

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.

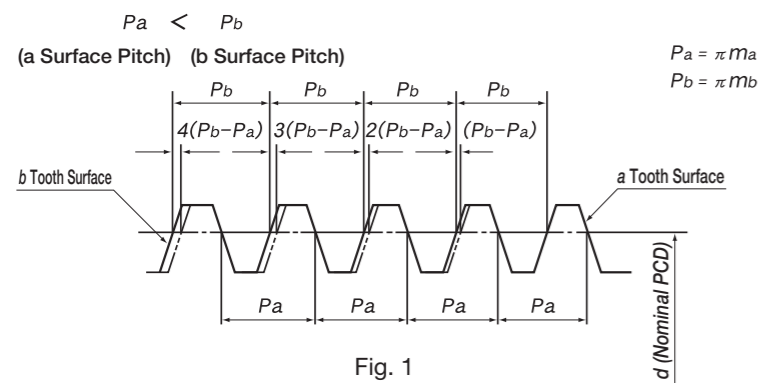


Fig. 1

[CAUTION] The amount of change in backlash (Δj 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)

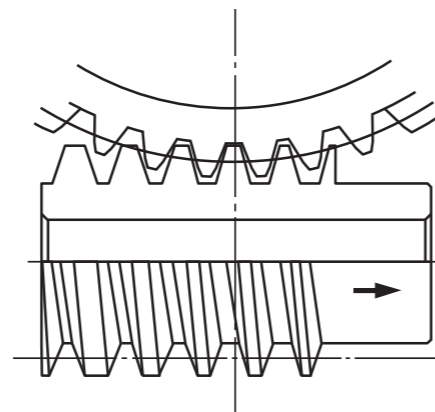


Fig. 2

[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.

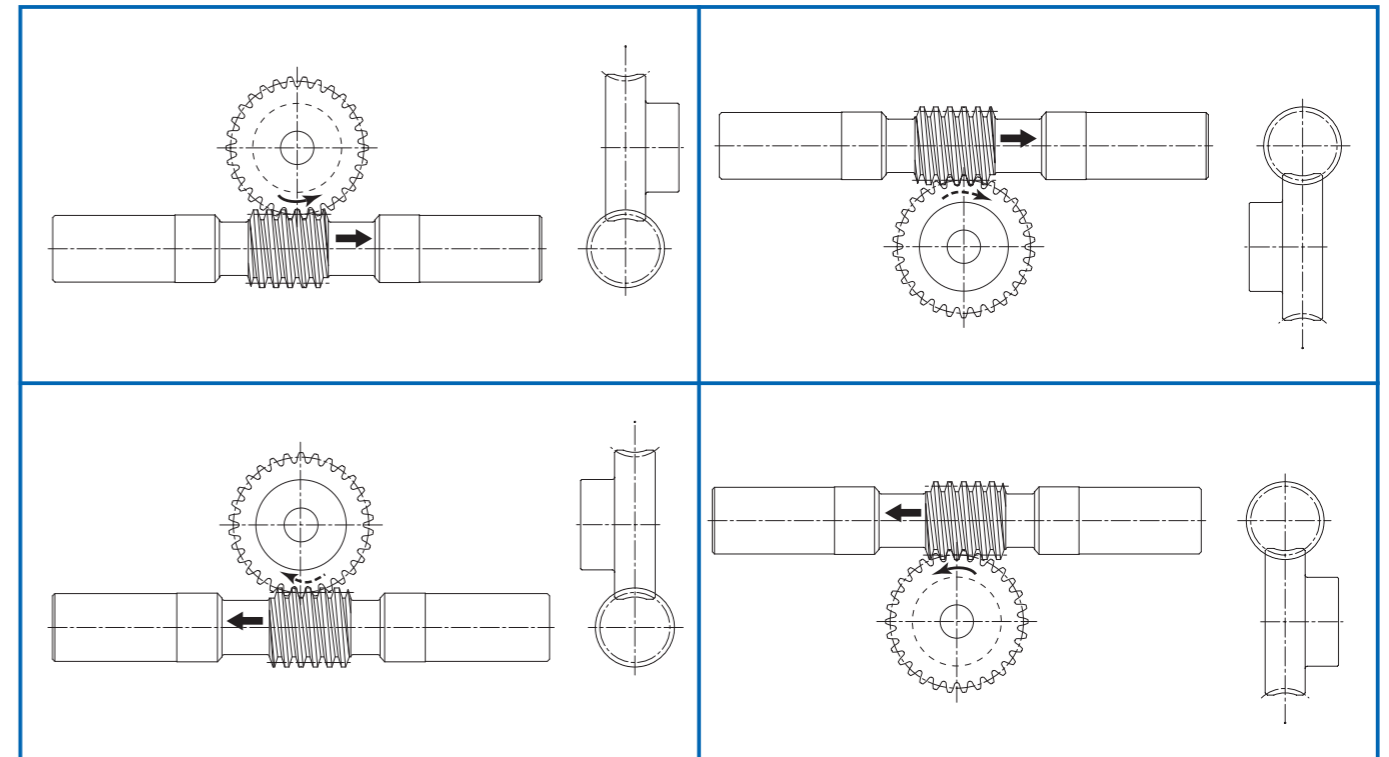
Application Examples * The illustration is a design example, not a design for machinery or a device in actual use.

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)

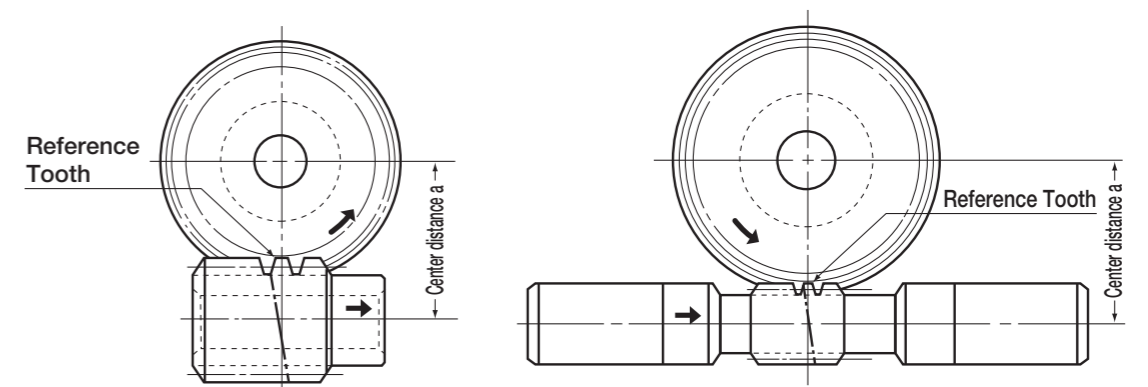
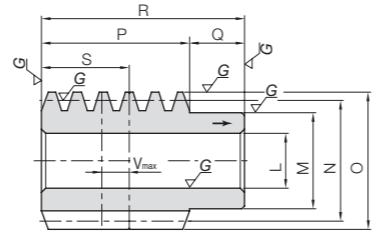


Fig. 4

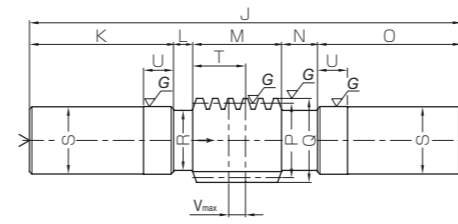


Specifications	
Precision grade	KHK W 001 grade 1
Reference section of gear	Axial direction
Gear teeth	Standard full depth
Normal pressure angle	17°30'
Material	SCM440
Heat treatment	Thermal refined, gear teeth induction hardened*
Tooth hardness	50 to 60HRC
Surface treatment	Black oxide coated except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

* Due to the gear teeth being induction hardened, no secondary operations can be performed on tooth areas including the bottom land (approx. 2 to 3 mm).



W4



W6

Catalog Number	Nominal axial module	Number of Starts	Nominal lead angle	Direction of helix	Shape	Bore		Pitch dia.	Outside dia.	Face width	Hub width	Total length
						L _{H7}	M					
KWGDL2-R1	m2	1	3°41'	R	W4	14	25	31	35	36	14	50

Position of reference tooth	Max. allowable shift	Weight (kg)	Catalog Number
S	V _{max}		
22	8	0.21	KWGDL2-R1

Catalog Number	Nominal axial module	Number of Starts	Nominal lead angle	Direction of helix	Shape	Total Length		Neck length (left)	Face width	Neck length (right)	Shaft length (R)	Pitch dia.
						J	K					
KWGDLS1.5-R1	m1.5	1	3°26'	R	W6	190	66	12	28	18	66	25
KWGDLS2-R1	m2	1	3°41'	R	W6	220	75	13	36	21	75	31

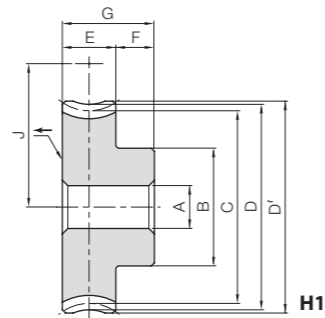
Outside dia.	Neck dia.	Shaft dia.	Position of reference tooth	Grinding length of shaft	Max. allowable shift	Weight (kg)	Catalog Number
Q	R	S	T	U	V _{max}		
28	21	26.2	17	20	6	0.74	KWGDLS1.5-R1
35	24	30.2	22	20	8	1.17	KWGDLS2-R1

[Caution on Product Characteristics] ① When adjusting the worm to reduce the backlash, V_{max} is the maximum amount of distance that you may shift it without causing problems with the gear mesh. V_{max} is not the recommended value to use for adjustment during assembly.

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 & 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						
AGDL1.5-20R1	20	m1.5	20	3°26'	R	H1	8	22	30	33	34.5	14	10	
AGDL1.5-30R1	30		10				30							
AGDL1.5-40R1	40		12				35							
AGDL1.5-50R1	50		12				45							
AGDL1.5-60R1	60		12				50							
AGDL2-20R1	20	m2	20	3°41'	R	H1	12	33	40	44	46	18	15	
AGDL2-30R1	30		15				40							
AGDL2-40R1	40		15				45							
AGDL2-50R1	50		15				50							
AGDL2-60R1	60		15				60							

[Caution on Product Characteristics] ① For duplex worm gears, mount the worm and wheel with the arrows pointing in the same direction. The arrows on the wheels indicate the direction of assembly and do not determine the direction of rotation. See assembly instructions on page 404.

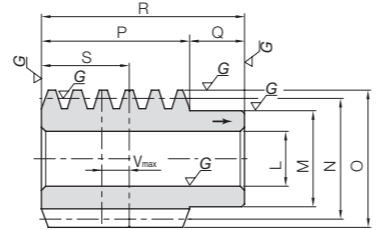
Total length	Web thickness	Web O.D.	Mounting distance	Allowable torque (N·m) <small>NOTE 1</small>							Backlash (mm)	Weight (kg)	Catalog Number	
				30 _{rpm}	100 _{rpm}	300 _{rpm}	600 _{rpm}	900 _{rpm}	1200 _{rpm}	1800 _{rpm}				
24	—	—	J	27.5	9.84	8.18	6.40	5.30	4.68	4.25	3.68	0±0.045	0.10	AGDL1.5-20R1
				35	20.8	17.5	13.9	11.7	10.4	9.40	8.28			
				42.5	35.6	30.0	24.2	20.6	18.3	16.6	14.6			
				50	53.8	45.4	36.9	31.6	28.3	25.8	22.6			
				57.5	75.3	63.8	51.9	44.7	40.4	36.7	32.4			
33	—	—	J	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			
				55.5	75.8	64.0	51.4	43.6	38.5	34.9	30.7			
				65.5	115	96.8	78.4	66.9	59.5	54.2	47.6			
				75.5	160	136	110	94.6	84.9	77.2	68.1			

[NOTE 1] Allowable torque based on worm speed (rpm).

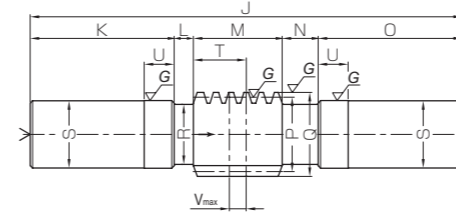


Specifications	
Precision grade	KHK W 001 grade 1
Reference section of gear	Axial direction
Gear teeth	Standard full depth
Normal pressure angle	17°30'
Material	SCM440
Heat treatment	Thermal refined, gear teeth induction hardened*
Tooth hardness	50 to 60HRC
Surface treatment	Black oxide coated except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

* Due to the gear teeth being induction hardened, no secondary operations can be performed on tooth areas including the bottom land (approx. 2 to 3 mm).



W4



W6

Catalog Number	Nominal axial module	Number of Starts	Nominal lead angle	Direction of helix	Shape	Bore		Pitch dia.	Outside dia.	Face width	Hub width		Total length
						L _{H7}	M				N	O	
KWGDL2.5-R1	m2.5	1	3°52'	R	W4	18	30	37	42	48	17	65	
KWGDL3-R1	m3	1	3°54'	R	W4	20	35	44	50	54	20	74	

Position of reference tooth	Max. allowable shift	Weight (kg)	Catalog Number
S	V _{max}		
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						
KWGDL2.5-R1	m2.5	1	3°52'	R	W6	260	85	16	48	26	85	37	
KWGDL3-R1	m3	1	3°54'	R	W6	300	100	18	54	28	100	44	

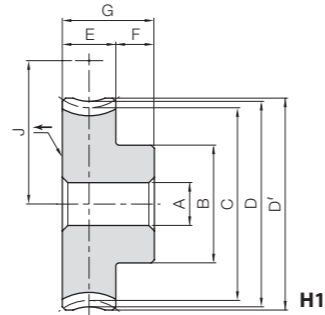
Outside dia.	Neck dia.	Shaft dia.	Position of reference tooth	Grinding length of shaft	Max. allowable shift	Weight (kg)	Catalog Number
Q	R	S	T	U	V _{max}		
42	30	36.2	29	25	10	2.00	KWGDL2.5-R1
50	34	40.2	32	25	10	2.95	KWGDL3-R1

[Caution on Product Characteristics] ① When adjusting the worm to reduce the backlash, V_{max} is the maximum amount of distance that you may shift it without causing problems with the gear mesh. V_{max} is not the recommended value to use for adjustment during assembly.

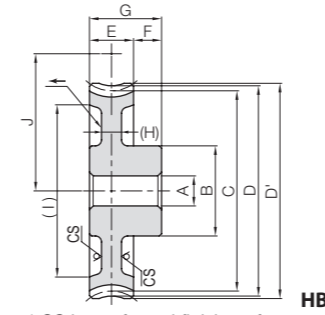
AGDL
Duplex Worm Wheels



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 & BC2)
Heat Treatment	—
Tooth hardness	—



H1



HB

* CS has a forged finish surface.



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							
AGDL2.5-36R1	36	m2.5	36	3°52'	R	H1	15	45	90	95	97.5	22	15		
AGDL2.5-40R1	40		HB			100								105	107.5
AGDL2.5-50R1	50		HB			125								130	132.5
AGDL2.5-60R1	60		HB			150								155	157.5
AGDL3-30R1	30	m3	30	3°54'	R	H1	20	55	90	96	99	28	17		
AGDL3-36R1	36		H1			108								114	117
AGDL3-40R1	40		HB			120								126	129
AGDL3-50R1	50		HB			150								156	159
AGDL3-60R1	60		HB			180								186	189

Total length	Web thickness	Web O.D.	Mounting distance	Allowable torque (N·m) <small>NOTE 1</small>							Backlash (mm)	Weight (kg)	Catalog Number		
				30 _{rpm}	100 _{rpm}	300 _{rpm}	600 _{rpm}	900 _{rpm}	1200 _{rpm}	1800 _{rpm}					
37	G	(H)	(I)	J	63.5	113	94.5	75.5	63.8	56.0	51.0	44.3	0±0.045	1.25	AGDL2.5-36R1
	(10)	(86)	68.5	138	115	92.4	78.3	68.8	62.7	54.4					
	(12)	(108)	81	208	174	141	120	106	97.3	84.3					
	(12)	(133)	93.5	291	245	198	170	152	139	121					
45	G	(H)	(I)	J	67	137	114	90.0	74.7	65.5	59.5	51.2	0±0.045	1.65	AGDL3-30R1
	(14)	(106)	82	235	195	157	131	115	105	90.1					
	(14)	(134)	97	355	295	239	202	178	163	140					
	(14)	(164)	112	497	415	336	285	254	233	200					
	(14)	(164)	112	497	415	336	285	254	233	200					

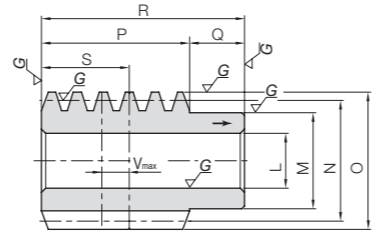
[NOTE 1] Allowable torque based on worm speed (rpm).

[Caution on Product Characteristics] ① For duplex worm gears, mount the worm and wheel with the arrows pointing in the same direction. The arrows on the wheels indicate the direction of assembly and do not determine the direction of rotation. See assembly instructions on page 404.

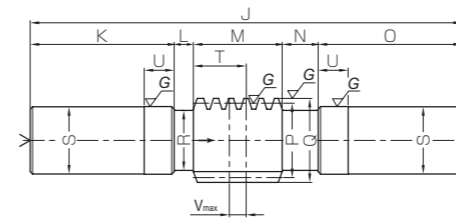


Specifications	
Precision grade	KHK W 001 grade 1
Reference section of gear	Axial direction
Gear teeth	Standard full depth
Normal pressure angle	17°30'
Material	SCM440
Heat treatment	Thermal refined, gear teeth induction hardened*
Tooth hardness	50 to 60HRC
Surface treatment	Black oxide coated except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

* Due to the gear teeth being induction hardened, no secondary operations can be performed on tooth areas including the bottom land (approx. 2 to 3 mm).



W4



W6

Catalog Number	Nominal axial module	Number of Starts	Nominal lead angle	Direction of helix	Shape	Bore		Pitch dia.	Outside dia.	Face width	Hub width		Total length
						L _{H7}	M				N	O	
KWGDL3.5-R1	m3.5	1	3°47'	R	W4	24	44	53	60	62	23	85	
KWGDL4-R1	m4	1	3°41'	R	W4	28	50	62	70	74	26	100	

Position of reference tooth	Max. allowable shift	Weight (kg)	Catalog Number
S	V _{max}		
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						
KWGDL3.5-R1	m3.5	1	3°47'	R	W6	330	110	18	62	30	110	53	
KWGDL4-R1	m4	1	3°41'	R	W6	360	120	16	74	30	120	62	

Outside dia.	Neck dia.	Shaft dia.	Position of reference tooth	Grinding length of shaft	Max. allowable shift	Weight (kg)	Catalog Number
Q	R	S	T	U	V _{max}		
60	42	48.2	37	25	12	4.72	KWGDL3.5-R1
70	50	56.2	44	25	14	7.10	KWGDL4-R1

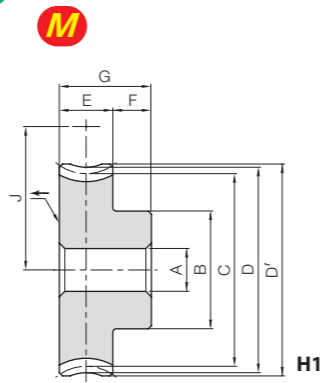
[Caution on Product Characteristics] ① When adjusting the worm to reduce the backlash, V_{max} is the maximum amount of distance that you may shift it without causing problems with the gear mesh. V_{max} is not the recommended value to use for adjustment during assembly.

AGDL
Duplex Worm Wheels

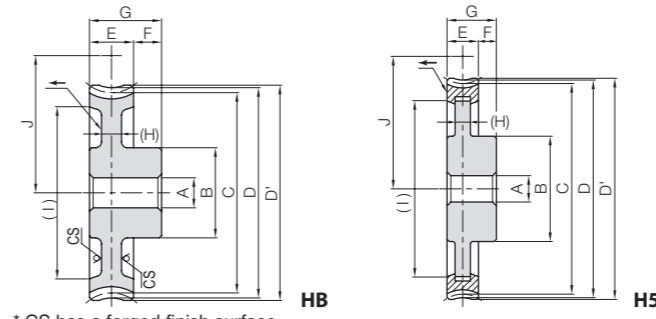


Specifications	
Precision grade	KHK W 002 grade 1
Reference section of gear	Rotating plane
Gear teeth	Standard full depth
Normal pressure angle	17°30'
Material	CAC702 (old JIS A & BC2) *
Heat treatment	—
Tooth hardness	—

*The hub material of H5 is S45C.



H1



HB

H5

* CS has a forged finish surface.



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						
AGDL3.5-30R1	30	m3.5	30	3°47'	R	H1	20	60	105	112	115.5	32	18	
AGDL3.5-40R1 (Made to Order)	40	m3.5	40	3°47'	R	HB	20	70	140	147	150.5	32	18	
AGDL3.5-50R1	50	m3.5	50	3°47'	R	HB	20	80	175	182	185.5	32	18	
AGDL3.5-60R1	60	m3.5	60	3°47'	R	HB	20	90	210	217	220.5	32	18	
AGDL4-30R1 (Made to Order)	30	m4	30	3°41'	R	HB	20	65	120	128	132	35	20	
AGDL4-36R1 (Made to Order)	36	m4	36	3°41'	R	HB	20	75	144	152	156	35	20	
AGDL4-40R1	40	m4	40	3°41'	R	HB	20	75	160	168	172	35	20	
AGDL4-50R1	50	m4	50	3°41'	R	HB	20	90	200	208	212	35	20	
AGDL4-60R1	60	m4	60	3°41'	R	H5	30	120	240	248	252	35	20	

Total length	Web thickness	Web O.D.	Mounting distance	Allowable torque (N·m) ^{NOTE 1}								Backlash (mm)	Weight (kg)	Catalog Number
				30 rpm	100 rpm	300 rpm	600 rpm	900 rpm	1200 rpm	1800 rpm				
G	(H)	(I)	J	30 rpm	100 rpm	300 rpm	600 rpm	900 rpm	1200 rpm	1800 rpm				
50	—	—	79	208	172	136	111	98.1	88.3	75.7	0±0.045	2.51	AGDL3.5-30R1	
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	
50	(16)	(189)	131.5	753	627	506	425	381	345	296	0±0.045	6.87	AGDL3.5-60R1	
55	(17)	(99)	91	284	234	184	150	132	118	101	0±0.045	3.01	AGDL4-30R1 (Made to Order)	
55	(17)	(121)	103	400	329	262	215	190	170	144	0±0.045	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	
55	(17)	(177)	131	735	605	488	405	361	324	275	0±0.045	7.07	AGDL4-50R1	
55	(17)	(200)	151	1030	851	687	572	515	461	393	0±0.045	11.5	AGDL4-60R1	

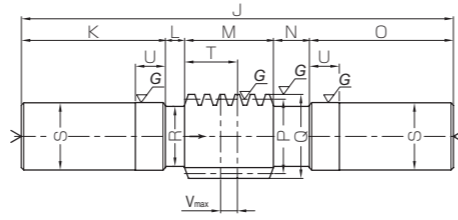
[NOTE 1] Allowable torque based on worm speed (rpm).

[Caution on Product Characteristics] ① For duplex worm gears, mount the worm and wheel with the arrows pointing in the same direction. The arrows on the wheels indicate the direction of assembly and do not determine the direction of rotation. See assembly instructions on page 404.

[Precautions for Made to Order Products] ① Prices and lead times for Made to Order products require separate estimates. Contact your dealer.



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	—



W6

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						
KWGDLS5-R1S	m5	1	4°05'	R	W6	400	130	17	90	33	130	70	
KWGDLS6-R1S	m6	1	4°17'	R	W6	400	120	18	105	37	120	80	

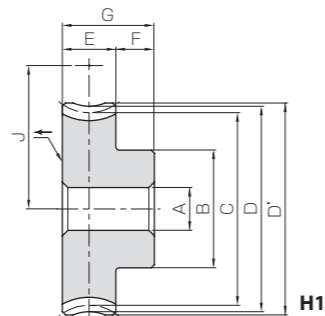
[Caution on Product Characteristics] ① When adjusting the worm to reduce the backlash, Vmax is the maximum amount of distance that you may shift it without causing problems with the gear mesh. Vmax is not the recommended value to use for adjustment during assembly.
 ② Products with S at the end of the catalog number are semi-custom stock products. See page 42 for lead times and allowable order quantities. See page 44 for other precautions.

Outside dia.	Neck dia.	Shaft dia.	Position of reference tooth	Grinding length of shaft	Max. allowable shift	Weight (kg)	Catalog Number
Q	R	S	T	U	Vmax		
80	54	60	53	30	16	9.39	KWGDLS5-R1S
92	60	70	62	30	20	12.6	KWGDLS6-R1S

AGDL Duplex Worm Wheels **NEW**



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 & 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						
AGDL5-20R1S	20	m5	20	4°05'	R	H1	25	70	100	110	115	42	23	
AGDL5-30R1S	30		25				80							
AGDL5-40R1S	40		25				90							
AGDL5-50R1S	50		150				230							
AGDL5-60R1S	60		200				280							
AGDL6-20R1S	20	m6	20	4°17'	R	H1	30	85	120	132	138	46	24	
AGDL6-30R1S	30		30				90							
AGDL6-40R1S	40		130				220							
AGDL6-50R1S	50		190				280							
AGDL6-60R1S	60		250				340							

[Caution on Product Characteristics] ① For duplex worm gears, mount the worm and wheel with the arrows pointing in the same direction. The arrows on the wheels indicate the direction of assembly and do not determine the direction of rotation. See assembly instructions on page 404.
 ② Products with S at the end of the catalog number are semi-custom stock products. See page 42 for lead times and allowable order quantities. See page 44 for other precautions.
 ③ For S semi-custom standard products weighing 15 kg or more, eyebolt screw threads (2-M12 depth 25 mm) are machined around the outside of the hub side surface. Details of the PCD of the screw threads are located on page 51.



Total length	Mounting distance	Allowable torque (N·m) <small>NOTE 1</small>							Backlash (mm)	Weight (kg)	Catalog Number
		30 rpm	100 rpm	300 rpm	600 rpm	900 rpm	1200 rpm	1800 rpm			
G	J	30 rpm	100 rpm	300 rpm	600 rpm	900 rpm	1200 rpm	1800 rpm	0±0.045	3.17	AGDL5-20R1S
65	85	243	195	152	122	106	94.8	78.6			
65	110	513	418	330	269	236	210	177			
65	135	878	716	573	473	415	370	311			
47	160	1330	1080	875	726	641	575	482			
47	185	1860	1520	1230	1030	915	819	690	14.3	AGDL5-60R1S	
70	100	362	290	225	180	155	139	115	0±0.045	4.93	AGDL6-20R1S
70	130	766	619	488	398	345	307	258			
51	160	1310	1060	848	700	607	543	453			
51	190	1980	1610	1290	1070	938	843	703			
51	220	2770	2260	1820	1520	1340	1200	1010			

[NOTE 1] Allowable torque based on worm speed (rpm).