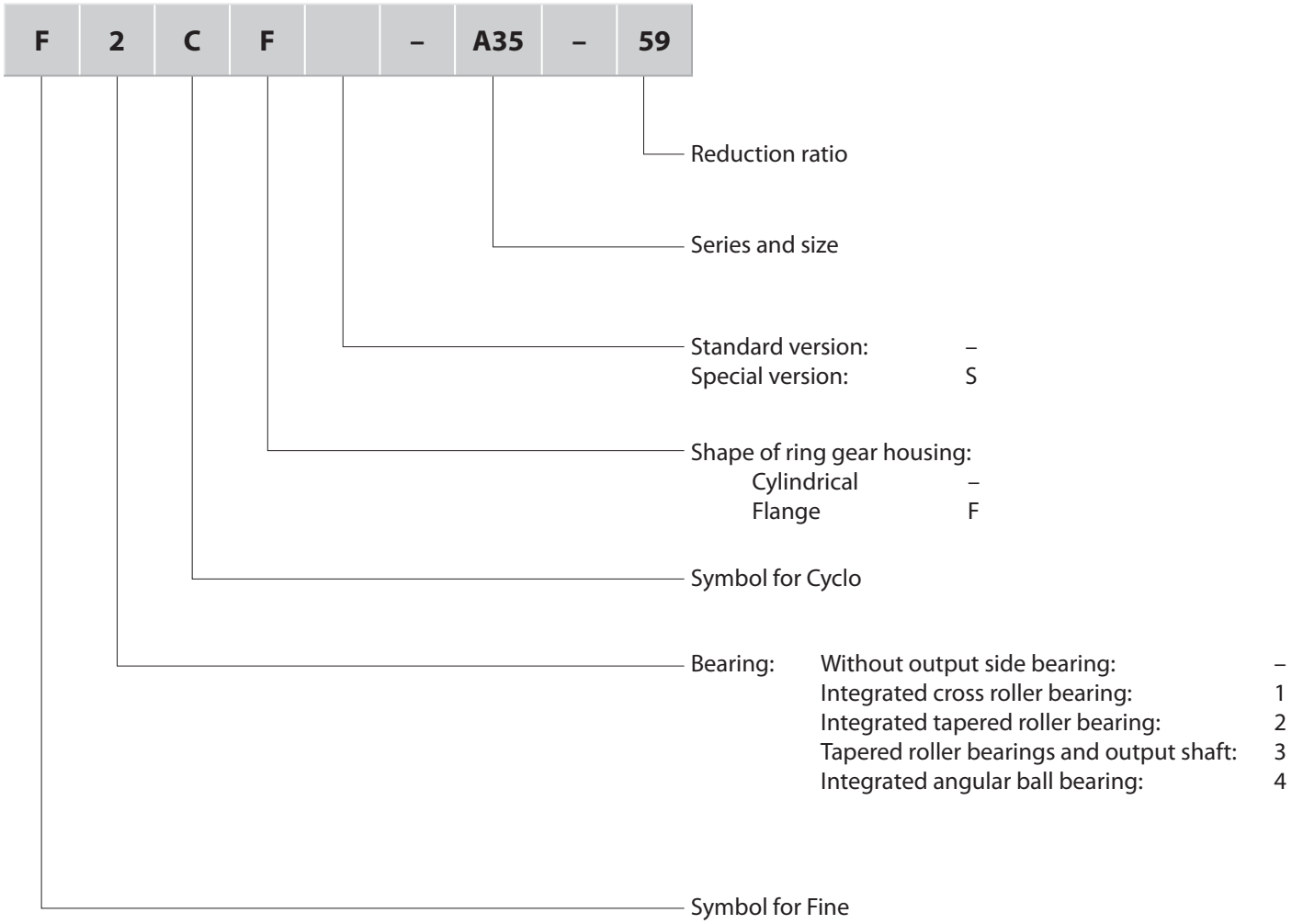
Welding positioner

Machine tool
Automatic pallet pool input

Palletising robot

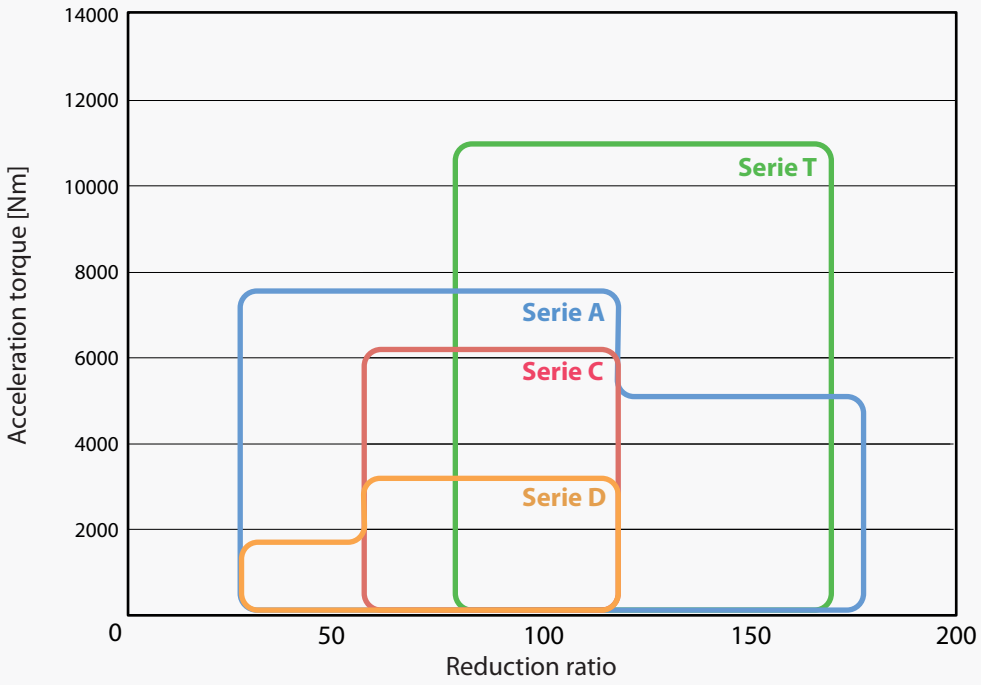
Liquid crystal transfer robot

2 Nomenclature

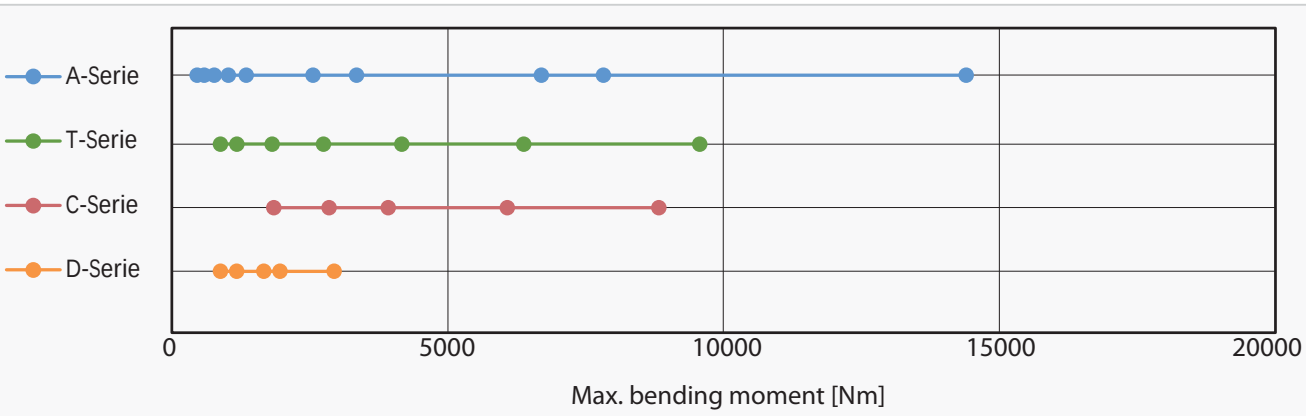


3 Gearbox selection

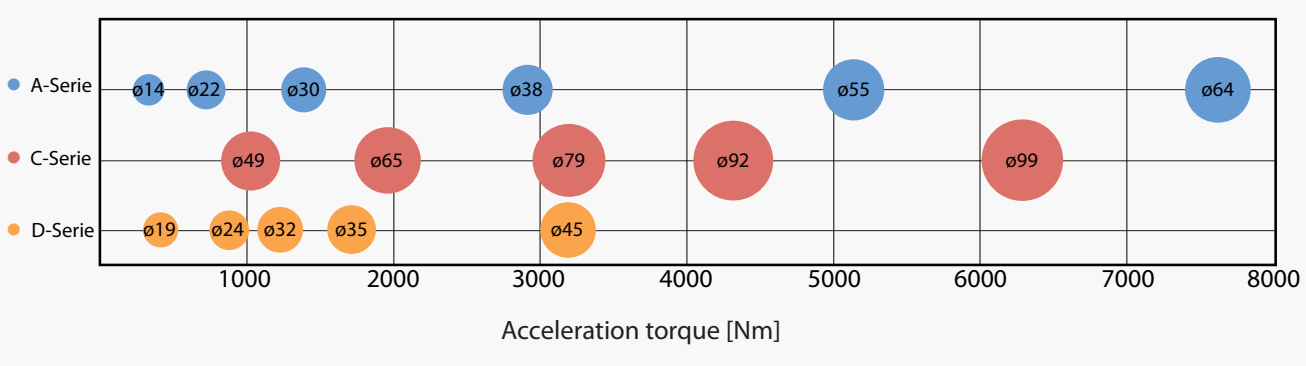
3.1 Reduction ratio and acceleration torque



3.2 Max. bending moment on the output flange



3.3 Max. hollow shaft diameter

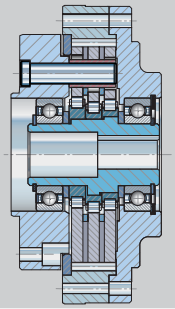
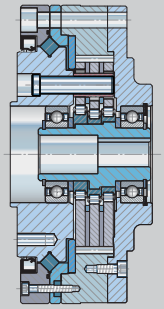
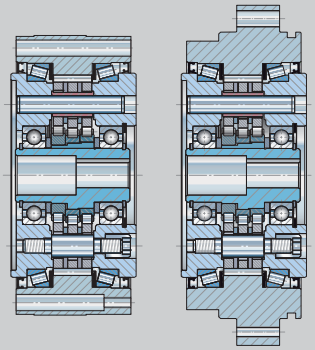
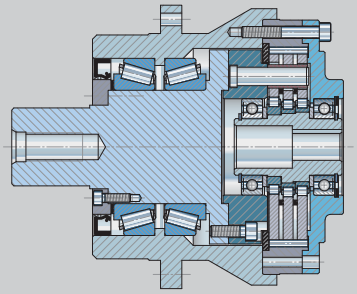


3.4 Reduction ratio and outer diameter

A-Series

Special feature: Both a reduction kit without an output side bearing as well as fully sealed versions and a gearbox with output shaft instead of output flange are available

Optional: Available with motor adapter, customer-specific input shaft or output flange and other modifications

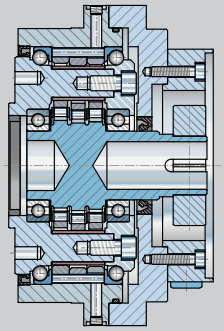
Model		Size	Available single stage reduction ratios					Outer-ø flange	Outer-ø cylindrical	Max. hollow shaft-ø
			29	59	89	119	179			
FC-		A15G		•	•				115	14
		A25G	•	•	•	•			145	22
		A35G	•	•	•	•			180	30
		A45G	•	•	•	•	•		220	38
		A65G	•	•	•	•	•		270	55
		A75G	•	•	•	•			310	64
F1C-		A15		•	•				140	14
		A25	•	•	•	•			170	22
		A35	•	•	•	•			205	30
		A45G	•	•	•	•	•		265	38
		A65G	•	•	•	•	•		350	55
		A75G	•	•	•	•			430	64
F2C(F)-		A15		•	•			145	126	14
		A25	•	•	•	•		190	156	22
		A35	•	•	•	•		222	186	30
		A45	•	•	•	•	•	256	231	38
F3C-		A15G		•	•				140	
		A25G	•	•	•	•			170	
		A35G	•	•	•	•			200	
		A45G	•	•	•	•	•		250	
		A65G	•	•	•	•	•		300	
		A75G	•	•	•	•			350	

•: available reduction ratio

D-Series

Special feature: By default the gearboxes are supplied with matching clamp ring adapter and motor flange

Optional: The gearboxes can also be purchased with other mounting options or without customer-specific flange

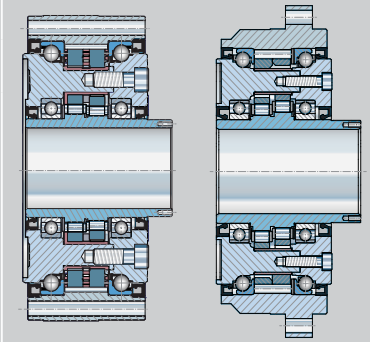
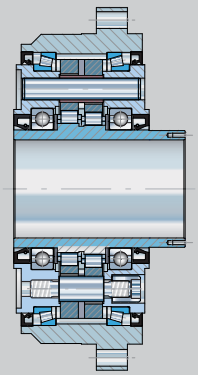
Model		Size	Available single stage reduction ratios					Outer-Ø flange	Outer-Ø cylindrical	Max. hollow shaft-Ø
			29	59	89	119	179			
F4CF-		D15		•	•			145	a. A.	19
		D25		•	•	•		169	a. A.	24
		D30		•	•	•		187	a. A.	32
		D35		•	•	•		204	a. A.	35
		D45		•	•	•		256	a. A.	45

•: available reduction ratio a. A.: Housing shape on request

C-Series

Special feature: The large diameter of the hollow shaft allows for effective use of space for cable or media feed-through

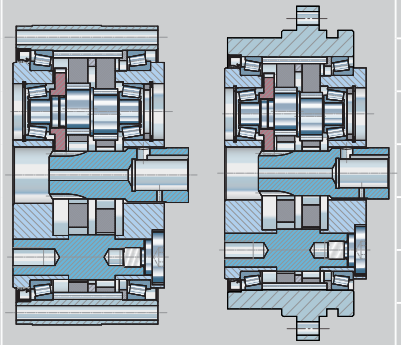
Optional: Customer-specific customisation of input shaft, output flange, and housing possible

Model		Size	Available single stage reduction ratios					Outer-Ø flange	Outer-Ø cylindrical	Standard hollow shaft-Ø
			29	59	89	119	179			
F4C(F)-		C25		•	•	•		a. A.	185	49
		C35		•	•	•		256	a. A.	65
F2CF-		C45		•	•	•		292	a. A.	79
		C55		•	•	•		325	a. A.	92
		C65		•	•	•		362	a. A.	99

•: available reduction ratio a. A.: Housing shape on request

T-Series

Special feature: Gearboxes with high positioning and path accuracy, even under highly fluctuating dynamic conditions
Optional: Fitting of motors without key with clamp ring design possible

Model		Size	Available double stage reduction ratios				Outer-Ø flange	Outer-Ø cylindrical	Max. motor shaft-Ø with keyway (clamp ring design on request)
			81	118.5	141	171			
F2C(F)-		T155	•	•	•		145	126	14
		T255	•	•	•		190	156	17
		T355	•	•	•		222	186	22
		T455	•	•	•	•	256	231	28
		T555	•	•	•	•	292	261	28
		T655	•	•	•	•	325	296	35
		T755	•	•	•	•	370	331	35

•: available reduction ratio

3.5 Torques and speeds

Maximum permissible input speed $n_{1\ ED}$
The gearbox can be used within the maximum input speed range indicated in the table, however, the max. permissible mean input speed is limited by the load duty cycle (%ED).

A-Series

Model	Size	Reduction ratio i	Max. permissible input speed $n_{1\ ED}$ [min^{-1}]		Max. acceleration torque [Nm]	Max. torque for emergency stop
			50% ED	100% ED		
FC- F1C- F2C- F3C-	A15(G)	59 / 89	5600	2800	335	785
	A25(G)	29	3100	1550	721	1930
		59 / 89 / 119	4200	2100	721	1930
	A35(G)	29	2500	1250	1390	3580
		59 / 89 / 119	3300	1650	1390	3580
	A45(G)	29	1900	950	2910	7210
		59 / 89 / 119 / 179	2600	1300	2910	7210
	A65(G)	29	1500	750	5130	13800
		59 / 89 / 119 / 179	2000	1000	5130	13800
	A75(G)	29	1200	600	7610	24000
		59 / 89 / 119	1750	850	7610	24000

D-Series

Model	Size	Reduction ratio i	Max. permissible input speed $n_{1\ ED}$ [min^{-1}]		Max. acceleration torque [Nm]	Max. torque for emergency stop
			50% ED	100% ED		
F4CF-	D15	59 / 89	5600	2800	417	834
	D25	59 / 89 / 119	4200	2100	883	1766
	D30	59 / 89 / 119	3800	1900	1226	2453
	D35	59 / 89 / 119	3300	1650	1717	3581
	D45	59 / 89 / 119	2600	1300	3188	6377

C-Series

Model	Size	Reduction ratio i	Max. permissible input speed $n_{1\ ED}$ [min^{-1}]		Max. acceleration torque [Nm]	Max. torque for emergency stop
			50% ED	100% ED		
F4C(F)-	C25	59 / 89 / 119	2900	1450	1030	2060
	C35	59 / 89 / 119	2100	1050	1962	3924
F2CF-	C45	59 / 89 / 119	1800	900	3188	6377
	C55	59 / 89 / 119	1500	750	4316	8633
	C65	59 / 89 / 119	1400	700	6278	12577

T-Series

Model	Size	Reduction ratio i	Max. permissible output speed $n_{2\ max}$ [min^{-1}]	Max. acceleration torque [Nm]	Max. torque for emergency stop
F2C(F)-	T155	81 / 118.5 / 141	60	417	834
	T255	81 / 118.5 / 141	50	1030	2060
	T355	81 / 118.5 / 141	40	1960	3920
	T455	81 / 118.5 / 141 / 171	30	3190	6380
	T555	81 / 118.5 / 141 / 171	30	4910	9820
	T655	81 / 118.5 / 141 / 171	25	7850	15700
	T755	81 / 118.5 / 141 / 171	25	11000	22000

3.6 Flow chart and equation of selection

Sumitomo Drive Technologies would be happy to take over the selection and calculation process for you. Please refer to the application data sheet in the appendix.

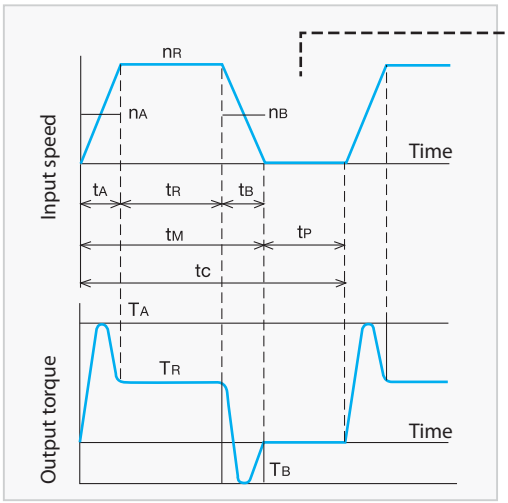


Fig. 6 Load cycle

n_{1A} : Mean input speed during acceleration [min^{-1}]

as per **Fig. 6** $\mathbf{n_{1A} = \frac{n_{1R}}{2}}$

n_{1R} : Input speed during uniform movement [min^{-1}]

n_{1B} : Mean Input speed during braking [min^{-1}]

as per **Fig. 6** $\mathbf{n_{1B} = \frac{n_{1R}}{2}}$

n_{1m}: Mean input speed [min^{-1}]

t : Time [sec.]

t_A : Run-up time [sec.]

t_R : Duration of uniform movement [sec.]

t_B : Braking time [sec.]

t_M : Duration of the movement phase of a working cycle [sec.]

t_p : Duration of pause [sec.]

t_c : Duration of one working cycle [sec.]

T_{2A}: Output side acceleration torque [Nm]

T_{2R}: Output torque at constant speed [Nm]

T_{2B}: Output side braking torque [Nm]

T_{2V}: Equivalent output torque [Nm]

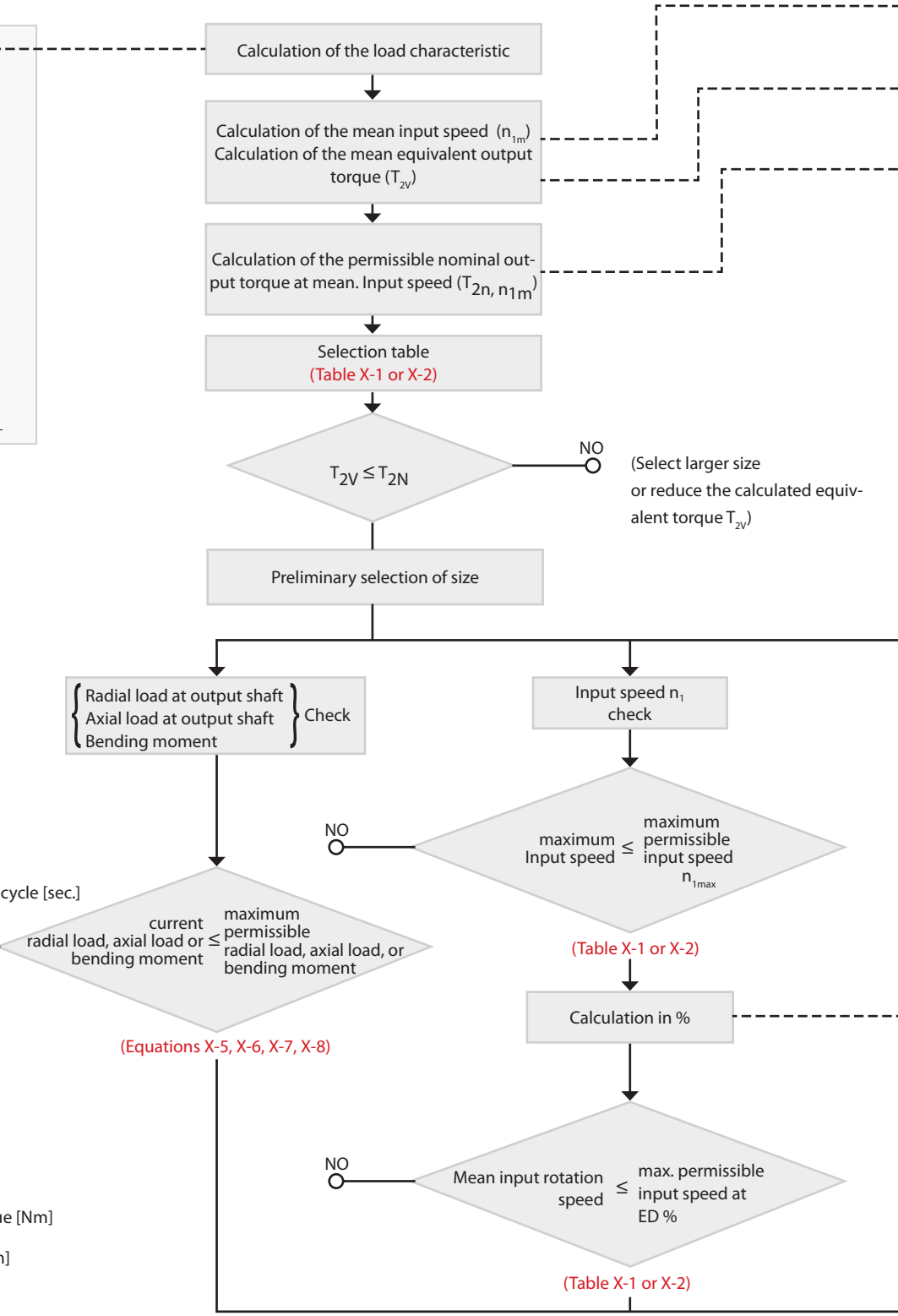
T_{2N}: Nominal output torque [Nm]

$T_{2N\,max}$: Maximum permissible nominal output torque [Nm]

$T_{2N\,600}$: Nominal output torque at n_1 = 600 min^{-1} [Nm]

B_{f2} : Service factor output

ED: Load time ratio %



The tables and equations relating to the references marked red are located in the respective sections covering the series (A, D, C, and T):

	Page number			
	Series:			
	A	D	C	T
Table X-1	p. 24	p. 60	p. 78	p. 96
Table X-2	p. 26	p. 62	p. 80	p. 98
Table X-3	p. 26	p. 62	p. 80	p. 98

	Page number			
	Series:			
	A	D	C	T
Equation X-1	p. 31	p. 67	p. 85	-
Equation X-5	from p. 33	p. 69	p. 87	p. 103
Equation X-6,7	from p. 33	p. 69	p. 87	p. 103
Equation X-8	from p. 33	p. 69	p. 87	p. 103

Calculation in load condition as per Fig. 6

Mean input speed

$$n_{1m} = \left(\frac{t_A \cdot n_{1A} + t_R \cdot n_{1R} + t_B \cdot n_{1B}}{t_M} \right) \quad \text{(Equation - 8)}$$

Mean equivalent output torque

$$T_{2V} = \left(\frac{t_A \cdot n_{1A} \cdot T_{2A}^{\ 3} + t_R \cdot n_{1R} \cdot T_{2R}^{\ 3} + t_B \cdot n_{1B} \cdot T_{2B}^{\ 3}}{t_M \cdot n_{1m}} \right)^{1/3} \cdot B_{f2} \quad \text{(Equation - 9)}$$

Max. permissible nominal output torque at mean input speed

$$T_{2N\,max} = T_{2N,600} \cdot \left(\frac{600}{n_{1m}} \right)^{0,3} \quad \text{(Equation -10)}$$

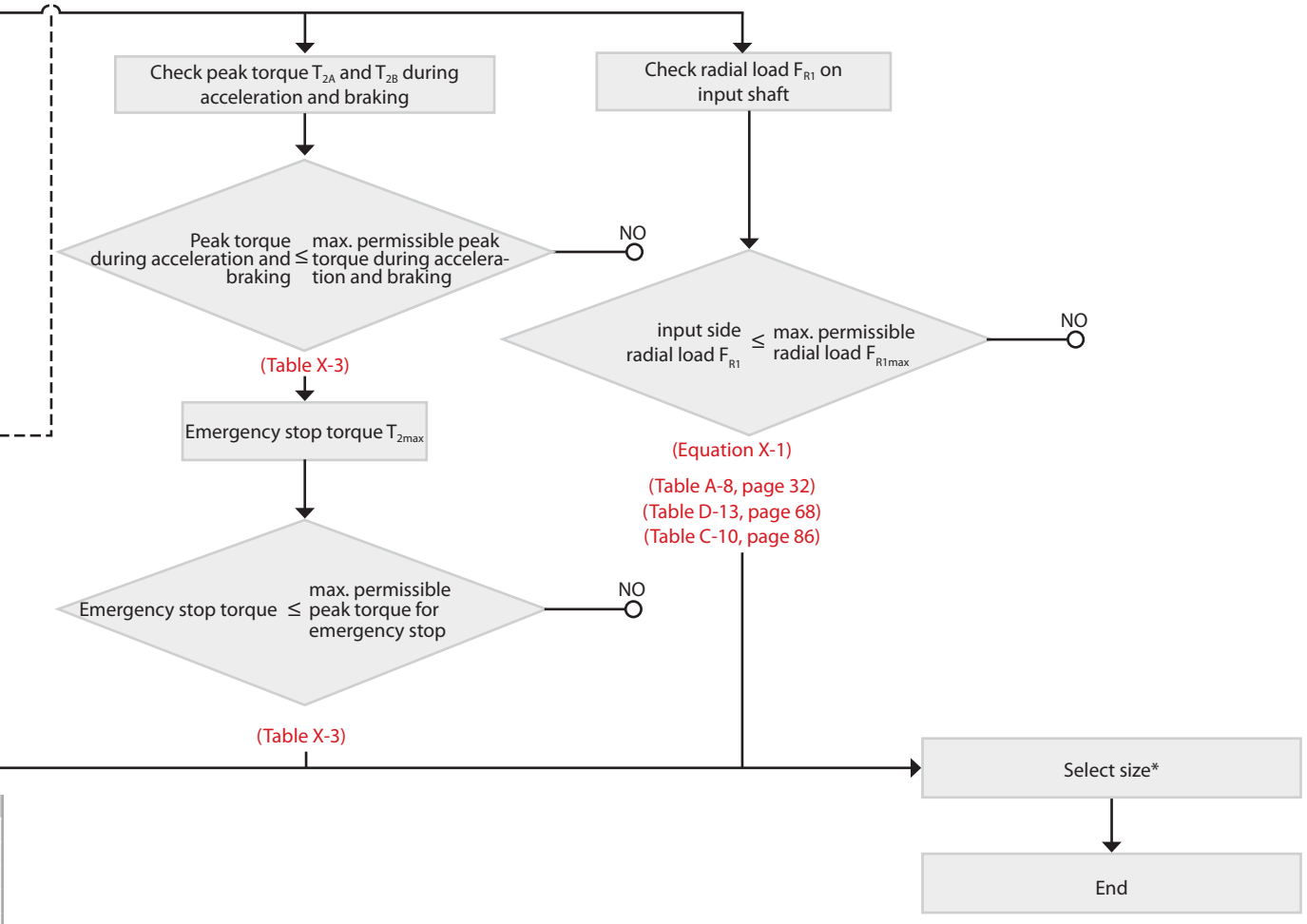
ED %

$$ED\,\% = \left(\frac{t_m}{t_c} \right) \cdot 100\,[\%] = \left(\frac{t_c - t_p}{t_c} \right) \cdot 100\,[\%] \quad \text{(Equation -11)}$$

$T_{2N,600}$: Nominal output torque at an input speed of 600 min^{-1} (Table X-2)

If $n_{1m} < 600\ min^{-1}$, the value in the table at input speed of 600 min^{-1} applies for T_{2N}

Please note the instructions on load duty cycles in chapter 4.



* When selecting the motor, the input side breakaway torque (BTI) or no-load running torque (NLRT) must be taken into account.

3.6.1 Selection example

Calculation example for Type F4C-C25-119 for the following specification:

T_{2A}	= output side acceleration torque	600 Nm
T_{2R}	= output torque at constant speed	250 Nm
T_{2B}	= output side braking torque	400 Nm
$T_{2\,max}$	= emergency stop torque	1700 Nm (1000 x over the entire lifetime)
n_{1A}	= mean input speed during acceleration	1250 min^{-1}
n_{1R}	= input speed during uniform movement	2500 min^{-1}
n_{1B}	= mean input speed during braking	1250 min^{-1}
t_A	= start-up time	0.3 sec
t_R	= duration of uniform movement	3.0 sec
t_B	= braking time	0.3 sec
t_m	= duration of the movement phase of a working cycle	3.6 sec
t_p	= duration of pause	3.6 sec
t_c	= duration of one working cycle	7.2 sec
F_{R1}	= radial load on input shaft	driven by toothed belt , minor shocks, F_{R1} = 196 N, with force application point 25 mm
F_{R2}	= radial load on the output shaft	Connection with pinion, minor shocks, F_{R2} = 4116 N, 55 mm from the side of the flange

As this gearbox is to be used to operate a robot joint under uniform load the service factor B_{F1} should = 1 (refer to table C-13, page 86, for service factor output (B_F)).

Mean input speed

$$n_{1m} = \left(\frac{0.3 \cdot 1250 + 3.0 \cdot 2500 + 0.3 \cdot 1250}{3.6} \right) = 2292 \text{ min}^{-1}$$

Mean equivalent output torque

$$T_{2V} = \left(\frac{0.3 \cdot 1250 \cdot 600^3 + 3.0 \cdot 2500 \cdot 250^3 + 0.3 \cdot 1250 \cdot 400^3}{3.6 \cdot 2292} \right)^{1/3} \cdot 1 = 300 \text{ Nm}$$

Max. permissible output torque at mean input speed

$$T_{2N\,max} = 568 \cdot \left(\frac{600}{2292} \right)^{0,3} = 380 \text{ Nm} \geq 300 \text{ Nm}$$ ⇨ Type **F4C-C25-119**

Calculation of ED %

$$ED\,\% = \left(\frac{3.6}{7.2} \right) \cdot 100 = 50\%$$

○ Checking the maximum input speed

$n_1 = 2500\ min^{-1} < n_{1\ max} = 3500\ min^{-1}$ (Table C-1)

○ Checking the mean input speed

$n_{1m} = 2292\ min^{-1}$ at 50% ED $< n_{1m\ max} = 2900\ min^{-1}$ at 50% ED
(Table C-1)

○ Checking the peak torque during acceleration and braking

$T_{2A} = 600\ Nm < 1030\ Nm$ (Table C-3)

○ Checking the emergency stop torque

$T_{2\ max} = 1700\ Nm < 2060\ Nm$ (Table C-3)

○ Max. permissible radial load on input shaft when taking correction factors into account

$$F_{R1\ max} = F_{R1,\ 600} \times \left(\frac{600}{n_{1m}}\right)^{1/3} = 841 \cdot \left(\frac{600}{2292}\right)^{1/3} = 538\ N$$

$$F_{R1} = \frac{F_{R1\ max}}{L_{f1} \cdot C_{f1} \cdot B_{f1}} = \frac{538}{1.14 \cdot 1.25 \cdot 1.2} = 315\ N > 196\ N$$

(Table C-9, Equation C-1, see p. 77 et seq.)

○ Checking the max. permissible bending moment T_k

$\mathbf{l}_r = x - a + \mathbf{l}_1 = 55 - 43.2 + 162 = 173.8$ mm
Calculated dimension for bending moment $\mathbf{l}_r$

○ Correction factors are used to calculate the external bending moment

$C_{f2} = 1.25;\ B_{f2} = 1.0$

$T_k = C_{f2} \cdot B_{f2} \cdot F_{R2} \cdot \mathbf{l}_r < T_{k\ max}$

$T_{ke} = 1.25 \cdot 1.0 \cdot 4116 \cdot 173.8 \cdot 10^{-3}$

$T_{ke} = 891\ Nm < 1850\ Nm$

Selection/result

⇨ Type **F4C-C25-119** was selected by using the above evaluation.

4 Explaining the technical details

Rigidity and Lost Motion

If a torque is introduced in the output shaft when the input shaft is stationary, the relation between the distortion angle and the torque can be read off on the following hysteresis curve (Fig. 7).

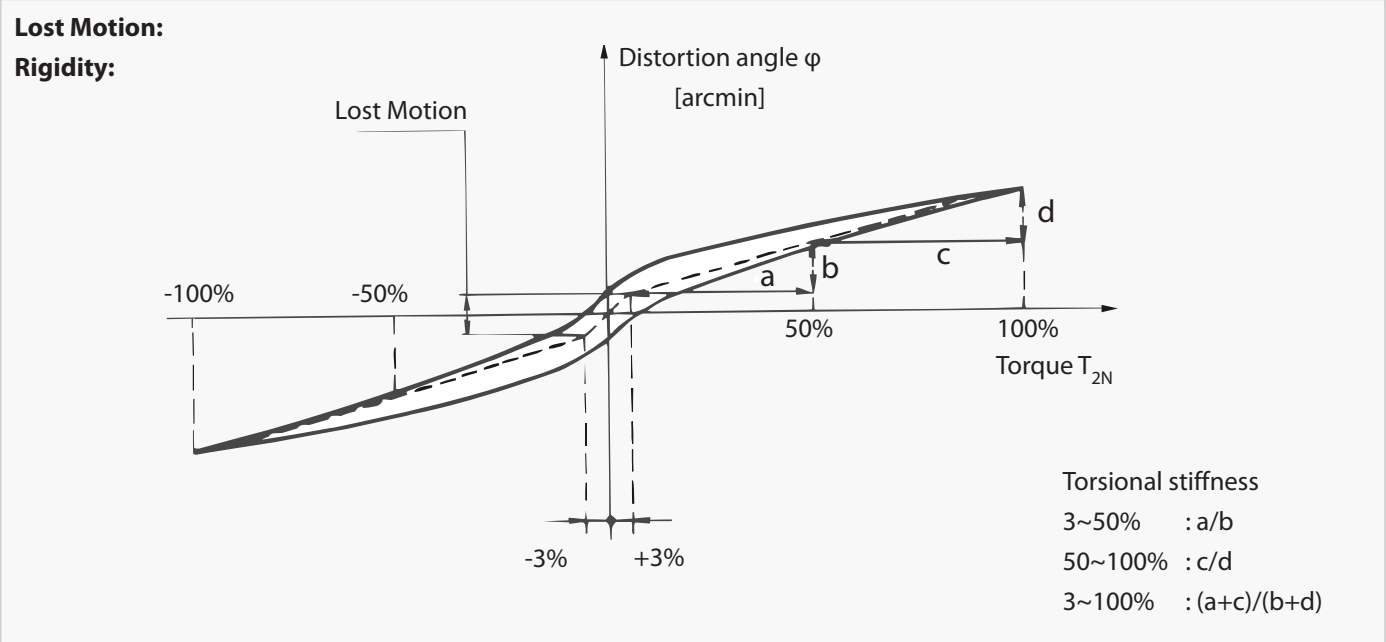


Fig. 7 Hysteresis curve

Lost Motion: Distortion angle at 3% of nominal torque.
Rigidity: Inclination of a straight line connecting two points on the hysteresis curve.
The table value indicates the average torsional stiffness as a function of the nominal output torque.

Note arcmin means "angular minute"

$$1 \text{ arcmin} = \frac{1^\circ}{60}$$

No-load running torque

No-load running torque must be applied to keep the gearbox in motion without load on the output. The information in the catalogue refers to average values which occur after the gearbox has been run in.

Breakaway torque

Specifies the torque which is necessary to "break loose" the load-free gearbox from standstill, i.e. to start a rotational movement. This can be done on both the input (BTI) and the output side (BTO).

Efficiency

Efficiency varies according to speed, load torque, grease temperature, reduction ratio gearbox size, etc.
The relationship between efficiency and input speed is shown in the figures relevant to the respective series, under measurement conditions with permissible output torque and stable grease temperature.
Variations in models and different reduction ratios are taken into account in the efficiency curve.

Transmission error

The transmission error indicates the deviation of the actual rotation angle of the gearbox from the theoretical value. A defined input-side rotation of the gearbox divided by the reduction ratio gives the theoretical position of the output. The actual angle of rotation varies with a deviation of some angular seconds around this value.

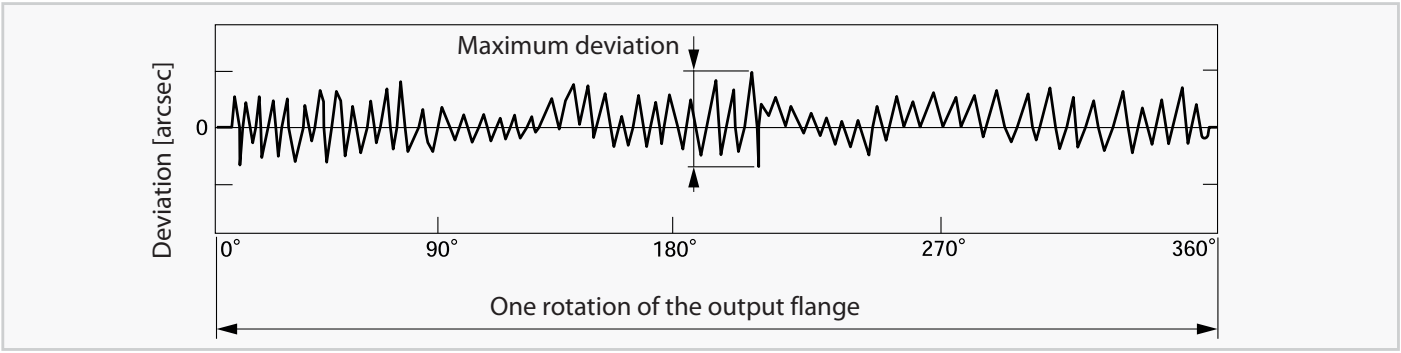


Fig. 8 Typical transmission error

Note arcsec means "angular second"

$$1 \text{ arcsec} = \frac{1°}{3600}$$

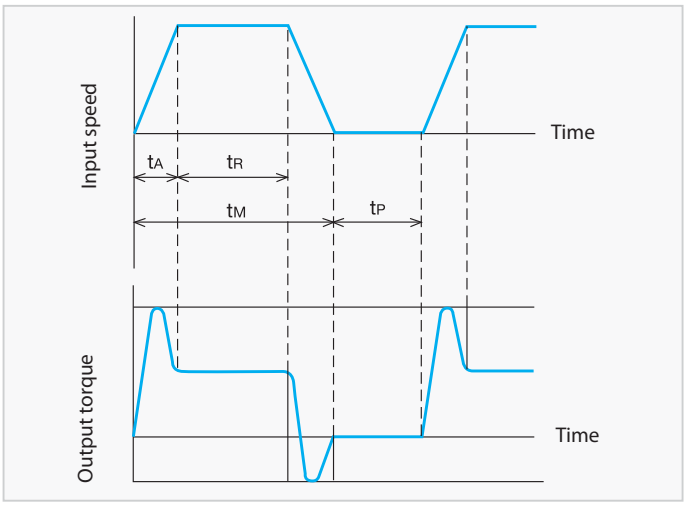
Applications for precision gearboxes generally differentiate between positioning and smooth traverse applications.

For positioning applications only the standstill positions of the gearbox play a role (e.g.- tool magazine). Here, the transmission error is usually not important.

For smooth traverse applications, precision is important at every moment of movement (e.g. continuously welding robots). Here, a major transmission error can lead to unsatisfactory results.

Fine Cyclo reducers are ideally suited for both applications. Both single stage and double stage gearboxes show only minimal transmission error. If maximum path accuracy is required, Fine Cyclo double stage reducers provide additional advantages. Please contact Sumitomo Drive Technologies for assistance in choosing the correct gearbox.

Load cycle



The load cycle reflects the sequence of movements in the application used. This typically consists of at least one acceleration phase (t_A), one constant speed phase (t_R), one deceleration (t_B), and one pause of movement (t_P).

Load duty cycle

The load duty cycle time is the percentage duration of the movement phase in proportion to the duration of the working cycle within a periodically repeating load cycle. In particular, the speed and load duty cycle, as well as the torque and the installation situation (e.g. convection or external heat influence) determine the temperature development in the gearbox. Continuous operation of the gearbox at high speeds, or load duty cycles, would lead to overheating and eventual destruction of the gearbox. To avoid this, the temperature of the gearbox housing during operation should not exceed 70°C.

Therefore, a few basic principles must be taken into account.

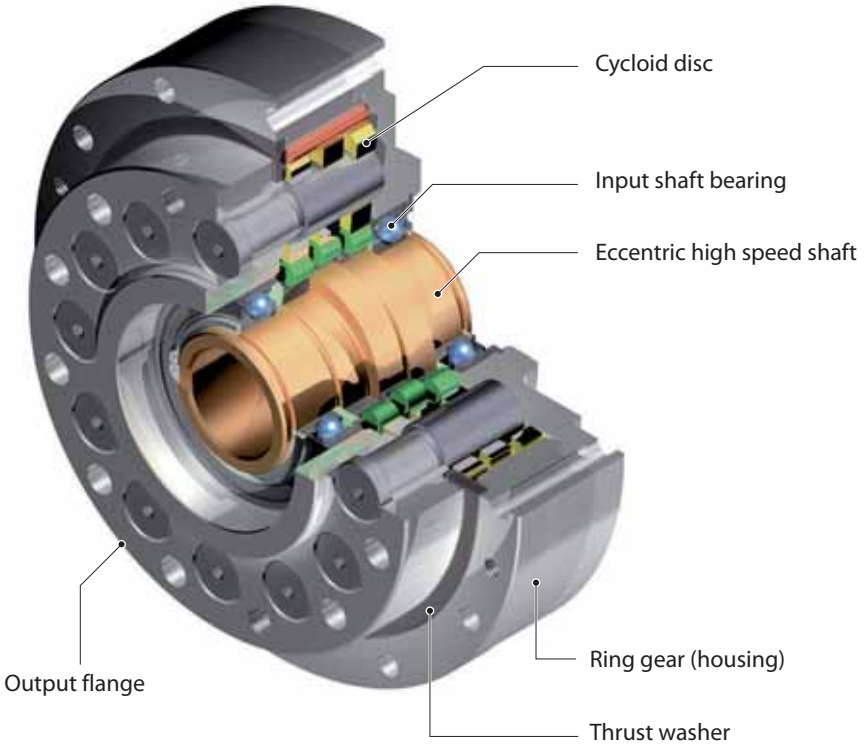
For F_C-A; D; C:
The basis of measurement is intermittent operation (S5 operation) with a maximum running time (t_c) of 10 minutes, which includes an off-time. This means that it is necessary to check the allowed mean input speed n_{1m} according to the permitted nominal speed for %ED ($n_{1m} < n_{1\,ED}$). For load duty cycles of less than 50%, we recommend using 50%ED nominal speeds, and for those greater than 50%, 100%ED nominal speeds, for checking n_{1m}.

For F2C-T:
The basis of measurement for F2C-T is the maximum output speed ($n_{2\,max}$), which corresponds simultaneously to the limit speed that is allowed in continuous operation (100 %ED). It is therefore necessary to check the maximum occurring speed $n_{2\,max}$ in the movement cycle against the limiting speed $n_{2\,max}$. The need to check a permissible nominal speed according to the duty cycle (%ED) is not required here.

Also:
If the duration of the movement phase of the working cycle t_M is greater than 10 minutes, in the case of continuous operation (S1) or if complex load cycles are performed, please consult Sumitomo Drive Technologies.

5 A-Series

FC-A

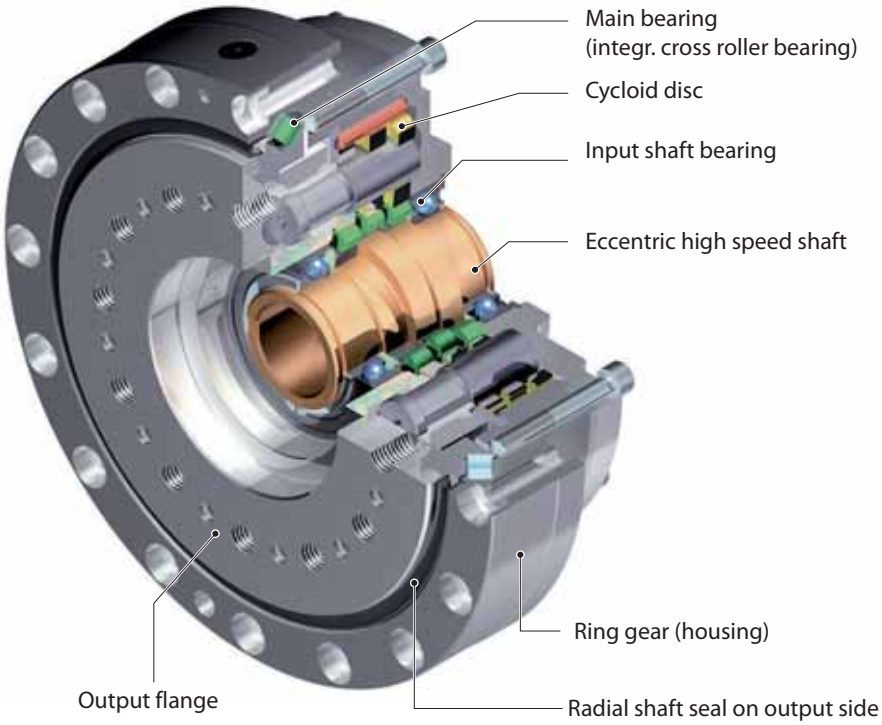


Special feature:

Customers can use their own bearings, hollow shaft possible, compact reduction kit

- 6 sizes
- Reduction ratios (single stage) 29/59/89/119/179
- Can be customised to fit individual designs
- Smaller installation space
- Nominal output torques up to 5140 Nm
- Acceleration torques up to 7610 Nm
- Input speeds up to 6150 min^{-1}
- Lost Motion < 2 arcmin (optional Lost Motion < 1 arcmin)

F1C-A

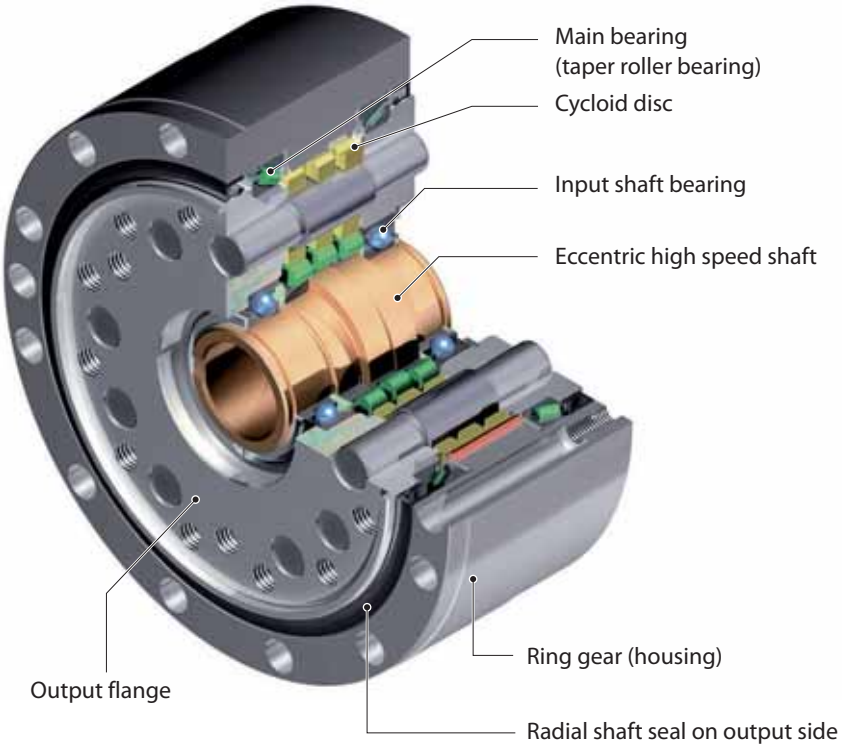


Special feature:

High rigidity, compact design

- 6 sizes
- Reduction ratios (single stage) 29/59/89/119/179
- Nominal output torques up to 5140 Nm
- Acceleration torques up to 7610 Nm
- Input speeds up to 6150 min^{-1}
- Lost Motion < 2 arcmin (optional Lost Motion < 1 arcmin)

F2C-A

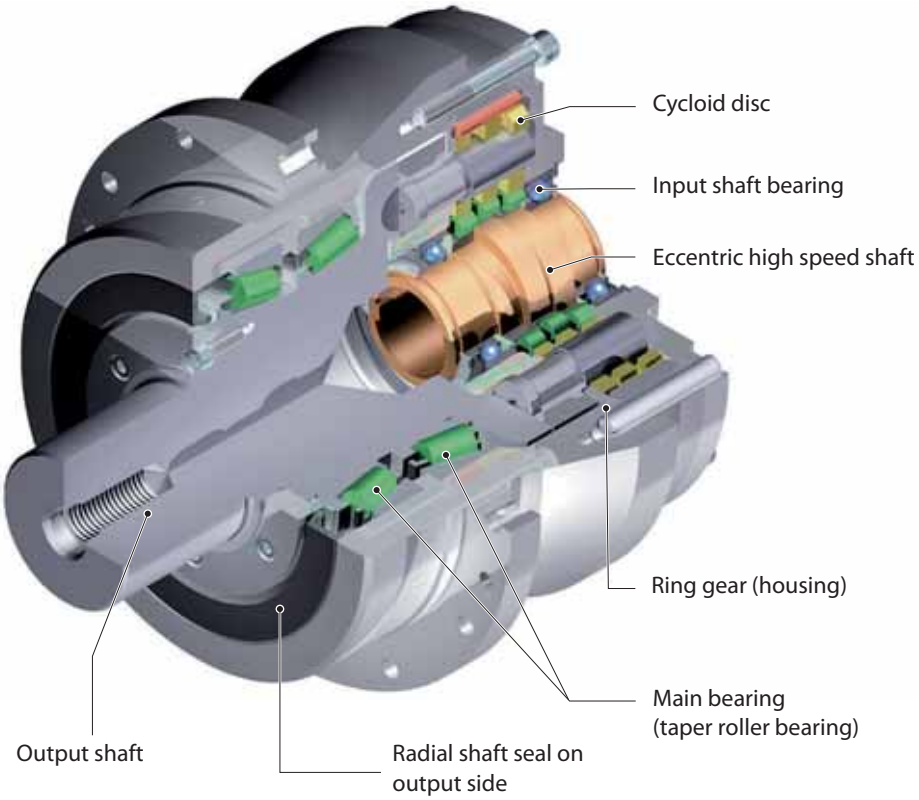


Special feature:

Low noise, high rigidity, compact design

- 4 sizes
- Reduction ratios (single stage) 29/59/89/119/179
- Tapered roller bearings with high permissible tilting moments
- Nominal output torques up to 1830 Nm
- Acceleration torques up to 2910 Nm
- Input speeds up to 6150 min^{-1}
- Lost Motion < 2 arcmin (optional Lost Motion < 1 arcmin)

F3C-A



Special feature:

Allows high radial forces

- 6 sizes
- Reduction ratios (single stage) 29/59/89/119/179
- Nominal output torques up to 5140 Nm
- Acceleration torques up to 7610 Nm
- Input speeds up to 6150 min^{-1}
- Lost Motion < 2 arcmin (optional Lost Motion < 1 arcmin)

5.1 Torques according to output speeds

Output speed n_{2m} [min^{-1}]			5			10			15			20			25		
Model	Size	Reduction ratio i	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]
FC- F1C- F2C(F)- F3C-	A15	59	196	295	0.13	196	590	0.26	174	885	0.34	160	1180	0.42	150	1475	0.49
		89	196	445	0.13	174	890	0.23	154	1335	0.30	141	1780	0.37	132	2225	0.43
	A25	29	373	145	0.24	373	290	0.49	373	435	0.73	373	580	0.98	352	725	1.15
		59	460	295	0.30	460	590	0.60	409	885	0.80	376	1180	0.98	351	1475	1.15
		89	460	445	0.30	409	890	0.53	362	1335	0.71	332	1780	0.87	310	2225	1.02
		119	460	595	0.30	375	1190	0.49	332	1785	0.65	304	2380	0.80	285	2975	0.93
	A35	29	657	145	0.43	657	290	0.86	657	435	1.29	657	580	1.72	621	725	2.03
		59	879	295	0.58	879	590	1.15	782	885	1.54	718	1180	1.88	671	1475	2.20
		89	879	445	0.58	781	890	1.02	691	1335	1.36	634	1780	1.66	593	2225	1.94
		119	879	595	0.58	716	1190	0.94	634	1785	1.24	581	2380	1.52	544	2975	1.78
	A45	29	1390	145	0.91	1390	290	1.82	1390	435	2.73	1390	580	3.64	1313	725	4.30
		59	1830	295	1.20	1830	590	2.40	1629	885	3.20	1494	1180	3.91	1397	1475	4.57
		89	1830	445	1.20	1626	890	2.13	1440	1335	2.83	1321	1780	3.46	1235	2225	4.04
		119	1830	595	1.20	1490	1190	1.95	1319	1785	2.59	1210	2380	3.17			
		179	1623	895	1.06	1318	1790	1.72	1167	2685	2.28						
	A65	29	2460	145	1.61	2460	290	3.22	2460	435	4.83	2460	580	6.44	2324	725	7.61
		59	3380	295	2.21	3380	590	4.42	3008	885	5.91	2759	1180	7.22	2581	1475	8.45
		89	3380	445	2.21	3003	890	3.93	2659	1335	5.22	2439	1780	6.39	2281	2225	7.47
		119	3380	595	2.21	2752	1190	3.60	2437	1785	4.79						
		179	2998	895	1.96	2435	1790	3.19									
	A75	29	4170	145	2.73	4170	290	5.46	4170	435	8.19	4170	580	10.92	3940	725	12.89
		59	5140	295	3.36	5140	590	6.73	4574	885	8.98	4196	1180	10.99	3924	1475	12.84
		89	5140	445	3.36	4567	890	5.98	4044	1335	7.94	3709	1780	9.71			
		119	5140	595	3.36	4185	1190	5.48	3706	1785	7.28						

Table A-1 Rating values (reference value output speed n_{2m})

30			40			50			60			Max. permissible input speed $n_{1\,max}$	Max. permissible input speed $n_{1\,ED}$ [min^{-1}]		Moment of inertia j related to the input shaft [$\cdot 10^{-4}$ kgm^2]
Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Max. permissible input speed short term [min^{-1}]	50% ED	100% ED	
142	1770	0.56	130	2360	0.68	122	2950	0.80	115	3540	0.90	6150	5600	2800	0.46
125	2670	0.49	115	3560	0.60	107	4450	0.70	102	5340	0.80	6150	5600	2800	
334	870	1.31	306	1160	1.60	286	1450	1.87	271	1740	2.13	4350	3100	1550	1.42
333	1770	1.31	305	2360	1.60	285	2950	1.87	270	3540	2.12	5050	4200	2100	
294	2670	1.15	270	3560	1.41							5050	4200	2100	
269	3570	1.06										5050	4200	2100	
588	870	2.31	539	1160	2.82	504	1450	3.30	477	1740	3.75	3500	2500	1250	4.58
635	1770	2.50	583	2360	3.05	545	2950	3.57				3950	3300	1650	
562	2670	2.21										3950	3300	1650	
												3950	3300	1650	
1243	870	4.88	1141	1160	5.97	1067	1450	6.98	1010	1740	7.93	2700	1900	950	12.7
1323	1770	5.19	1213	2360	6.35							3150	2600	1300	
1169	2670	4.59										3150	2600	1300	
												3150	2600	1300	
												3150	2600	1300	
2201	870	8.64	2019	1160	10.57	1888	1450	12.36				2200	1500	750	49.5
2443	1770	9.59										2350	2000	1000	
												2350	2000	1000	
												2350	2000	1000	
												2350	2000	1000	
3730	870	14.65	3422	1160	17.92							1950	1200	600	110.0
3715	1770	14.59										2000	1750	850	
												2000	1750	850	
												2000	1750	580	

: 50% ED range : 100% ED range (but max. 10 min. without pause)

1. T_{2N} = nominal output torque
   Nominal output torque corresponds to the max. permissible average load torque at all output speeds.
   The nominal output torque for speeds less than 5 min^{-1} is equal to the value at 5 min^{-1}.
   The value for the maximum permissible input power is calculated from the nominal output torque at 100%.
   This value takes the efficiency of Fine Cyclo into consideration.
2. n_{1max} = maximum permissible input speed
   However, it must be n_{1m} (mean input speed) < $n_{1\,ED}$.
3. $n_{1\,ED}$ = permissible input speed according to load duty cycles
4. T_{2A} = max. Acceleration and braking torque (for fatigue strength at $2 \cdot 10^7$ load cycles)
   Permissible peak torque for normal start and stop procedures.
5. T_{2max} = max. permissible torque for emergency stop situations or in the event of heavy shocks (limited by the mechanical strength) (permissible 1000 times during the entire lifetime).
6. The nominal torque T_{2N} is calculated using the following equation when the speed is not shown in the table above:

$$T_{2N} = T_{2N,\,5} \left(\frac{5}{n_{2m}} \right)^{0,3}$$

T_{2N} : Nominal torque at output speed n_{2m}
$T_{2N,\,5}$: Nominal torque at output speed n_{2m} is 5 min^{-1}

5.2 Torques according to input speeds

Input speed n_{1m} [min^{-1}]			4000			3000			2500			2000			1750		
Model	Size	Reduction ratio i	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]
FC- F1C- F2C(F)- F3C-	A15	59	111	67.8	0.89	121	50.8	0.80	128	42.4	0.71	137	33.9	0.60	142	29.7	0.55
		89	111	44.9	0.65	121	33.7	0.53	128	28.1	0.47	137	22.5	0.40	142	19.7	0.37
	A25	29				230	103	3.12	243	86.2	2.74	260	69.0	2.34	270	60.3	2.14
		59	260	67.8	2.3	284	50.8	1.88	299	42.4	1.6	320	33.9	1.42	333	29.7	1.29
		89	260	44.9	1.53	284	33.7	1.25	299	28.1	1.10	320	22.5	0.94	333	19.7	0.86
		119	260	33.6	1.14	284	25.2	0.93	299	21.0	0.82	320	16.8	0.70	333	14.7	0.64
	A35	29							428	86.2	4.83	458	69.0	4.13	476	60.3	3.76
		59				534	50.8	3.60	573	42.4	3.17	613	33.9	2.71	638	29.7	2.47
		89				543	33.7	2.39	573	28.1	2.10	613	22.5	1.80	638	19.7	1.64
		119				543	25.2	1.79	573	21.0	1.57	613	16.8	1.34	638	14.7	1.23
	A45	29										972	69.0	8.75	1010	60.3	7.97
		59							1190	42.4	6.57	12.80	33.9	5.65	1330	29.7	5.13
		89							1190	28.1	4.36	1280	22.5	3.75	1330	19.7	3.40
		119							1190	21.0	3.26	1280	16.8	2.80	1330	14.7	2.55
		179							1190	14.0	2.17	1280	11.2	1.86	1330	9.78	1.69
	A65	29															
		59										2360	33.9	10.40	2459	29.7	9.51
		89										2360	22.5	6.91	2459	19.7	6.30
		119										2360	16.8	5.17	2459	14.7	4.71
		179										2360	11.2	3.44	2459	9.78	3.13
	A75	29															
		59													3720	29.7	14.5
		89													3720	19.7	9.58
		119													3720	14.7	7.16

Table A-2 Rating values (reference value input speed n_{1m})

Size	Max. acceleration and deceleration torque T_{2A}	Peak torque for emergency stop T_{2max}
	[Nm]	[Nm]
A15	335	785
A25	721	1930
A35	1390	3580
A45	2910	7210
A65	5130	13800
A75	7610	24000

Table A-3 Maximum acceleration or deceleration torque

1500			1000			750			< 600			Max. permissible input speed $n_{1\,max}$ short term [min^{-1}]	Max. permissible input speed $n_{1\,ED}$ [min^{-1}]		Moment of inertia j related to the input shaft [$\times 10^{-4}$ kgm^2]
Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]		50% ED	100% ED	
149	25.4	0.50	168	16.9	0.37	183	12.7	0.30	196	10.10	0.26	6150	5600	2800	0.46
149	16.9	0.33	168	11.2	0.25	183	8.4	0.20	196	6.74	0.17	6150	5600	2800	
283	51.7	1.92	320	34.5	1.44	349	25.9	1.18	373	20.70	1.00	4350	3100	1550	1.42
349	25.4	1.16	395	16.9	0.87	430	12.7	0.71	460	10.10	0.61	5050	4200	2100	
349	16.9	0.77	395	11.2	0.58	430	8.4	0.47	460	6.74	0.41	5050	4200	2100	
349	12.6	0.77	395	8.4	0.43	430	6.3	0.35	460	5.04	0.30	5050	4200	2100	
499	51.7	3.38	564	34.5	2.54	615	25.9	20.8	657	20.70	1.78	3500	2500	1250	4.58
668	25.4	2.22	754	16.9	1.76	822	12.7	1.27	879	10.10	1.17	3950	3300	1650	
668	16.9	1.47	754	11.2	1.11	822	8.4	0.91	879	6.74	0.77	3950	3300	1650	
668	12.6	1.10	754	8.4	0.83	822	6.3	0.68	879	5.04	0.58	3950	3300	1650	
1060	51.7	7.16	1190	34.5	5.39	1300	25.9	4.41	1390	20.70	3.77	2700	1900	950	12.7
1390	25.4	4.60	1570	16.9	3.48	1710	12.7	2.84	1830	10.10	2.43	3150	2600	1300	
1390	16.9	3.05	1570	11.2	2.30	1710	8.4	1.88	1830	6.74	1.61	3150	2600	1300	
1390	12.6	2.28	1570	8.4	1.72	1770	6.3	1.41	1830	5.04	1.20	3150	2600	1300	
1390	8.38	1.51	1570	5.59	1.15	1710	4.2	0.93	1830	3.35	0.80	3150	2600	1300	
1870	51.7	12.70	2110	34.5	9.50	2300	25.9	7.79	2460	20.70	6.66	2200	1500	750	49.5
2570	25.4	8.54	2900	16.9	6.43	3160	12.7	5.25	3380	6.74	2.98	2350	2000	1000	
2570	16.9	5.66	2900	11.2	4.26	3160	8.43	3.48	3380	5.04	2.23	2350	2000	1000	
2570	12.6	4.23	2900	8.4	3.19	3160	6.3	2.6	3380	5.04	2.23	2350	2000	1000	
2570	8.38	2.81	2900	5.59	2.12	3160	4.19	1.73	3380	3.35	1.48	2350	2000	1000	
			3580	34.5	16.10	3900	25.9	13.2	4170	20.70	11.30	1950	1200	600	110.0
3900	25.4	13.00	4410	16.9	9.76	4810	12.7	7.99	5140	10.10	6.83	2000	1750	850	
3900	16.9	8.60	4410	11.2	6.47	4810	8.43	5.29	5140	6.74	4.53	2000	1750	850	
3900	12.6	6.43	4410	8.4	4.84	4810	6.3	3.96	5140	5.0	3.39	2000	1750	580	

: 50% ED range : 100% ED range (but max. 10 min. without pause)

1. T_{2N} = nominal output torque
   Nominal output torque corresponds to the max. permissible average load torque at all input speeds.
   The nominal output torque for speeds less than 600 min^{-1} is equal to the value at 600 min^{-1}.
   The value for the maximum permissible input power is calculated from the nominal output torque at 100%.
   This value takes the efficiency of Fine Cyclo into consideration.
2. n_{1max} = maximum permissible input speed
   However, it must be n_{1m} (mean input speed) < $n_{1\,ED}$.
3. $n_{1\,ED}$ = permissible input speed according to load duty cycles
4. T_{2A} = max. Acceleration and braking torque (for fatigue strength at $2 \cdot 10^7$ load cycles)
   Permissible peak torque for normal start and stop procedures.
5. T_{2max} = max. permissible torque for emergency stop situations or in the event of heavy shocks (limited by the mechanical strength) (permissible 1000 times during the entire lifetime).
6. The nominal torque T_{2N} is calculated using the following equation when the speed is not shown in the table above:

$$T_{2N} = T_{2N,\,600} \left(\frac{600}{n_{1m}} \right)^{0,3}$$

T_{2N} : Rated torque at input speed n_{1m}
$T_{2N,600}$: Rated torque at input speed n_{1m} is 600 min^{-1}

5.3 Rigidity and Lost Motion

Size	i	Test torque T_p [Nm]	Lost Motion		Torsional stiffness 3% - 50% T_p [Nm/arcmin]	Torsional stiffness 3% - 100% T_p [Nm/arcmin]	Torsional stiffness 50% - 100% T_p [Nm/arcmin]
			Lost Motion [arcmin]	Domain of definition [Nm]			
A15	59	±149	< 2 arcmin standard < 1 arcmin optional	±4.5	15 (14)	20 (18)	28 (24)
	89				15 (14)	20 (18)	28 (24)
A25	29	±349		±11	40 (37)	53 (47)	80 (70)
	59				52 (46)	70 (60)	100 (81)
	89				52 (46)	70 (60)	100 (81)
	119				52 (46)	70 (60)	100 (81)
A35	29	±668		±20	70 (65)	95 (85)	140 (120)
	59				110 (95)	145 (120)	210 (161)
	89				110 (95)	145 (120)	210 (161)
	119				110 (95)	145 (120)	210 (161)
A45	29	±1390		±42	170 (155)	220 (195)	300 (255)
	59				220 (195)	300 (225)	445 (350)
	89				220 (195)	300 (225)	445 (350)
	119				220 (195)	300 (225)	445 (350)
	179				220 (195)	300 (225)	445 (350)
A65	29	±2570		±77	310 (285)	400 (360)	530 (460)
	59				400 (360)	530 (460)	770 (627)
	89				400 (360)	530 (460)	770 (627)
	119				400 (360)	530 (460)	770 (627)
	179				400 (360)	530 (460)	770 (627)
A75	29	±3900		±117	590 (530)	740 (650)	960 (810)
	59				610 (550)	790 (685)	1100 (910)
	89				610 (550)	790 (685)	1100 (910)
	119				610 (550)	790 (685)	1100 (910)

Table A-4 Torsional stiffness
(...) Values in brackets apply for F3C-A
T_p: Test torque at input speed $n_1 = 1500\ min^{-1}$

1) At a load torque less than 3% T_p

$$\varphi = \frac{\text{Lost Motion}}{2} \cdot \frac{\text{Load torque}}{0.03 \cdot T_p}$$

2) At a load torque greater than 3% T_p (standard case)

$$\varphi = \frac{\text{Lost Motion}}{2} + \frac{\text{Load torque} - (0.03 \cdot T_p)}{\text{Torsional stiffness}}$$

Note arcmin means "angular minute".
Table values for rigidity are average values

5.4 No-load running torque NLRT

No-load running torque for i = 59, 89, and 119

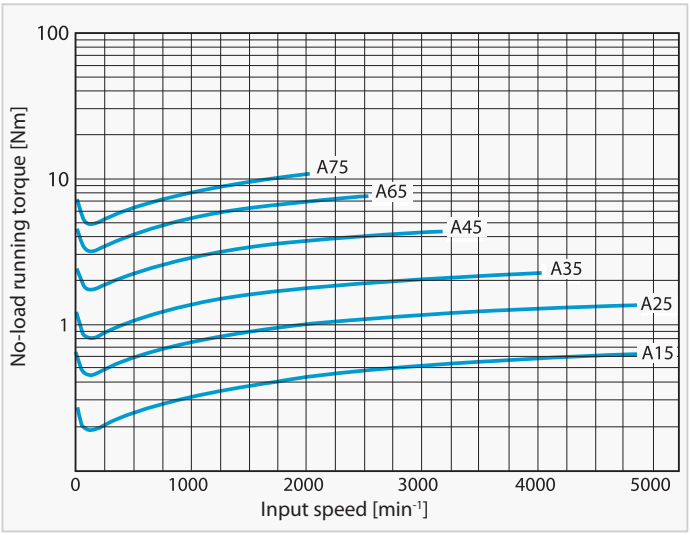


Fig. A-1 Input side no-load running torque (i 59-119)

No-load running torque for i = 29

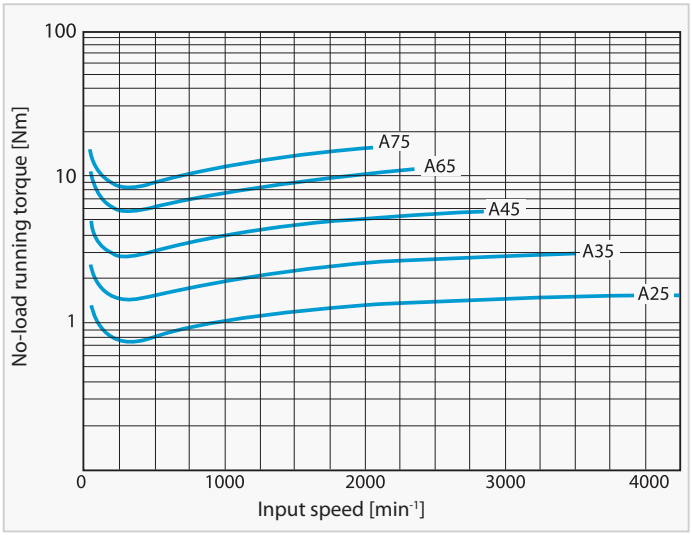


Fig. A-2 Input side no-load running torque (i 29)

Note

1. Fig. A-1 and Fig. A-2 show the average no-load-running torques after gearbox is run in (not factory-new condition)
2. Table A-5 shows the measuring conditions

5.5 Breakaway torque

Breakaway torque on output side (BTO)

Note

1. Table A-6 shows the max. breakaway torque on the output side BTO. Fine Cyclo reducers are not self-locking. The BTO is defined as the maximum value (factory-new condition), which steadily decreases during the lifetime.
2. Table A-5 shows the measuring conditions

Ring gear housing temperature	approx. 30 °C
Precision during assembly	as per chapter 5.9.1, 5.10.1, 5.11.1, 5.12.1
Lubrication	Standard lubrication

Table A-5 Measurement conditions

Size	Breakaway torque BTO [Nm]
A15	< 75
A25	< 180
A35	< 245
A45	< 360
A65	< 530
A75	< 700

Table A-6 Value of the breakaway torque on the output side (BTO)

Breakaway torque on input side (BTI)

Note

1. Table A-7 shows the max. breakaway torque BTI on the input side. The BTI is defined as the maximum value (factory-new condition) which steadily decreases during the lifetime.
2. Table A-5 shows the measuring conditions

Size	i	Breakaway torque BTI [Nm]
A15	59	< 1
	89	< 0.8
A25	29	< 5.6
	59	< 2.8
	89	< 2.45
	119	< 1.9
A35	29	< 7
	59	< 2.8
	89	< 2.0
	119	< 2
A45	29	< 8
	59	< 4.3
	89	< 3.15
	119	< 2
	179	< 1.8
A65	29	< 9
	59	< 5
	89	< 4.5
	119	< 3.8
	179	< 2.6
A75	29	< 20
	59	< 6.5
	89	< 5.5
	119	< 4.5

Table A-7 Value of the breakaway torque on the input side (BTI)

5.6 Efficiency

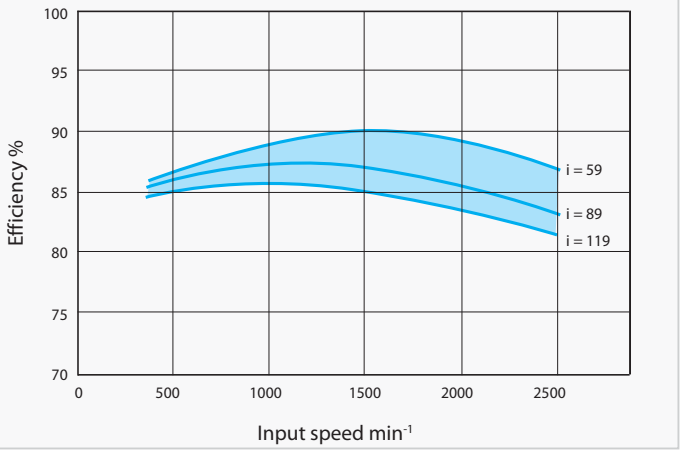


Fig. A-3 Efficiency curve

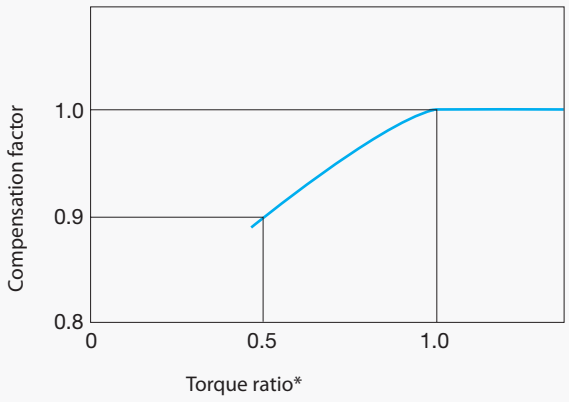


Fig. A-4 Compensation curve for efficiency

Fig. A-3 shows the relation between efficiency and input speed. For further information see "4 Explaining the technical details" on page 18.

Note

1. The efficiency changes if the load torque does not match the nominal torque. Check the compensation factor in the diagram Fig. A-4
2. When the torque ratio is over 1.0, the compensation factor for efficiency is 1.0 (diagram Fig. A-4)

$$* \text{Torque ratio} = \frac{\text{Load torque}}{\text{Nominal output torque}}$$

Compensation efficiency = efficiency · compensation factor

5.7 Bearing loads

5.7.1 Maximum permissible radial and axial load on the input shaft

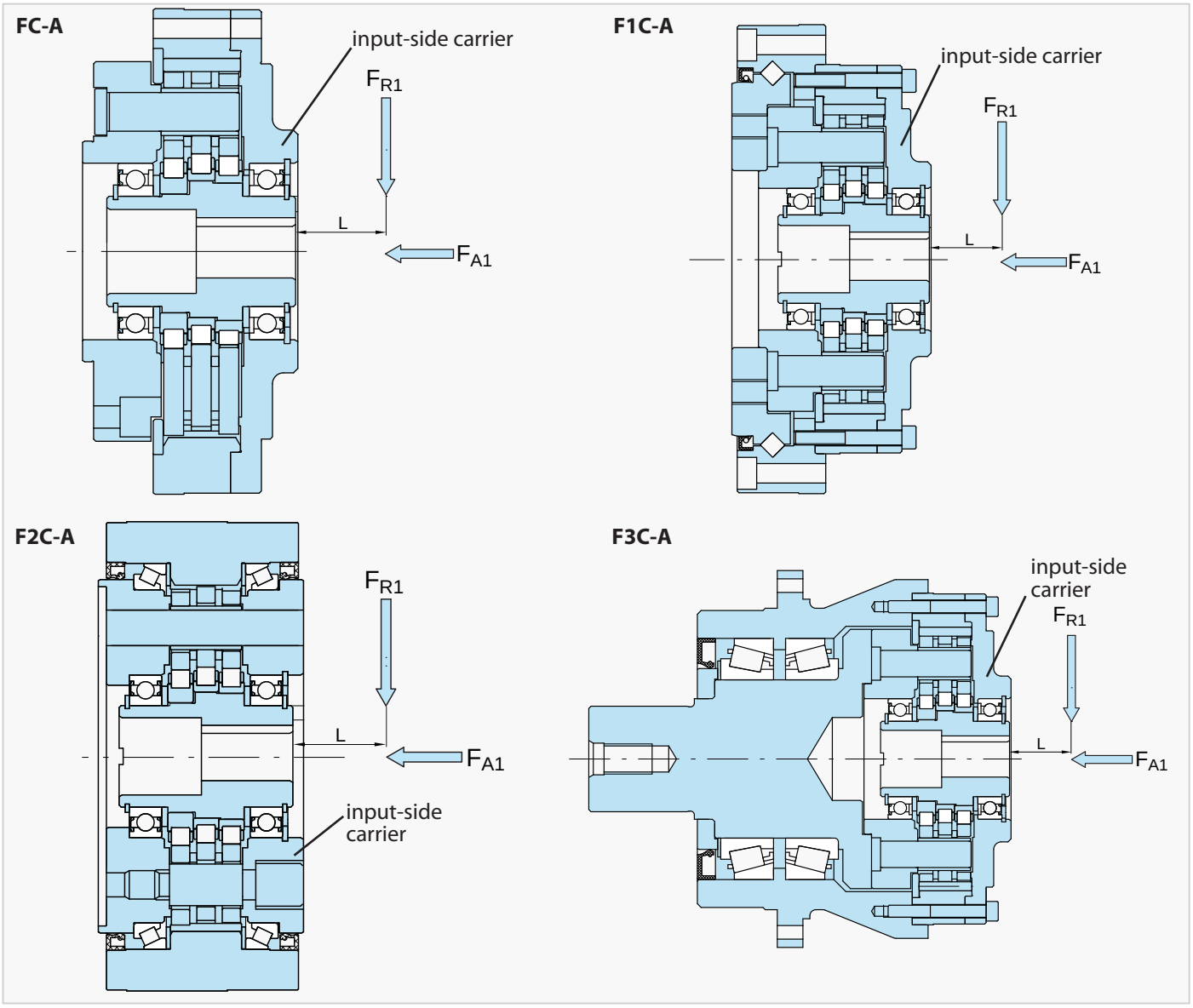


Fig. A-5 Load position on input shaft

If a pinion or toothed belt pulley is mounted on the input shaft, the values for radial load and axial load should be equal to or less than the permissible values. The following equation is used to check whether the shaft load is permissible:

1. Input radial load F_{R1}

$$F_{R1} = 10^3 \cdot \frac{T_{2V}}{\eta \cdot i \cdot r_0} \leq \frac{F_{R1\,max}}{L_{f1} \cdot C_{f1} \cdot B_{f1}} \quad [N] \qquad \text{(Equation A-1)}$$

2. Input side axial load F_{A1}

$$F_{A1} \leq \frac{F_{A1\,max}}{C_{f1} \cdot B_{f1}} \quad [N] \qquad \text{(Equation A-2)}$$

3. When radial and axial loads co-exist

$$\left(\frac{F_{R1} \cdot L_{f1}}{F_{R1\,max}} + \frac{F_{A1}}{F_{A1\,max}} \right) \cdot C_{f1} \cdot B_{f1} \leq 1 \qquad \text{(Equation A-3)}$$

F_{R1} = input side radial load [N]
T_{2V} = equivalent output torque on output shaft [Nm]
r_0 = pitch circle radius of sprocket, pinion, or toothed belt pulley [mm]
$F_{R1\,max}$ = max. permissible input side radial load [N] (Table A-8)
F_{A1} = input side axial load [N]
$F_{A1\,max}$ = max. permissible input side axial load [N] (Table A-9)
L_{f1} = load factor input (Table A-10)
C_{f1} = correction factor input (Table A-11)
B_{f1} = service factor input (Table A-12)
L = distance of radial load from front end on input side of the input shaft [mm] (Table A-10)
η = 0.8 (efficiency)

Size	Input speed n_{1m} [min^{-1}]								
	4000	3000	2500	2000	1750	1500	1000	750	600
A15	225	245	255	275	295	300	350	390	410
A25	330	360	390	420	440	460	530	580	360
A35		490	520	560	590	620	700	780	835
A45			610	660	690	720	820	900	980
A65				880	930	980	1120	1240	1320
A75					1180	1240	1410	1560	1670

Table A-8 Max. permissible input side radial load $F_{R1\,max}$ [N]

Size	Input speed n_{1m} [min^{-1}]								
	4000	3000	2500	2000	1750	1500	1000	750	600
A15	245	285	315	345	360	390	470	550	610
A25	360	410	450	500	540	580	700	805	880
A35		600	650	725	765	825	1000	1100	1100
A45			1010	1120	1200	1290	1290	1290	1290
A65				1440	1440	1440	1440	1440	1440
A75					2120	2280	2770	3170	3210

Table A-9 Max. permissible input side axial load $F_{A1\,max}$ [N]

$$F_{R1\,max} = F_{R1,600} \left(\frac{600}{n_{1m}} \right)^{1/3}$$

$$F_{A1\,max} = F_{A1,600} \left(\frac{600}{n_{1m}} \right)^{0,47}$$

$F_{R1\,max}$ = maximum permissible input side radial load at input speed n_{1m}

$F_{R1,600}$ = input side radial load at input speed $n_{1m} = 600$ min^{-1}

$F_{A1\,max}$ = maximum permissible input side axial load at input speed n_{1m}

$F_{A1,600}$ = input side axial load at input speed $n_{1m} = 600$ min^{-1}

Load factor input L_{f1}						
L	Size					
[mm]	A15	A25	A35	A45	A65	A75
10	0.90	0.86				
15	0.98	0.93	0.91			
20	1.25	1.00	0.96	0.86		
25	1.56	1.25	1.09	0.94		
30	1.88	1.50	1.30	0.99	0.89	0.89
35	2.19	1.75	1.52	1.13	0.93	0.92
40		2.00	1.74	1.29	0.97	0.96
45			1.96	1.45	1.02	0.99
50			2.17	1.61	1.14	1.09
60				1.94	1.36	1.30
70					1.59	1.52
80					1.82	1.74

Table A-10 Load factor input L_{f1}

L = Distance from input side input shaft front end

Correction factor input	C_{f1}
Chain	1
Pinion*	1.25
Toothed belt	1.25
V-Belt	1.5

Table A-11 Correction factor input C_{f1}

* For helical pinions or bevel gears, please consult Sumitomo Drive Technologies.

Service factor input	B_{f1}
Uniform load	1
Light impacts	1.2
Severe impacts	1.6

Table A-12 Service factor input B_{f1}

5.7.2 Main bearings

Fine Cyclo - F1C-A

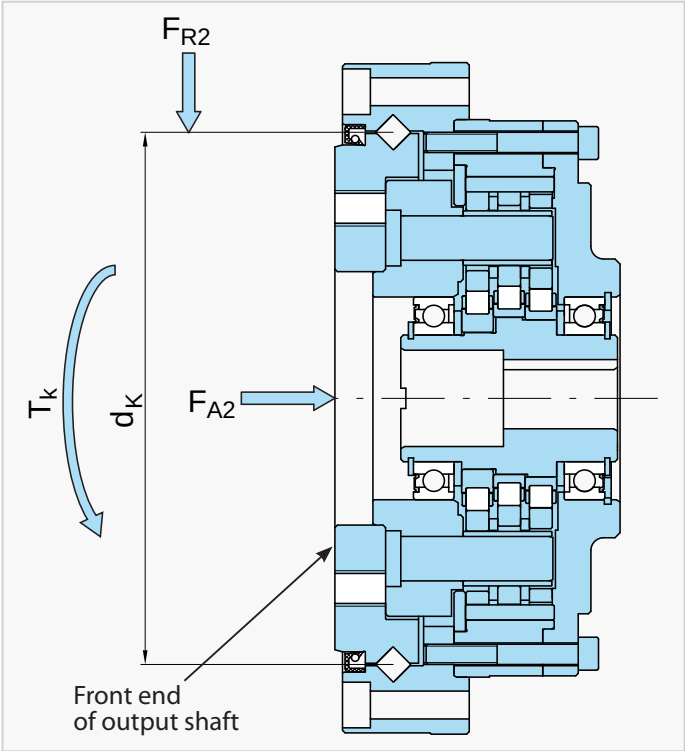


Fig. A-6 Load position output

	Load factor	
	Radial load X_L	Axial load Y_L
$\frac{F_{A2}}{F_{R2}+\frac{2\cdot10^3\cdot T_k}{d_k}} \leq 1.5$	1	0.45
$\frac{F_{A2}}{F_{R2}+\frac{2\cdot10^3\cdot T_k}{d_k}} > 1.5$	0.67	0.67

F_{A2} = output side axial load [N]
F_{R2} = output side radial load [N]
C_{f2} = correction factor output
B_{f2} = service factor output
d_k = mean bearing diameter [mm]
$T_{k\,max}$ = maximum permissible bending moment [Nm]
T_k = bending moment [Nm]
φ_1 = tilt angle [arcmin]
Θ_1 = moment stiffness main bearing [Nm/arcmin]
T_{2v} = equivalent output torque [Nm]
d_0 = pitch circle diameter of output element [mm]
C = dynamic load rating
C_0 = static load rating

For power transmission by pinion, toothed belt, or similar:

$$F_{R2} = C_{f2} \cdot B_{f2} \cdot \frac{2\cdot10^3\cdot T_{2V}}{d_0} \qquad \text{(Equation A-9)}$$

Size	Θ_1 [Nm/arcmin]	$T_{k\,max}$ [Nm]	d_k [mm]	C [N]	C_0 [N]
A15	205	460	101	26700	25400
A25	370	770	123	29600	31000
A35	750	1350	149	62300	64500
A45	3500	3350	210	81000	159000
A65	7800	6700	279	170000	325000
A75	15600	14400	340	263000	510000

Table A-13 Specification cross roller bearings

1. Moment stiffness

   The moment stiffness is the bending moment at which the output flange is tilted by the tilt angle.

   The tilt angle of the output flange is determined as follows:

$$\varphi_1 = \frac{T_k}{\Theta_1} \qquad \text{(Equation A-5)}$$

Correction factor	C_{f2}
Chain	1
Pinion or rack	1.25
Toothed belt	1.25
V-Belt	1.5

Table A-14 Correction factor output C_{f2}

Service factor	B_{f2}
Uniform load	1
Light impacts	1.2
Severe impacts	1.6

Table A-15 Service factor output B_{f2}

A dynamically equivalent load P on the bearing is calculated from these loads.
With the equivalent load P and the mean input speed n_{2m}, it is possible to test whether the output bearing achieves the desired lifetime L_{h10}.

$$P = X_L \left(F_{R2} + \frac{2\cdot10^3\cdot T_K}{d_k} \right) + Y_L \cdot F_{A2} \qquad \text{(Equation A-10)}$$

$$L_{h10} = \frac{10^6}{60\cdot n_{2m}} \left(\frac{C}{P} \right)^{\frac{10}{3}} \qquad \text{(Equation A-11)}$$

Fine Cyclo - F2C(F)

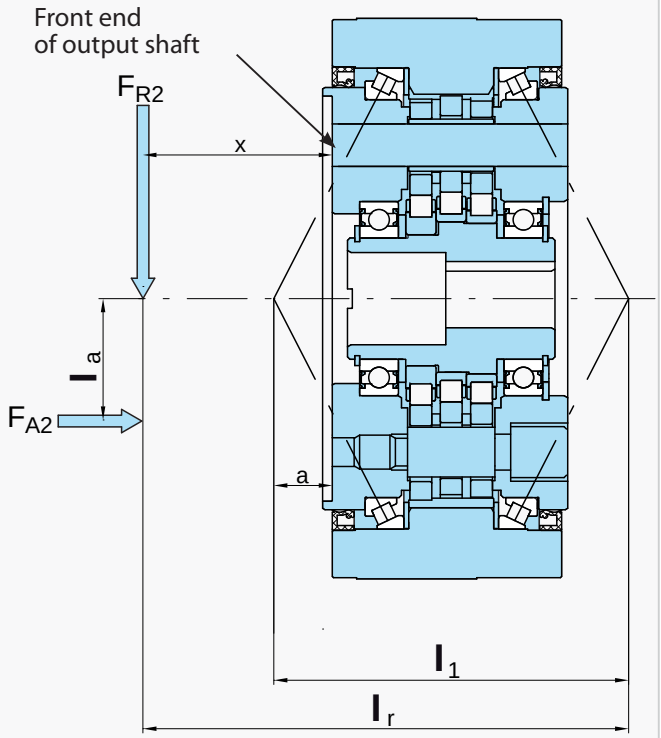


Fig. A-7 Distance between the individual loading points

$$l_r = x - a + l_1 \quad \text{(Equation A-4)}$$

Size	Values of internal bearing distance	
	l_1 [mm]	a [mm]
A15	72.6	6.5
A25	80.4	8.7
A35	108.0	14.5
A45	139.2	20.6

Table A-16 Bearing clearances

Note If: $l_r > 4 \cdot l_1$, please contact Sumitomo Drive Technologies.

1. Moment stiffness

   The moment stiffness is the bending moment at which the output flange is tilted by the tilt angle.

   The tilt angle of the input flange is determined as follows:

$$\varphi_1 = \frac{T_k}{\Theta_1} \quad \text{(Equation A-5)}$$

External bending moment T_k

$$T_k = 10^{-3} \cdot (F_{R2} \cdot l_r + F_{A2} \cdot l_a) \quad \text{(Equation A-6)}$$

2. Max. permissible bending moment and max. permissible axial load

   Check the equivalent bending moment and the equivalent axial load using equations A-6, A-7, A-8, and Fig. A-8.

Equivalent bending moment T_{ke}

$$T_{ke} = 10^{-3} \cdot (C_{f2} \cdot B_{f2} \cdot F_{R2} \cdot l_r + C_{f2} \cdot B_{f2} \cdot F_{A2} \cdot l_a) \quad < T_{k\,max} \quad \text{(Equation A-7)}$$

Equivalent axial load F_{A2e} at the output shaft

$$F_{A2e} = F_{A2} \cdot C_{f2} \cdot B_{f2} \quad < F_{A2\,max} \quad \text{(Equation A-8)}$$

F_{A2} = output side axial load [N]
$F_{A2\,max}$ = maximum permissible output side axial load [N]
F_{A2e} = equivalent output side axial load [N]
F_{R2} = output side radial load [N]
C_{f2} = correction factor output (Table A-17)
B_{f2} = service factor output (Table A-18)
l_1 = bearing clearance [mm] (Table A-16)
l_r = calculated dimension for bending moment [mm]
l_a = distance of axial load [mm]
x = distance from radial force to flange collar [mm]
a = correction factor [mm] (Table A-16)
T_k = external bending moment [Nm]
$T_{k\,max}$ = max. permissible bending moment [Nm] (Table A-19)
T_{ke} = equivalent bending moment [Nm]
φ_1 = tilt angle [arcmin]
Θ_1 = moment stiffness main bearing [Nm/arcmin] (Table A-20)

Correction factor output	C_{f2}
Chain	1
Pinion or rack	1.25
Toothed belt	1.25
V-Belt	1.5

Table A-17 Correction factor output C_{f2}

Service factor output	B_{f2}
Uniform load	1
Light impacts	1.2
Severe impacts	1.6

Table A-18 Service factor output B_{f2}

Size	Max. permissible bending moment $T_{k\,max}$	Max. permissible axial load $F_{A2\,max}$	
		Tension	Compression
	[Nm]	[N]	[N]
A15	608	2450	3920
A25	1030	3920	5400
A35	1620	5400	7850
A45	2550	6870	11800

Table A-19 Max. permissible bending moment and max. permissible axial load

Size	Moment stiffness Θ_1
	[Nm/arcmin]
A15	230
A25	400
A35	950
A45	1600

Table A-20 Average values for moment stiffness

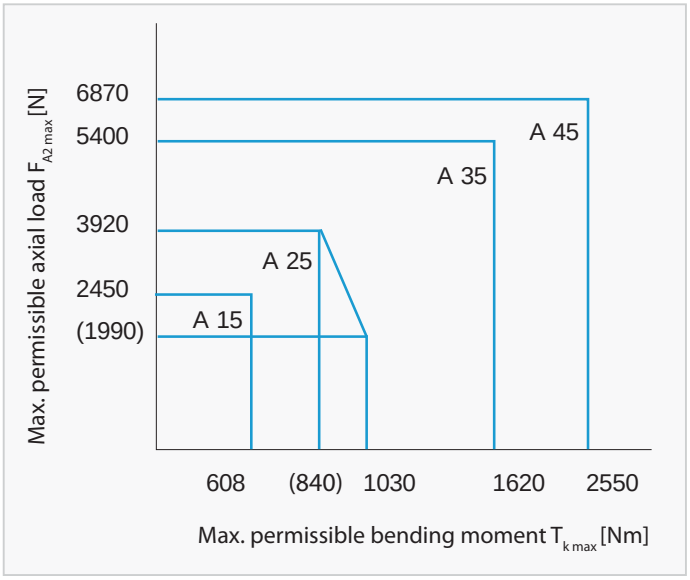


Fig. A-8 Diagram: Max. permissible bending moment and axial load

Fine Cyclo - F3C-A

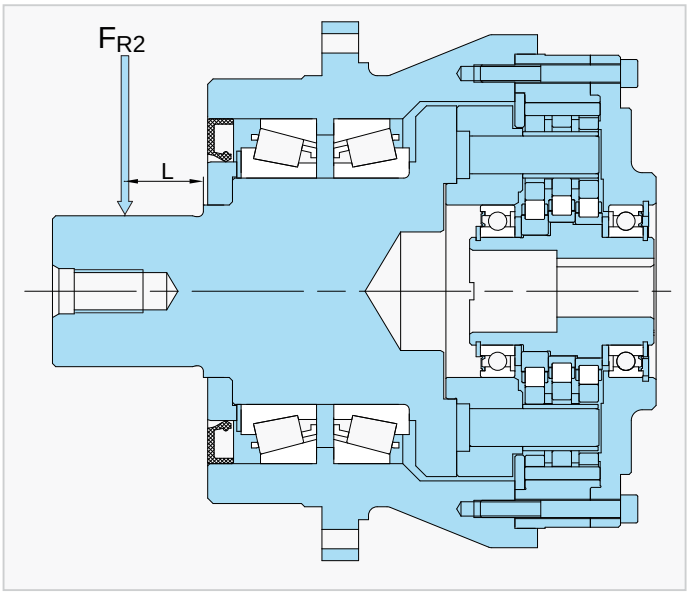


Fig. A-9 Load position output

If the output shaft is fitted with a pinion or a disc, a force acts on the shaft. The following equation is used to check whether the shaft load is permissible.

Radial load F_{R2} [kN]

$$F_{R2} = \frac{T_{2V} \cdot L_{f2} \cdot B_{f2} \cdot C_{f2}}{r_0} \leq F_{R2\,zul} \qquad \text{(Equation A-12)}$$

Radial load
F_{R2zul} = permissible radial load [kN]
T_{2V} = equivalent output torque [Nm]
L_f = load factor
B_f = service factor
C_f = correction factor
r_0 = pitch circle radius of the pinion [mm]

Correction factor output	C_{f2}
Chain	1
Pinion or rack	1.25
Toothed belt	1.25
V-Belt	1.5

Table A-21 Correction factor output C_{f2}

Service factor output	B_{f2}
Uniform load	1
Light impacts	1.2
Severe impacts	1.6

Table A-22 Service factor output B_{f2}

n_{2m} [min^{-1}]	Permissible radial load $F_{R2\,zul}$ [kN] for F3C-					
	A15	A25	A35	A45	A65	A75
~ 5	17.4	31.8	44.4	87.9	126	157
10	17.4	31.8	44.4	81.2	114	153
15	17.4	31.8	44.4	71.7	114	135
20	17.4	31.8	44.4	65.6	104	124
25	17.4	31.8	41.1	61.2	97.5	115
30	17.4	29.8	38.8	57.9	92.5	109
35	17.4	28.4	37.0	55.2	88.2	104
40	17.4	27.3	35.5	52.9	84.6	100
50	17.4	25.4	33.2	49.4	78.9	93.5
60	17.4	24.1	31.3	46.6		
80		22.0				

Table A-23 Permissible radial load $F_{R2\,zul}$

L [mm]	Load factor L_{f2} for F3C-					
	A15	A25	A35	A45	A65	A75
10	0.91	0.86				
15	0.97	0.92	0.88	0.85		
20	1.03	0.97	0.93	0.88	0.84	
25	1.09	1.03	0.98	0.92	0.88	0.86
30	1.16	1.08	1.02	0.98	0.91	0.89
35	1.22	1.14	1.07	1.00	0.94	0.92
40		1.19	1.12	1.04	0.97	0.95
45		1.25	1.16	1.08	1.00	0.97
50			1.21	1.12	1.03	1.00
60				1.19	1.09	1.05
70				1.27	1.16	1.11
80					1.22	1.16
90					1.28	1.22
100						1.27

Table A-24 Load factor L_{f2}

5.8 Lubrication

- The gearboxes of the Fine Cyclo A-Series are filled with grease before delivery and ready to use.
- Inspection and overhaul recommended after 20,000 operating hours or 3-5 years.
- An overhaul requires experience and specialised knowledge and may only be performed by authorized specialised staff. The lifespan of the gearbox can be increased by returning it to the factory for overhauling and regreasing.

Grease prescribed	Manufacturer
CITRAX FA NO. 2	Kyodo Yushi Co., Ltd.
Conditions for use: Environmental temperature -10 °C to +40 °C	

Table A-25 Specified grease for the A-Series

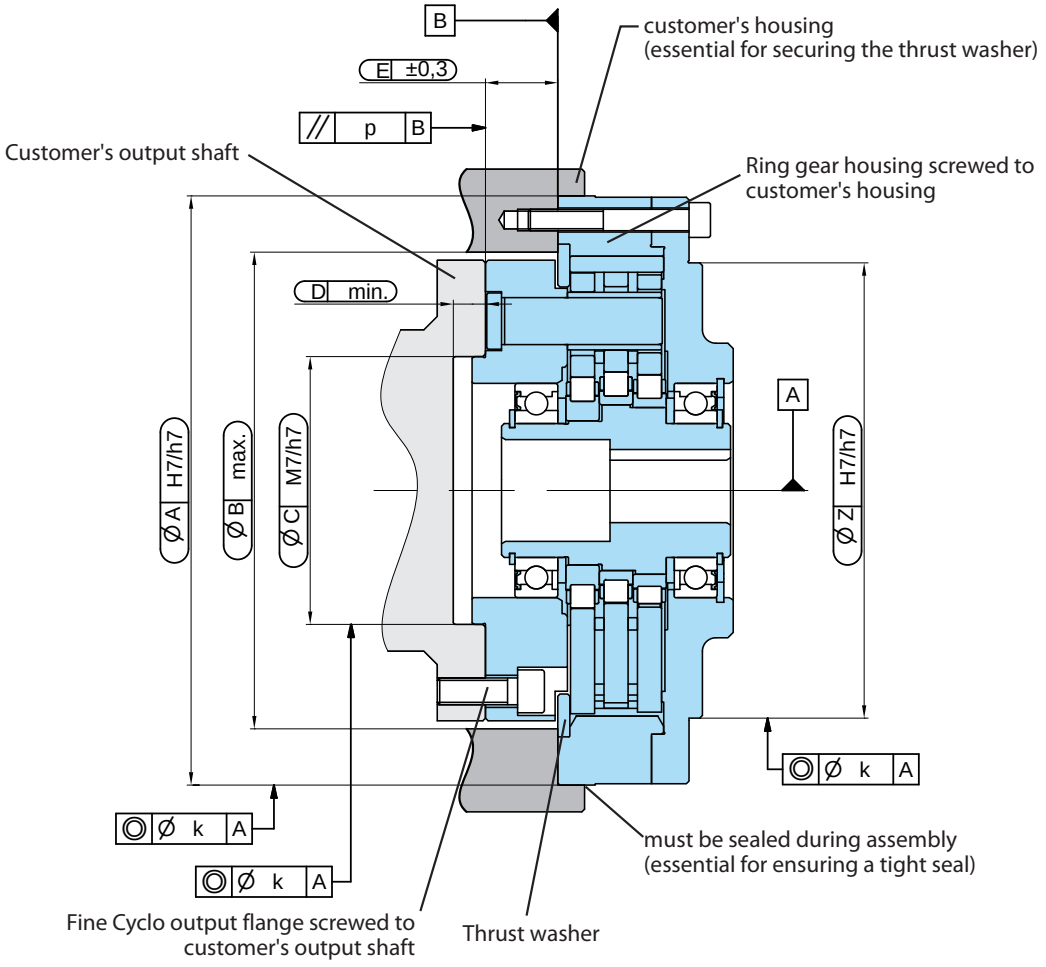
5.9 Model FC-A

5.9.1 Assembly tolerances

In order for the thrust washer to be retained by the customer's housing, the inside diameter B must not exceed the specified values. The depth of the customer's output shaft spigot must be equal to or less than dimension D to prevent jamming the output flange. Furthermore, dimension E must be adhered to. The recommended precision of the assembly part (housing and output shaft) must lie within concentricity k and parallelism p.

The recommended diameters of the housing, output shaft, and input side flange spigots are shown schematically below.

To ensure the function, lifetime, and characteristics of the gearboxes, the radial run-out of the shaft ends, the concentricity, and the axial run-out of the fastening surface as per EN 50347:2001 are sufficient. When used in high-precision applications, the tolerance according to EN 50347:2001 should be reduced by 50%.



Size	Ø A	Ø B	Ø C	Ø Z	D	E	k	p
A15	115	90	45	85	5	15.5	0.030	0.025
A25	145	115	60	110	6	21	0.030	0.035
A35	180	144	80	135	6	24	0.030	0.040
A45	220	182	100	170	8	27	0.030	0.050
A65	270	226	130	210	8	33	0.030	0.065
A75	310	262	150	235	8	38	0.030	0.070

Table A-26 (Dimensions in mm)

5.9.2 Tightening torque and maximum permissible transmitted torque for bolts

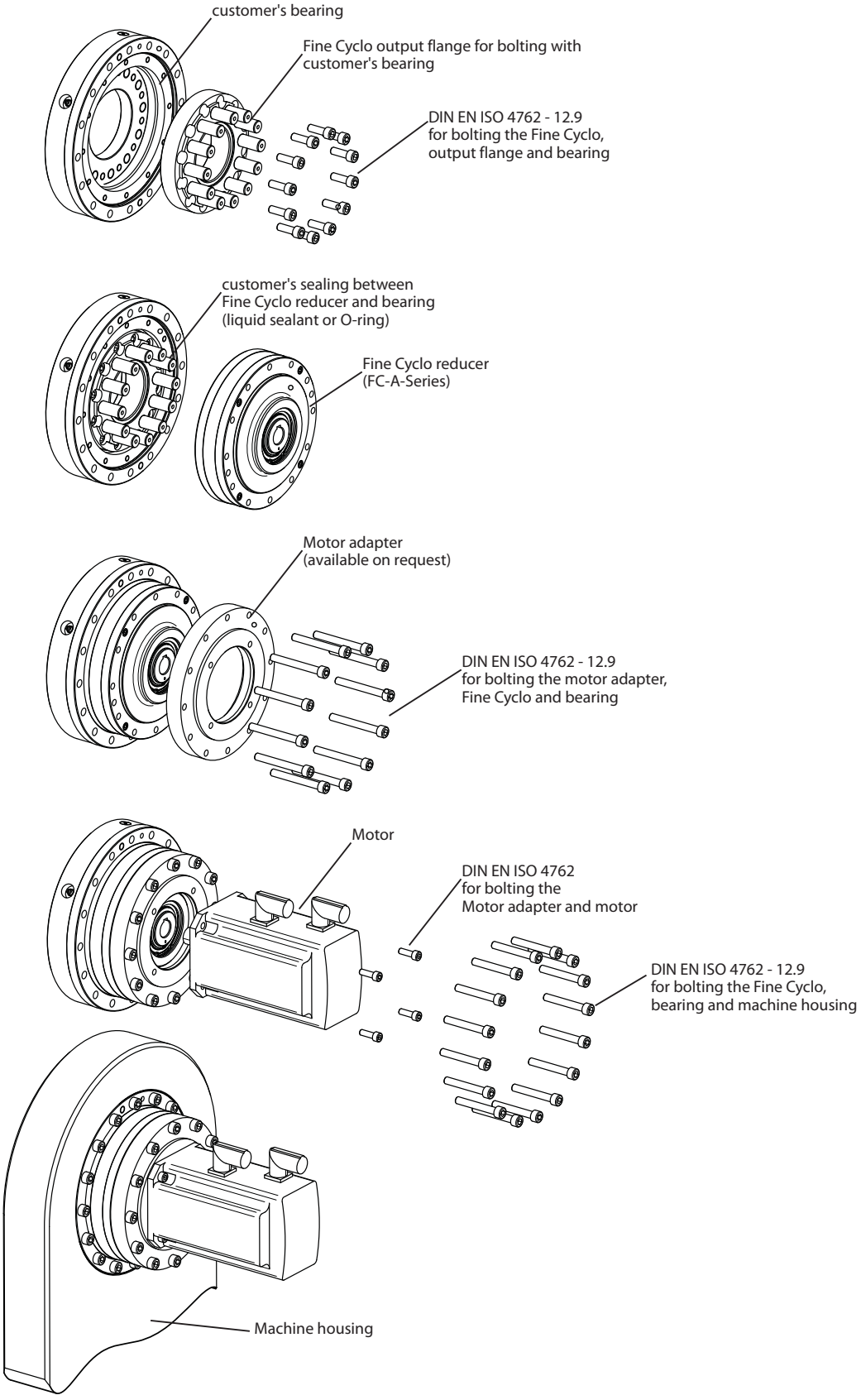
The permissible transmitted torque for bolts and the number, size, and tightening torque for fastening the output side flange and the ring gear housing are listed in Table A-27. In the event of an emergency stop with corresponding load peaks, the output flange and ring gear housing bolts must all be replaced.

Size	Output flange bolts		Bolts for ring gear (housing)		Max. permissible transmitted torque for bolts [Nm]
	Number and size of bolts	Tightening torque [Nm]	Number and size of bolts	Tightening torque [Nm]	
A15	12 × M5	9.2	8 × M5	9.2	470
A25	12 × M6	16	8 × M6	16	830
A35	12 × M8	39	8 × M8	39	1900
A45	12 × M10	77	12 × M8	39	3550
A65	12 × M12	135	12 × M10	77	7000
A75	12 × M12	135	12 × M10	77	8000

Table A-27

- **Bolting:** Use metric hexagon socket head cap screws (DIN 4762, strength category 12.9).
- **Countermeasure for bolts loosening:** Use adhesives (Loctite 262, etc.) or spring washer (DIN 127A).
- **Use conical spring washers** (DIN 6796) when connecting the gearbox to the flange side, so that the bolt contact faces do not get damaged.

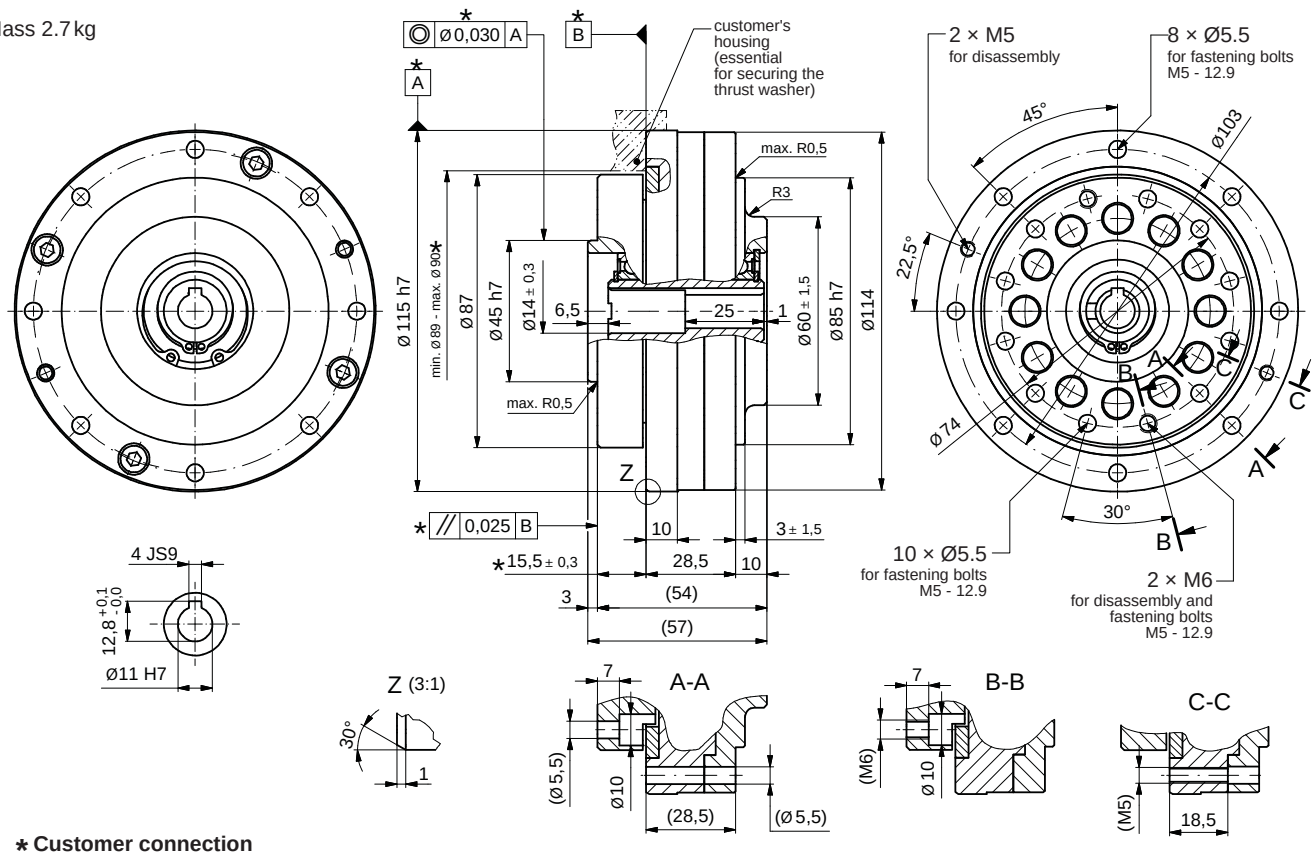
5.9.3 Installation example



5.9.4 Dimensioned drawings

FC-A15G

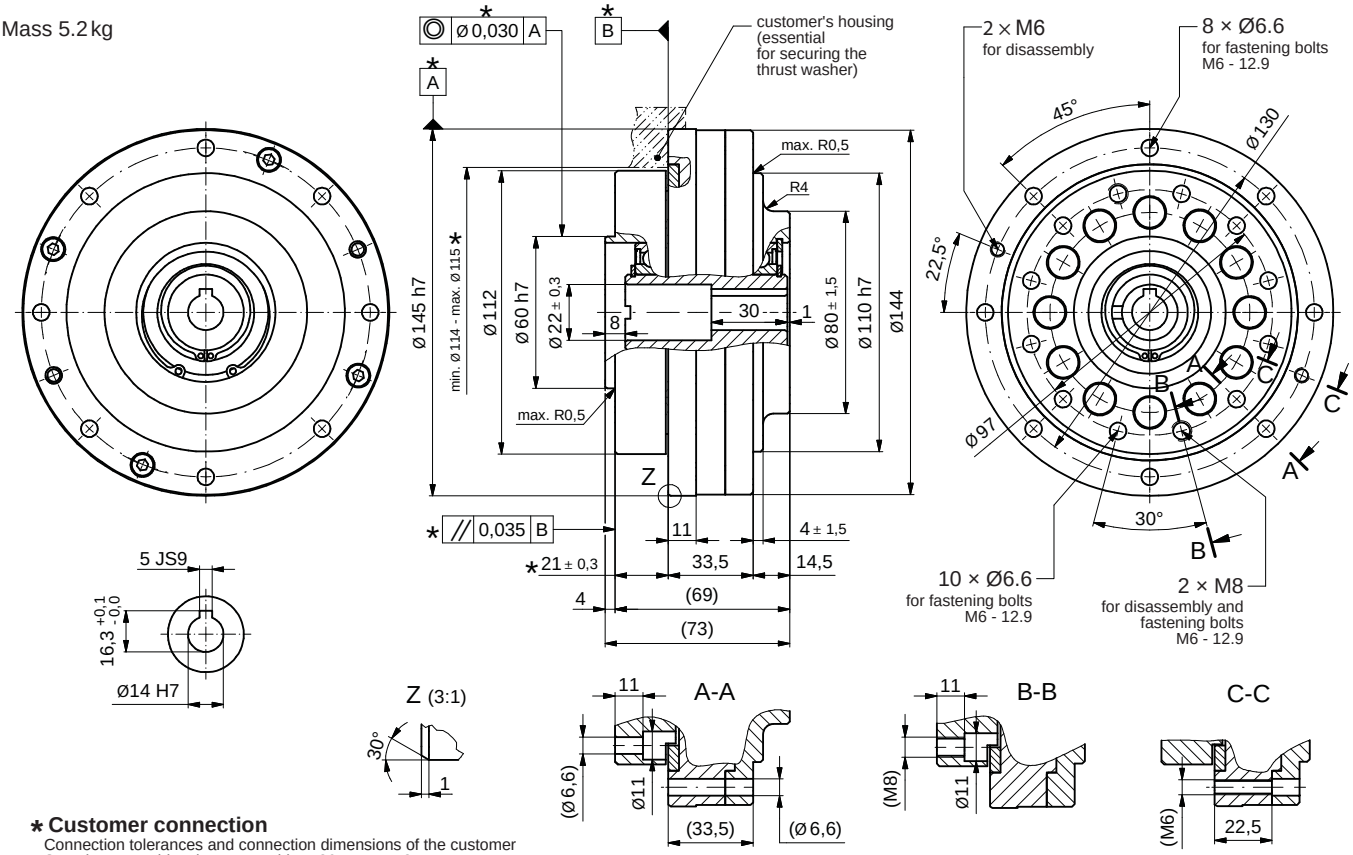
Mass 2.7 kg



∗ Customer connection
Connection tolerances and connection dimensions of the customer
See also assembly tolerances Table A-26 on page 37

FC-A25G

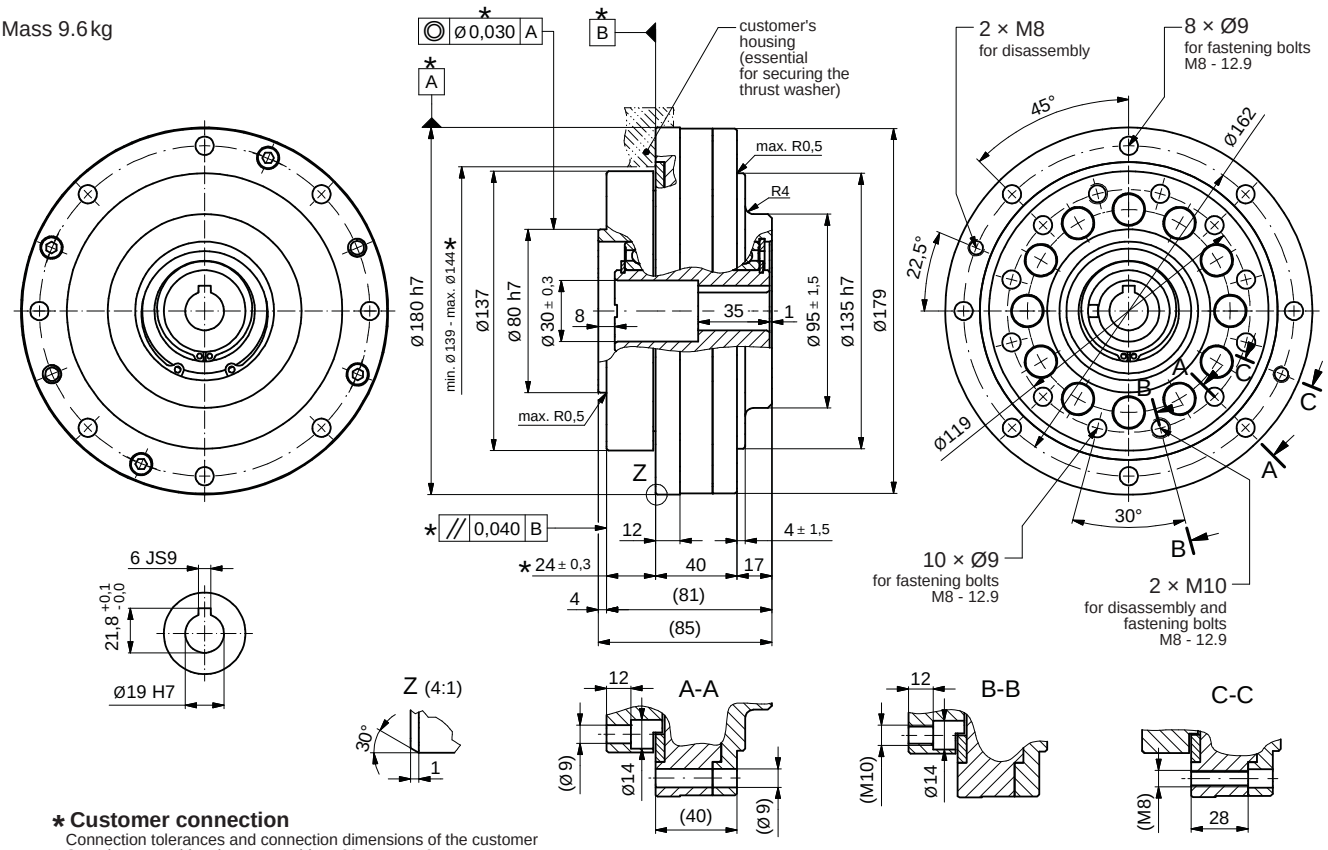
Mass 5.2 kg



∗ Customer connection
Connection tolerances and connection dimensions of the customer
See also assembly tolerances Table A-26 on page 37

FC-A35G

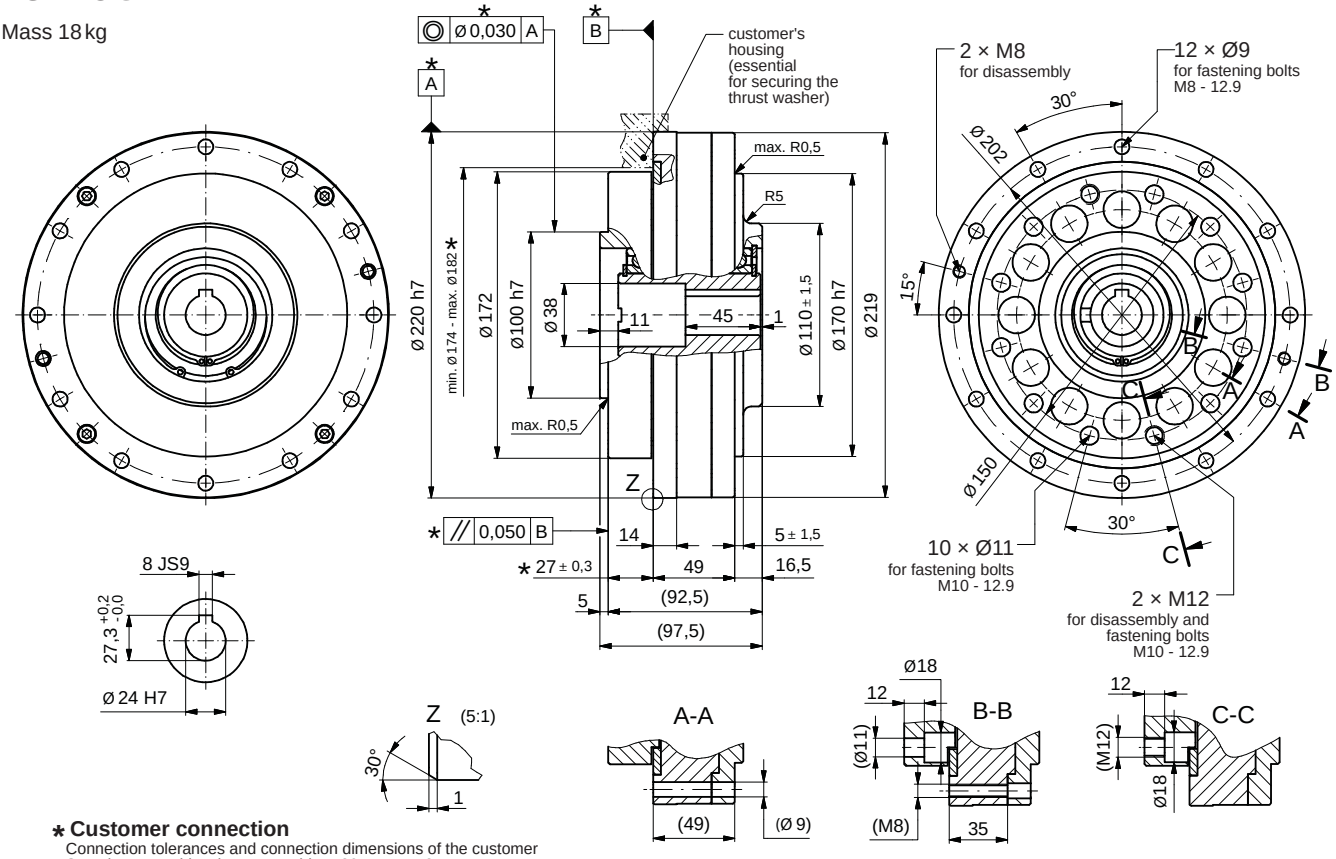
Mass 9.6 kg



∗ **Customer connection**
Connection tolerances and connection dimensions of the customer
See also assembly tolerances Table A-26 on page 37

FC-A45G

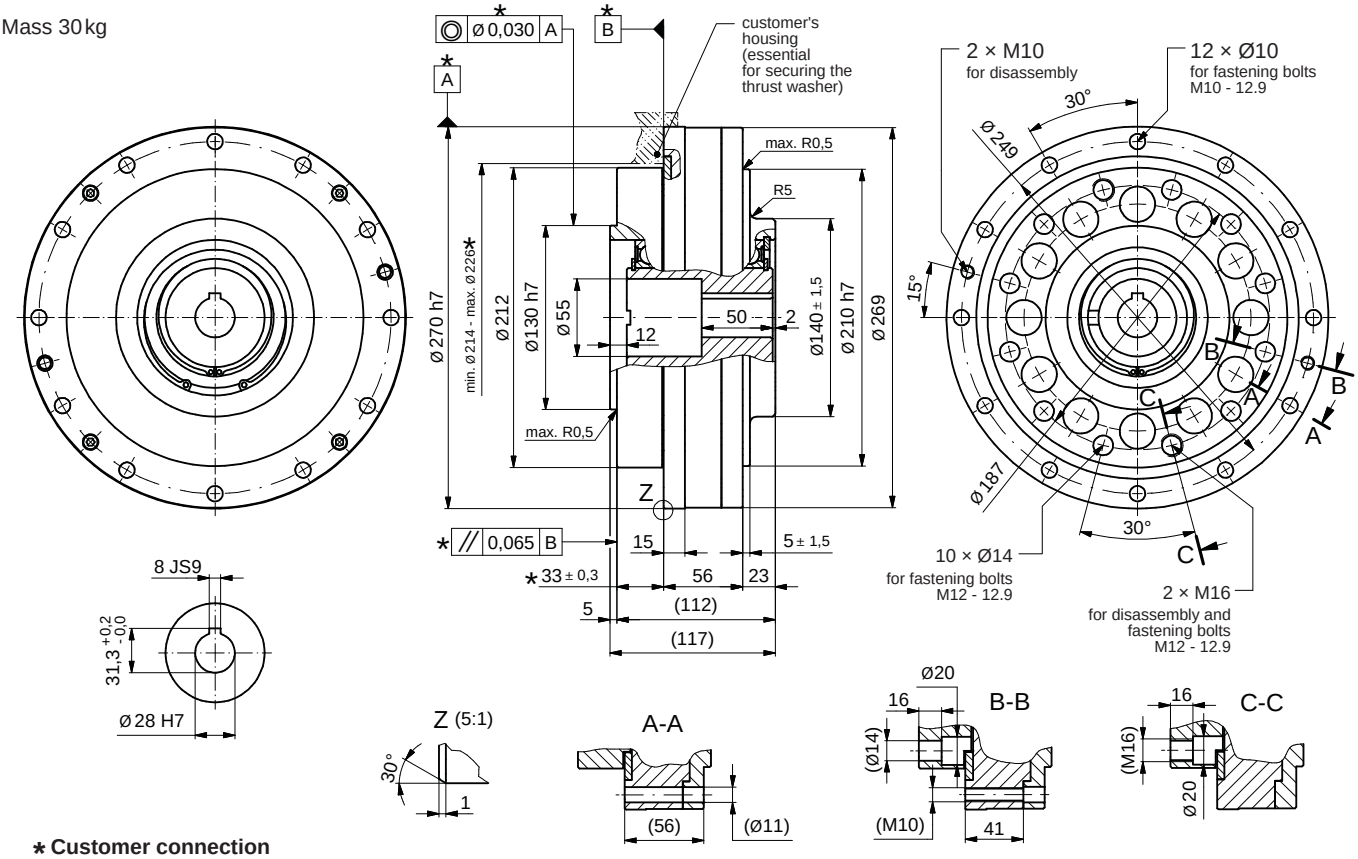
Mass 18 kg



∗ **Customer connection**
Connection tolerances and connection dimensions of the customer
See also assembly tolerances Table A-26 on page 37

FC-A65G

Mass 30 kg

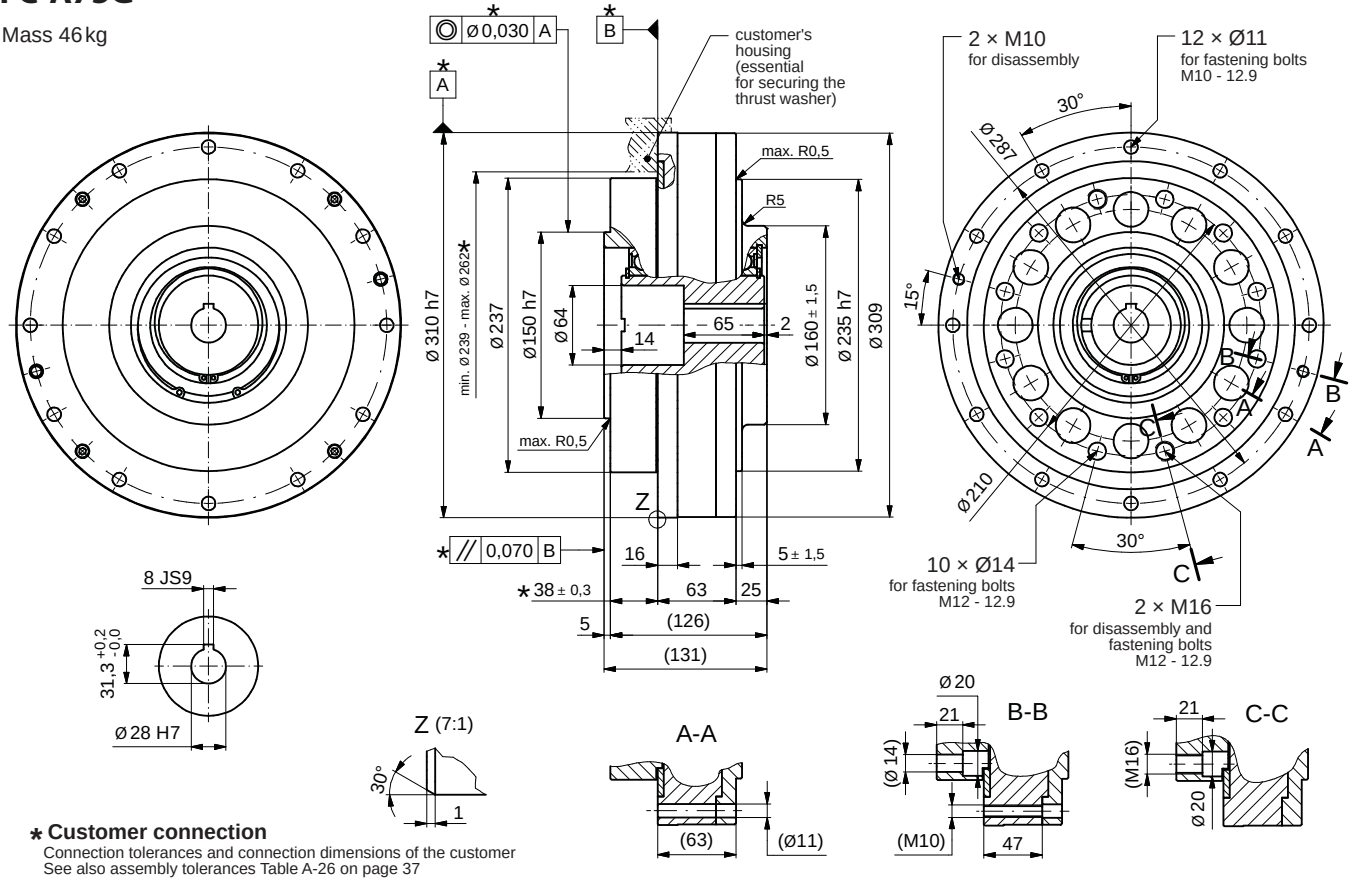


*** Customer connection**

Connection tolerances and connection dimensions of the customer
See also assembly tolerances Table A-26 on page 37

FC-A75G

Mass 46 kg



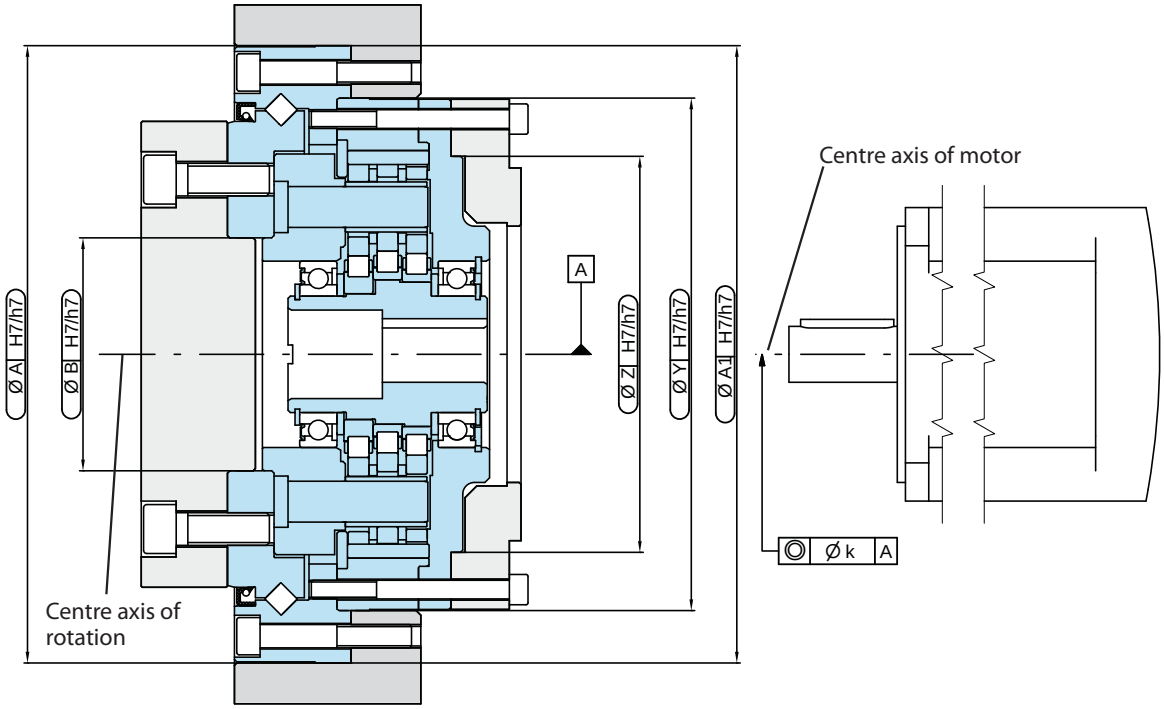
*** Customer connection**

Connection tolerances and connection dimensions of the customer
See also assembly tolerances Table A-26 on page 37

5.10 Model F1C-A

5.10.1 F1C-A assembly tolerances

To ensure the function, lifetime, and characteristics of the gearbox, the radial run-out of the shaft ends, the concentricity, and the axial run-out of the fastening surface as per EN 50347:2001 are sufficient. When used in high-precision applications, the tolerance according to EN 50347:2001 should be reduced by 50%.



Size	Ø A	Ø A1	Ø B	Ø K	Ø Y	Ø Z
A15	140		45	0.030		85
A25	170		60	0.030		110
A35	205		80	0.030		135
A45		265	100	0.030	220	170
A65		350	130	0.030	270	210
A75		430	150	0.030	310	235

Table A-28 (Dimensions in mm)

5.10.2 Tightening torque and maximum permissible transmitted torque for bolts

The permissible transmitted torque for bolts and the number, size, and tightening torque for fastening the output side flange and the ring gear housing are listed in Table A-29. In the event of an emergency stop with corresponding load peaks, the output flange and ring gear housing bolts must all be replaced.

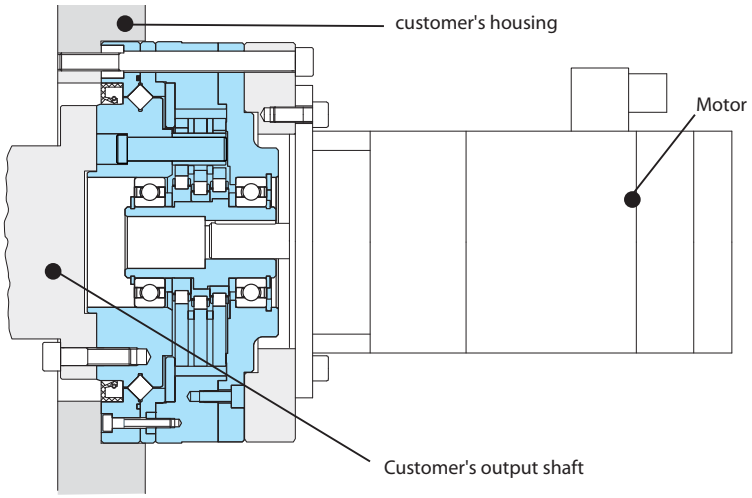
Size	Output flange bolts		Bolts for ring gear (housing)		Max. permissible transmitted torque for bolts [Nm]
	Number and size of bolts	Tightening torque [Nm]	Number and size of bolts	Tightening torque [Nm]	
A15	12 × M6	16	12 × M6	16	750
A25	12 × M8	39	12 × M8	39	1700
A35	12 × M10	77	12 × M10	77	3150
A45	12 × M14	210	16 × M10	77	3550
A65	16 × M16	330	20 × M12	135	7000
A75	16 × M16	330	20 × M12	135	8000

Table A-29

- **Bolting:** Use metric hexagon socket head cap screws (DIN 4762, strength category 12.9).
- **Countermeasure for bolts loosening:** Use adhesives (Loctite 262, etc.) or spring washer (DIN 127A).
- **Use conical spring washers** (DIN 6796) when connecting the gearbox to the flange side, so that the bolt contact faces do not get damaged.

5.10.3 Installation example

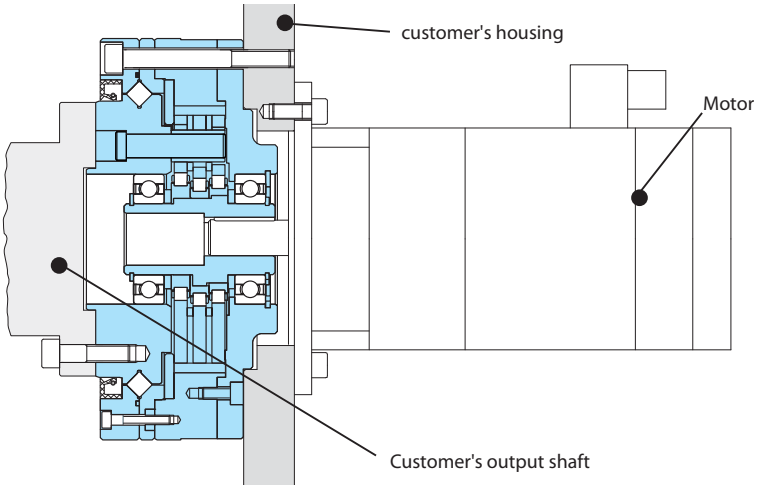
(1)



The motor is connected via an intermediate flange with the Fine Cyclo F1C-A gearbox and bolted onto the customer's housing.

The customer's output shaft is bolted to the output flange of the gearbox.

(2)



The motor and the Fine Cyclo F1C-A gearbox are both bolted onto the customer's housing.

The customer's output shaft is bolted to the output flange of the gearbox.

5.10.4 Lubrication bearings

- The cross roller bearings of the F1C- gearboxes, sizes A45, A65 and A75, are also suitable for all installation positions, but require regreasing after 4,000 operating hours or at least every six months.
- For information on regreasing quantities for the cross roller bearings and on grease types, see Table A-30.

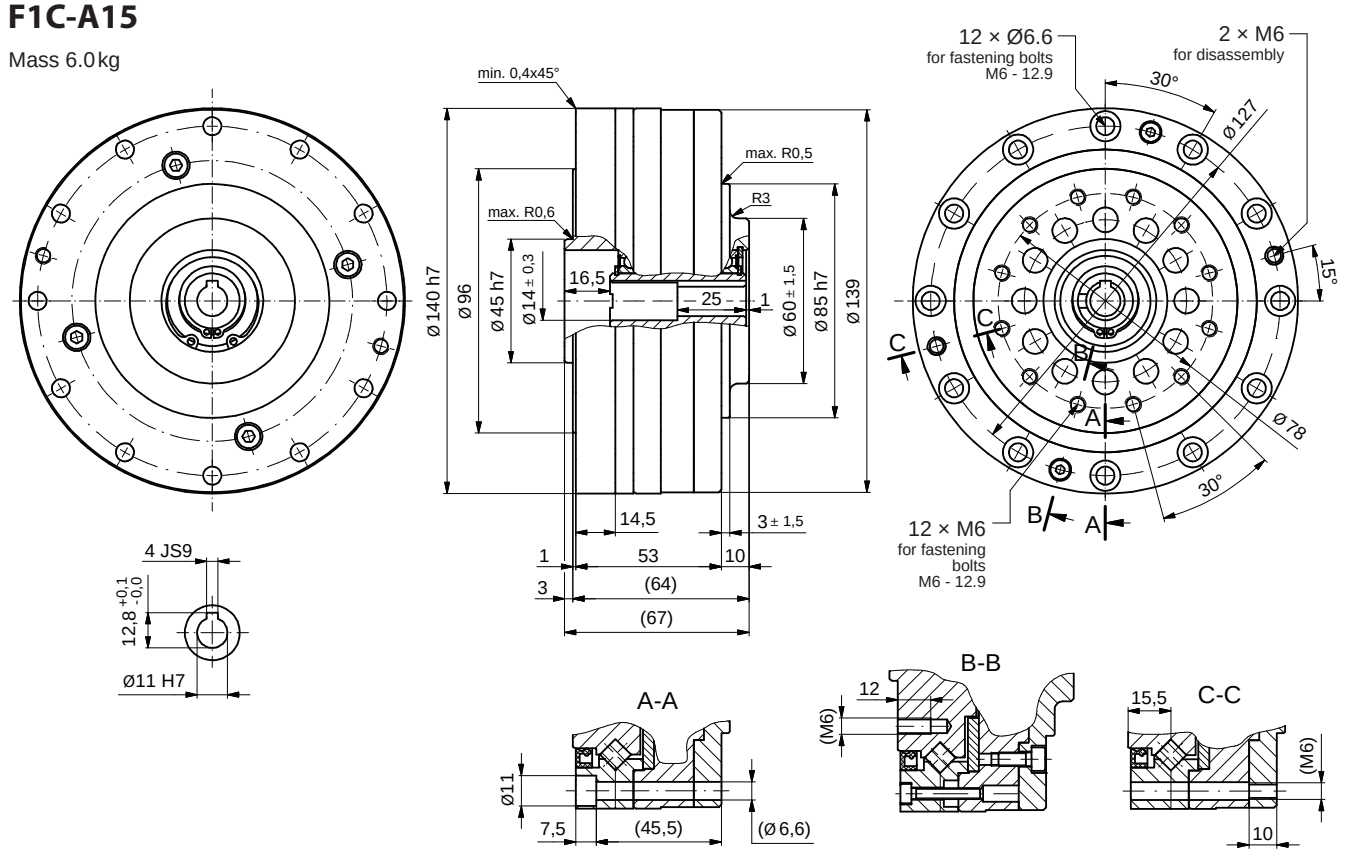
Size	Quantity of grease [g]	Manufac-turer	Grease type
A45	23	SHELL	GADUS S2 V220 2
A55	62		
A65	108		

Table A-30 Lubrication

5.10.5 Dimensioned drawings

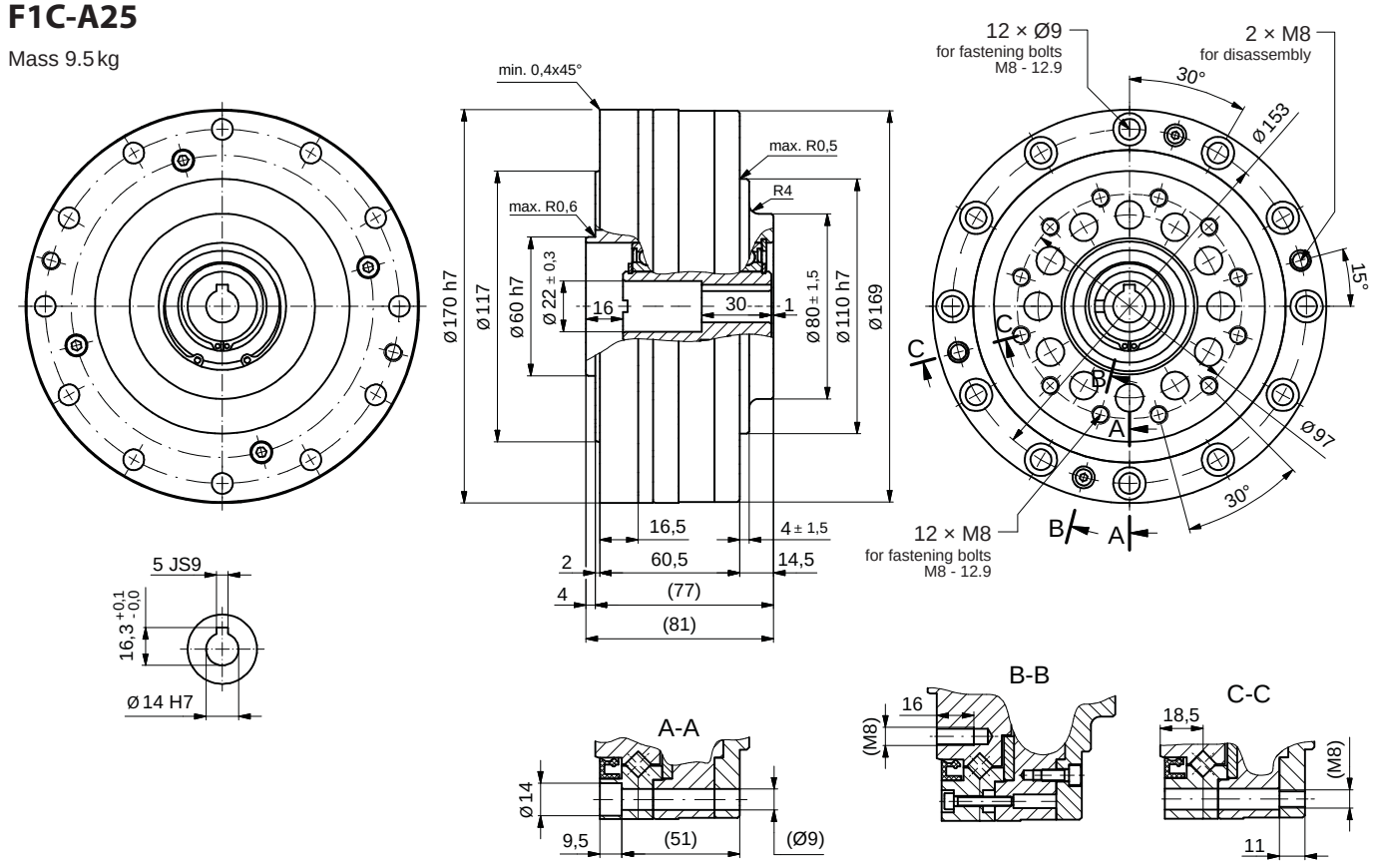
F1C-A15

Mass 6.0 kg



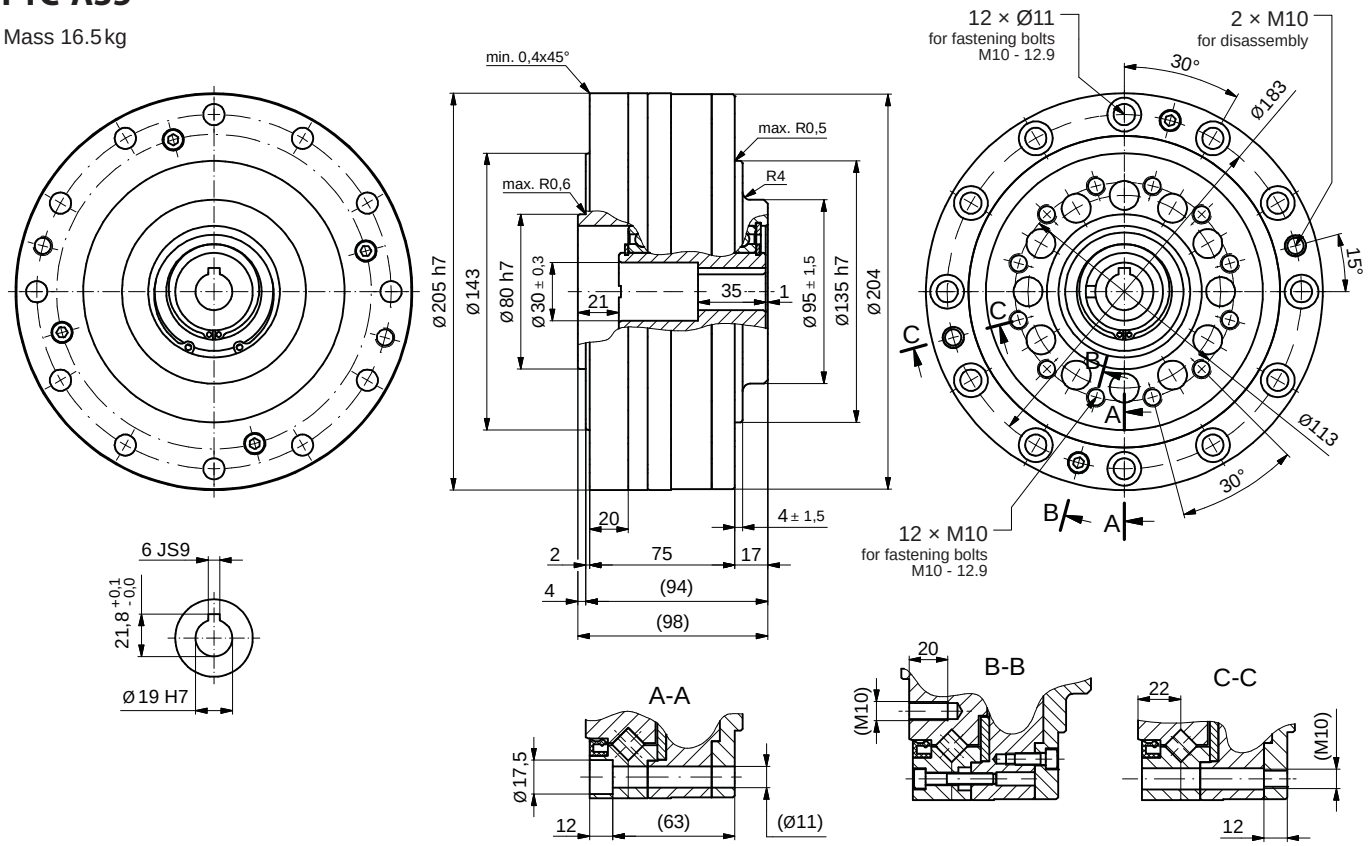
F1C-A25

Mass 9.5 kg



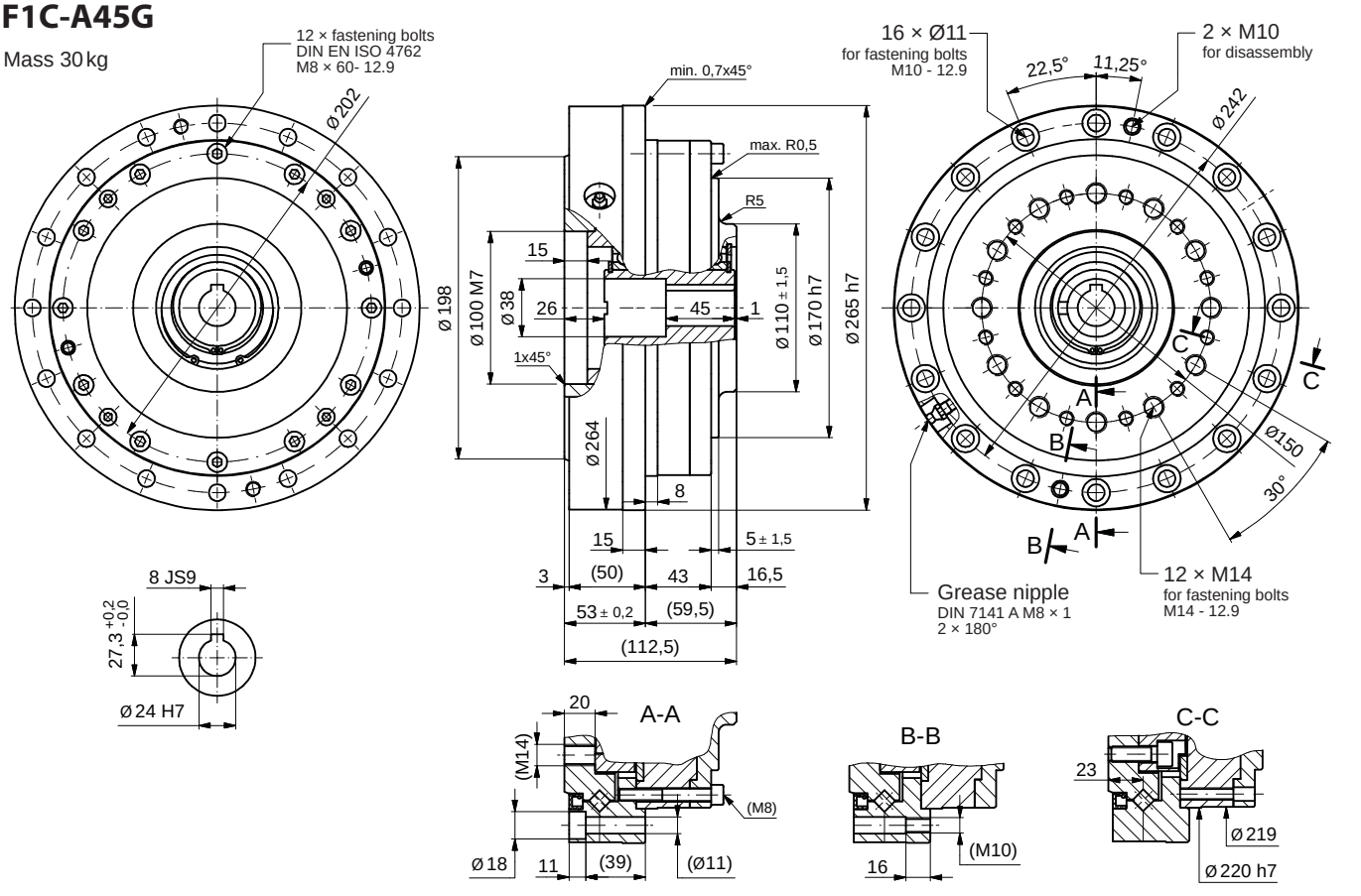
F1C-A35

Mass 16.5 kg



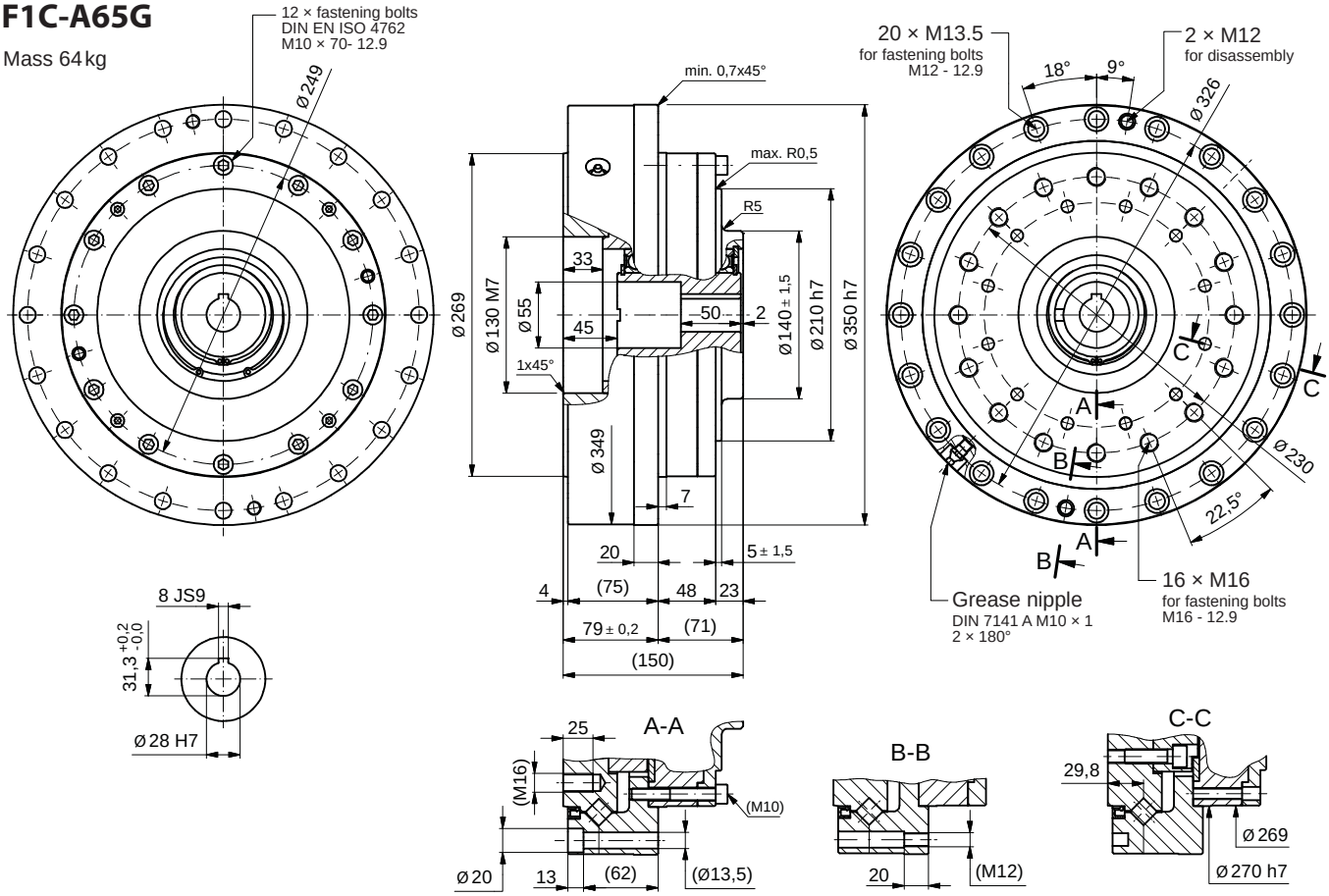
F1C-A45G

Mass 30 kg



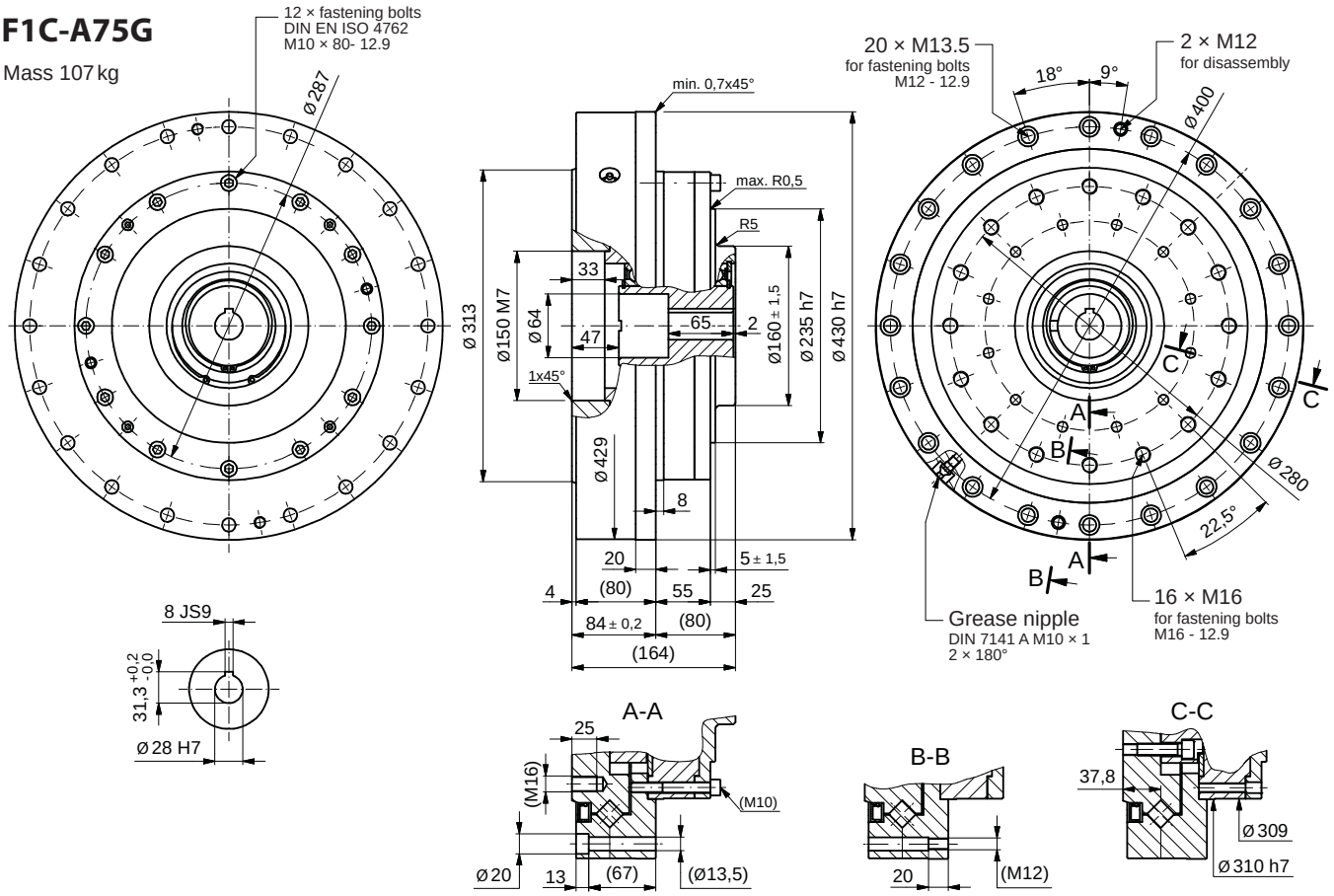
F1C-A65G

Mass 64 kg



F1C-A75G

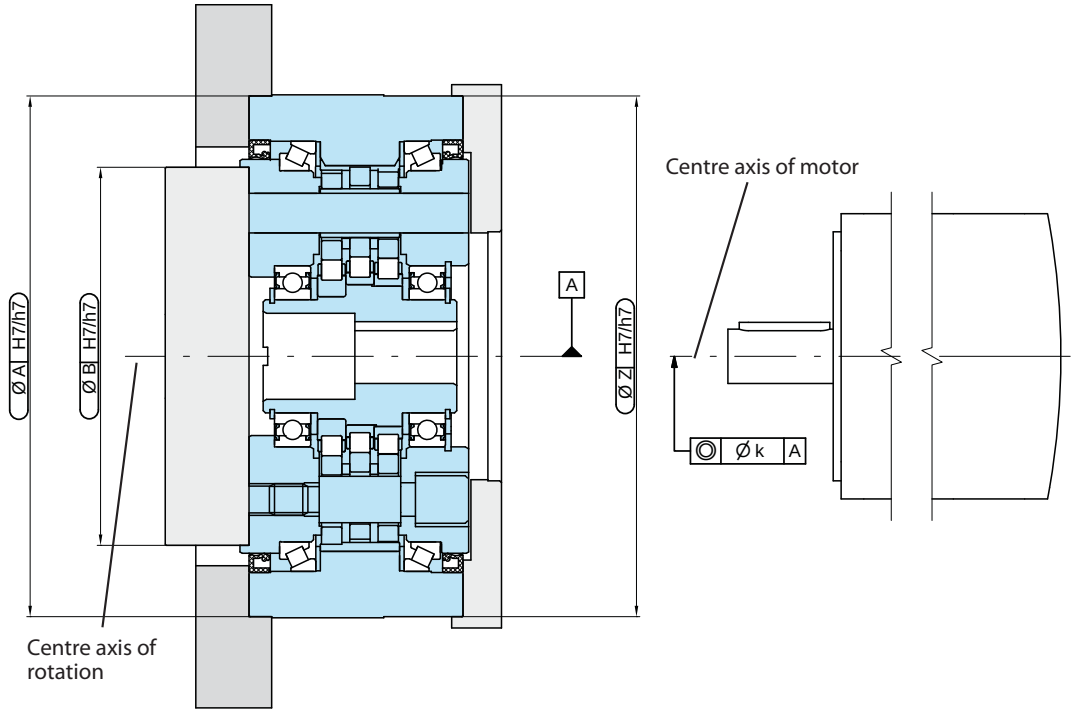
Mass 107 kg



5.11 Model F2C(F)-A

5.11.1 Assembly tolerances

To ensure the function, lifetime, and characteristics of the gearboxes, the radial run-out of the shaft ends, the concentricity, and the axial run-out of the fastening area as per EN 50347:2001 are sufficient. When used in high-precision applications, the tolerance according to EN 50347:2001 should be reduced by 50 %.



F2C-				
Size	**Ø A**	**Ø B**	**Ø Z**	**Ø K**
A15	125	84	125	0.030
A25	155	106	155	
A35	185	133	185	
A45	230	167	230	

Table A-31

F2CF-				
Size	**Ø A**	**Ø B**	**Ø Z**	**Ø K**
A15	124	84	123	0.030
A25	160	106	160	
A35	190	133	190	
A45	220	167	220	

Table A-32

5.11.2 Tightening torque and maximum permissible transmitted torque for bolts

The permissible transmitted torque for bolts and the number, size, and tightening torque for fastening the output side flange and the ring gear housing are listed in Table A-33. In the event of an emergency stop with corresponding load peaks, the output flange and ring gear housing bolts must all be replaced.

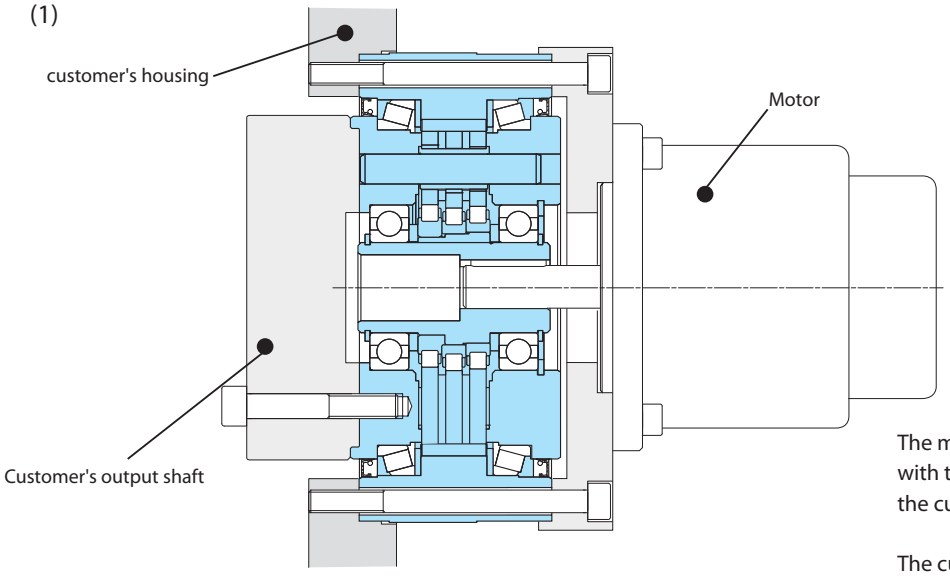
Size F2C(F)-	**Output flange bolts**		**Bolts for ring gear (housing)**		**Max. permissible transmitted torque for bolts [Nm]**
	Number and size of bolts	**Tightening torque [Nm]**	**Number and size of bolts**	**Tightening torque [Nm]**	
A15	12 × M6	16	16 × M6 (8 × M6)*	16	700
A25	12 × M8	39	12 × M8 (16 × M8)*	39	1500
A35	12 × M10	77	16 × M8	39	3200
A45	12 × M14	210	12 × M12 (16 × M10)*	135 (77)*	8200

Table A-33
* Values in brackets apply only for type F2C**F**-A

- **Bolting:** Use metric hexagon socket head cap screws (DIN 4762, strength category 12.9).
- **Countermeasure for bolts loosening:** Use adhesives (Loctite 262, etc.) or spring washer (DIN 127A).
- **Use conical spring washers** (DIN 6796) when connecting the gearbox to the flange side, so that the bolt contact faces do not get damaged.

5.11.3 Installation example

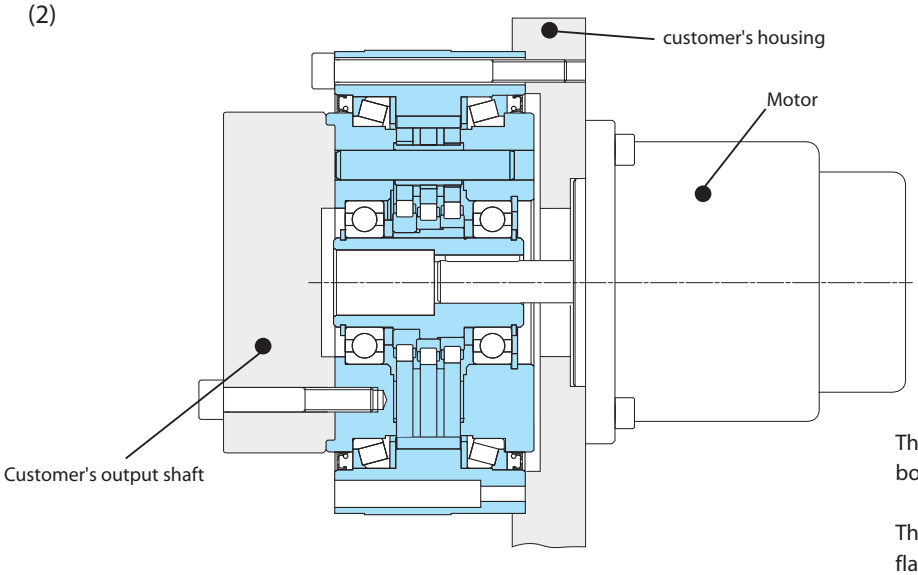
(1)



The motor is connected via an intermediate flange with the Fine Cyclo F2C-A gearbox and bolted onto the customer's housing.

The customer's output shaft is bolted to the output flange of the gearbox.

(2)



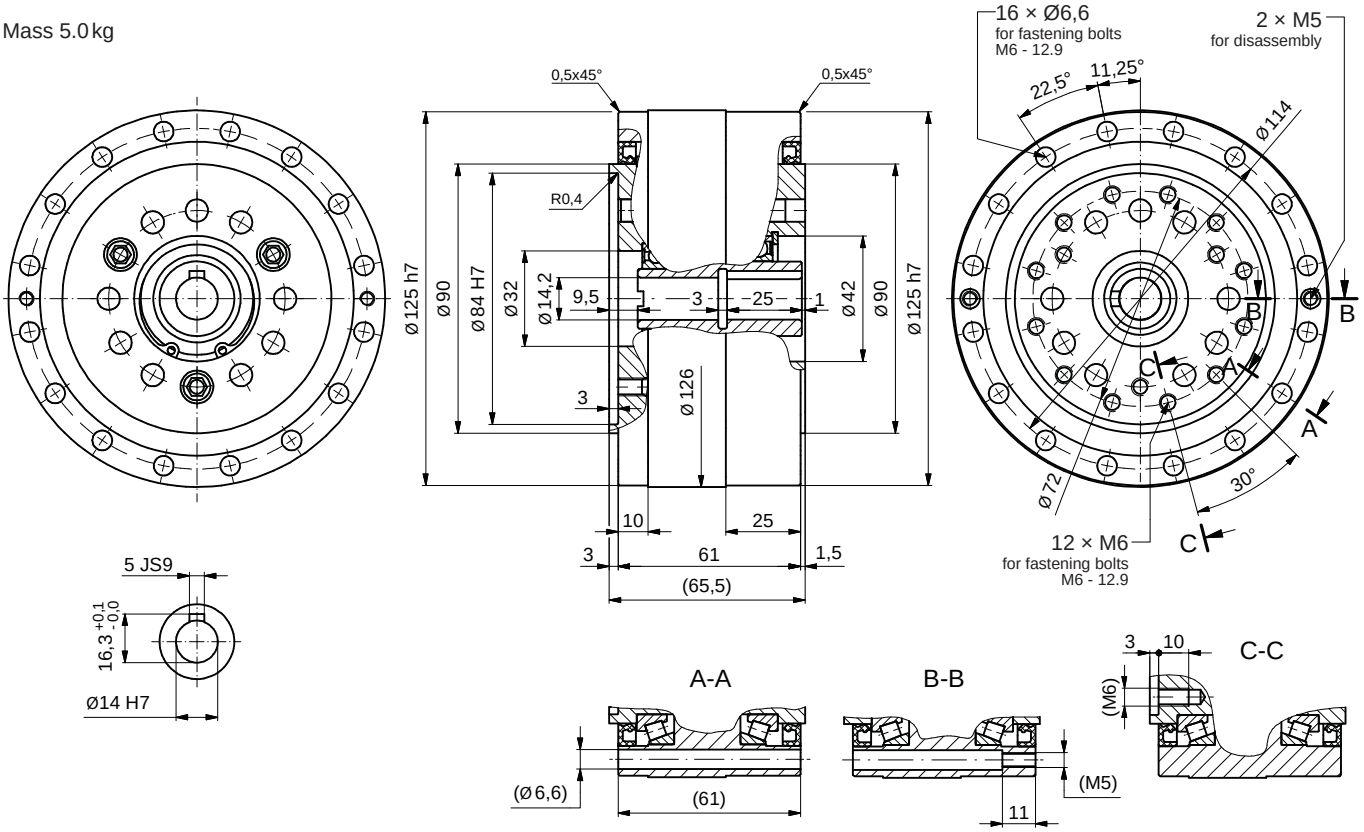
The motor and the Fine Cyclo F2C-A gearbox are both bolted onto the customer's housing.

The customer's output shaft is bolted to the output flange of the gearbox.

5.11.4 Dimensioned drawings

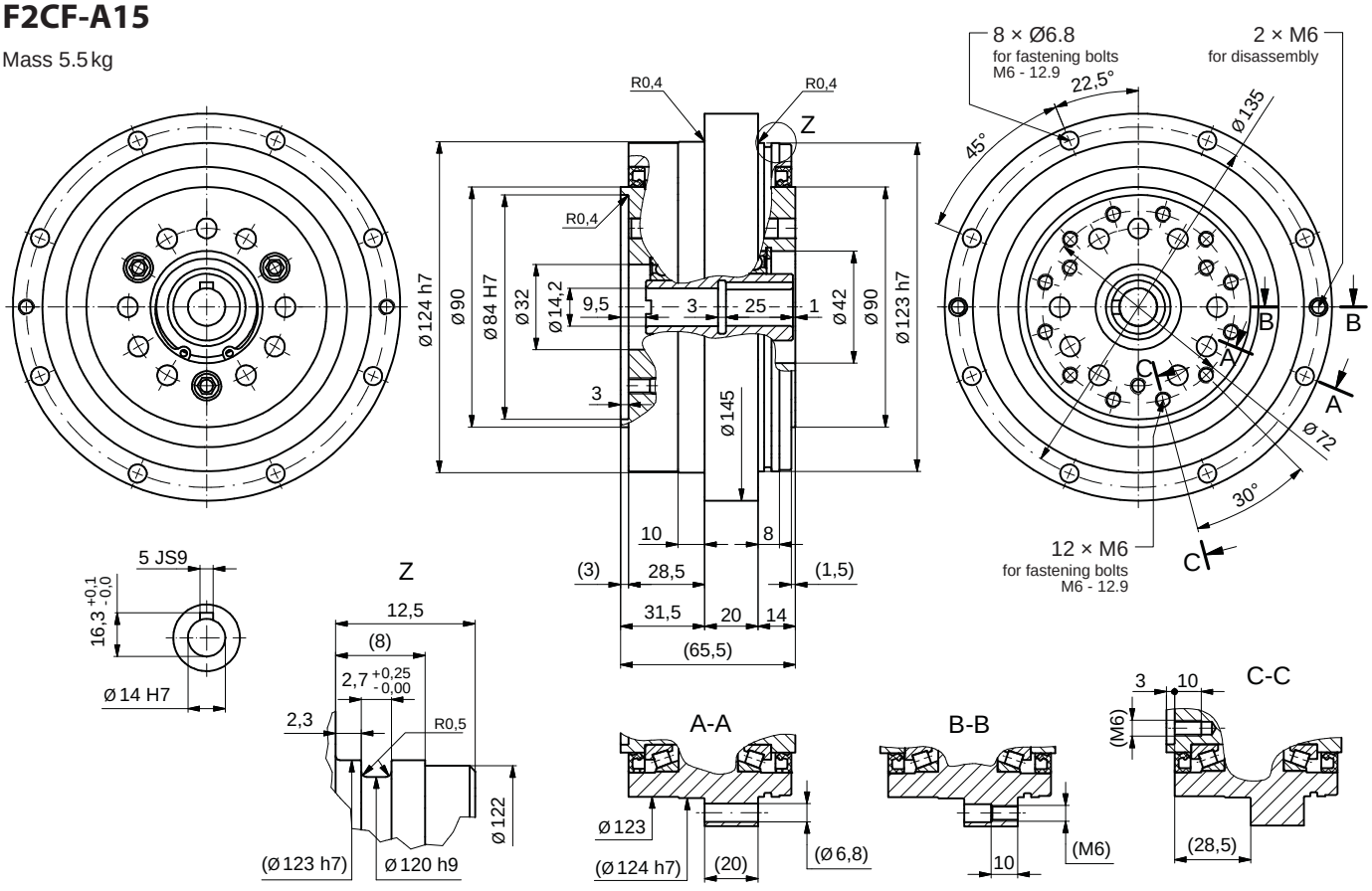
F2C-A15

Mass 5.0 kg



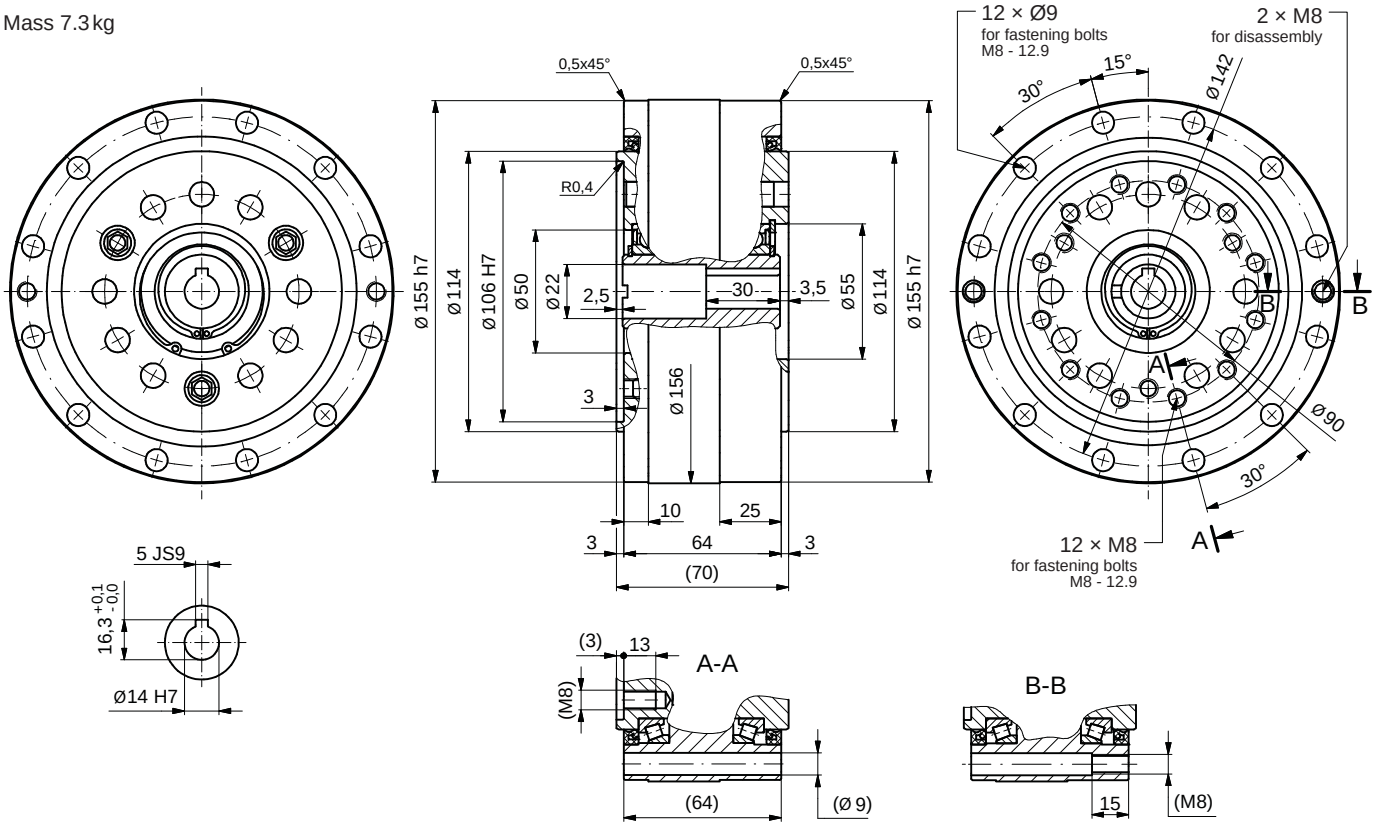
F2CF-A15

Mass 5.5 kg



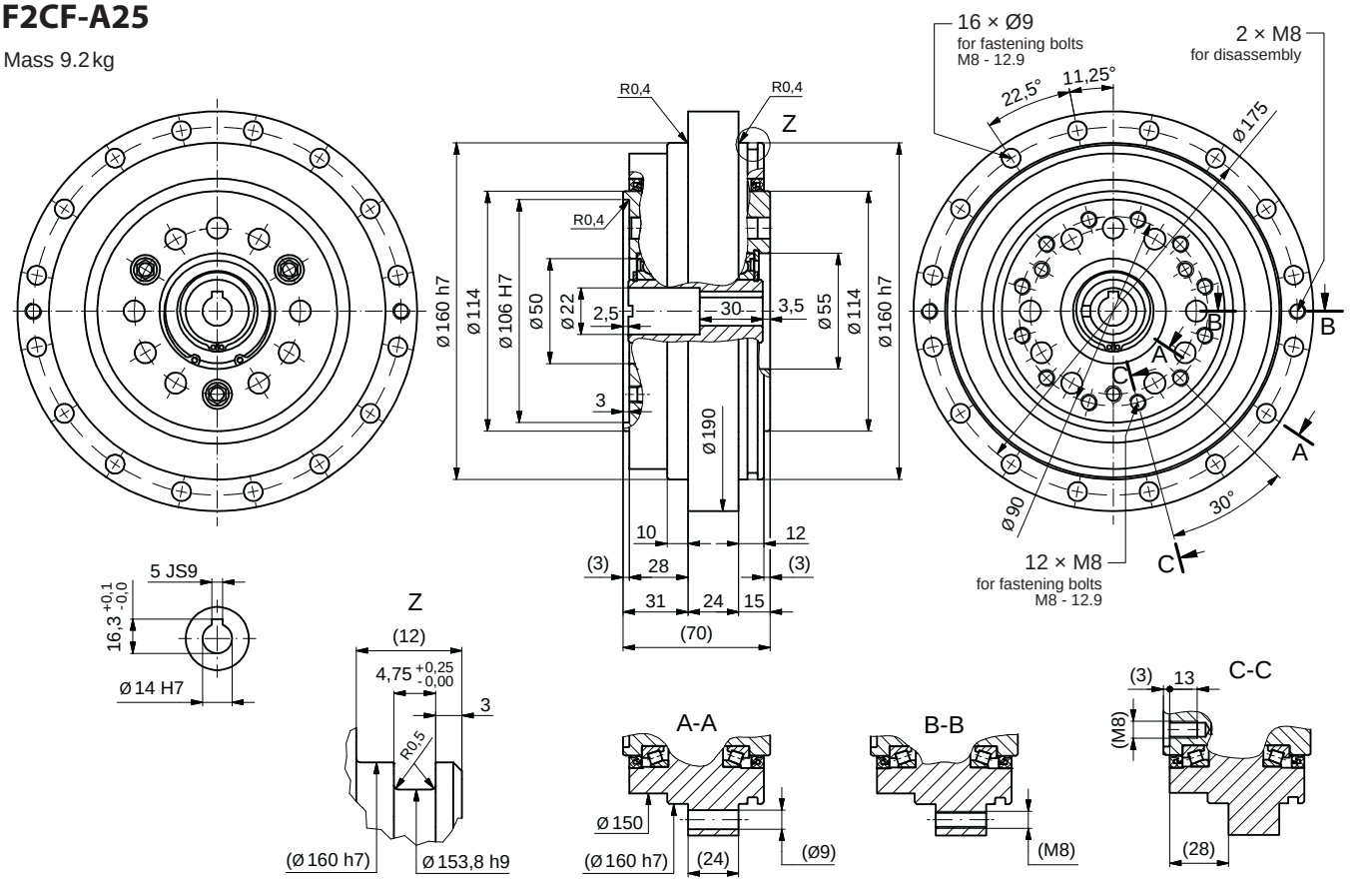
F2C-A25

Mass 7.3 kg



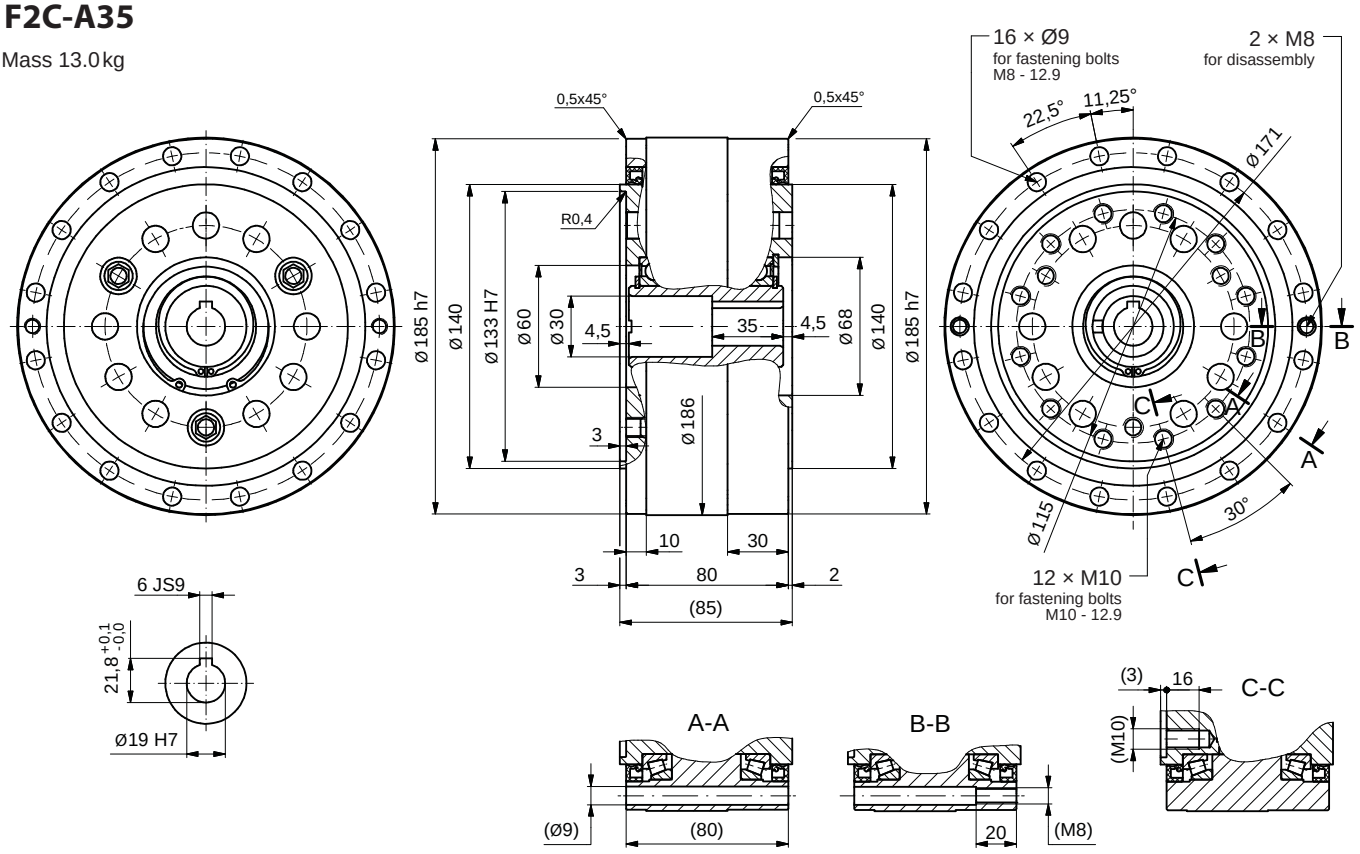
F2CF-A25

Mass 9.2 kg



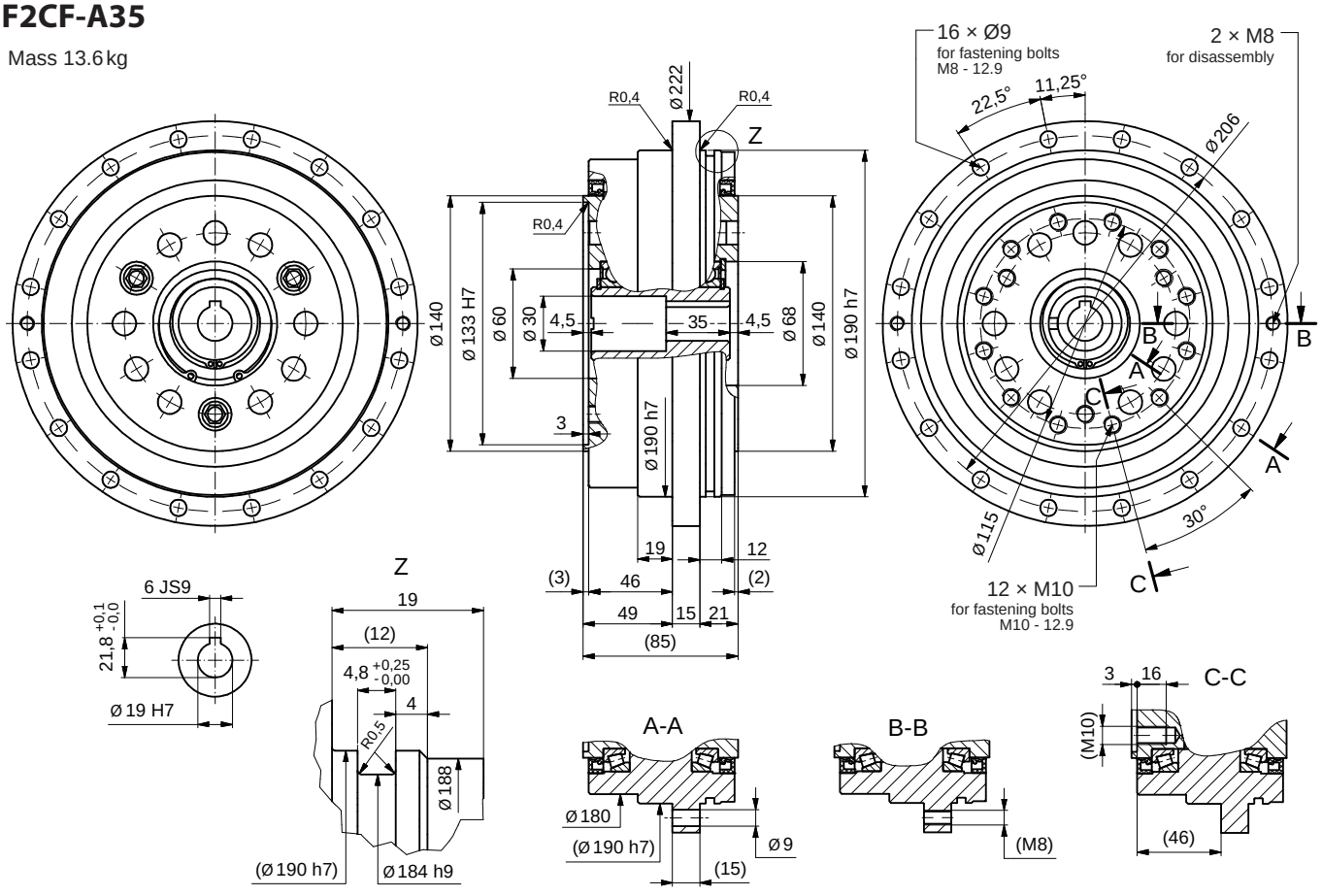
F2C-A35

Mass 13.0 kg



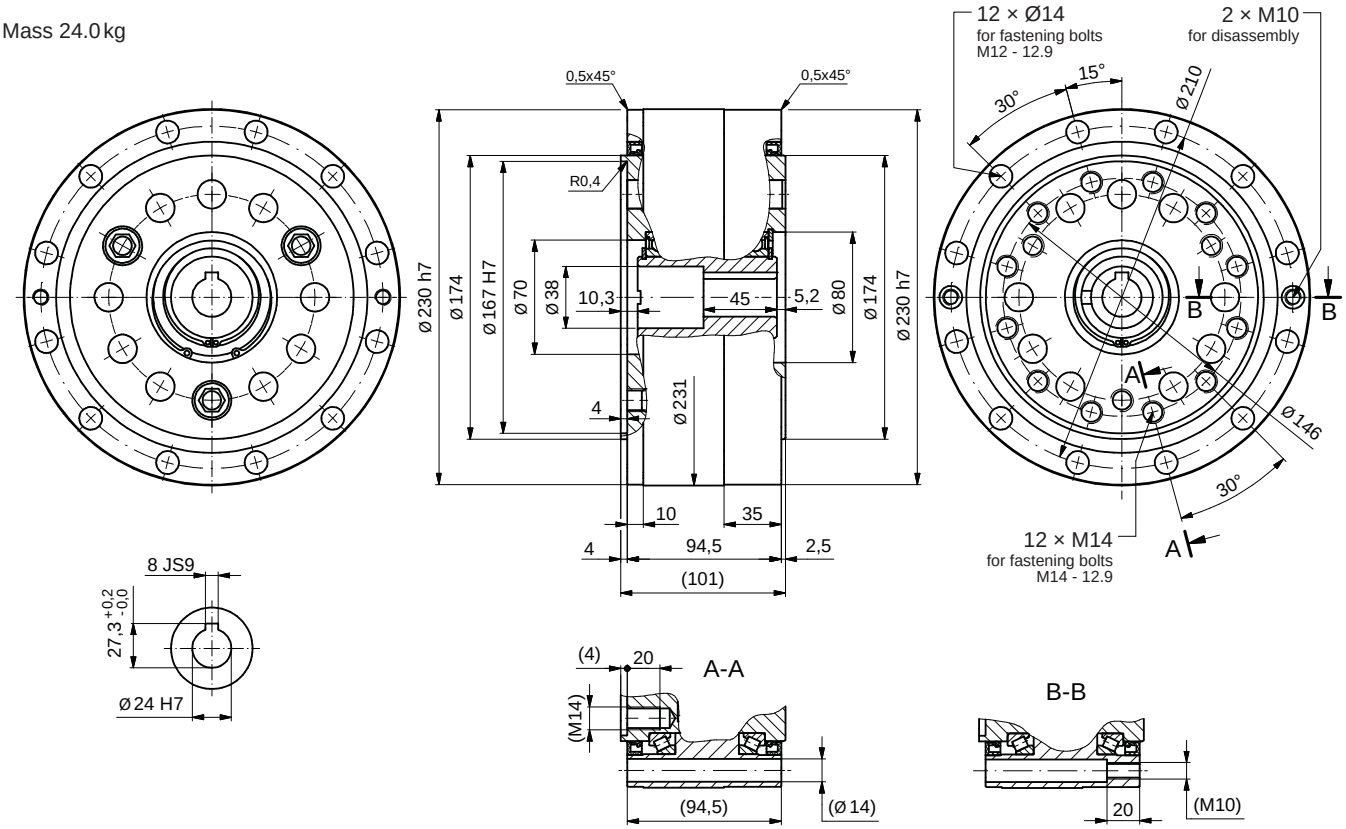
F2CF-A35

Mass 13.6 kg



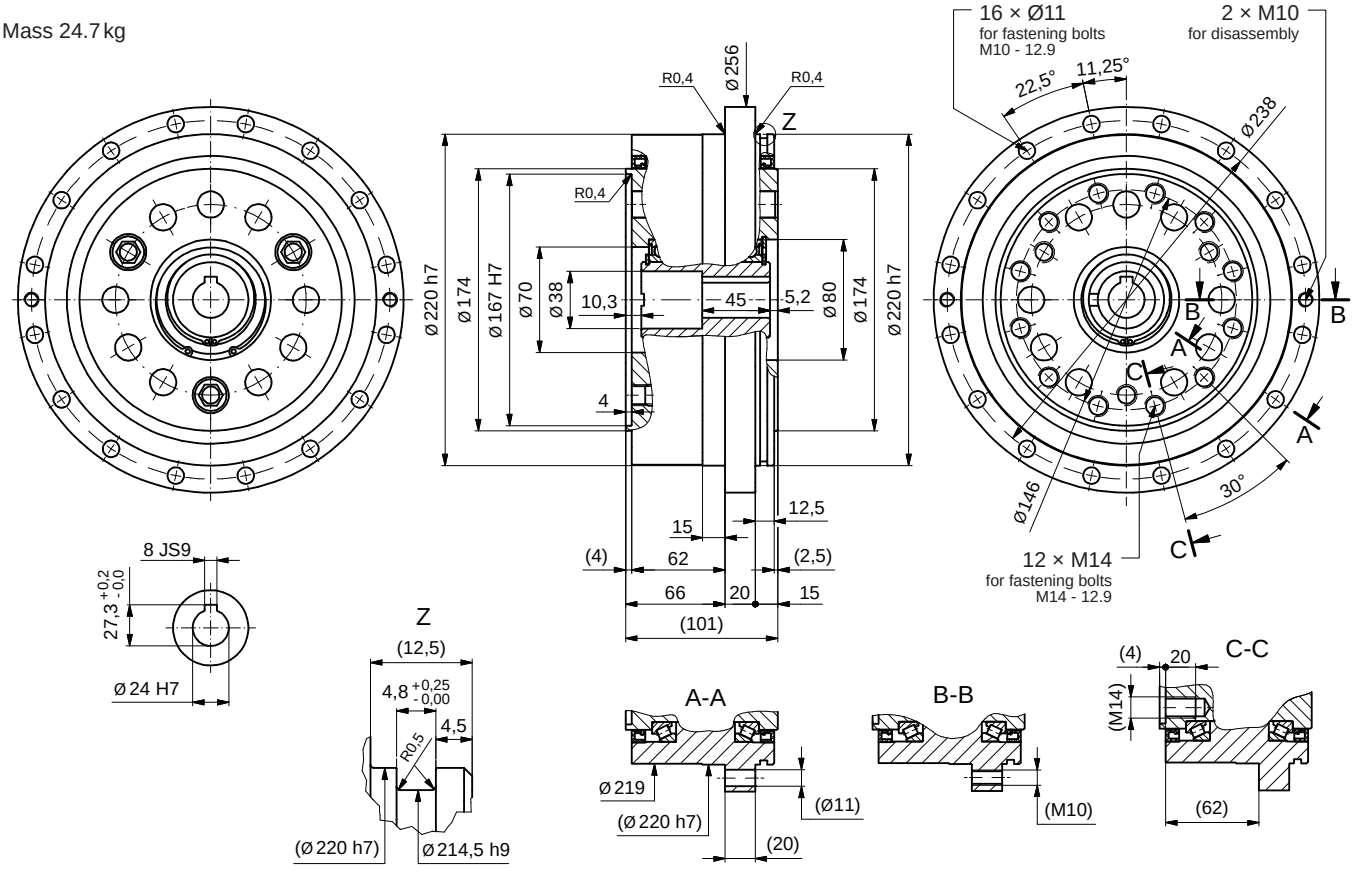
F2C-A45

Mass 24.0 kg



F2CF-A45

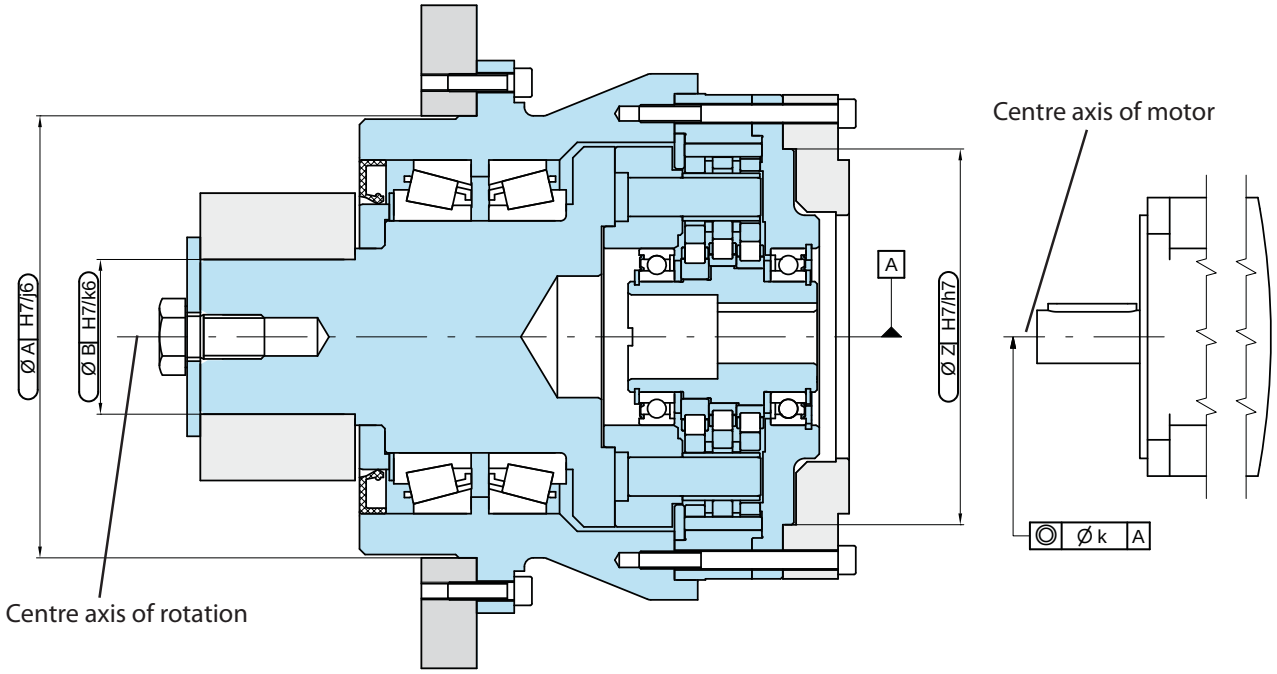
Mass 24.7 kg



5.12 Model F3C-A

5.12.1 Assembly tolerances

To ensure the function, lifetime, and characteristics of the gearbox, the radial run-out of the shaft ends, the concentricity, and the axial run-out of the fastening surface as per EN 50347:2001 are sufficient. When used in high-precision applications, the tolerance according to EN 50347:2001 should be reduced by 50%.



Size	Ø A	Ø B	Ø Z	Ø k
A15	110	35	85	0.030
A25	135	45	110	
A35	160	55	135	
A45	200	70	170	
A65	240	90	210	
A75	280	100	235	

Table A-34 (Dimensions in mm)

Tightening torque and maximum permissible transmitted torque for bolts

The permissible transmitted torque for bolts and the number, size, and tightening torque for fastening the output side flange and the ring gear housing are listed in Table A-35. In the event of an emergency stop with corresponding load peaks, the output flange and ring gear housing bolts must all be replaced.

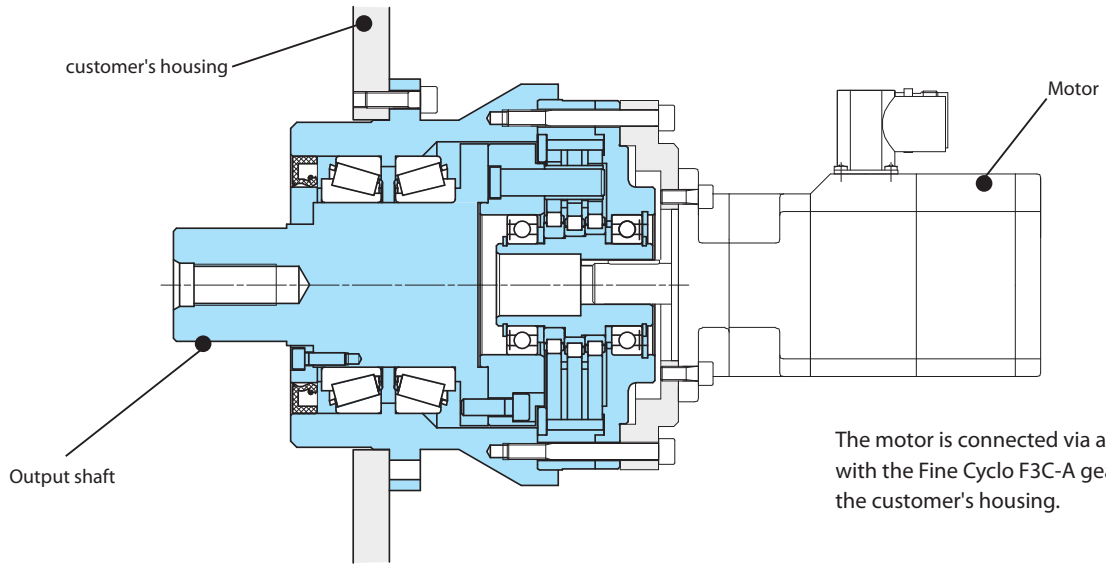
Size F3C-	Bolts for ring gear (housing)		
	Number and size of bolts	Tightening torque [Nm]	Max. permissible transmitted torque for bolts [Nm]
A15G	8 × M6	16	550
A25G	8 × M6	16	1000
A35G	8 × M8	39	2100
A45G	12 × M8	39	4000
A65G	12 × M10	77	7700
A75G	12 × M10	77	9000

Table A-35

- **Bolting:** Use metric hexagon socket head cap screws (DIN 4762, strength category 12.9).
- **Countermeasure for bolts loosening:** Use adhesives (Loctite 262, etc.) or spring washer (DIN 127A).

5.12.2 Installation example

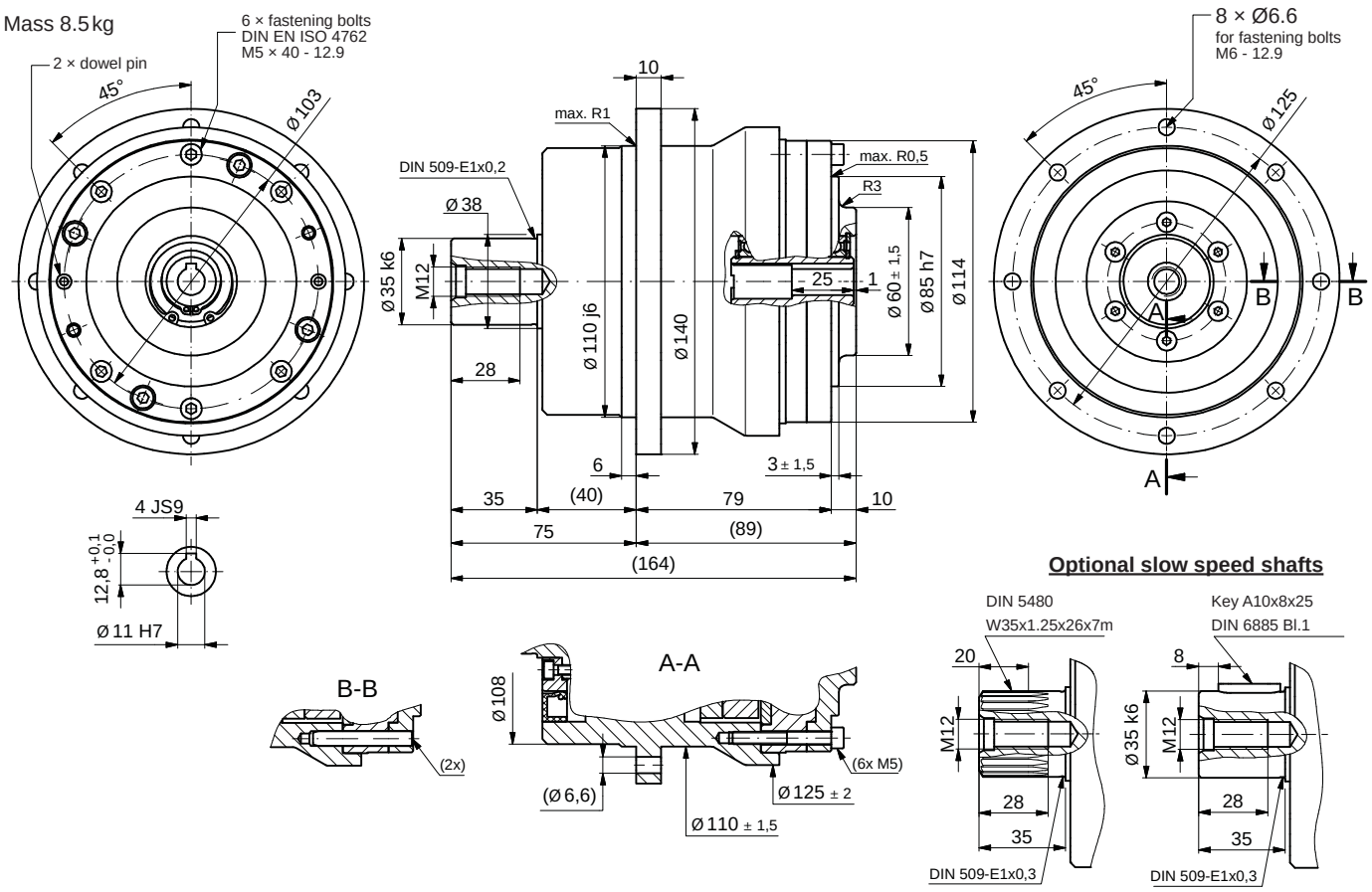
(1)



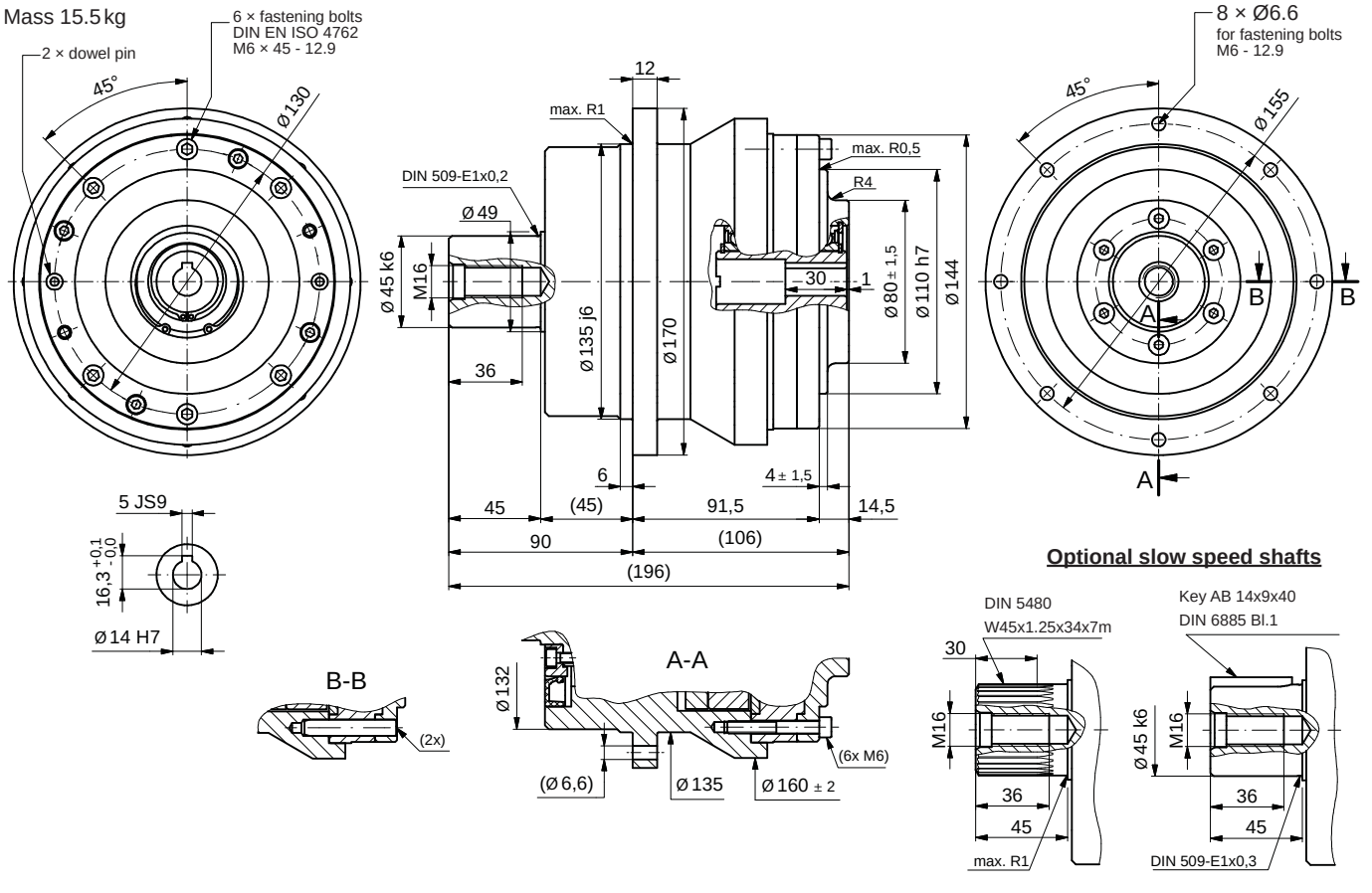
The motor is connected via an intermediate flange with the Fine Cyclo F3C-A gearbox and bolted onto the customer's housing.

5.12.3 Dimensioned drawings

F3C-A15G

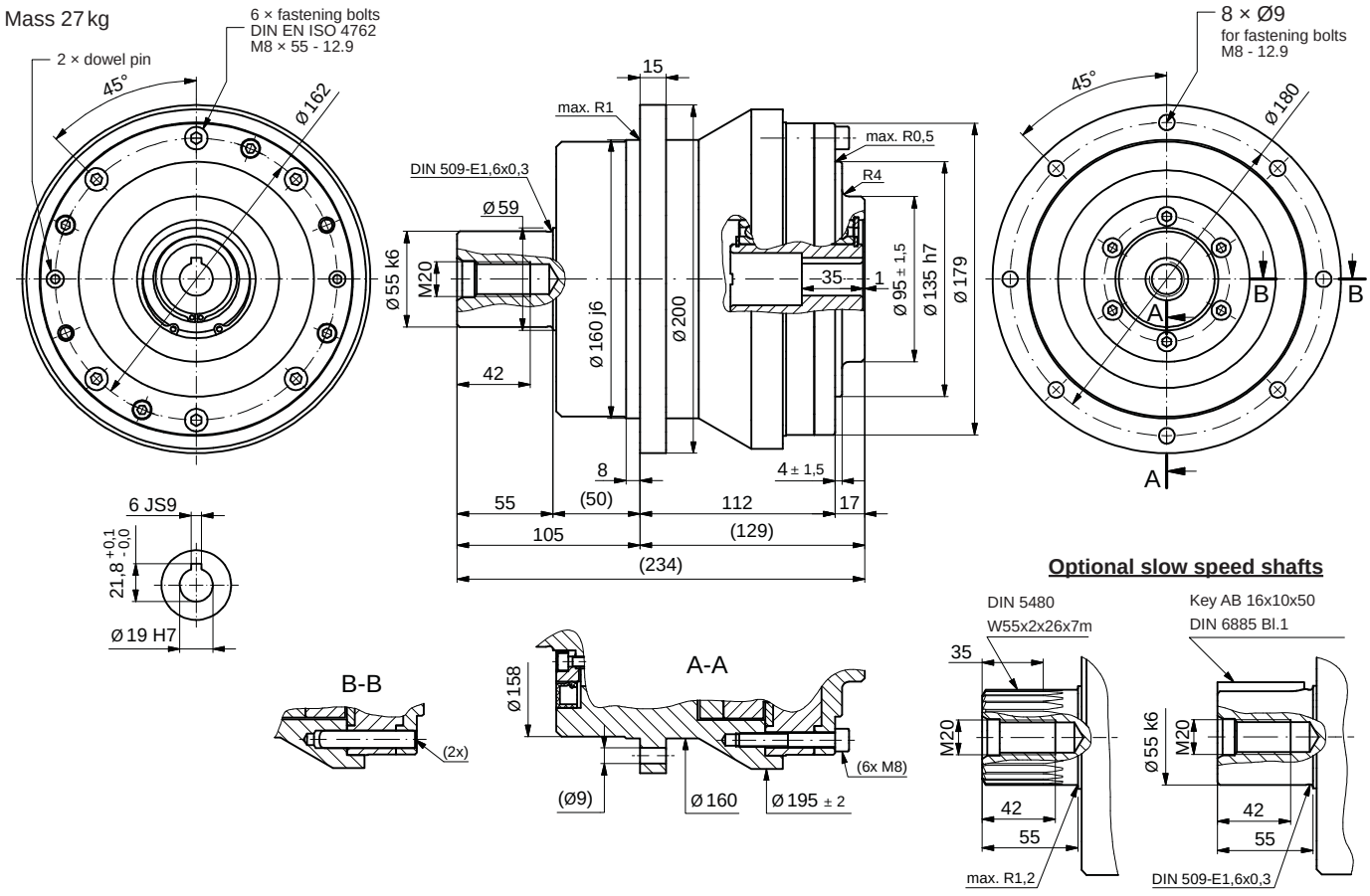


F3C-A25G



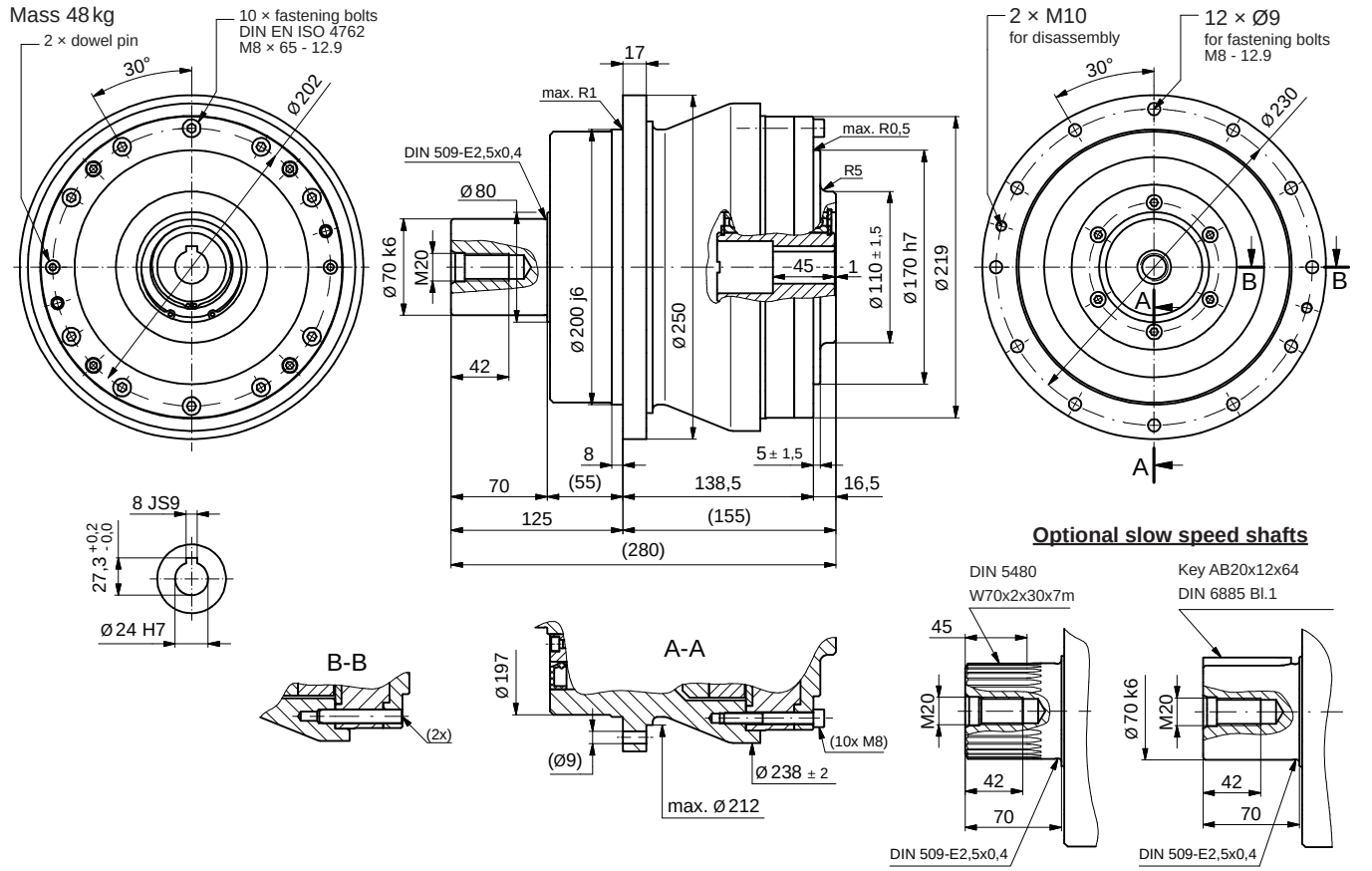
F3C-A35G

Mass 27 kg



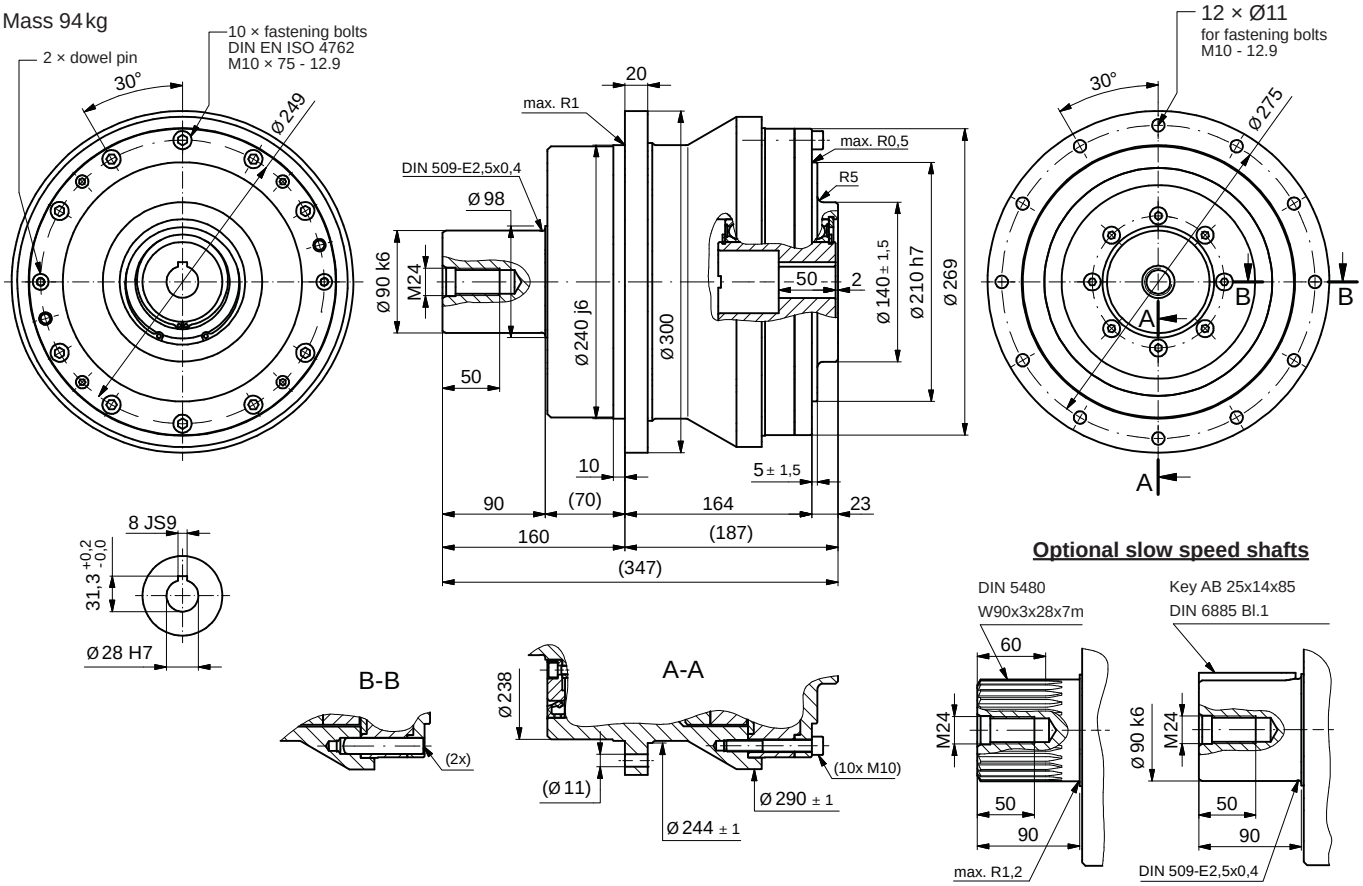
F3C-A45G

Mass 48 kg



F3C-A65G

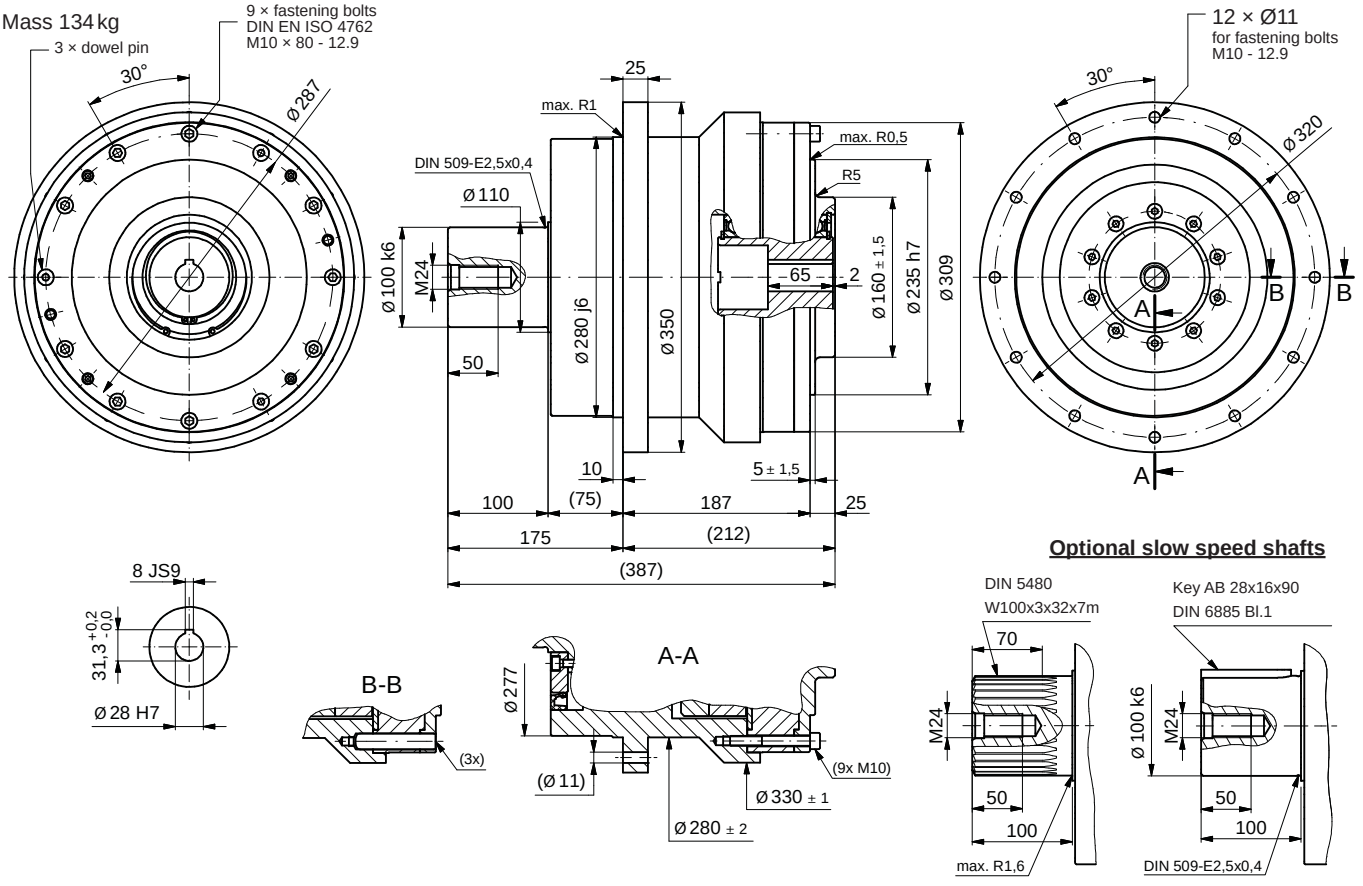
Mass 94 kg



Optional slow speed shafts

F3C-A75G

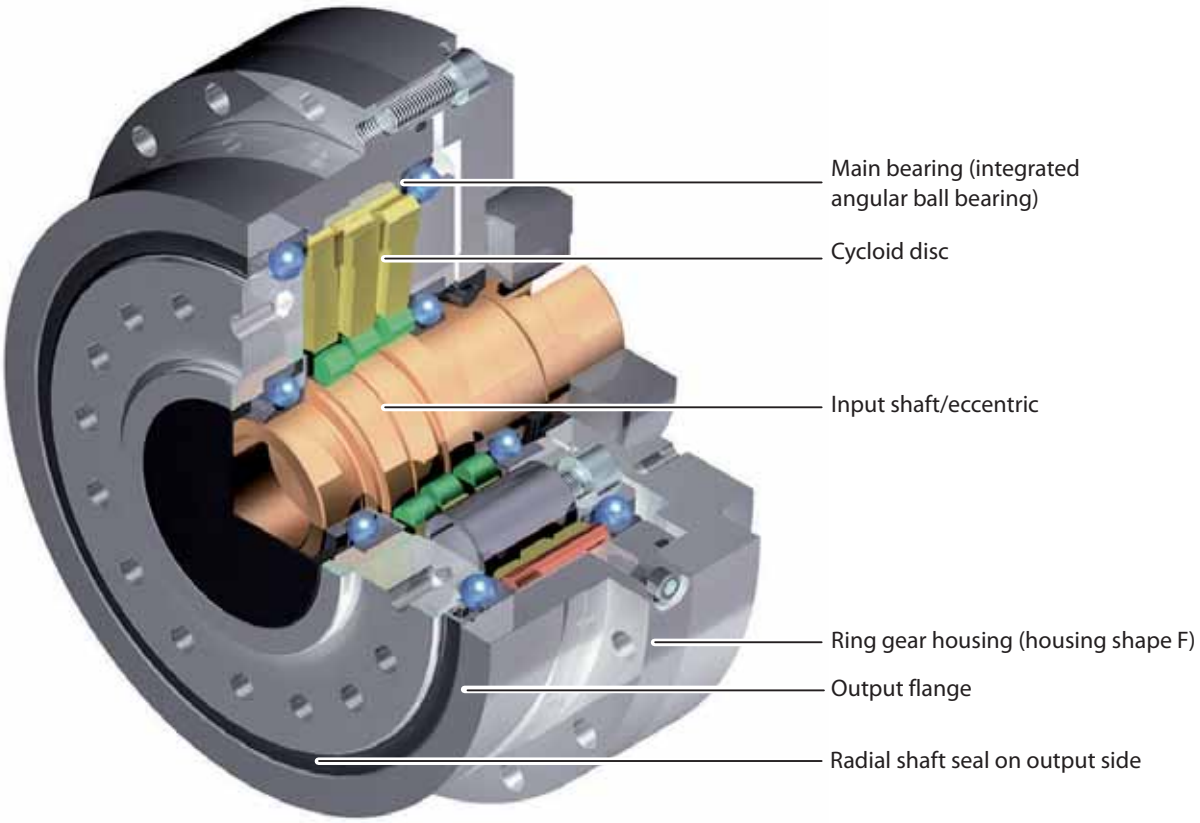
Mass 134 kg



Optional slow speed shafts

6 D-Series

F4CF-D



Special feature:

Single stage flange gearbox with high power density and improved bearings

- Easy motor mounting with clamp ring and adapter flange
- Also obtainable as basic gearbox with hollow shaft
- 5 sizes
- Reduction ratios (single stage) 59/89/119
- Nominal output torques up to 1756 Nm
- Acceleration torques up to 3188 Nm
- Lost motion < 1 arcmin
- Excellent cost-effectiveness
- High torques
- High permissible tilting moments
- Compact design

6.1 Torques according to output speeds

Output speed n_{2m} [min^{-1}]			5			10			15			20			25		
Model	Size	Reduction ratio i	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]
F4CF-	D15	59	226	295	0.15	226	590	0.3	201	885	0.39	184	1180	0.48	172	1475	0.56
		89	226	445	0.15	201	890	0.26	178	1335	0.35	163	1780	0.43	153	2225	0.5
	D25	59	487	295	0.32	487	590	0.64	434	885	0.85	398	1180	1.04	372	1475	1.22
		89	487	445	0.32	433	890	0.57	383	1335	0.75	351	1780	0.92	329	2225	1.08
		119	487	595	0.32	396	1190	0.52	351	1785	0.69	322	2380	0.84	301	2975	0.99
	D30	59	635	295	0.42	635	590	0.84	566	885	1.11	519	1180	1.36	486	1475	1.59
		89	635	445	0.42	565	890	0.74	500	1335	0.98	459	1780	1.2	429	2225	1.4
		119	635	595	0.42	517	1190	0.68	458	1785	0.9	420	2380	1.1	393	2975	1.29
	D35	59	899	295	0.59	899	590	1.18	800	885	1.57	734	1180	1.92	686	1475	2.25
		89	899	445	0.59	798	890	1.05	707	1335	1.39	649	1780	1.7	607	2225	1.98
		119	899	595	0.59	732	1190	0.96	648	1785	1.27	594	2380	1.56	556	2975	1.82
	D45	59	1756	295	1.15	1756	590	2.31	1565	885	3.07	1436	1180	3.76	1343	1475	4.39
		89	1756	445	1.15	1562	890	2.04	1383	1335	2.72	1269	1780	3.32	1180	2225	3.88
		119	1756	595	1.15	1431	1190	1.87	1267	1785	2.49	1162	2380	3.04			

Table D-1 Rating values (reference value output speed n_{2m})

30			40			50			60			Max. permissible input speed $n_{1\,max}$	Max. permissible input speed $n_{1\,ED}$ [min^{-1}]		Moment of inertia j related to the input shaft [×10^{-4} kgm^2]	Mass [kg]
Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Max. permissible input speed short term [min^{-1}]	50% ED	100% ED		
163	1770	0.64	150	2360	0.78	140	2950	0.92	133	3540	1.04	6150	5600	2800	CF	7
145	2670	0.57	133	3560	0.69	124	4450	0.81	117	5340	0.92				CF	
353	1770	1.38	323	2360	1.69	302	2950	1.98	286	3540	2.25	5050	4200	2100	CF	12
311	2670	1.22	285	3560	1.49										CF	
285	3570	1.12													CF	
460	1770	1.81	422	2360	2.21	394	2950	2.58	373	3540	2.93	4550	3800	1900	CF	15.5
406	2670	1.59	373	3560	1.95										CF	
372	3570	1.46													CF	
650	1770	2.55	596	2360	3.12	557	2950	3.65				3950	3300	1650	CF	20.5
574	2670	2.25													CF	
															CF	
1271	1770	4.99	1166	2360	6.11							3150	2600	1300	CF	35.5
															CF	
															CF	

: 50% ED range : 100% ED range (but max. 10 min. without pause) CF= Consult Factory

1. T_{2N} = nominal output torque
   Nominal output torque corresponds to the max. permissible average load torque at all output speeds.
   The nominal output torque for speeds less than 5 min^{-1} is equal to the value at 5 min^{-1}.
   The value for the maximum permissible input power is calculated from the nominal output torque at 100%.
   This value takes the efficiency of Fine Cyclo into consideration.
2. n_{1max} = maximum permissible input speed
   However, it must be n_{1m} (mean input speed) < $n_{1\,ED}$.
3. $n_{1\,ED}$ = permissible input speed according to load duty cycles
4. T_{2A} = max. Acceleration and braking torque (for fatigue strength at $2 \cdot 10^7$ load cycles)
   Permissible peak torque for normal start and stop procedures.
5. T_{2max} = max. permissible torque for emergency stop situations or in the event of heavy shocks (limited by the mechanical strength).
   (permissible 1000 x over the entire lifetime)
6. The nominal torque T_{2N} is calculated using the following equation when the speed is not shown in the table above:

$$T_{2N} = T_{2N,5} \left(\frac{5}{n_{2m}} \right)^{0,3}$$

T_{2N} : Nominal torque at output speed n_{2m}
$T_{2N,5}$: Nominal torque at output speed n_{2m} is 5 min^{-1}

6.2 Torques according to input speeds

Input speed n_{1m} [min^{-1}]			4000			3000			2500			2000			1750		
Model	Size	Reduction ratio i	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]
F4CF-	D15	59	128	67.8	1.13	139	50.8	0.93	147	42.4	0.82	157	33.9	0.7	164	29.7	0.64
		89	128	44.9	0.75	139	33.7	0.61	147	28.1	0.54	157	22.5	0.46	164	19.7	0.42
	D25	59	275	67.8	2.44	300	50.8	2	317	42.4	1.76	339	33.9	1.5	353	29.7	1.37
		89	275	44.9	1.62	300	33.7	1.32	317	28.1	1.16	339	22.5	1	353	19.7	0.91
		119	275	33.6	1.21	300	25.2	0.99	317	21	0.87	339	16.8	0.75	353	14.7	0.68
	D30	59				392	50.8	2.61	414	42.4	2.3	443	33.9	1.96	461	29.7	1.79
		89				392	33.7	1.73	414	28.1	1.52	443	22.5	1.3	461	19.7	1.19
		119				392	25.2	1.29	414	21	1.14	443	16.8	0.97	461	14.7	0.89
	D35	59				554	50.8	3.69	586	42.4	3.25	626	33.9	2.78	652	29.7	2.53
		89				554	33.7	2.44	589	28.1	2.15	626	22.5	1.84	652	19.7	1.68
		119							589	21	1.61	626	16.8	1.38	652	14.7	1.25
	D45	59							1145	42.4	6.35	1224	33.9	5.43	1274	29.7	4.94
		89							1145	28.1	4.21	1224	22.5	3.6	1274	19.7	3.28
		119							1145	21	3.15	1224	16.8	2.69	1274	14.7	2.45

Table D-2 Rating values (reference value input speed n_{1m})

Size	Max. acceleration and deceleration torque T_{2A}	Peak torque for emergency stop T_{2max}
	[Nm]	[Nm]
D15	417	834
D25	883	1766
D30	1226	2453
D35	1717	3581
D45	3188	6377

Table D-3 Maximum acceleration or deceleration torque

1500			1000			750			600			Max. permissible input speed $n_{1\,max}$	Max. permissible input speed $n_{1\,ED}$ [min^{-1}]		Moment of inertia j related to the input shaft [×10^{-4} kgm^2]	Mass [kg]
Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Max. permissible input speed short term [min^{-1}]	50% ED	100% ED		
171	25.4	0.57	194	16.9	0.43	211	12.7	0.35	226	10.2	0.3	6150	5600	2800	CF	7
171	16.9	0.38	194	11.2	0.28	211	8.43	0.23	226	6.74	0.2				CF	
370	25.4	1.23	418	16.9	0.93	455	12.7	0.76	487	10.2	0.65	5050	4200	2100	CF	12
370	16.9	0.81	418	11.2	0.61	455	8.43	0.5	487	6.74	0.43				CF	
370	12.6	0.61	418	8.4	0.46	455	6.3	0.38	487	5.04	0.32				CF	
483	25.4	1.61	545	16.9	1.21	594	12.7	0.99	635	10.2	0.85	4550	3800	1900	CF	15.5
483	16.9	1.06	545	11.2	0.8	594	8.43	0.66	635	6.74	0.56				CF	
483	12.6	0.8	545	8.4	0.6	594	6.3	0.49	635	5.04	0.42				CF	
683	25.4	2.27	771	16.9	1.71	840	12.7	1.4	899	10.2	1.2	3950	3300	1650	CF	20.5
683	16.9	1.5	771	11.2	1.13	840	8.43	0.93	899	6.74	0.79				CF	
683	12.6	1.13	771	8.4	0.85	840	6.3	0.69	899	5.04	0.59				CF	
1334	25.4	4.44	1507	16.9	3.34	1643	12.7	2.73	1756	10.2	2.34	3150	2600	1300	CF	35.5
1334	16.9	2.94	1507	11.2	2.22	1643	8.43	1.81	1756	6.74	1.55				CF	
1334	12.6	2.2	1507	8.4	1.66	1643	6.3	1.35	1756	5.04	1.16				CF	

: 50% ED range : 100% ED range CF = Consult Factory

1. T_{2N} = nominal output torque
   Nominal output torque corresponds to the max. permissible average load torque at all input speeds.
   The nominal output torque for speeds less than 600 min^{-1} is equal to the value at 600 min^{-1}.
   The value for the maximum permissible input power is calculated from the nominal output torque at 100%.
   This value takes the efficiency of Fine Cyclo into consideration.
2. n_{1max} = maximum permissible input speed
   However, it must be n_{1m} (mean input speed) < $n_{1\,ED}$.
3. $n_{1\,ED}$ = permissible input speed according to load duty cycles
4. T_{2A} = max. Acceleration and braking torque (for fatigue strength at $2 \cdot 10^7$ load cycles)
   Permissible peak torque for normal start and stop procedures.
5. T_{2max} = max. permissible torque for emergency stop situations or in the event of heavy shocks (limited by the mechanical strength).
   (permissible 1000 x over the entire lifetime)
6. The nominal torque T_{2N} is calculated using the following equation when the speed is not shown in the table above:

$$T_{2N} = T_{2N,\,600} \left(\frac{600}{n_{1m}} \right)^{0,3}$$

T_{2N} : Rated torque at input speed n_{1m}
$T_{2N,\,600}$: Rated torque at input speed n_{1m} is 600 min^{-1}

6.3 Rigidity and Lost Motion

Size	i	Test torque T_p [Nm]	Lost Motion		Torsional stiffness 3% - 50% T_p [Nm/arcmin]	Torsional stiffness 3% - 100% T_p [Nm/arcmin]	Torsional stiffness 50% - 100% T_p [Nm/arcmin]
			Lost Motion [arcmin]	Domain of definition [Nm]			
D15	59	±171	< 1	±5.13	33.5	40	49
	89						
D25	59	±370		±11.1	67.7	85	112
	89						
	119						
D30	59	±483		±14.49	103	130	173
	89						
	119						
D35	59	±683		±20.49	124	160	220
	89						
	119						
D45	59	±1334		±40.02	257	330	450
	89						
	119						

Table D-4 Torsional stiffness

T_p: Test torque at input speed $n_1 = 1500\ min^{-1}$

1) At a load torque less than 3% T_p

$$\varphi = \frac{\text{Lost Motion}}{2} \cdot \frac{\text{Load torque}}{0.03 \cdot T_p}$$

2) At a load torque greater than 3% T_p (standard case)

$$\varphi = \frac{\text{Lost Motion}}{2} + \frac{\text{Load torque} - (0.03 \cdot T_p)}{\text{Torsional stiffness}}$$

Note arcmin means "angular minute".
Table values for rigidity are average values

6.4 No-load running torque NLRT

The quoted values apply to indicated standard constructions in clamp ring design.

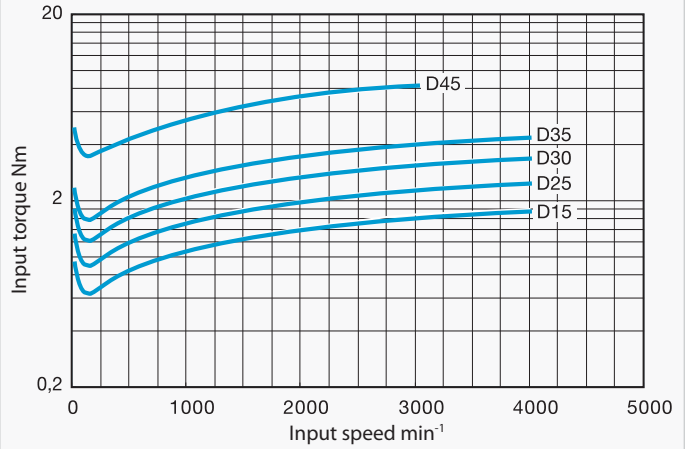


Fig. D-1

Note
1. Fig. D-1 shows the average no-load running torque after gearbox is run in. (not factory-new condition)
2. Table D-6 shows the measuring conditions

Ring gear housing temperature	approx. 30 °C
Precision during assembly	as per 6.8.1
Lubrication	Standard lubrication

Table D-5 Measurement conditions

6.5 Breakaway torque

Breakaway torque on output side (BTO)

Note
1. Table D-7 shows the max. breakaway torque on the output side BTO. Fine Cyclo reducers are not self-locking. The BTO is defined as the maximum value (factory-new condition), which steadily decreases during the lifetime.
2. Table D-6 shows the measuring conditions

Precision during assembly	as per 6.8.1
Lubrication	Standard lubrication

Table D-6 Measurement conditions

Size	Breakaway torque BTO [Nm]
D15	< 70
D25	< 100
D30	< 120
D35	< 140
D45	< 245

Table D-7 Value of the breakaway torque on the output side (BTO)

Breakaway torque on input side (BTI)

Note
1. Table D-8 shows the max. breakaway torque BTI on the input side. The BTI is defined as the maximum value (factory-new condition) which steadily decreases during the lifetime.
2. Table D-6 shows the measuring conditions

Size	i	Breakaway torque BTI [Nm]
D15	59	< 0.9
	89	
D25	59	< 1.3
	89	
	119	
D30	59	< 1.8
	89	
	119	
D35	59	< 3.0
	89	
	119	
D45	59	< 5.0
	89	
	119	

Table D-8 Value of the breakaway torque on the input side (BTI)

6.6 Efficiency

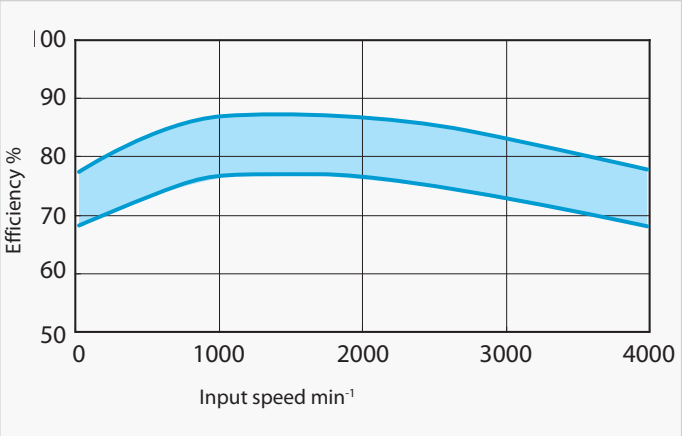


Fig. D-2 Efficiency curve

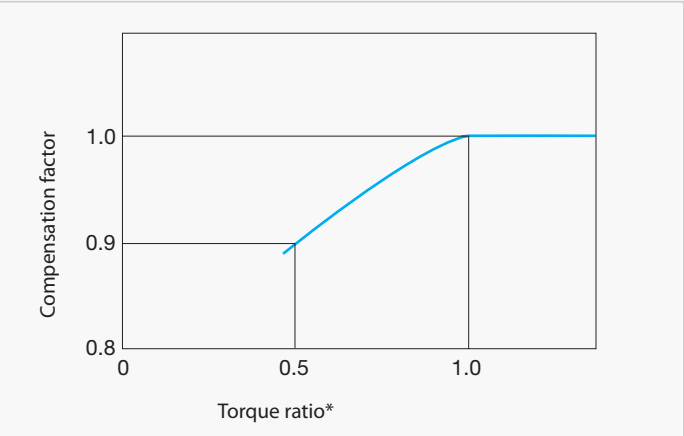


Fig. D-3 Compensation curve for efficiency

Fig. D-2 shows the relation between efficiency and input speed. For further information see "4 Explaining the technical details" on page 18.

Note

1. The efficiency changes if the load torque does not match the nominal torque. Check the compensation factor in the diagram Fig. D-3
2. When the torque ratio is over 1.0, the compensation factor for efficiency is 1.0 (diagram Fig. D-3).

Compensation efficiency = efficiency · compensation factor

$$* \textbf{Torque ratio} = \frac{\textbf{Load torque}}{\textbf{Nominal output torque}}$$

6.7 Bearing loads

6.7.1 Maximum permissible radial and axial load on the input shaft

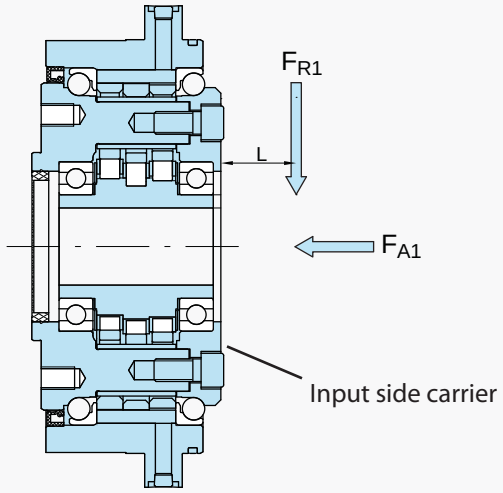


Fig. D-4

L [mm]	Load factor input L_{f1}				
	Size				
	D15	D25	D30	D35	D45
10	0.91	0.87			
15	0.99	0.94	0.92	0.91	
20	1.25	1.00	0.98	0.97	0.90
25	1.56	1.25	1.14	1.09	0.94
30	1.88	1.50	1.36	1.30	0.99
35	2.19	1.75	1.59	1.52	1.13
40		2.00	1.82	1.74	1.29
45			2.05	1.96	1.45
50				2.17	1.61
60					1.94

Table D-9 Load factor
L = distance from input side carrier

If the input shaft is fitted with a pinion or a disc, axial and radial forces act on the input shaft.
The following equation is used to check whether the shaft load is permissible:

1. Input radial load F_{R1}

$$F_{R1} = 10^3 \cdot \frac{T_{2V}}{\eta \cdot i \cdot r_0} \leq \frac{F_{R1\,max}}{L_{f1} \cdot C_{f1} \cdot B_{f1}} \quad [N] \qquad \text{(Equation D-1)}$$

2. Input side axial load F_{A1}

$$F_{A1} \leq \frac{F_{A1\,max}}{C_{f1} \cdot B_{f1}} \quad [N] \qquad \text{(Equation D-2)}$$

3. When radial and axial loads co-exist

$$\left(\frac{F_{R1} \cdot L_{f1}}{F_{R1\,max}} + \frac{F_{A1}}{F_{A1\,max}} \right) \cdot C_{f1} \cdot B_{f1} \leq 1 \qquad \text{(Equation D-3)}$$

F_{R1} = input side radial load [N]
T_{2V} = equivalent output torque on output shaft [Nm]
d_0 = pitch circle diameter of sprocket, pinion [mm]
$F_{R1\,max}$ = maximum permissible input side radial load [N]
F_{A1} = input side axial load [N]
$F_{A1\,max}$ = maximum permissible input side axial load [N]
L_{f1} = load factor input (Table D-9)
C_{f1} = correction factor input (Table D-10)
B_{f1} = service factor input (Table D-11)
L = distance of radial force from input side carrier on gear-boxes without motor adapter (Table D-9)
η = 0.8 (efficiency)

Correction factor input	C_{f1}
Chain	1
Pinion*	1.25
Toothed belt	1.25
V-Belt	1.5

Table D-10

* For helical pinions or bevel gears, please consult Sumitomo Drive Technologies.

Load conditions input	B_{f1}
Uniform load	1
Light impacts	1.2
Severe impacts	1.6

Table D-11

Size	Input speed n_{1m} [min^{-1}] (input side radial load [N])								
	4000	3000	2500	2000	1750	1500	1000	750	600
D15	226	245	265	284	294	314	335	392	422
D25	334	373	392	422	441	461	530	589	628
D30		432	461	500	520	549	628	687	746
D35		491	520	559	589	618	706	785	844
D45			608	657	687	726	824	912	981

Table D-12 max. permissible input side radial load $F_{R1\,max}$

Size	Input speed n_{1m} [min^{-1}] (input side axial load [N])								
	4000	3000	2500	2000	1750	1500	1000	750	600
D15	245	284	314	343	363	392	471	549	608
D25	363	412	451	500	540	579	697	804	883
D30		520	569	638	677	726	883	1001	1118
D35		540	589	657	706	755	922	1059	1167
D45			1010	1118	1197	1295	1570	1795	2001

Table D-13 max. permissible input side axial load $F_{A1\,max}$

Calculation of the max. permissible radial load on the input shaft

Calculation of the max. permissible radial load using the following equation when the speed is not shown in the table above.

$$F_{R1\,max} = F_{R1,600} \left(\frac{600}{n_{1m}} \right)^{1/3}$$

$F_{R1\,max}$ = maximum permissible input side radial load at input speed n_{1m}

$F_{R1,600}$ = input side radial load at input speed $n_{1m} = 600\ min^{-1}$

Calculation of the max. permissible axial load on the input shaft

Calculation of the max. permissible axial load using the following equation when the speed is not shown in the table above.

$$F_{A1\,max} = F_{A1,600} \left(\frac{600}{n_{1m}} \right)^{0,47}$$

$F_{A1\,max}$ = maximum permissible input side axial load at input speed n_{1m}

$F_{A1,600}$ = input side axial load at input speed $n_{1m} = 600\ min^{-1}$

6.7.2 Main bearings

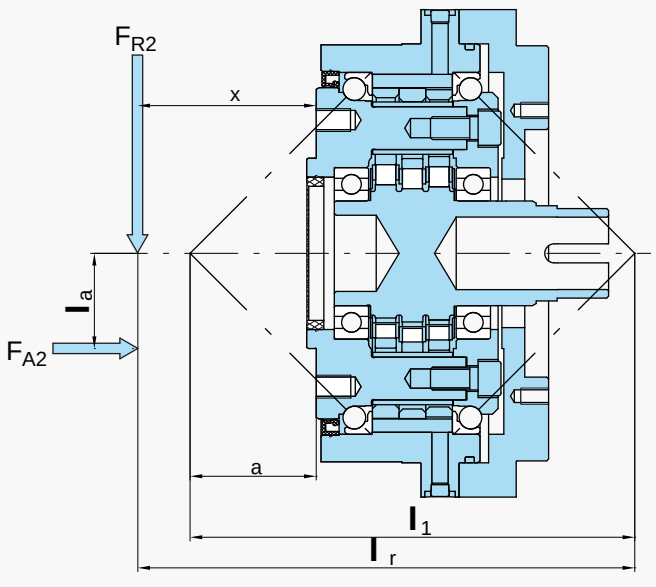


Fig. D-5 Distance between the individual loading points

$$l_r = x - a + l_1 \qquad \text{(Equation D-4)}$$

Size	Values of internal bearing distance	
	l_1 [mm]	a [mm]
D15	119	23.6
D25	139	23.4
D30	157	24.5
D35	170	40.5
D45	206	52.4

Table D-14 Bearing clearances (mm)

Note If: $l_r > 4 \cdot l_1$ please contact Sumitomo Drive Technologies (SDT).

1. Moment stiffness

The moment stiffness is the bending moment at which the output flange is tilted by the tilt angle.

The tilt angle of the input flange is determined as follows:

$$\varphi_1 = \frac{T_k}{\Theta_1} \quad \text{(Equation D-5)}$$

External bending moment T_k

$$T_k = 10^{-3} \cdot (F_{R2} \cdot l_r + F_{A2} \cdot l_a) \quad \text{(Equation D-6)}$$

2. Max. permissible bending moment and max. permissible axial load

Check the equivalent bending moment and the equivalent axial load using the equations D-6, D-7, D-8, and Fig. D-6.

Equivalent bending moment T_{ke} at output

$$T_{ke} = 10^{-3} \cdot (C_{f2} \cdot B_{f2} \cdot F_{R2} \cdot l_r + C_{f2} \cdot B_{f2} \cdot F_{A2} \cdot l_a) \quad < T_{k\,max} \quad \text{(Equation D-7)}$$

Equivalent axial load F_{A2e} at the output shaft

$$F_{A2e} = F_{A2} \cdot C_{f2} \cdot B_{f2} \quad < F_{A2\,max} \quad \text{(Equation D-8)}$$

F_{A2} = output side axial load [N]
$F_{A2\,max}$ = maximum permissible output side axial load [N]
F_{A2e} = equivalent input side axial load [N]
F_{R2} = output side radial load [N]
C_{f2} = correction factor output (Table D-16)
B_{f2} = service factor output (Table D-17)
l_1 = bearing clearance [mm] (Table D-14)
l_r = calculated dimension for bending moment [mm]
l_a = distance of axial load [mm]
x = distance from radial force to flange collar [mm]
a = correction factor [mm] (Table D-14)
T_k = external bending moment [Nm]
$T_{k\,max}$ = maximum bending moment [Nm] (Table D-18)
T_{ke} = equivalent bending moment [Nm]
φ_1 = tilt angle [arcmin]
Θ_1 = moment stiffness main bearing [Nm/arcmin] (Table D-15)

Size	Moment stiffness Θ_1
	[Nm/arcmin]
D15	510
D25	833
D30	1127
D35	1470
D45	2450

Table D-15 Average values for moment stiffness

Correction factor output	C_{f2}
Chain	1
Pinion or rack	1.25
Toothed belt	1.25
V-Belt	1.5

Table D-16

Service factor output	B_{f2}
Uniform load (no shock)	1
Light impacts	1.2
Severe impacts	1.6

Table D-17

Size	Max. permissible bending moment $T_{k\,max}$	Max. permissible axial load $F_{A2\,max}$
	[Nm]	[N]
D15	883	3924
D25	1177	3924
D30	1668	5199
D35	1962	7848
D45	2943	10791

Table D-18 Maximum bending moment and max. permissible output side axial load

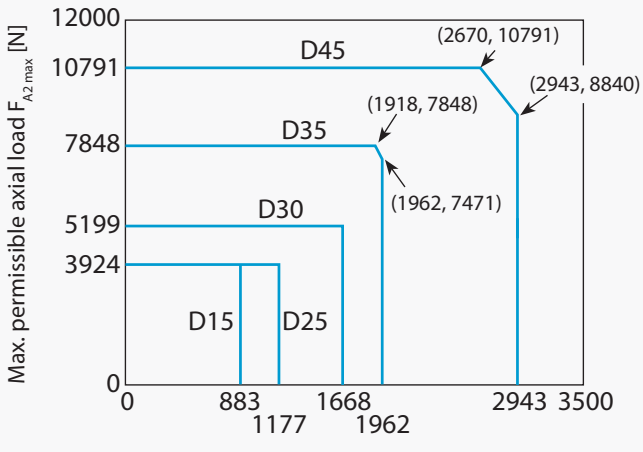
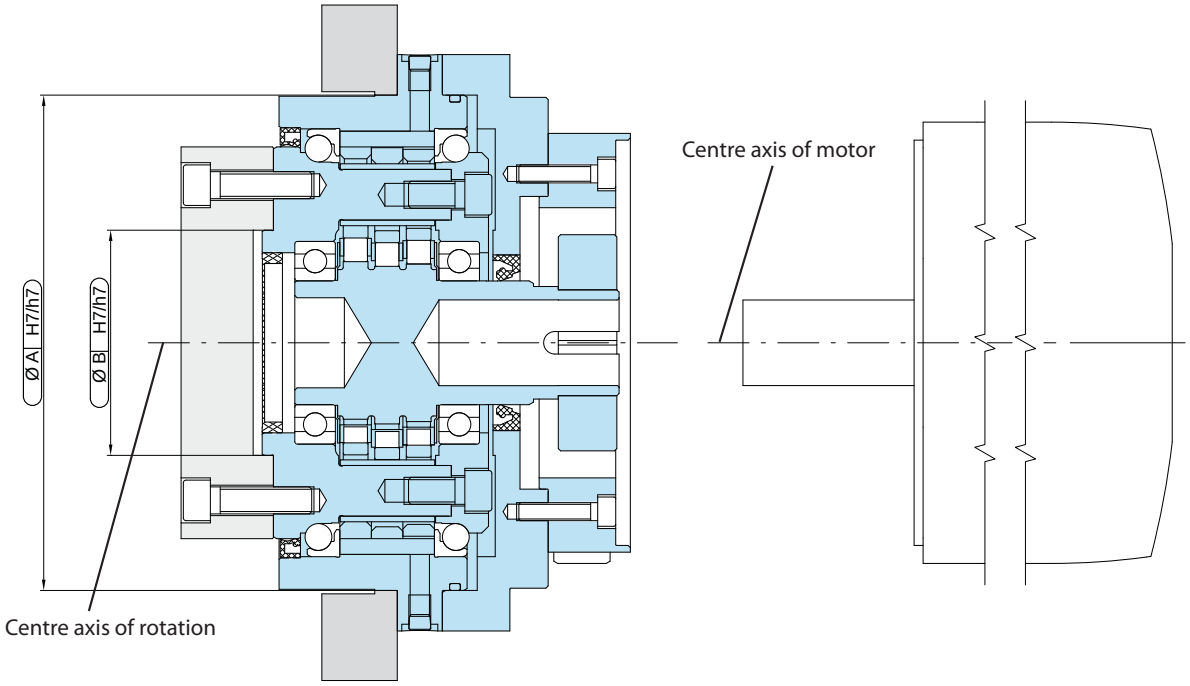


Fig. D-6 Diagram max. permissible bending moment and axial load

6.8 Assembly specifications and tolerances

6.8.1 Assembly tolerances

To ensure the function, lifetime, and characteristics of the gearbox, the radial run-out of the shaft ends, the concentricity, and the axial run-out of the fastening surface as per EN 50347:2001 are sufficient. When used in high-precision applications, the tolerance according to EN 50347:2001 should be reduced by 50%.



Size	Ø A	Ø B
D15	124	47
D25	145	113
D30	163	100
D35	174	75
D45	220	100

Table D-19
(Dimensions in mm)

6.8.2 Tightening torque and maximum permissible transmitted torque for bolts

The permissible transmitted torque for bolts and the number, size, and tightening torque for fastening the output side flange and the ring gear housing are listed in Table D-20. In the event of an emergency stop with corresponding load peaks, the output flange and ring gear housing bolts must all be replaced.

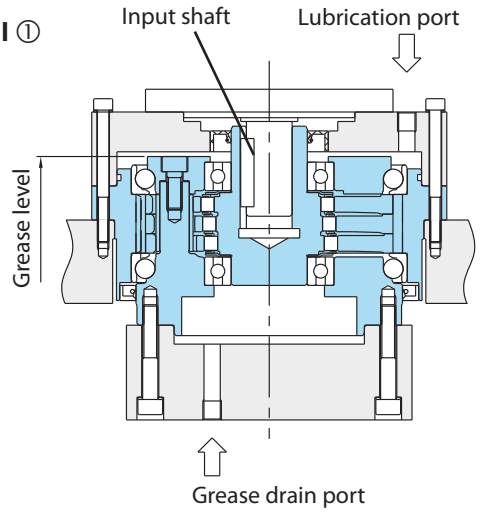
Size	Output flange bolts		Ring gear housing		Max. permissible transmitted torque for bolts [Nm]
	Number and size of bolts	Tightening torque [Nm]	Number and size of bolts	Tightening torque [Nm]	
D15	12 × M8	38.3	12 × M6	15.7	1478
D25	12 × M8	38.3	16 × M6	15.7	2065
D30	16 × M8	38.3	16 × M6	15.7	2786
D35	12 × M10	76.5	16 × M8	38.3	3962
D45	16 × M12	133	16 × M10	76.5	9347

Table D-20

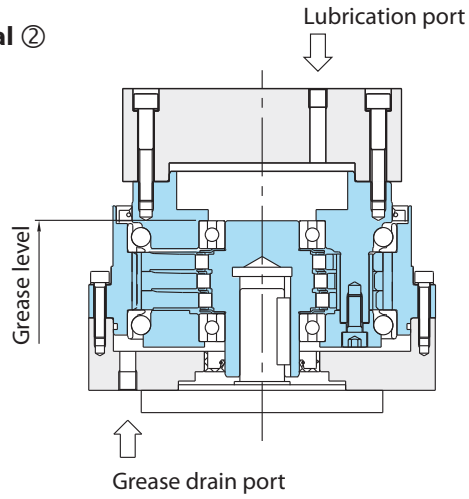
- **Bolting:** Use metric hexagon socket head cap screws (DIN 4762, strength category 12.9).
- **Countermeasure for bolts loosening:** Use adhesives (Loctite 262, etc.) or spring washer (DIN 127A).
- **Use conical spring washers** (DIN 6796) when connecting the gearbox to the flange side, so that the bolt contact faces do not get damaged.

6.8.3 Lubrication

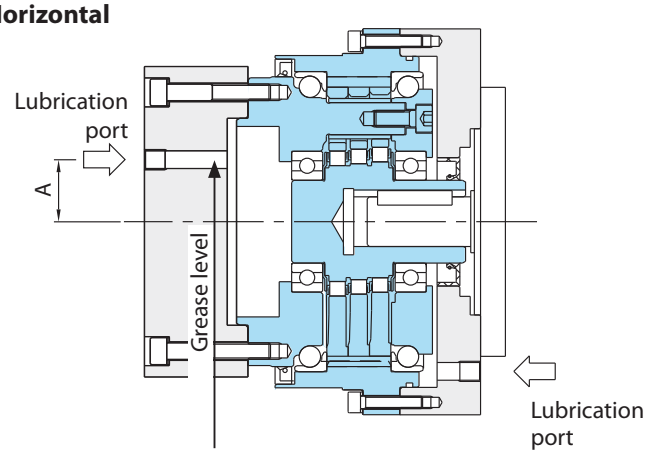
Vertical ①



Vertical ②



Horizontal



- For gearboxes that are not sealed, delivery does not include lubricant (grease filling). Upon receipt, the customer must therefore fill it with the appropriate amount (Table D-22) of the recommended grease (Table D-21).
- Use the quantity quoted in Table D-22 as a guideline value; check the grease level.
- Fit the lubrication port and the grease drain on the output side. (See "A" and Table D-22).
- When filling grease for the first time use the bottom hole in order to ensure grease circulation.
- The grease must be replaced after 20,000 operating hours or every 3-5 years. Regreasing the D gearbox can extend the lifetime of the gearbox.

Grease prescribed	Manufacturer
Multemp FZ No. 00	Kyodo Yushi Co., Ltd.
Conditions for use: Environmental temperature -10 °C to +40 °C	

Table D-21 Specified grease

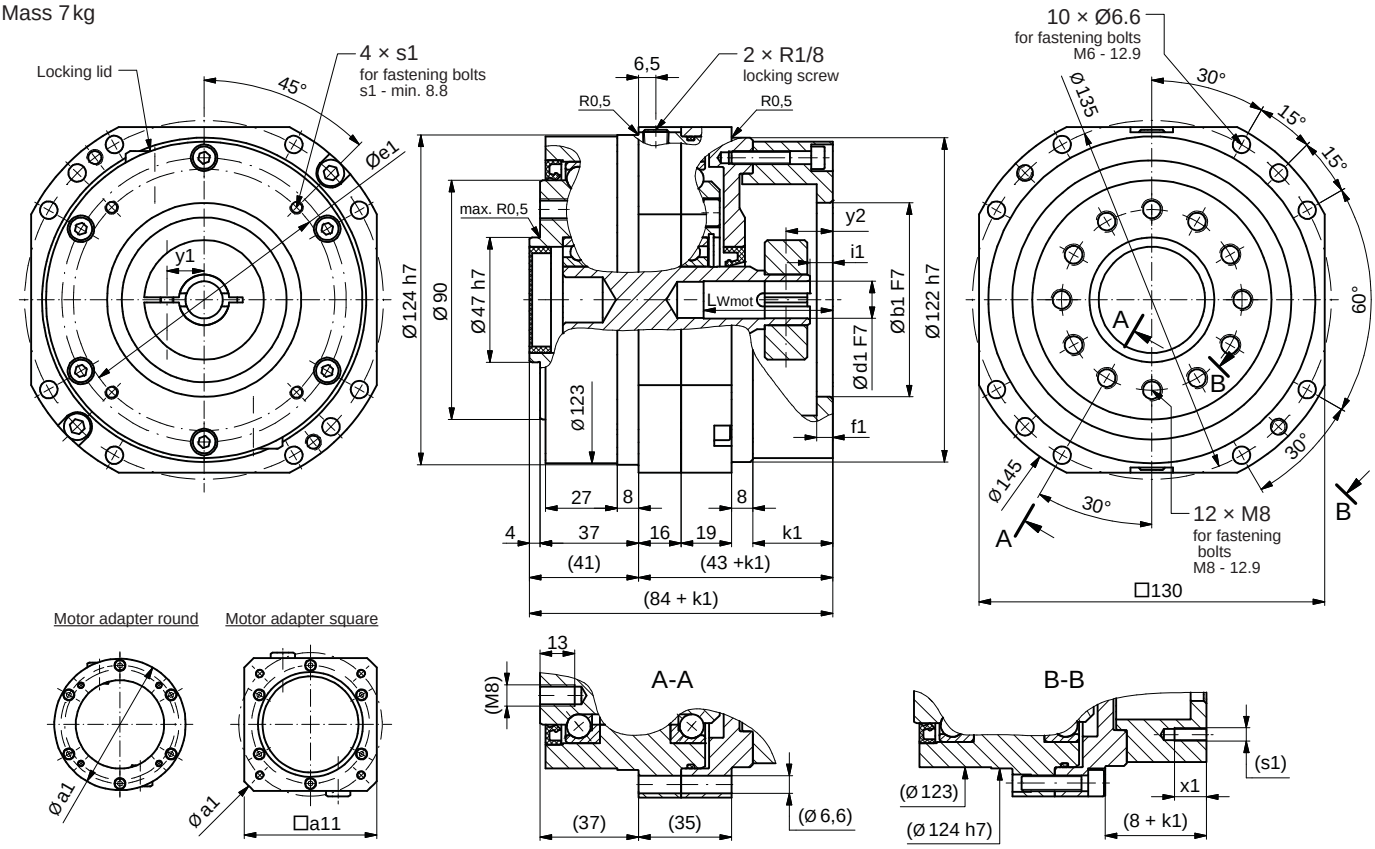
Size	Quantity of grease [g]			Lubrication port distance A [mm]
	Vertical ①	Vertical ②	Horizontal	
D15	55	40	50	20
D25	100	45	95	26
D30	220	85	200	29
D35	190	150	160	34
D45	320	260	270	39

Table D-22 (if delivered without grease filling)

6.9 Dimensioned drawings

F4CF-D15

Mass 7 kg



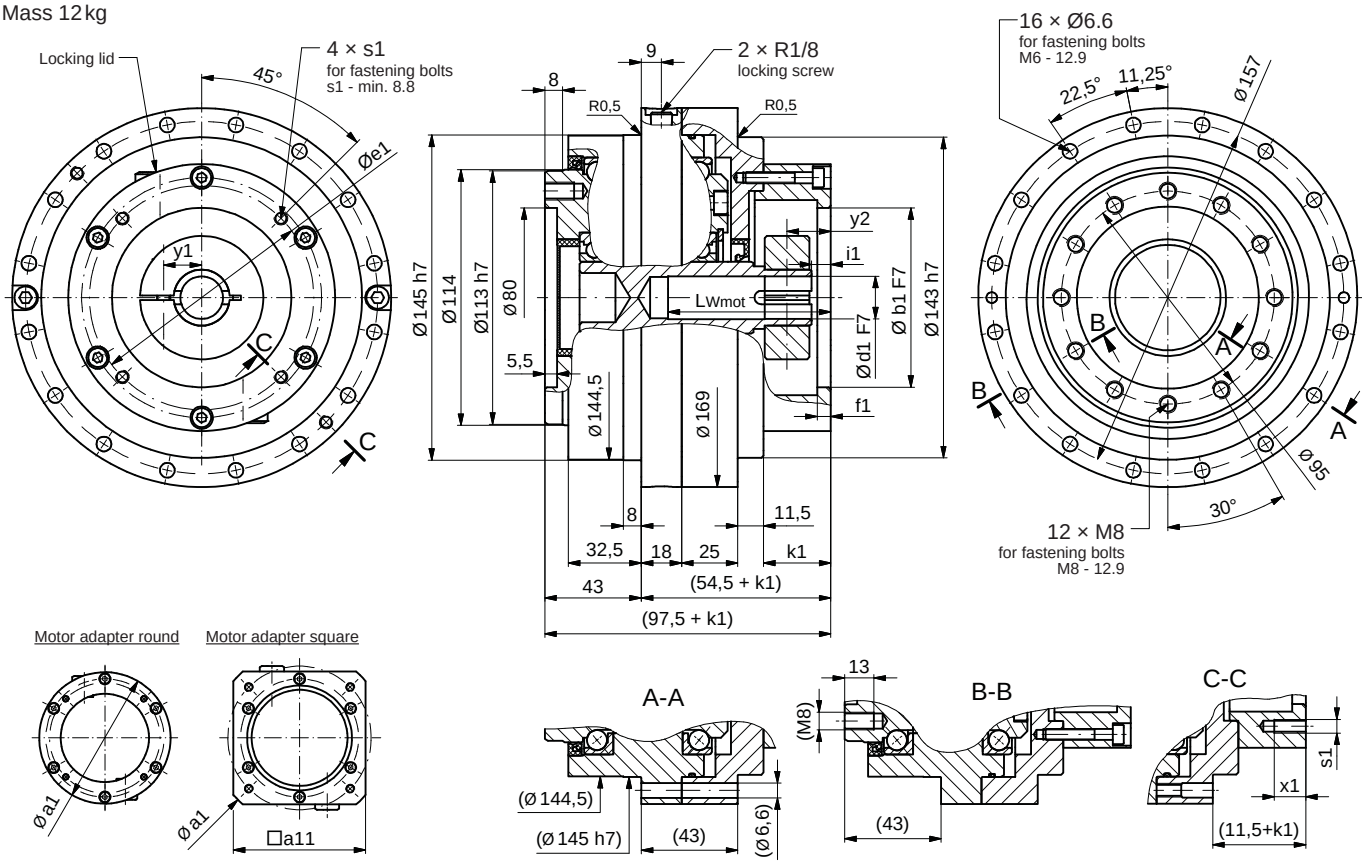
Motor connection dimensions F4CF-D15

Motor code	Hole for shaft	Min./Max. Length of motor shaft	Spigot F7	Spigot seat depth	Pitch circle Ø	Thread in gearbox flange	Thread depth	Flange diameter	Flange square dimension	Flange width	Shaft recess without bushing	Shaft recess with bushing	Positional dimensions locking lid	
	Ød1	$L_{w\,Mot\ min/max}$	Øb1	f1	Øe1	4x s1	x1	Øa1	□a11	k1	i1		y1	y2
	mm													
C06G	9	24.0 / 47.5	40	5.5	63	M4	7.5	119	-	29	-	6.5	17	16.5
C08G		24.0 / 47.5	40	5.5	63	M5	7.5	119	-	29	-	6.5	17	16.5
D30G	10	25.0 / 48.5	80	6	100	M6	14	119	-	30	-	7.5	18.5	16.5
E08G	11	24.0 / 47.5	40	5.5	63	M5	7.5	119	-	29	-	6.5	17	16.5
E10G		24.0 / 47.5	50	5.5	70	M4	7.5	119	-	29	-	6.5	17	16.5
E11G		24.0 / 47.5	60	5.5	75	M5	7.5	119	-	29	-	6.5	18.5	16.5
H10G	14	24.0 / 47.5	50	5.5	70	M4	7.5	119	-	29	7.5	-	17	16.5
H25G		24.0 / 47.5	50	5.5	70	M5	7.5	119	-	29	7.5	-	17	16.5
H20G		24.0 / 47.5	50	6	95	M6	14	119	-	29	7.5	-	17	16.5
H11G		24.0 / 47.5	60	5.5	75	M5	7.5	119	-	29	7.5	-	18.5	16.5
H12G		24.0 / 47.5	60	5.5	75	M6	7.5	119	-	29	7.5	-	18.5	16.5
H18G		25.5 / 49.0	70	6	90	M6	14	119	-	30.5	9	-	18.5	17
H30G		25.0 / 48.5	80	6	100	M6	14	119	-	30	8.5	-	18.5	16.5
H30L		34.0 / 57.5	80	6	100	M6	14	119	-	39	8.5	-	18.5	25.5
H35G		25.0 / 48.5	95	6	115	M8	17	138	120	30	8.5	-	18.5	18
H50G		25.0 / 48.5	110	6	130	M8	17	158	120	30	8.5	-	25	18
H60L		36.5 / 60.0	110	8	145	M8	17	158	120	41.5	20	-	25	29.5
J18G	16	30.0 / 73.0	70	6	90	M6	14	119	-	30.5	-	8	18.5	17
J30L		38.5 / 81.5	80	6	100	M6	14	119	-	39	-	16.5	18.5	25.5
J60G		29.5 / 72.5	110	6.5	145	M8	17	158	120	30	-	7.5	25	18
K60L	17	43.0 / 84.0	110	8	145	M8	17	158	120	41.5	-	19	25	29.5
M30G	19	29.5 / 72.5	80	6	100	M6	14	119	-	30	8.5	-	18.5	16.5
M30L		38.5 / 81.5	80	6	100	M6	14	119	-	39	8.5	-	18.5	25.5
M35G		29.5 / 72.5	95	6	115	M8	17	138	120	30	8.5	-	18.5	18
M45G		29.5 / 72.5	95	6	130	M8	17	158	120	30	8.5	-	25	18
M50G		29.5 / 72.5	110	6	130	M8	17	158	120	30	8.5	-	25	18
M60G		29.5 / 72.5	110	6.5	145	M8	17	158	120	30	8.5	-	25	18
M60L		43.0 / 84.0	110	8	145	M8	17	158	120	41.5	20	-	25	29.5

Note Other motor connection dimensions available on request.

F4CF-D25

Mass 12 kg



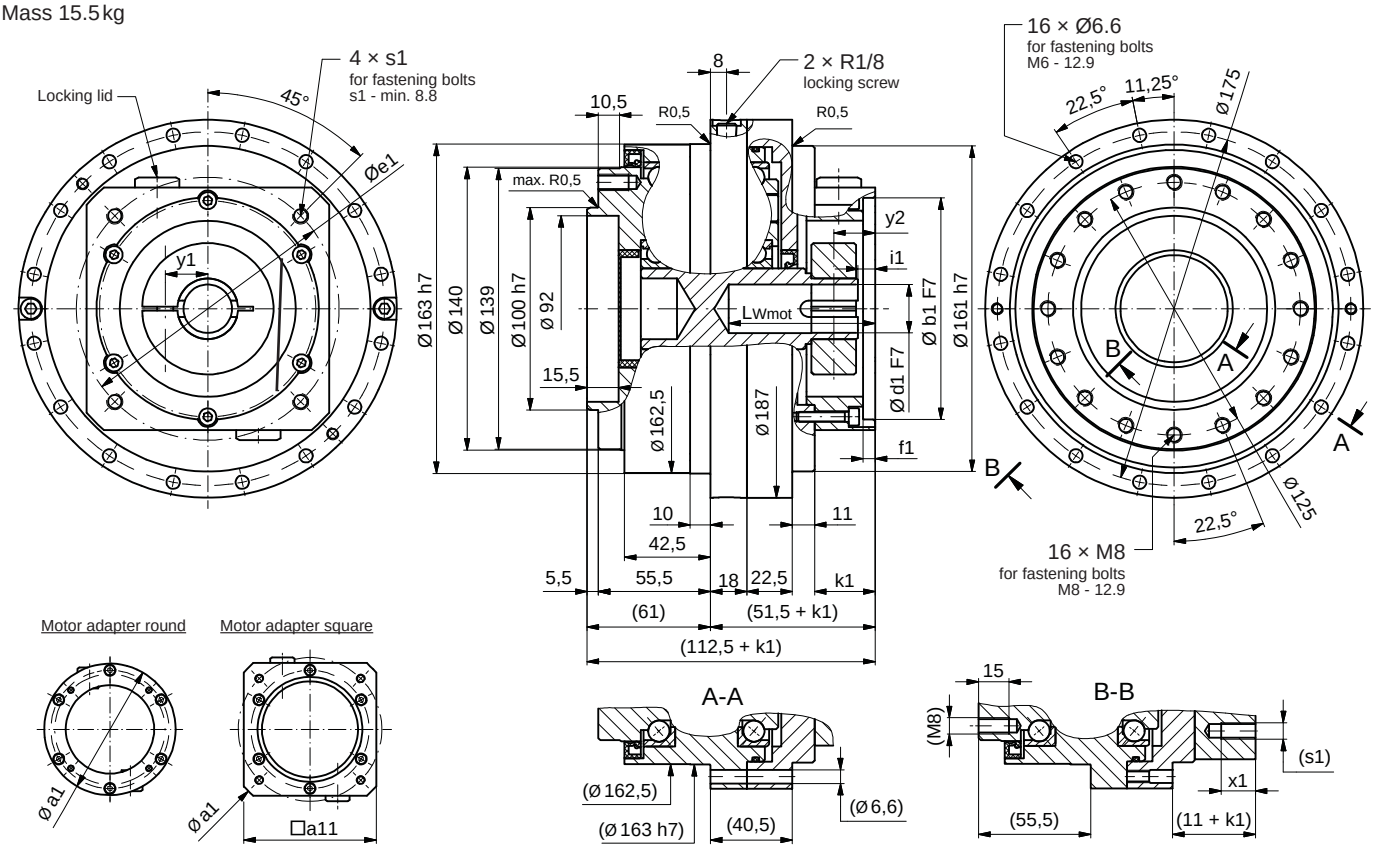
Motor connection dimensions F4CF-D25

Motor code	Hole for shaft	Min./Max. Length of motor shaft	Spigot F7	Spigot seat depth	Pitch circle Ø	Thread in gearbox flange	Thread depth	Flange diameter	Flange square dimension	Flange width	Shaft recess without bushing	Shaft recess with bushing	Positional dimensions locking lid	
	Ød1	$L_{w\,Mot\ min/max}$	Øb1	f1	Øe1	4x s1	x1	Øa1	□a11	k1	i1		y1	y2
							mm							
D30G	10	25.0 / 48.5	80	6	100	M6	14	119	-	30	-	7.5	18.5	16.5
H10G	14	24.0 / 47.5	50	5.5	70	M4	7.5	119	-	29	7.5	-	17	16.5
H25G		24.0 / 47.5	50	5.5	70	M5	7.5	119	-	29	7.5	-	17	16.5
H20G		24.0 / 47.5	50	6	95	M6	14	119	-	29	7.5	-	17	16.5
H11G		24.0 / 47.5	60	5.5	75	M5	7.5	119	-	29	7.5	-	18.5	16.5
H12G		24.0 / 47.5	60	5.5	75	M6	7.5	119	-	29	7.5	-	18.5	16.5
H18G		25.5 / 49.0	70	6	90	M6	14	119	-	30.5	9	-	18.5	17
H30G		25.0 / 48.5	80	6	100	M6	14	119	-	30	8.5	-	18.5	16.5
H30L		34.0 / 57.5	80	6	100	M6	14	119	-	39	8.5	-	18.5	25.5
H35G		25.0 / 48.5	95	6	115	M8	17	138	120	30	8.5	-	18.5	18
H50G		25.0 / 48.5	110	6	130	M8	17	158	120	30	8.5	-	25	18
H60L		36.5 / 60.0	110	8	145	M8	17	158	120	41.5	20	-	25	29.5
J18G	16	30.0 / 73.0	70	6	90	M6	14	119	-	30.5	-	8	18.5	17
J30L		38.5 / 81.5	80	6	100	M6	14	119	-	39	-	16.5	18.5	25.5
J60G		29.5 / 72.5	110	6.5	145	M8	17	158	120	30	-	7.5	25	18
K60L	17	43.0 / 84.0	110	8	145	M8	17	158	120	41.5	-	19	25	29.5
M30G	19	29.5 / 72.5	80	6	100	M6	14	119	-	30	8.5	-	18.5	16.5
M30L		38.5 / 81.5	80	6	100	M6	14	119	-	39	8.5	-	18.5	25.5
M35G		29.5 / 72.5	95	6	115	M8	17	138	120	30	8.5	-	18.5	18
M45G		29.5 / 72.5	95	6	130	M8	17	158	120	30	8.5	-	25	18
M50G		29.5 / 72.5	110	6	130	M8	17	158	120	30	8.5	-	25	18
M60G		29.5 / 72.5	110	6.5	145	M8	17	158	120	30	8.5	-	25	18
M60L		43.0 / 84.0	110	8	145	M8	17	158	120	41.5	20	-	25	29.5
N60G	22	31.5 / 72.5	110	6.5	145	M8	17	158	120	30	-	7.5	25	18
Z35G	24	31.5 / 72.5	95	6	115	M8	17	138	120	30	8.5	-	18.5	18
Z50G		31.5 / 72.5	110	6	130	M8	17	158	120	30	8.5	-	25	18
Z70G		31.5 / 72.5	130	6	165	M10	20	188	144	30	8.5	-	25	18

Note Other motor connection dimensions available on request.

F4CF-D30

Mass 15.5 kg



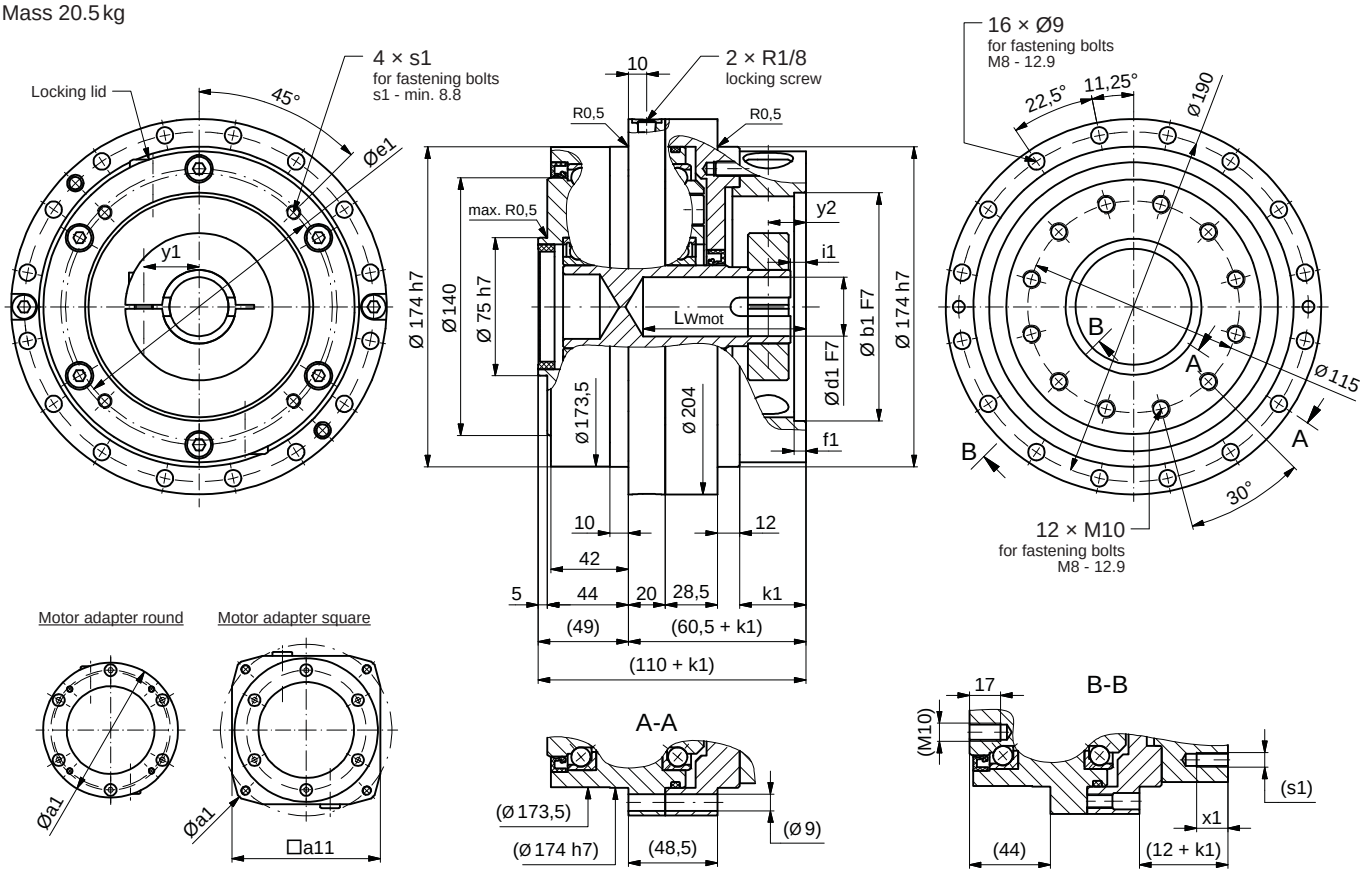
Motor connection dimensions F4CF-D30

Motor code	Hole for shaft	Min./Max. Length of motor shaft	Spigot F7	Spigot seat depth	Pitch circle Ø	Thread in gearbox flange	Thread depth	Flange diameter	Flange square dimension	Flange width	Shaft recess without bushing	Shaft recess with bushing	Positional dimensions locking lid	
	Ød1	$L_{w\ Mot\ min/max}$	Øb1	f1	Øe1	4x s1	x1	Øa1	□a11	k1	i1		y1	y2
							mm							
H35G	14	25.0 / 48.5	95	6	115	M8	17	138	120	30	8.5	-	18.5	18
H50G		25.0 / 48.5	110	6	130	M8	17	158	120	30	8.5	-	25	18
H60L		36.5 / 60.0	110	8	145	M8	17	158	120	41.5	20	-	25	29.5
J18G	16	30.0 / 73.0	70	6	90	M6	14	119	-	30.5	-	8	18.5	17
J30L		38.5 / 81.5	80	6	100	M6	14	119	-	39	-	16.5	18.5	25.5
J60G		29.5 / 72.5	110	6.5	145	M8	17	158	120	30	-	7.5	25	18
K60L	17	43.0 / 84.0	110	8	145	M8	17	158	120	41.5	-	19	25	29.5
M30G	19	29.5 / 72.5	80	6	100	M6	14	119	-	30	8.5	-	18.5	16.5
M30L		38.5 / 81.5	80	6	100	M6	14	119	-	39	8.5	-	18.5	25.5
M35G		29.5 / 72.5	95	6	115	M8	17	138	120	30	8.5	-	18.5	18
M45G		29.5 / 72.5	95	6	130	M8	17	158	120	30	8.5	-	25	18
M50G		29.5 / 72.5	110	6	130	M8	17	158	120	30	8.5	-	25	18
M60G		29.5 / 72.5	110	6.5	145	M8	17	158	120	30	8.5	-	25	18
M60L		43.0 / 84.0	110	8	145	M8	17	158	120	41.5	20	-	25	29.5
N60G	22	31.5 / 72.5	110	6.5	145	M8	17	158	120	30	-	7.5	25	18
Z35G	24	31.5 / 72.5	95	6	115	M8	17	138	120	30	8.5	-	18.5	18
Z50G		31.5 / 72.5	110	6	130	M8	17	158	120	30	8.5	-	25	18
Z70G		31.5 / 72.5	130	6	165	M10	20	188	144	30	8.5	-	25	18
Q60G	28	31.5 / 88.5	110	6.5	145	M8	17	158	120	30	-	7.5	25	18
Q60L		43.0 / 100.0	110	8	145	M8	17	158	120	41.5	-	19	25	29.5
Q70G		31.5 / 88.5	130	6	165	M10	20	188	144	30	-	7.5	25	18
S70G	32	31.5 / 88.5	130	6	165	M10	20	188	144	30	8.5	-	25	18

Note Other motor connection dimensions available on request.

F4CF-D35

Mass 20.5 kg



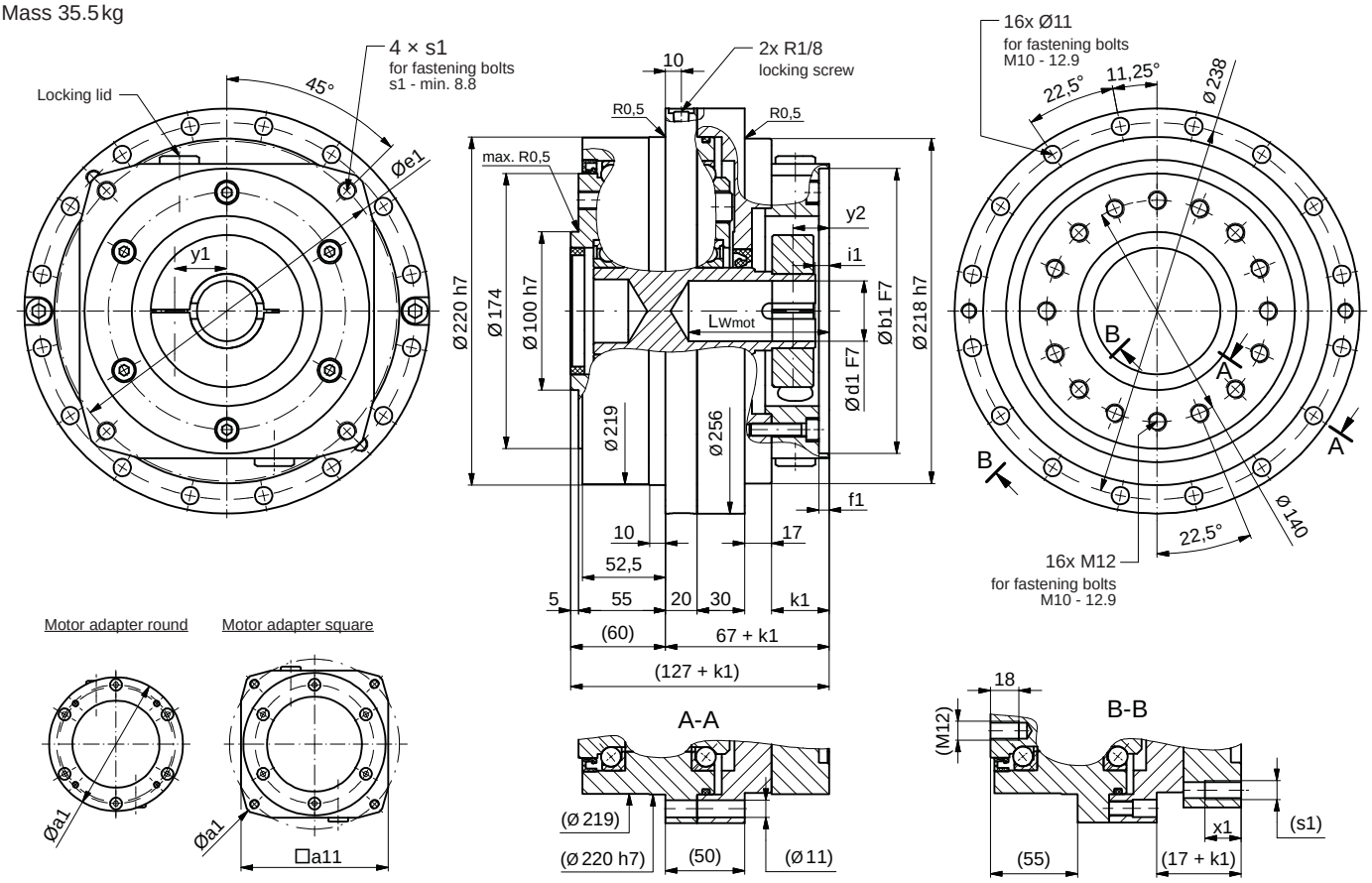
Motor connection dimensions F4CF-D35

Motor code	Hole for shaft	Min./Max. Length of motor shaft	Spigot F7	Spigot seat depth	Pitch circle Ø	Thread in gearbox flange	Thread depth	Flange diameter	Flange square dimension	Flange width	Shaft recess without bushing	Shaft recess with bushing	Positional dimensions locking lid	
	Ød1	$L_{w\,Mot\ min/max}$	Øb1	f1	Øe1	4x s1	x1	Øa1	□a11	k1	i1		y1	y2
							mm							
H35G	14	25.0 / 48.5	95	6	115	M8	17	138	120	30	8.5	-	18.5	18
H50G		25.0 / 48.5	110	6	130	M8	17	158	120	30	8.5	-	25	18
H60L		36.5 / 60.0	110	8	145	M8	17	158	120	41.5	20	-	25	29.5
J18G	16	30.0 / 73.0	70	6	90	M6	14	119	-	30.5	-	8	18.5	17
J30L		38.5 / 81.5	80	6	100	M6	14	119	-	39	-	16.5	18.5	25.5
J60G		29.5 / 72.5	110	6.5	145	M8	17	158	120	30	-	7.5	25	18
K60L	17	43.0 / 84.0	110	8	145	M8	17	158	120	41.5	-	19	25	29.5
M30G	19	29.5 / 72.5	80	6	100	M6	14	119	-	30	8.5	-	18.5	16.5
M30L		38.5 / 81.5	80	6	100	M6	14	119	-	39	8.5	-	18.5	25.5
M35G		29.5 / 72.5	95	6	115	M8	17	138	120	30	8.5	-	18.5	18
M45G		29.5 / 72.5	95	6	130	M8	17	158	120	30	8.5	-	25	18
M50G		29.5 / 72.5	110	6	130	M8	17	158	120	30	8.5	-	25	18
M60G		29.5 / 72.5	110	6.5	145	M8	17	158	120	30	8.5	-	25	18
M60L		43.0 / 84.0	110	8	145	M8	17	158	120	41.5	20	-	25	29.5
N60G	22	31.5 / 72.5	110	6.5	145	M8	17	158	120	30	-	7.5	25	18
Z35G	24	31.5 / 72.5	95	6	115	M8	17	138	120	30	8.5	-	18.5	18
Z50G		31.5 / 72.5	110	6	130	M8	17	158	120	30	8.5	-	25	18
Z70G		31.5 / 72.5	130	6	165	M10	20	188	144	30	8.5	-	25	18
Q60G	28	31.5 / 88.5	110	6.5	145	M8	17	158	120	30	-	7.5	25	18
Q60L		43.0 / 100.0	110	8	145	M8	17	158	120	41.5	-	19	25	29.5
Q70G		31.5 / 88.5	130	6	165	M10	20	188	144	30	-	7.5	25	18
R50G	30	31.5 / 88.5	110	6	130	M8	17	169	-	36	-	7.5	24	20.5
S70G	32	31.5 / 88.5	130	6	165	M10	20	188	144	30	8.5	-	25	18
T76G	35	37.0 / 94.0	114.3	6	200	M12	23	223	176	41.5	14	13	33	26.5

Note Other motor connection dimensions available on request.

F4CF-D45

Mass 35.5 kg



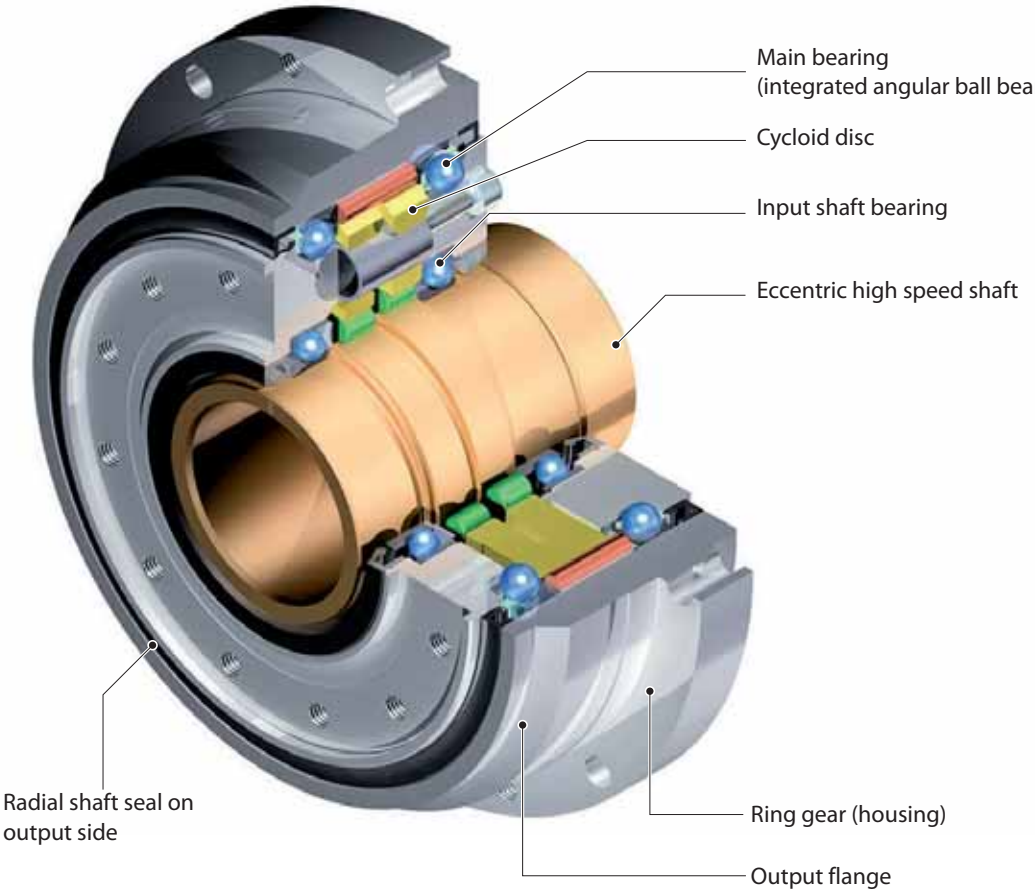
Motor connection dimensions F4CF-D45

Motor code	Hole for shaft	Min./Max. Length of motor shaft	Spigot F7	Spigot seat depth	Pitch circle Ø	Thread in gearbox flange	Thread depth	Flange diameter	Flange square dimension	Flange width	Shaft recess without bushing	Shaft recess with bushing	Positional dimensions locking lid	
	Ød1	$L_{w\,Mot\ min/max}$	Øb1	f1	Øe1	4x s1	x1	Øa1	□a11	k1	i1		y1	y2
							mm							
H35G	14	25.0 / 48.5	95	6	115	M8	17	138	120	30	8.5	-	18.5	18
H50G		25.0 / 48.5	110	6	130	M8	17	158	120	30	8.5	-	25	18
H60L		36.5 / 60.0	110	8	145	M8	17	158	120	41.5	20	-	25	29.5
J18G	16	30.0 / 73.0	70	6	90	M6	14	119	-	30.5	-	8	18.5	17
J30L		38.5 / 81.5	80	6	100	M6	14	119	-	39	-	16.5	18.5	25.5
J60G		29.5 / 72.5	110	6.5	145	M8	17	158	120	30	-	7.5	25	18
K60L	17	43.0 / 84.0	110	8	145	M8	17	158	120	41.5	-	19	25	29.5
M30G	19	29.5 / 72.5	80	6	100	M6	14	119	-	30	8.5	-	18.5	16.5
M30L		38.5 / 81.5	80	6	100	M6	14	119	-	39	8.5	-	18.5	25.5
M35G		29.5 / 72.5	95	6	115	M8	17	138	120	30	8.5	-	18.5	18
M45G		29.5 / 72.5	95	6	130	M8	17	158	120	30	8.5	-	25	18
M50G		29.5 / 72.5	110	6	130	M8	17	158	120	30	8.5	-	25	18
M60G		29.5 / 72.5	110	6.5	145	M8	17	158	120	30	8.5	-	25	18
M60L		43.0 / 84.0	110	8	145	M8	17	158	120	41.5	20	-	25	29.5
N60G	22	31.5 / 72.5	110	6.5	145	M8	17	158	120	30	-	7.5	25	18
Z35G	24	31.5 / 72.5	95	6	115	M8	17	138	120	30	8.5	-	18.5	18
Z50G		31.5 / 72.5	110	6	130	M8	17	158	120	30	8.5	-	25	18
Z70G		31.5 / 72.5	130	6	165	M10	20	188	144	30	8.5	-	25	18
Q60G	28	31.5 / 88.5	110	6.5	145	M8	17	158	120	30	-	7.5	25	18
Q60L		43.0 / 100.0	110	8	145	M8	17	158	120	41.5	-	19	25	29.5
Q70G		31.5 / 88.5	130	6	165	M10	20	188	144	30	-	7.5	25	18
R50G	30	31.5 / 88.5	110	6	130	M8	17	169	-	36	-	7.5	24	20.5
S70G	32	31.5 / 88.5	130	6	165	M10	20	188	144	30	8.5	-	25	18
T76G	35	37.0 / 94.0	114.3	6	200	M12	23	223	176	41.5	14	13	33	26.5
U80G	38	32.0 / 89.0	180	6.5	215	M12	23	237	168	36.5	9	-	30	21.5

Note Other motor connection dimensions available on request.

7 C-Series

F4C(F)-C
F2CF-C



Special feature:

The large diameter of the hollow shaft allows for effective use of space for cables or pipelines

- 5 sizes
- Reduction ratios (single stage) 59/89/119
- Nominal output torques up to 4328 Nm
- Acceleration torques up to 6278 Nm
- Hollow shaft diameter from 49 to 99 mm
- Completely sealed and maintenance-free
- Lost Motion < 1

7.1 Torques according to output speeds

Output speed n_{2m} [min^{-1}]			5			10			15			20		
Model	Size	Reduction ratio i	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]
F4C-	C25	59	568	295	0.40	568	590	0.79	505	885	1.06	464	1180	1.29
		89	568	445	0.40	505	890	0.70	447	1335	0.94	410	1780	1.14
		119	568	595	0.40	463	1190	0.65	410	1785	0.86	376	2380	1.05
F4CF-	C35	59	1082	295	0.76	1082	590	1.51	963	885	2.02	883	1180	2.47
		89	1082	445	0.76	961	890	1.34	851	1335	1.78	781	1780	2.18
		119	1082	595	0.76	881	1190	1.23	780	1785	1.63	716	2380	2.00
F2CF-	C45	59	1758	295	1.23	1758	590	2.45	1565	885	3.28	1435	1180	4.01
		89	1758	445	1.23	1562	890	2.18	1383	1335	2.90	1269	1780	3.54
		119	1758	595	1.23	1432	1190	2.00	1268	1785	2.65			
	C55	59	2705	295	1.89	2705	590	3.78	2407	885	5.04	2208	1180	6.17
		89	2705	445	1.89	2403	890	3.36	2128	1335	4.46			
		119	2705	595	1.89	2203	1190	3.08						
	C65	59	4328	295	3.02	4328	590	6.04	3852	885	8.07	3533	1180	9.87
		89	4328	445	3.02	3845	890	5.37	3405	1335	7.13			
		119	4328	595	3.02	3524	1190	4.92						

Table C-1 **Rating values (reference value output speed n_{2m})**

25			30			Max. permissible input speed $n_{1\,max}$ short term [min^{-1}]	Max. permissible input speed $n_{1\,ED}$ [min^{-1}]		Moment of inertia j related to the input shaft [$\times 10^{-4}$ kgm^2]	Mass [kg]
Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]		50% ED	100% ED		
434	1475	1.51	411	1770	1.72				8.3	
383	2225	1.34	363	2670	1.52	3500	2900	1450	8.2	12.5
									8.2	
826	1475	2.88	782	1770	3.28				32.8	
						2500	2100	1050	32.7	21
									32.7	
1342	1475	4.69	1271	1770	5.32				69.6	
						2100	1800	900	69.4	32
									69.3	
2065	1475	7.21							129.4	
						1800	1500	750	129.0	45
									128.8	
									223.6	
						1700	1400	700	222.9	62
									222.6	

: 50% ED range : 100% ED range

1. T_{2N} = nominal output torque
   Nominal output torque corresponds to the max. permissible average load torque at all output speeds.
   The nominal output torque for speeds less than 5 min^{-1} is equal to the value at 5 min^{-1}.
   The value for the maximum permissible input power is calculated from the nominal output torque at 100%.
   This value takes the efficiency of Fine Cyclo into consideration.
2. n_{1max} = maximum permissible input speed
   However, it must be n_{1m} (mean input speed) < $n_{1\,ED}$.
3. $n_{1\,ED}$ = permissible input speed according to load duty cycles
4. T_{2A} = max. Acceleration and braking torque (for fatigue strength at $2 \cdot 10^7$ load cycles)
   Permissible peak torque for normal start and stop procedures.
5. T_{2max} = max. permissible torque for emergency stop situations or in the event of heavy shocks (limited by the mechanical strength) (permissible 1000 times during the entire lifetime).
6. The nominal torque T_{2N} is calculated using the following equation when the speed is not shown in the table above:

$$T_{2N} = T_{2N,\,5} \left(\frac{5}{n_{2m}} \right)^{0,3}$$

T_{2N} : Nominal torque at output speed n_{2m}
$T_{2N,\,5}$: Nominal torque at output speed n_{2m} is 5 min^{-1}

7.2 Torques according to input speeds

Input speed n_{1m} [min^{-1}]			2500			2000			1750			1500		
Model	Size	Reduction ratio i	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]
F4C-	C25	59	370	42.4	2.19	396	33.9	1.87	412	29.7	1.7	432	25.4	1.53
		89	370	28.1	1.45	396	22.5	1.24	412	19.7	1.13	432	16.9	1.01
		119	370	21	1.08	396	16.8	0.93	412	14.7	0.84	432	12.6	0.76
F4CF-	C35	59				754	33.9	3.56	785	29.7	3.24	822	25.4	2.91
		89				754	22.5	2.36	785	19.7	2.15	822	16.9	1.93
		119				754	16.8	1.77	785	14.7	1.61	822	12.6	1.44
F2CF-	C45	59							1275	29.7	5.27	1336	25.4	4.73
		89							1275	19.7	3.5	1336	16.9	3.14
		119							1275	14.7	2.61	1336	12.6	2.35
	C55	59										2055	25.4	7.28
		89										2055	16.9	4.83
		119										2055	12.6	3.61
	C65	59												
		89												
		119												

Table C-2 Rating values (reference value input speed n_{1m})

Size	Max. acceleration and deceleration torque T_{2A}	Peak torque for emergency stop T_{2max}
	[Nm]	[Nm]
C25	1030	2060
C35	1962	3924
C45	3188	6377
C55	4316	8633
C65	6278	12577

Table C-3 Maximum acceleration or deceleration torque

1000			750			600			Max. permissible input speed $n_{1\ max}$ short term [min^{-1}]	Max. permissible input speed $n_{1\ ED}$ [min^{-1}]		Moment of inertia j related to the input shaft [$\times 10^{-4}$ kgm^2]	Mass [kg]
Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]		50% ED	100% ED		
487	16.9	1.15	531	12.7	0.94	568	10.2	0.81				8.3	
487	11.2	0.76	531	8.4	0.62	568	6.7	0.53	3500	2900	1450	8.2	12.5
487	8.4	0.57	531	6.3	0.47	568	5	0.4				8.2	
928	16.9	2.19	1012	12.7	1.79	1082	10.2	1.53				32.8	
928	11.2	1.45	1012	8.4	1.19	1082	6.7	1.02	2500	2100	1050	32.7	21
928	8.4	1.09	1012	6.3	0.89	1082	5	0.76				32.7	
1508	16.9	3.56	1644	12.7	2.91	1758	10.2	2.49				69.6	
1508	11.2	2.36	1644	8.4	1.93	1758	6.7	1.65	2100	1800	900	69.4	32
1508	8.4	1.77	1644	6.3	1.44	1758	5	1.24				69.3	
2321	16.9	5.48	2530	12.7	4.48	2705	10.2	3.83				129.4	
2321	11.2	3.63	2530	8.4	2.97	2705	6.7	2.54	1800	1500	750	129.0	45
2321	8.4	2.72	2530	6.3	2.22	2705	5	1.9				128.8	
3713	16.9	8.77	4048	12.7	7.17	4328	10.2	6.14				223.6	
3713	11.2	5.82	4048	8.4	4.75	4328	6.7	4.07	1700	1400	700	222.9	62
3713	8.4	4.35	4048	6.3	3.56	4328	5	3.04				222.6	

: 50% ED range : 100% ED range

1. T_{2N} = nominal output torque
   Nominal output torque corresponds to the max. permissible average load torque at all input speeds.
   The nominal output torque for speeds less than 600 min^{-1} is equal to the value at 600 min^{-1}.
   The value for the maximum permissible input power is calculated from the nominal output torque at 100%.
   This value takes the efficiency of Fine Cyclo into consideration.
2. n_{1max} = maximum permissible input speed
   However, it must be n_{1m} (mean input speed) < $n_{1\ ED}$.
3. $n_{1\ ED}$ = permissible input speed according to load duty cycles
4. T_{2A} = max. Acceleration and braking torque (for fatigue strength at $2 \cdot 10^7$ load cycles)
   Permissible peak torque for normal start and stop procedures.
5. T_{2max} = max. permissible torque for emergency stop situations or in the event of heavy shocks (limited by the mechanical strength) (permissible 1000 times during the entire lifetime).
6. The nominal torque T_{2N} is calculated using the following equation when the speed is not shown in the table above:

$$T_{2N} = T_{2N,\,600} \left(\frac{600}{n_{1m}} \right)^{0,3}$$

T_{2N} : Rated torque at input speed n_{1m}
$T_{2N,\,600}$: Rated torque at input speed n_{1m} is 600 min^{-1}

7.3 Rigidity and Lost Motion

Size	i	Test torque T_p [Nm]	Lost Motion		Torsional stiffness 3% - 50% T_p [Nm/arcmin]	Torsional stiffness 3% - 100% T_p [Nm/arcmin]	Torsional stiffness 50% - 100% T_p [Nm/arcmin]
			Lost Motion [arcmin]	Domain of definition [Nm]			
C25	59	±412	< 1	±12.4	71	115	128
	89						
	119						
C35	59	±785		±23.5	200	259	294
	89						
	119						
C45	59	±1275		±38.3	353	404	491
	89						
	119						
C55	59	±1962		±58.9	588	635	687
	89						
	119						
C65	59	±3139		±94.2	765	918	1030
	89						
	119						

Table C-4 Torsional stiffness
T_p: Test torque at input speed $n_1 = 1750\ min^{-1}$

1) At a load torque less than 3% T_p

$$\varphi = \frac{\text{Lost Motion}}{2} \cdot \frac{\text{Load torque}}{0.03 \cdot T_p}$$

2) At a load torque greater than 3% T_p (standard case)

$$\varphi = \frac{\text{Lost Motion}}{2} + \frac{\text{Load torque} - (0.03 \cdot T_p)}{\text{Torsional stiffness}}$$

Note arcmin means "angular minute".
Table values for rigidity are average values

7.4 No-load running torque NLRT

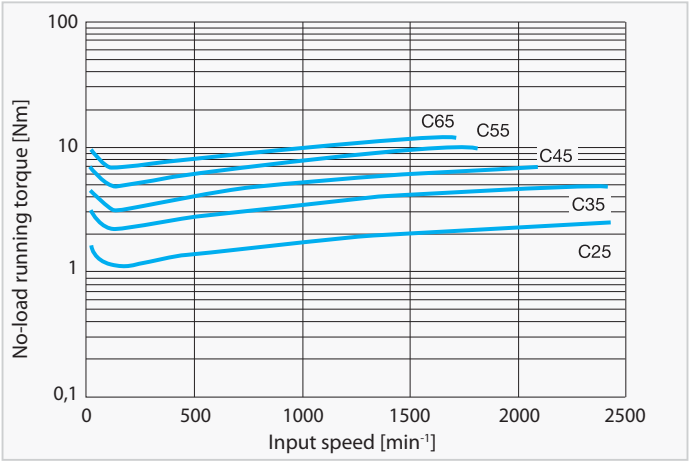


Fig. C-1 Input side no-load running torque

Note

1. Fig. C-1 shows the average no-load running torque after gearbox is run in (not factory-new condition).
2. Table C-5 shows the measuring conditions.

Ring gear housing temperature	approx. 30 °C
Precision during assembly	as per 7.8.1
Lubrication	Standard lubrication

Table C-5 Measurement conditions

7.5 Breakaway torque

Indicates the necessary torque for breakaway of the gearbox on the input or output side, after stop without output side load.

Breakaway torque on output side (BTO)

Note

1. Table C-7 shows the max. breakaway torque on the output side BTO. Fine Cyclo reducers are not self-locking. The BTO is defined as the maximum value (factory-new condition), which steadily decreases during the lifetime.
2. Table C-6 shows the measuring conditions

Precision during assembly	as per 7.8.1
Lubrication	Standard lubrication

Table C-6 Measurement conditions

Size	i	Breakaway torque BTO [Nm]
C25	59	< 200
	89	< 220
	119	< 240
C35	59	< 300
	89	< 415
	119	< 550
C45	59	< 340
	89	< 550
	119	< 715
C55	59	< 600
	89	< 810
	119	< 1000
C65	59	< 700
	89	< 1000
	119	< 2100

Table C-7 Value of the breakaway torque on the output side (BTO)

Breakaway torque on input side (BTI)

Note

1. Table C-8 shows the max. breakaway torque BTI on the input side. The BTI is defined as the maximum value (factory-new condition) which steadily decreases during the lifetime.
2. Table C-6 shows the measuring conditions

Size	i	Breakaway torque BTI [Nm]
C25	59	< 3.5
	89	
	119	
C35	59	< 4.5
	89	
	119	
C45	59	< 6.5
	89	
	119	
C55	59	< 9.0
	89	
	119	
C65	59	< 11.5
	89	
	119	

Table C-8 Value of the breakaway torque on the input side (BTI)

7.6 Efficiency

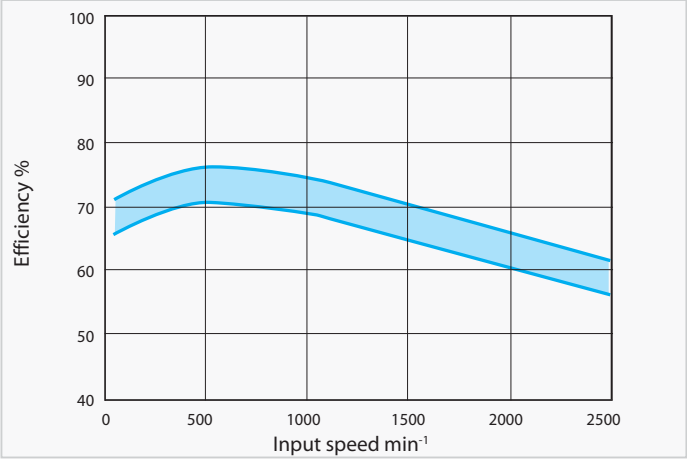


Fig. C-2 a Efficiency curve (size C25-C45)

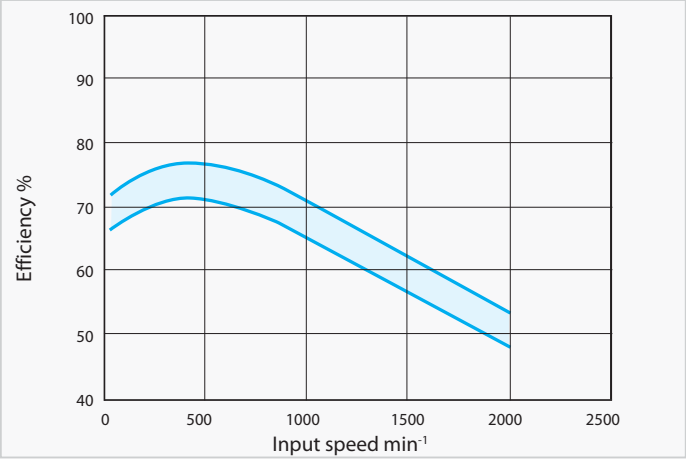


Fig. C-2b Efficiency curve (size C55-C65)

Fig. C-2a and Fig. C-2b show the relation between efficiency and input speed Further information see "4 Explaining the technical details" on page 18.

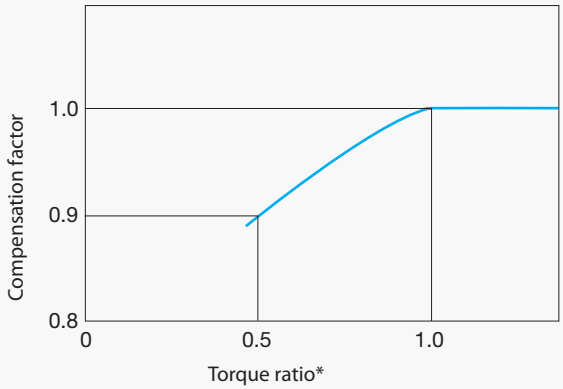


Fig. C-3 Compensation curve for efficiency

*** Torque ratio = Load torque / Nominal output torque**

Compensation efficiency = efficiency · compensation factor

Note

1. The efficiency changes if the load torque does not match the nominal torque. Check the compensation factor in the diagram Fig. C-3
2. When the torque ratio is over 1.0, the compensation factor for efficiency is 1.0 (Diagram Fig. C-3).

7.7 Bearing loads

7.7.1 Maximum permissible radial and axial load on the input shaft

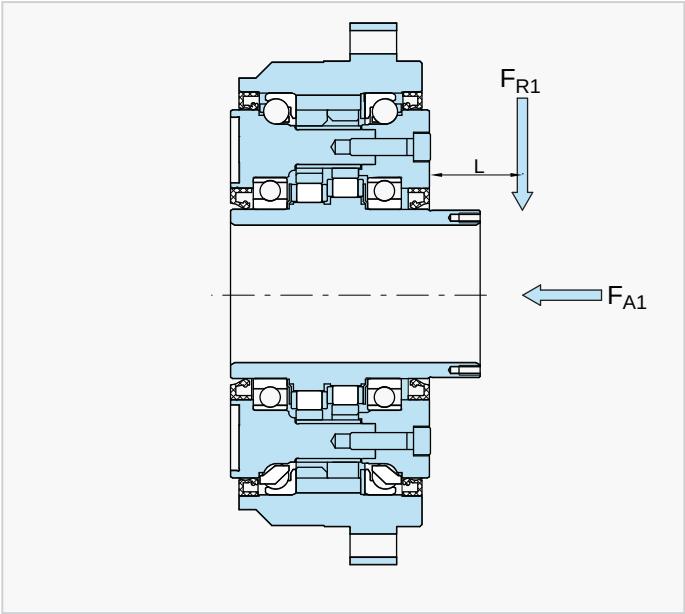


Fig. C-4 Load position on input shaft

L [mm]	Load factor input L_{f1} Size C25	C35	C45	C55	C65
5	0.8	0.76	0.75	0.73	0.73
10	0.86	0.81	0.79	0.77	0.77
15	0.92	0.86	0.83	0.8	0.8
20	0.98	0.9	0.87	0.84	0.84
25	1.14	0.95	0.91	0.88	0.87
30	1.36	1	0.95	0.91	0.9
35	1.59	1.17	0.99	0.95	0.94
40	1.82	1.33	1.11	0.99	0.97
45	2.05	1.5	1.25	1.07	1.02
50		1.67	1.39	1.19	1.14
60		2	1.67	1.43	1.36
70			1.94	1.67	1.59
80				1.9	1.82

Table C-9 Load factor input L_{f1}
L = distance from input side carrier

If a pinion or toothed belt pulley is mounted on the input shaft, the values for radial load and axial load should be equal to or less than the permissible values. The following equation is used to check whether the shaft load is permissible:

1. Input radial load F_{R1}

$$F_{R1} = 10^3 \cdot \frac{T_{2V}}{\eta \cdot i \cdot r_0} \leq \frac{F_{R1\,max}}{L_{f1} \cdot C_{f1} \cdot B_{f1}} \quad [N] \qquad \text{(Equation C-1)}$$

2. Input side axial load F_{A1}

$$F_{A1} \leq \frac{F_{A1\,max}}{C_{f1} \cdot B_{f1}} [N] \qquad \text{(Equation C-2)}$$

3. When radial and axial loads co-exist

$$\left(\frac{F_{R1} \cdot L_{f1}}{F_{R1\,max}} + \frac{F_{A1}}{F_{A1\,max}} \right) \cdot C_{f1} \cdot B_{f1} \leq 1 \qquad \text{(Equation C-3)}$$

F_{R1} = input side radial load [N]
T_{2V} = equivalent output torque on output shaft [Nm]
r_0 = pitch circle radius of sprocket, pinion, or toothed belt pulley [mm]
$F_{R1\,max}$ = maximum permissible input side radial load [N] (Table C-10)
F_{A1} = input side axial load [N]
$F_{A1\,max}$ = maximum permissible input side axial load [N] (Table C-11)
L_{f1} = load factor input (Table C-8)
C_{f1} = correction factor input (Table C-12)
B_{f1} = service factor input (Table C-13)
L = distance of the radial load from the input side carrier (Table C-9)
η = 0.7 (efficiency)

Size	Input speed n_{1m} [min^{-1}]						
	2500	2000	1750	1500	1000	750	600
C25		563	589	620	709	781	841
C35			687	723	828	911	981
C45			785	826	946	1041	1121
C55				981	1123	1236	1332
C65					1419	1561	1682

Table C-10 Max. permissible input side radial load $F_{R1\,max}$ [N]

Size	Input speed n_{1m} [min^{-1}]						
	2500	2000	1750	1500	1000	750	600
C25	540	589	628	677	824	942	1040
C35		746	795	863	1040	1197	1334
C45			912	981	1197	1373	1530
C55				1481	1785	2050	2276
C65					2570	2953	3286

Table C-11 Max. permissible input side axial load $F_{A1\,max}$ [N]

Calculation of the max. permissible radial load on the input shaft

Calculation of the max. permissible radial load using the following equation when the speed is not shown in the table above.

$$F_{R1\,max} = F_{R1,600} \left(\frac{600}{n_{1m}} \right)^{1/3}$$

$F_{R1\,max}$ = maximum permissible input side radial load at input speed n_{1m}

$F_{R1,600}$ = input side radial load at input speed $n_{1m} = 600\ min^{-1}$

Calculation of the max. permissible axial load on the input shaft

Calculation of the max. permissible axial load using the following equation when the speed is not shown in the table above.

$$F_{A1\,max} = F_{A1,600} \left(\frac{600}{n_{1m}} \right)^{0,47}$$

$F_{A1\,max}$ = maximum permissible input side axial load at input speed n_{1m}

$F_{A1,600}$ = input side axial load at input speed $n_{1m} = 600\ min^{-1}$

Correction factor input	C_{f1}
Chain	1
Pinion*	1.25
Toothed belt	1.25
V-Belt	1.5

Table C-12 Correction factor input C_{f1}

* For helical pinions or bevel gears, please consult Sumitomo Drive Technologies.

Service factor input	B_{f1}
Uniform load	1
Light impacts	1.2
Severe impacts	1.6

Table C-13 Service factor input B_{f1}

7.7.2 Main bearings

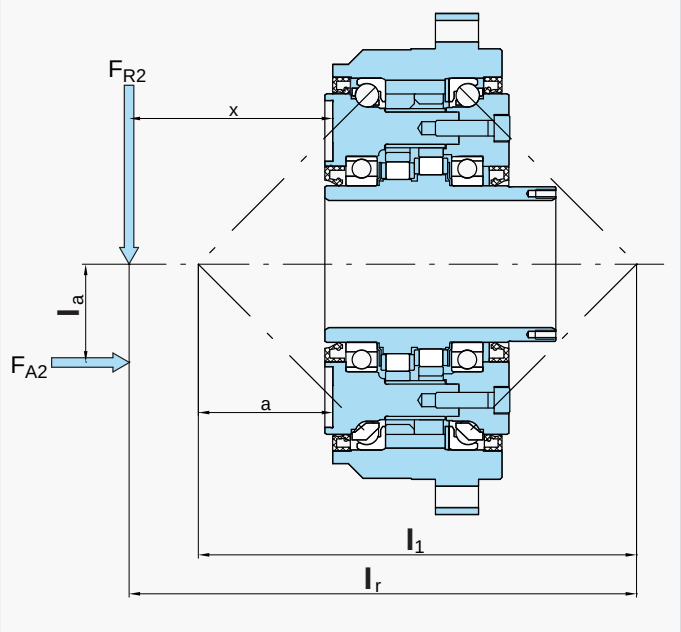


Fig. C-5 Distance between the individual loading points

$$l_r = x - a + l_1 \quad \text{(Equation C-4)}$$

1. Moment stiffness

   The moment stiffness is the bending moment at which the output flange is tilted by the tilt angle.

   The tilt angle of the input flange is determined as follows:

$$\varphi_1 = \frac{T_k}{\Theta_1} \quad \text{(Equation C-5)}$$

External bending moment T_k

$$T_k = 10^{-3} \cdot (F_{R2} \cdot l_r + F_{A2} \cdot l_a) \quad \text{(Equation C-6)}$$

2. Max. permissible bending moment and max. permissible axial load

   Check the external bending moment and the external axial load using equations C-6, C-7, and C-8.

Equivalent bending moment T_{ke}

$$T_{ke} = 10^{-3} \cdot (C_{f2} \cdot B_{f2} \cdot F_{R2} \cdot l_r + C_{f2} \cdot B_{f2} \cdot F_{A2} \cdot l_a) \quad < T_{k\,max} \quad \text{(Equation C-7)}$$

Equivalent axial load F_{A2e} at the output shaft

$$F_{A2e} = F_{A2} \cdot C_{f2} \cdot B_{f2} \quad < F_{A2\,max} \quad \text{(Equation C-8)}$$

Size	Values of internal bearing distance	
	l_1 [mm]	a [mm]
C25	162	43.3
C35	196.2	54.9
C45	158.8	30.9
C55	191.8	41.9
C65	211.8	46.4

Table C-14 Bearing clearances

Note If: $l_r > 4 \cdot l_1$, please contact Sumitomo Drive Technologies.

F_{A2} = output side axial load [N]
$F_{A2\,max}$ = maximum permissible output side axial load [N]
F_{A2e} = equivalent output side axial load [N]
F_{R2} = output side radial load [N]
C_{f2} = correction factor output (Table C-16)
B_{f2} = service factor output (Table C-17)
l_1 = bearing clearance [mm] (Table C-14)
l_r = calculated dimension for bending moment [mm]
l_a = distance of axial load [mm]
x = distance from radial force to flange collar [mm]
a = correction factor [mm] (Table C-14)
T_k = external bending moment [Nm]
$T_{k\,max}$ = max. permissible bending moment [Nm] (Table C-18)
T_{ke} = equivalent bending moment [Nm]
φ_1 = tilt angle [arcmin]
Θ_1 = moment stiffness main bearing [Nm/arcmin] (Table C-15)

Size	Moment stiffness Θ_1
	[Nm/arcmin]
C25	1150
C35	2400
C45	2649
C55	3924
C65	5690

Table C-15 Average values for moment stiffness

Correction factor output	C_{f2}
Chain	1
Pinion or rack	1.25
Toothed belt	1.25
V-Belt	1.5

Table C-16 Correction factor output C_{f2}

Service factor output	B_{f2}
Uniform load (no shock)	1
Light impacts	1.2
Severe impacts	1.6

Table C-17 Service factor output B_{f2}

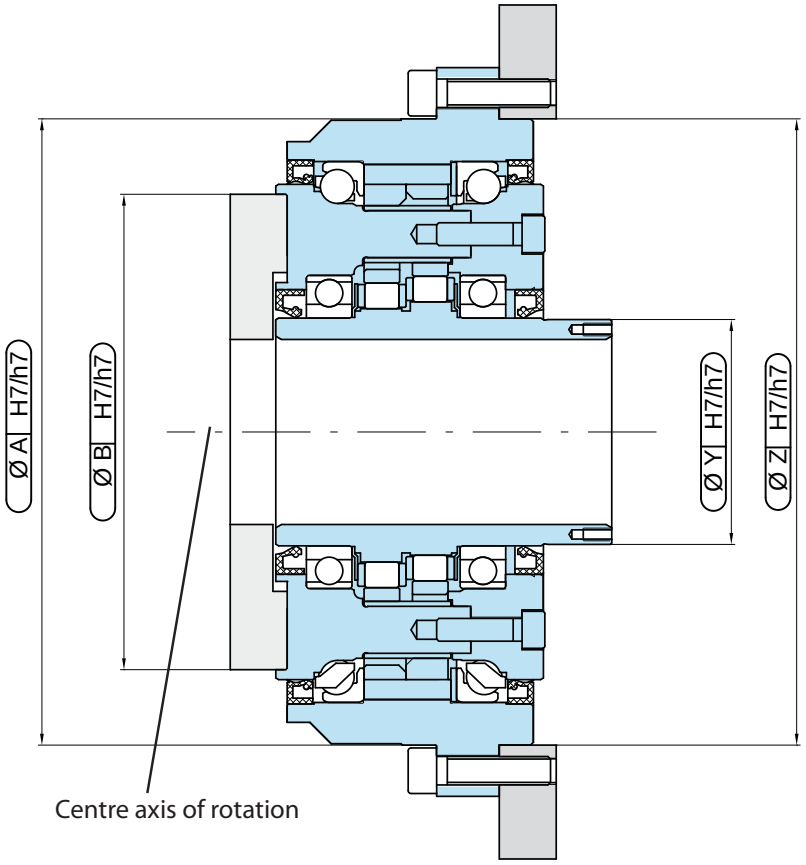
Size	Max. permissible bending moment $T_{k\,max}$	Max. permissible axial load $F_{A2\,max}$
	[Nm]	[N]
C25	1850	7848
C35	2850	10791
C45	3924	8339
C55	6082	10791
C65	8829	13734

Table C-18 Max. permissible bending moment and max. permissible axial load

7.8 Assembly specifications and tolerances

7.8.1 Assembly tolerances

Fittings for assembly of input and output parts (toothed belt, disc, pinion, etc.) are shown schematically in the following figure. Use the diameters and tolerances shown in the table below.

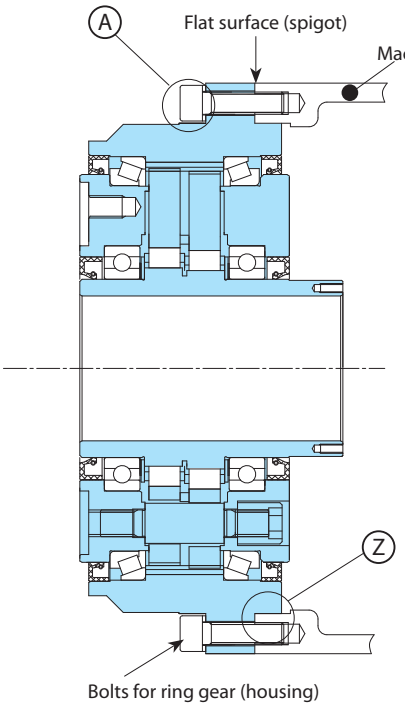


Size	Ø A	Ø B	Ø Y	Ø Z
C25	185	133	185	59
C35	220	167	220	79
C45	250	192	250	94
C55	284	218	284	109
C65	320	245	320	119

Table C-19 (Dimensions in mm)

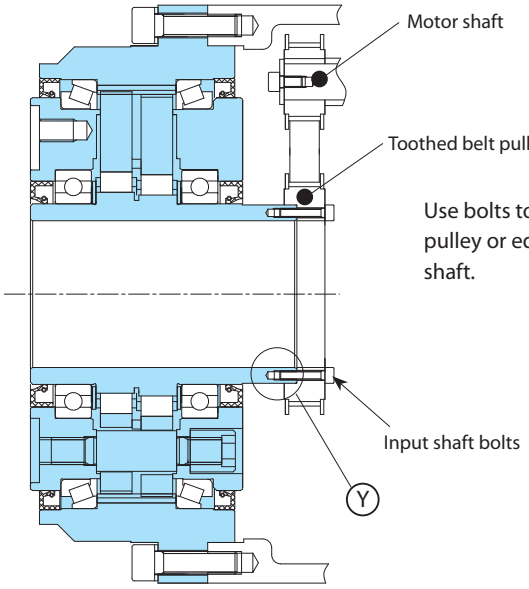
7.8.2 Assembly procedure

(1)



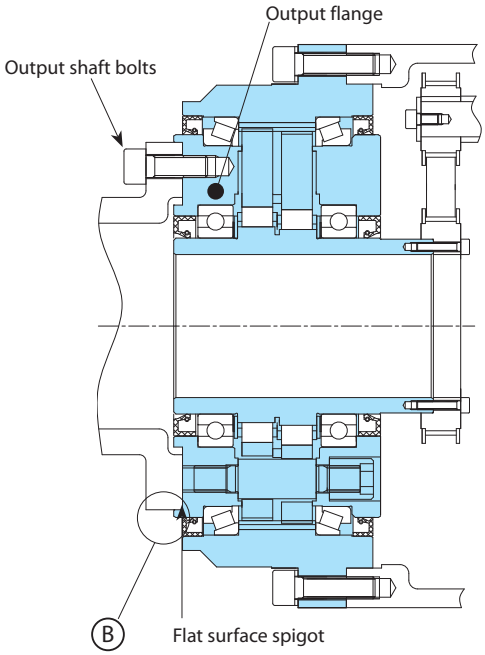
The Fine Cyclo C-Series is attached to the machine casing by bolts. (spigot Z)
The opposite side (spigot A) can also be used for attachment to a machine housing when installed into the machine.

(2)



Use bolts to attach the toothed belt pulley or equivalent parts to the input shaft.

(3)



Use bolts to attach output flange of Fine Cyclo to output shaft of machine.
(spigot B)

Note!
1. Make sure that you use the correct tightening torque for all fastening bolts when attaching the gearbox (see. Table C-20).
2. Use bolts that are shorter than the depth of the threaded holes in the dimensioned drawing of the output flange.

7.8.3 Tightening torque and maximum permissible transmitted torque for bolts

The permissible transmitted torque for bolts and the number, size, and tightening torque for fastening the output side flange and the ring gear housing are listed in Table C-20. In the event of an emergency stop with corresponding load peaks, the output flange and ring gear housing bolts must all be replaced.

Size	Output flange bolts			Bolts for ring gear (housing)		
	Number and size of bolts	Tightening torque [Nm]	Max. permissible transmitted torque for bolts [Nm]	Number and size of bolts	Tightening torque [Nm]	Max. permissible transmitted torque for bolts [Nm]
C25	12 × M8	33.4	2080	12 × M8	33.4	3178
C35	12 × M10	65.7	4267	8 × M10	65.7	4670
C45	12 × M12	114	7191	8 × M12	114	7760
C55	12 × M14	181	10919	12 × M12	114	13008
C65	12 × M16	284	16893	16 × M12	114	19404

Size	Eccentric high speed shaft		
	Number and size of bolts	Tightening torque [Nm]	Max. permissible transmitted torque for bolts [Nm]
C25	6 × M3	17	69
C35	6 × M4	40	157
C45	6 × M4	40	196
C55	8 × M5	82	481
C65	12 × M5	82	785

Table C-20

- **Bolting:** Use metric hexagon socket head cap screws (DIN 4762, strength category 10.9).
- **Countermeasure for bolts loosening:** Use adhesives (Loctite 262, etc.) or spring washer (DIN 127A).
- **Use conical spring washers** (DIN 6796) when connecting the gearbox to the flange side, so that the bolt contact faces do not get damaged.

7.8.4 Lubrication

- The gearboxes of the Fine Cyclo C-Series are filled with grease before delivery and are ready to use.
- Inspection and overhaul recommended after 20,000 operating hours or 3-5 years.
- An overhaul requires experience and specialised knowledge and may only be performed by authorized specialised staff. The lifespan of the gearbox can be increased by returning it to the factory for overhauling and regreasing.

Grease prescribed	Manufacturer
Multemp FZ No. 00	Kyodo Yushi Co., Ltd.
Conditions for use: Environmental temperature -10 °C to +40 °C	

Table C-21 Specified grease for the C-Series

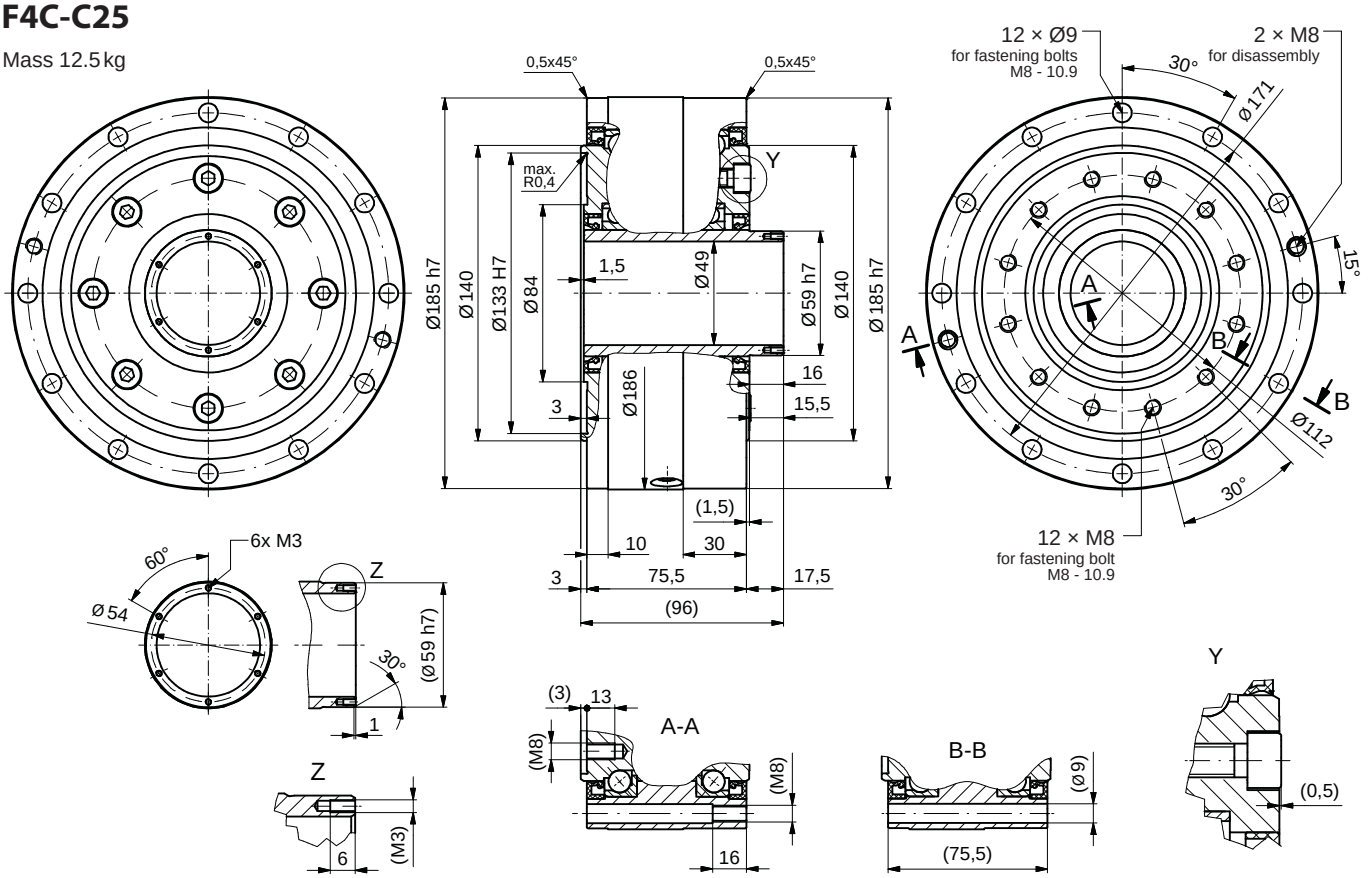
Size	Quantity of grease [g]
C25	75
C35	110
C45	140
C55	200
C65	300

Table C-22 Lubrication

7.9 Dimensioned drawings

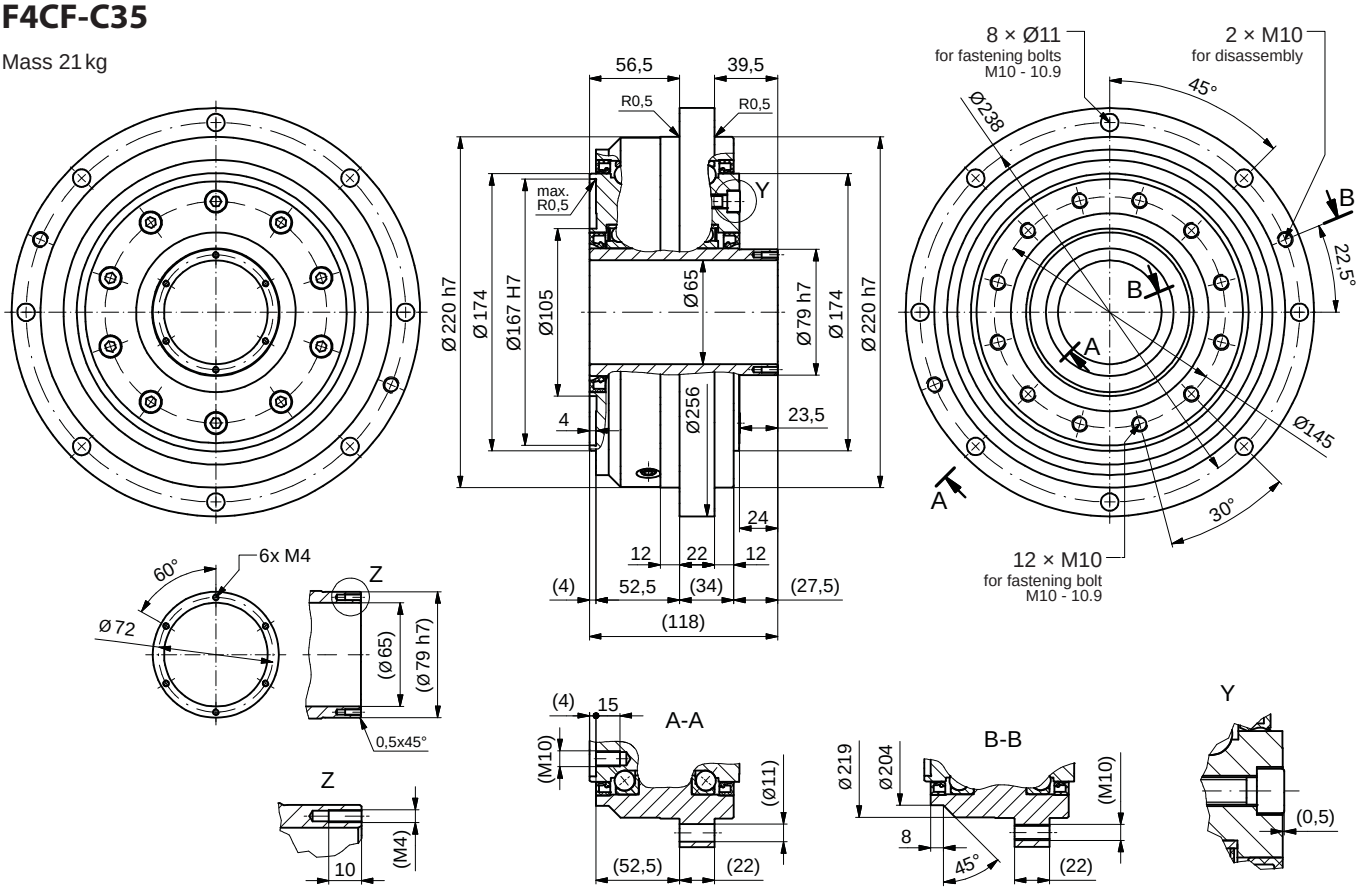
F4C-C25

Mass 12.5 kg



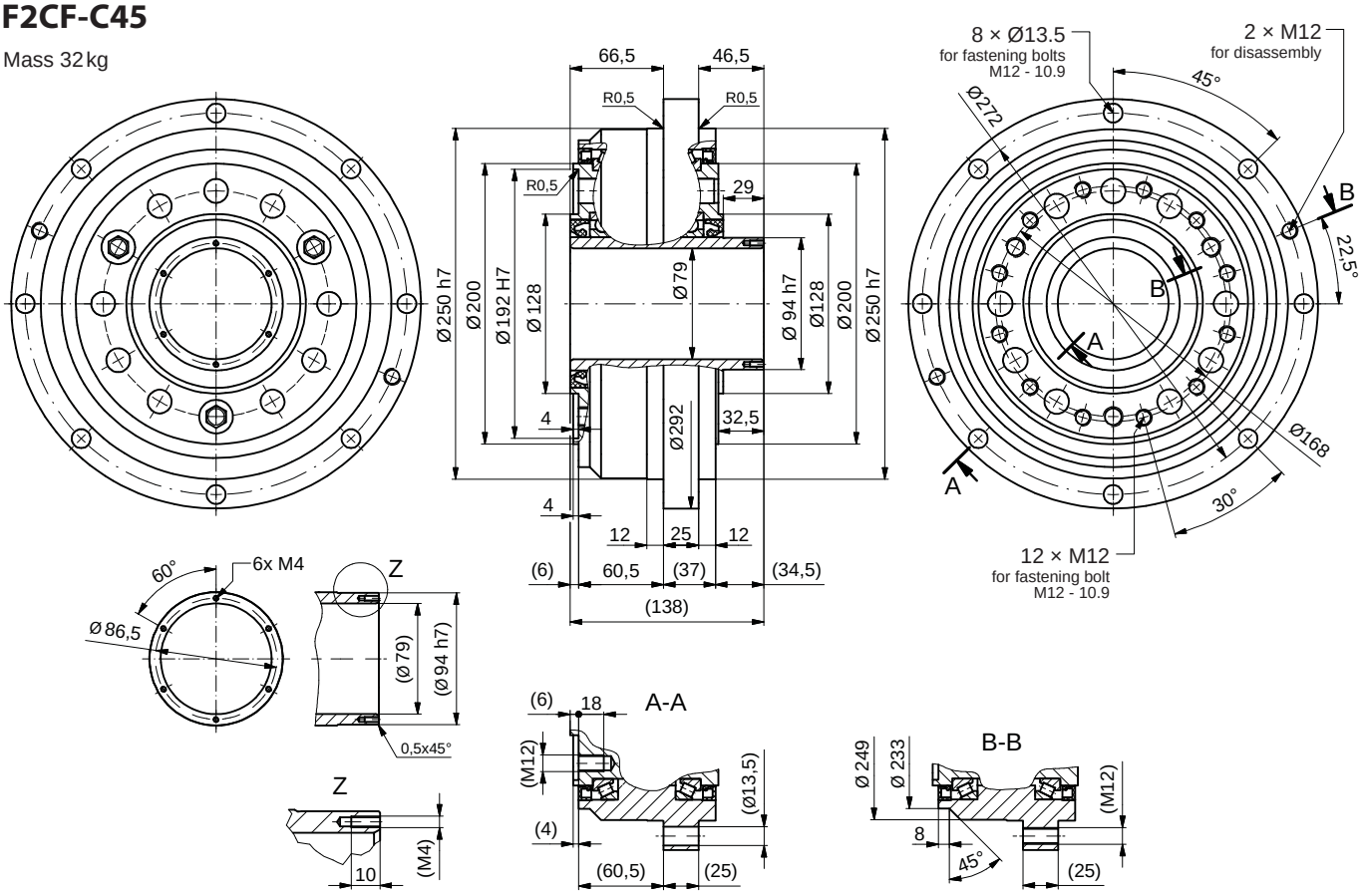
F4CF-C35

Mass 21 kg



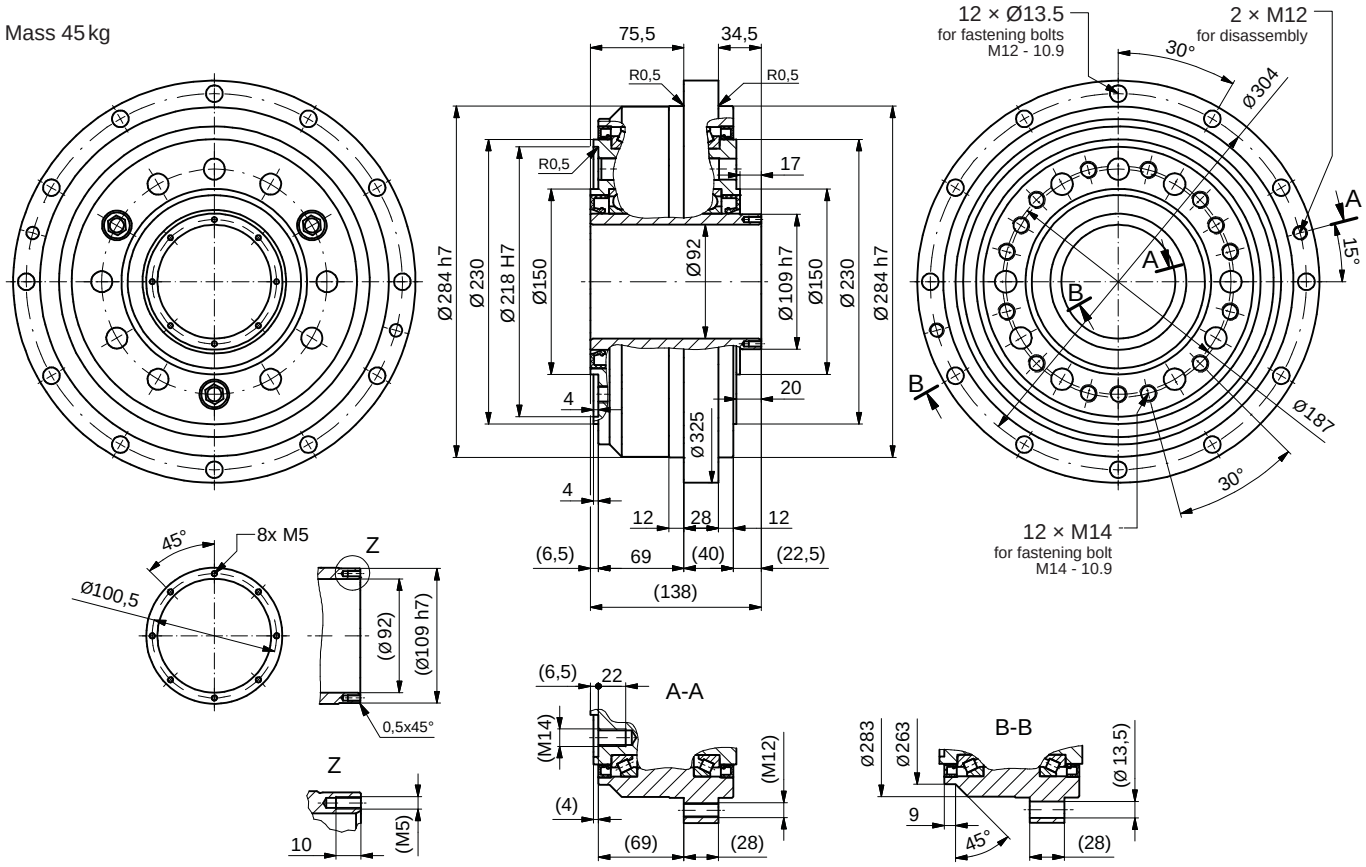
F2CF-C45

Mass 32 kg



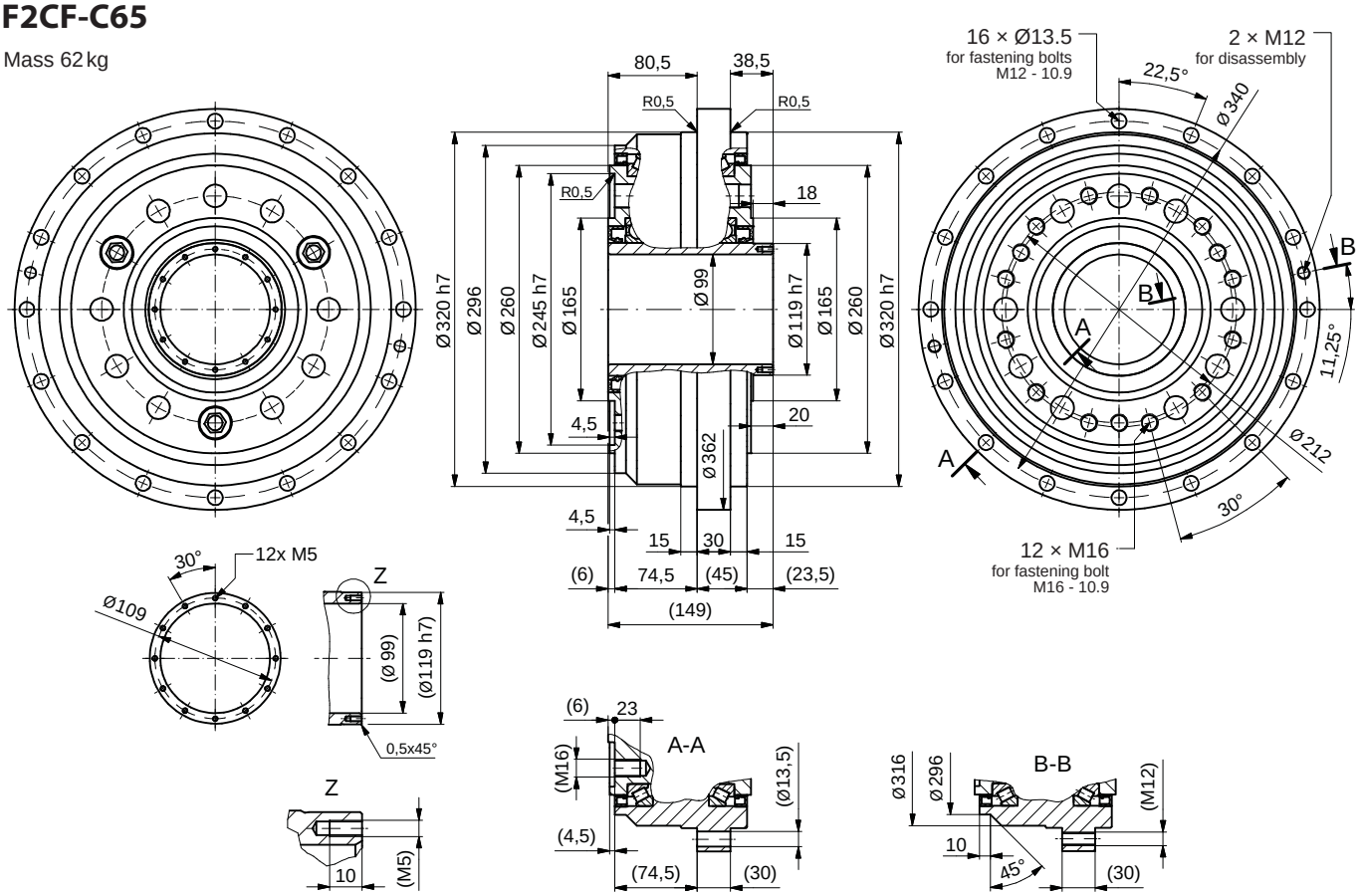
F2CF-C55

Mass 45 kg



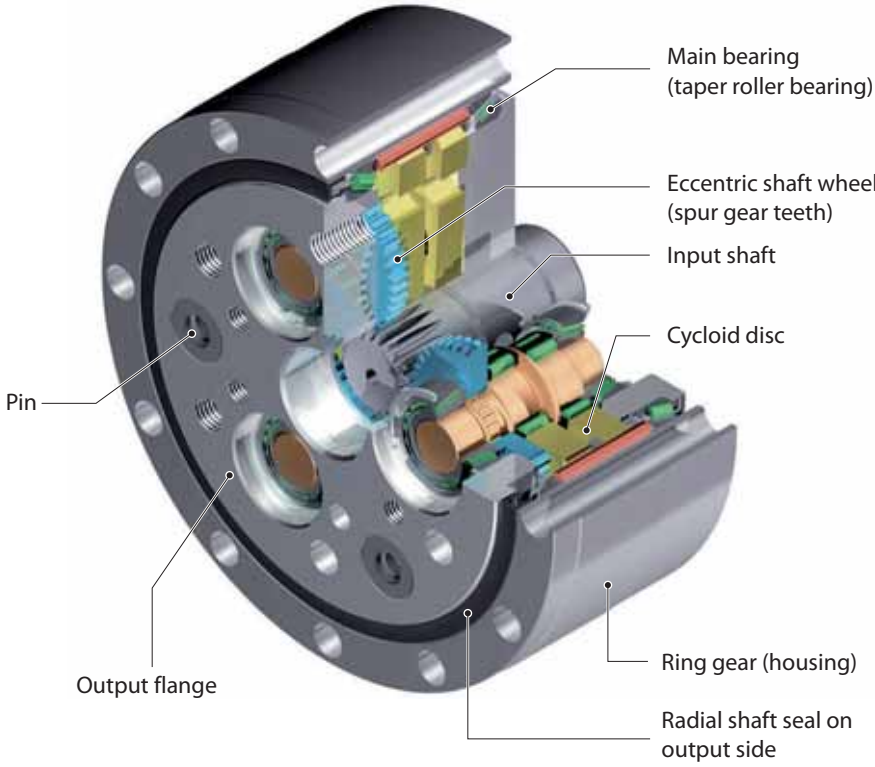
F2CF-C65

Mass 62 kg



8 T-Series

F2C(F)-T



Special feature:

Gearboxes with high positioning and path accuracy, even under highly fluctuating dynamic conditions

- 7 sizes
- Integral spur wheel pre-stage
- Low moments of inertia
- Reduction ratios (double stage) 81/118.5/141/171
- Nominal output torques up to 6140 Nm
- Acceleration torques up to 11000 Nm
- Input speeds up to 8460 min^{-1}
- Lost motion < 0.5 arcmin
- Very smooth running
- High efficiency, even at low speeds
- Low vibration

8.1 Torques according to output speeds

Output speed n_{2m} [min^{-1}]			5			10			15			20			25		
Model	Size	Reduction ratio i	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]
F2C(F)-	T155	81	232	405	0.16	188	810	0.26	167	1215	0.35	153	1620	0.43	143	2025	0.5
		118.5	232	593	0.16	188	1185	0.26	167	1778	0.35	153	2370	0.43	143	2963	0.5
		141	232	705	0.16	188	1410	0.26	167	2115	0.35	153	2820	0.43	143	3525	0.5
	T255	81	573	405	0.4	465	810	0.65	412	1215	0.86	378	1620	1.05	353	2025	1.23
		118.5	573	593	0.4	465	1185	0.65	412	1778	0.86	378	2370	1.05	353	2963	1.23
		141	573	705	0.4	465	1410	0.65	412	2115	0.86	378	2820	1.05	353	3525	1.23
	T355	81	1091	405	0.76	886	810	1.24	785	1215	1.64	720	1620	20.1	673	2025	2.35
		118.5	1091	593	0.76	886	1185	1.24	785	1778	1.64	720	2370	20.1	673	2963	2.35
		141	1091	705	0.76	886	1410	1.24	785	2115	1.64	720	2820	20.1	673	3525	2.35
	T455	81	1770	405	1.24	1440	810	2.01	1280	1215	2.76	1170	1620	3.26	1090	2025	3.81
		118.5	1770	593	1.24	1440	1185	2.01	1280	1778	2.76	1170	2370	3.26	1090	2963	3.81
		141	1770	705	1.24	1440	1410	2.01	1280	2115	2.76	1170	2820	3.26	1090	3525	3.81
		171	1770	855	1.24	1440	1710	2.01	1280	2565	2.76	1170	3420	3.26	1090	4275	3.81
	T555	81	2730	405	1.9	2220	810	3.09	1960	1215	4.1	1800	1620	5.02	1680	2025	5.87
		118.5	2730	593	1.9	2220	1185	3.09	1960	1778	4.1	1800	2370	5.02	1680	2963	5.87
		141	2730	705	1.9	2220	1410	3.09	1960	2115	4.1	1800	2820	5.02	1680	3525	5.87
		171	2730	855	1.9	2220	1710	3.09	1960	2565	4.1	1800	3420	5.02	1680	4275	5.87
	T655	81	4360	405	3.04	3550	810	4.94	3140	1215	6.56	2880	1620	8.03	2690	2025	9.39
		118.5	4360	593	3.04	3550	1185	4.94	3140	1778	6.56	2880	2370	8.03	2690	2963	9.39
		141	4360	705	3.04	3550	1410	4.94	3140	2115	6.56	2880	2820	8.03	2690	3525	9.39
		171	4360	855	3.04	3550	1710	4.94	3140	2565	6.56	2880	3420	8.03	2690	4275	9.39
	T755	81	6140	405	4.28	4990	810	6.95	4410	1215	9.23	4050	1620	11.3	3790	2025	13.2
		118.5	6140	593	4.28	4990	1185	6.95	4410	1778	9.23	4050	2370	11.3	3790	2963	13.2
		141	6140	705	4.28	4990	1410	6.95	4410	2115	9.23	4050	2820	11.3	3790	3525	13.2
		171	6140	855	4.28	4990	1710	6.95	4410	2565	9.23	4050	3420	11.3	3790	4275	13.2

Table T-1 Rating values (reference value output speed n_{2m})

30			40			50			60			Max. permissible input speed $n_{1\,max}$ short term [min^{-1}]	Moment of inertia j related to the input shaft [×10^{-4} kgm^2]	Mass [kg]
Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Input speed [min^{-1}]	Max. permissible input power [kW]			
135	2430	0.57	124	3240	0.67	116	4050	0.81	110	4860	0.92	4860	0.138	
135	3555	0.57	124	4740	0.67	116	5925	0.81	110	7110	0.92	7110	0.103	4.8
135	4230	0.57	124	5640	0.67	116	7050	0.81	110	8460	0.92	8460	0.092	
335	2430	1.40	307	3240	1.71	287	4050	2.0				4050	0.373	
335	3555	1.40	307	4740	1.71	287	5925	2.0				5925	0.263	8.4
335	4230	1.40	307	5640	1.71	287	7050	2.0				7050	0.23	
637	2430	2.67	585	3240	3.26							3240	1.05	
637	3555	2.67	585	4740	3.26							4740	0.733	14
637	4230	2.67	585	5640	3.26							5640	0.638	
1040	2430	4.33										2430	2.55	
1040	3555	4.33										3555	1.92	24
1040	4230	4.33										4230	1.72	
1040	5130	4.33										5130	1.54	
1590	2430	6.66										2430	4.98	
1590	3555	6.66										3555	3.65	34
1590	4230	6.66										4230	3.23	
1590	5130	6.66										5130	2.88	
												2025	9.65	
												2963	7.13	48
												3525	6.35	
												4275	5.68	
												2025	16.7	
												2963	12.2	71
												3525	10.8	
												4275	9.6	

1. T_{2N} = nominal output torque
   Nominal output torque corresponds to the max. permissible average load torque at all output speeds.
   The nominal output torque for speeds less than 5 min^{-1} is equal to the value at 5 min^{-1}.
   The value for the maximum permissible input power is calculated from the nominal output torque at 100%.
   This value takes the efficiency of Fine Cyclo into consideration.
2. n_{1max} = maximum permissible input speed
   Gearbox can be used in the maximum input speed range specified in the table.
3. T_{2A} = max. Acceleration and braking torque (for fatigue strength at $2 \cdot 10^7$ load cycles)
   Permissible peak torque for normal start and stop procedures.
4. T_{2max} = max. permissible torque for emergency stop situations or in the event of heavy shocks (limited by the mechanical strength).
   (permissible 1000 x over the entire lifetime)
5. The nominal torque T_{2N} is calculated using the following equation when the speed is not shown in the table above:

$$T_{2N} = T_{2N,\,15} \left(\frac{15}{n_{2m}} \right)^{0,3}$$

T_{2N} : Nominal torque at output speed n_{2m}
$T_{2N,15}$: Nominal torque at output speed n_{2m} is 15 min^{-1}

8.2 Torques according to input speeds

Input speed n_{1m} [min^{-1}]			4000			3000			2500			2000			1750		
Model	Size	Reduction ratio i	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]
F2C(F)-	T155	81	117	49	0.81	127	37	0.66	134	31	0.58	144	25	0.50	150	22	0.45
		118.5	131	34	0.62	143	25	0.50	151	21	0.44	161	17	0.38	168	15	0.35
		141	138	28	0.55	150	21	0.45	159	18	0.39	170	14	0.34	177	12	0.31
	T255	81	288	49	1.99	314	37	1.62	332	31	1.43	355	25	1.22	369	22	1.11
		118.5	323	34	1.52	352	25	1.24	372	21	1.10	398	17	0.94	414	15	0.85
		141	340	28	1.35	371	21	1.10	392	18	0.97	419	14	0.83	436	12	0.76
	T355	81				599	37	3.10	632	31	2.72	676	25	2.33	704	22	2.12
		119	615	34	2.90	671	25	2.37	709	21	2.09	758	17	1.79	789	15	1.63
		141	648	28	2.57	707	21	2.10	747	18	1.85	798	14	1.58	831	12	1.44
	T455	81							1031	31	4.44	1102	25	3.80	1147	22	3.46
		118.5				1094	25	3.87	1156	21	3.40	1236	17	2.91	1286	15	2.65
		141	1057	28	4.19	1153	21	3.42	1217	18	3.01	1302	14	2.58	1355	12	2.35
		171	1120	23	3.66	1221	18	2.99	1290	15	2.63	1379	12	2.25	1436	10	2.05
	T555	81							1579	31	6.80	1688	25	5.82	1757	22	5.30
		118.5				1675	25	5.92	1769	21	5.21	1892	17	4.46	1969	15	4.06
		141	1619	28	6.41	1765	21	5.24	1864	18	4.61	1993	14	3.95	2075	12	3.60
		171	1715	23	5.60	1870	18	4.58	1975	15	4.03	2112	12	3.45	2198	10	3.14
	T655	81										2704	25	9.32	2814	22	8.49
		118.5				2684	25	9.49	2835	21	8.35	3031	17	7.14	3155	15	6.51
		141				2827	21	8.40	2986	18	7.39	3193	14	6.32	3324	12	5.76
		171	2748	23	8.98	2996	18	7.34	3164	15	6.46	3383	12	5.53	3522	10	5.03
	T755	81										3798	25	13.09	3953	22	11.92
		118.5				3769	25	13.32	3981	21	11.73	4257	17	10.03	4431	15	9.14
		141				3971	21	11.80	4194	18	10.38	4485	14	8.88	4668	12	8.09
		171	3860	23	12.61	4208	18	10.31	4444	15	9.07	4752	12	7.76	4946	10	7.07

Table T-2 Rating values (reference value input speed n_{1m})

Size	Max. acceleration and deceleration torque T_{2A}	Peak torque for emergency stop T_{2max}
	[Nm]	[Nm]
T155	417	834
T255	1030	2060
T355	1960	3920
T455	3190	6380
T555	4910	9820
T655	7850	15700
T755	11000	22000

Table T-3 Maximum acceleration or deceleration torque

1500			1000			750			600					
Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Nominal output torque [Nm]	Output speed [min^{-1}]	Max. permissible input power [kW]	Max. permissible input speed $n_{1\,max}$ short term [min^{-1}]	Moment of inertia j related to the input shaft [$\times 10^{-4}$ kgm^2]	Mass [kg]
157	19	0.41	177	12	0.31	193	9	0.25	206	7	0.21	4860	0.138	
176	13	0.31	198	8	0.23	216	6	0.19	231	5	0.16	7110	0.103	4.8
185	11	0.27	209	7	0.21	228	5	0.17	244	4	0.14	8460	0.092	
387	19	1.00	437	12	0.75	476	9	0.62	509	7	0.53	4050	0.373	
434	13	0.77	490	8	0.58	534	6	0.47	571	5	0.40	5925	0.263	8.4
457	11	0.68	516	7	0.51	562	5	0.42	601	4	0.36	7050	0.23	
737	19	1.91	832	12	1.43	907	9	1.17	970	7	1.00	3240	1.05	
826	13	1.46	933	8	1.10	1017	6	0.90	1087	5	0.77	4740	0.733	14
870	11	1.29	983	7	0.97	1071	5	0.80	1146	4	0.68	5640	0.638	
1202	19	3.11	1357	12	2.34	1479	9	1.91	1582	7	1.64	2430	2.55	
1347	13	2.38	1521	8	1.79	1658	6	1.47	1773	5	1.25	3555	1.92	24
1419	11	2.11	1603	7	1.59	1747	5	1.30	1868	4	1.11	4230	1.72	
1504	9	1.84	1698	6	1.39	1851	4	1.13	1979	4	0.97	5130	1.54	
1840	19	4.76	2078	12	3.58	2265	9	2.93	2422	7	2.51	2430	4.98	
2062	13	3.65	2329	8	2.74	2539	6	2.24	2715	5	1.92	3555	3.65	34
2173	11	3.23	2454	7	2.43	2675	5	1.99	2860	4	1.70	4230	3.23	
2302	9	2.82	2600	6	2.12	2834	4	1.74	3031	4	1.48	5130	2.88	
2948	19	7.62	3329	12	5.74	3629	9	4.69	3880	7	4.01	2025	9.65	
3304	13	5.84	3731	8	4.40	4068	6	3.59	4349	5	3.07	2963	7.13	48
3481	11	5.17	3931	7	3.89	4286	5	3.18	4582	4	2.72	3525	6.35	
3688	9	4.52	4165	6	3.40	4541	4	2.78	4855	4	2.38	4275	5.68	
4140	19	10.70	4675	12	8.06	5097	9	6.59	5450	7	5.64	2025	16.7	
4640	13	8.20	5241	8	6.17	5713	6	5.05	6109	5	4.32	2963	12.2	71
4889	11	7.26	5521	7	5.47	6019	5	4.47	6436	4	3.82	3525	10.8	
5180	9	6.34	5850	6	4.78	6377	4	3.91	6819	4	3.34	4275	9.6	

1. T_{2N} = nominal output torque
   Nominal output torque corresponds to the max. permissible average load torque at all input speeds.
   The nominal output torque for speeds n_2 less than 5 min^{-1} is equal to the value at 5 min^{-1}.
   The value for the maximum permissible input power is calculated from the nominal output torque at 100%.
   This value takes the efficiency of Fine Cyclo into consideration.

2. n_{1max} = maximum permissible input speed
   Gearbox can be used in the maximum input speed range specified in the table.

3. T_{2A} = max. Acceleration and braking torque (for fatigue strength at $2 \cdot 10^7$ load cycles)
   Permissible peak torque for normal start and stop procedures.

4. T_{2max} = max. permissible torque for emergency stop situations or in the event of heavy shocks (limited by the mechanical strength).
   (permissible 1000 x over the entire lifetime)

5. The nominal torque T_{2N} is calculated using the following equation when the speed is not shown in the table above:

$$T_{2N} = T_{2N,\,600} \cdot \left(\frac{600}{n_{1m}} \right)^{0,3}$$

T_{2N} : Rated torque at input speed n_{1m}
$T_{2N,\,600}$: Rated torque at input speed n_{1m} is 600 min^{-1}

8.3 Rigidity and Lost Motion

Size	i	Test torque T_p [Nm]	Lost Motion		Torsional stiffness 3% - 50% T_p [Nm/arcmin]	Torsional stiffness 3% - 100% T_p [Nm/arcmin]	Torsional stiffness 50% - 100% T_p [Nm/arcmin]
			Lost Motion [arcmin]	Domain of definition [Nm]			
T155	81	±167	< 0.75	±5	25	36	41
	118.5						
	141						
T255	81	±412	< 0.5	±12.4	72	103	118
	118.5						
	141						
T355	81	±785		±23.6	130	186	206
	118.5						
	141						
T455	81	±1280		±38.4	213	304	343
	118.5						
	141						
T555	81	±1960		±58.8	371	530	589
	118.5						
	141						
T655	81	±3140		±94.2	584	834	981
	118.5						
	141						
T755	81	±4410		±132	804	1148	1280
	118.5						
	141						

Table T-4 Torsional stiffness

T_p: Test torque at input speed $n_1 = 1500\ min^{-1}$

1) At a load torque less than 3% T_p

$$\varphi = \frac{\text{Lost Motion}}{2} \cdot \frac{\text{Load torque}}{0.03 \cdot T_p}$$

2) At a load torque greater than 3% T_p (standard case)

$$\varphi = \frac{\text{Lost Motion}}{2} + \frac{\text{Load torque - } (0.03 \cdot T_p)}{\text{Torsional stiffness}}$$

Note arcmin means "angular minute".
Table values for rigidity are average values

8.4 No-load running torque NLRT

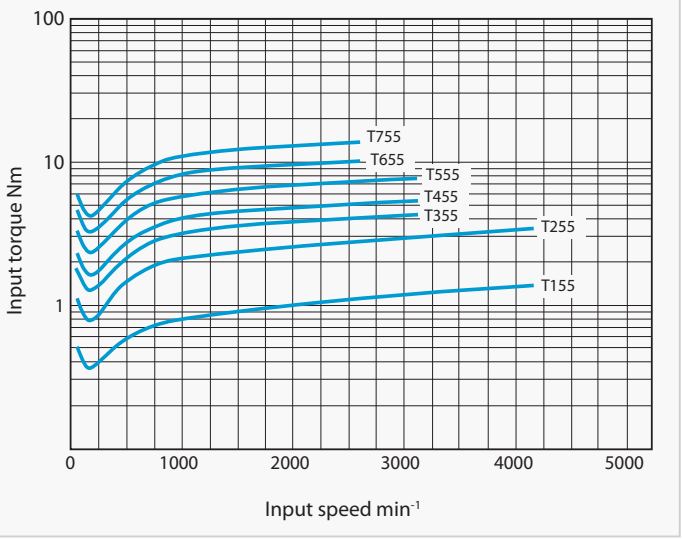


Fig. T-1

Note
1. Fig. T-1 shows the average no-load running torque after gearbox is run in (not factory-new condition).
2. Table T-5 shows the measuring conditions

Ring gear housing temperature	approx. 30 °C
Precision during assembly	as per 8.8.1
Lubrication	Standard lubrication

Table T-5 Measurement conditions

8.5 Breakaway torque

Indicates the necessary torque for breakaway of the gearbox on the input or output side, after stop without output side load.

Breakaway torque on output side (BTO)

Note

1. Table T-7 shows the max. breakaway torque on the output side BTO. Fine Cyclo reducers are not self-locking. The BTO is defined as the maximum value (factory-new condition), which steadily decreases during the lifetime
2. Table T-6 shows the measuring conditions

Precision during assembly	as per 8.8.1
Lubrication	Standard lubrication

Table T-6 Measurement conditions

Size	Breakaway torque BTO [Nm]
T155	< 40
T255	< 90
T355	< 150
T455	< 190
T555	< 270
T655	< 380
T755	< 500

Table T-7 Value of the breakaway torque on the output side (BTO)

Breakaway torque on input side (BTI)

Note

1. Table T-8 shows the max. breakaway torque BTI on the input side. The BTI is defined as the maximum value (factory-new condition) which steadily decreases during the lifetime.
2. Table T-6 shows the measuring conditions

Size	i	Breakaway torque BTI [Nm]
T155	81	< 0.5
	118.5	< 0.3
	141	< 0.3
T255	81	< 1.1
	118.5	< 0.7
	141	< 0.6
T355	81	< 1.8
	118.5	< 1.2
	141	< 1
T455	81	< 2.3
	118.5	< 1.6
	141	< 1.3
	171	< 1.1
T555	81	< 3.3
	118.5	< 2.2
	141	< 1.9
	171	< 1.5
T655	81	< 4.6
	118.5	< 3.1
	141	< 2.6
	171	< 2.2
T755	81	< 6
	118.5	< 4.1
	141	< 3.5
	171	< 2.9

Table T-8 Value of the breakaway torque on the input side (BTI)

8.6 Efficiency

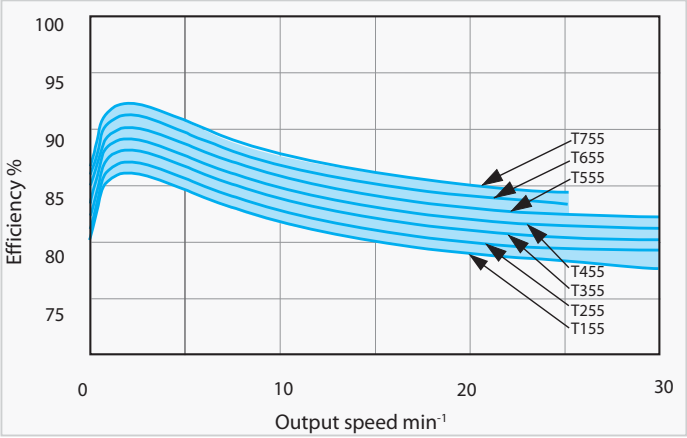


Fig. T-2 a Efficiency curve

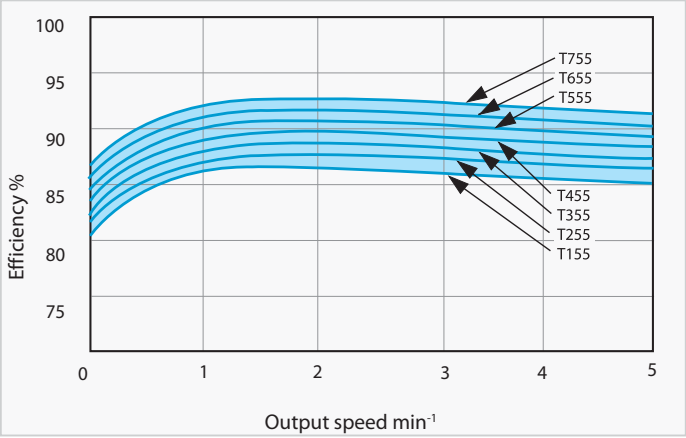


Fig. T-2b Efficiency curve at low speeds

The Fig. T-2a and Fig. T-2b show the efficiency of a run-in gearbox under nominal load at an ambient temperature of 20°. For further information see "4 Explaining the technical details" on page 18.

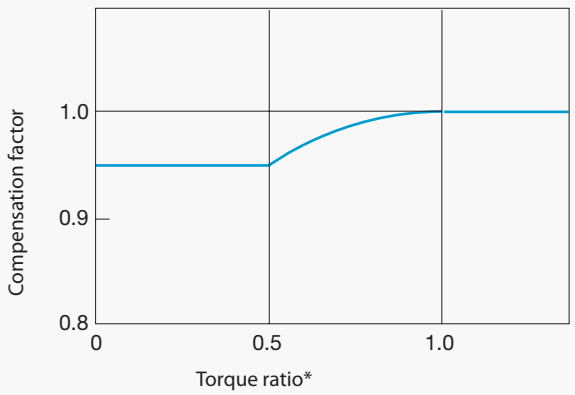


Fig. T-3 Compensation curve for efficiency

*** Torque ratio = Load torque / Nominal output torque**

Compensation efficiency = efficiency · compensation factor

Note

1. The efficiency changes if the load torque does not match the nominal torque. Check the compensation factor in the diagram Fig. T-3
2. When the torque ratio is over 1.0, the compensation factor for efficiency is 1.0 (diagram Fig. T-3)

8.7 Main bearings

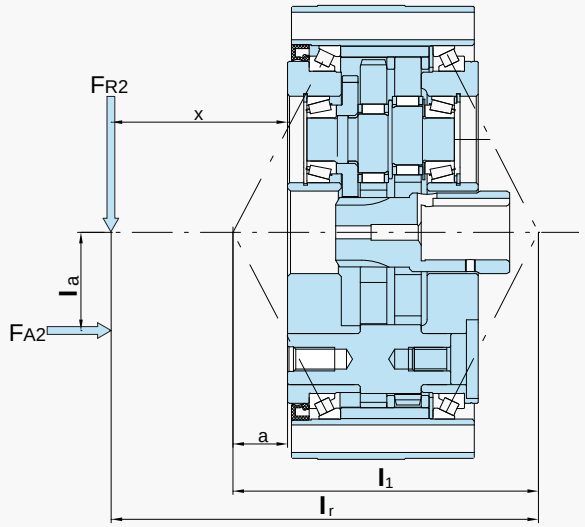


Fig. T-4 Distance between the individual loading points

$$l_r = x - a + l_1 \quad \text{(Equation T-4)}$$

1. Moment stiffness

   The moment stiffness is the bending moment at which the output flange is tilted by the tilt angle.

   The tilt angle of the input flange is determined as follows:

$$\varphi_1 = \frac{T_k}{\Theta_1} \quad \text{(Equation T-5)}$$

External bending moment T_k

$$T_k = 10^{-3} \cdot (F_{R2} \cdot l_r + F_{A2} \cdot l_a) \quad \text{(Equation T-6)}$$

2. Max. permissible bending moment and max. permissible axial load

   Check the external bending moment and the external axial load using equations T-6, T-7, T-8 and Fig. T-13.

Equivalent bending moment T_{ke}

$$T_{ke} = 10^{-3} \cdot (C_{f2} \cdot B_{f2} \cdot F_{R2} \cdot l_r + C_{f2} \cdot B_{f2} \cdot F_{A2} \cdot l_a) \quad < T_{k\,max} \quad \text{(Equation T-9)}$$

Equivalent axial load F_{A2e} at the output shaft

$$F_{A2e} = F_{A2} \cdot C_{f2} \cdot B_{f2} \quad < F_{A2\,max} \quad \text{(EquatioT-10)}$$

Size	Values of internal bearing distance	
	l_1 [mm]	a [mm]
T155	80.9	5.2
T255	92.4	5.7
T355	120.0	12.0
T455	147.2	22.6
T555	169.8	28.9
T655	205.8	39.4
T755	227.8	43.9

Table T-9 Bearing clearances

Note If: $l_r > 4 \cdot l_1$, please contact Sumitomo Drive Technologies.

F_{A2} = output side axial load [N]
$F_{A2\,max}$ = maximum permissible output side axial load [N]
F_{A2e} = equivalent output side axial load [N]
F_{R2} = output side radial load [N]
C_{f2} = correction factor output (Table T-12)
B_{f2} = service factor output (Table T-13)
l_1 = bearing clearance [mm] (Table T-9)
l_r = calculated dimension for bending moment [mm]
l_a = distance of axial load [mm]
x = distance from radial force to flange collar [mm]
a = correction factor [mm] (Table T-9)
T_k = external bending moment [Nm]
$T_{k\,max}$ = maximum permissible bending moment [Nm] (Table T-14)
T_{ke} = equivalent bending moment [Nm]
φ_1 = tilt angle [arcmin]
Θ_1 = moment stiffness main bearing [Nm/arcmin] (Table T-10)

Size	Moment stiffness Θ_1
	[Nm/arcmin]
T155	390
T255	835
T355	1370
T455	1860
T555	2940
T655	4420
T755	6380

Table T-10 Average values for moment stiffness

Correction factor output	C_{f2}
Chain	1
Pinion or rack	1.25
Toothed belt	1.25
V-Belt	1.5

Table T-12 Correction factor output C_{f2}

Service factor output	B_{f2}
Uniform load (no shock)	1
Light impacts	1.2
Severe impacts	1.6

Table T-13 Service factor output B_{f2}

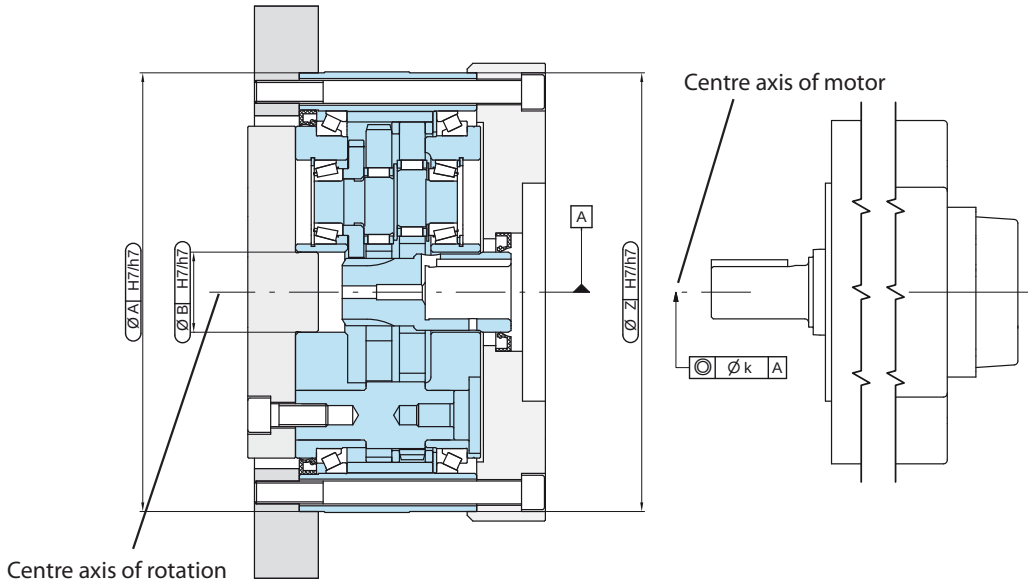
Size	Max. permissible bending moment T_{kmax}	Max. permissible axial load $F_{A2\,max}$	
		Tension	Compression
	[Nm]	[N]	[N]
T155	883	3920	3920
T255	1180	3920	5400
T355	1820	5400	7850
T455	2750	6870	11800
T555	4170	8340	15700
T655	6380	10800	19600
T755	9570	13700	24500

Table T-14 Max. permissible bending moment and max. permissible axial load

8.8 Assembly specifications and tolerances

8.8.1 Assembly tolerances

To ensure the function, lifetime, and characteristics of the gearboxes, the radial run-out of the shaft ends, the concentricity, and the axial run-out of the fastening flange as per EN 50347:2001 are sufficient. When used in high-precision applications, the tolerance according to EN 50347:2001 should be reduced by 50 %.



Size	Ø A	Ø B	Ø Z	Ø k
T155	125	23.5	125	0.030
T255	155	28	155	
T355	185	35	185	
T455	230	42	230	
T555	260	47	260	0.050
T655	295	58	295	
T755	330	62	330	

Table T-11 (Dimensions in mm)

Tightening torque and maximum permissible transmitted torque for bolts

The permissible transmitted torque for bolts and the number, size, and tightening torque for fastening the output side flange and the ring gear housing are listed in Table T-15. In the event of an emergency stop with corresponding load peaks, the output flange and ring gear housing bolts must all be replaced. Liquid sealing material must be applied between all fittings of the gearbox with the customer's applications.

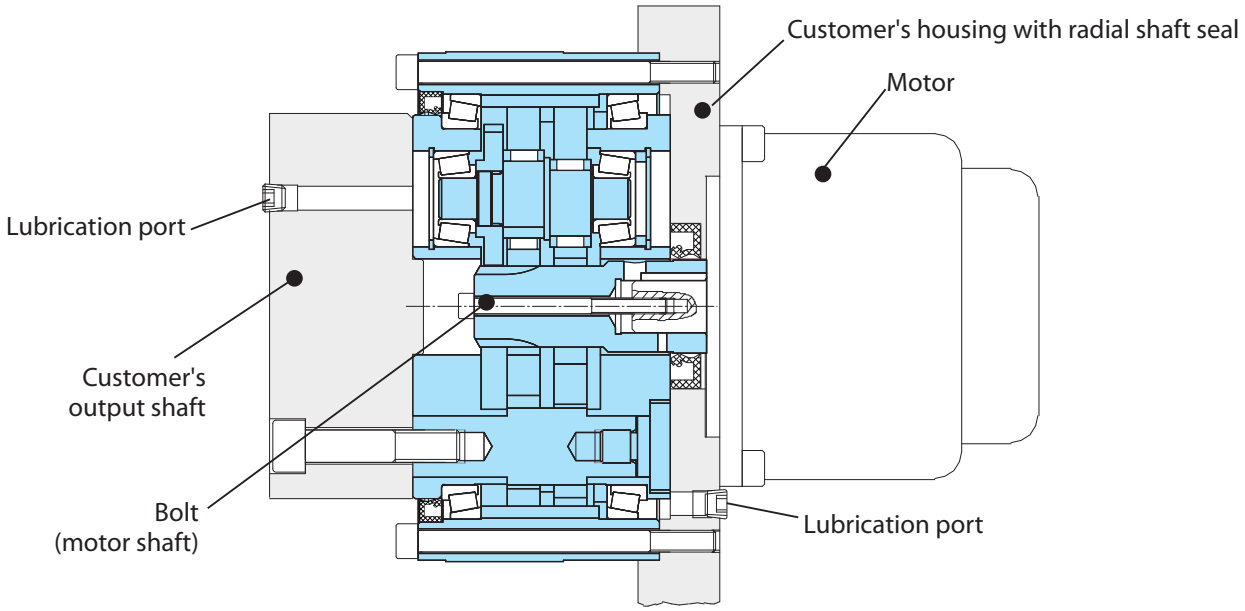
Size	Output flange bolts				Bolts for ring gear (housing)		
	Number and size of bolts	Pitch circle-ø	Tightening torque [Nm]	Max. permissible transmitted torque for bolts [Nm]	Number and size of bolts	Tightening torque [Nm]	Max. permissible transmitted torque for bolts [Nm]
T155	6 × M6 3 × M8 6 × M8	45 66 72	14 33 33	970	16 × M6	14	1250 (1480)*
T255	6 × M12 3 × M8 6 × M8	84 82 50	115 33 33	2160	12 × M8 (16 × M8)*	33	2150 (3500)*
T355	6 × M14 3 × M12 6 × M12	104 102 63	180 115 115	4500	16 × M8	33	3450 (4150)*
T455	6 × M16 3 × M12 6 × M12	135 129 63	280 115 115	7250	12 × M12 (16 × M10)*	115 (66)*	7350 (7650)*
T555	6 × M18 3 × M14 6 × M14	165 150 115	390 180 180	11200	16 × M12	115	11200 (14300)*
T655	6 × M22 3 × M16 6 × M16	180 170 115	750 280 280	18200	16 × M14 (16 × M12)*	180 (115)*	17300 (14300)*
T755	6 × M24 3 × M18 6 × M18	200 190 130	950 390 390	24000	16 × M16 (24 × M12)*	280 (115)*	27000 (24300)*

Table T-15
* Values in brackets apply only for type F2C**F**-T

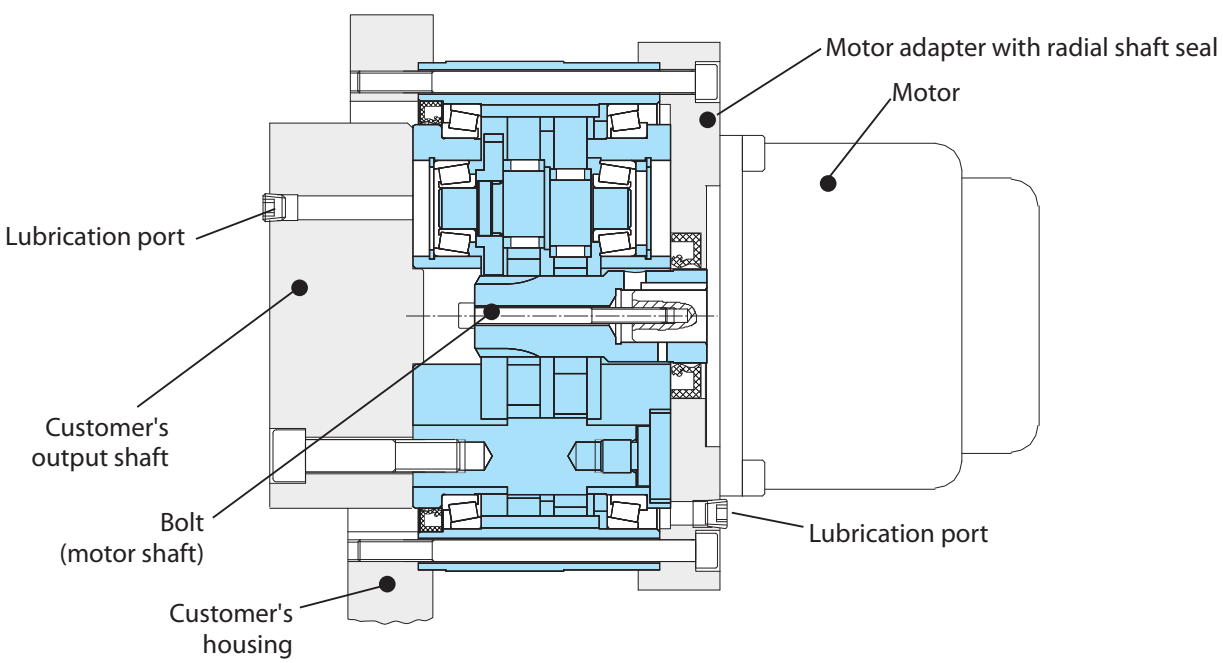
- **Bolting:** Use metric hexagon socket head cap screws (DIN 4762, strength category 10.9).
- **Countermeasure for bolts loosening:** Use adhesives (Loctite 262, etc.) or spring washer (DIN 127A).
- **Use conical spring washers** (DIN 6796) when connecting the gearbox to the flange side, so that the bolt contact faces do not get damaged.

8.8.2 Installation example

(1)



(2)



An adapter is required for the installation of the motor on the input side flange. This can be supplied. An radial shaft seal must be provided in this adapter. The input shaft of the gearbox is not mounted in the gearbox.

The customer's output shaft is bolted to the output flange of the gearbox.

In the case of standard installations with a hollow shaft and keyway, the input shaft of the gearbox must be screwed to the front threaded hole of the motor shaft. The motor shaft must have a key. The correct insertion depth of the spline (shaft distance from output) must be observed as per the Fine Cyclo catalogue (see the dimension sheets).

8.8.3 Lubrication

- Fine Cyclo Type F2C(F)-T gearboxes are delivered without grease and must first be filled with Multemp FZ No. 00 grease. As per Table T-16, and sealed before commissioning (lubrication port see figure).
  These greases are suitable for ambient temperatures from -10°C to +40°C.
- After the described grease filling, the gearboxes are maintenance-free.

Grease prescribed	Manufacturer
Multemp FZ No. 00	Kyodo Yushi Co., Ltd.
Conditions for use: Environmental temperature -10 °C to +40 °C	

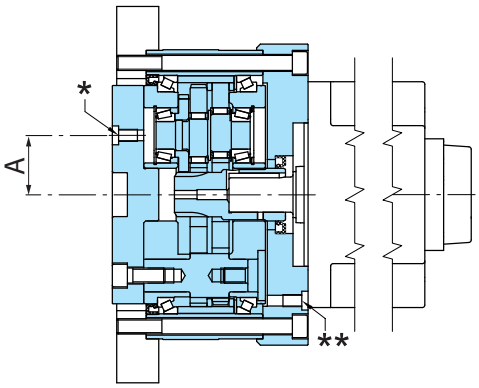
Table T-16 Specified grease for the T-Series

Size	Quantity of grease [g]		A [mm]
	Vertical	Horizontal	
T155	80	60	25
T255	120	100	31
T355	230	180	39
T455	300	240	47
T555	400	320	55
T655	700	560	63
T755	800	640	73

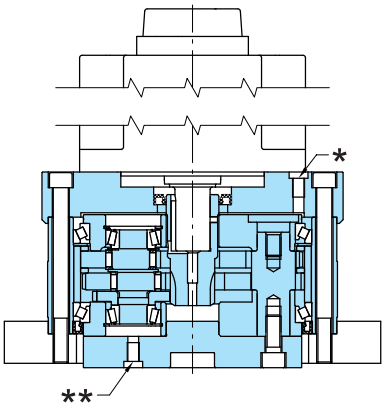
Table T-17 Lubrication

The grease quantity above relates to the gearbox. The cavity between the gearbox and the motor (intermediate flange) must also be taken into account.

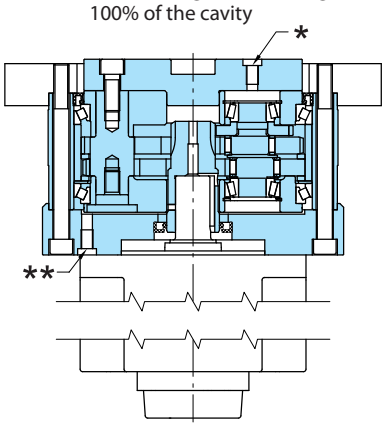
Mounting position
Horizontal
Additional amount of grease for flange:
50% of the cavity



Mounting position
Vertical 1
Output down
Additional amount of grease for flange:
0% of the cavity

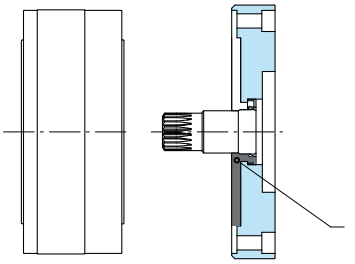


Mounting position
Vertical 2
Output up
Additional amount of grease for flange:
100% of the cavity

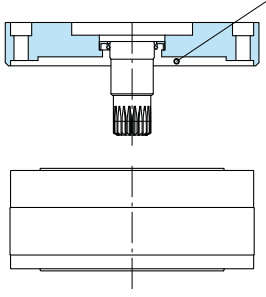


* Filling port for grease
** Grease drain port for grease change

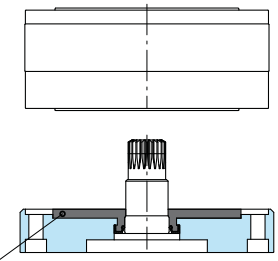
Determination of the cavity
The additional amount of grease is necessary for the functioning of the gearbox



Additional motor flange cavity must be taken into account when grease filling (50% of the volume)



Additional cavity on the motor flange must not be taken into account.
(The radial shaft seal must, however, be smeared with grease).

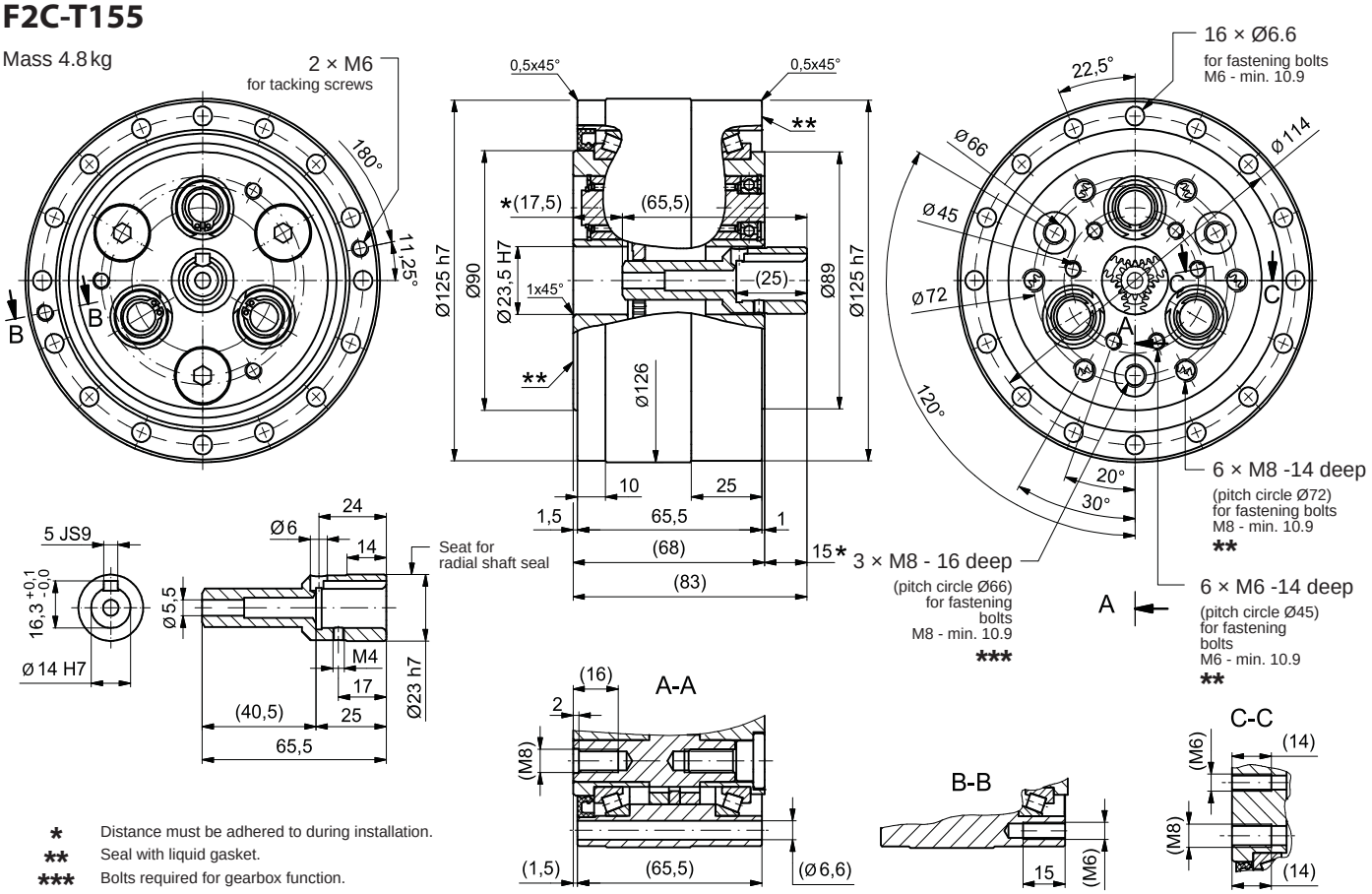


Additional motor flange cavity must be taken into account when grease filling (100% of the volume)

8.9 Dimensioned drawings

F2C-T155

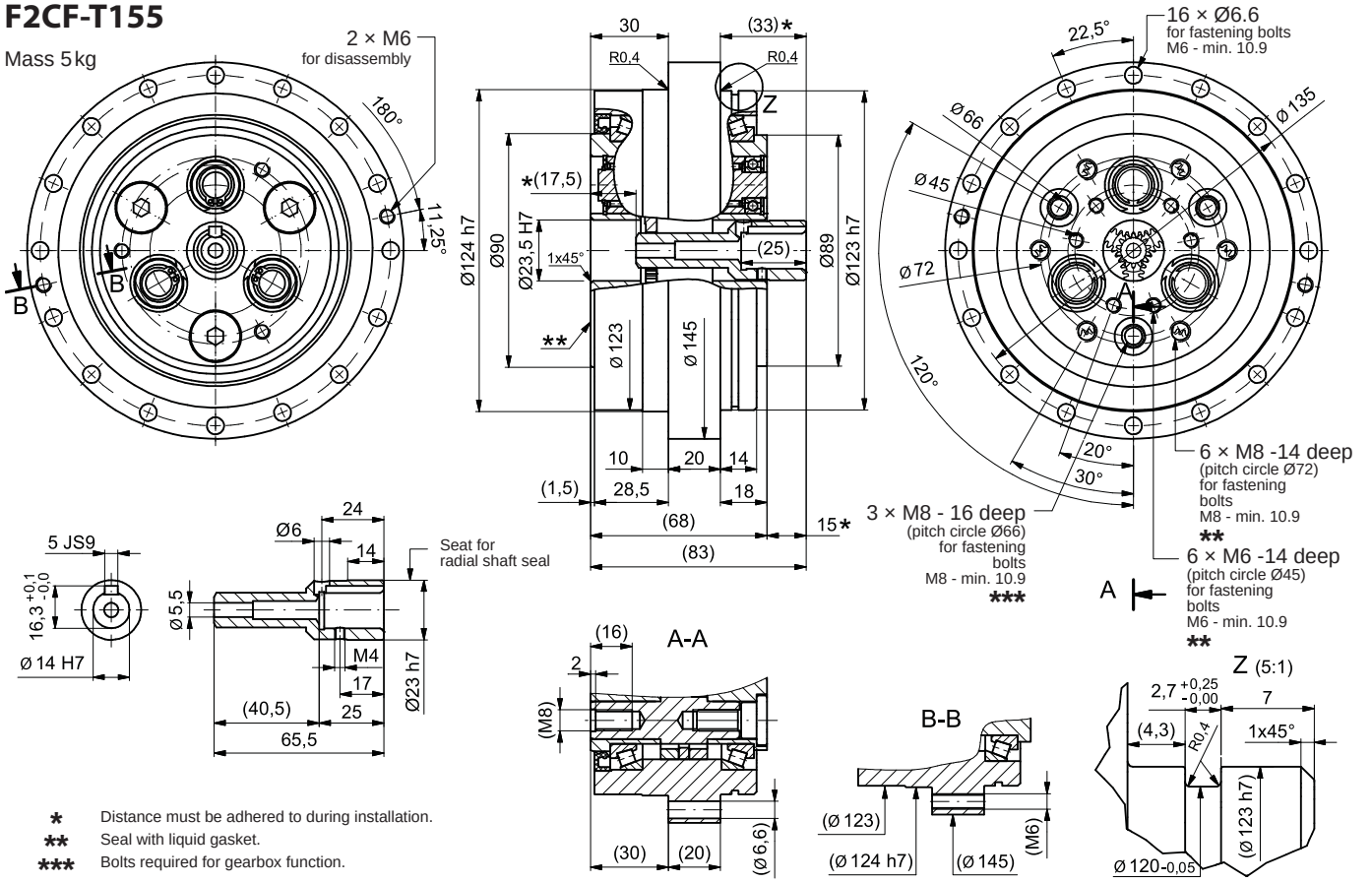
Mass 4.8 kg



* Distance must be adhered to during installation.
** Seal with liquid gasket.
*** Bolts required for gearbox function.

F2CF-T155

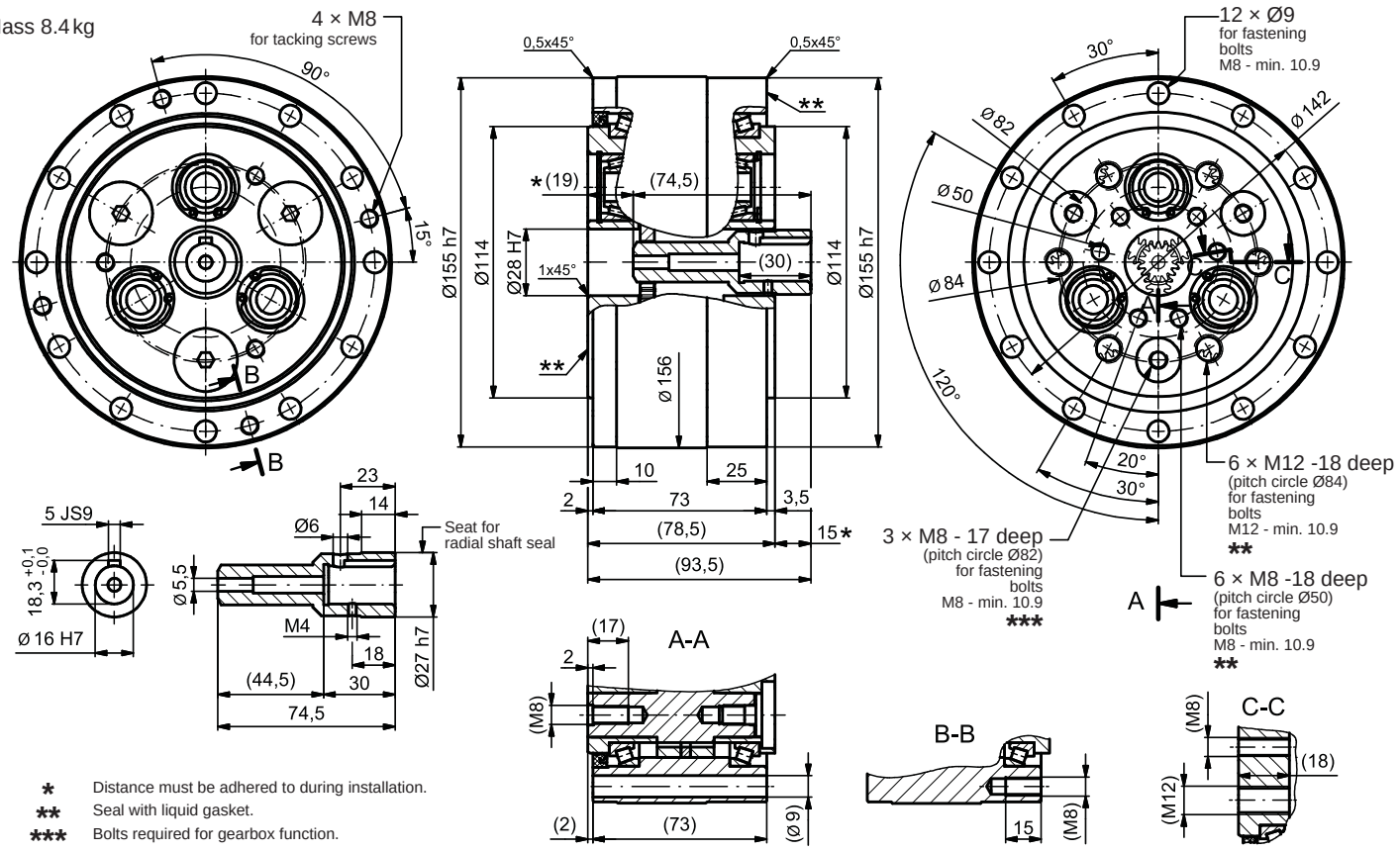
Mass 5 kg



* Distance must be adhered to during installation.
** Seal with liquid gasket.
*** Bolts required for gearbox function.

F2C-T255

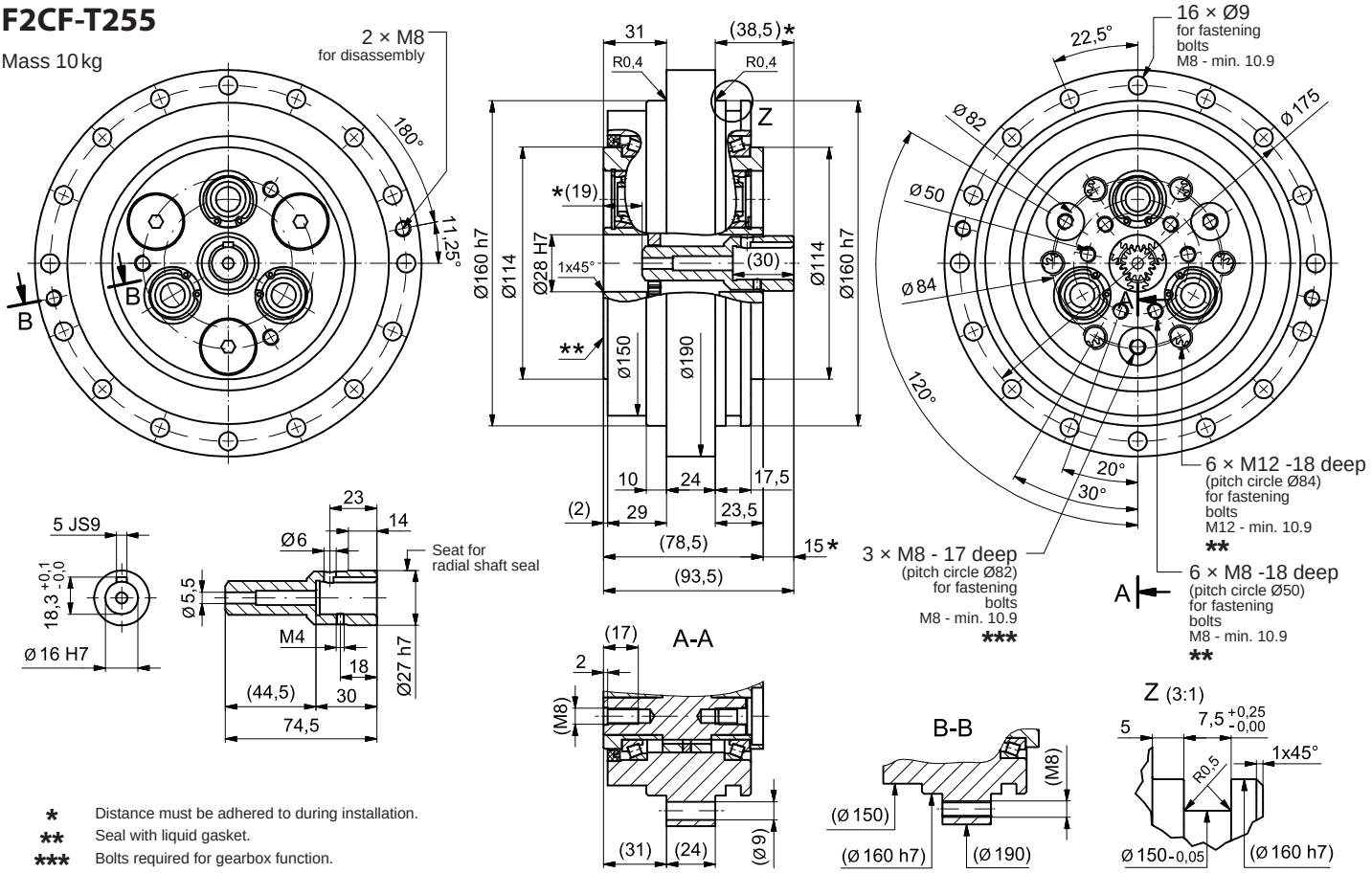
Mass 8.4 kg



* Distance must be adhered to during installation.
** Seal with liquid gasket.
*** Bolts required for gearbox function.

F2CF-T255

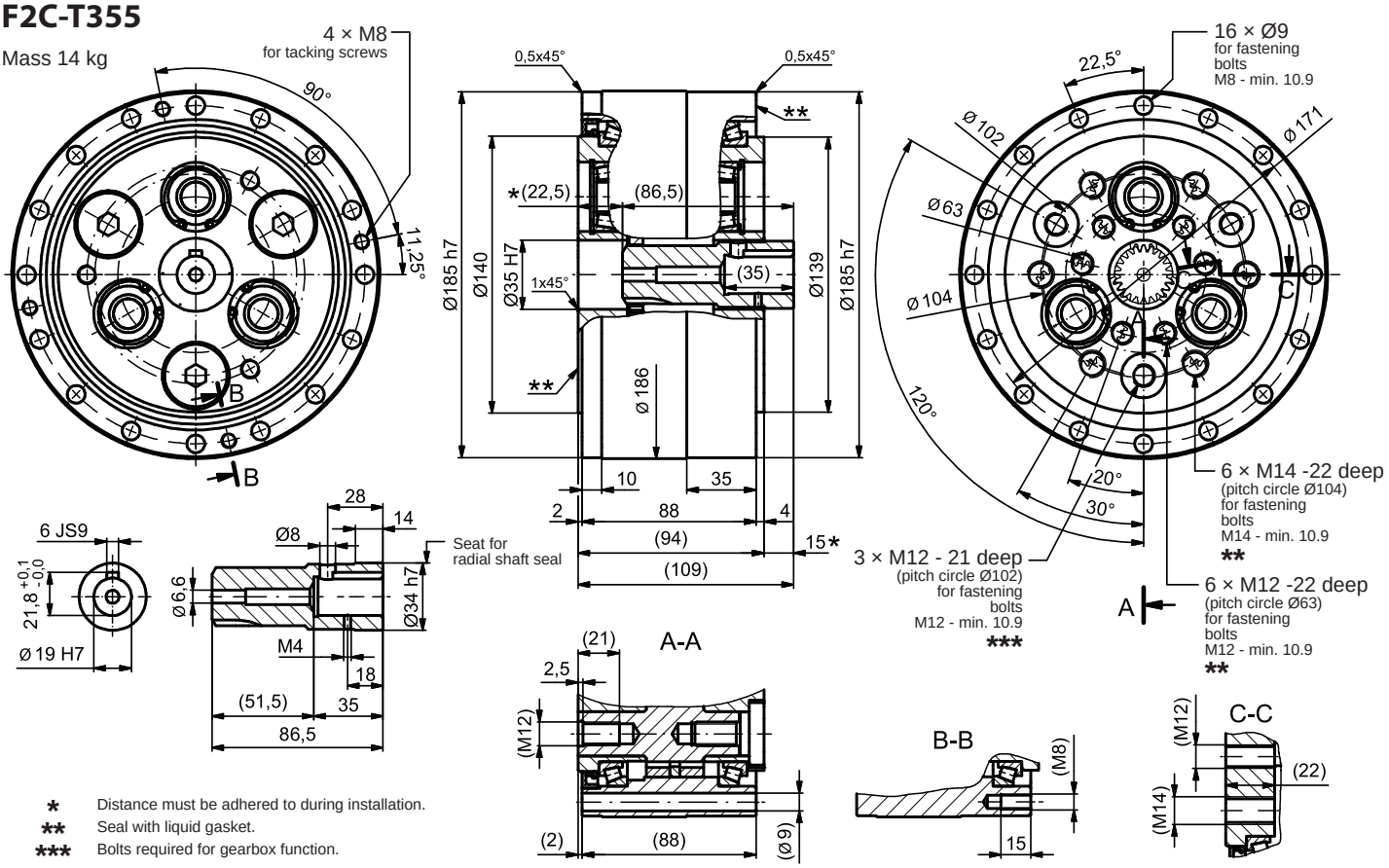
Mass 10 kg



* Distance must be adhered to during installation.
** Seal with liquid gasket.
*** Bolts required for gearbox function.

F2C-T355

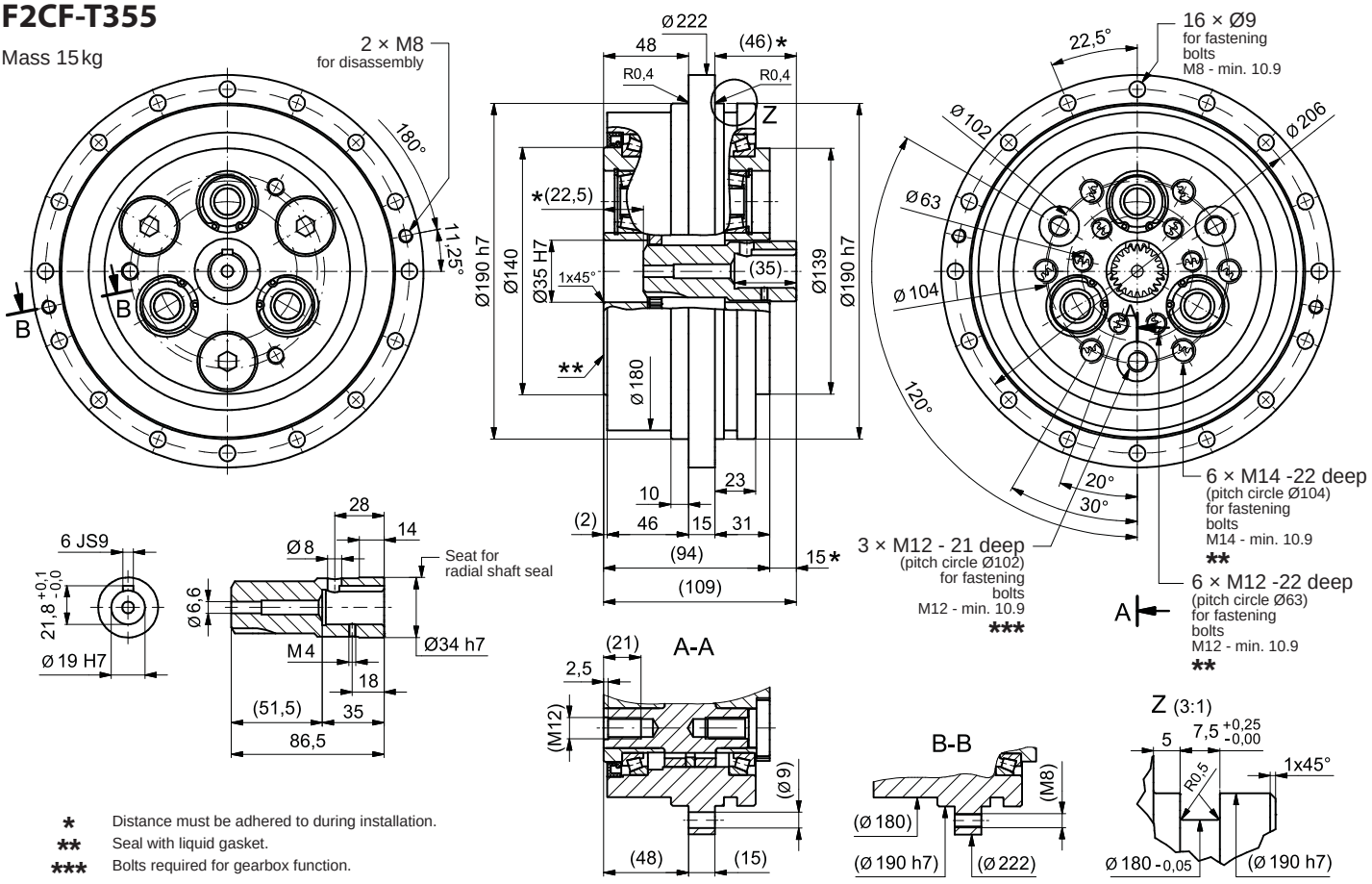
Mass 14 kg



* Distance must be adhered to during installation.
** Seal with liquid gasket.
*** Bolts required for gearbox function.

F2CF-T355

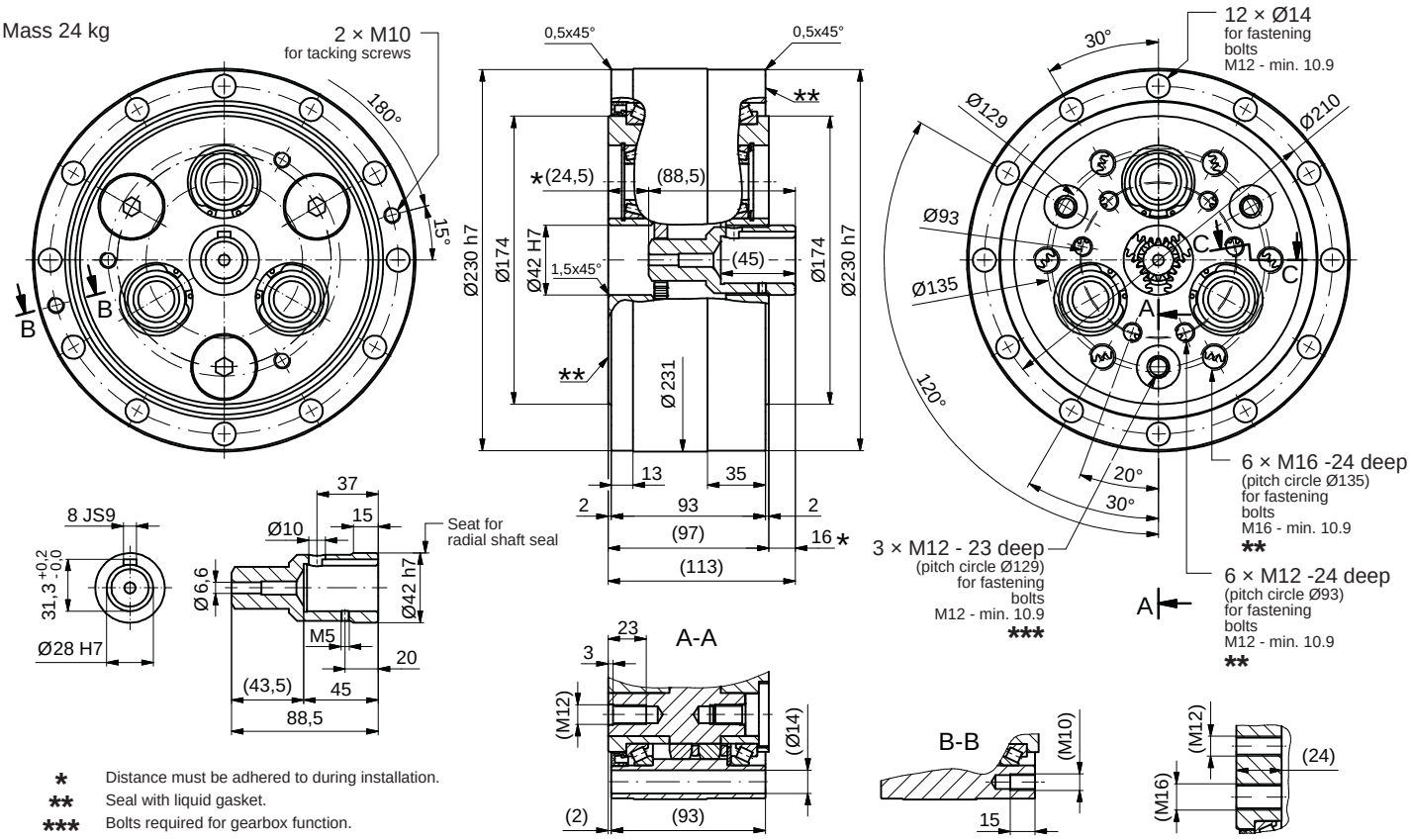
Mass 15 kg



* Distance must be adhered to during installation.
** Seal with liquid gasket.
*** Bolts required for gearbox function.

F2C-T455

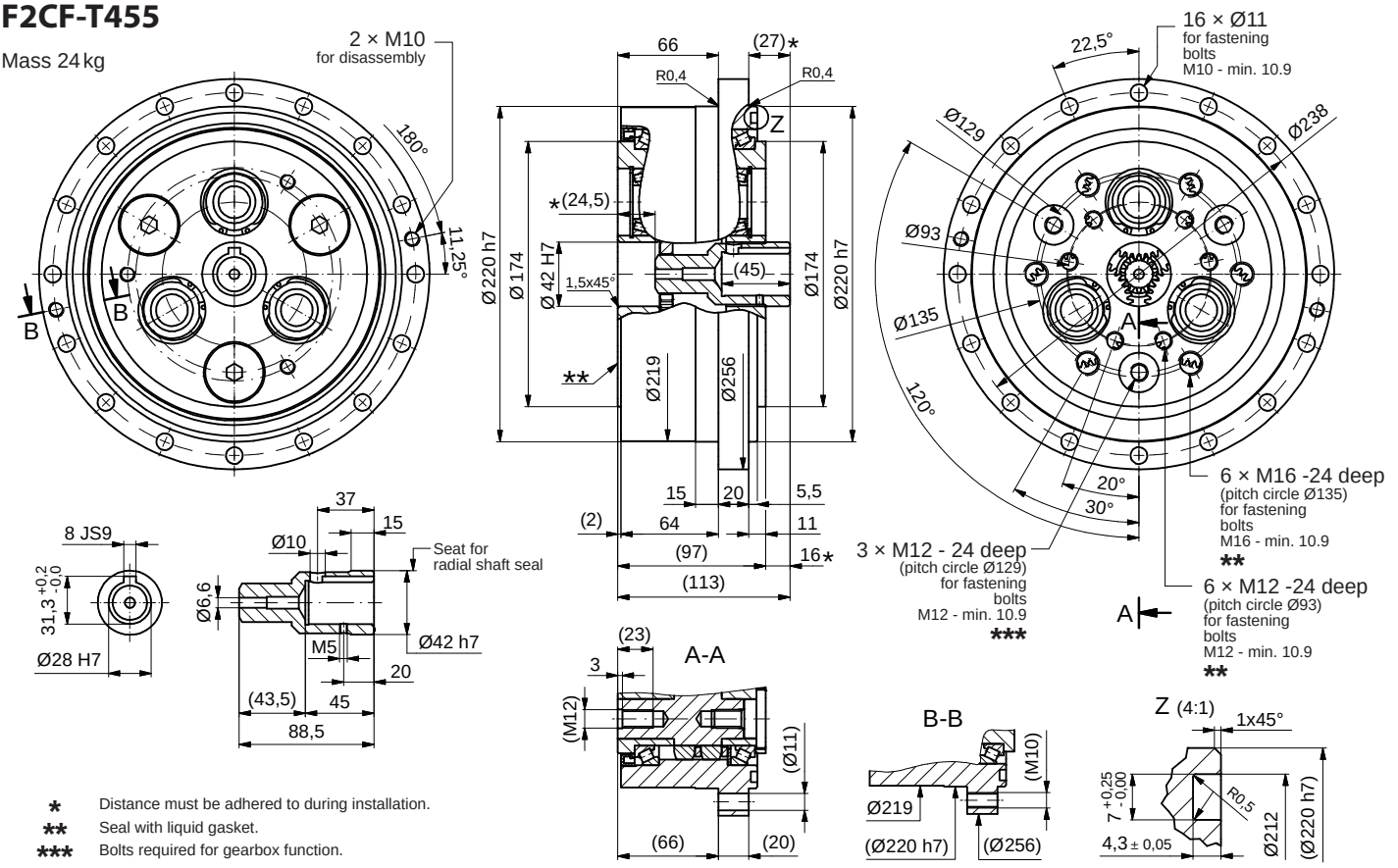
Mass 24 kg



* Distance must be adhered to during installation.
** Seal with liquid gasket.
*** Bolts required for gearbox function.

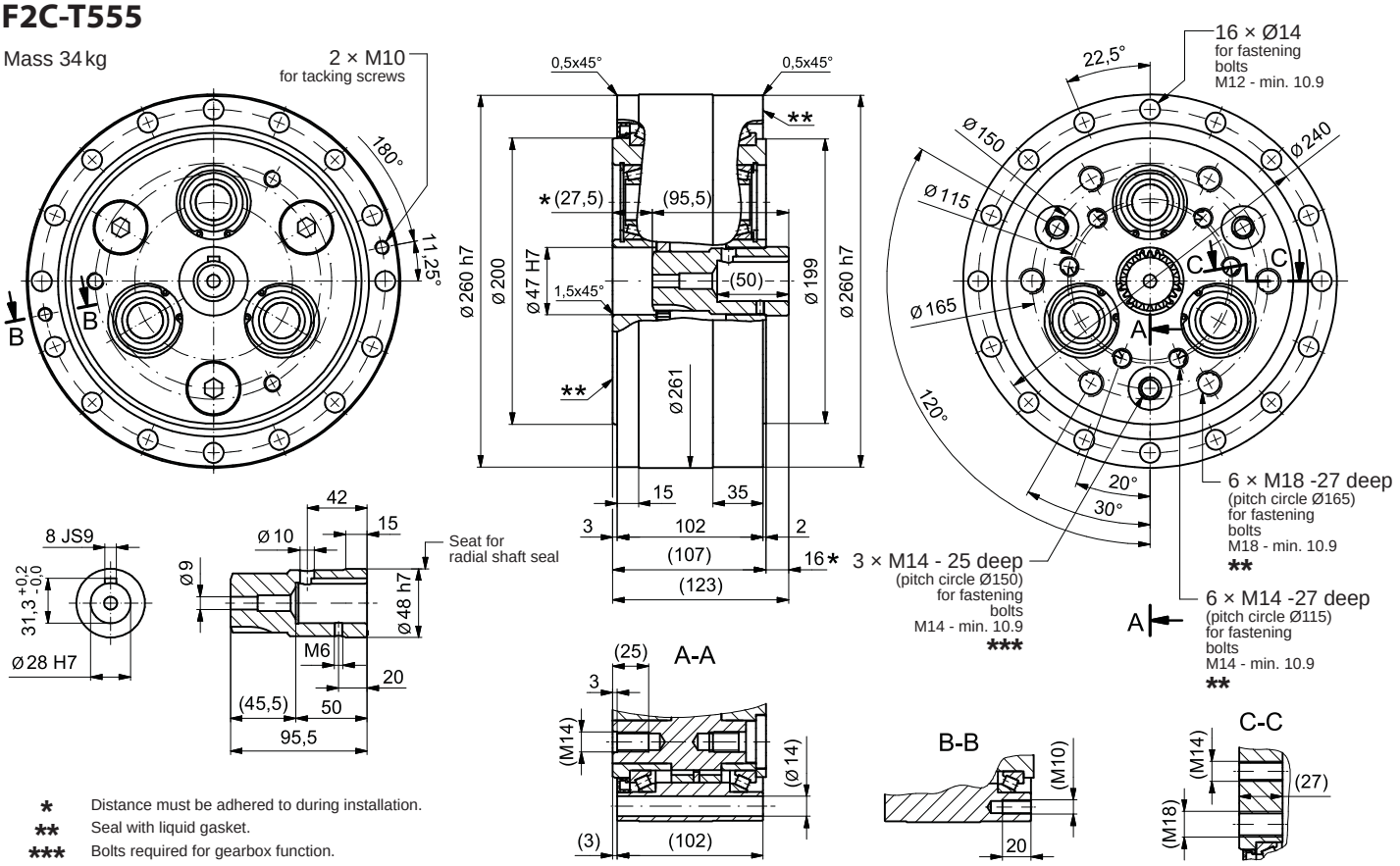
F2CF-T455

Mass 24 kg



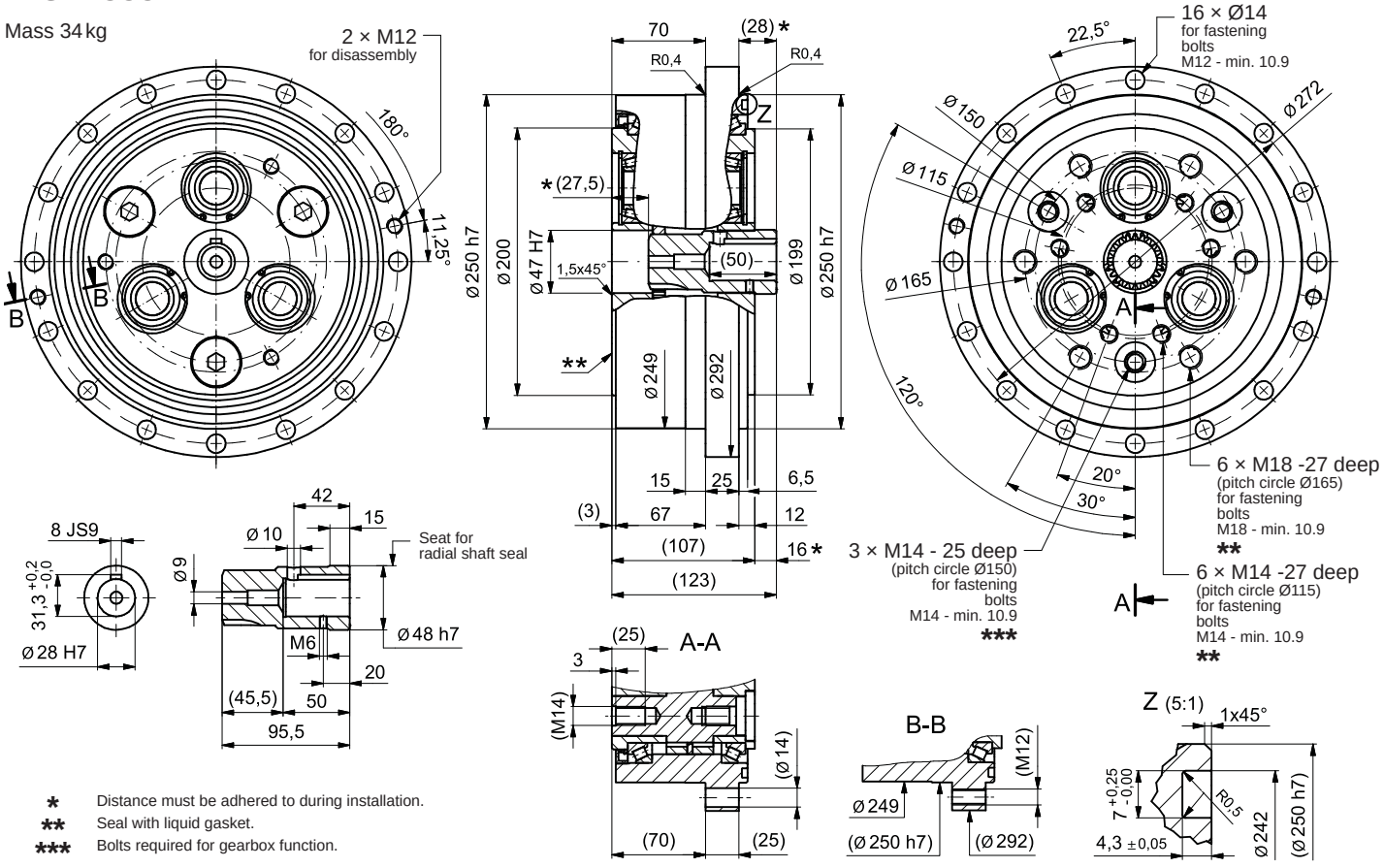
* Distance must be adhered to during installation.
** Seal with liquid gasket.
*** Bolts required for gearbox function.

F2C-T555



* Distance must be adhered to during installation.
** Seal with liquid gasket.
*** Bolts required for gearbox function.

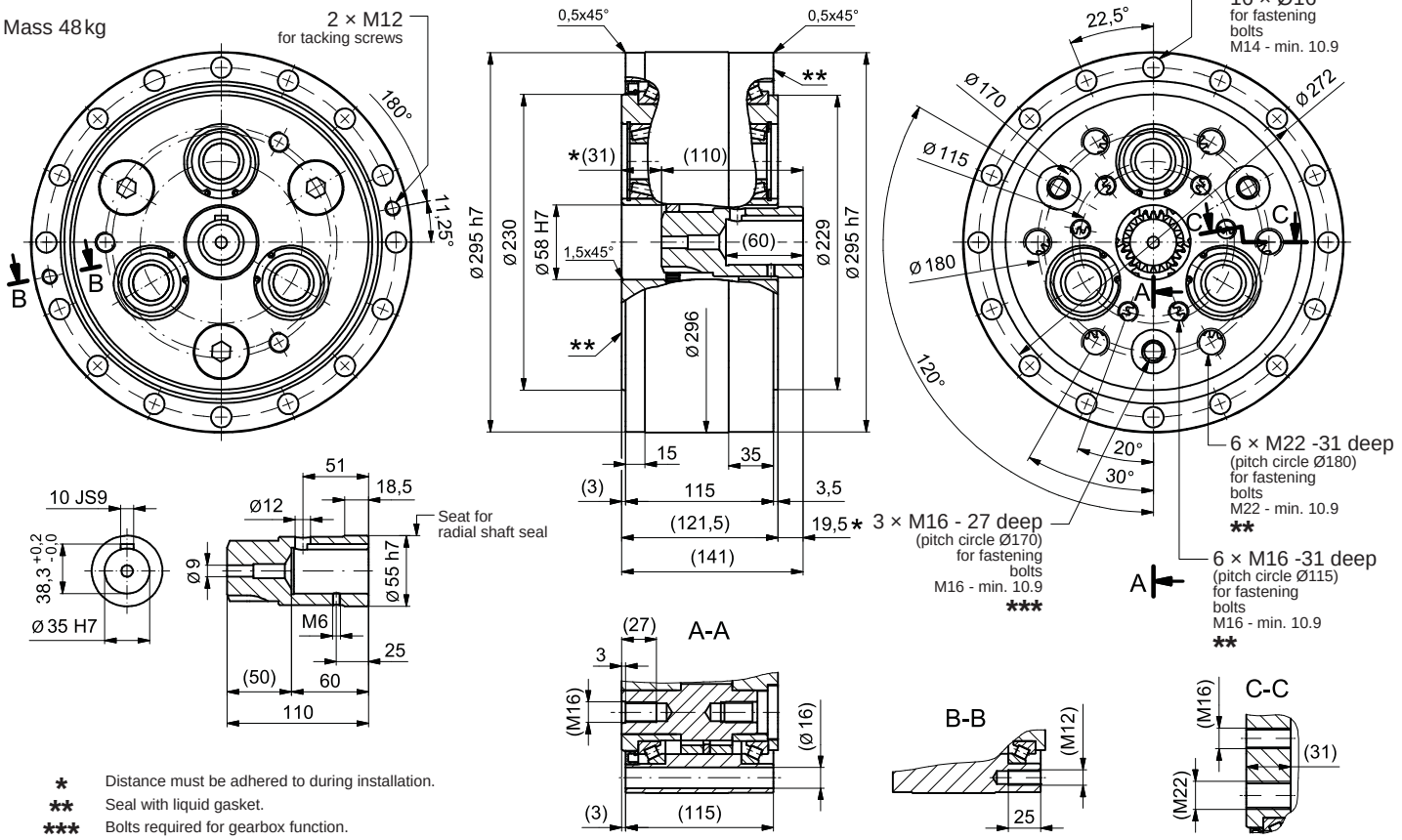
F2CF-T555



* Distance must be adhered to during installation.
** Seal with liquid gasket.
*** Bolts required for gearbox function.

F2C-T655

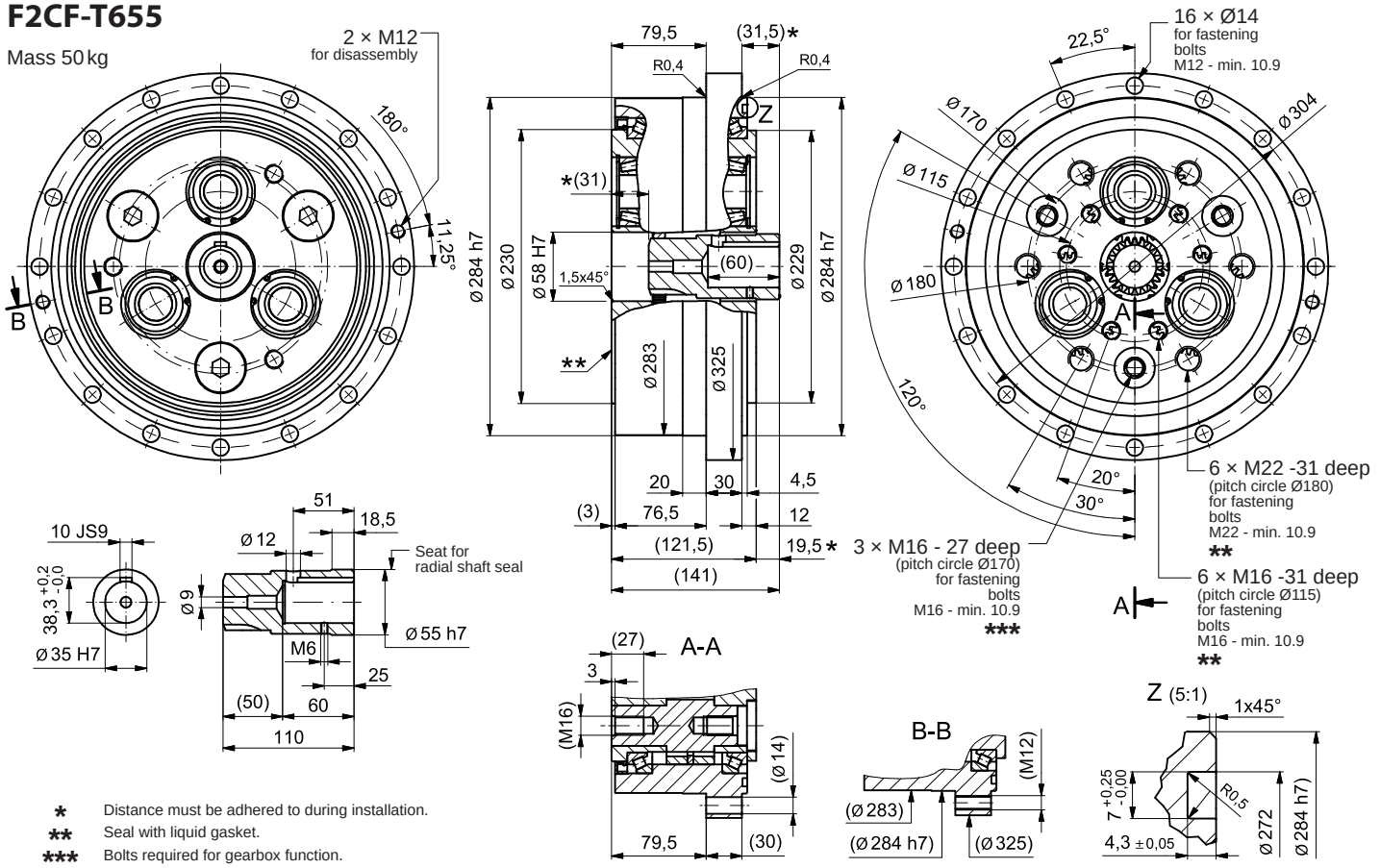
Mass 48 kg



* Distance must be adhered to during installation.
** Seal with liquid gasket.
*** Bolts required for gearbox function.

F2CF-T655

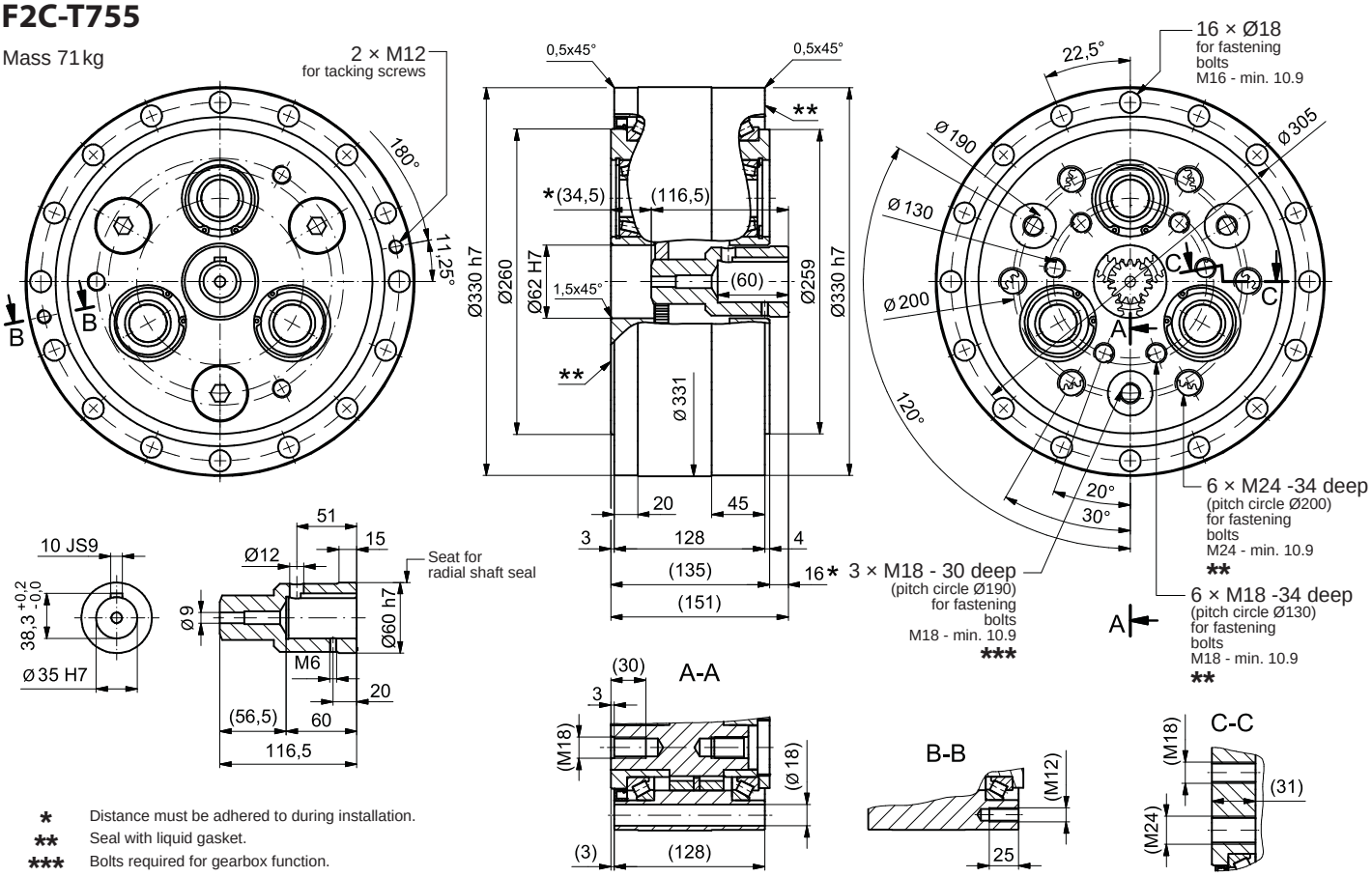
Mass 50 kg



* Distance must be adhered to during installation.
** Seal with liquid gasket.
*** Bolts required for gearbox function.

F2C-T755

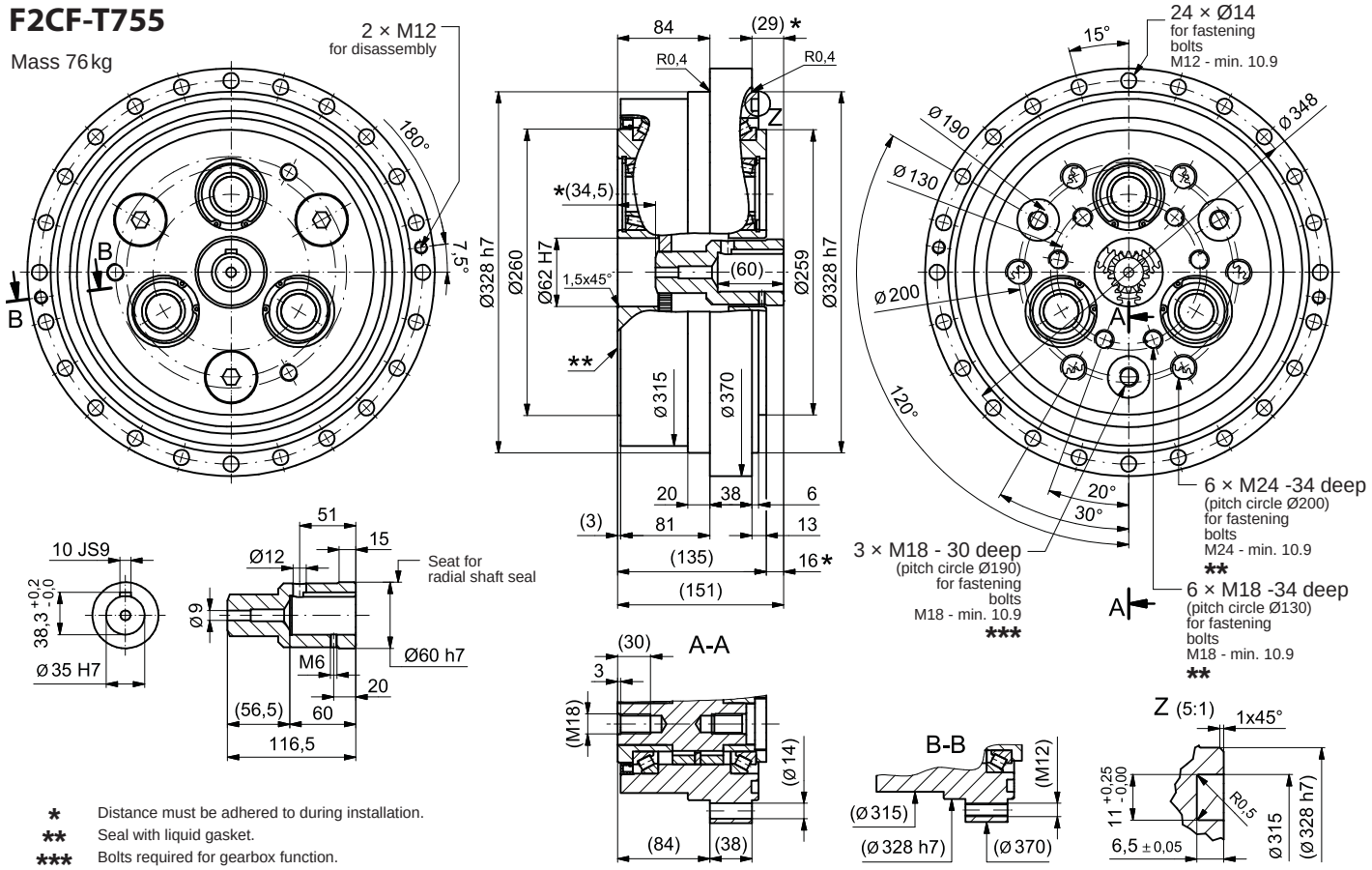
Mass 71 kg



* Distance must be adhered to during installation.
** Seal with liquid gasket.
*** Bolts required for gearbox function.

F2CF-T755

Mass 76 kg



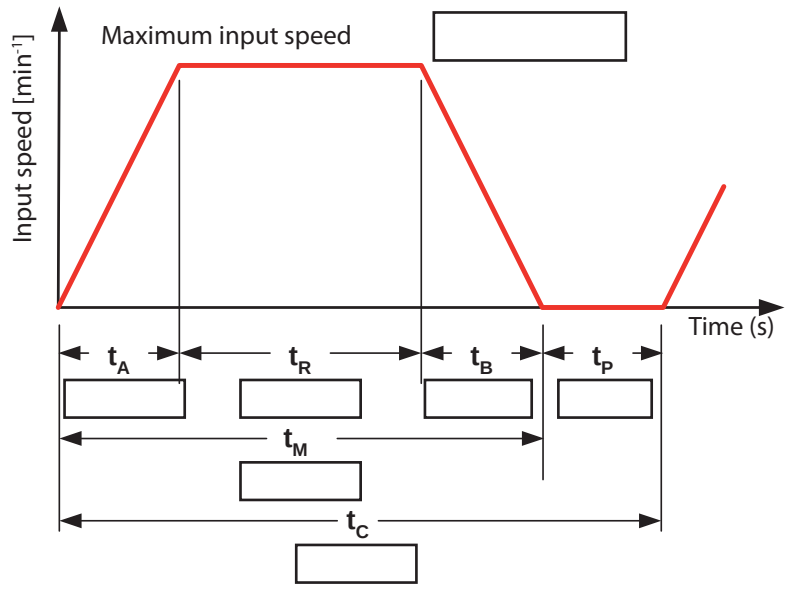
* Distance must be adhered to during installation.
** Seal with liquid gasket.
*** Bolts required for gearbox function.

9 Appendix

Precision gearbox - application data sheet

Specific application data is required for the selection of a suitable precision gearbox.
Please complete the following data sheet to enable us to respond quickly. Thank you.

1. Load cycle:



t_A = acceleration time

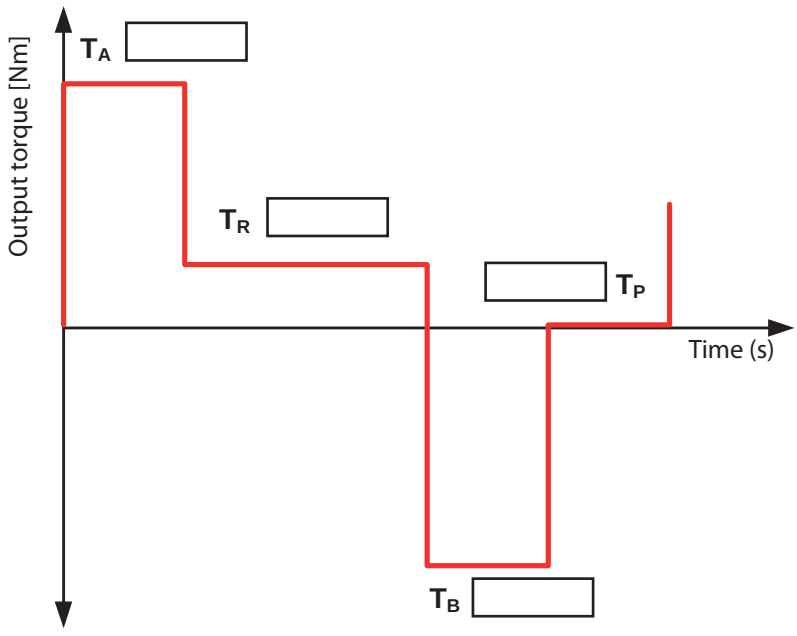
t_R = duration of uniform movement

t_B = braking time (deceleration time)

t_P = off-time - time between movements

t_M = duration of the movement phase of a working cycle ($t_A + t_R + t_B$)

t_C = duration of the entire working cycle ($t_M + t_P$)



T_A = torque when starting (acceleration torque)

T_R = torque at constant speed

T_B = brake torque (deceleration torque)

T_P = pause torque (to hold the position between the movements if necessary)

Precision gearbox - application data sheet

2. For how many hours a day is the application in operation? _____

3. What is the required reduction ratio? _____: 1

4. Please specify the following input power data (motor):

1. Nominal speed: _____ [min^{-1}]

2. Continuous static torque: _____ [Nm]

3. Peak torque: _____ [Nm]

4. Manufacturer: _____

5. Model number: _____

5. Shall Sumitomo provide an input adapter?

☐ yes
☐ no

If you have selected "Yes", please specify the dimensions of the input or submit a copy of the dimensioned drawing.

Is it a motor shaft with or without a key?

☐ With key
☐ Without key

6. How is the gearbox connected to the final load?

☐ Direct coupling
☐ Toothed belt or sprocket drive (go to number 8 on the next page)
☐ V-belt (go to number 8 on the next page)
☐ Toothed gearbox or other gearbox (go to number 8 on the next page)
☐ Other (go to number 8 on the next page)

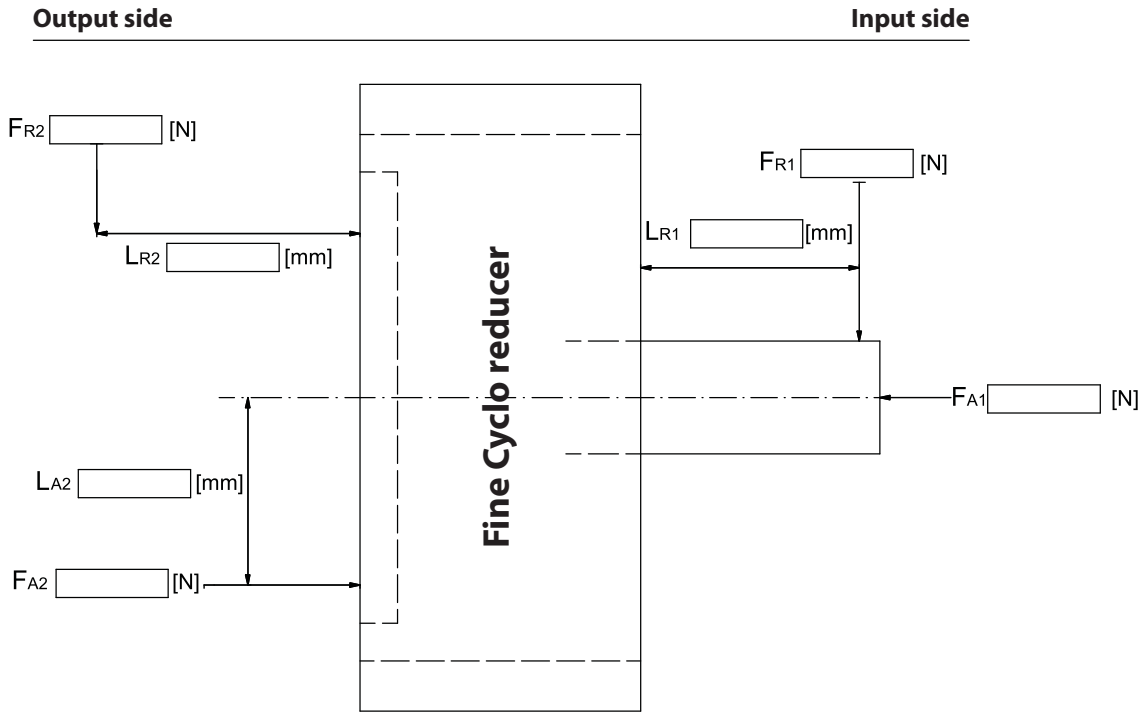
7. Please select one of the following load properties

☐ Uniform load
☐ Moderate impact load
☐ Heavy impact load

8. Radial and axial load

Is there a radial and/or axial load on the output flange?

☐ yes
☐ no



F_R = radial load
L_R = distance from radial force to flange collar
F_A = axial load
L_A = distance of the axial load from the centre line
1: Input side
2: Output side

9. Please describe your application in as much detail as possible (if possible, please enclose drawing).

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