Harmonic Drive®
Triangle Technology

Harmonic
Drive SE

Our inspiration

With either Apollo 15 on the moon or in the depths of the rough oceans, for more than 50 years, we have been providing significant applications across the planet and beyond with our drive solutions. We, as an industry leader in high precision drive technology, have not only continued to expand our portfolio based on the unique Harmonic Drive® Strain Wave Gear but have also recognised the requirements of modern, trend setting markets and applications: The future of drive technology is intelligent, sustainable and efficient.

Thanks to their special characteristics, which have been continuously developed over decades, Harmonic Drive® Gears and Actuators are perfectly suited to important key industries, including robotics, handling & automation, medical technology, special environments, aviation & space and mechanical engineering.

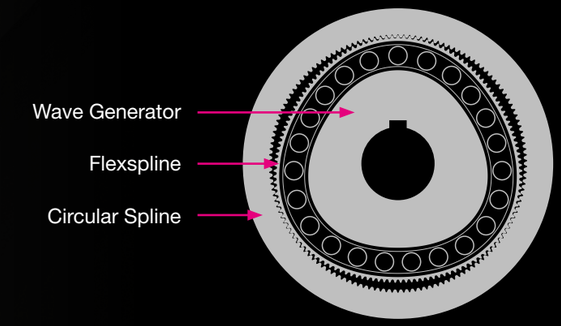
Highest precision and quality for our customers are key principles of our corporate culture. Eighty percent of our products that leave our factory in Limburg/Lahn are customised versions and are therefore specially developed, designed and manufactured according to customer specifications - from space saving gear component sets to intelligent drive systems.

Due to the high complexity in the configuration of suitable drive technology components, we partner and advise our customers comprehensively. The proposed solution for the drive task to be realised is developed in close cooperation to enable the subsequent integration into the application environment without any problems. Vital for this are, on the one hand, the high flexibility and, on the other hand, the customised scope of services and the integration level. The result is an optimal, highly individualised drive solution.

Successfully shaping the future together with, and for our customers, in demanding industries is a sign of our innovative strength in the field of high precision drive technology.

Production and development sites at the highest technological level in Germany, Japan and America as well as subsidiaries in Europe and Asia ensure that we can offer highly specialised and intelligent drive solutions as well as mechatronic systems worldwide.

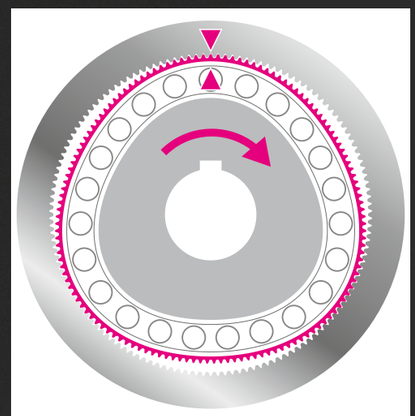
Triangle Technology is based on a revolutionary further development of the proven Harmonic Drive® operating principle



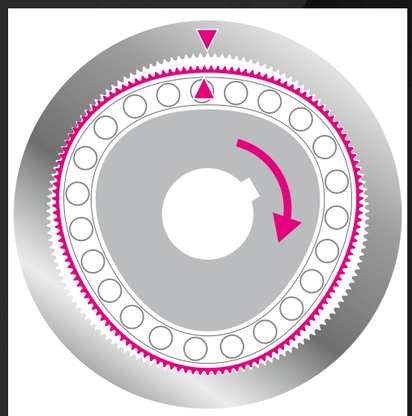
The rounded triangular shape of the Wave Generator creates three tooth engagement areas between the Flexspline, which has external teeth, and the Circular Spline, which has internal teeth.

The rotation of the Wave Generator causes a permanent circumferential tooth engagement between Flexspline and Circular Spline. Since the Flexspline has three teeth fewer than the Circular Spline, a rotation of the Wave Generator causes a relative movement of the Flexspline to the Circular Spline.

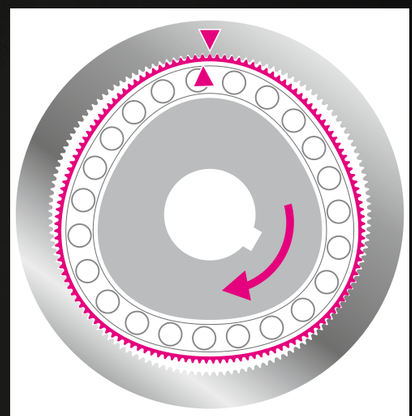
Compared to Harmonic Drive® Gears with an elliptical Wave Generator, the three tooth engagement areas of the Triangle technology result in higher torsional stiffness under load.



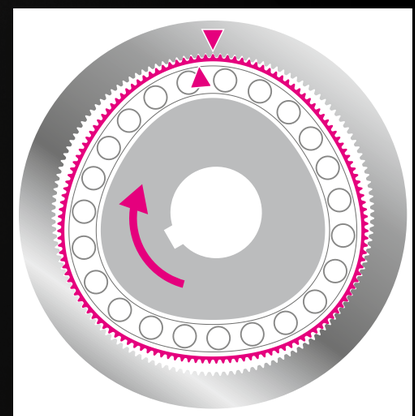
1. Start



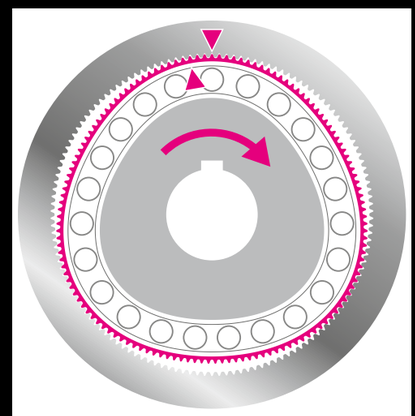
2. 1/6 Input rotation



3. 1/3 Input rotation



4. 2/3 Input rotation



5. 1 Input rotation

Product description

Triangle Technology – highest torsional stiffness and outstanding precision

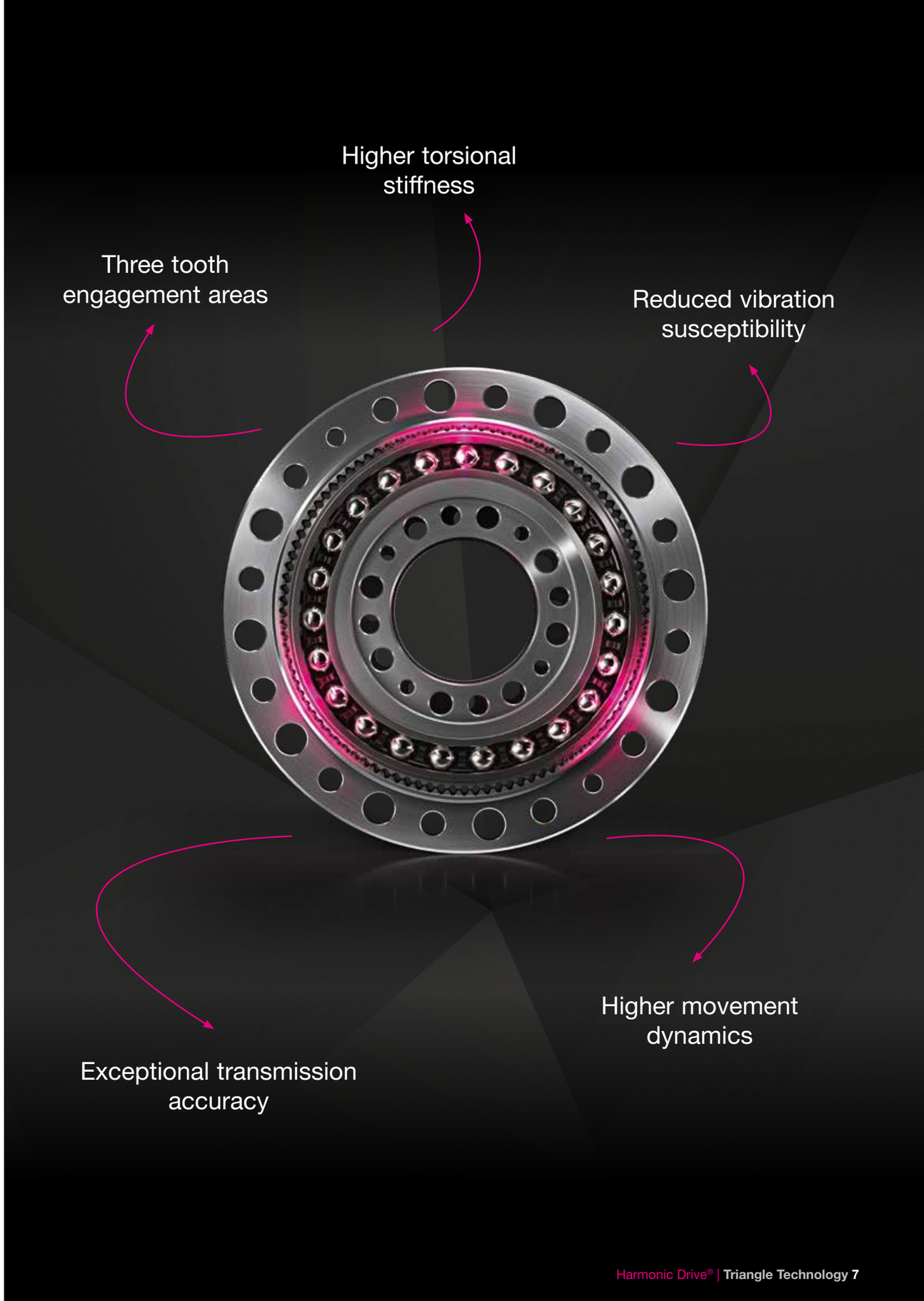
Triangle Technology sets new standards in torsional stiffness, transmission accuracy and dynamics. This enables a new level of precision and acceleration.

Features

- **Higher torsional stiffness**
  The three tooth engagement areas of the Triangle technology result in a significantly increased torsional stiffness of at least 40%. The load related twisting of the gear is thus considerably reduced.
  For milling machines, for example, higher feed rates can be achieved with the same surface quality.

- **Exceptional transmission accuracy**
  With Triangle Technology, exceptionally precise transmission accuracy of < 0.5 minutes of arc is achieved. This enables highly precise applications even without the use of an output side encoder system.

- **Reduced vibration susceptibility**
  The higher torsional stiffness of the gear results in a lower tendency of the drive system to vibrate. This enables highly dynamic motion cycles and a reduction in the cycle time of your system.



Series

Triangle Technology can be applied to gear component sets, hollow shaft gears, motor mounted gears and gears with a Cup Type or Silk Hat Type input shaft.

CSG-2A

Highest torque capacity and lifelong precision

The CSG-2A Series Gear Component Sets are characterised by maximum torque capacity and service life with a small outer diameter as well as lifelong precision and freedom from backlash.

CPL-2A

The lightweight gear with large hollow shaft

The CPL-2A Series Gear Component Sets are characterised by their very low weight, low moment of inertia and are perfectly suited for moving axes with the highest dynamics.

CSG-2UH

Highest torque capacity and lifelong precision

The CSG-2UH Series Gears with output bearing are characterised by maximum torque capacity and service life with a small outer diameter as well as lifelong precision and freedom from backlash.

SHG-2A

High overload capacity and service life

The SHG-2A Series Gear Component Sets are characterised by maximum torque capacity, service life and overload capacity and are available with a large hollow shaft as an option.

SHG-2UH/-2SO/-2SH

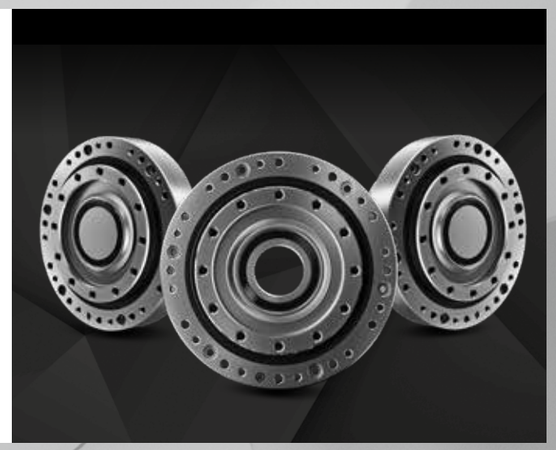
Highest torque capacity and lifetime precision

The SHG-2UH/2SO/2SH Series Gears with output bearing are characterised by their high torque capacity, lifetime and overload capacity and are optionally available with a large hollow shaft.

CSG-CPM/-CPH/-CPS

Highest torque capacity and reinforced output bearing

The CSG-CPM/H/S Series gears with output bearing consist of a precise CSG-2A Gear Component Set and a tilt resistant output bearing. They are available as motor mounted gear, with hollow shaft or with input shaft.



Combinations

Table 1

TriCSG-2A

Size		14	17	20	25	32	40	45	50	58	65
Ratio	30 (HFUC)	-	-	-	-	-	-	-	-	-	-
	50	-	-	-	-	-	-	-	-	-	-
	80	-	-	-	-	-	-	-	-	-	-
	100	-	-	-	o	-	o	-	-	-	-
	120	-	-	-	-	-	-	-	-	-	-
	160	-	-	-	-	o	-	-	-	-	-

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Table 2

TriSHG-2A

Size		14	17	20	25	32	40	45	50	58	65
Ratio	30 (HFUS)	-	-	-	-	-	-	-	-	-	-
	50	-	-	-	-	-	-	-	-	-	-
	80	-	-	-	-	-	-	-	-	-	-
	100	-	-	-	●	-	o	-	-	-	-
	120	-	-	-	-	-	-	-	-	-	-
	160	-	-	-	-	●	-	-	-	-	-

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Table 3

TriCPL-2A

Size		14	17	20	25	32
Ratio	30	-	-	-	-	-
	50	-	-	-	-	-
	80	-	-	-	-	-
	100	-	-	-	o	-
	120	-	-	-	-	-
	160	-	-	-	-	o

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Table 4

TriSHG-2UH/-2SO/-2SH

Size		11	14	17	20	25	32	40	45	50	58	65
Ratio	30 (HFUS)	-	-	-	-	-	-	-	-	-	-	-
	50	-	-	-	-	-	-	-	-	-	-	-
	80	-	-	-	-	-	-	-	-	-	-	-
	100	-	-	-	-	●	-	o	-	-	-	-
	120	-	-	-	-	-	-	-	-	-	-	-
	160	-	-	-	-	-	●	-	-	-	-	-

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Table 5

TriCSG-2UH

Size		14	17	20	25	32	40	45	50	58	65
Ratio	30 (HFUC)	-	-	-	-	-	-	-	-	-	-
	50	-	-	-	-	-	-	-	-	-	-
	80	-	-	-	-	-	-	-	-	-	-
	100	-	-	-	o	-	o	-	-	-	-
	120	-	-	-	-	-	-	-	-	-	-
	160	-	-	-	-	o	-	-	-	-	-

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Table 6

TriCSG-CPM/-CPH/-CPS

Size		14	17	20	25	32	40	45	50	58
Ratio	30	-	-	-	-	-	-	-	-	-
	50	-	-	-	-	-	-	-	-	-
	80	-	-	-	-	-	-	-	-	-
	100	-	-	-	o	-	o	-	-	-
	120	-	-	-	-	-	-	-	-	-
	160	-	-	-	-	o	-	-	-	-

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Technical data

• Performance data

The following values apply to a gear component set using Triangle Technology.

Table 7

Size	Ratio	Limit for repeated peak torque	Limit for average torque	Rated torque at 2000 rpm	Limit for momentary peak torque	Maximum input speed [rpm]	Limit for average input speed [rpm]
	i	T_R [Nm]	T_A [Nm]	T_N [Nm]	T_M [Nm]	Grease lubrication	Grease lubrication
25	100	204	140	87	369	7500	3500
32	160	484	281	178	892	7000	

• Accuracy

Table 8

	Size 25 … 32
Ratio	100, 160
Transmission accuracy	< 0.5
Hysteresis loss	< 1.0
Lost Motion	< 1.0
Repeatability	< ±0.1

• Torsional stiffness

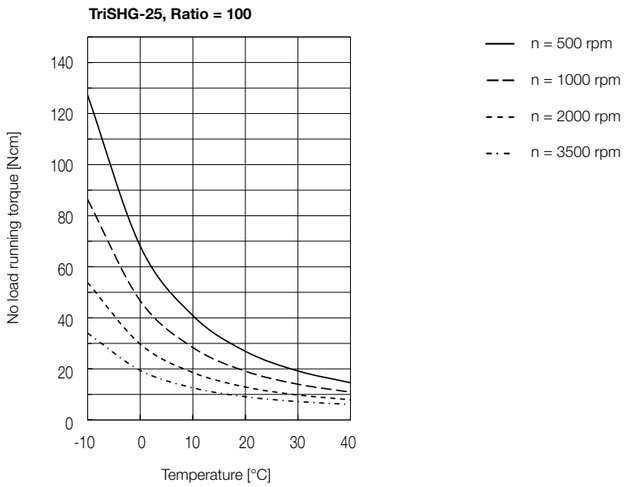
Table 9

	Symbol [Unit]	Size 25	Size 32
Limit torques	T1 [Nm]	14	29
	T2 [Nm]	48	108
i ≥ 100	K_3 [x 10^4 Nm/rad]	8.0	22.7
	K_2 [x 10^4 Nm/rad]	6.9	16.6
	K_1 [x 10^4 Nm/rad]	6.3	13.1

• No load running torque

The diagram applies to Harmonic Drive® Flexolub®-A1 grease.

Illustration 1

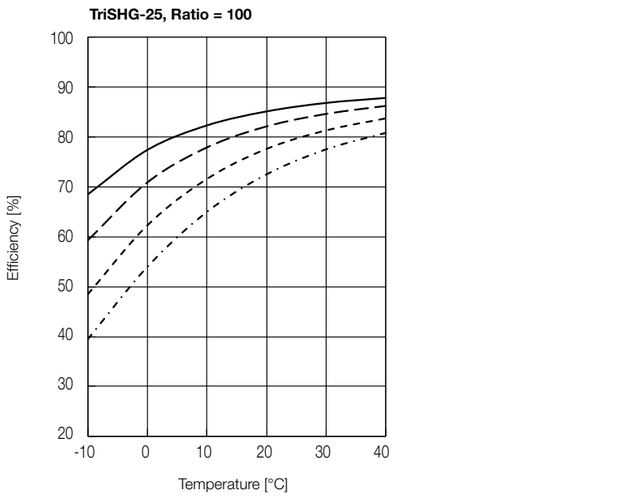


• Efficiency

Efficiency for grease lubrication at rated torque

The diagram applies to Harmonic Drive® Flexolub®-A1 grease.

Illustration 2



Our gears, which are based on Triangle Technology, combine maximum torsional stiffness, exceptional transmission accuracy and dynamic motion – ideal for applications in the following areas:

Robotics, handling & automation

Maximum precision and shorter cycle times in industrial and service robots, as well as in production and assembly systems.

Medical technology

Precise motion transmission in surgical robotics and imaging devices.

Mechanical engineering

In milling machines for wood and plastic, the increased torsional stiffness of Triangle Technology ensures better surface properties for the workpieces.

Aerospace

High torsional stiffness and low vibration susceptibility for demanding applications in Aerospace.

PASSION GENERATES THE HIGHEST QUALITY

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