Description of duplex worm gears

The usual method of adjusting the backlash of a worm gear assembly is to modify the center distance. Once assembled, such adjustment requires a major rework of the gearbox housing. The use of duplex worm gears allows the backlash adjustment to be made by axially shifting the worm. This simplifies greatly the assembly and maintenance operations. Because of the unique characteristics of the product, please take time to study its construction and proper use.

Backlash adjustment mechanism and method of adjustment

The dual-lead worm is formed to give a difference between the right tooth surface and left tooth surface so that it provides a unique tooth profile in which the tooth thickness varies continuously, corresponding with the lead difference. (Fig.1)
The worm gear is also formed in its right and left tooth surface. When such a worm and worm gear are set up at a constant assembly distance and the worm is moved in the axial direction, the tooth thickness of the worm in mesh with the worm gear changes making backlash adjustment possible.

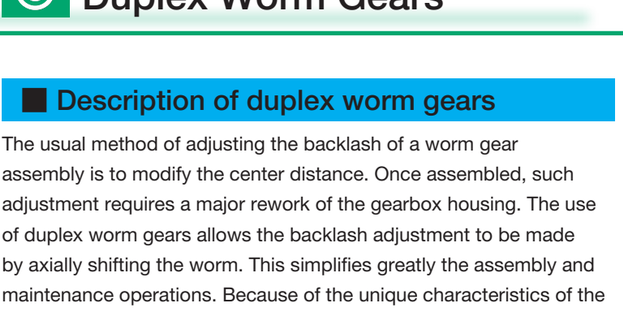


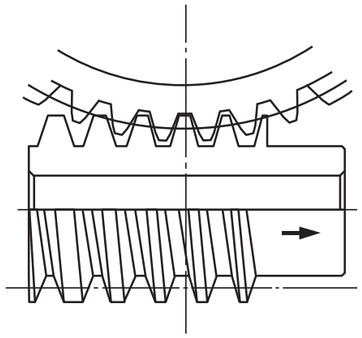
Fig. 1

[CAUTION] The amount of change in backlash (Δ j mm) in relation to the axial movement of the duplex worm shaft (V mm) can be calculated from the formula below.

$$\Delta j = 2V \frac{m_b - m_a}{m_a + m_b}$$

Where
m_a = Nominal Axial Module - (0.01× Nominal Axial Module)
m_b= Nominal Axial Module + (0.01× Nominal Axial Module)

An arrow marking on the outer circumference of the hub of the KHK duplex worm indicates the direction of assembly as well as acts as a direction for the backlash adjustment. When the worm is held with arrow mark pointing right, the tooth thickness is thinner on the right and thicker on the left. Therefore, moving the worm to the right causes the thicker teeth to come into actual engagement with the worm gear, thereby reducing the backlash. (Fig.2)



Reference Tooth

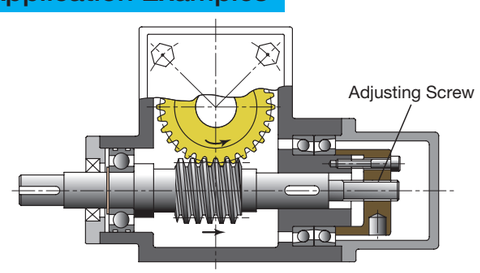
Moving the worm in the direction of the arrow diminishes the backlash.

Fig. 2

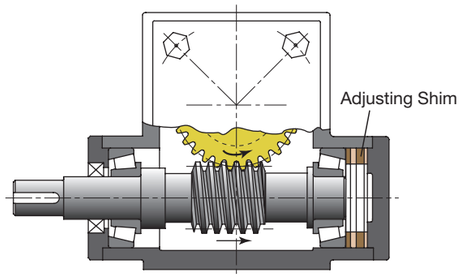
[CAUTION] The KHK duplex worm is designed so that, for all modules, the backlash reduces by 0.02 mm when the worm is shifted 1 mm.

Application Examples

* The illustration is a design example, not a design for machinery or a device in actual use.



Adjustment by using Screws

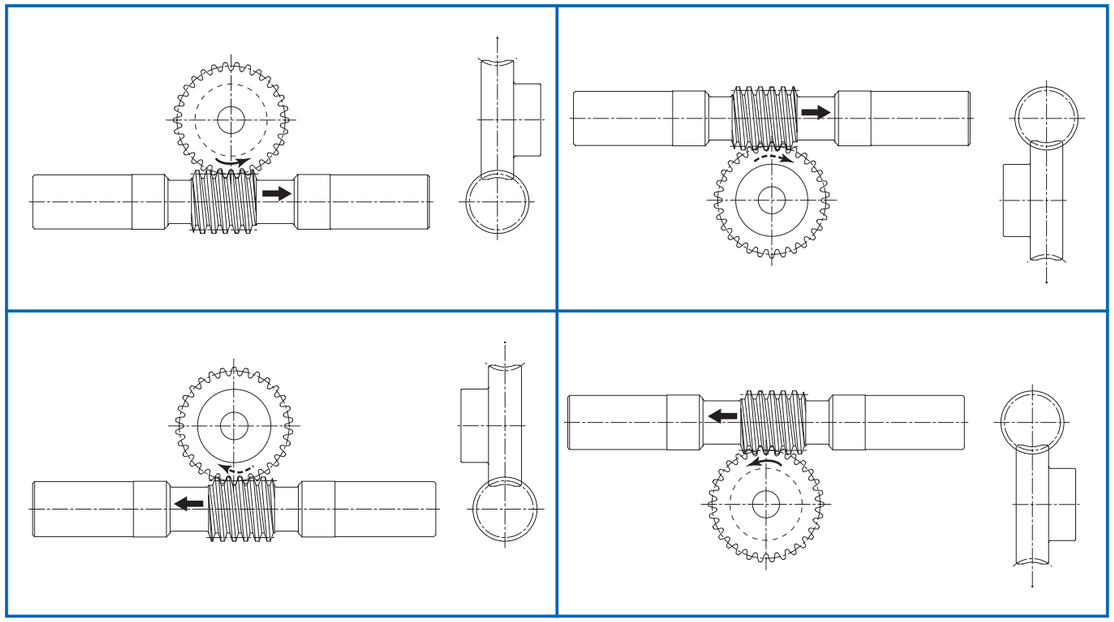


Adjustment by using Shims

Points of caution during assembly

KHK duplex worm gears differ in module between the right and left tooth surface and, therefore, you must orient the worm and worm wheel properly. Please carefully verify the following two aspects before proceeding with assembly.

1. Verifying the orientation of assembly
   An arrow indicating the orientation of assembly is stamped on both the duplex worm and worm wheel. When assembling the worm and worm wheel, check the worm wheel of the arrow mark on the front such that the direction of arrow mark on the worm coincides with that on the worm wheel. Incorrect assembly results in difficulty of assembly and improper gear engagement. (Fig.3)



Arrow mark indicates the correct orientation of two gears when assembled. As shown, the two arrows must point in the same direction.
Fig. 3

2. Verifying the reference position
   A V-groove (60°, 0.3 mm deep line) on tip peripheral of the duplex worm tooth marks the reference tooth. The gear set is designated to have a backlash of nearly zero (tolerance: ±0.045) when the reference tooth is positioned in alignment with the center of rotation of the worm wheel with the center distance set at the value “a”. (Fig.4)

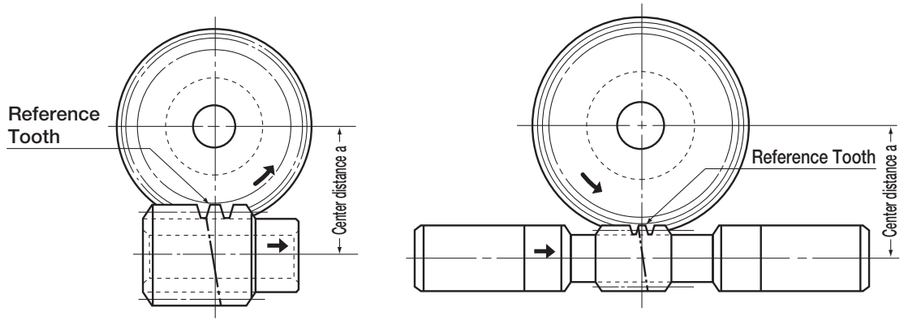
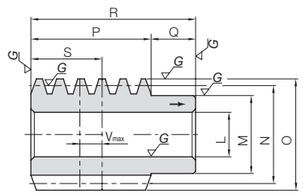


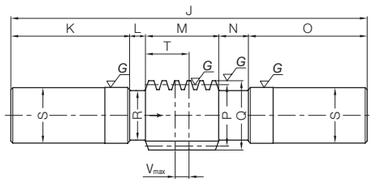
Fig. 4

KWGDL/KWGDLS Duplex Worms

Specifications	
Precision grade	KHK W 001 grade 1
Reference section of gear	Axial direction
Gear teeth	Standard full depth
Normal pressure angle	17°30’
Material	SCM440
Heat treatment	Thermal refined, gear teeth induction hardened
Tooth hardness	50 to 60HRC
Surface treatment	Black oxide coated except for ground part



W4



W6

Catalog Number	Nominal axial module	Number of Starts	Nominal lead angle	Direction of helix	Shape	Bore	Hub dia.	Pitch dia.	Outside dia.	Face width	Hub width	Total length
						L_{H7}	M	N	O	P	Q	R
KWGDL2-R1	***m*2**	1	3°41′	R	W4	14	25	31	35	36	14	50

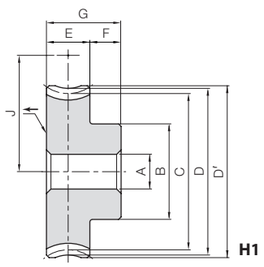
Position of reference tooth	Max. allowable shift	Weight (kg)	Catalog Number
S	Vmax		
22	8	0.21	**KWGDL2-R1**

Catalog Number	Nominal axial module	Number of Starts	Nominal lead angle	Direction of helix	Shape	Total Length	Shaft length (L)	Neck length (left)	Face width	Neck length (right)	Shaft length (R)	Pitch dia.
						J	K	L	M	N	O	P
KWGDLS1.5-R1	***m*1.5**	1	3°26′	R	W6	190	66	12	28	18	66	25
KWGDLS2-R1	***m*2**	1	3°41′	R	W6	220	75	13	36	21	75	31

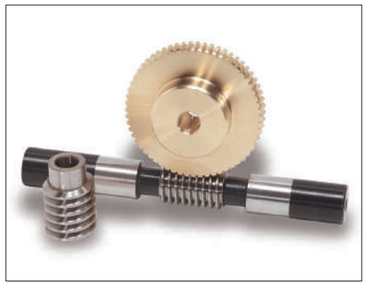
Outside dia.	Neck dia.	Shaft dia.	Position of reference tooth	Max. allowable shift	Weight (kg)	Catalog Number
Q	R	S	T	Vmax		
28	21	26.2	17	6	0.74	**KWGDLS1.5-R1**
35	24	30.2	22	8	1.17	**KWGDLS2-R1**

AGDL Duplex Worm Wheels

Specifications	
Precision grade	KHK W 002 grade 1
Reference section of gear	Rotating plane
Gear teeth	Standard full depth
Normal pressure angle	17°30’
Material	CAC702 (old JIS A ℓ BC2)
Heat Treatment	—
Tooth hardness	—



H1



Catalog Number	Reduction ratio	Nominal transverse module	No. of teeth	Lead angle	Direction of helix	Shape	Bore	Hub dia.	Pitch dia.	Throat dia.	Outside dia.	Face width	Hub width
							A_{H7}	B	C	D	D’	E	F
AGDL1.5-20R1	20	***m*1.5**	20	3°26′	R	H1	8	22	30	33	34.5	14	10
AGDL1.5-30R1	30		30				10	30	45	48	49.5		
AGDL1.5-36R1	36		36				10	35	54	57	58.5		
AGDL1.5-40R1	40		40				12	35	60	63	64.5		
AGDL1.5-50R1	50		50				12	45	75	78	79.5		
AGDL1.5-60R1	60		60				12	50	90	93	94.5		
AGDL2-20R1	20	***m*2**	20	3°41′	R	H1	12	33	40	44	46	18	15
AGDL2-30R1	30		30				15	40	60	64	66		
AGDL2-36R1	36		36				15	45	72	76	78		
AGDL2-40R1	40		40				15	45	80	84	86		
AGDL2-50R1	50		50				15	50	100	104	106		
AGDL2-60R1	60		60				15	60	120	124	126		

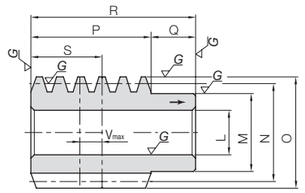
NOTE 1: Allowable torque based on worm speed (rpm)

Total length	Web thickness	Web O.D.	Mounting distance	Allowable torque (N·m) NOTE 1							Backlash (mm)	Weight (kg)	Catalog Number
G	(H)	(I)	J	30 rpm	100 rpm	300 rpm	600 rpm	900 rpm	1200 rpm	1800 rpm			
24	—	—	27.5	9.84	8.18	6.40	5.30	4.68	4.25	3.68	0±0.045	0.10	**AGDL1.5-20R1**
			35	20.8	17.5	13.9	11.7	10.4	9.40	8.28		0.22	**AGDL1.5-30R1**
			39.5	29.3	24.6	19.8	16.8	14.9	13.5	11.9		0.32	**AGDL1.5-36R1**
			42.5	35.6	30.0	24.2	20.6	18.3	16.6	14.6		0.37	**AGDL1.5-40R1**
			50	53.8	45.4	36.9	31.6	28.3	25.8	22.6		0.59	**AGDL1.5-50R1**
			57.5	75.3	63.8	51.9	44.7	40.4	36.7	32.4		0.83	**AGDL1.5-60R1**
33	—	—	35.5	21.0	17.5	13.6	11.2	9.84	8.94	7.75	0±0.045	0.26	**AGDL2-20R1**
			45.5	44.3	37.3	29.6	24.8	21.9	19.8	17.4		0.51	**AGDL2-30R1**
			51.5	62.3	52.6	42.0	35.5	31.3	28.4	25.0		0.73	**AGDL2-36R1**
			55.5	75.8	64.0	51.4	43.6	38.5	34.9	30.7		0.86	**AGDL2-40R1**
			65.5	115	96.8	78.4	66.9	59.5	54.2	47.6		1.30	**AGDL2-50R1**
			75.5	160	136	110	94.6	84.9	77.2	68.1		1.88	**AGDL2-60R1**

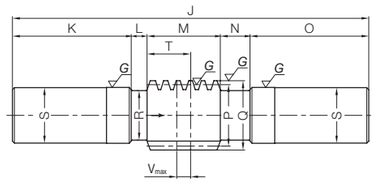
Product Precautions → Page 398

KWGDL/KWGDLS Duplex Worms

Specifications	
Precision grade	KHK W 001 grade 1
Reference section of gear	Axial direction
Gear teeth	Standard full depth
Normal pressure angle	17°30'
Material	SCM440
Heat treatment	Thermal refined, gear teeth induction hardened
Tooth hardness	50 to 60HRC
Surface treatment	Black oxide coated except for ground part



W4



W6

Catalog Number	Nominal axial module	Number of Starts	Nominal lead angle	Direction of helix	Shape	Bore	Hub dia.	Pitch dia.	Outside dia.	Face width	Hub width	Total length
						L_{H7}	M	N	O	P	Q	R
KWGDL2.5-R1	***m*2.5**	1	3°52′	R	W4	18	30	37	42	48	17	65
KWGDL3-R1	***m*3**	1	3°54′	R	W4	20	35	44	50	54	20	74

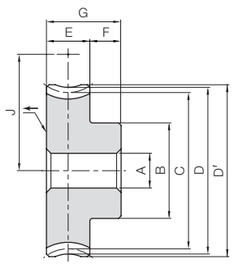
Position of reference tooth	Max. allowable shift	Weight	Catalog Number
S	Vmax	(kg)	
29	10	0.37	**KWGDL2.5-R1**
32	10	0.61	**KWGDL3-R1**

Catalog Number	Nominal axial module	Number of Starts	Nominal lead angle	Direction of helix	Shape	Total Length	Shaft length (L)	Neck length (left)	Face width	Neck length (right)	Shaft length (R)	Pitch dia.
						J	K	L	M	N	O	P
KWGDLS2.5-R1	***m*2.5**	1	3°52′	R	W6	260	85	16	48	26	85	37
KWGDLS3-R1	***m*3**	1	3°54′	R	W6	300	100	18	54	28	100	44

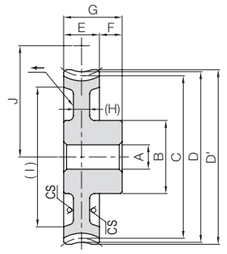
Outside dia.	Neck dia.	Shaft dia.	Position of reference tooth	Max. allowable shift	Weight	Catalog Number
Q	R	S	T	Vmax	(kg)	
42	30	36.2	29	10	2.00	**KWGDLS2.5-R1**
50	34	40.2	32	10	2.95	**KWGDLS3-R1**

AGDL Duplex Worm Wheels

Specifications	
Precision grade	KHK W 002 grade 1
Reference section of gear	Rotating plane
Gear teeth	Standard full depth
Normal pressure angle	17°30'
Material	CAC702 (old JIS AℓBC2)
Heat Treatment	—
Tooth hardness	—



H1



HB

* CS has a forged finish surface.

NOTE 1: Allowable torque based on worm speed (rpm)

Catalog Number	Reduction ratio	Nominal transverse module	No. of teeth	Lead angle	Direction of helix	Shape	Bore	Hub dia.	Pitch dia.	Throat dia.	Outside dia.	Face width	Hub width
							A_{H7}	B	C	D	D'	E	F
AGDL2.5-20R1	20	***m*2.5**	20	3°52′	R	H1	15	40	50	55	57.5	22	15
AGDL2.5-30R1	30		30			H1		40	75	80	82.5		
AGDL2.5-36R1	36		36			H1		45	90	95	97.5		
AGDL2.5-40R1	40		40			HB		45	100	105	107.5		
AGDL2.5-50R1	50		50			HB		60	125	130	132.5		
AGDL2.5-60R1	60		60			HB		80	150	155	157.5		
AGDL3-20R1	20	***m*3**	20	3°54′	R	H1	20	50	60	66	69	28	17
AGDL3-30R1	30		30			H1		55	90	96	99		
AGDL3-36R1	36		36			H1		60	108	114	117		
AGDL3-40R1	40		40			HB		60	120	126	129		
AGDL3-50R1	50		50			HB		70	150	156	159		
AGDL3-60R1	60		60			HB		80	180	186	189		

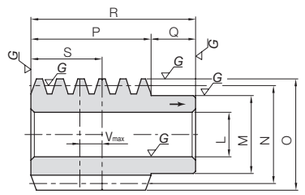
Total length	Web thickness	Web O.D.	Mounting distance	Allowable torque (N·m) NOTE 1							Backlash	Weight	Catalog Number
G	(H)	(I)	J	30 rpm	100 rpm	300 rpm	600 rpm	900 rpm	1200 rpm	1800 rpm	(mm)	(kg)	
37	—	—	43.5	38.1	31.4	24.5	20.1	17.6	16.0	13.8	0±0.045	0.45	**AGDL2.5-20R1**
	—	—	56	80.5	67.1	53.1	44.5	39.1	35.5	30.9		0.88	**AGDL2.5-30R1**
	—	—	63.5	113	94.5	75.5	63.8	56.0	51.0	44.3		1.25	**AGDL2.5-36R1**
	(10)	(86)	68.5	138	115	92.4	78.3	68.8	62.7	54.4		1.14	**AGDL2.5-40R1**
	(12)	(108)	81	208	174	141	120	106	97.3	84.3		1.93	**AGDL2.5-50R1**
	(12)	(133)	93.5	291	245	198	170	152	139	121		2.90	**AGDL2.5-60R1**
45	—	—	52	65.0	53.3	41.5	33.8	29.5	26.9	22.8	0±0.045	0.81	**AGDL3-20R1**
	—	—	67	137	114	90.0	74.7	65.5	59.5	51.2		1.65	**AGDL3-30R1**
	—	—	76	193	160	128	107	93.8	85.6	73.4		2.32	**AGDL3-36R1**
	(14)	(106)	82	235	195	157	131	115	105	90.1		2.19	**AGDL3-40R1**
	(14)	(134)	97	355	295	239	202	178	163	140		3.26	**AGDL3-50R1**
	(14)	(164)	112	497	415	336	285	254	233	200		4.48	**AGDL3-60R1**

Product Precautions → Page 398

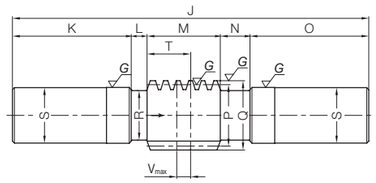
You can download CAD data (DXF format) of KHK Products from the Website.

KWGDL/KWGDLS Duplex Worms

Specifications	
Precision grade	KHK W 001 grade 1
Reference section of gear	Axial direction
Gear teeth	Standard full depth
Normal pressure angle	17°30'
Material	SCM440
Heat treatment	Thermal refined, gear teeth induction hardened
Tooth hardness	50 to 60HRC
Surface treatment	Black oxide coated except for ground part



W4



W6

Catalog Number	Nominal axial module	Number of Starts	Nominal lead angle	Direction of helix	Shape	Bore	Hub dia.	Pitch dia.	Outside dia.	Face width	Hub width	Total length
						L_{H7}	M	N	O	P	Q	R
KWGDL3.5-R1	***m*3.5**	1	3°47′	R	W4	24	44	53	60	62	23	85
KWGDL4-R1	***m*4**	1	3°41′	R	W4	28	50	62	70	74	26	100

Position of reference tooth	Max. allowable shift	Weight	Catalog Number
S	Vmax	(kg)	
37	12	1.05	**KWGDL3.5-R1**
44	14	1.67	**KWGDL4-R1**

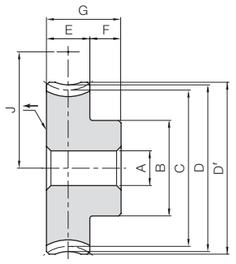
Catalog Number	Nominal axial module	Number of Starts	Nominal lead angle	Direction of helix	Shape	Total Length	Shaft length (L)	Neck length (left)	Face width	Neck length (right)	Shaft length (R)	Pitch dia.
						J	K	L	M	N	O	P
KWGDLS3.5-R1	***m*3.5**	1	3°47′	R	W6	330	110	18	62	30	110	53
KWGDLS4-R1	***m*4**	1	3°41′	R	W6	360	120	16	74	30	120	62

Outside dia.	Neck dia.	Shaft dia.	Position of reference tooth	Max. allowable shift	Weight	Catalog Number
Q	R	S	T	Vmax	(kg)	
60	42	48.2	37	12	4.72	**KWGDLS3.5-R1**
70	50	56.2	44	14	7.10	**KWGDLS4-R1**

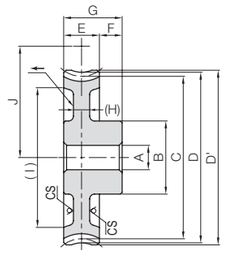
AGDL Duplex Worm Wheels

Specifications	
Precision grade	KHK W 002 grade 1
Reference section of gear	Rotating plane
Gear teeth	Standard full depth
Normal pressure angle	17°30'
Material	CAC702 (old JIS AℓBC2) *
Heat treatment	—
Tooth hardness	—

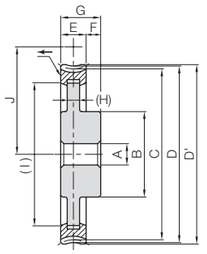
*The hub material of H5 is S45C.



H1

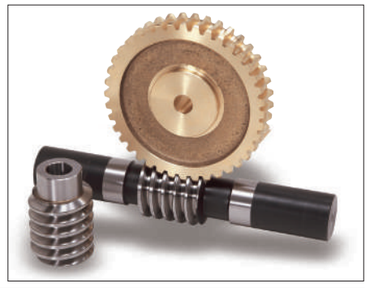


HB



H5

* CS has a forged finish surface.



NOTE 1: Allowable torque based on worm speed (rpm)

Catalog Number	Reduction ratio	Nominal transverse module	No. of teeth	Lead angle	Direction of helix	Shape	Bore	Hub dia.	Pitch dia.	Throat dia.	Outside dia.	Face width	Hub width
							A_{H7}	B	C	D	D'	E	F
AGDL3.5-20R1	20		20			H1		55	70	77	80.5		
AGDL3.5-30R1	30	***m*3.5**	30	3°47'	R	H1	20	60	105	112	115.5	32	18
AGDL3.5-36R1	36		36			H1		70	126	133	136.5		
AGDL3.5-40R1 (Made to Order)	40	***m*3.5**	40	3°47'	R	HB	20	70	140	147	150.5	32	18
AGDL3.5-50R1	50	***m*3.5**	50	3°47'	R	HB	20	80	175	182	185.5	32	18
AGDL3.5-60R1	60		60			HB		90	210	217	220.5		
AGDL4-20R1	20	***m*4**	20	3°41'	R	H1	20	60	80	88	92	35	20
AGDL4-30R1 (Made to Order)	30	***m*4**	30	3°41'	R	HB	20	65	120	128	132	35	20
AGDL4-36R1 (Made to Order)	36		36			HB		75	144	152	156		
AGDL4-40R1	40		40			HB	20	75	160	168	172		
AGDL4-50R1	50	***m*4**	50	3°41'	R	HB	20	90	200	208	212	35	20
AGDL4-60R1	60		60			H5	30	120	240	248	252		

[Precautions for Made to Order Products] Prices and lead times for Made to Order products require separate estimates. Contact your dealer.

Total length	Web thickness	Web O.D.	Mounting distance	Allowable torque (N·m) NOTE 1							Backlash	Weight	Catalog Number
G	(H)	(I)	J	30 rpm	100 rpm	300 rpm	600 rpm	900 rpm	1200 rpm	1800 rpm	(mm)	(kg)	
50	—	—	61.5	98.5	80.4	62.5	50.4	44.2	40.0	33.7	0±0.045	1.24	**AGDL3.5-20R1**
	—	—	79	208	172	136	111	98.1	88.3	75.7		2.51	**AGDL3.5-30R1**
	—	—	89.5	293	242	193	160	141	127	109		3.61	**AGDL3.5-36R1**
50	(15)	(124)	96.5	356	295	236	196	173	156	133	0±0.045	3.34	**AGDL3.5-40R1** (Made to Order)
50	(16)	(155)	114	538	446	360	301	267	243	207	0±0.045	5.02	**AGDL3.5-50R1**
	(16)	(189)	131.5	753	627	506	425	381	345	296		6.87	**AGDL3.5-60R1**
55	—	—	71	134	109	84.8	67.9	59.7	53.4	44.8	0±0.045	1.76	**AGDL4-20R1**
55	(17)	(99)	91	284	234	184	150	132	118	101	0±0.045	3.01	**AGDL4-30R1** (Made to Order)
	(17)	(121)	103	400	329	262	215	190	170	144		4.18	**AGDL4-36R1** (Made to Order)
55	(17)	(137)	111	486	400	320	264	233	208	177	0±0.045	4.78	**AGDL4-40R1**
	(17)	(177)	131	735	605	488	405	361	324	275		7.07	**AGDL4-50R1**
	(17)	(200)	151	1030	851	687	572	515	461	393		11.5	**AGDL4-60R1**

Product Precautions → Page 398

You can download CAD data (DXF format) of KHK Products from the Website.