



# Robotics, handling & automation



Harmonic  
Drive SE





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## 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, mechanical engineering, medical technology, special environments and aerospace.

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 special 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.



## Harmonic Drive® Gears

Harmonic Drive® Gears consist of three individual components – Circular Spline, Flexspline and Wave Generator. Gear component sets with extremely compact design ensures installation in applications with the most demanding space requirements. Gears with output bearings ease integration by combining the precise component sets with high capacity tilt resistant output bearings.



Catalogue  
Harmonic Drive® Gears

### GEAR COMPONENT SETS



### GEARS WITH OUTPUT BEARING



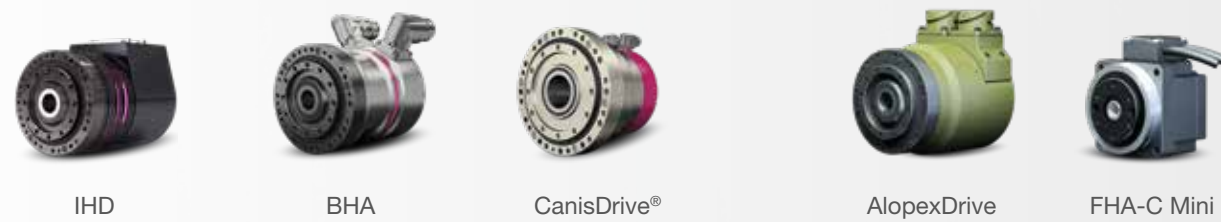
## Harmonic Drive® Servo Actuators

Harmonic Drive® Servo Actuators are the perfect combination of highly dynamic compact servo motors, precision Harmonic Drive® Gear Component Sets and integral high load capacity, tilt resistant output bearings.



Catalogue  
Harmonic Drive® Mechatronics

### SERVO ACTUATORS WITH HOLLOW SHAFT



### SERVO ACTUATORS WITH SOLID SHAFT



## Harmonic Planetary Gears

Harmonic Planetary Gears have lower gear ratios usually operating higher speeds where there is often the need for very high precision. Our special design with a flexible ring gear in the output stage means that we guarantee constant high precision over the entire lifetime – we call this Permanent Precision®!



Catalogue  
Harmonic Planetary Gears







LBR iiwa, KUKA AG  
Image source: KUKA AG

## Human robot collaboration

The KUKA lightweight robot LBR iiwa (intelligent industrial work assistant) can work safely together with humans.

It is sensitive, precise, flexible and, due to its mechanics and drive technology, an intelligent helper in industry and medical robotics.

With its programmable sensitivity, the LBR iiwa resembles the human arm. It has seven axes and is equipped with integrated joint torque sensors and an effective collision detection. The lightweight robot is prepared for the automation of sensitive joining processes and complex assembly tasks.

Thanks to its slim design and low weight, the LBR iiwa can also be integrated in confined installation situations. It can be mounted on a mobile platform as an autonomously navigating transport solution and can handle payloads from 7 kg to 14 kg.

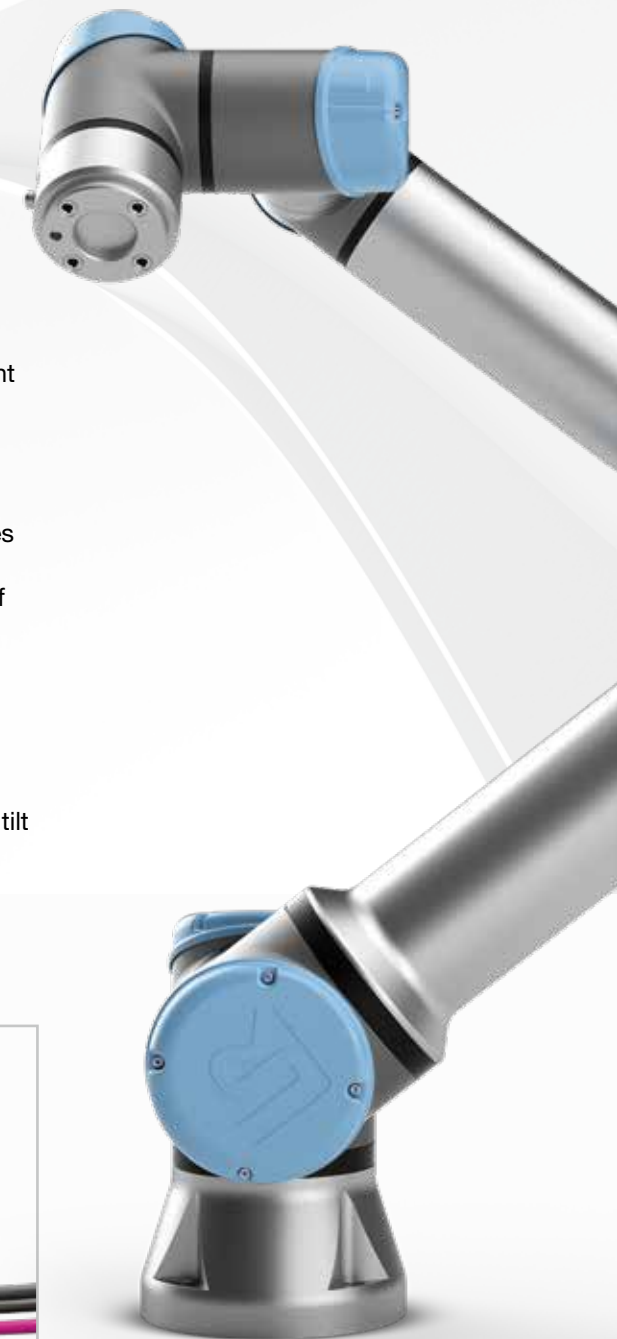
The LBR iiwa can act as the operator's "third hand" and relieve him of heavy or non ergonomic work - in the automotive industry, for example, when placing components or joining fitted elements such as pistons in cylinders or tasks in restricted spaces.

## Universal and lightweight system

The Danish company Universal Robots A/S develops and produces cobots that are optimally suited for a variety of applications due to their design and nature. Above all, the lightweight robots are characterised by their low weight as well as their flexible and intuitive setup and operability.

The UR3e to UR16e Series can be easily integrated into the production lines and can be used flexibly within processes, depending on the task. Harmonic Drive® Gears with integrated output bearing are used in all six axes of the robots, which are optimised in terms of weight, inertia and installation space. The intelligent software simplifies the retooling and commissioning of the robot by the user.

Harmonic Drive® Products are used in robot axes, which are focusing on a compact robot design and therefore enable the high overall dynamics of the system. In addition to a reduction of the installation space, this optimisation leads to a significant weight reduction, which amounts to more than 30 %, depending on the size. At the same time the use of a high performance and tilt resistant cross roller bearing optimizes the drive concept.



UR5, Universal Robots A/S  
Image source: Universal Robots

SHG-2SH Gears with output bearing

Table 7.1

Size	Ratio	Outer diameter [mm]	Hollow shaft diameter [mm]	Repeated peak torque [Nm]
14	50 ... 100	70	14	23 ... 36
17	50 ... 120	80	19	44 ... 70
20	50 ... 160	90	21	73 ... 120
25	50 ... 160	110	29	127 ... 229
32	50 ... 160	142	36	281 ... 484
40	50 ... 160	170	46	523 ... 841
45	50 ... 160	190	52	650 ... 1147
50	80 ... 160	214	60	1223 ... 1534
58	80 ... 160	240	70	1924 ... 2392
65	80 ... 160	276	80	2743 ... 3419



## Master of speed

Compact, precise, agile and fast are the attributes describing the robots of the KR AGILUS Series from KUKA AG. For handling tasks, especially "Pick & Place", the KR AGILUS provides convincing results with short cycle times. At the same time, this series of small industrial robots works very precisely and enables highest production quality and reliability.

The energy supply system of the KR AGILUS is integrated in the robot structure to save space. Thanks to its optimal ratio of size, manoeuvrability and range, it is ideally suited for narrow installation space and can carry out tasks in floor, ceiling and wall mounted positions. In addition, the KR AGILUS has Safe Operation functionality, which simplifies and improves the cooperation between humans and robots.

Our precision gears ensure reliable power transmission in all six axes of the small robot. The CSG-2UH Series represent an optimum in terms of torque capacity and service life.



KR AGILUS, KUKA AG  
Image source: KUKA AG

Table 9.1

**CSG-2UH Gears with output bearing**

Size	Ratio	Outer diameter [mm]	Repeated peak torque [Nm]
14	50 ... 100	73	23 ... 36
17	50 ... 120	79	44 ... 70
20	50 ... 160	93	73 ... 120
25	50 ... 160	107	127 ... 229
32	50 ... 160	138	281 ... 484
45	50 ... 160	180	650 ... 1147
50	80 ... 160	190	1223 ... 1534
58	80 ... 160	226	1924 ... 2392
65	80 ... 160	260	2743 ... 3419



## Infinite possibilities of interaction

MAiRA, Multi sensing Intelligent Robotic Assistant, is the first commercially available cognitive robot. It was developed and built by the company Neura Robotics. Thanks to advanced AI and integrated sensors, MAiRA can dynamically adapt to changing working environments and autonomously perform tasks, setting it apart from conventional cobots. The robust and rigid design combines the performance (speed, accuracy) of a high end machine with simple drag-and-drop programming, lead through programming, voice and gesture control, opening up endless possibilities for interaction: for beginners as well as experts.

Harmonic Drive® Gears are an excellent solution for cognitive robots. The SHD-2SH Gears with output bearings are extremely short, lightweight and feature a large hollow shaft. These gears consist of a gear component set with a shortened Flexspline and a high capacity integrated output bearing that can absorb high tilting moments and bearing forces without additional bearing.



MAiRA, Neura Robotics GmbH  
Image source: Neura Robotics GmbH



SHD-2SH Gears with output bearing

Table 10.1

Size	Ratio	Outer diameter [mm]	Hollow shaft diameter [mm]	Repeated peak torque [Nm]
14	50 ... 100	70	11	12 ... 19
17	50 ... 120	80	15	23 ... 37
20	50 ... 160	90	20	39 ... 64
25	50 ... 160	110	24	69 ... 123
32	50 ... 160	142	32	151 ... 261
40	50 ... 160	170	40	281 ... 453

## Dynamics and precision for clean room applications

The robot portfolio of ASYS Automatic Systems GmbH & Co. KG is designed as a modular system. Thanks to decades of experience in robot design, reliable solutions can be offered for all applications, especially in high vacuum, ultra high vacuum and clean rooms. The robots of the Vario Series are the consequent evolution of the proven SCARA robot, which ensures by using a central motor design that no heat is transferred by the motors into the working environment of the arm. The drive system impresses with its high dynamics and precision.

For such applications, Harmonic Drive SE recommends compact servo actuators that meet the highest demands in terms of reliability and performance, such as the BHA Series Servo Actuators. The compact design and the hollow shaft ensure that the design effort can be significantly reduced in many applications. The BHA Servo Actuators are characterised by a compact and modular design with low cogging torque.



SCARA-AAR 740,  
ASYS AUTOMATIC SYSTEMS  
GMBH & CO. KG  
Image source: ASYS Automatic Systems  
GmbH & Co. KG



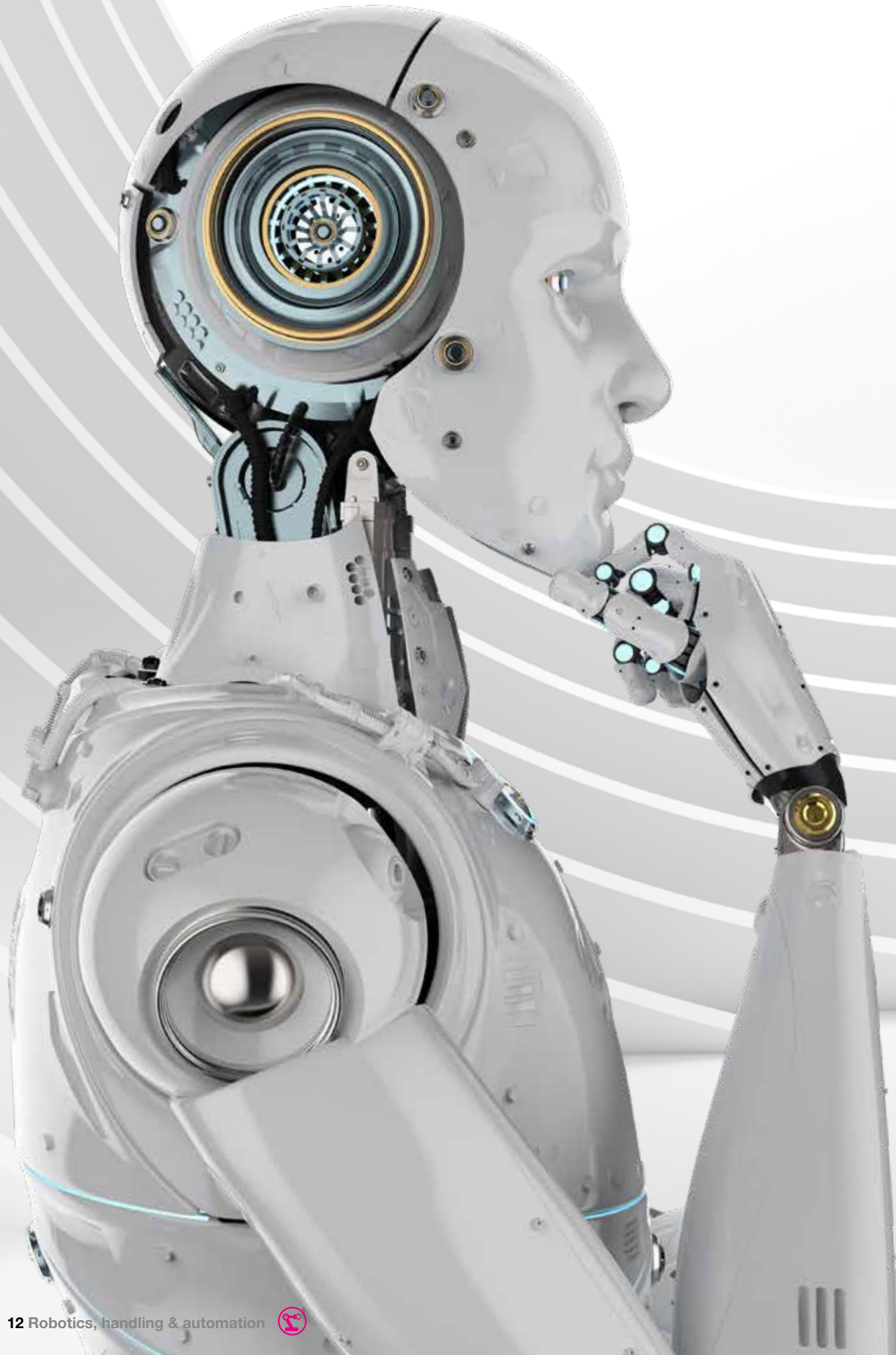
BHA Servo Actuators

Table 11.1

Size	Ratio	Maximum torque [Nm]	Maximum speed [rpm]	Hollow shaft diameter [mm]
17	50 ... 100	44 ... 70	7300	18
20	50 ... 160	73 ... 120	6500	18
25	50 ... 160	127 ... 229	5600	27







## Mobile on two legs

Humanoid robots are highly sophisticated machines whose design is based on the shape of humans. Often the joint positions and the motion sequences of a humanoid robot are similar to those of humans.

Humanoid robots impressively demonstrate how natural and fluent walking movements of these machines can look. These robots owe the smooth and backlash free motion sequences in the joints to Harmonic Drive® Gears.

High gear reduction, low vibration, highest accuracy as well as maximum torque capacity at low own weight are the elementary requirements for drive components for such robot systems. For these applications, the Harmonic Drive® CPL-2A, CSD-2A and SHG-2A Series Gear component sets are used for these applications.

It has been proven that the humanoid machines can relieve skilled human workers of work, leaving them more time for qualified activities in areas such as care, administration, sales and production.



CPL-2A

CSD-2A

SHG-2A

Table 13.1

Size	Ratio			Outer diameter [mm]			Repeated peak torque [Nm]		
	CPL-2A	CSD-2A	SHG-2A	CPL-2A	CSD-2A	SHG-2A	CPL-2A	CSD-2A	SHG-2A
14	30 ... 100	50 ... 100	50 ... 100	50	50	60	9 ... 28	12 ... 19	23 ... 36
17	30 ... 120	50 ... 120	50 ... 120	60	60	72	16 ... 54	23 ... 37	44 ... 70
20	30 ... 160	50 ... 160	50 ... 160	70	70	82	27 ... 92	39 ... 64	73 ... 120
25	30 ... 160	50 ... 160	50 ... 160	85	85	104	50 ... 176	69 ... 123	127 ... 229
32	30 ... 160	50 ... 160	50 ... 160	110	110	134	100 ... 372	151 ... 261	281 ... 484
40	-	50 ... 160	50 ... 160	-	135	164	-	281 ... 453	523 ... 841
45	-	-	50 ... 160	-	-	190	-	-	650 ... 1147
50	-	50 ... 160	80 ... 160	-	170	214	-	500 ... 823	1223 ... 1534
58	-	-	80 ... 160	-	-	240	-	-	1924 ... 2392
65	-	-	80 ... 160	-	-	276	-	-	2743 ... 3419





## Automated warehouse logistics

Picking robots are driverless warehouse machines that are used in logistics. The target of picking automation is to simplify the handling of incoming goods and to gain better control over the inventory.

In contrast to conventional warehouse storage systems, in which products are stored according to a specific order, modern automation solutions are based on a random storage principle. Here, the packages are stored according to height classes.

Perception controlled and networked, order picking robots have integrated camera and laser systems with which they are able to identify products from shelves, grab them precisely and move them on.

Backlash free gears from Harmonic Drive SE are used in the swivel axes of the grippers. The CPU-M Series Gears enable simple and time saving assembly of the motor. The integrated output bearing allows direct support of the bearing loads, which enables a simple design of the system.



Table 14.1

CPU-M Gears with output bearing

Size	Ratio	Outer diameter [mm]	Repeated peak torque [Nm]
14	30 ... 100	78	9 ... 28
17	30 ... 120	88	16 ... 54
20	30 ... 160	98	27 ... 92
25	30 ... 160	116	50 ... 176
32	30 ... 160	148	100 ... 372
40	50 ... 160	180	402 ... 647
45	50 ... 160	206	500 ... 882
50	50 ... 160	222	715 ... 1180
58	50 ... 160	255	1020 ... 1840

## Flexibility meets power

Exoskeletons are technical solutions that enable users to carry out their activities in the long term in a way that is gentle on their health. In many work processes, human flexibility is needed to perform tasks efficiently. However, in processes with high physical stress levels, the health of employees can quickly be impaired. This is where industrial exoskeletons play their role, acting as active support systems to reduce the strain on employees and thus prevent health problems.

In these applications, the short design SHD-2SH Series Gears with integrated output bearing are mostly used in combination with very compact electric motors.

In the industrial sector, the external structures take over supporting tasks. Whether on the assembly line, in the warehouse or when delivering goods, workers are often subjected to heavy physical strain when they have to lift, carry and process loads over a long period of time. By imitating and therefore reinforcing movements with the help of electronic, sensoric and mechanical components, exoskeletons ease the work of their wearers in the industrial sector. As a result, potential discomfort - primarily in the torso and back muscles - is prevented in advance and work efficiency is increased.

The aim is to use technology to make human work not only more efficient and productive, but also health promoting and sustainable.



SHD-2SH





## Pick & place

Pick & place robots, like those from the Italian manufacturer Automa Robotics S.r.l. are the optimal solution for fast sorting, processing and assembly of small components. Speed is the key performance of the delta robots. Due to their extremely fast reactivity and precision, they achieve maximum pick & place cycle rates per minute. They can perform high vertical forces which enables the force controlled assembly of components.

The additional axis for the rotation of the gripper is exposed to particularly high dynamics. Here a drive system with the lowest weight is required. The gears of the CSF-ULW (Ultra Light Weight) Series are the preferred choice for this application. The ULW Series achieves the same performance data as the HFUC-2UH Series at a weight reduction of approx. 50 % and an overall length reduction of approx. 30 %.

These precision gears are also ideal for use in hand axes of small and collaborative robots, as well as for industrial applications where low weight is required.



Image source: Automa Robotics

Table 17.1

CSF-ULW Gears with output bearing

Size	Ratio	Outer diameter [mm]	Repeated peak torque [Nm]
8	30 ... 100	54	1.8 ... 4.8
11	30 ... 100	63	4.5 ... 11
14	50 ... 100	71	18 ... 28
17	50 ... 120	81	34 ... 54
20	50 ... 160	93	56 ... 92





## Injection moulding automation

ENGEL Austria GmbH is positioned on the global market with its own automation systems. The ENGEL viper linear robot combines stability and dynamics. Thanks to its innovative design, it saves weight and scores with a higher payload capacity than comparable handling devices of up to 120 kg.

Clever software such as "vibration control" or "mass identification" automatically reduces natural vibrations even with long boom dimensions and optimises its movements and dynamic parameters.

Demanding linear kinematics with high cycle rates in limited installation space are the field of application of our compact servo actuators of the LynxDrive Series. Based on the proven Harmonic Drive® Gears with integrated output bearing, in combination with a highly dynamic servo motor, the compact LynxDrive Servo Actuators offer maximum precision and dynamics.

A variety of common encoder systems and the use of a specially developed, highly compact concentrated motor windings meet the market demand in terms of maximum flexibility and versatile controller compatibility.



Linear robot,  
ENGEL Austria GmbH  
Image source: ENGEL Austria GmbH

Table 18.1

LynxDrive Servo Actuators

Size	Ratio	Maximum torque [Nm]	Maximum speed [rpm]	Outer diameter [mm]	Length [mm]
14	30 ... 100	9 ... 28	85 ... 283	73	126
17	30 ... 100	16 ... 54	73 ... 243	79	129
20	30 ... 160	27 ... 92	41 ... 217	93	128
25	30 ... 160	50 ... 176	30 ... 160	111	149
32	30 ... 160	100 ... 372	30 ... 160	138	159
40	50 ... 160	402 ... 647	25 ... 80	160	169
50	50 ... 160	715 ... 1180	22 ... 70	190	226





## Helpers in need

Unmanned mobile robot systems are used in areas that would be too dangerous for humans, such as defusing bombs and booby traps or in radioactive environments. Their flexible design allows the adaptation of different payloads such as sensors and tools. The gripper arm has numerous degrees of freedom to allow optimum freedom of movement in narrow spaces. The travel speeds vary from creep to rapid travel. The six wheeled vehicle offers optimal mobility and high reliability in all environments and climates.

In the wheel drives of such mobile work platforms, the advantages of Harmonic Planetary Gears show their performance. With the HPGP Series, new precision planetary gears for the highest demands on accuracy and optimal torque capacities are also available.



Table 20.1

HPGP Planetary Gears

Size	Ratio	Repeated peak torque $T_R$ [Nm]	Maximum input speed $n_{i, (max)}$ [rpm]	Backlash [arcmin]
11A	5 ... 45	13	10000	$\leq 3$
14A	5 ... 45	30	6000	$\leq 3$ or $\leq 1$
20A	5 ... 45	133	6000	$\leq 3$ or $\leq 1$
32A	5 ... 45	400	6000	$\leq 3$ or $\leq 1$
50A	5 ... 45	1130	4500	$\leq 3$ or $\leq 1$
65A	4 ... 25	2920	3000	$\leq 3$ or $\leq 1$

## All-in-one solution

Our new IHD Servo Actuator: as rigid as a direct drive, as compact as a geared motor, more intelligent than ever before.

Save time and space with the all-in-one solution IHD: Thanks to the optimal combination of motor, gear, feedback system, controller and other components, the classic control cabinet is obsolete.

With the integrated application processor, the IHD Servo Actuator becomes a flexible and progressive smart system. The processor enables custom programming and applications in the area of condition monitoring.

Future oriented, sustainable and efficient: thanks to its software, the IHD is ready for use as a smart system within a very short time. Whether communications technology and communication, automation and handling or special environments - as a drive unit, the new IHD defies the most diverse requirements.



Table 21.1

IHD Servo Actuators

Size	Ratio	Maximum torque [Nm]	Maximum speed motor side at 48 VDC [rpm]	Hollow shaft diameter [mm]	Power supply [V <sub>DC</sub> ]	Power consumption [A <sub>DC</sub> ]
17	50, 100	44 ... 70	6000	18	24/48	14 ... 18
20	50, 100, 160	73 ... 120	6000	18		16 ... 29
25	50, 100, 160	127 ... 229	5600	25		25 ... 38



## Special gears for robotics

Robotic applications often place requirements on the drive system which are not yet ideally solved by our standard products. In close partnership with our customers we develop individual solutions according to your requirements.

### Individual combinations

Our individual solutions enable a new combination of proven and reliable components. This means that customised solutions can be realised quickly and flexibly.

### Adaptations of the interfaces

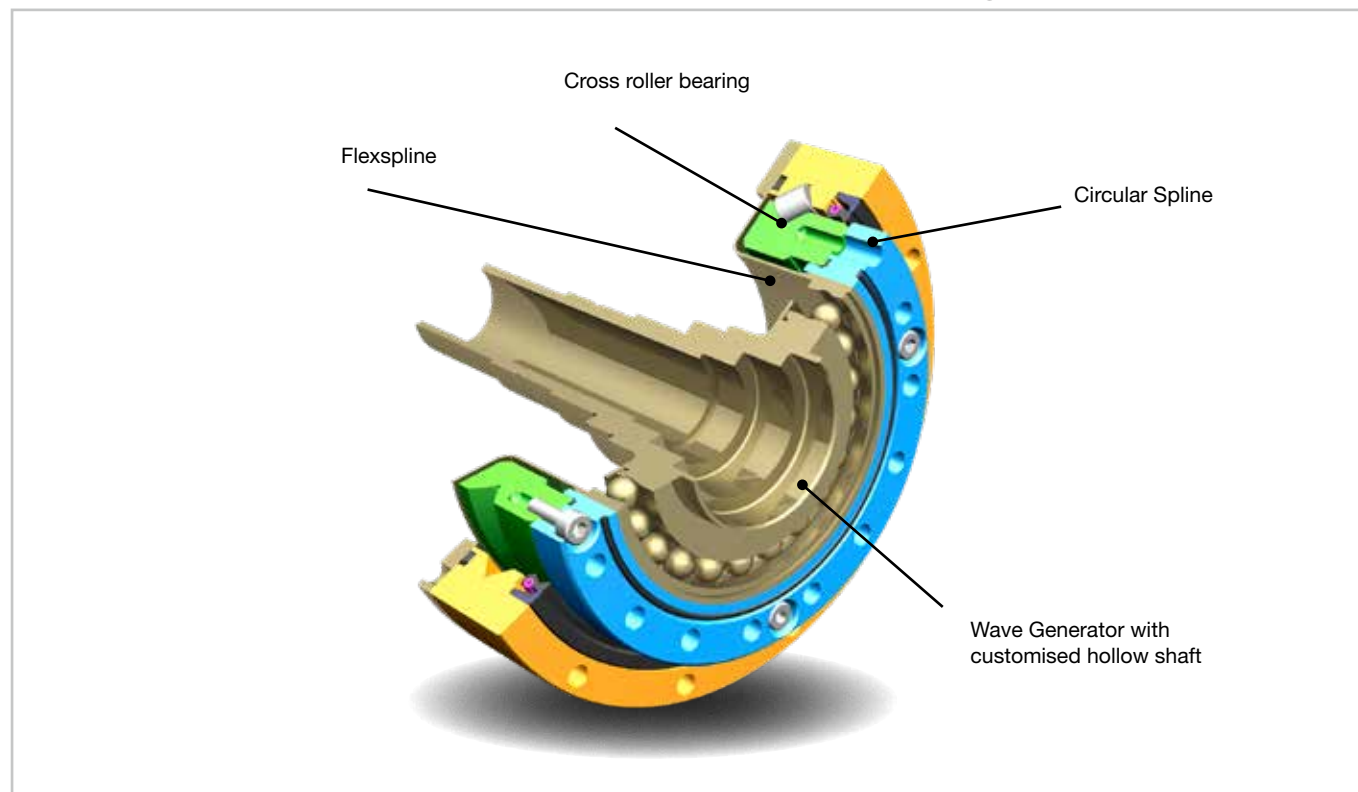
In order to adapt our products to the design particulars of your application, the mechanical interfaces often have to be changed. In this way, components such as the housing, motor adaptation, etc. can be customised. The interfaces of the core components such as Circular Spline, Flexspline and Wave Generator can be adapted as long as their function is not affected.

### Short development times

Since the core components remain unchanged in their function, the basic qualification of the components can remain. This enables a high degree of individualisation with a short development time.

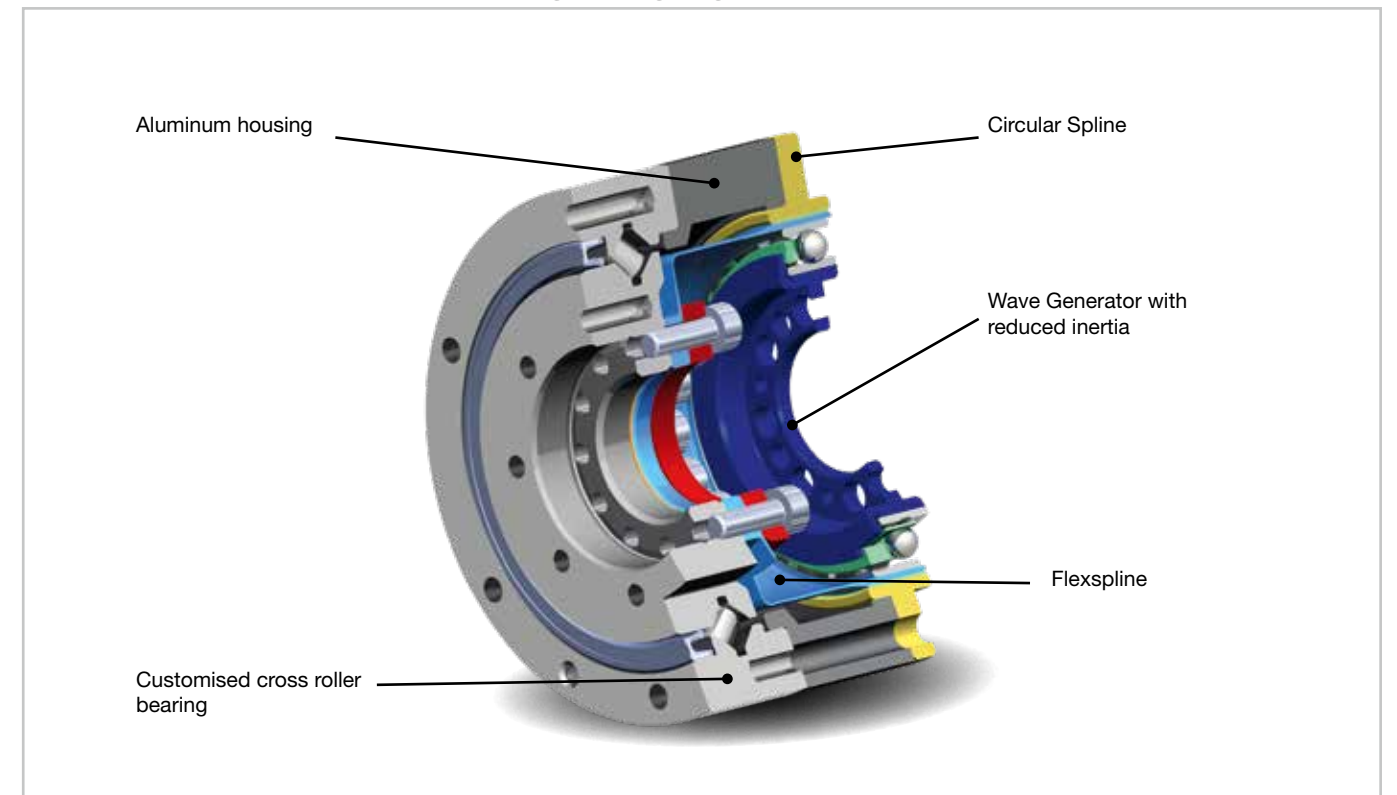
**Gear for robotic axis with customised hollow shaft for adaptation of rotor magnets, encoder and brake**

Illustration 22.1



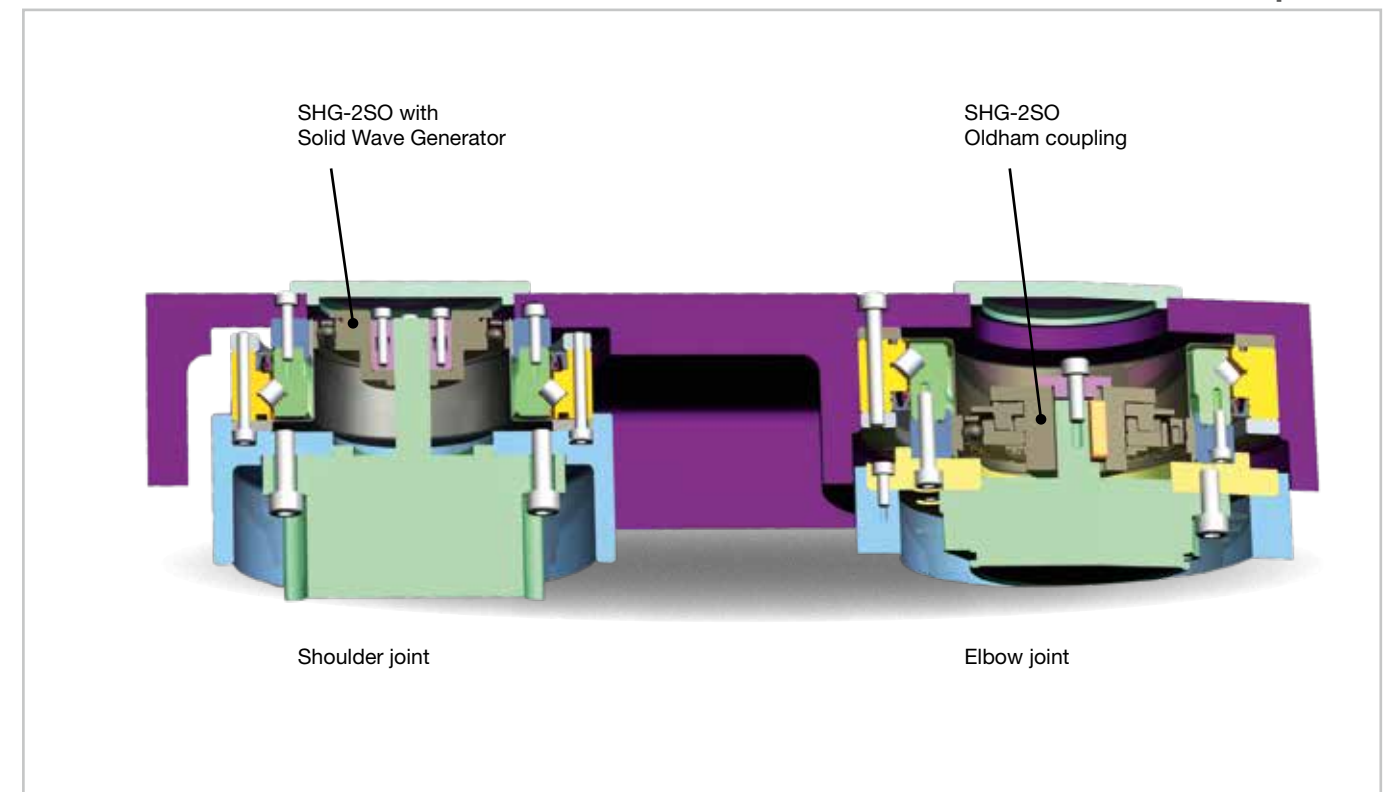
**Lightweight gear based on CPL-2A Gear Component Set**

Illustration 23.1



**Two SCARA robot axes based on SHG-2SO with motor adaptation**

Illustration 23.2







PASSION GENERATES THE HIGHEST QUALITY

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