

A- II Technical Description of NSK Linear Guides

A- II -1 Accuracy

A- II -1.1 Accuracy Standard

• Table II-1•1, Figure II-1•1 and Figure II-1•2 show accuracy characteristics.

Table II-1•1 Definition of accuracy

Characteristics	Definition (Figures II-1•1, II-1•2)
Mounting height H	Distance from A (rail bottom datum face) to C (ball slide top face)
Variation of H	Variation of H in ball slides assembled to the rails of a set of linear guide
Mounting width W_2 or W_3	Distance from B (rail side datum face) to D (ball slide side datum face). Applicable only to the reference linear guide.
Variation of W_2 or W_3	Difference of the width (W_2 or W_3) between the assembled ball slides which are installed in the same rail. Applicable only to the reference linear guide.
Running parallelism of ball slide, face C to face A	Variation of C (ball slide top face) to A (rail bottom datum face) when ball slide is moving.
Running parallelism of ball slide, face D to face B	Variation of D (ball slide side datum face) to B (rail side datum face) when a ball slide is moving.

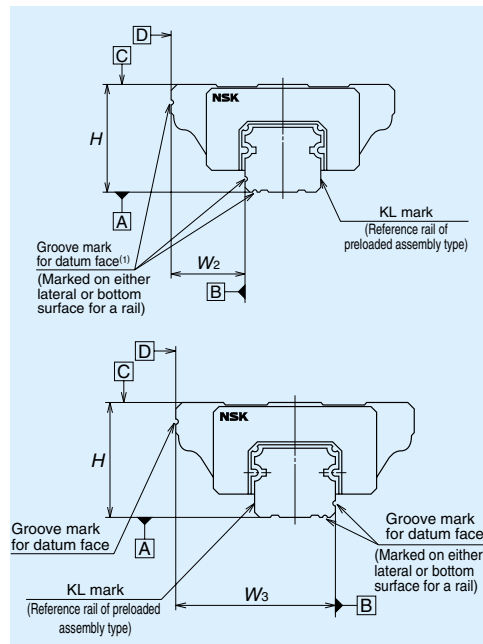


Fig. II-1.1 Assembled accuracy (Height and width)

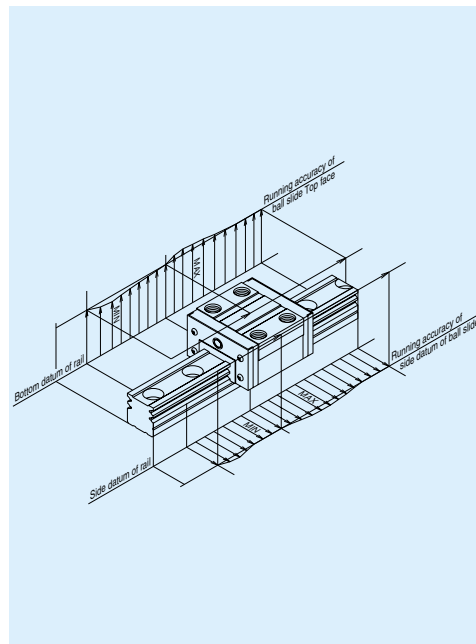


Fig. II-1.2 Running parallelism of ball slide

Mounting width: W_2 , W_3

- Mounting width differs depending on the arrangement of the datum faces of the rail and ball

slide on the reference linear guide (indicated as KL on the rail). (Fig. II-1•3 and Fig. II-1•4)

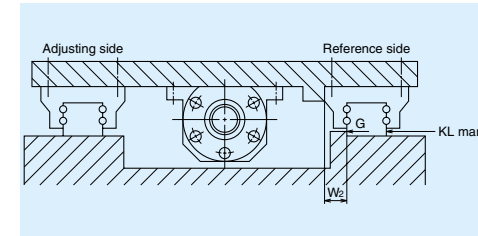


Fig. II-1.3 Mounting width W_2

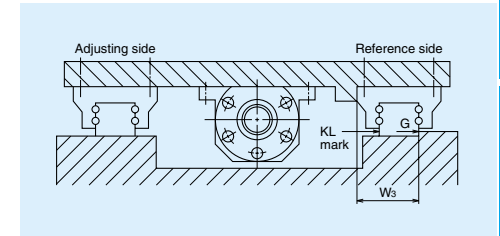


Fig. II-1.4 Mounting width W_3

A- II -1.2 Running Parallelism of Ball Slide

- Running parallelism of ball slide is common in all series. Specifications of all accuracy grades are shown in Table II-1•2.

However, applicable accuracy grades differ by series. Please refer to "Table I-3.1 Accuracy grade and applicable series" on page A22.

Table II-1•2 Running parallelism of ball slide

Unit: μm

Rail over all length (mm) over or less	Preloaded assembly (Non-interchangeable)					Interchangeable type
	Ultra precision P3	Super precision P4	High precision P5	Precision grade P6	Normal grade PN	Normal grade PC
~50	2	2	2	4.5	6	6
50~80	2	2	3	5	6	6
80~125	2	2	3.5	5.5	6.5	6.5
125~200	2	2	4	6	7	7
200~250	2	2.5	5	7	8	8
250~315	2	2.5	5	8	9	9
315~400	2	3	6	9	11	11
400~500	2	3	6	10	12	12
500~630	2	3.5	7	12	14	14
630~800	2	4.5	8	14	16	16
800~1000	2.5	5	9	16	18	18
1000~1250	3	6	10	17	20	20
1250~1600	4	7	11	19	23	23
1600~2000	4.5	8	13	21	26	26
2000~2500	5	10	15	22	29	29
2500~3150	6	11	17	25	32	32
3150~4000	9	16	23	30	34	34

A-II-1.3 Accuracy Standard in Each Series

LH, LS, LA, LY, LW Series

Table II-1.3 shows accuracy standards of the preloaded assembly in LH, LS, LA, LY and LW Series. Table II-1.4 shows accuracy standards of LH

Series interchangeable type. Table II-1.5 shows accuracy standards of LS and LW Series interchangeable type.

Table II-1.3 Tolerance of preloaded assembly in LH, LS, LA, LY and LW Series Unit: μm

Characteristic	Accuracy grade	Ultra precision P3	Super precision P4	High precision P5	Precision grade P6	Normal grade PN
Mounting height H Variation of H (all ball slides installed in rails for a set of linear guides)		± 10 3	± 10 5	± 20 7	± 40 15	± 80 25
Mounting width W_2 or W_3 Variation of W_2 or W_3 (all ball slides on the reference linear guide)		± 15 3	± 15 7	± 25 10	± 50 20	± 100 30
Running parallelism of ball slide, face C to face A Running parallelism of ball slide, face D to face B		Refer to Figure II-1*1 and Table II-1*2				

Table II-1.4 Tolerance of LH Series interchangeable type: Normal grade PC Unit: μm

Characteristics	Model No.	LH15, 20, 25, 30, 35	LH45, 55, 65
	Interchangeable type with clearance		
Mounting height H		± 20	± 30
Variation of mounting height H		15① 30②	20① 35②
Mounting width W_2 or W_3		± 30	± 35
Variation of mounting width W_2 or W_3		25	30
Running parallelism of ball slide, face A to face C Running parallelism of ball slide, face B to face D		See Fig. II-1.1 and Table II-1*2.	
Interchangeable type with preload			
Mounting height H		± 20	± 30
Variation of mounting height H		15① 30②	20① 35②
Mounting width W_2 or W_3		± 30	± 35
Variation of mounting width W_2 or W_3		25	30
Running parallelism of ball slide, face A to face C Running parallelism of ball slide, face B to face D		See Fig. II-1.1 and Table II-1*2.	

Table II-1.5 Tolerance of LS and LW Series interchangeable type: Normal grade PC Unit: μm

Characteristics	Model No.	LS15, 20, 25, 30, 35 LW17, 21, 27, 35, 50
Mounting height H		± 20
Variation of mounting height H		15① 30②
Mounting width W_2 or W_3		± 30
Variation of mounting width W_2 or W_3		25
Running parallelism of ball slide, face A to face C Running parallelism of ball slide, face B to face D		See Fig. II-1*1 and Table II-1*2.

Note:
① Variation on the same rail
② Variation on multiple rails

Indication of rail datum face in LH, LS, LA, LY and LW series.

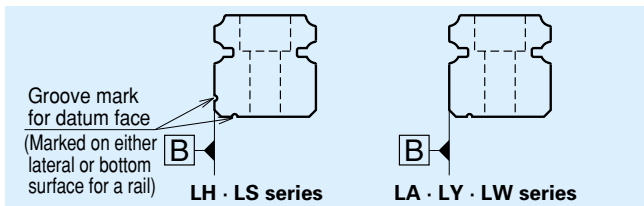


Fig. II-1.5 For special high carbon steel (NSK standard material)

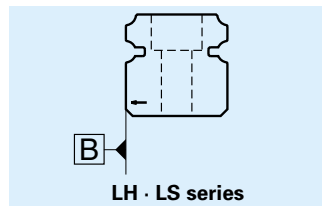


Fig. II-1.6 For stainless steel

LE, LU Series

Table II-1.6 shows tolerance of preloaded assembly in LE and LU Series. Table II-1.7 shows tolerance of LE and LU Series interchangeable type.

Table II-1.6 Tolerance of preloaded assembly in LE and LU Series Unit: μm

Characteristic	Accuracy grade	Super precision P4	High precision P5	Precision grade P6	Normal grade PN
Mounting height H Variation of H (all ball slides installed in rails for a set of linear guides)		± 10 5	± 15 7	± 20 15	± 40 25
Mounting width W_2 or W_3 Variation of W_2 or W_3 (all ball slides on the reference linear guide)		± 15 7	± 20 10	± 30 20	± 50 30
Running parallelism of ball slide, face C to face A Running parallelism of ball slide, face D to face B		Refer to Table II-1*2, Figure II-1*7 and Figure II-1*8			

Table II-1.7 Tolerance of interchangeable type in LE and LU Series Normal grade (PC) Unit: μm

Characteristic	Model No.	LU09, 12, 15 LE09, 12, 15
Mounting height H Variation of H		± 20 40
Mounting width W_2 or W_3 Variation of width W_2 or W_3		± 20 40
Running parallelism of ball slide, face C to face A Running parallelism of ball slide, face D to face B		Refer to Table I-1*2, Fig. II-1*7 and Fig. II-1*8

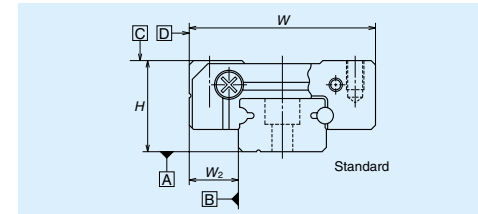


Fig. II-1.7 Mounting width (W_2)

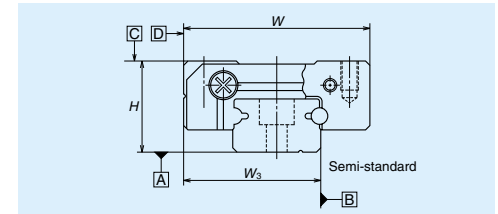


Fig. II-1.8 Mounting width (W_3)

Table II-1.8 Indication of rail datum face in LE and LU Series

Model No.	LU05, 07, 09 LE07, 09, 12	LU12, 15	LE05, 15 LE09, 12 (with a ball retainer)
Material			
Special high carbon steel			
Stainless steel			

LL Series

Table II-1-9 shows tolerance of LL Series.

Table II-1-9 Tolerance of LL Series Normal grade (PN)

Unit: μm

Characteristic	Model No.	LL15
Mounting height		± 20
Running parallelism, face C to face A		20
Running parallelism, face D to face B		(See Fig. II-1-9)

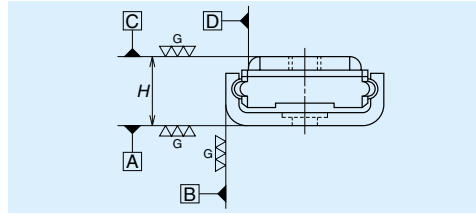


Fig. II-1-9 Standard LL

A-II-2 Preload and Rigidity

A-II-2.1 Preload and rigidity

- In NSK linear guides, slight size changes of balls, which are going to be inserted in the ball slide, controls clearance and amount of preload.
- In NSK linear guide, rigidity is further increased and elastic deformation is reduced by applying preload.
- In general, a load range in which the preload is effective becomes about 2.8 times of the preload (Fig. II-2-1).
- Fig. II-2-2 shows the relationship of ball slide deformation by external vertical load and preload. LY35 is used as a case.
- The following show the definition of linear guide rigidity.
 - 1) Radial rigidity: Rigidity of vertical and lateral directions -- up/down and right/left (Fig. II-2-3).
 - 2) Moment rigidity: Three moment directions -- pitching, rolling, and yawing (Fig. II-2-4).

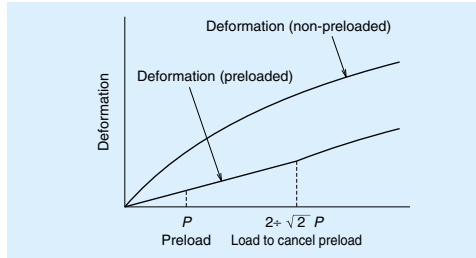


Fig. II-2-1 Elastic deformation

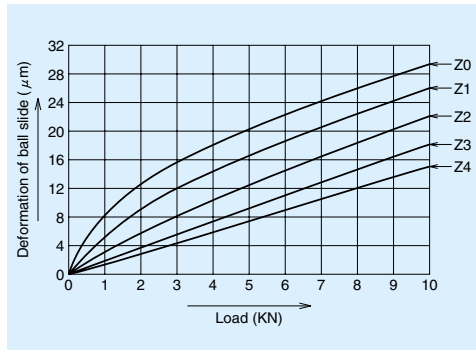


Fig. II-2-2 Rigidity of LY35, downward direction load (example)

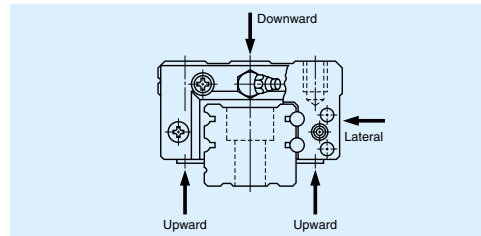


Fig. II-2-3 Radial rigidity

- Since two rails and four ball slides are used in general as a pair, considering only the radial rigidity is sufficient.

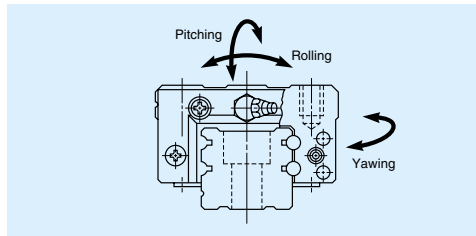


Fig. II-2-4 Moment rigidity

- However, in cases as shown in Fig. II-2-5, Fig. II-2-6 and Fig. II-2-7, it is necessary to take into account the moment rigidity in addition to the radial rigidity.

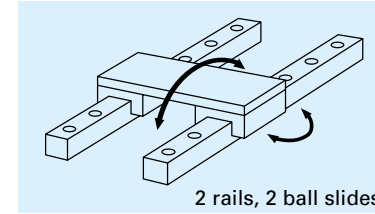


Fig. II-2-5 Pitching and yawing direction

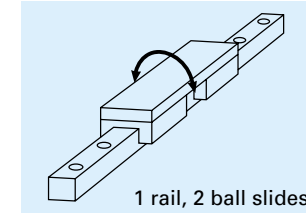


Fig. II-2-6 Rolling direction

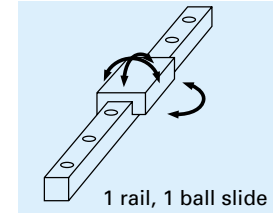


Fig. II-2-7 All directions

A-II-2.2 Preload and Rigidity of Each Series

LH Series (Preloaded assembly)

Table II-2-1 shows preload and rigidity of preloaded assembly of LH Series.

Table II-2-1 Preload and rigidity of preloaded assembly of LH Series

Model No.	Preload (N)		Rigidity (N/ μm)				
			Vertical directions		Lateral direction		
	Slight preload Z1	Medium preload Z3	Slight preload Z1	Medium preload Z3	Slight preload Z1	Medium preload Z3	
High load type	LH15 AN,EL,FL,EM	78	490	137	226	98	186
	LH20 AN,EL,FL,EM	147	835	186	335	137	245
	LH25 AN,EL,FL,EM	196	1270	206	380	147	284
	LH30 AN,AL	245	1570	216	400	157	294
	LH30 EL,FL	294	1770	265	480	186	355
	LH35 AL,AN,EL,FL,EM	390	2350	305	560	216	390
	LH45 AN,EL,FL,EM	635	3900	400	745	284	540
	LH55 AN,EL,FL,EM	980	5900	490	910	345	645
	LH65 AN,EL,FL,EM	1470	8900	580	1070	400	755
	Super high load type	LH15 BN,GL,HL,GM	98	685	196	345	137
LH20 BN,GL,HL,GM		196	1080	265	480	196	355
LH25 BL,BN,GL,HL,GM		245	1570	294	560	216	400
LH30 BL,BN,GL,HL,GM		390	2260	360	665	265	480
LH35 BL,BN,GL,HL,GM		490	2940	430	795	305	570
LH45 BN,GL,HL,GM		785	4800	520	960	370	695
LH55 BN,GL,HL,GM		1180	7050	635	1170	440	835
LH65 BN,GL,HL,GM		1860	11300	805	1480	550	1040
LH85 BN,GL,HL		2840	16800	1020	1870	695	1300

Clearance for fine clearance Z0 is 0 ~ 3 μm . Therefore, preload is zero. However, Z0 of PN Grade is 0 ~ 15 μm .

LH Series (Interchangeable type)

Table II-2*2 shows clearance and preload of interchangeable in LH Series.

Table II-2*2 Clearance and preload of interchangeable type in LH Series Unit: μm

Model No.	Fine clearance	Slight preload
	ZT	ZZ
LH15	-4~15	-4~0
LH20	-5~15	-5~0
LH25		-5~0
LH30		-7~0
LH35		-7~0
LH45		-7~0
LH55		-9~0
LH65		-9~0

Minus sign denotes that a value is an amount of preload (elastic deformation of balls).

LS Series (Preloaded assembly)

Table II-2*3 shows preload and rigidity of LS Series.

Table II-2*3 Preload and rigidity of preloaded assembly in LS Series

	Model No.	Preload (N)		Rigidity (N/ μm)			
		Slight preload Z1	Medium preload Z3	Vertical directions		Lateral direction	
				Slight preload Z1	Medium preload Z3	Slight preload Z1	Medium preload Z3
High load type	LS15 AL,EL,FL,EM	69	390	127	226	88	167
	LS20 AL,EL,FL,EM	88	540	147	284	108	206
	LS25 AL,EL,FL,EM	147	880	206	370	147	275
	LS30 AL,EL,FL,EM	245	1370	255	460	186	345
	LS35 AL,EL,FL,EM	345	1960	305	550	216	400
Medium load type	LS15 CL,JL,KL,JM	49	294	78	147	59	108
	LS20 CL,JL,KL,JM	69	390	108	186	78	137
	LS25 CL,JL,KL,JM	98	635	127	235	88	177
	LS30 CL,JL,KL,JM	147	980	147	275	108	206
	LS35 CL,JL,KL,JM	245	1370	186	335	137	245

Clearance for fine clearance Z0 is 0 ~3 μm . Therefore, preload is zero. However, Z0 of PN grade is 0 ~15 μm .

LS Series (Interchangeable type)

Table II-2*4 shows clearance of interchangeable type of LS Series.

Table II-2*4 Preload and clearance of interchangeable type of LS Series Unit: μm

Model No.	Fine clearance	Slight preload
	ZT	ZZ
LS15	-4~15	-4~0
LS20	-4~15	-4~0
LS25	-5~15	-5~0
LS30	-5~15	-5~0
LS35	-5~15	-6~0

Minus sign denotes that a value is an amount of preload (elastic deformation of balls).

LA Series

Table II-2*5 shows preload and rigidity of LA Series.

LA Series has two types of preload Z3 (medium preload) and Z4 (heavy preload).

Table II-2*5 Preload and rigidity of LA Series

	Model No.	Preload (N)		Rigidity (N/ μm)	
		Medium preload Z3	Heavy preload Z4	Medium preload Z3	Heavy preload Z4
LA30 AL, AN, EL, FL	2450	3140	705	835	
LA35 AL, AN, EL, FL	3450	4300	825	970	
LA45 AL, AN, EL, FL	5050	6350	1100	1240	
LA55 AL, AN, EL, FL	8100	10200	1400	1540	
LA65 AN, EL, FL	13800	18800	1730	2030	
Super high load type	LA25 BL, BN, GL, HL	2260	2840	700	820
	LA30 BL, BN, GL, HL	3250	4050	1000	1180
	LA35 BL, BN, GL, HL	4450	5650	1200	1400
	LA45 BL, BN, GL, HL	6150	7750	1450	1640
	LA55 BL, BN, GL, HL	9550	12100	1840	2020
	LA65 BN, GL, HL	18000	24400	2450	2840

LY Series

Table II-2*6 shows preload and rigidity of LY Series.

Table II-2*6 Preload and rigidity of LY Series

	Model No.	Preload (N)				Rigidity (N/μm)			
		Slight preload	Light preload	Medium preload	Heavy preload	Slight preload	Light preload	Medium preload	Heavy preload
		Z1	Z2	Z3	Z4	Z1	Z2	Z3	Z4
High load type	LY15 AL,AN,EL,FL	59	147	294	–	98	137	167	–
	LY20 AL, EL,FL	98	245	490	–	127	167	216	–
	LY25 AL,AN,EL,FL	147	440	835	1180	167	284	390	460
	LY30 AL,AN,EL,FL	245	635	1270	1770	196	325	480	580
	LY35 AL,AN,EL,FL	345	880	1770	2450	245	360	580	655
	LY45 AL,AN,EL,FL	490	1270	2550	3600	315	500	735	860
	LY55 AL,AN,EL,FL	785	1960	3900	5600	370	600	880	1020
	LY65 AN,EL,FL	1670	4200	8450	11800	560	910	1340	1560
Super high load type	LY20 BL, GL,HL	98	294	590	–	147	216	275	–
	LY25 BL,BN,GL,HL	196	540	1080	1570	226	360	540	645
	LY30 BL,BN,GL,HL	294	785	1570	2160	245	400	610	695
	LY35 BL,BN,GL,HL	440	1080	2160	2940	305	450	685	805
	LY45 BL,BN,GL,HL	635	1570	3150	4400	400	625	940	1100
	LY55 BL,BN,GL,HL	980	2450	5000	6950	470	755	1140	1340
	LY65 BN,GL,HL	2260	5600	11300	15700	805	1280	1920	2230

Clearance for fine clearance Z0 is 0 ~ 3μm. Therefore, preload is zero. However, Z0 of PN Grade is 8 ~ 18μm.

LW Series (Preloaded assembly)

Table II-2*7 shows preload and rigidity of preloaded assembly of LW Series. Rigidities are for the median of the preload range.

Table II-2*7 Preload and rigidity of LW Series

Model No.	Preload (N)		Rigidity(N/μm)			
			Vertical directions		Lateral direction	
	Slight preload Z1	Medium preload Z3	Slight preload Z1	Medium preload Z3	Slight preload Z1	Medium preload Z3
LW17 EL	0~245	–	156	–	112	–
LW21 EL	0~294	–	181	–	130	–
LW27 EL	0~390	–	226	–	167	–
LW35 EL	0~490	785	295	440	213	315
LW50 EL	0~590	1470	345	600	246	425

Clearance of fine clearance Z0 is 0 ~ 3μm. Therefore, preload is zero. However, Z0 of PN Grade is 0 ~ 15μm.

LW Series (Interchangeable type)

Clearance and preload of LW Series interchangeable type are shown in Table II-2*8.

Table II-2*8 Preload and clearance of interchangeable type of LW Series

Unit: μm

Model No.	Fine clearance	Slight preload
	ZT	ZZ
LW17	-3~15	-3.5~0
LW21	-3~15	-3.5~0
LW27	-4~15	-4~0
LW35	-5~15	-5~0
LW50	-5~15	-7~0

Minus sign denotes that a value is an amount of preload (elastic deformation of balls).

LE Series (Preloaded assembly)

Table II-2-9 shows preload and rigidity of preloaded assembly of LE Series. Rigidities are for the median of the preload range.

Table II-2-9 Preload and rigidity of LE Series

	Model No.	Preload (N)	Rigidity (N/ μ m)
		Slight preload Z1	Slight preload Z1
High load type	LE05 AL	0~23	36
	LE07 TL	0~29	46
	LE09 AL,TL LE09 AR,TR	0~37	61
	LE12 AL LE12 AR	0~40	63
	LE15 AL,AR	0~49	66
Medium load type	LE05 CL	0~18	29
	LE07 SL	0~16	28
	LE09 CL,SL	0~21	33
	LE12 CL	0~23	36
	LE15 CL	0~29	44
Super high load type	LE07 UL	0~43	71
	LE09 BL,UL	0~54	86
	LE12 BL	0~59	97
	LE15 BL	0~75	114

Clearance of fine clearance Z0 is 0 ~3 μ m. Therefore, preload is zero.
However, Z0 of PN grade is 3 ~10 μ m.

LE Series (Interchangeable type)

Table II-2-10 shows clearance of interchangeable type of LE Series.

Table II-2-10 Clearance of interchangeable type of LE Series
Unit: μ m

Model No.	Fine clearance
	ZT
LE09	0~15
LE12	
LE15	

LU Series (Preloaded assembly)

Table II-2-11 shows preload and rigidity of preloaded assembly of LU Series. Rigidities are for the median of the preload range.

Table II-2-11 Preload and rigidity of LU Series

	Model No.	Preload (N)	Rigidity (N/ μ m)
		Slight preload Z1	Slight preload Z1
High load type	LU05 TL	0~3	15
	LU07 AL	0~8	22
	LU09 AL,TL	0~12	26
	LU09 AR,TR	0~10	30
	LU12 AL,TL	0~17	33
	LU12 AR,TR	0~17	33
	LU15 AL	0~33	45
Super high load type	LU09 BL,UL	0~17	43
	LU12 BL,UL	0~25	52
	LU15 BL	0~51	75

Clearance of fine clearance Z0 is 0 ~3 μ m. Therefore, preload is zero.
However, Z0 of PN grade is 3 ~10 μ m.

LU Series (Interchangeable type)

Table II-2-12 shows clearance of interchangeable type of LU Series

Table II-2-12 Clearance of interchangeable type of LU Series
Unit: μ m

Model No.	Fine clearance
	ZT
LU09	0~15
LU12	
LU15	

LL Series

Table II-2-13 shows clearance of LL Series

Table II-2-13 Radial clearance
Unit: μ m

Model No.	Clearance
LL15	0~10