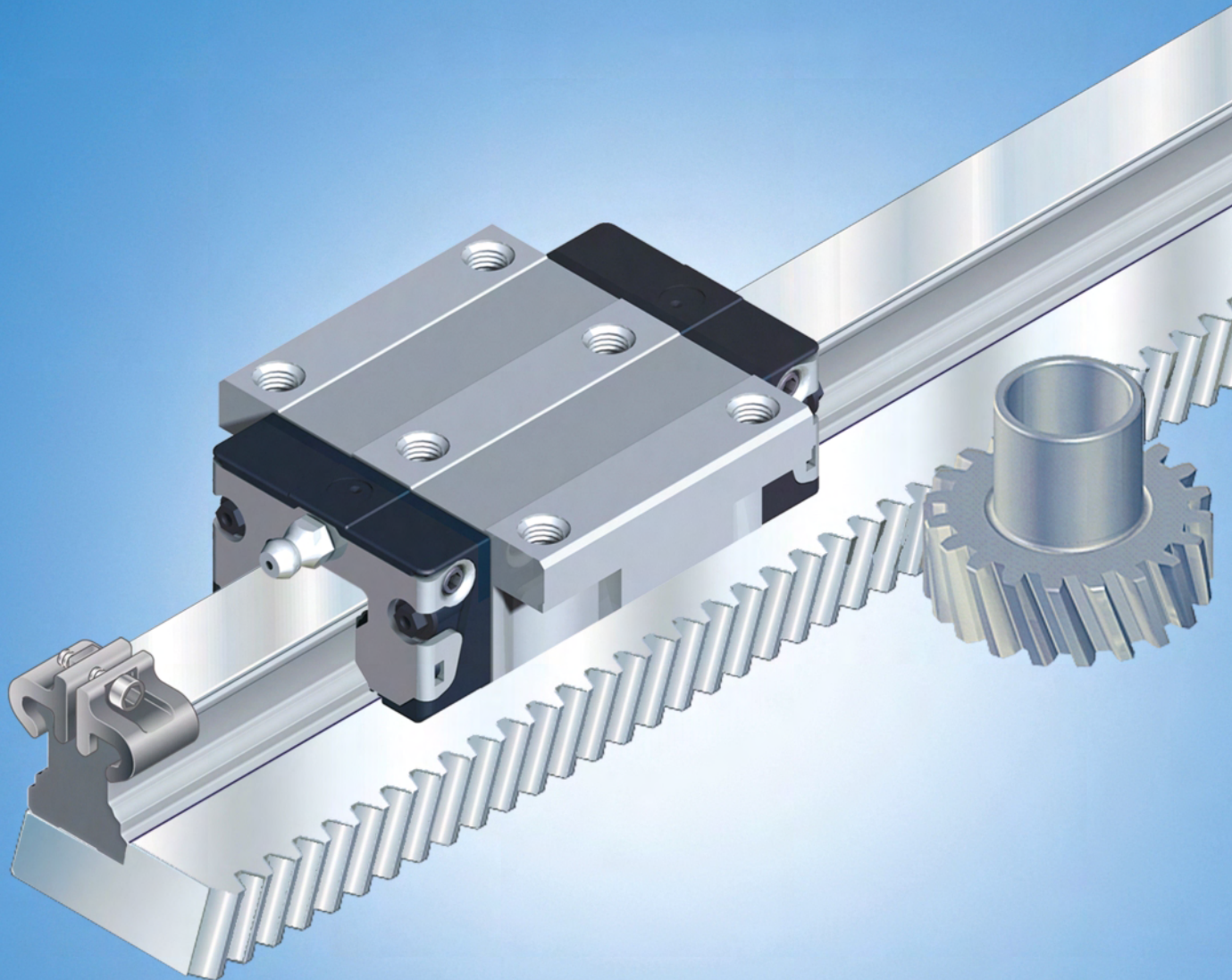


Ball Rail Systems with Gear Rack

R310EN 2217 (2005.01)

The Drive & Control Company



Linear Motion Technology

Ball Rail Systems

Standard Ball Rail Systems
 Super Ball Rail Systems
 Ball Rail Systems with Aluminum Runner Blocks
 High Speed Ball Rail Systems
 Corrosion Resistant Ball Rail Systems
 Wide Ball Rail Systems

Ball Rail Systems with Integrated Measuring System
 Braking and Clamping Units for Ball Rail Systems
Gear Racks for Ball Rail Systems
 Miniature Ball Rail Systems
 Cam Roller Guides

Roller Rail Systems

Standard Roller Rail Systems
 Wide Roller Rail Systems
 Heavy Duty Roller Rail Systems
 Roller Rail Systems with Integrated Measuring System
 Braking and Clamping Units for Roller Rail Systems
 Gear Racks for Roller Rail Systems

Linear Bushings and Shafts

Linear Bushings, Linear Sets
 Shafts, Shaft Support Rails, Shaft Support Blocks

Ball Transfer Units
 Traditional Engineering Components

Screw Drives

Linear Motion Systems

Linear Motion Slides	<ul style="list-style-type: none"> - Ball Screw Drive - Toothed Belt Drive
Linear Modules	<ul style="list-style-type: none"> - Ball Screw Drive - Toothed Belt Drive - Rack and Pinion Drive - Pneumatic Drive - Linear Motor
Compact Modules	<ul style="list-style-type: none"> - Ball Screw Drive - Toothed Belt Drive - Linear Motor
Multi-Axis Motion Systems	
Precision Modules	<ul style="list-style-type: none"> - Ball Screw Drive
Ball Rail Tables	<ul style="list-style-type: none"> - Ball Screw Drive - Linear Motor

Controllers, Motors, Electrical Accessories

Linear Actuators

Ball Rail Systems with Gear Rack

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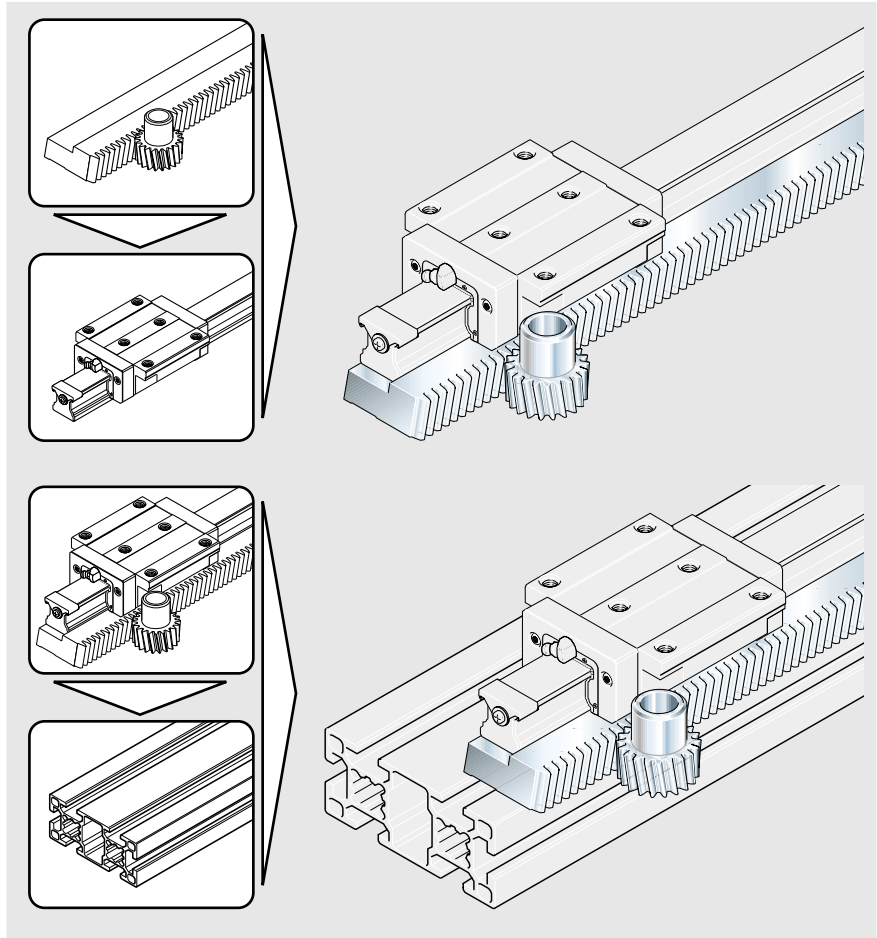
Product Overview

Gear rack, slot-type with helical teeth for all ball runner blocks

Only gear racks and runner blocks of the same size can be combined.

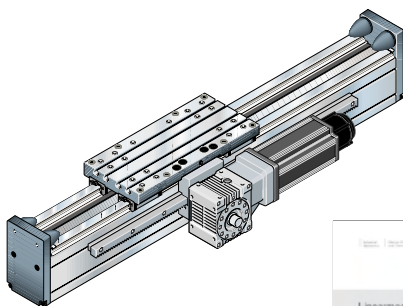
Gear rack size	Ball rail system size
25	25
30	30
35	35

Guide and gear rack can be mounted on profile system elements.

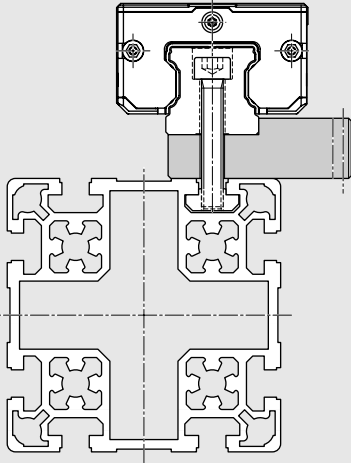
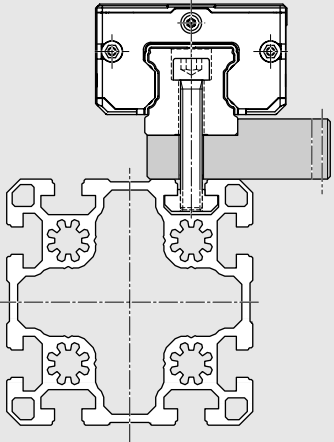
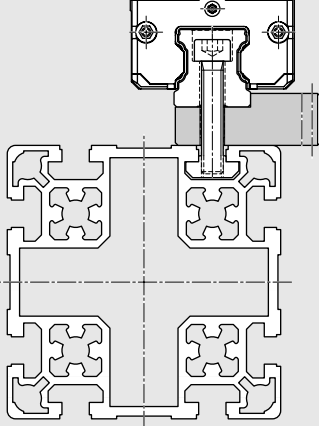
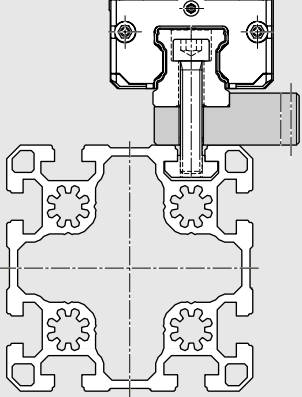
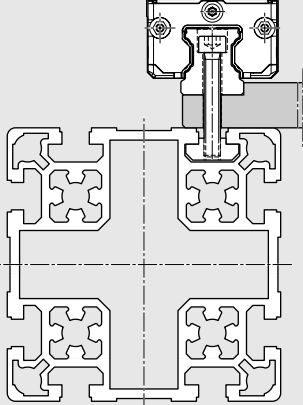
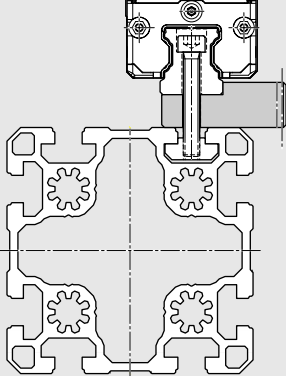


If desired, we can supply Linear Modules with rack and pinion drive. See "Linear Modules" catalog.

Gear racks with pinion drive are an addition to the Ball Rail Systems range.

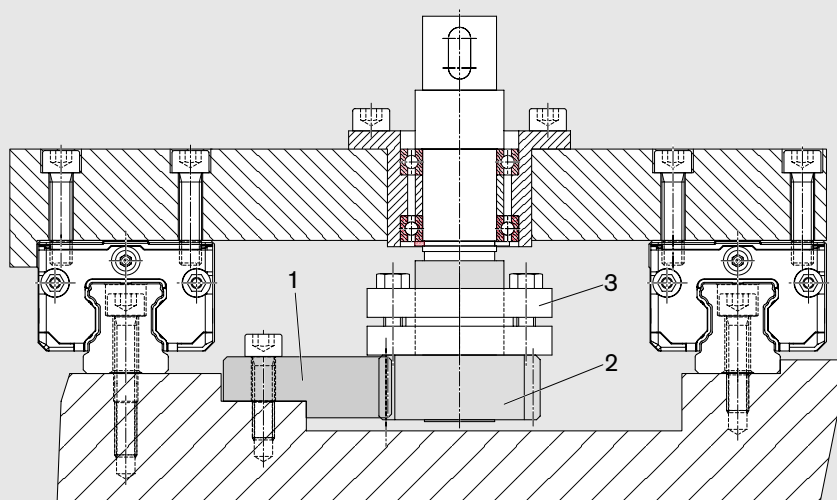
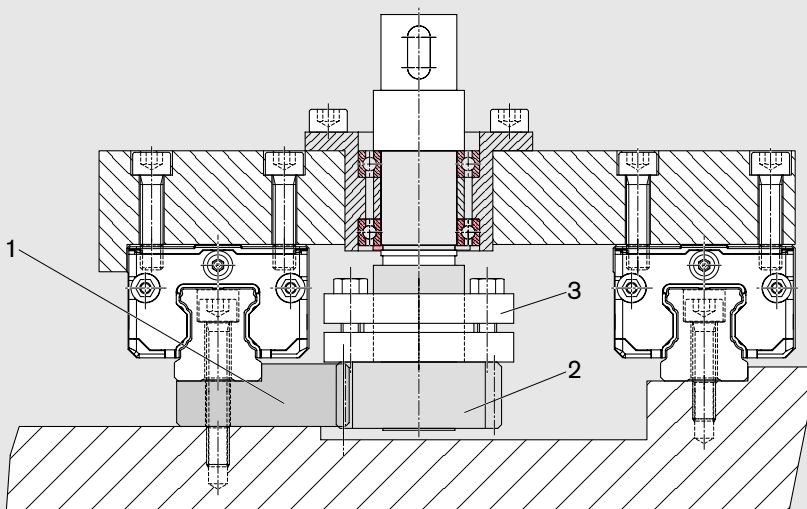
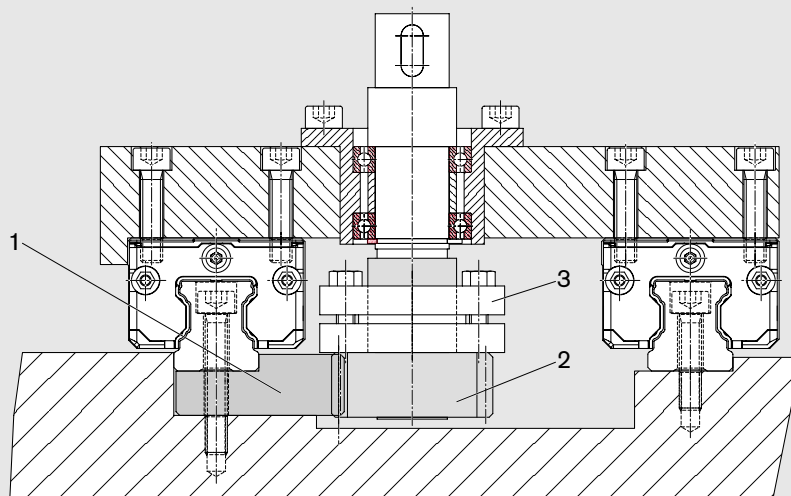


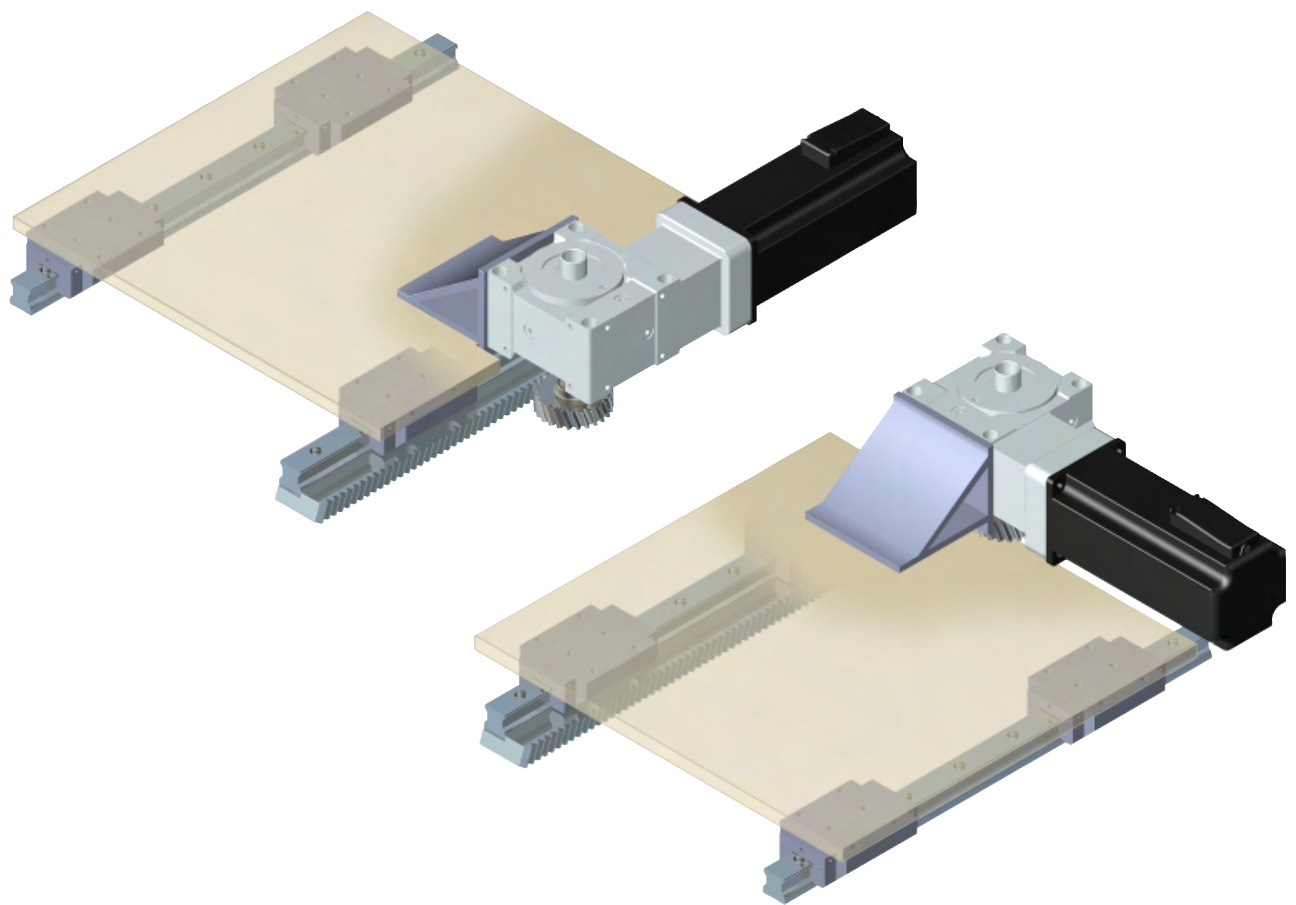
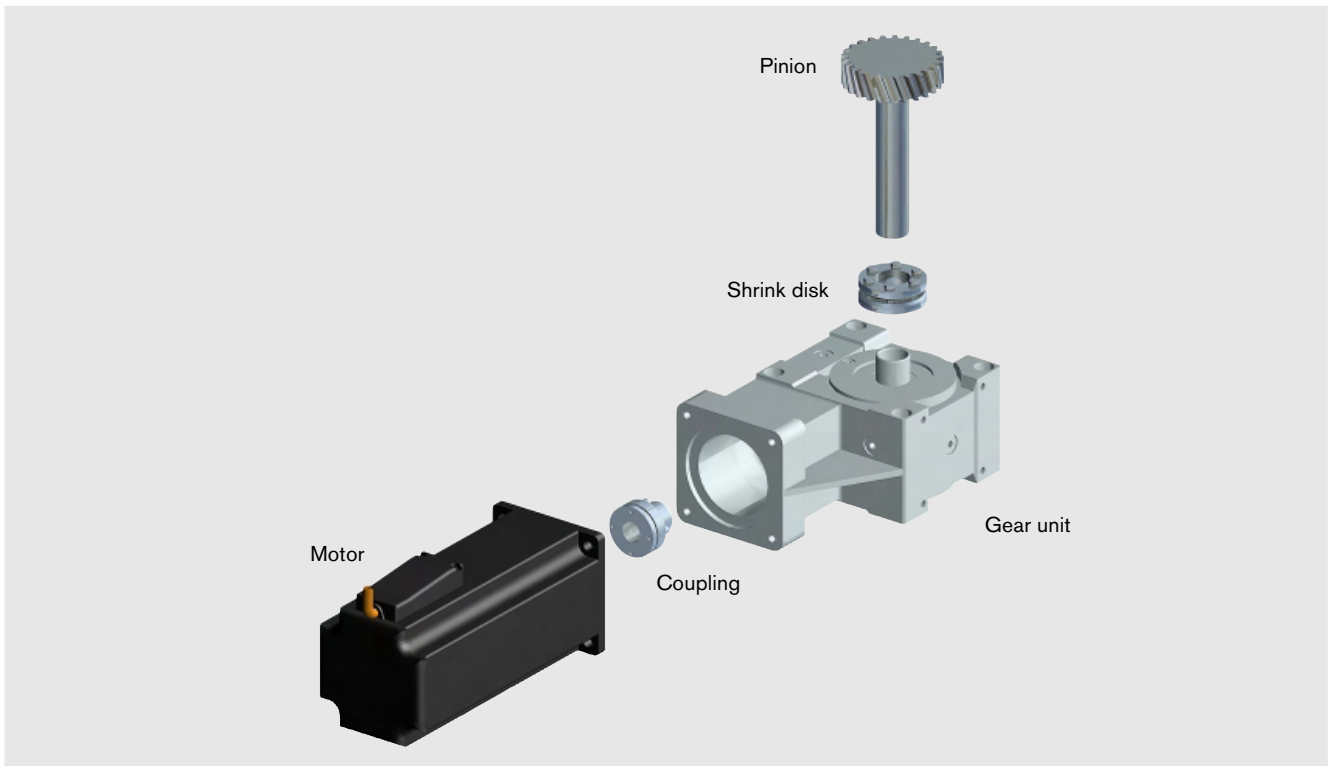
Combination Options with Profile System

Ball Rail System with gear rack	Mounted on profile 100 x 100	Mounted on profile 90 x 90
Size 35		
Size 30		
Size 25		

Application Examples

- 1 Gear rack
- 2 Pinion
- 3 Shrink disk





Combination Options

Real pitch module	Size	Gear Rack		Pinion		Shrink disk Part number
		Part number	Length	Part number	Version	
1,5	25	R2050 213 02	1200	R2051 253 01	T = 20 Collar d = 24	R3454 011 35 D = 24
		R2050 214 02	600	R2051 254 01	T = 25 Collar d = 24	
		R2050 215 02	300	R2051 274 01	T = 25 Shaft d = 25	R3454 010 89 D = 30
3	30	R2050 713 02	1200	R2051 353 01	T = 20 Collar d = 36	R3454 010 90 D = 36
		R2050 714 02	640	R2051 354 01	T = 25 Collar d = 36	
		R2050 715 02	320			
	35	R2050 313 02	1200	R2051 374 01	T = 25 Shaft d = 28	R3454 010 90 D = 36
		R2050 314 02	640			
		R2050 315 02	320			

Center distance	Gear unit Part number	Reduction	Coupling Part number	Motor Part number
Customer attachments e.g. shafts, bearings, side drive timing belts, gear unit, motor				
$a_0 = 50$	R3454 040 14	$i = 4,75$	R3454 001 08 Shaft d = 19	R3471 011 03 MKD 71B
	R3454 040 04	$i = 6,75$		
	R3454 040 05	$i = 9,25$		
	R3454 040 06	$i = 14,5$		
	R3454 040 07	$i = 19,5$		
	R3454 040 08	$i = 39,0$		
Customer attachments e.g. shafts, bearings, side drive timing belts, gear unit, motor				
$a_0 = 63$ for motor M.. 71	R3454 040 16	$i = 4,75$	R3454 001 07 Shaft d = 19	R3471 011 03 MKD 71B
	R3454 040 17	$i = 6,75$		
	R3454 040 18	$i = 9,25$		
	R3454 040 19	$i = 14,5$		
	R3454 040 20	$i = 19,5$		
	R3454 040 21	$i = 39,0$		
$a_0 = 63$ for motor M.. 90	R3454 040 15	$i = 4,75$	R3454 001 09 Shaft d = 24	R3471 013 03 MKD 90B
	R3454 040 09	$i = 6,75$		
	R3454 040 10	$i = 9,25$		
	R3454 040 11	$i = 14,5$		
	R3454 040 12	$i = 19,5$		
	R3454 040 13	$i = 39,0$		

Gear Rack with Helical Teeth

Gear rack, slot-type, with helical teeth

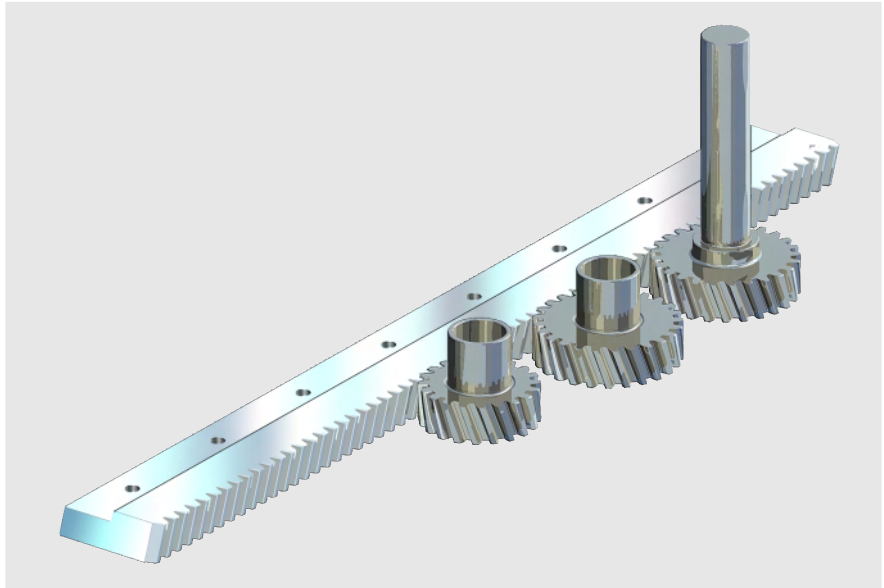
Inductively hardened and ground.
Quality grade 6 for all ball runner blocks

Pinion with helical teeth, with collar

Hardened teeth (HRC 52),
ground teeth, bore and collar.
Quality grade 6H24.

Pinion with helical teeth, with shaft

Case hardened (HRC 56) on all sides,
hardened teeth and shaft.
Quality grade 6H24.



Gear rack with helical teeth

Size	Dimensions [mm]													Part number	Weight [kg]
	L	m_t	H1	H2	T	T1	p_t	B1	(B2)	B3	B4	B5	S5		
25	1200	1,59	12	16,5	60	30	5	11,5	22,4	21,6	23,1	45,5	7	R2050 213 02	5,86
25	600	1,59	12	16,5	60	30	5	11,5	22,4	21,6	23,1	45,5	7	R2050 214 02	2,93
25	300	1,59	12	16,5	60	30	5	11,5	22,4	21,6	23,1	45,5	7	R2050 215 02	1,47
30	1200	3,18	14	19	80	40	10	14	27,5	22,47	25,47	53	9	R2050 713 02	7,53
30	640	3,18	14	19	80	40	10	14	27,5	22,47	25,47	53	9	R2050 714 02	4,02
30	320	3,18	14	19	80	40	10	14	27,5	22,47	25,47	53	9	R2050 715 02	2,0
35	1200	3,18	16	22	80	40	10	17	33,15	30,85	33,85	67	9	R2050 313 02	11,25
35	640	3,18	16	22	80	40	10	17	33,15	30,85	33,85	67	9	R2050 314 02	6,0
35	320	3,18	16	22	80	40	10	17	33,15	30,85	33,85	67	9	R2050 315 02	3,0

Pinion with helical teeth, with bore and collar

Module m_t : 1.59 mm for gear rack size 25, m_n : 1.5

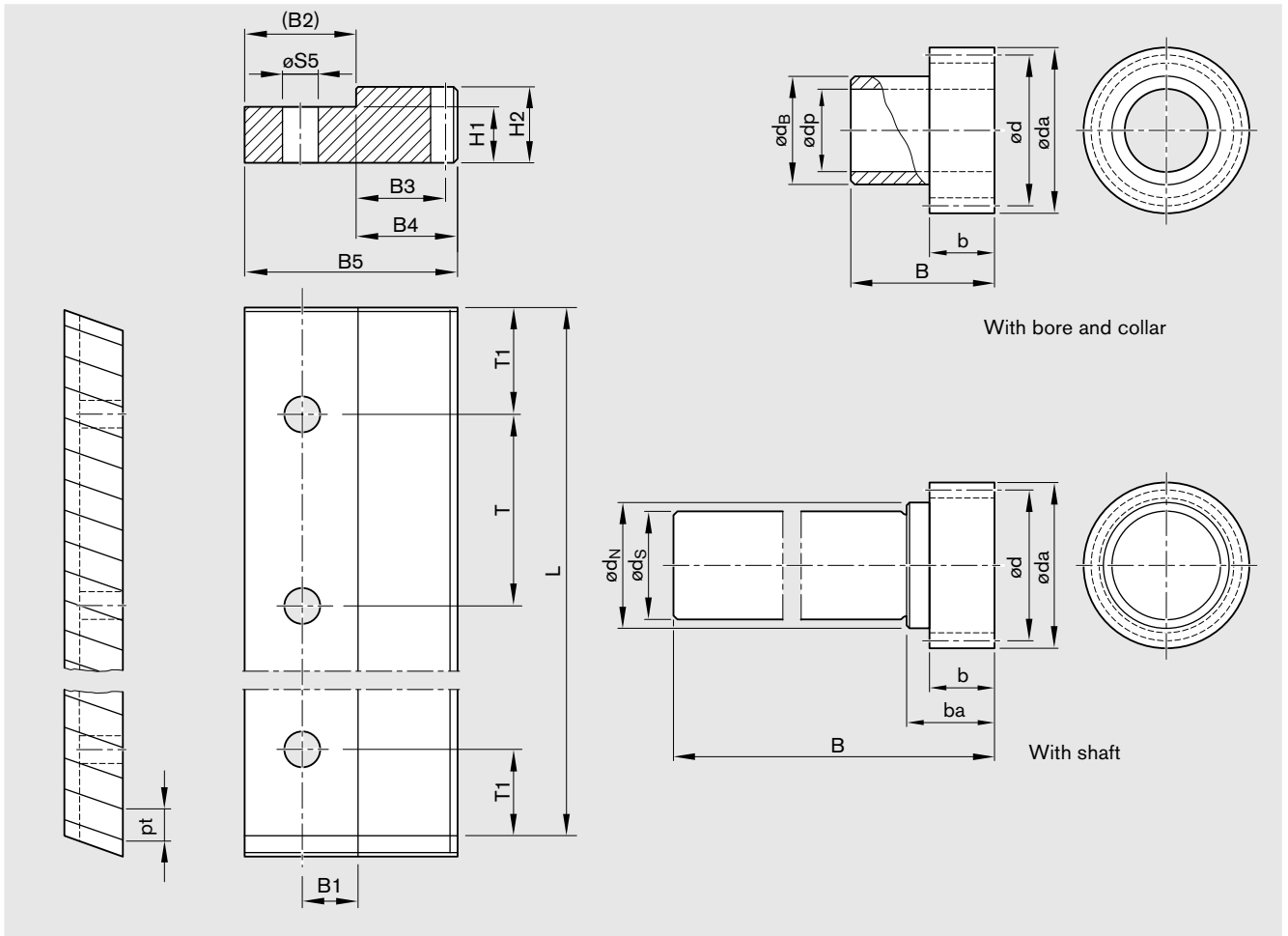
Number of teeth	Dimensions [mm]							Part number	Weight [kg]
	p_t	d_a	d	b	B	d_p H6	d_B h8		
20	5	34,8	31,831	17,5	43	19	24	R2051 253 01	0,103
25	5	42,8	39,789	17,5	43	19	24	R2051 254 01	0,164

Module m_t : 3.18 mm for gear rack size 30 and size 35, m_n : 3

Number of teeth	Dimensions [mm]							Part number	Weight [kg]
	p_t	d_a	d	b	B	d_p H6	d_B h8		
20	10	69,7	63,662	23	55	30	36	R2051 353 01	0,539
25	10	85,6	79,578	23	55	30	36	R2051 354 01	0,860

Customer drive shaft for pinion version with bore and collar combined with shrink disks.

For safe torque transmission, the clearance between the customer shaft and the bore must not be more than 0.017 mm. The shaft must be manufactured with a tolerance of j6.



Pinion with helical teeth with shaft for worm gear unit

Module m_t : 1.59 mm for gear rack size 25, m_n : 1.5

Number of teeth	Dimensions [mm]								Part number	Weight [kg]
	p_t	d_a	d	b	ba	d_s j6	B	d_N		
25	5	42,8	39,789	17,5	25	25	130	32	R2051 274 01	0,622

Module m_t : 3.18 mm for gear rack size 30 and size 35, m_n : 3

Number of teeth	Dimensions [mm]								Part number	Weight [kg]
	p_t	d_a	d	b	ba	d_s j6	B	d_N		
25	10	85,6	79,578	23	33	28	160	38	R2051 374 01	1,598

Number of teeth	Maximum transmittable torques M_{max} [Nm]		
	Module 1.59 mm Gear rack size 25 $P_t = 5$	Modul 3.18 mm Gear rack size 30 $P_t = 10$	Modul 3.18 mm Gear rack size 35 $P_t = 10$
	20	56	270
25	70	330	380

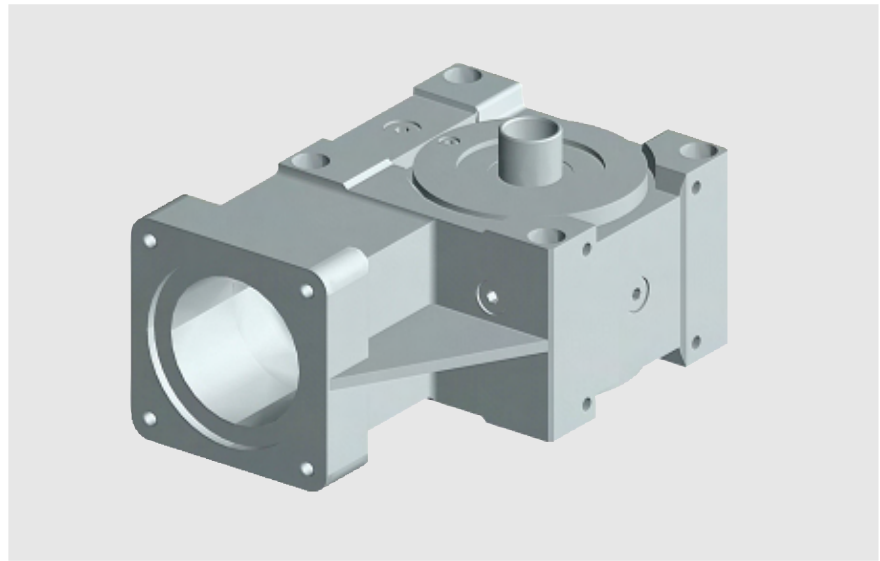
High Performance Servo Gear Unit with Adjustable Backlash

These high performance worm gears have been specially developed for use with the latest three-phase and DC servo motors.

Typical features of these servo-performance gear units are:

- adjustable low-clearance gearing (backlash $< 2'$)
- up to 70% higher load capacities
- casing of light metal for optimal heat dissipation
- robust tapered-roller bearings of the hollow drive output shaft permitting greater additional forces

The tooth shape has been optimized to allow easy adjustment of the gear backlash by simply changing the center distance using eccentric flanges. The use of ground, right-hand worms, a worm gear made from special worm-gear bronze, and dip-feed lubrication (special synthetic oil) ensures a high degree of efficiency, smooth running in both directions of rotation, and a long service life. The casing is machined on all sides. Its many fixing bores and tapped holes permit mounting in any position. The demand for an absolutely



force-locking and virtually torsion free connection between the gear unit and the output shaft, especially in intermittent operation, is met by a new gear version designed for shrink disk fastening of the output shaft.

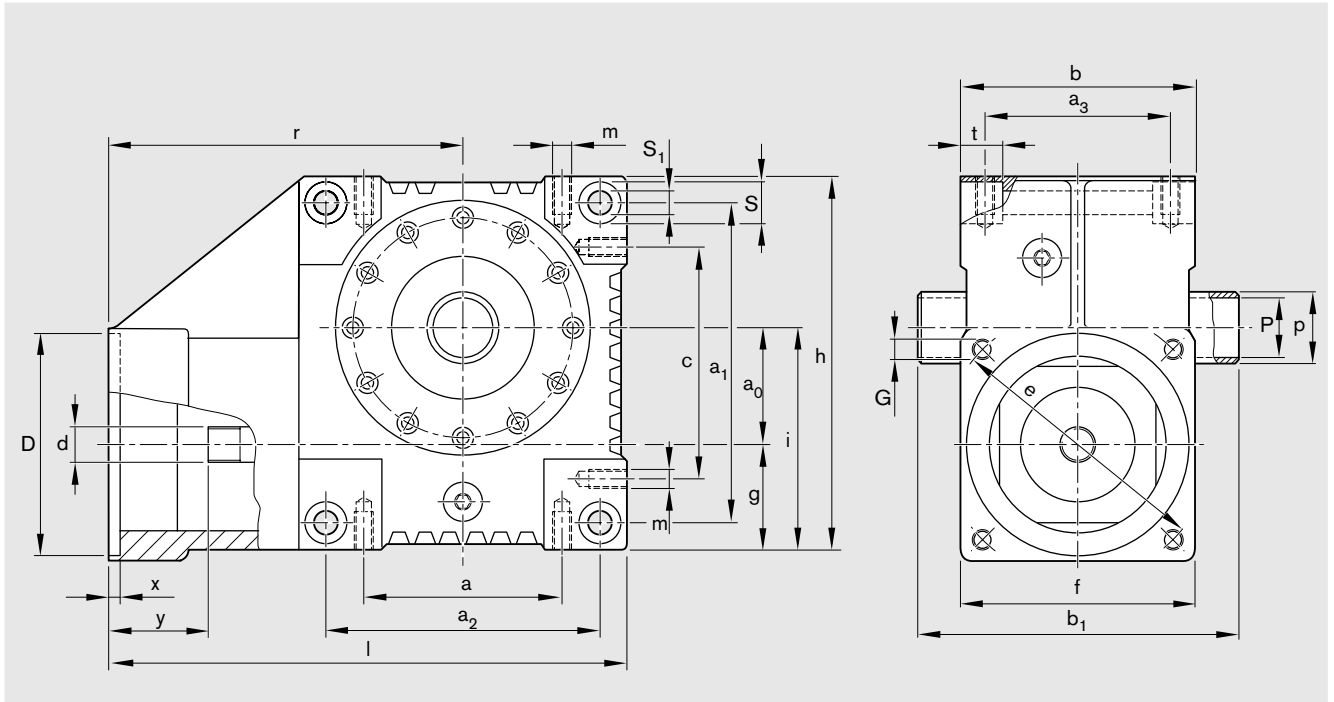
A special coupling ensures backlash-free power transmission from the drive motor to the servo gear. On the gear

side, internal gearing meshes with the crowned splines of the drive shaft. On the motor side the smooth drive shaft is rigidly clamped by annular spring elements.

Part numbers

Gear ratio i	Center distance $a_0 = 50$ mm for servo motor M.. 71		Center distance $a_0 = 63$ mm			
	Part number	J_{red} [10^{-4} kgm 2]	Part number	J_{red} [10^{-4} kgm 2]	Part number	J_{red} [10^{-4} kgm 2]
4,75	R3454 040 14	0,4830	R3454 040 16	1,8560	R3454 040 15	1,8560
6,75	R3454 040 04	0,4140	R3454 040 17	1,3720	R3454 040 09	1,3720
9,25	R3454 040 05	0,3490	R3454 040 18	0,9825	R3454 040 10	0,9825
14,50	R3454 040 06	0,2800	R3454 040 19	0,9590	R3454 040 11	0,9590
19,50	R3454 040 07	0,1960	R3454 040 20	0,6940	R3454 040 22	0,6940
39,00	R3454 040 08	0,2310	R3454 040 21	1,0100	R3454 040 23	1,0100

Dimensions



Center distance a_0	for motor	Dimensions [mm]																				Weight [kg]					
		a	a_1	a_2	a_3	b	b_1	c	d	D	e	f	g	G	h	i	l	m	p	P	r		S	S_1	t	x	y
50 $\pm 0,12$	M..71	85	138	118	80	100	137	100	14,7	95	130	115	45	M8	160	95	238	M8x16	25	30	168	18	10	16	5	58	8,0
63 $\pm 0,2$	M..71	110	175	145	105	130	168	125	24,7	95	130	115	52	M8	195	115	265	M10x15	28	36	180	18	11	25	5	48	12,0
63 $\pm 0,2$	M..90	110	175	145	105	130	168	125	24,7	110	165	140	52	M10	195	115	270	M10x15	28	36	185	18	11	25	5	53	12,5

High Performance Servo Gear Unit with Adjustable Backlash

Selection and load tables for high performance servo gear units

The values in the table are based upon wear or maximum flank load at 12,000 h full load and on servo operation. With continuous full-load operation it may be necessary to consider temperature limits! (If in doubt, please consult us.)

a ₀	i	T _{2max}	Drive speed n ₁ [min ⁻¹]														η at 1500 [Nm]
			500		750		1000		1500		3000		4000		5000		
			P ₁ [kW]	T ₂ [Nm]	P ₁ [kW]	T ₂ [Nm]	P ₁ [kW]	T ₂ [Nm]	P ₁ [kW]	T ₂ [Nm]	P ₁ [kW]	T ₂ [Nm]	P ₁ [kW]	T ₂ [Nm]	P ₁ [kW]	T ₂ [Nm]	
50	4,75	550	0,81	65	1,20	65	1,70	70	2,52	70	5,00	70	6,20	65	7,30	61	0,92
	6,75	400	0,50	56	0,77	59	1,10	63	1,75	69	3,50	69	4,40	65	5,20	61	0,91
	9,25	275	0,32	48	0,50	51	0,70	54	1,10	58	2,55	70	3,55	70	4,10	65	0,89
	14,50	350	0,26	57	0,40	60	0,5	65	0,89	70	1,82	75	2,50	75	3,15	75	0,83
	19,50	250	0,16	45	0,25	48	0,34	50	0,55	55	1,20	65	1,65	65	2,10	65	0,81
	39,00	200	0,12	53	0,17	56	0,24	60	0,37	65	0,77	75	1,00	75	1,25	75	0,70
63	4,75	1000	2,10	170	3,30	180	4,40	180	6,11	170	10,30	145	13,20	135	-	-	0,92
	6,75	750	1,50	170	2,35	180	3,10	180	4,25	170	7,20	145	9,30	135	-	-	0,91
	9,25	500	0,74	115	1,18	125	1,63	130	2,52	135	4,93	135	6,35	126	-	-	0,90
	14,50	600	0,74	165	1,19	180	1,54	180	2,45	180	4,18	170	5,25	160	-	-	0,84
	19,50	500	0,39	115	0,61	125	0,85	130	1,28	135	2,98	165	3,83	155	-	-	0,83
	39,00	450	0,30	140	0,44	150	0,61	160	0,97	175	1,88	190	2,55	190	-	-	0,73

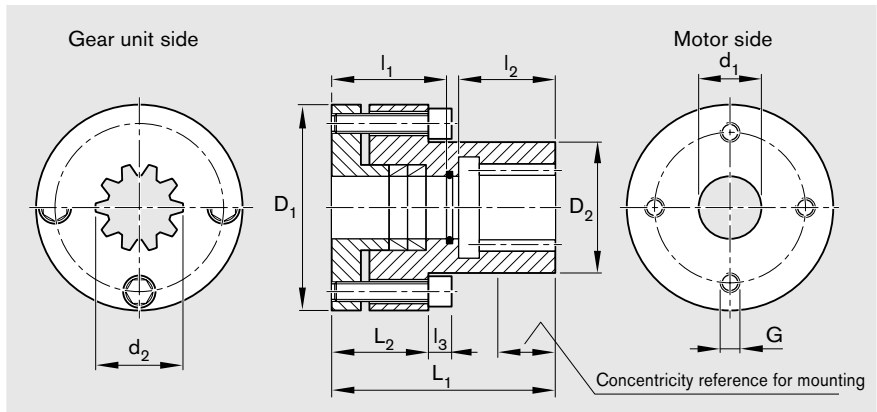
T_{2max} = statistical torque to avoid tooth fracture
 P₁ = drive power in kW
 T₂ = output torque in Nm

Special couplings for motor/gear units

Rigid model, nitrided, preassembled for motor shafts without key

Bore on gear unit side, low-clearance internal spline similar to DIN 5480 for push-fitting

Bore on motor side with annular spring elements as clamping connection

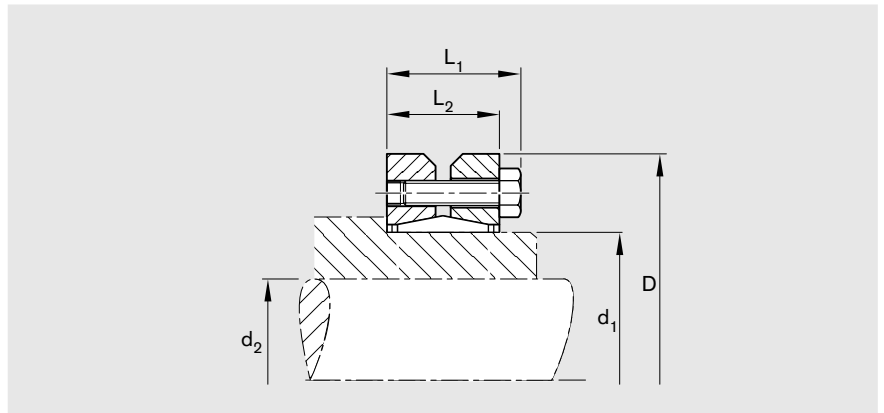


Part number	Dimensions [mm]										J _{red} [10 ⁻⁴ kgm ²]	Tightening torque [Nm]	Weight [kg]
	d ₁	d ₂	D ₁	D ₂	l ₁	l ₂	l ₃	L ₁	L ₂	G			
R3454 001 08	19	15x1,25x10	48	29	24	16	5	40	18	4 x M5	0,799	7	0,40
R3454 001 07	19	15x1,25x10	48	29	23	17	5	55	18	4 x M5	0,853	7	0,45
R3454 001 09	24	25x1,25x18	50	29	41,5	24	6	66,5	59,5	4 x M6	2,628	10	0,75

Shrink disk clamping kits for output shafts

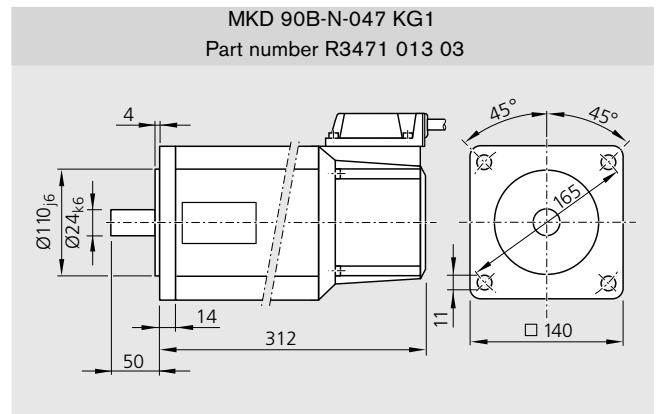
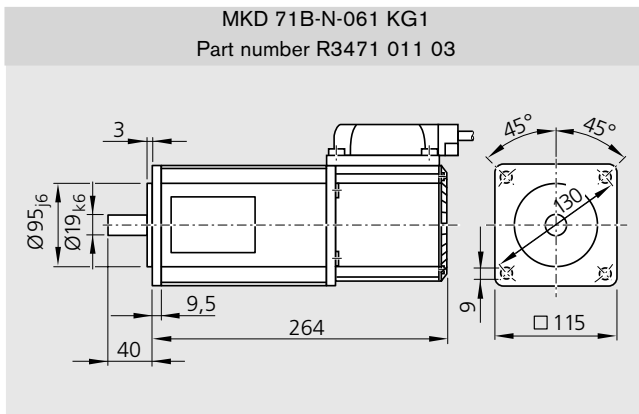
Supplied as complete kits

$$J_{red} = \frac{J}{i^2}$$



Part number	Dimensions [mm]						G	J [10 ⁻⁴ kgm ²]	Tightening torque [Nm]	Weight [kg]
	d ₁	d ₂	D	L ₁	L ₂					
R3454 011 35	24	19	50	24,5	21	6xM5	1,756	5	0,20	
R3454 010 89	30	25	60	26	22	7xM5	1,756	5	0,30	
R3454 010 90	36	28	72	28	24	5xM6	4,029	12	0,40	

Dimensions of AC servo motors



Motor data of AC servo motors

Motor		MKD 71B	MKD 90B
Maximum effective speed n _{max}	[min ⁻¹]	⚡	⚡
Rated torque M _N	[Nm]	8	12
Maximum torque M _{max}	[Nm]	⚡	⚡
Mass moment of inertia J _M + J _{Br}	[10 ⁻⁶ kgm ²]	870 + 72	4300 + 360
Brake holding torque M _{Br}	[Nm]	5	11
Mass with brake m _{Br}	[kg]	9,42	15,1

⚡ See catalog RE 82 710, Controllers, Electrical Accessories

Lubrication and Calculation of the Gear Rack Drive

Lubrication of the gear rack drive

The teeth of the gear rack have to be lubricated with grease after approx. 280 hours of operation. For units used in difficult operating conditions the lubrication intervals have to be shortened. Gear racks and pinions have to be cleaned of dirt and residues of old grease.

Lubricants for gear racks

Recommended lubricants for felt gear rack lubrication: Klüber Microlube GB 0 Klüber Structovis AHD Other lubricants: Rexroth Dynalub 520	Recommended lubricants for brush/manual lubrication: Klüber Microlube GB 0 Other lubricants: Rexroth Dynalub 510
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Part numbers	Designation acc. to Rexroth	Designation acc. to DIN51825	Consistency class to DIN 51818	Temperature range [°C]	Packing unit
R3416 037 00	Dynalub 510	KP2K	2	-20 up to +80	1 x 400 g
R3416 043 00	Dynalub 520	KP00P	00	-20 up to +80	1 x 400 g

Lubricants for runner blocks

Runner blocks are greased in-factory with Dynalub 510. Dynalub 510 is also recommended for re-lubrication.

Calculation

for a horizontal axis

$$F_H = F_R + m \cdot a; [N]$$

F_R = friction of all the runner blocks used [N]
 $= F_1 + F_2$

for a vertical axis

$$F_V = \pm m \cdot g + m \cdot a + F_R; [N]$$

m = moved mass [kg]
 $g = 9,81 \frac{m}{s^2}$;
 a = acceleration [$\frac{m}{s^2}$]

$$M_{req.} = \frac{F_V \cdot d}{2} ; [Nm]$$

$$M_{perm.} = \frac{M_{max.}}{k \cdot s \cdot f} ; [Nm]$$

Type of loading k

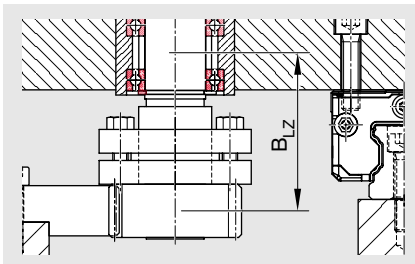
Drive	Type of loading k of the machine to be driven		
	Uniform	Medium shocks	Severe shocks
Uniform	1,00	1,25	1,75
Medium shocks	1,25	1,50	2,00
Severe shocks	1,50	1,75	2,25

Safety factor s

1.1 - 1.4

Service life factor f

Axial distance between rotary bearing centerline and pinion tooth width centerline.



Axial bearing distance B_{LZ}	Peripheral speed	Service life factor f			
		1 x tooth width Lubrication		2 x tooth width Lubrication	
		Continuous	Daily	Continuous	Daily
0,5	30	0,85	0,95	1,05	1,15
1,0	60	0,95	1,10	1,15	1,30
1,5	90	1,00	1,20	1,20	1,45
2,0	120	1,05	1,30	1,25	1,60
3,0	180	1,10	1,50	1,40	1,90
5,0	300	1,25	1,90	1,55	2,30

Condition

$$M_{req.} \leq M_{perm.}$$

Frictional forces

Ball runner blocks, frictional forces F_1, F_2

1. Frictional forces F_1

Ball runner block, standard length, on a guide rail with cover strip

Size	Up to approx. 10 μm clearance [N]	Preload class		
		Preload 0.02 C [N]	Preload 0.08 C [N]	Preload 0.13 C [N]
25	13,5	18,5	22,5	26,5
30	15,8	21,8	26,8	32,8
35	20,8	28,8	34,8	42,8

Ball runner block, long, on a guide rail with cover strip

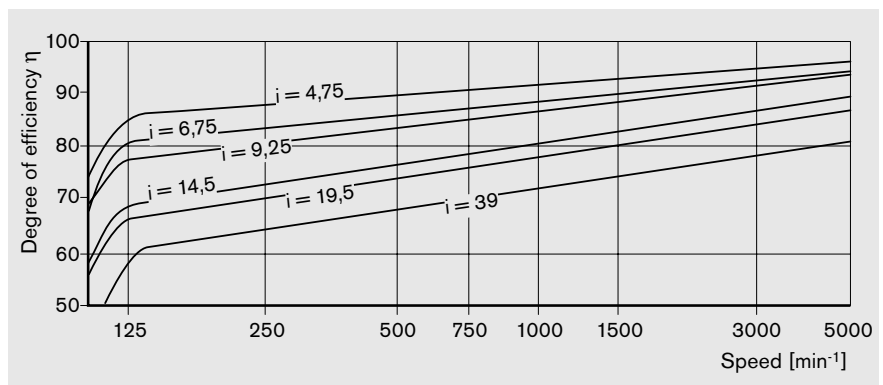
Size	Up to approx. 10 μm clearance [N]	Preload class		
		Preload 0.02 C [N]	Preload 0.08 C [N]	Preload 0.13 C [N]
25	13,5	20,5	25,5	30,5
30	15,8	23,8	29,8	36,8
35	20,8	29,8	37,8	48,8

2. Frictional forces F_2

$$F_2 = F \times 0,003 \text{ [N]} \quad F = \text{resulting external force [N]}$$

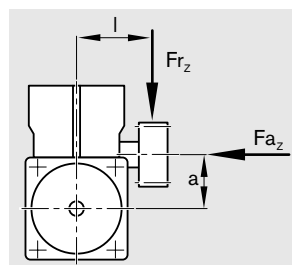
Gearing efficiency of servo worm gear units

with driving worm and under full load



Additional loads on drive output

The data given are reference values. You should consider the forces arising from the choice of tooth system. It is assumed that the point of action of the force is the center of the shaft journal. In cases where additional axial forces occur, over and above high transverse forces, please ask for advice.



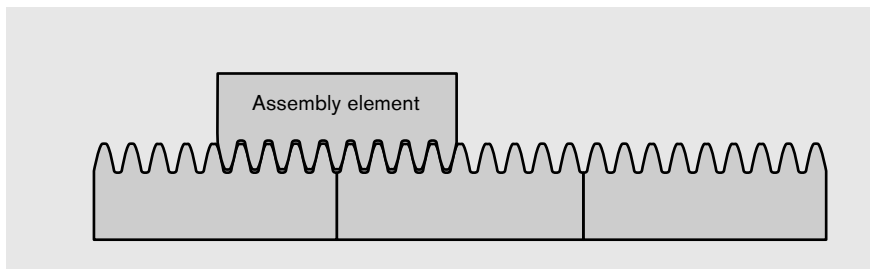
Center distance a [mm]	Dimensions center casing/center teeth l [mm]	Max. additional load	
		radial F_{r_z} [N]	axial F_{a_z} [N]
50	90	3600	1800
	140	2300	1800
63	110	5000	2500
	160	3500	2500

Mounting the Gear Rack Drive

Mounting

Composite gear racks:

Composite gear racks are mounted with an assembly element.



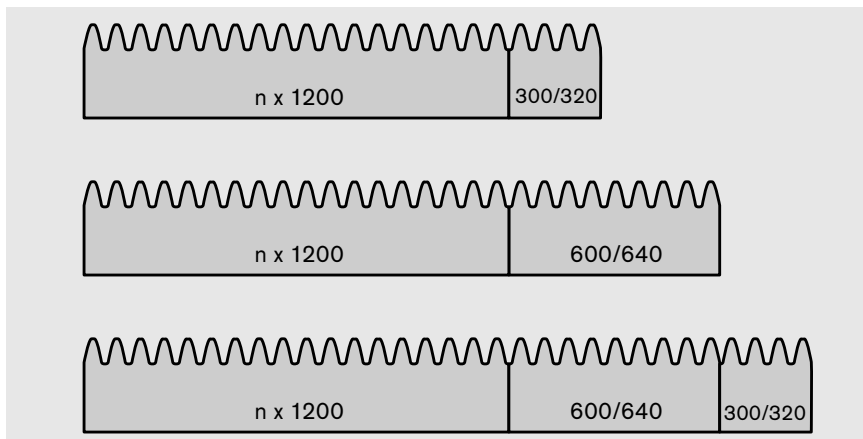
Gear rack with helical teeth Assembly elements

Size	L [mm]	m _t [mm]	Part number	
			Gear rack	Assembly element
25	200	1,59	R2050 213 02	R2052 213 01
30	200	3,18	R2050 713 02	R2052 713 01
35	200	3,18	R2050 313 02	R2052 713 01

Tooth flank clearance:

To be adjusted according to the required level of precision. For normal applications, do not set a value smaller than 0.02 mm over the entire travel path.

Length grid



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Subject to technical modifications.

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Ball Rail Systems
with Gear Rack
R310EN 2217 (2005.01)



Поставки промышленного оборудования

Системы линейного перемещения:

- линейные подшипники
- линейные направляющие
- прецизионные валы
- линейные модули
- координатные столы
- системы позиционирования
- шариковинтовые передачи (ШВП),
и роликвинтовые передачи (РВП),
стандартизованные и по чертежам
заказчика, опоры к ШВП и РВП
- линейные приводы и актуаторы
- электромеханические приводы

Сборочные технологии:

- модульные системы профилей

Прецизионное оборудование:

- шпиндели

Промышленные вентиляторы:

- центробежные вентиляторы низкого,
среднего и высокого давления
- осевые вентиляторы
- калориферы
- канальные вентиляторы
- вентиляторы отводного канала
- крышные вентиляторы
- бытовые вентиляторы

Другая продукция:

- опорно-поворотные устройства
- шариковые опоры
- уплотнения, муфты, ремни, шкивы
- другая продукция промышленного
назначения

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