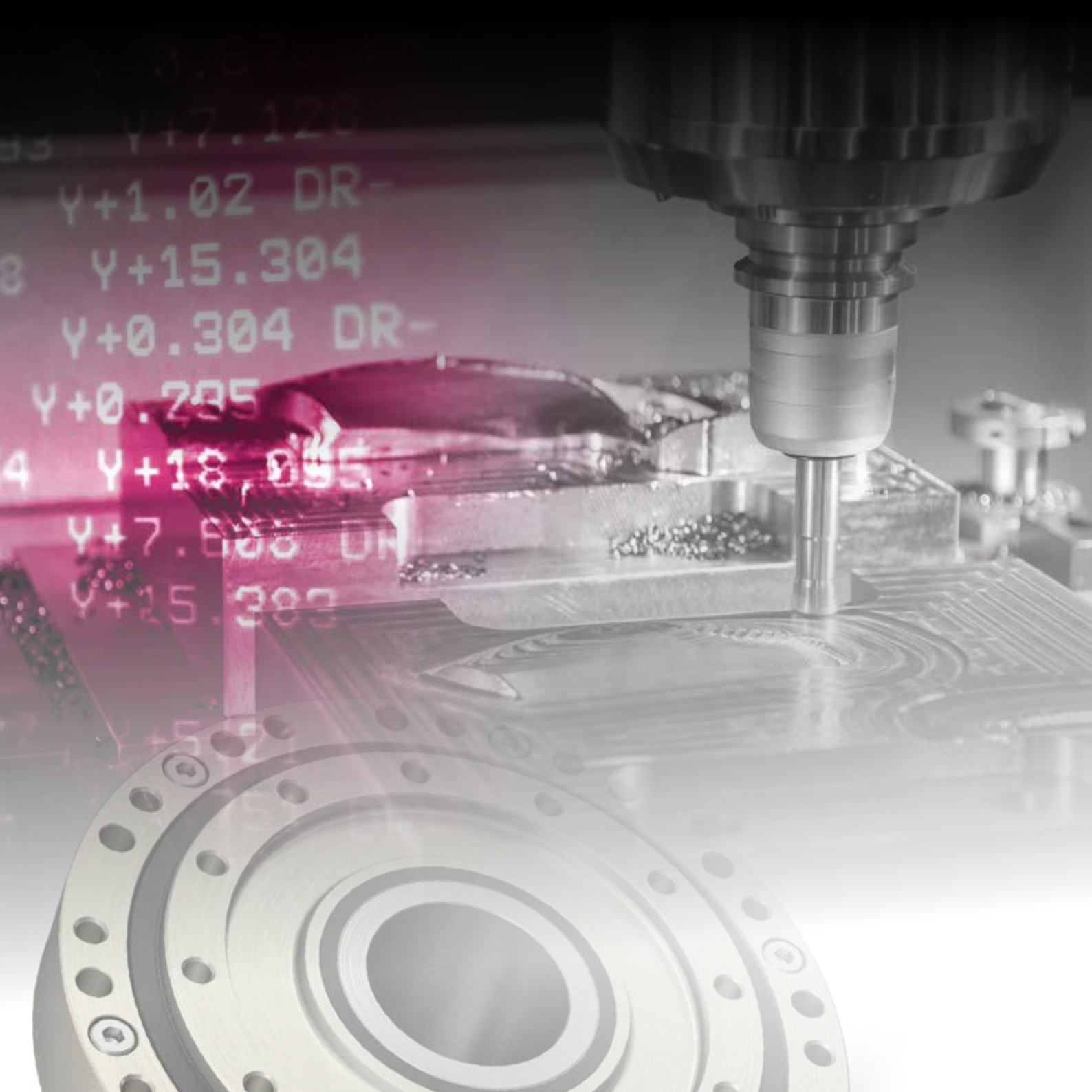
Machine Tools

Harmonic Drive SE



Content

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 the 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.

Product Programme

The overview shows a selection of Harmonic Drive® Products used in machine tools and mechanical engineering.

SERVO ACTUATORS WITH HOLLOW SHAFT

Series	IHD (Actuator with integrated controller)	BHA	CanisDrive®	FHA-C Mini
				
Product focus	High standardisation Function adaptation via software	High standardisation Cost-optimised Reduced variance	Extensive combination possibilities and customised adaptations for industrial applications	High standardisation Reduced variance
Design	short / compact	short / compact	short / compact	short / compact
Torque capacity and lifetime	●●●	●●●	●●●	●●
Small outer diameter	●●	●●	●	●●
Short design	●●	●●	●●●	●●●
Tilting moment output bearing	●●●	●●●	●●●	●●
Low weight	●●	●●	●●	●●
Key data				
Hollow shaft diameter [mm]	18 ... 25	18 ... 25	12 ... 65	6.2 ... 13.5 (only with incremental encoder)
Maximum torque [Nm]	44 ... 229	44 ... 229	23 ... 1840	1.8 ... 28
Maximum speed [rpm]	35 ... 120	35 ... 120	19 ... 170	60 … 200
Outer diameter [mm]	88 ... 116	88 ... 116	78 ... 255	50 … 75
Length [mm]	141 ... 200	110 ... 173	97 ... 235	48 ... 78

SERVO ACTUATORS WITH SOLID SHAFT

LynxDrive

Extensive combination options and customer specific specific adaptations for industrial applications
slim design
●●
●●●
●
●●
●●
-
9 ... 1180
22 ... 283
73 ... 190
126 ... 288

[1] On request and depending on the DC link voltage

●●● perfect ●● optimal ● good

GEAR COMPONENT SETS

Series	CSG-/HFUC-2A	SHG-2A
		
Type	CT	ST
Torque capacity and service life	●●●/●●	●●●/●●
Transmission accuracy	●●●	●●●
Small outer diameter	●●●	●●
Short design	●●	●●
Tilting moment output bearing	-	-
Low weight	●●	●●
Key data		
Maximum torque [Nm]	1.8 … 9180	9 … 3419
Tilting moment output bearing [Nm]	-	-
Hollow shaft diameter [mm]	-	-

Description:
CT = Cup Type Gear
CH = Closed hollow shaft gear
M = Motor mounting gear
S = Input shaft gear

GEARS WITH OUTPUT BEARING

CSG-2UH/HFUC-2UH	CPU-M	CPU-H	CPU-S	CSG-CPM	CSG-CPH	CSG-CPS
						
M	M	CH	S	M	CH	S
●●●/●●	●●	●●	●●	●●●	●●●	●●●
●●●	●●●	●●●	●●●	●●●	●●●	●●●
●●	●	●	●	●	●	●
●●	●●	●	●	●●	●	●
●●	●●●	●●●	●●●	●●●	●●●	●●●
●●	●	●	●	●	●	●
9 … 6840	9 … 1840	9 … 1840	9 … 1840	34 … 586	34 … 586	34 … 586
41 … 4210	73 … 2222	73 … 2222	73 … 2222	114 … 886	114 … 886	114 … 886
-	-	14 … 70	-	-	19 … 46	-

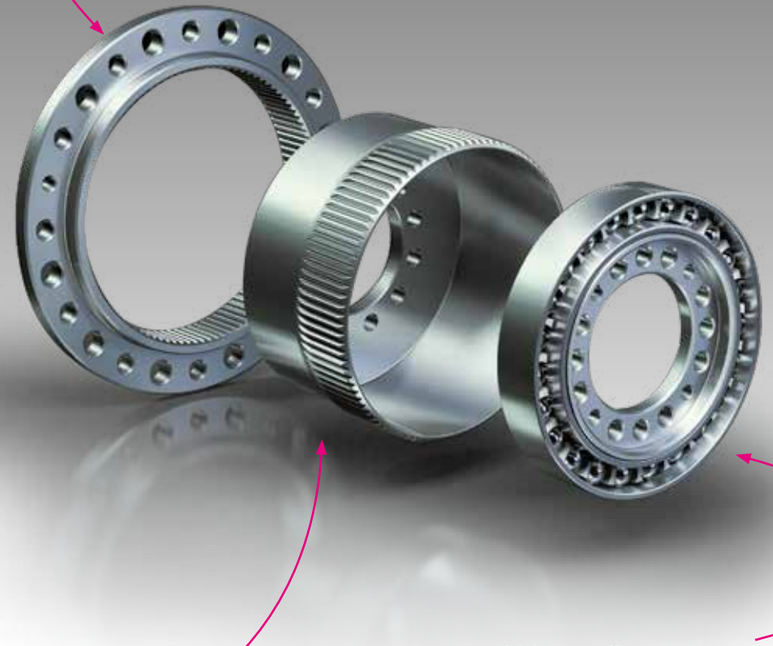
●●● perfect ●● optimal ● good

Principle of operation Harmonic Drive® Gears

Highly precise and backlash free gear component sets form the central element of Harmonic Drive® Gears and Servo Actuators. Harmonic Drive® Gear Component Sets consist of only three precision components:

Circular Spline

The Circular Spline is designed as a rigid ring with internal teeth. The Circular Spline has two teeth more than that of Flexspline.



Flexspline

The Flexspline is a high strength, torsionally stiff yet flexible component with external teeth, which reliably transmits high loads.

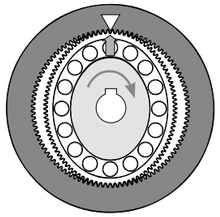
Wave Generator

The Wave Generator is the driven element of the transmission. The elliptical shaped Wave Generator is fitted with a specially designed thin race ball bearing assembly.

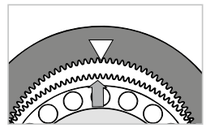
By inserting the Wave Generator into the Flexspline, the Flexspline assumes the elliptical shape of the Wave Generator. The rotating Wave Generator causes the Flexspline to radially deform.

The assembled gear has two diametrically opposed tooth engagement areas around the major axis of the ellipse. The rotation of the Wave Generator causes the meshing of Flexspline with the Circular Spline to move around circumference. Since the Flexspline has two teeth less than the Circular Spline, rotating the Wave Generator leads to a relative movement between the Flexspline and the Circular Spline.

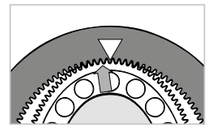
Harmonic Drive® Gears and Servo Actuators are used wherever zero backlash, extraordinary precision and high reliability are required – in all areas where drive technology is required.



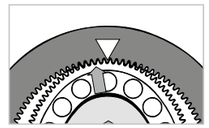
1. Start



2. 1/4 Input rotation



3. 1/2 Input rotation



4. 1/1 Input rotation

FURTHER INFORMATION regarding the strain wave gear principle can be found at www.harmonicdrive.co.uk in section Technology - Harmonic Drive® Gears.

Product description

LynxDrive Servo Actuator with solid shaft

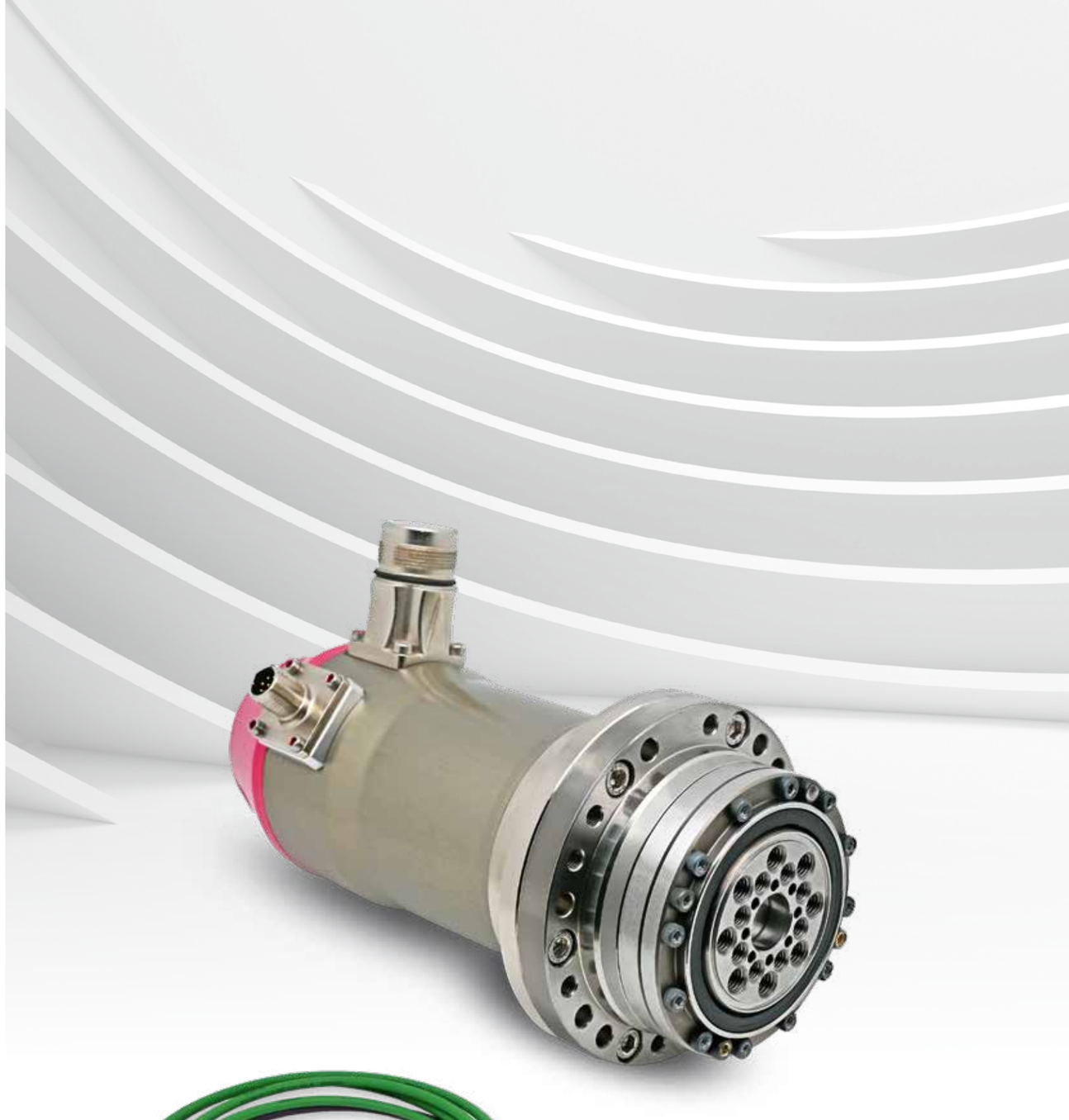
LynxDrive Servo Actuators feature concentrated winding technology, which reduces the motor length and, in combination with the encapsulated stator, results in a compact servo actuator. These servo actuators are particularly suitable for positioning tasks with very high demands on dynamics, precision and stability.

Features:

- CSG Gear with output bearing, AC servo motor and encoder (EnDat HIPERFACE®, resolver)
- Integrated tilt resistant output bearing
- Available in 7 sizes (14 … 50)
- Maximum torque of 9 to 1534 Nm
- Insulation system for max. DC bus voltage of 680 V
- Stator in single tooth winding
- Transmission accuracy ≤60 seconds of arc for sizes 20 … 50
- (≤ 90 seconds of arc for sizes 14 and 17)
- Repeatability ≤ 5 seconds of arc
- High compactness due to adapted motor design for best performance in combination with the Harmonic Drive® Gear
- Degree of protection IP65 and corrosion protected
- Sealing air connection available on request
- Advanced motor feedback systems with EnDat 2.2, DRIVE-CLiQ including secure mounting of encoder to motor shaft for applications with Siemens S120 and other CNC controls, fault exclusion for connection of encoder to motor shaft confirmed by TÜV Rheinland
- UL certified according to UL 1004-1/6 (Class B)
- PT-1000 and PTC temperature sensors

Table 1

Converter type (Heidenhain Code)	Input	Output	Controller manufacturer
EIB 3392S	EnDat 2.2	DRIVE-CLiQ	Siemens
EIB 3392F	EnDat 2.2	Fanuc-Serial	Fanuc



M12 connector with EnDat 2.2 for conversion to Siemens and Fanuc protocols via converter cable

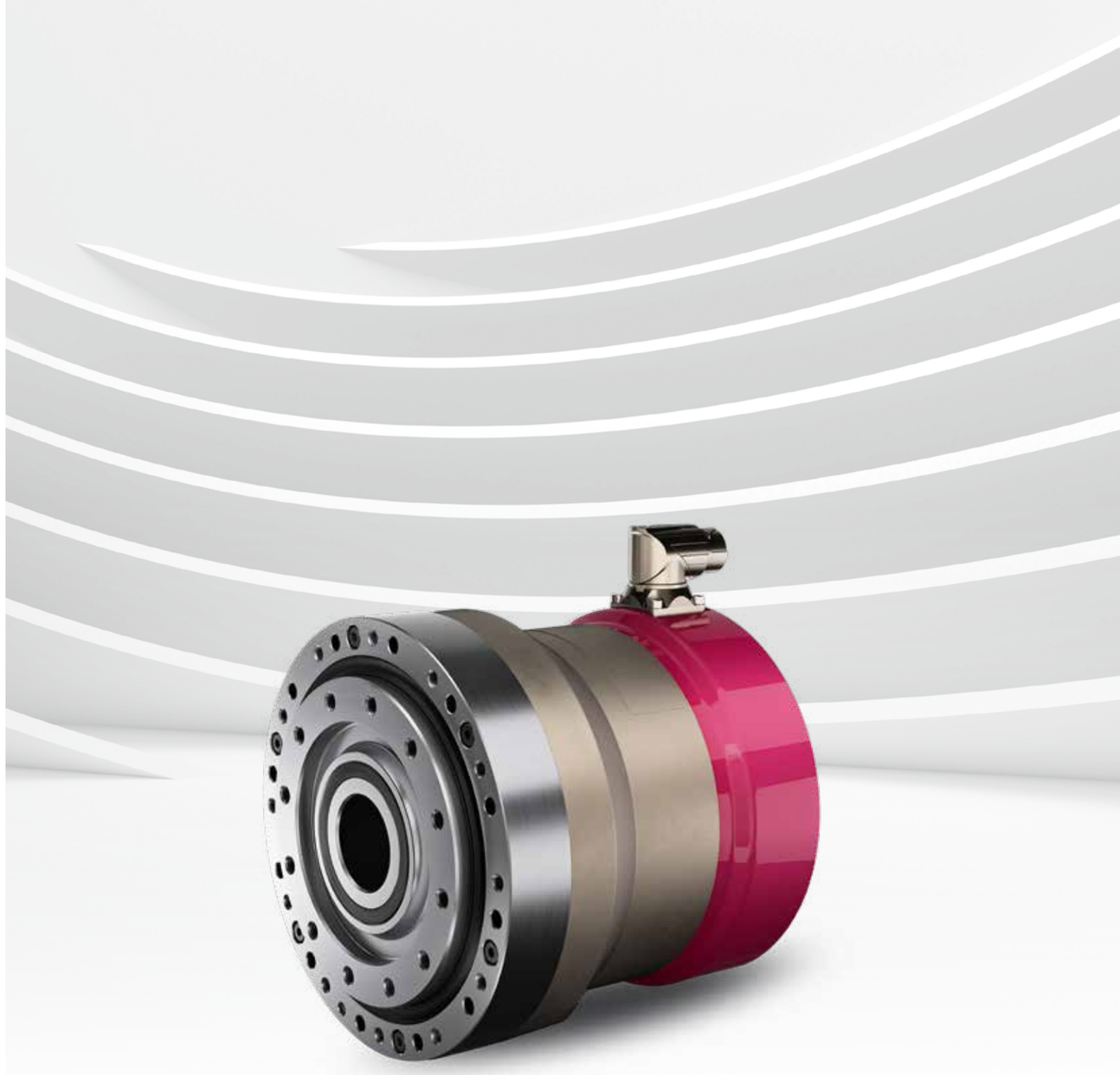
Product description

CanisDrive® Servo Actuator with hollow shaft

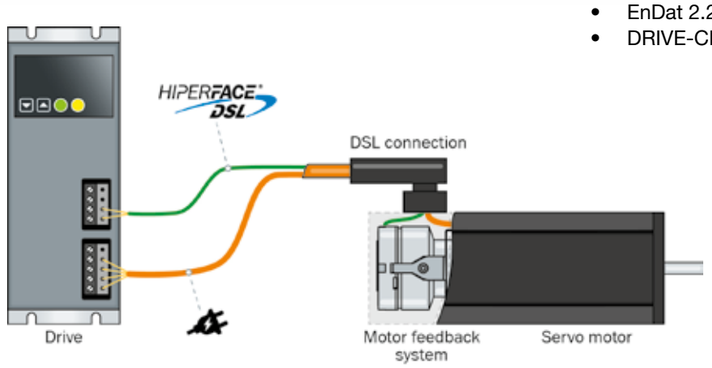
The CanisDrive® Servo Actuators combine an adaptable and compact synchronous servo motor winding with a zero backlash gear with output bearing and market leading feedback systems.
They impress with their high power density, broad flexibility and good adaptability in industrial applications.

Features:

- CSG/HFUC Gear with output bearing, AC servo motor and EnDat, HIPERFACE®, SSI, HIPERFACE DSL® encoder
- Integrated tilt resistant output bearing
- Available in 8 sizes (14 … 58)
- Hollow shaft inner diameter from 12 to 65.5 mm
- Maximum torque of 23 to 1840 Nm
- Stator in single tooth winding (#14, 17, 50, 58) and distributed winding (#20 … 40)
- Insulation system for max. DC bus voltage of 680 V
- Transmission accuracy ≤ 60 seconds of arc for sizes 20 … 50 (≤ 90 seconds of arc for sizes 14 and 17)
- Repeatability ≤ 5 seconds of arc
- High compactness due to adapted motor design for best performance in combination with the Harmonic Drive® Gear
- Degree of protection IP65 and corrosion protected
- Sealing air connection available on request
- Advanced motor feedback systems with EnDat 2.2, including secure encoder mounting for applications with Siemens S120 and other CNC controls (for #50, 58), fault exclusion for connection of encoder to motor shaft confirmed by TÜV Rheinland
- UL certified according to UL 1004-1/6 (Class A) for #20 … 40
- PT-1000 and PTC temperature sensors



- HIPERFACE® for Bosch Rexroth controllers
- EnDat 2.2 for Siemens signal converters SMC-40
- DRIVE-CLiQ on request for #50,58



- HIPERFACE DSL® as a single cable solution compatible with Beckhoff AX5000 and AX8000

Harmonic Drive® Servo Actuators and Gears have proven themselves for decades in the harsh everyday operation of machining centres thanks to their robustness and long term accuracy. The following illustrations show some examples of applications.

B- and C-Axes

Harmonic Drive® Servo Actuators and Gears in standard and special versions, e.g. with customer specific output bearing and output side position and feedback, are used in these axes (see Illustration 1 and Illustration 2).

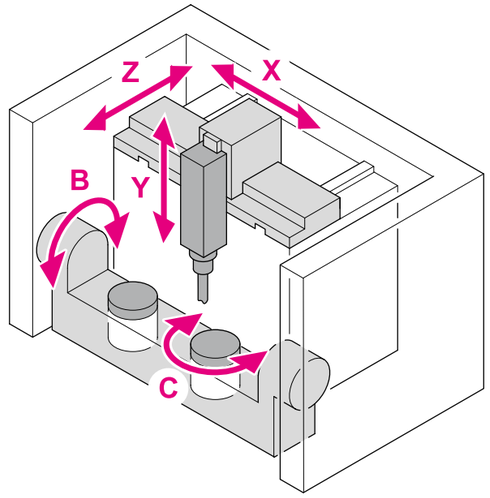
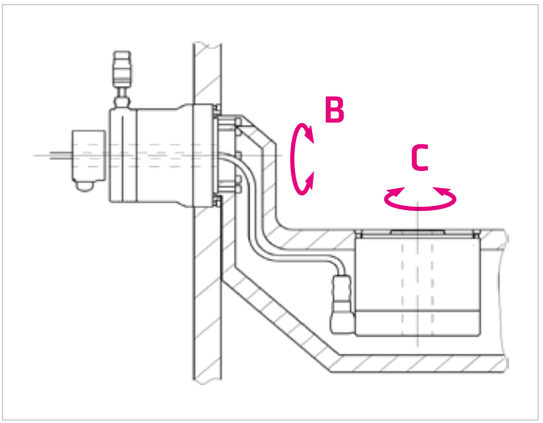
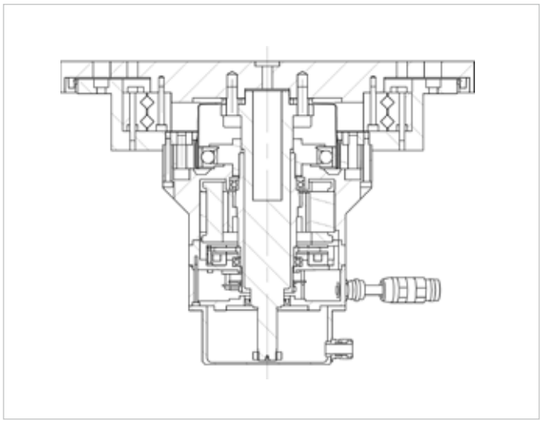


Illustration 1 **CanisDrive® Servo Actuator**



- Output side absolute measurement system
- Hollow shaft

Illustration 2 **CanisDrive® Servo Actuator**



- Customised output bearing
- Output side absolute encoder

CSG-2A
Gear Component Set

CanisDrive®
Servo Actuator

CPU-H / CSG-CPH
Gears with output bearing and hollow shaft

Harmonic Drive SE supplies precision gears as well as servo actuators for the machining and peripheral axes of machining centres.

4th and 5th axes

With these axes, the torsional stiffness and transmission accuracy of the servo actuator or gear used are particularly important, in addition to the accuracy of the output bearing. Therefore, these axes are always dimensioned with special consideration given to the torsional stiffness required for the application. Various Harmonic Drive® Products are used.

LynxDrive
Servo Actuator

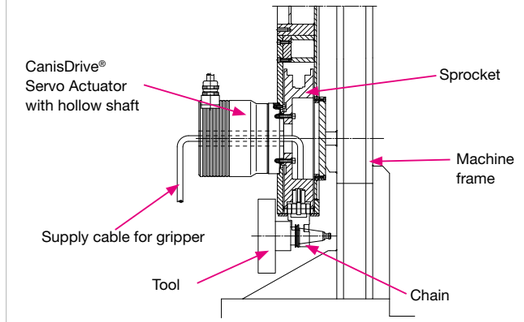
CanisDrive®
Servo Actuator

Tool magazines and tool changer

These axes require high repeatability, compact size and high dynamic performance. Illustration 3 and Illustration 4 show typical solutions with Harmonic Drive® Servo Actuators.

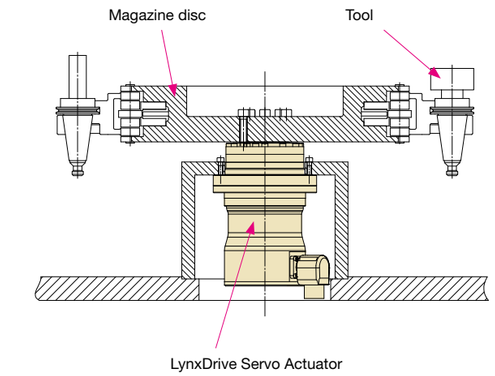
In addition to various Harmonic Drive® Gears with output bearings and servo actuators with hollow shafts, LynxDrive Servo Actuators are also used for high dynamic requirements.

Illustration 3 **CanisDrive® Servo Actuator**



- Hollow shaft
- Tilt resistant output bearing

Illustration 4 **LynxDrive Servo Actuator**



- Siemens compatible feedback system
- Tilt resistant output bearing

CSG-2UH
Gears with output bearing

CPU-M
Gears with output bearing

A and C Axes

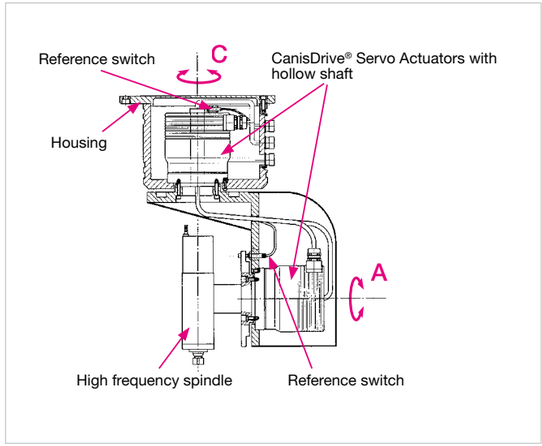
Harmonic Drive® Servo Actuators and Gears are a crucial element in the A and C axes of a machine tool and contribute to efficiency and precision. The selected products must be capable of transmitting both high torques and high speeds to enable fast and precise positioning of the axes. For high precision machining, CanisDrive® Actuators are equipped with an output side encoder (Illustration 6) to measure the actual position of the axis in real time.

The hollow shaft of the CanisDrive® Servo Actuator also allows a wide variety of lines for coolant, electricity, etc. to be routed to the spindle without being visible from the outside (Illustration 5).

In addition to the extremely important requirements for positioning and speed, there are also requirements for the stiffness and mounting of the axes. The combination of cross roller bearings and gears gives our products high positioning accuracy, which can also absorb high axial and radial loads as well as tilting moments. This design allows axes to be compact and simple, e.g. with a CPU-H Gear (Illustration 7).

Continuous development of gear technology enables increasingly precise and faster machining, which leads to increased productivity and improved quality.

Illustration 5 **CanisDrive® Servo Actuator**



- Extended hollow shaft for limit switches

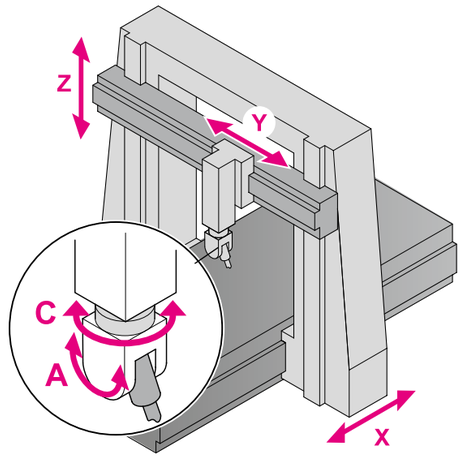


Illustration 6 **CanisDrive® Servo Actuator**

- Very high transmission and repeatability thanks to additional measurement system on the output side

Illustration 7 **CPU-H Gears with output bearing**

- Optimised transmission accuracy (± 10 angle seconds)

CanisDrive®
Servo Actuator

CPU-H
Gears with output bearing and hollow shaft

When high reliability, robustness and accuracy are required for use in milling centres, the proven Harmonic Drive® Products are the ideal solution.

B Axis

CPU-H Gears with output bearing are used in the B axes, and the CSG-2UH Series is used when there are increased requirements for torque capacity and lifetime. These products feature optional hollow shafts, particularly high transmission accuracy and an output bearing with very low coaxiality and parallelism errors. (see Illustration 8).

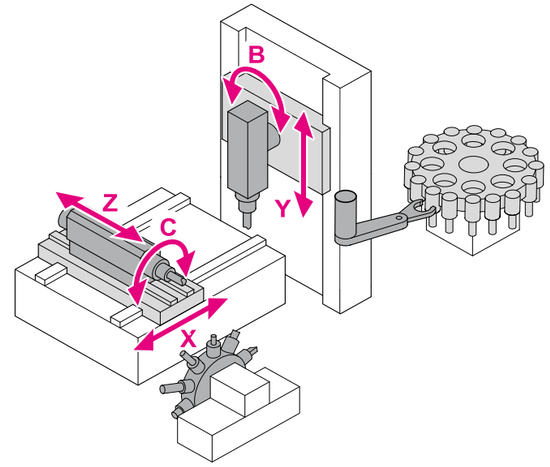
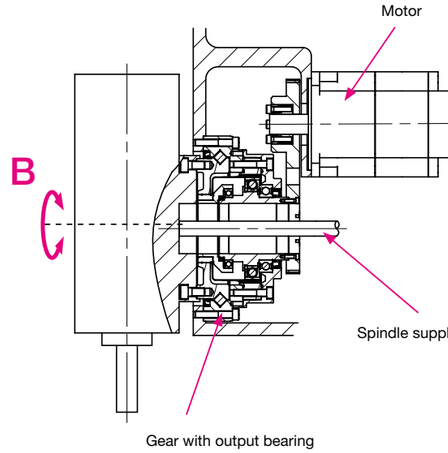


Illustration 8

CPU-H Gears with output bearing



- Hollow shaft
- Precise, tilt resistant output bearing

CPU-H
Gear with output bearing

LynxDrive
Servo Actuator

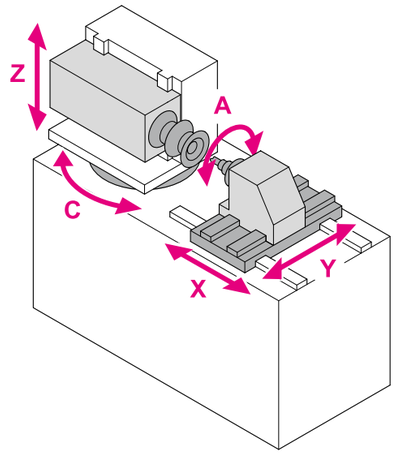
CSG-2UH
Gear with output bearing

The axes of tool grinding machines place particularly high demands on the servo actuators and gears, requiring good transmission accuracy and zero backlash.

A Axis (High precision indexing unit) and C Axis

CanisDrive® and BHA Servo Actuators are often used here. The servo actuators feature highly tilt resistant and highly accurate output bearings.

For further applications CPU-M/H/S Gears with output bearing and CSG-2A and SHG-2A Gear Component Sets are used.

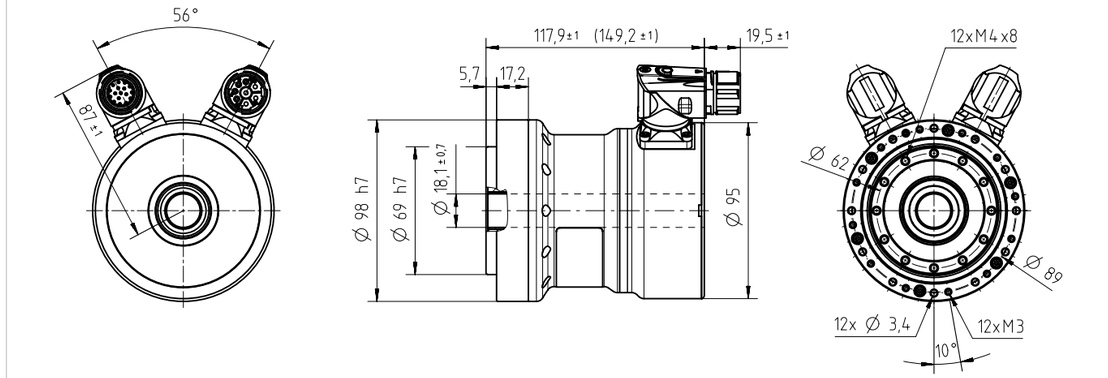


Auxiliary axes

The compact CanisDrive® and BHA Servo Actuators are also the preferred choice for dressing devices and tool changers.

Illustration 9

BHA Servo Actuator



- Singleturn absolute encoder, hollow shaft

Servo Actuator
CanisDrive®

Servo Actuator
BHA

Gear with output bearing
CPU-M/H/S

Gear Component Set
SHG-2A

The production of complex 3D workpiece geometries demands the most from the precision of the positioning axes. Harmonic Drive® Gears and Servo Actuators are therefore often used in EDM machines.

C Axis

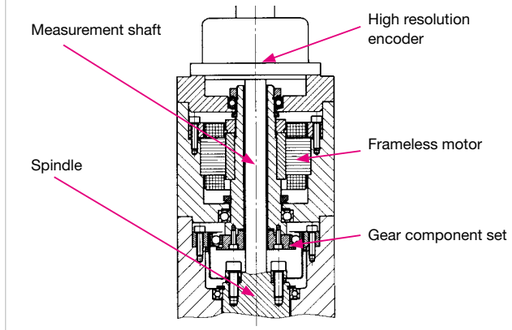
Due to the positioning accuracy required for this axis, position feedback on the output side is necessary. In the application described, CSG-2A Series Gear Component Sets are used with feedback of the output position using the encoder mounted on the input side, see Illustration 10. The gear is driven by a hollow shaft frameless motor. With these precise rotary axes, high torsional stiffness and zero backlash of the gears used are important prerequisites for good machining quality.

B Axis

While standard EDM machines are equipped with four axes, components with complex contours, such as engine blades, are EDM machined using 5 axis machines. In the example shown in Illustration 11, a LynxDrive Servo Actuator is used in the B axis of a 5 axis EDM machine.

Illustration 10

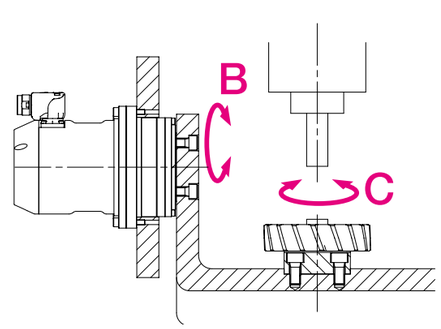
C Axis CSG-2A
Gear Component Set



- Hollow shaft
- Backlash free

Illustration 11

B and C Axis
LynxDrive Servo Actuator



- Compact design
- Backlash free

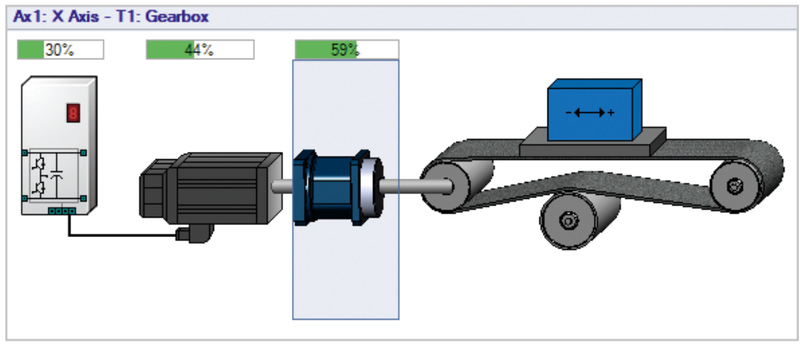
CSG-2A
Gear Component Set

LynxDrive
Servo Actuator

Gear dimensioning via SERVOsoft®

For an optimal design of Harmonic Drive® Strain Wave Gears and Servo Actuators, our sales and project engineers use the SERVOsoft® actuator dimensioning program.

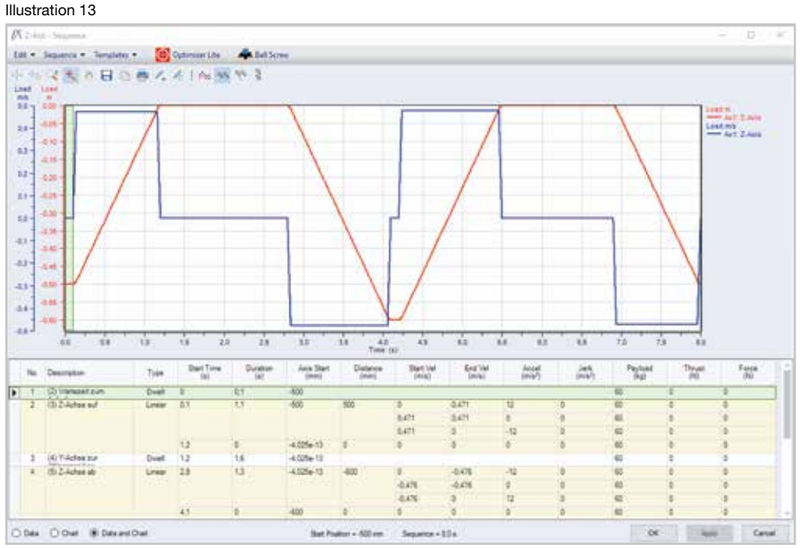
Illustration 12



The calculation with SERVOsoft® ensures that all components are correctly designed with regard to mechanical load and also all electrical data. For this purpose, a database was created with all relevant data of our gearboxes, motors, servo actuators and controllers.
Calculated margins are displayed in a way that is easy to understand in critcal applications.
Within the drive design SERVOsoft® helps to ensure your system is designed with sufficient safety margins on the one hand, but is also sensibly utilised and works efficiently on the other, taking into account all the load data and motion cycles entered. We create the load cycle of your machine for you according to your specification. Alternatively, do you have the load profile of your machine available as an Excel file or as a csv file? We will be able to integrate your load profile quickly and accurately into our simulation.

On request, you will receive a detailed list of all calculation results as well as the parts list of the selected drive components for your application.

Illustration 13



Support with calculation and design

We are happy to assist you in designing input drive elements with special requirements or particularly challenging boundary conditions using state-of-the-art calculation and simulation tools.

Examples:

- Model based simulation of a sawing unit

Illustration 14 shows the simulation model created for this purpose with all input drive elements integrated in the system. This allows, for example, different movement cycles of the angle and tilt axes to be carried out, taking into account masses, machining forces and gyroscopic moments of the saw blade. This allows critical operating points to be identified and avoided in advance of machine commissioning.

- Product and application specific FEM calculations

Illustration 15 shows the stress distribution of a customer-specific strain wave gear drive solution for a palette changer. Here, the maximum possible load was checked using FEM calculation.

- Ultra flat drive solution for tool magazine

Illustration 16 shows a very flat and compact arrangement for the actuator of a tool changer. Key data are: max. torque 229 Nm, width 66 mm, gear hollow shaft 29 mm.

Illustration 14

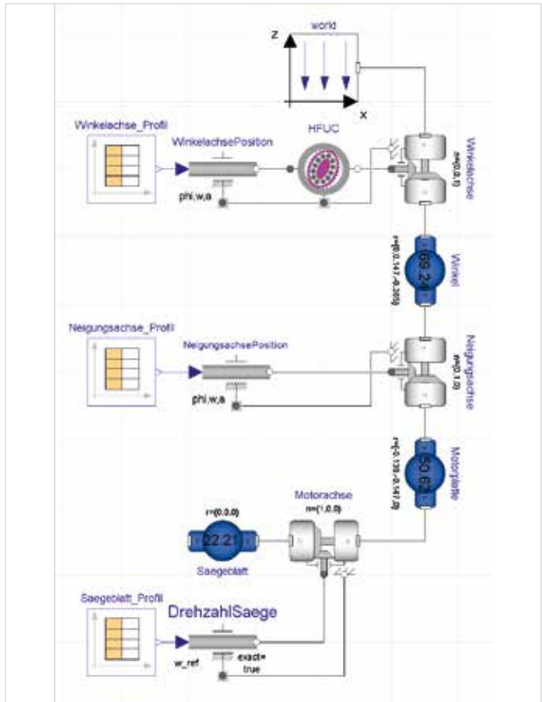


Illustration 15

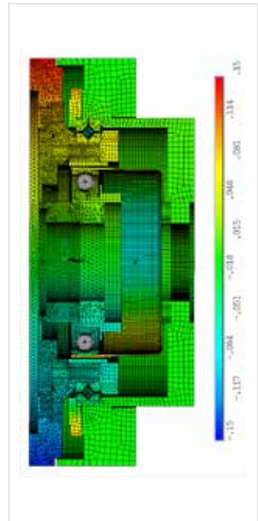
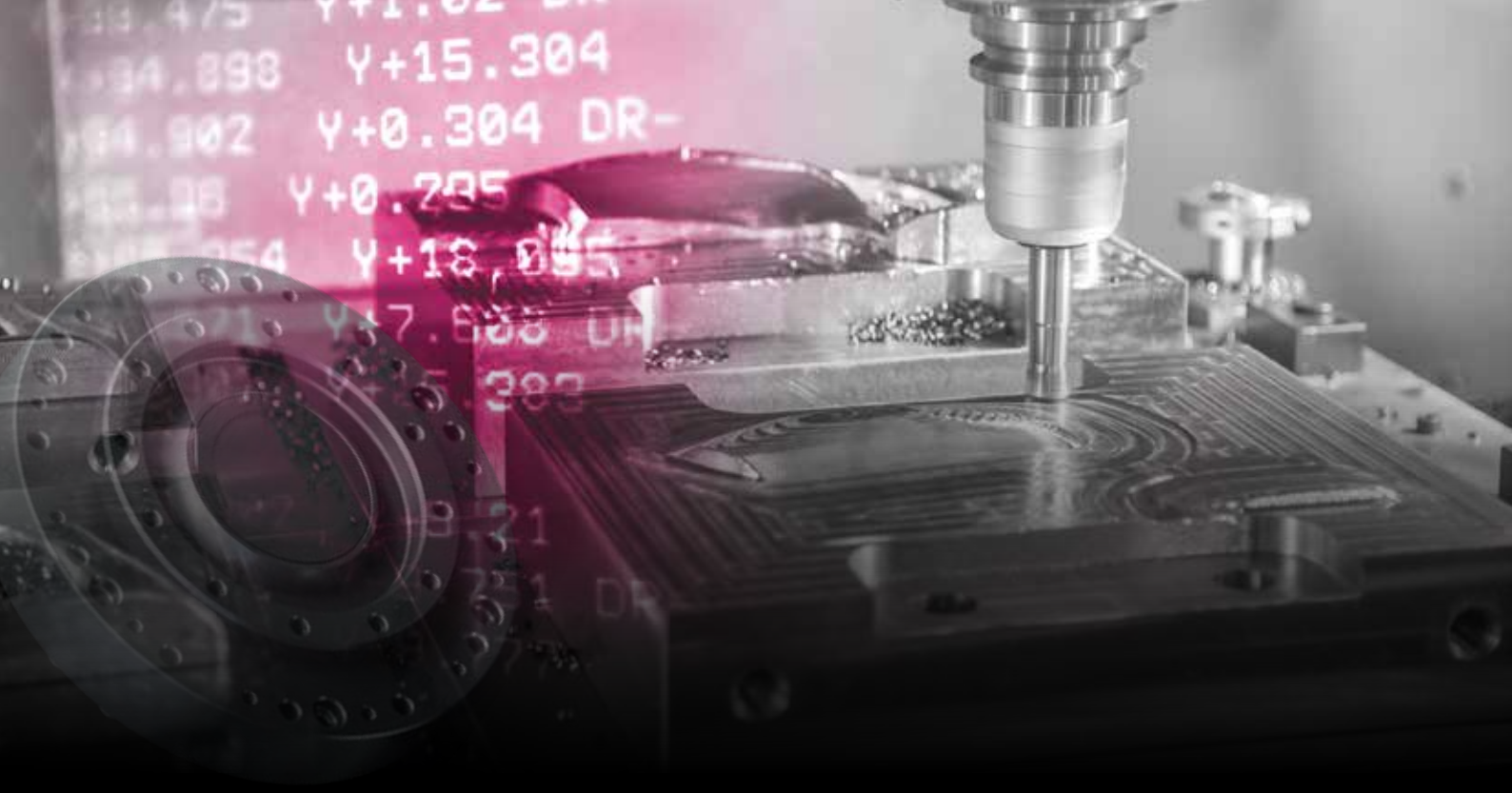


Illustration 16



PASSION GENERATES THE HIGHEST QUALITY

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