HKS Short Cup Component

HKS Photo

Harmonic Drive® TECHNOLOGIES

Nabtesco

FEATURES

- Zero backlash
- Precise positional accuracy
- High ratio
- High torque
- +/- 5 arc second repeatability
-

LOADING ANALYSIS

Normal operating conditions involve momentary peak torques substantially higher than constant speed running torques. These peak torques must be carefully considered when selecting a Harmonic Drive HKS Gear Set.

To select from the ratings table it is necessary to construct or estimate a torque speed profile diagram as in Figures 1 and 2.

Maximum Starting Torque, T1

The torque required to accelerate the driven components from rest to normal continuous running speed.

Normal Constant Speed Torque, T2

Normal Maximum Stopping Torque, T3

Maximum Momentary Torque, T4

The peak torque generated by sudden shock loads such as emergency stops or crashes. Particularly severe conditions exist with high output inertias and stringent rapid stop requirements.

Mean Torque, T

Calculate the mean torque.

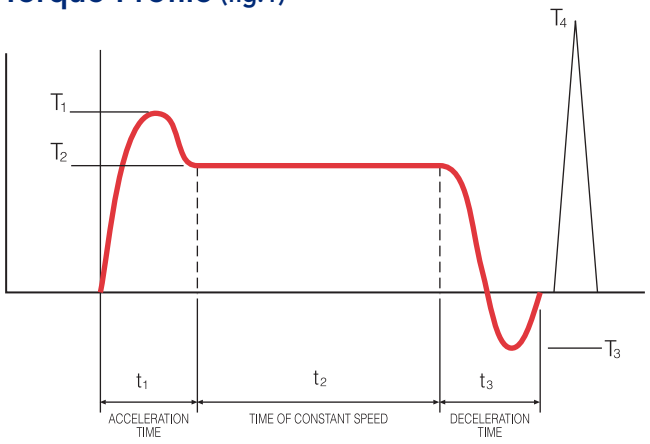
$$T = \sqrt[3]{\frac{t_1N_1T_1^3+t_2N_2T_2^3+t_3N_3T_3^3}{t_1N_1+t_2N_2+t_3N_3}}$$

Mean Speed, N

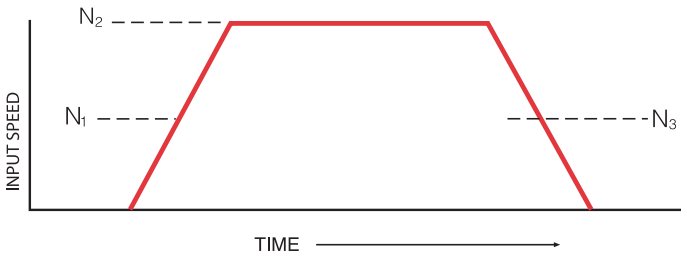
Calculate the mean speed

$$N = \frac{t_1N_1+t_2N_2+t_3N_3}{t_1+t_2+t_3}$$

Torque Profile (fig.1)



Speed Profile (fig.2)



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HKS SPECIFICATIONS

HKS Size	Ratio	Maximum Repeated Output Torque		Maximum Momentary Output Torque		INPUT SPEED								No Load Starting Torque		Input Inertia	
						1000 RPM		1500 RPM		2000 RPM		3000 RPM					
						RATED OUTPUT TORQUE											
		lb in	Nm	lb in	Nm	lb in	Nm	lb in	Nm	lb in	Nm	lb in	Nm	oz in	Ncm	lb in²	kgcm²
14	50	160	18	310	35	73	8	63	7	58	7	50	6	5	4	0.01	0.03
	80	200	23	416	47	105	12	92	10	83	9	73	8	3	2		
	100	250	28	478	54									3	2		
17	50	301	34	620	70	179	20	156	18	142	16	124	14	7	5	0.027	0.08
	80	380	43	770	87	246	28	214	24	195	22	170	19	4.3	3		
	100	470	54	760	86	267	30	233	26	212	24	185	21	4.3	3		
20	50	500	57	867	98	279	31	243	28	221	25	193	22	9	6	0.07	0.19
	80	650	73	1124	127	379	43	331	37	301	34	263	30	6	4		
	100	725	82	1300	147	446	50	390	44	354	40	309	35	5	4		
	120	770	87											5	4		
	160	812	92											4	3		
25	50	870	98	1646	186	435	49	380	43	345	39	302	34	17	12	0.14	0.41
	80	1215	137	2257	255	702	79	614	69	558	63	487	55	11	8		
	100	1400	158	2514	284	747	84	653	74	593	67	518	59	10	7		
	120	1480	167	2691	304									9	6		
	160	1560	176	2779	314									8	6		
32	50	1910	216	3381	382	847	96	740	84	673	76	588	66	40	28	0.58	1.70
	80	2700	305	5027	568	1315	149	1149	130	1044	118	912	103	24	17		
	100	2950	333	5726	647	1527	173	1334	151	1212	137	1059	120	21	15		
	120	3125	353	6072	686									20	14		
	160	3290	372											17	12		
40	50	2560	289	6072	686	1527	173	1334	151	1212	137	1059	120	62	44	1.54	4.50
	80	4590	519	8674	980	2296	259	2006	227	1823	206	1593	180	40	28		
	100	5030	568	9559	1080	2954	334	2581	292	2345	265	2049	232	37	26		
	120	5460	617	10444	1180	3277	370	2863	324	2602	294	2273	257	35	25		
	160	5730	647											30	21		

Maximum Repeated Output Torque

This is the maximum allowable output torque that should be developed with dynamic torque at the input. Repetitive momentary or continuous running loads (T1, T2, and T3) should not exceed this rating.

Max Momentary Output Torque

Such torques typically occur during severe emergency stop conditions or by "crashing" the output drive during rotation. This does not result in immediate failure of the gear set but causes poor performance and premature failure of the gear teeth and should, therefore, be avoided.

Maximum Input Speed

The maximum input speed for a Harmonic Drive Gear Set is limited by the DN value of the wave generator bearing and the type of lubricant used. Maximum input speeds for each size unit using recommended grease or oil lubricant are listed in the table.

Maximum Input Speed (rpm)						
Size	14	17	20	25	32	40
Oil	12000	11600	11200	9000	7000	5600
Grease	6000	5800	5600	4500	3500	2800

Ratings and Operating Life

The operating life expectancy of HKS Gear Sets is based on the life of the ball bearings used for the input wave generator when run continuously at rated torque. If gear sets are properly mounted and lubricated, gear tooth life will be well in excess of bearing life, provided maximum torque and speed limits are not exceeded. Flexspline life is infinite provided concentricity requirements are maintained. Ratings listed are for a continuous L10 life of 7000 hours. Average life, however, is 5 times this number.

Torque ratings for speeds other than those listed can be calculated by the following equations:

$$\text{Rating @ N RPM} = \left[\frac{2000}{N}\right]^{1/3} \times [\text{listed rating @ 2000 RPM}]$$

and predicted life by

$$L_{10} = \left(\frac{2000}{N}\right)\left[\frac{\text{listed rating @ 2000 RPM}}{T}\right]^3 \times 3000 \text{ hours}$$

Where T = mean torque and N = mean speed

Back Driving/Reversibility

HKS Gear Sets are **NOT** self-locking. They are reversible and cannot, therefore, be used to hold a load in position without the addition of a brake.

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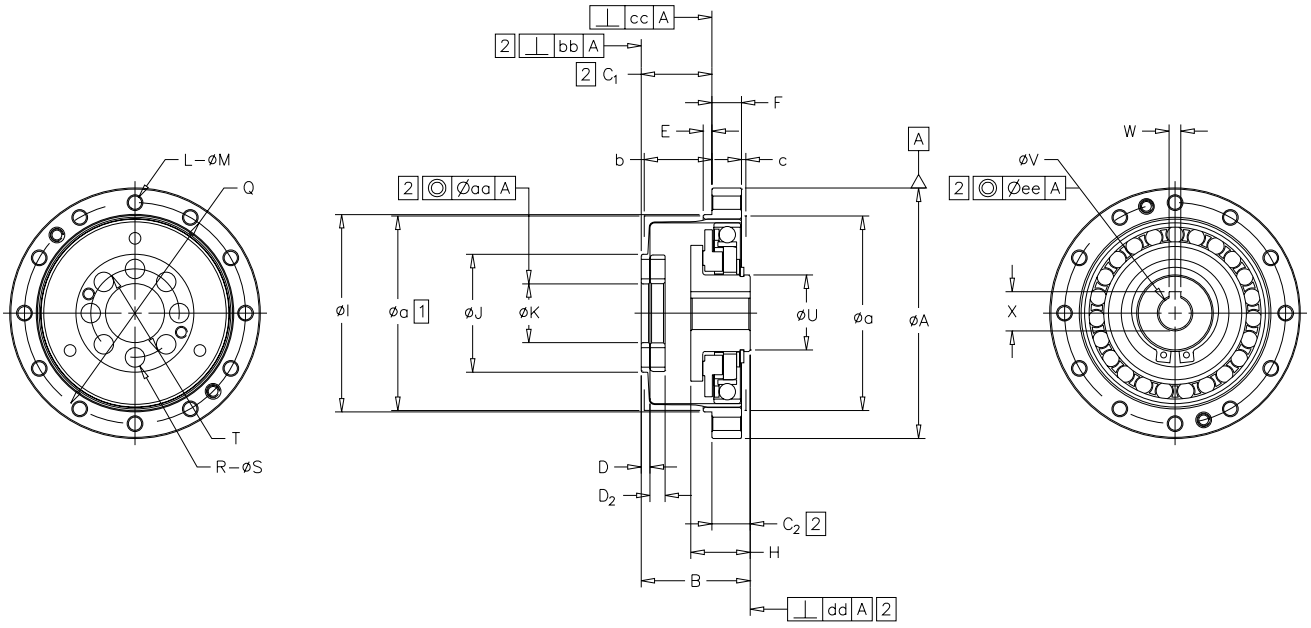
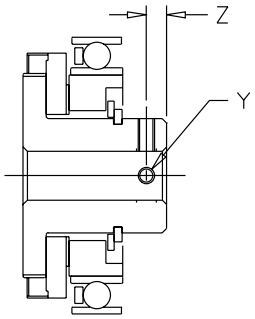
DIMENSIONS (mm)



HKS		14	17	20	25	32	40
ØA (h6)		$50^{-0.016}$	$60^{-0.019}$	$70^{-0.019}$	$85^{-0.019}$	$110^{-0.022}$	$135^{-0.025}$
B		$28.5_{-0.8}$	$32.5_{-0.9}$	$33.5_{-0.1}$	$37_{-0.1}$	$44^{-0.1}$	$52.8^{-0.1}$
C_1		17.5^{-0}	20^{-0}	21.5^{-0}	24^{-0}	28^{-0}	34^{-0}
C_2		11	12.5	12	13	16	18.8
D		2.4	3	3	3	3.2	3.2
D_2		2.4	2.5	3	5	7	7.1
E		2	2.5	3	3	3	4
F		6	6.5	7.5	10	14	17
H		$17.6^{-0.1}$	$19.5^{-0.1}$	$20.1^{-0.1}$	$20.2^{-0.1}$	$22^{-0.1}$	$28^{-0.1}$
ØI (h6)		$38^{-0.016}$	$48^{-0.016}$	$54^{-0.019}$	$67^{-0.019}$	$90^{-0.022}$	$110^{-0.023}$
ØJ		23	27.2	32	40	52	64
ØK (H6)		11^{-0}	10^{-0}	16^{-0}	20^{-0}	26^{-0}	32^{-0}
L		6	12	12	12	12	12
ØM		3.5	3.4	3.5	4.5	5.5	6.5
ØQ(PCD)		44	54	62	75	100	120
R		6	6	8	8	8	8
ØS		4.5	5.5	5.5	6.5	9	11
ØT(PCD)		17	19	24	30	40	50
ØU		14	18	21	26	26	32
ØV (H7)		6^{-0}	8^{-0}	9^{-0}	11^{-0}	14^{-0}	14^{-0}
W (J_S9)				3 ± 0.0125	4 ± 0.015	5 ± 0.015	5 ± 0.015
X				10.4	12.8	16.3	16.3
Y		M3	M3				
Z		2.5	3				
MINIMUM HOUSING CLEARANCE	Øa	36	45	53	66	86	106
	b	17.1	19	20.5	23	26.8	33
	c	1	1	1.5	1.5	1.5	2.5
aa		0.019	0.019	0.019	0.022	0.022	0.025
bb		0.014	0.014	0.014	0.018	0.022	0.025
cc		0.013	0.013	0.013	0.014	0.016	0.016
dd		0.020	0.020	0.020	0.024	0.024	0.025
ee		0.044	0.044	0.044	0.047	0.050	0.050
Weight (kgf)		0.09	0.15	0.28	0.42	0.89	1.7



ALTERNATE HUB STYLE
HKS 14 & 17

All dimensions and tolerances are shown with the gear set in its assembled and mounted condition.

Maintain the recommended tolerances for optimum performance.

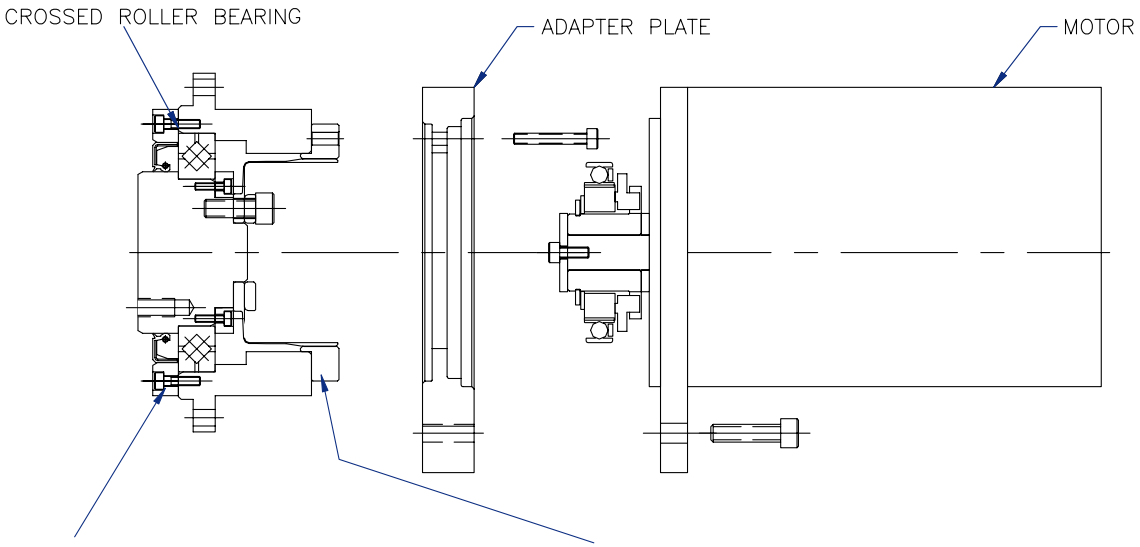
Dimensions are for reference only and may be subject to revisions.

Contact factory for installation drawing.

Visit us at harmonic-drive.com for technical information.

All dimensions are in mm.

INSTALLATION

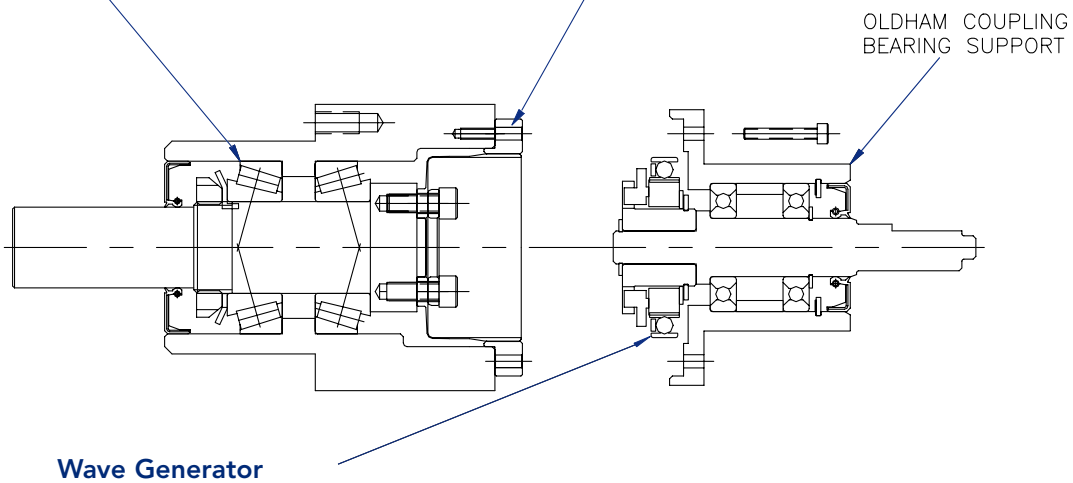


Flexspline Support

The flexspline must be connected to a bearing-supported shaft or fixed rotationally. Overhung loads from an external source require a suitable two-bearing support or cross roller bearing to maintain required tolerances.

Circular Spline

The circular spline may be located either in its outside diameter or on the pilot diameter provided. Vibration may occur if the housing is allowed to distort the circular spline from roundness.



Wave Generator

The standard wave generator is provided with an Oldham coupling to allow for misalignment of the input drive. The wave generator bearing is not designed to support a shaft. Additional bearing support should be provided.

ALIGNMENT AND ASSEMBLY

To achieve proper performance from Harmonic Drive Gear Sets, certain mounting and alignment requirements are necessary. Dimensions and tolerances marked [2] establish interface and installation requirements and must be adhered to under all load conditions.

Excessive deflection or improper alignment will affect the smoothness of motion or cause premature failure. All components must be restrained axially, including the wave generator which has a tendency to "walk" into the flexspline cup during operation.

Use high-strength alloy steel screws tightened to manufacturer's recommended torque specifications. Loctite or some other means to prevent loosening is also recommended.

TORSIONAL SPRING RATE

For most purposes, the torsional spring rate of (HKS) can be illustrated by a graph with two distinct slopes A and B

A low torque applied to the out put creates a nonlinear deflection shown in slope A. This is sometimes referred to as "soft windup" and is dependent upon the clearance between the flexspline and the wave generator bearing race and the diametral clearance of the bearing. Stiffness is shown in charts 1 and 2 below.

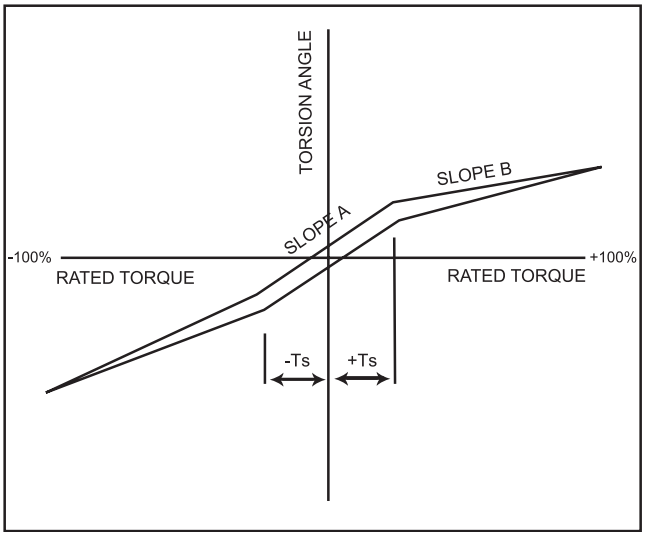


CHART 1 50:1 RATIO

HKS SIZE	SLOPE A R1 lb in/rad	SLOPE A R1 Nm/rad	TORQUE RANGE T_s lb in	TORQUE RANGE T_s Nm	SLOPE B R2 lb in/rad	SLOPE B R2 Nm/rad
14	29800	3366	8	2	41600	4700
17	71700	8100	35.4	4	95600	10800
20	115000	13000	62	7	159300	18000
25	2.2×10^5	2.5×10^4	124	14	3.0×10^5	3.4×10^4
32	4.7×10^5	5.3×10^4	257	29	6.9×10^5	7.8×10^4
40	8.9×10^5	1.0×10^5	478	54	1.24×10^6	1.4×10^5

CHART 2 OVER 50:1 RATIO

HKS SIZE	SLOPE A R1 lb in/rad	SLOPE A R1 Nm/rad	TORQUE RANGE T_s lb in	TORQUE RANGE T_s Nm	SLOPE B R2 lb in/rad	SLOPE B R2 Nm/rad
14	41780	4720	18	2	54000	6100
17	89400	10100	35.4	4	119500	13500
20	141000	16000	62	7	1.6×10^5	25000
25	2.8×10^5	3.5×10^4	124	14	4.4×10^5	5×10^4
32	5.9×10^5	6.7×10^4	257	29	9.7×10^6	1.1×10^5
40	1.15×10^6	1.3×10^5	478	54	1.8×10^6	2.0×10^5

The Torsional spring rates shown in charts 1 & 2 are measured by applying a torque to the output with the input fixed.

To calculate the maximum angular deflection on an HKS Short Cup Gear Set for an output torque, T, use the following equation:

$$\text{Radians} = \frac{T_s}{R_1} + \frac{[\,T - T_s]}{R_2}$$

See Chart 1 & 2 for T_s

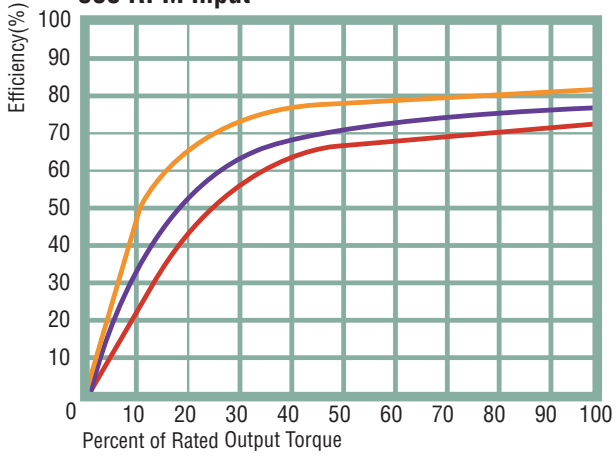
ACCURACY

HKS Size	Positional Error	Hysteresis	Lost Motion
14	<60 arc sec	<1arc min	<1arc min
17	<60 arc sec	<1arc min	<1arc min
20	<40 arc sec	<1arc min	<1arc min
25	<40 arc sec	<1arc min	<1arc min
32	<40 arc sec	<1arc min	<1arc min
40	<40 arc sec	<1arc min	<1arc min

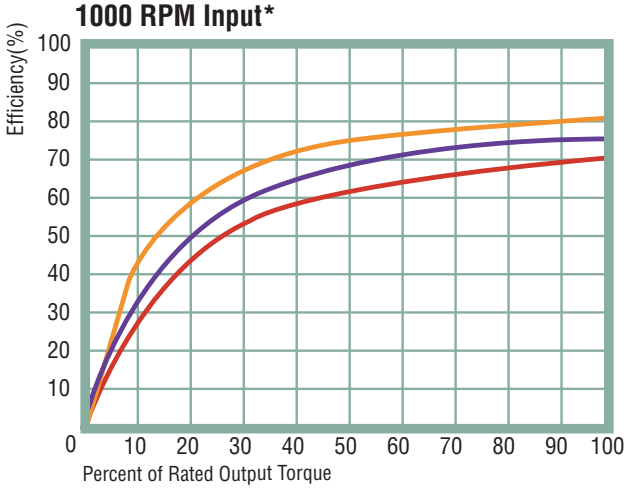
EFFICIENCY

The efficiency of HKS Gear Sets varies with speed, ratio, lubrication, and temperature. The following graphs show the approximate measured values of efficiency against percentage of rated torque. These values can be adjusted by a temperature factor; however, extremes of temperature or excessively low loading should be referred to our Engineering Department.

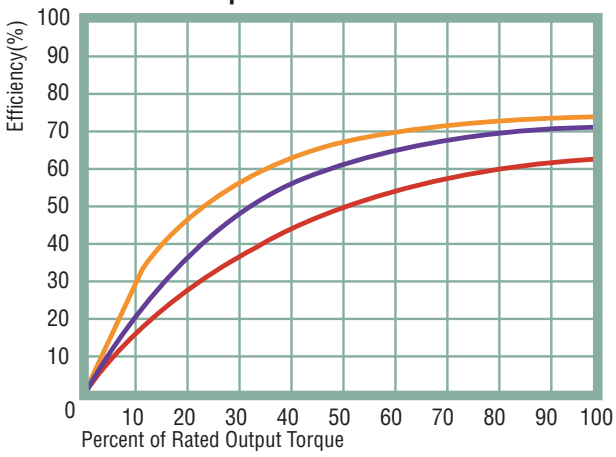
500 RPM Input*



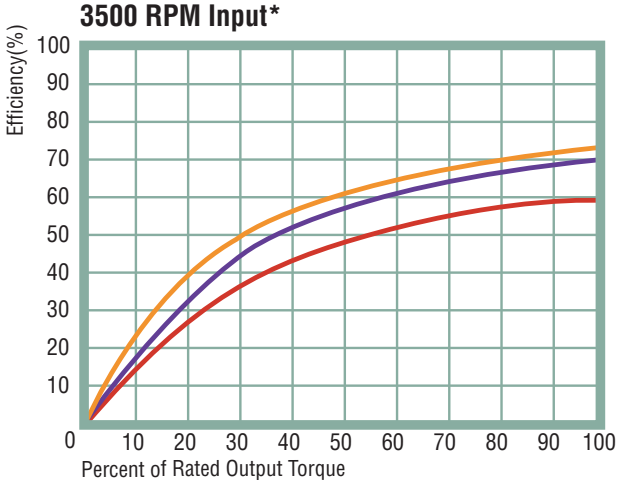
1000 RPM Input*



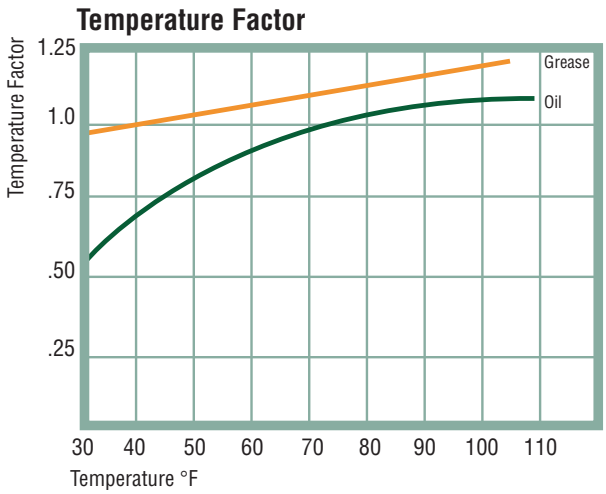
2000 RPM Input*

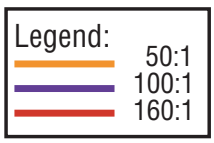


3500 RPM Input*



Temperature Factor





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Precision Reducers

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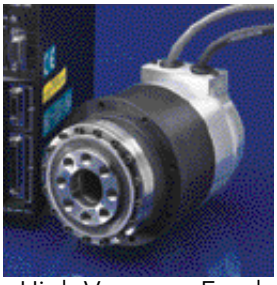
Gearheads and



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Harmonic Drive Technologies, a subsidiary of Teijin Seiki Company of Tokyo, Japan, is a world leader in the design, development and manufacturing of zero-backlash, high ratio harmonic drive gearing technology. Founded in 1955, Harmonic Drive Technologies operates from a state of the art, 34,000 square foot manufacturing facility headquartered in Peabody, Massachusetts. Industries benefiting from our wide product offerings include robotics, machine tool, aerospace, and semiconductor.

Precision gears, gearheads, and actuators from Harmonic Drive Technologies meet the needs of demanding motion control applications requiring precise positional accuracy and repeatability. Units are capable of accuracies better than 1 arc minute, repeatability of +/- 5 arc seconds and transmit high torque loads (up to 30,000 inch pounds) for their compact size. Both standard and customer specific units are available with ratios from 50:1.

Harmonic Drive® TECHNOLOGIES
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ISO 9001 Certified

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