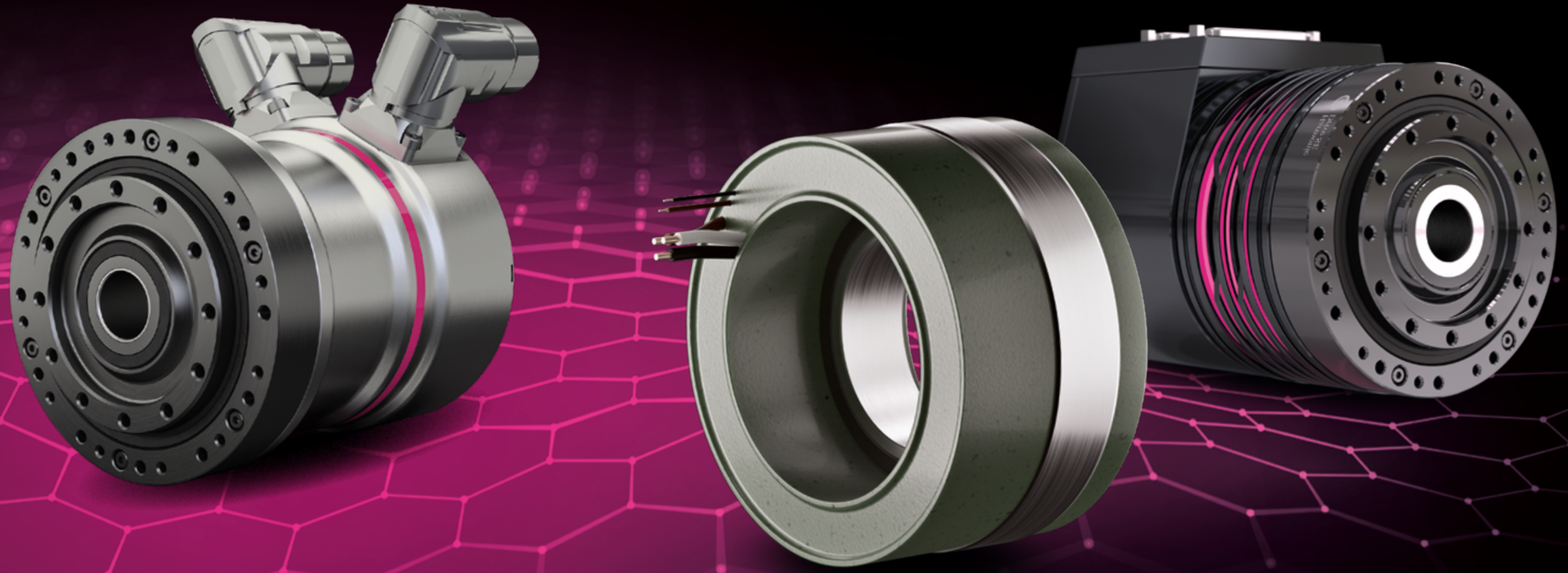
Harmonic Drive® **MECHATRONICS**

Harmonic Drive SE

- Servo actuators with hollow shaft
- Servo actuators with solid shaft
- Frameless motors
- Servo controller, accessories & cables
- Individual solutions



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.

Your global partner

You will find our sophisticated drive solutions all over the globe and even beyond - regardless of whether you are on the Red Planet or the Blue Planet: Motors, actuators and systems from Harmonic Drive SE are used wherever the highest demands are made on quality and reliability. Production and development sites at the highest technological level in Germany, Japan and USA, as well as subsidiaries in Europe and Asia, ensure that we can offer highly specialised and intelligent drive solutions and mechatronic systems worldwide.

Perhaps you will think of us the next time you fly beyond the horizon in an aircraft of the Airbus family: High precision Harmonic Drive® Gears for aviation help you fly safely and have the world at your feet right now.

„It is never a question as to whether it can be done –
it is only whether one cares to spend the time and effort.“

C. Walton Musser, Inventor of the Strain Wave Gear

Your idea, our engineering, your drive solution

We know that the configuration of suitable components is complex. Together with you, we can therefore develop a complete solution proposal for the drive task. Starting with the selection of the most suitable gears and the matching motor and sensor components, we can configure the complete drive axis for your application.

In doing so, we draw on decades of experience. Since 1970, we have been building on a sizeable number of complex drive solutions, giving our customers a definite technological edge. All design elements can be customised and optimally matched to each other. Integration into the application always takes place in close partnership with our customers. The key factors here are, on the one hand, the high flexibility and, on the other hand, the individual scope of services and the level of integration. The result will be optimal overall solution for your application.

In our modern development centre, a team of more than 40 designers and engineers is available on a daily basis. Up-to-date design and calculation tools, self designed tools for fast analytical calculations and equally established FEM supported methods are in place. In the directly connected test field, the newly developed actuators and drive systems are verified for performance and functionality with the help of specific test benches. The knowledge gained from this is fed back into development and gives the basis for further optimisation.

We produce your transmission solution beginning with lot size 1

In addition to a few standard products with higher quantities, our production is dominated by many specialised and diverse assemblies in smaller quantities down to lot size 1. This is because almost all products that leave our premises are configured together with you specifically according to your wishes and requirements and then manufactured in house. In order to achieve this high flexibility in production, we have developed an intelligent setup concept with which we can even manufacture lot size 1 economically.

Production lines per size enable us to change setups smoothly and therefore ensure maximum flexibility - even for small lot sizes. In order to meet these requirements throughout the entire value chain, we rely on long term supplier relationships based on mutual partnership in the area of supply chain management, which we continuously develop into efficient supplier structures and therefore synchronise with our production system. In this way, we fulfil your wishes individually, no matter what the quantity.

In the chapter „Individual solutions“ you will find a selection of customised designs that we can realise according to your wishes and requirements.

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.

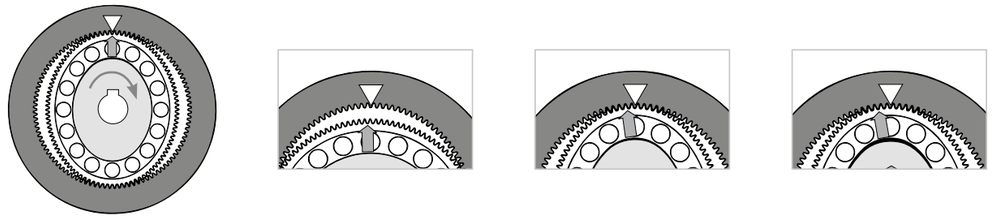
Wave Generator

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.

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

CSG-/HFUC-2A

CPL-2A

CSD-2A

SHG-/HFUS-2A

GEARS WITH OUTPUT BEARING

CSG-/HFUC-2UH

CSF-ULW

CPU-M/H/S

CSG-CPM/ CPH/CPS

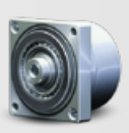
CSD-2UH/2UF

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

SHD-2SH

CSF Mini

PMG



CSF-2UP

FBS-2UH

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. The frameless motors BHK are available for integration into customer applications.

Catalogue
Harmonic Drive® Mechatronics

SERVO ACTUATORS WITH HOLLOW SHAFT

IHD

BHA

CanisDrive®

AlopexDrive

FHA-C Mini

SERVO ACTUATORS WITH SOLID SHAFT

LynxDrive

FLA

FRAMELESS MOTORS

BHK

SERVO CONTROLLER

YukonDrive

Harmonic Planetary Gears

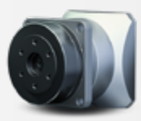
Harmonic Planetary Gears have lower gear ratios ususally operating higher speeds where there is often the need for very high precision. Our special design with a flexible ring gear in the output stage means that we guarantee constant high precision over the entire lifetime – we call this Permanent Precision®!

Catalogue
Harmonic Planetary Gears

HPN

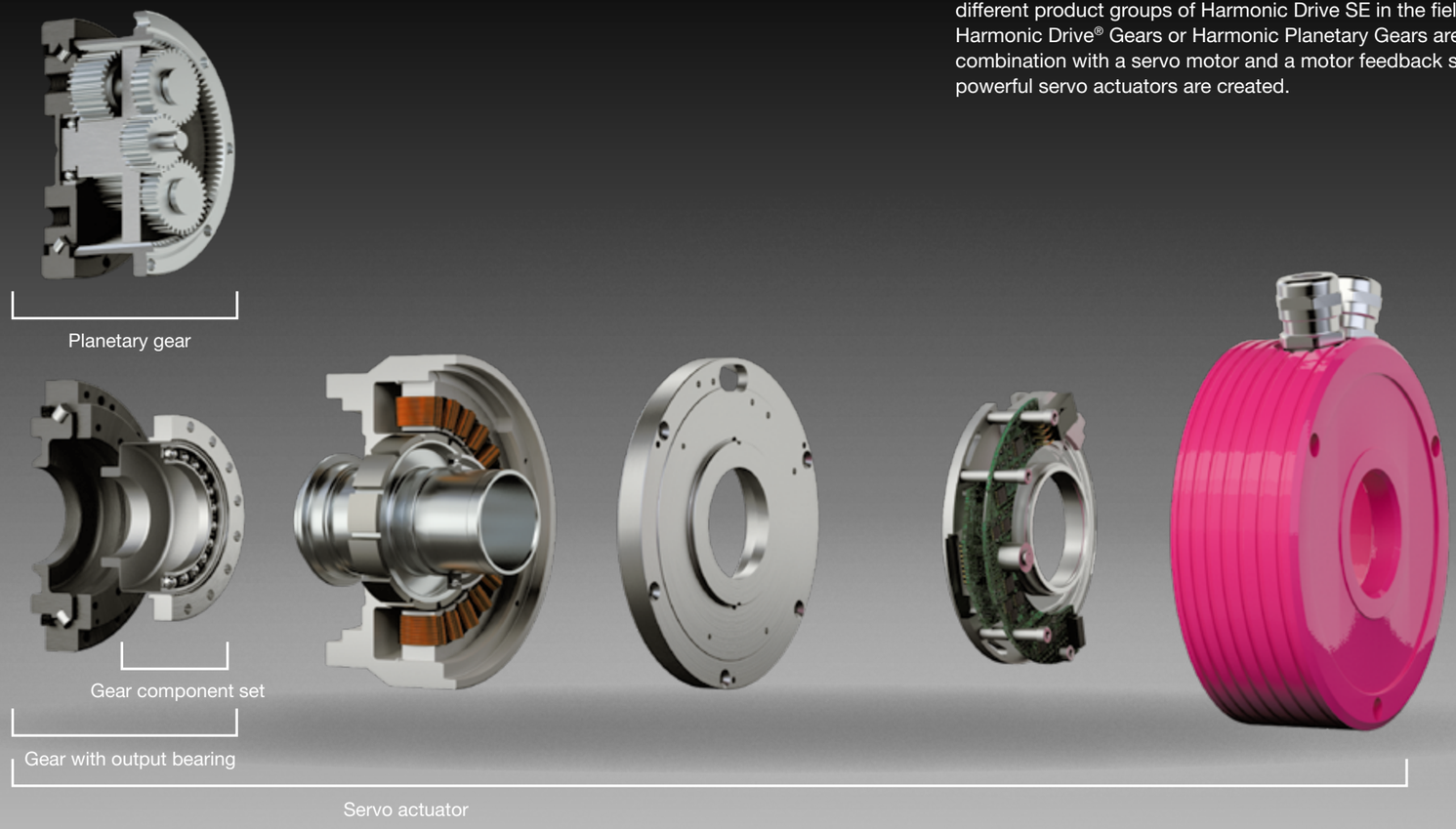
HPGP

HPG-R



HPG

The proven gear components, output bearings, motors and encoder systems form the basis for different product groups of Harmonic Drive SE in the field of high precision drive technology. Harmonic Drive® Gears or Harmonic Planetary Gears are the starting point for all products. In combination with a servo motor and a motor feedback system, highly integrated, compact and powerful servo actuators are created.



Harmonic Drive® Gears

Gear Component Sets

Harmonic Drive® Gear Component Sets work according to the strain wave gear principle and are characterised by high single stage gear ratios, zero backlash and precise motion as well as maximum torques with low weight and compact dimensions. Consisting of only three components Circular Spline, Flexspline and Wave Generator, they enable maximum flexibility in design integration. Harmonic Drive® Gear Component Sets are ideal for applications with existing output bearings. By using the existing bearings and housing structure, they can be used to achieve both a low total weight and a compact design within the application.

Gears with output bearing

Harmonic Drive® Gears with output bearings combine precise gear component sets with a tilt resistant cross roller or four point contact bearing. Due to its compact design and its high concentricity and accuracy, the output bearing complements perfectly with the strain wave gear. Different gear types allow use in different gear configurations. Motor mounted gearboxes provide the prerequisites for providing direct and easy interfacing of servomotors to the gear with little engineering and assembly expense. The hollow shaft gear allows the central implementation of supply cables and shafts.

Harmonic Drive® Servo Actuators

The continuously increasing demands placed on servo actuators require, among other things, perfect interaction between the motor, gears, motor feedback system and controller. To guarantee characteristics such as precision and dynamics, servo actuators from Harmonic Drive SE have a high degree of compatibility.

The option to choose between a zero backlash strain wave gear and a low backlash planetary gear. The tilt resistant output bearing enables the direct attachment of high payloads without additional support and thus permits a simple and space saving design. In addition, there are numerous possible combinations for the motor winding and the motor feedback system as well as choices for brakes, connecting cables and connecting plugs. Due to the flexibility in the configuration of the motor winding and the motor feedback system, the compatibility with almost all servo controllers of the market is guaranteed. The latest IHD Series also has an integrated drive controller and a dual measuring system for direct control of the position at the gearbox output. This system can be easily implemented in the application by means of fieldbus interfaces.

Harmonic Planetary Gears

Requirements of the market for gears that support high speeds or low ratios often require the highest precision. Harmonic Planetary Gears meet this requirement. Due to their integrated motor connection with clamping element and motor flange, they allow easy mounting of servo motors. The special design with a flexible ring gear in the last stage ensures consistently high precision over the entire service life - we call this Permanent Precision®.

	SERVO ACTUATORS WITH HOLLOW SHAFT					SERVO ACTUATORS WITH SOLID SHAFT		FRAMELESS MOTORS
Series	**IHD** (Actuator with integrated controller)	**BHA**	**CanisDrive®**	**AlopexDrive**	**FHA-C Mini**	**LynxDrive**	**FLA**	**BHK**
								
Product focus	High standardisation Function adaptation via software	High standardisation Cost-optimised Reduced variance	Extensive combination possibilities and customised adaptations for industrial applications	Customised development/ design for special environmental conditions (project business)	High standardisation Reduced variance	Extensive combination options and customer specific specific adaptations for industrial applications	High standardisation Reduced variance	High level of standardisation Cost optimised High load sizes
Design	short / compact	short / compact	short / compact	compact	short / compact	slim design	very short / compact	short / compact
Torque capacity and lifetime	●●●	●●●	●●●	●●	●●	●●	●	●●●
Small outer diameter	●●	●●	●	●	●●	●●●	●	●
Short design	●●	●●	●●●	●●●	●●●	●	●●●	●●
Tilting moment output bearing	●●●	●●●	●●●	●●●	●●	●●	●	-
Low weight	●●	●●	●●	●	●●	●●	●●●	●●
Chapter / Page	1.1 / 26	1.2 / 44	1.3 / 66	1.4 / 114	1.5 / 134	2.1 / 176	2.2 / 206	3.1 / 227
Key data								
Hollow shaft diameter [mm]	18 ... 25	18 ... 25	12 ... 65	12 ... 39	6,2 ... 13,5 (only with incremental encoder)	-	-	37.6
Maximum torque [Nm]	44 ... 229	44 ... 229	23 ... 1840	18 ... 647	1,8 ... 28	9 ... 1534	1,8 ... 33	3 ... 6
Maximum speed [rpm]	35 ... 120	35 ... 120	19 ... 170	25 ... 170	60 ... 200	22 ... 283	80 ... 500	5600 ... 7300
Outer diameter [mm]	88 ... 116	88 ... 116	78 ... 255	78 ... 180	50 ... 75	73 ... 190	71 ... 100	72
Length [mm]	141 ... 200	110 ... 173	97 ... 235	98 ... 240	48 ... 78	126 ... 288	40 ... 52	40 ... 51.9
Configurations								
Sizes	17 20 25	17 20 25	14 17 20 25 32 40 50 58	14 17 20 25 32 40 50[1)] 58[1)]	8 11 14	14 17 20 25 32 40 50	11 14 17 20	0100 0200
Ratio **(Preference types)**	30 **50** 80 **100** 120 **160**	30 **50** 80 **100** 120 **160**	**50** 80 **100** 120 **160**	30 **50** 80 **100** 120 **160**	30 **50** **100**	Size 14-32: 30 **50** 80 **100** 120 **160**	**50** 8 9	-
Winding	24/48 VDC	24/48 VDC 560 VDC	Size 14: 48V, 560 VDC Size 17: 48V, 560 VDC Size 20-58: 560 VDC	24/48/100 VDC 560 VDC	320 VDC 24 VDC	560 VDC	24/48 VDC	24/48 VDC 560 VDC
Encoder	Dual FlexFeedback	BiSS-C EnDat 2.2 HIPERFACE® SSI + Sin Cos	Size 14-20: SSI + Sin Cos Size 25-32: FFB SSI + Sin Cos Size 20-58: EnDat 2.1/2.2 Size 20-58: HIPERFACE DSL® Size 17-40: HIPERFACE® Size 14-17: Incremental encoder	SSI + Sin Cos Biss-C Incremental encoder Size 20-58: EnDat 2.1/2.2 Size 17-40: HIPERFACE®	Incremental encoder Endat 2.2	HIPERFACE® EnDat 2.1/2.2 Resolver DRIVE-CLiQ	Hall sensors	-
Connections	Sub-D connector Variable connector	Connector M23 90° angled rotatable	Connector M23 (M17) 90° angled rotatable Radial cable outlet possible Customised pinout possible	Connector straight Customised connectors	Incremental encoder: Cable outlet sideways Incremental encoder: Cable outlet sideways with connector Endat 2.2 Connector Y-Tec Endat 2.2 Cable outlet with connector Customised pinout possible	Connector M23 90° angled rotatable Radial cable outlet possible Customised pinout possible	Cable outlet Cable outlet with connector possible	open strands
Controller integrated	Yes	-	-	Optional	-	-	-	-
Brake	Spring pressure	Spring pressure	Spring pressure	Spring pressure	-	Permanent magnet	-	-
Lubricant	4BNo.2	4BNo.2	Flexolub®-A1	Flexolub®-A1 / Berulub	SK-2	Flexolub®-A1	4BNo.2	-
Temperature range	0 ... +40 °C	0 ... +40 °C	0 ... +40 °C	-40 ... +70 °C	0 ... +40 °C	0 ... +40 °C	0 ... +40 °C	0 ... +40 °C
Protection class	IP65	IP65	IP65	IP65	IP44	IP65	IP40	IP00
Surface finish	Corrosion protection	-	Corrosion protection	Corrosion protection	-	Corrosion protection	-	-

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

●●● perfect ●● optimal ● good

It is always fascinating to find out the areas where our products are used. Here you will find a selection of the industries in which we are represented.

Challenge us with your application – together we can find the appropriate solution.

Robotics, handling & automation

For a long time, robots have been taking over tasks which are too monotonous for humans to produce to the highest quality. With modern programming and performance improvements from drive technology, these aides are now entering fields which were unthinkable a short time ago. This cooperation between man and robot has become an important trend in recent years – one meets each other in some sense.

Mechanical engineering

Is it possible to strike a Euro coin at a distance of a hundred metres? It is not only possible but must absolutely be achievable if high value machine tools are to be manufactured. Harmonic Drive® Products are used in particular at sites where space is limited. The layout in such cases is not defined by torque but rather by rigidity or by hollow shaft diameter.

Medical technology

It is not only world class athletes who want to be fit again quickly after an operation, and today in most cases, recovery is being supported by more technologies which permit targeted training of the body parts affected. The secret of success is programmable movement sequences which can be implemented via a precision actuator. Reliable and precise drive technology is also a fundamental design requirement in the field of surgery.

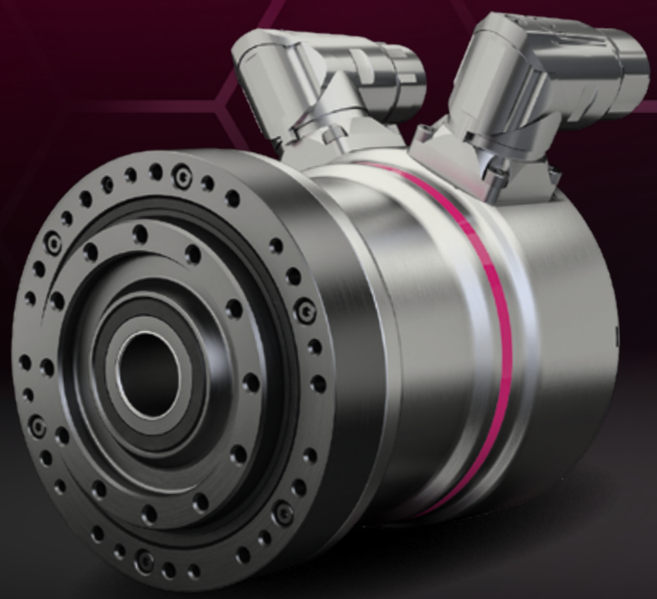
Special environments

The highest requirements for use in the harshest environmental conditions, such as extreme temperatures or other climatic peculiarities, can be achieved with Harmonic Drive® Products. System applications in defence, vacuum and safety technology or in the depths of our oceans are frequently confronted with such extreme conditions, where the integrated components have to prove themselves once again.

Aerospace

Our products have been working maintenance free in space for over 50 years, have been installed in aircraft for over 30 years and function under extreme low temperatures. Special materials, lightweight products and dry lubricants are specially developed for the aerospace industry.

Servo actuators with hollow shaft



Series	IHD (Actuator with integrated controller)	BHA	CanisDrive®	AlopexDrive	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	Customised development/design for special environmental conditions (project business)	High standardisation Reduced variance
Design	short / compact	short / compact	short / compact	compact	short / compact
Torque capacity and lifetime	●●●	●●●	●●●	●●	●●
Small outer diameter	●●	●●	●	●	●●
Short design	●●	●●	●●●	●●●	●●●
Tilting moment output bearing	●●●	●●●	●●●	●●●	●●
Low weight	●●	●●	●●	●	●●
Chapter / Page	1.1 / 26	1.2 / 44	1.3 /66	1.4 / 114	1.5 / 134
Key data					
Hollow shaft diameter [mm]	18 ... 25	18 ... 25	12 ... 65	12 ... 39	6.2 ... 13.5 (only with incremental encoder)
Maximum torque [Nm]	44 ... 229	44 ... 229	23 ... 1840	18 ... 647	1,8 ... 28
Maximum speed [rpm]	35 ... 120	35 ... 120	19 ... 170	25 ... 170	60 ... 200
Outer diameter [mm]	88 ... 116	88 ... 116	78 ... 255	78 ... 180	50 ... 75
Length [mm]	141 ... 200	110 ... 173	97 ... 235	98 ... 240	48 ... 78
Configurations					
Sizes	17 20 25	17 20 25	14 17 20 25 32 40 50 58	14 17 20 25 32 40 50[1)] 58[1)]	8 11 14
Ratio **(Preference types)**	30 **50** 80 **100** 120 **160**	30 **50** 80 **100** 120 **160**	30 **50** 80 **100** 120 **160**	30 **50** 80 **100** 120 **160**	30 **50** **100**
Winding	24/48 VDC	24/48 VDC 560 VDC	Size14: 48V, 560 VDC Size17: 48V, 560 VDC Size 20-58: 560 VDC	24/48/100 VDC 560 VDC	320 VDC 24 VDC
Encoder	Dual FlexFeedback	BiSS-C EnDat 2.2 HIPERFACE® SSI + Sin Cos	Size14-20: SSI + Sin Cos Size 25-32: FFB SSI + Sin Cos Size 20-58: EnDat 2.1/2.2 Size 20-58: HIPERFACE DSL® Size 17-40: HIPERFACE® Size 14-17: Incremental encoder	SSI + Sin Cos Biss-C Incremental encoder Size 20-58: EnDat 2.1/2.2 Size 17-40: HIPERFACE®	Incremental encoder Endat 2.2
Connections	Sub-D connector Variable connector	Connector M23 90° angled rotatable	Connector M23 (M17) 90° angled rotatable Radial cable outlet possible Customised pinout possible	Connector straight Customised connectors	Incremental encoder: Cable outlet sideways Incremental encoder: Cable outlet sideways with connector Endat 2.2 Connector Y-Tec Endat 2.2 Cable outlet with connector Customised pinout possible
Controller integrated	Yes	-	-	Optional	-
Brake	Spring pressure	Spring pressure	Spring pressure	Spring pressure	-
Lubricant	4BNo.2	4BNo.2	Flexolub®-A1	Flexolub®-A1 / Berulub	SK-2
Temperature range	0 ... +40 °C	0 ... +40 °C	0 ... +40 °C	-40 ... +70 °C	0 ... +40 °C
Protection class	IP65	IP65	IP65	IP65	IP44
Surface finish	Corrosion protection	-	Corrosion protection	Corrosion protection	-

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

●●● perfect ●● optimal ● good

Content

Product description

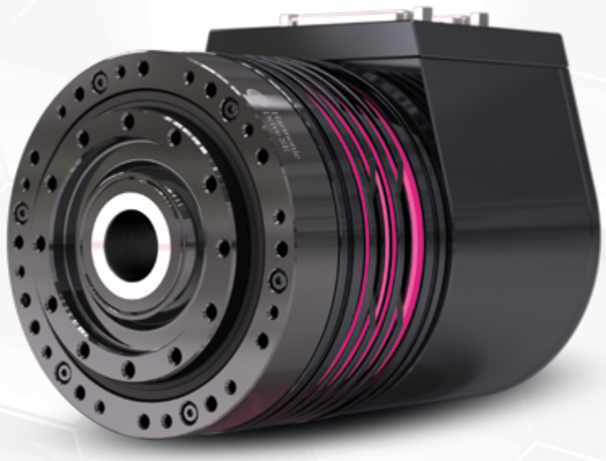
Smart, compact & highly integrated

Plug and Play via software: The new Smart System IHD from Harmonic Drive SE brings together 50 years of experience with precision gears and state-of-the-art motor and drive technology. Experience innovation with our highly integrated drive solution, all without a control cabinet.

Highly compact and highly integrated: The IHD system comprises a backlash free gearbox, a sophisticated servo motor, a dual feedback system for position measurement at the motor shaft and gear output and a powerful motion controller in a ready to use drive solution. Easy integration into your application is supported not only by the drive's central hollow shaft, which is predestined to carry a wide variety of media, but also by our specially developed, user-friendly solution for simple commissioning – Plug and Play.

Thanks to thermal optimization of its design, the IHD meets all requirements for high performance applications in the field of stationary and mobile drive technology. Advanced simulation tools for thermal evaluation of the system have been developed for this purpose. The IHD system provides an additional application processor for future smart applications such as condition monitoring and can be used as a separate platform for customer specific application programming. The system can operate with DC voltages of 24 V or 48 V.

Communication with the master controller is possible via CANopen, Ethernet and EtherCAT. The servo actuators in our IHD Series are the perfect combination of highly dynamic, compact synchronous servo motors and zero backlash gears with output bearings. Our servo actuators with hollow shaft are another outstanding choice thanks to their low weight, small volume, excellent torque density, long lifetime
and high reliability.



Ordering code

Table 1.1.1

Ordering code	IHD	-	20	A	-	100	-	48	-	II1	-	E	-	RS	-	B	-	XX	-	SP
IHD Series																				
Size (corresponds to the pitch circle diameter of the Flexspline toothing in inches x 10)			17 20 25																	
Product generation				A																
Ratio						30 50 80 100 120 160														
Power supply																				
DC link voltage 24 VDC								24												
DC link voltage 48 VDC								48												
Controller																				
Integrated controller										II1										
External controller										IE1										
Communication interface																				
EtherCAT												E								
CANopen												C								
Ethernet												N								
Connector version																				
Radial connector outlet M8/M12														RM						
Radial connector outlet (Sub-D)														RS						
Option Holding brake																				
With holding brake 24 V																B				
Without holding brake (= Field remains empty)																[ ]				
Option Smart Features																				
With customised design (on request)																		XX		
Standard design (= Field remains empty)																		[ ]		
Customised design																				
Standard design (Field remains empty)																				[ ]
Customised design (on request)																				SP

Please refer to the table of possible combinations (Table 1.1.2).

Smart features

The integrated dual core microcontroller has additional computing power that can be used to develop further functionalities for specific applications. This application specific function development can be carried out in close coordination with the customer.

Customised design

The integrated drive system consists of a modular system in which the individual components can be adapted to customer requirements. Modifications to the housing or the electrical connection can be made as part of customer specific projects.

Combinations

Table 1.1.2

Size		17A	20A	25A
Ratio	30	o	o	o
	50	●	●	●
	80	o	o	o
	100	●	●	●
	120	o	o	o
	160	-	●	●
Power supply	24 VDC	●	●	●
	48 VDC	●	●	●
Controller	II1	●	●	●
	IE1	-	-	-
Communication interface	E	●	●	●
	C	●	●	●
	N	●	●	●
Connector version	RM	●	●	●
	RS	o	o	o
Option holding brake	B	●	●	●
Option Smart Features	XX	o	o	o

● available o on request - not available

Technical data

• Features

Table 1.1.3

	[Unit]	17A/20A/25A
Insulation class (EN 60034-1)		F
Insulation resistance (500 VDC)	[MΩ]	100
Insulation voltage (10 s)	[V_{eff}]	700
Lubrication		4BNo.2
Degree of protection (EN 60034-5)		IP65[1)]
Ambient operating temperature	[°C]	0 … 40
Ambient storage temperature	[°C]	-20 … 60
Altitude (a.s.l.)	[m]	< 1000
Relative humidity (without condensation)	[%]	20 … 80
Vibration resistance (DIN IEC 60068 Part 2-6. 10 … 500 Hz)	[g]	5
Shock resistance (DIN IEC 60068 Part 2-27. 11 ms)	[g]	30
Corrosion protection (DIN IEC 60068 Part 2-11 Salt spray test)	[h]	-
Temperature sensors		1 x PT1000[2)]
Gear component set		CSG-2A
Controller data		
Controller		i201A-H1-1.1.0
Power Supply		
Recommended power supply	[V_{DC}]	24-48
Recommended STO input voltage	[V_{DC}]	5-30
Recommended logic power supply (optional)	[V_{DC}]	8-30
Standby power consumption	[W]	<= 5
Interfaces		
EtherNet EtherCAT CANopen		Cyclic Synchronous Position Cyclic Synchronous Velocity Cyclick Synchronous Current Profiled Position (trapezoidal and s-curves) Profile Velocity Interpolated Position (P, PT, PVT) Homing
Additional inputs and outputs		
Digital Input	[V_{DC}]	3.3 & 5
Open collector output with maximum sink current	[mA]	100
Differential analog input	[V_{DC}]	+/- 10
Recommended braking resistor	[Ω]	10 (200 W / max 5A)

1) With mounted sealed connectors. For higher protection class requirements, please contact us.
2) Safe separation according to EN 61800-5-1.

• Cooling

The continuous operating characteristics given in the following apply to an ambient temperature of 40 °C and an aluminium cooling surface with the following dimensions:

Table 1.1.4

Series	Size	[Unit]	Dimension
IHD	17A	[mm]	300 x 300 x15
	20A	[mm]	300 x 300 x15
	25A	[mm]	350 x 350 x18

- Actuator data

IHD-17A with 48 VDC bus voltage

Table 1.1.5

	Symbol [Unit]	17A	
Mechanical Data			
Ratio	i [ ]	**50**	**100**
Maximum output torque	T_{max} [Nm]	44	70
Maximum output speed	n_{max} [rpm]	120	60
Continuous stall torque	T_0 [Nm]	34	51
Hollow shaft diameter	d_H [mm]	18.1	
Weight without brake	m [kg]	3.2	
Weight with brake	m [kg]	3.6	
Mechanical time constant (without brake)	T_m [ms]	5.7	
Electrical Data			
Rated current power supply unit	I_{DC} [A_{DC}]	18.4	14.6
Maximum DC bus voltage	U_{DCmax} [V_{DC}]	60	
Rated voltage power supply unit	U_{DC} [V_{DC}]	48	
Electrical time constant (20 °C)	t_e [ms]	1.2	
Torque constant (motor)	K_T [Nm/A_{rms}]	0.06	
AC voltage constant (L-L, 20°C)	K_E [V_{rms}/1000 rpm]	4.00	
Parameters for calculation of gear service life			
Rated torque gear component set for calculating Wave Generator service life	T_N [Nm]	21	31
Rated speed gear component set for calculating Wave Generator service life	n_N [rpm]	2000	
Thermal specification			
Ambient temperature	T_{amb} [°C]	40	
Maximum winding temperature	$T_{cu,max}$ [°C]	105	100
Maximum housing temperature	$T_{frame,max}$[°C]	85	80
Thermal time constant of actuator	T_{th} [s]	2000	

Technical data for operation at 24 V are available on request.

You will find more information on this in the Engineering data chapter.

IHD-20A with 48 VDC bus voltage

Table 1.1.6

	Symbol [Unit]	20A		
Mechanical Data				
Ratio	i [ ]	**50**	**100**	**160**
Maximum output torque	T_{max} [Nm]	73	107	120
Maximum output speed	n_{max} [rpm]	120	60	38
Continuous stall torque	T_0 [Nm]	44	64	64
Hollow shaft diameter	d_H [mm]	18.1		
Weight without brake	m [kg]	3.3		
Weight with brake	m [kg]	3.7		
Mechanical time constant (without brake)	T_m [ms]	6.2		
Elektrical Data				
Rated current power supply unit	I_{DC} [A_{DC}]	29.3	22.6	16.7
Maximum DC bus voltage	U_{DCmax} [V_{DC}]	60		
Rated voltage power supply unit	U_{DC} [V_{DC}]	48		
Electrical time constant (20 °C)	t_e [ms]	1.2		
Torque constant (motor)	K_T [Nm/A_{rms}]	0.06		
AC voltage constant (L-L, 20°C)	K_E [V_{rms}/1000 rpm]	4.00		
Parameters for calculation of gear service life				
Rated torque gear component set for calculating Wave Generator service life	T_N [Nm]	33	52	52
Rated speed gear component set for calculating Wave Generator service life	n_N [rpm]	2000		
Thermal specification				
Ambient temperature	T_{amb} [°C]	40		
Maximum winding temperature	$T_{cu,max}$ [°C]	105	105	100
Maximum housing temperature	$T_{frame,max}$[°C]	85	85	80
Thermal time constant of actuator	T_{th} [s]	2200		

Technical data for operation at 24 V are available on request.

You will find more information on this in the Engineering data chapter.

IHD-25A with 48 VDC bus voltage

Table 1.1.7

	Symbol [Unit]	25A		
Mechanical Data				
Ratio	i [ ]	**50**	**100**	**160**
Maximum output torque	T_{max} [Nm]	127	204	229
Maximum output speed	n_{max} [rpm]	112	56	35
Continuous stall torque	T_0 [Nm]	58	119	140
Hollow shaft diameter	d_H [mm]	25		
Weight without brake	m [kg]	4.3		
Weight with brake	m [kg]	4.7		
Mechanical time constant (without brake)	T_m [ms]	11.2		
Electrical Data				
Rated current power supply unit	I_{DC} [A_{DC}]	37.6	32.1	25.6
Maximum DC bus voltage	U_{DCmax} [V_{DC}]	60		
Rated voltage power supply unit	U_{DC} [V_{DC}]	48		
Electrical time constant (20 °C)	t_e [ms]	2.3		
Torque constant (motor)	K_T [Nm/A_{rms}]	0.071		
AC voltage constant (L-L, 20°C)	K_E [V_{rms}/1000 rpm]	4.70		
Parameters for calculation of gear service life				
Rated torque gear component set for calculating Wave Generator service life	T_N [Nm]	51	87	87
Rated speed gear component set for calculating Wave Generator service life	n_N [rpm]	2000		
Thermal specification				
Ambient temperature	T_{amb} [°C]	40		
Maximum winding temperature	$T_{cu.max}$ [°C]	105	105	105
Maximum housing temperature	$T_{frame.max}$[°C]	90	90	90
Thermal time constant of actuator	T_{th} [s]	2400		

Technical data for operation at 24 V are available on request.

You will find more information on this in the Engineering data chapter.

• Moment of inertia

Table 1.1.8

	Symbol [Unit]	17A		20A			25A		
Ratio	i [ ]	**50**	**100**	**50**	**100**	**160**	**50**	**100**	**160**
Moment of inertia output side									
Moment of inertia without brake	J_{out} [kgm^2]	0.33	1.34	0.35	1.40	3.58	0.66	2.62	6.71
Moment of inertia with brake	J_{out} [kgm^2]	0.38	1.50	0.40	1.60	4.10	0.73	2.92	7.84
Moment of inertia at motor									
Moment of inertia at motor without brake	J [$x10^{-4}$ kgm^2]	1.34		1.40			2.62		
Moment of inertia at motor with brake	J [$x10^{-4}$ kgm^2]	1.50		1.60			2.92		

• Technical data motor brake

Table 1.1.9

	Symbol [Unit]	17A		20A			25A		
Ratio	i [ ]	50	100	50	100	160	50	100	160
Brake voltage	U_{Br} [VDC]	24 ± 10 %		24 ± 10 %			24 ± 10 %		
Brake holding torque (at output)	T_{Br} [Nm]	36	70	36	72	115	72	144	229
Brake power consumption	P_{Br} [W]	9.5		9.5			9.5		
Opening time	t_O [ms]	15		15			18		
Closing time	t_C [ms]	15		15			18		

• Performance characteristics

The performance curves shown below are valid for the specified ambient operating temperature and the indicated power supply (voltage, current).

Illustration 1.1.1 **IHD-17A-50, 48 VDC/18.4 ADC**

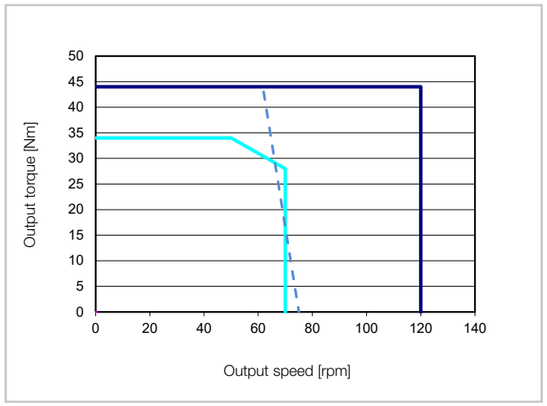


Illustration 1.1.2 **IHD-17A-100, 48 VDC/14.6 ADC**

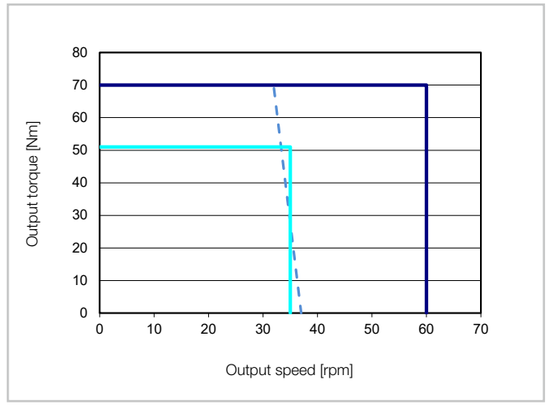


Illustration 1.1.3 **IHD-20A-50, 48 VDC/29.3 ADC**

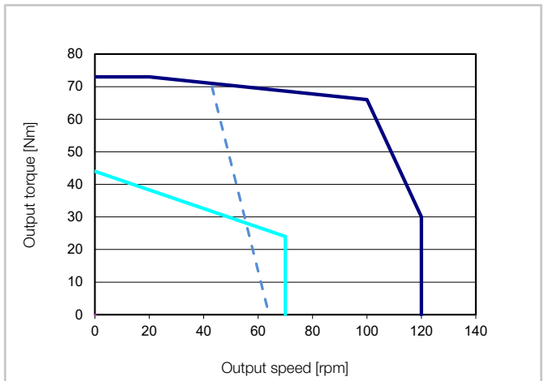


Illustration 1.1.4 **IHD-20A-100, 48 VDC/22.6 ADC**

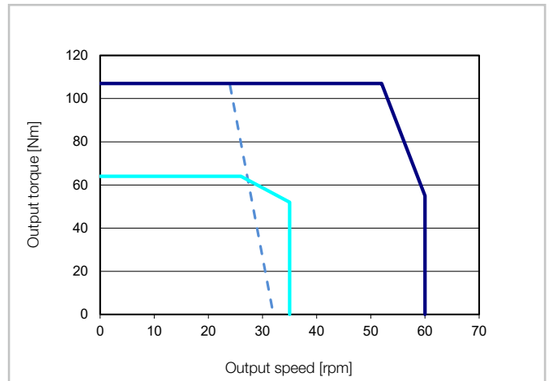


Illustration 1.1.5 **IHD-20A-160, 48 VDC/16.7 ADC**

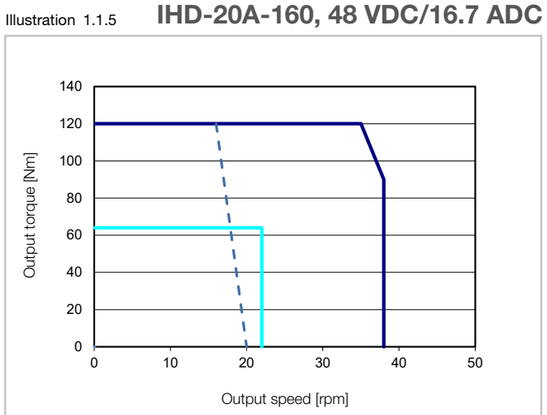


Illustration 1.1.6 **IHD-25A-50, 48 VDC/37.6 ADC**

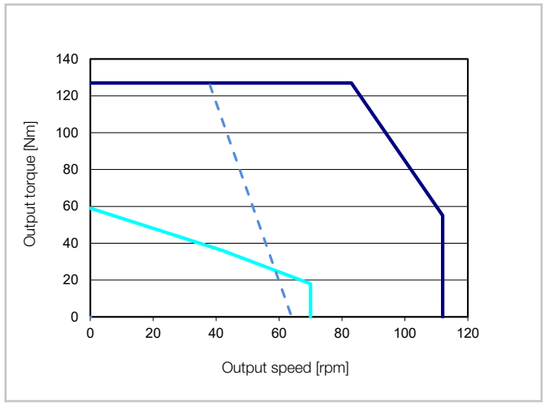


Illustration 1.1.7 **IHD-25A-100, 48 VDC/32.1 ADC**

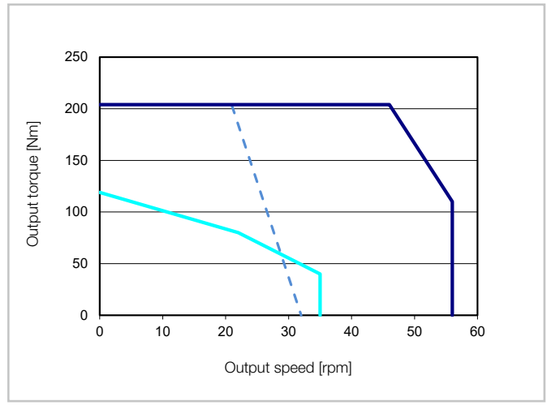
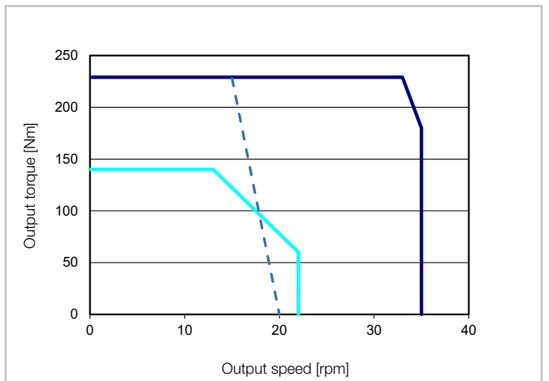


Illustration 1.1.8 **IHD-25A-160, 48 VDC/25.6 ADC**



Intermittent duty ——— Continuous duty ——— Limit speed reduction with 24 VDC bus voltage - - - - - - - -

• Dimensions

Illustration 1.1.9

IHD-17A [mm]

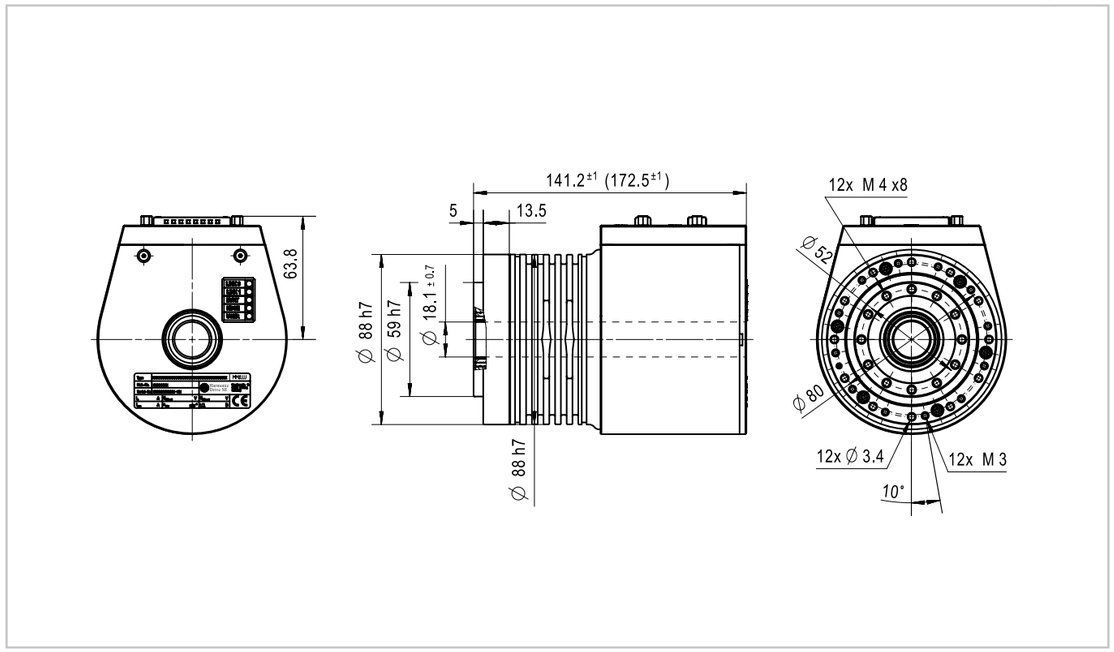
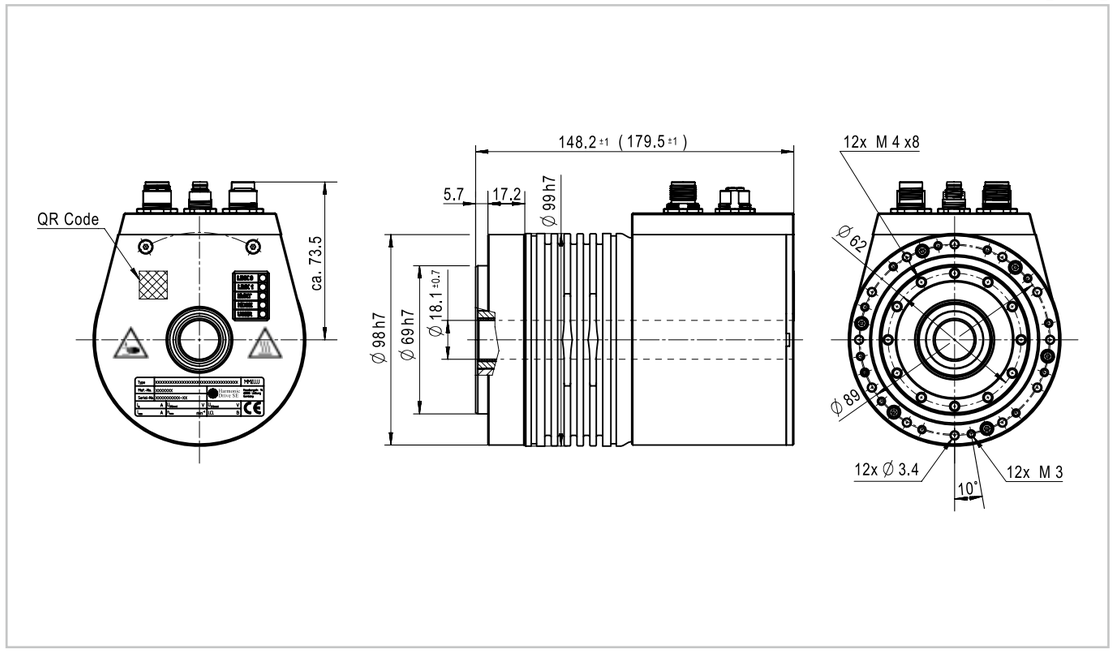


Illustration 1.1.10

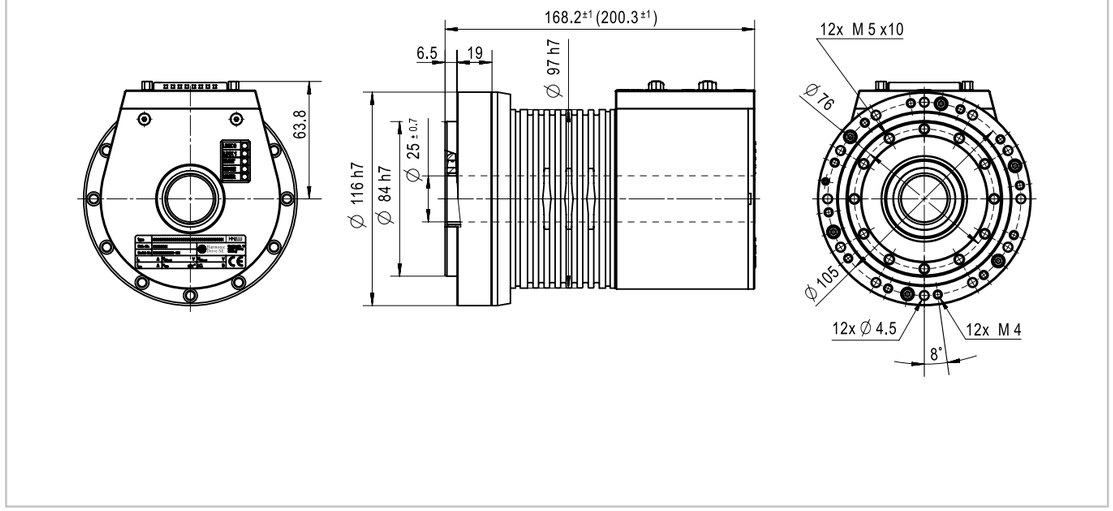
IHD-20A [mm]



CAD drawings for download: www.harmonicdrive.co.uk

Illustration 1.1.11

IHD-25A [mm]



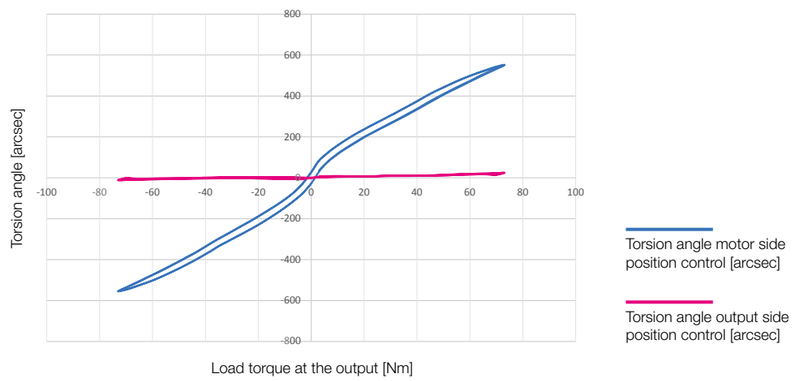
System stiffness

Due to the position control on the gear output, the system can directly compensate for angle changes caused by external load influences. The system stiffness with optimally adjusted control loops is many times higher than with classic motor side position control. The influence of the hysteresis loss typical for strain wave gears can be significantly reduced. The behaviour in terms of stiffness, hysteresis and dynamics is now more dependent on the setting of the control loops than on the mechanical properties of the gear.

The diagram below shows the difference in positioning behaviour depending on the command mode: position control via motor-side encoder or via encoder at the gear output. The angle of rotation is shown as a function of the load torque with different command modes.

Table 1.1.10

System stiffness with different reference variables



Output bearing

Our servo actuators incorporate a high stiffness output bearing. This specially developed bearing can withstand axial forces and radial forces as well as tilting moments. The reduction gear is therefore protected from external loads, so guaranteeing a long life and consistent performance. The integration of an output bearing also serves to reduce subsequent design and production cost, by removing the need for an additional output bearing in many applications.

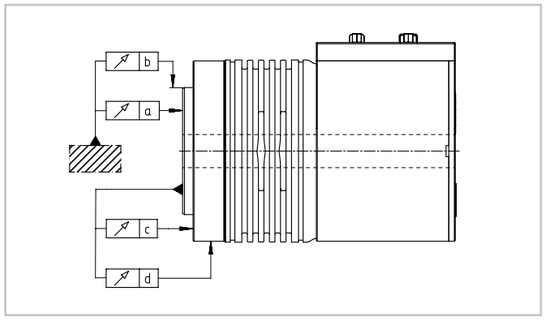
• Performance data

Table 1.1.11

	Symbol [Unit]	17A	20A	25A
Bearing type[1)]		C[6)]	C[6)]	C
Pitch circle diameter	d_p [m]	0.0592	0.0700	0.0889
Offset[2)]	R [m]	0.0136	0.0162	0.0182
Dynamic load rating	C [N]	10700	21000	24800
Static load rating	C_0 [N]	14800	27700	37500
Permissible dynamic tilting moment[3,4)]	M [Nm]	114	172	254
Tilting moment stiffness[5)]	K_B [Nm/arcmin]	40	70	114
Permissible axial force[4)]	F_a [N]	2286	4486	5298
Permissible radial force[4)]	F_r [N]	1532	3006	3550

1) Bearing type C = Cross roller bearing; F = Four point contact bearing
2) Distance between the centre of the rolling bearing and the screw mounting surface on the output side, see chapter Actuator dimensioning.
3) These values are valid for moving gears. They are not based on the equation for lifetime of the output bearing but on the maximum allowable deflection of the Harmonic Drive® Gear Component Set. The values indicated in the table must not be exceeded even if the lifetime equation of the bearing permits higher values.
4) These data are valid for **M**: F_a = 0, Fr = 0 I $\mathbf{F_a}$: M = 0, F_r = 0 I $\mathbf{F_r}$: M = 0, F_a = 0
5) The value of tilting moment stiffness is the average value (± 20 %).
6) Alternatively, a four point contact bearing can be used.

Illustration 1.1.12



• Tolerances

Table 1.1.12

	[Unit]	17A	20A	25A
a	[mm]	0.01		
b	[mm]	0.01		
c	[mm]	0.01		
d	[mm]	0.01		

Feedback systems

The IHD system is equipped with a so called Dual Feedback System.

Two singleturn absolute position sensors are available within the system. One sensor is connected to the motor shaft, the second is connected to the gear output side, meaning gear hollow shaft. Major parameters are:

Table 1.1.13

Sensor types	Symbol [Unit]	
Function		Singleturn absolute
Code disk		Master Nonius
Number of poles		64/63
Position accuracy	p2p [°]	0.2

Temperature sensors

A temperature sensor is integrated into the motor winding for winding protection for speeds greater than zero. For applications with high load at zero speed, additional protection (for example I^2t monitoring) is recommended. Furthermore, the power electronics are monitored with a temperature sensor and evaluated internally by the controller itself.

Table 1.1.14

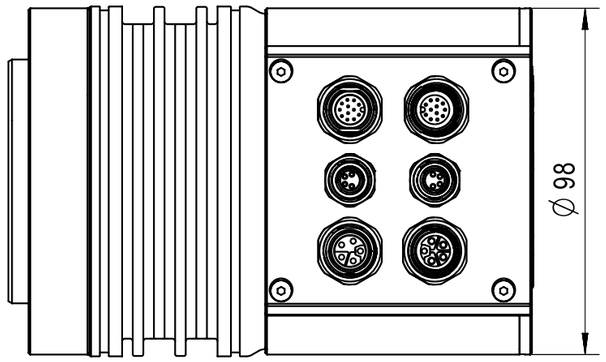
Sensor type	Quantity	Parameter	Symbol [Unit]	Limit	
				Warning	Switch off
PT 1000	1	Temperature	T [°C]	105	115

Electrical connections

- Standard connectors (M8/M12)

Standard connectors (M8/M12) for use of standard cables made by Phoenix Contact

Illustration 1.1.13



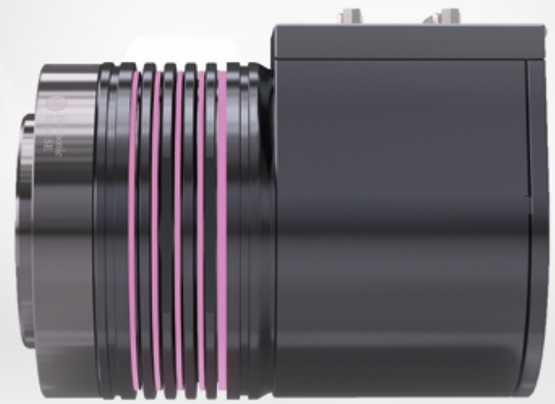


Table 1.1.15

Input connector J2, J4, J6				Output connector J1, J3, J5			
Connector type	INPUT [Pin]	Pin	Signal	Connector type	Output [Socket]	Pin	Signal
M12 A-kodiert	J2 Signal	1	STO-1	M12 A-kodiert	J1 Signal	1	STO-1
		2	LOGIC-N			2	LOGIC-N
		3	STO-REF			3	STO-REF
		4	AN-N			4	AN-N
		5	D-Out/In			5	D-Out/In
		6	AN-P			6	AN-P
		7	N.C			7	N.C
		8	AN-REF/D-GND			8	AN-REF/D-GND
		9	LOGIC-P			9	LOGIC-P
		10	N.C			10	N.C
		11	STO-2			11	STO-2
		12	N.C			12	N.C
M8 A-kodiert	J4 Feldbus	1	P0/1 TX_P / CH	M8 A-kodiert	J3 Feldbus	1	P0/1 TX_P / CH
		2	P0/1 RX_P / CG			2	P0/1 RX_P / CG
		3	P0/1 RX_N / CT			3	P0/1 RX_N / CT
		4	P0/1 TX_N / CL			4	P0/1 TX_N / CL
M12 L-kodiert	J6 Leistung	1	DC_BUS_P	M12 L-kodiert	J5 Leistung	1	DC_BUS_P
		2	DC_BUS_P			2	DC_BUS_P
		3	DC_BUS_N			3	DC_BUS_N
		4	DC_BUS_N			4	DC_BUS_N
		FE	B_RES_N			FE	B_RES_N

Table 1.1.16

Input cable (Phoenix-Contact)			Output cable (Phoenix-Contact)		
Designation	Length [m]	Material number Phoenix-Contact	Designation	Length [m]	Material number Phoenix-Contact
SAC_12P- X,X-35T/FS SH SCO	3.0	1430132	SAC_12P-MS/ X,X-35T/ FS SH SCO	3.0	1402551
	5.0	1430145		5.0	on request
	10.0	1430158		10.0	on request
	15.0	on request		15.0	on request
NBC-M 8FS-R4AC/…/…	3.0	1408714 /93C/3,000 m	NBC-M 8MS-M8FS/…/…	3.0	1408715/93C/3.000 m
	5.0	1408714 /93C/5,000 m		5.0	1408715/93C/5.000 m
	10.0	1408714 /93C/10,000 m		10.0	1408715/93C/10.000 m
	15.0	1408714 /93C/15,000 m		15.0	1408715/93C/15.000 m
SAC-5P-M12MSL/X,X-280-FE-SH	3.0	1414791	SAC-5P-M12MSL-FSLFESH/…/...	3.0	1276573/280/3.000 m
	5.0	1414807		5.0	1276573/280/5.000 m
	10.0	1414824		10.0	1276573/280/10.000 m
	15.0	on request		15.0	1276573/280/15.000 m

- Special connection based on D-Sub type

Illustration 1.1.14

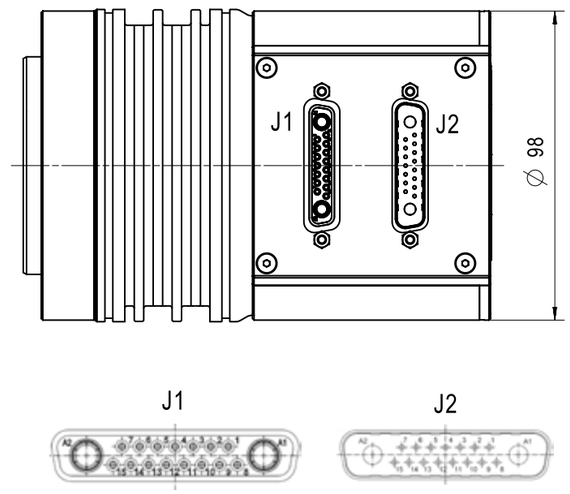
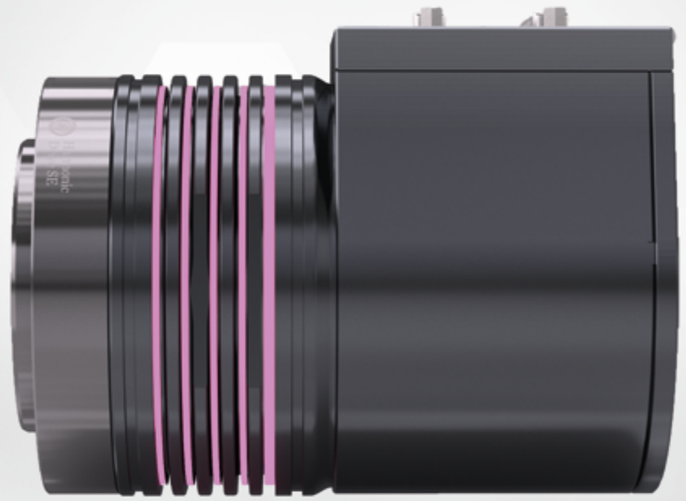


Table 1.1.17

Output connector J1				Input connector J2			
Connector Type	Output [Female]	Pin	Signal	Connector Type	Input [Male]	Pin	Signal
Sub-D	Output J1	16	DC Supply +	Sub-D	Input J2	16	DC Supply +
		1	CAN High /Transceive + (P1 - CH / TX+)			1	CAN High /Transceive + (P0 - CH / TX+)
		2	CAN Low /Transceive - (P1 - CL / TX-)			2	CAN Low /Transceive - (P0 - CL / TX-)
		3	CAN Ground /Receive + (P1 - CG / RX+)			3	CAN Ground /Receive + (P0 - CG / RX+)
		4	CAN Terminition / Receive - (P1 - CT / RX -)			4	CAN Terminition / Receive - (P0 - CT / RX -)
		5	Digital Output (D-Out)			5	Digital Output (D-In)
		6	Digital Ground & Analog Reference (D-GND & AN REF)			6	Digital Ground & Analog Reference (D-GND & AN REF)
		7	NC			7	Brake Resistor (Bres)
		8	NC			8	Brake Resistor (Bres)
		9	AN+			9	AN+
		10	AN-			10	AN-
		11	Logic +			11	Logic +
		12	Logic -			12	Logic -
		13	STO-1			13	STO-1
		14	STO-REF			14	STO-REF
		15	STO-2			15	STO-2
		17	DC Supply -			17	DC Supply -

Table 1.1.18

Output Connecting Cable			Input Connecting Cable		
Ordering code	Length [m]	Mat.-No.	Ordering code	Length [m]	Mat.-No.
Cable IHD Output	3	1047332	Cable IHD Input	3	1053022
	5	1052126		5	1053023
	10	1053024		10	1053019
	15	1053025		15	1053020



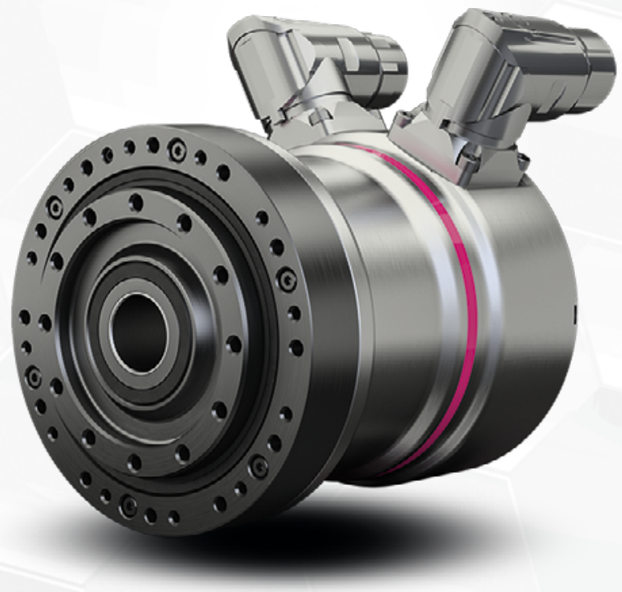
Product description

Lifetime precision at high cost-efficiency

The servo actuators in our BHA Series are the perfect combination of highly dynamic, compact synchronous servo motors and zero backlash gears with output bearings. Our servo actuators with hollow shaft are another outstanding choice thanks to their low weight, small volume, excellent torque density, long lifetime and high standards of reliability.

Features

- Outstanding, lifelong precision
- Large hollow shaft
- Optimally matched components
- Ready to connect servo actuator
- Small outer diameter
- Third party controller compatibility
- Integrated, tilt resistant output bearing
- Increased power density due to segmented stator winding



Ordering code

Table 1.2.1

Ordering code	BHA	-	20	A	-	100	-	AO	-	LA	-	MZE	-	B	-	1	-	SP
BHA Series																		
Size (corresponds to the pitch circle diameter of the Flexspline toothing in inches x 10)			17 20 25															
Product generation				A														
Ratio						30 50 80 100 120 160												
Motor winding type																		
Winding type AO (DC voltage link 560 V, voltage constant 27, 2 Vrms/1000 rpm)								AO										
Winding type DB (DC voltage link 48 V, voltage constant 4 Vrms/1000 rpm)								DB										
Winding type AU (DC voltage link 560 V, voltage constant 49,1 Vrms/1000 rpm)								AU										
Winding type DD (DC voltage link 48 V, voltage constant 4,7 Vrms/1000 rpm)								DD										
Connector version																		
Motor connector M23 8-pol.; Encoder connector M23 17-pol.										LA								
Motor connector M23 8-pol.; Encoder connector M23 12-pol.										LB								
Motor connector M23 8-pol.; Encoder connector M23 17-pol. (straight connector)										IA								
Motor connector M23 8-pol.; Encoder connector M23 12-pol. (straight connector)										IB								
Motor feedback system																		
EnDat 2.2 Singleturn absolute encoder ECI-119 (19 bit Singleturn)												SZE						
HIPERFACE® Singleturn absolute encoder SES70 (32 SinCos, 10 bit Singleturn)												SIH						
HIPERFACE® Singleturn absolute encoder SES90 (64 SinCos, 10 bit Singleturn)												SHH						
BiSS-C Singleturn absolute encoder FFB (16 bit Singleturn)												SZB						
EnDat 2.2 Multi-turn absolute encoder EBI-135 (19 bit Singleturn, 16 bit Multi-turn battery buffered)												MZE						
HIPERFACE® Multi-turn absolute encoder SEM70 (32 SinCos, 10 bit Singleturn/12 bit Multi-turn (mechanical)												MIH						
HIPERFACE® Multi-turn absolute encoder SEM90 (64 SinCos, 10 bit Singleturn/12 bit Multi-turn (mechanical)												MHH						
BiSS-C Multi-turn absolute encoder FFB (16 bit Singleturn, 16 bit Multi-turn battery buffered)												MZB						
SSI Multi-turn absolute encoder FFB (64 SinCos, 16 bit Singleturn, 12 bit Multi-turn battery buffered)												MHS						
Option Holding brake																		
With holding brake 24 V														B				
Without holding brake														O				
Option Temperature sensor																		
1: Temperature sensor in motor connector (standard)																1		
2: Temperature sensor in encoder connector (optional)																2		
Customised design																		
Standard design (Field remains empty)																		[ ]
Customised design (on request)																		SP

Please refer to the table of possible combinations.

Designation of motor feedback system

Table 1.2.2

Example: ECI119	S	Z	E
Type			
Singleturn absolute	S		
Multi-turn absolute	M		
Number of sine cosine periods			
64		H	
32		I	
none		Z	
Protocol			
BiSS-C			B
EnDat 2.2/22			E
HIPERFACE®			H
SSI			S

Combinations

Table 1.2.3

Size		17A	20A	25A
Ratio	30	o	o	o
	50	●	●	●
	80	o	o	o
	100	●	●	●
	120	o	o	o
	160	-	●	●
Motor winding type	AO	●	●	-
	DB	●	●	-
	AU	-	-	●
	DD	-	-	●
Connector version	LA	●	●	●
	LB	●	●	●
Motor feedback system	SZE	●	●	●
	SIH	o	o	-
	SHH	-	-	o
	SZB	o	o	o
	MZE	●	●	●
	MIH	●	●	-
	MHH	-	-	●
	MZB	●	●	●
	MHS	●	●	●
Option holding brake	B	o	o	o
Option temperature sensor	1	●	●	●
	2	o	o	o

● available o on request - not available

Technical data

• Features

Table 1.2.4

Motor winding	[Unit]	AO/AU	DB/DD
Machine type		Permanent magnet synchronous motor with concentrated winding	
Magnet material		Neodymium-iron-boron	
Insulation class (EN 60034-1)		F	F
Insulation resistance (500 VDC)	[MΩ]	100	
Insulation voltage (10 s)	[VAC]	2500	700
Lubrication		4BNo2	
Degree of protection (EN 60034-5)		IP65 (Shaft seal ring is standard)	
Ambient operating temperature	[°C]	0 … 40	
Ambient storage temperature	[°C]	-20 … 60	
Maximum installation altitude (above sea level)	[m]	4000 above sea level	
Relative humidity (without condensation)	[%]	maximum 80 non dewing	
Vibration resistance (DIN IEC 60068 part 2-6, 10 … 500 Hz)	[g]	5	
Shock resistance (DIN IEC 60068 part 2-27, 11 ms)	[g]	30	
Corrosion protection (DIN IEC 60068 part 2-11 Salt spray test)	[h]	-	-
Temperature sensors		1 x PT1000[1)]	
Gear component set		CSG-2A	

[1)] Safe separation according to EN 61800-5-1, design class B according to IEC 60751

• Cooling

Unless otherwise indicated, the values given in the tables refer to an overtemperature of the winding of 65 K at an ambient temperature of 40 °C and a maximum installation altitude of 1000 m above sea level. From an installation altitude > 1000 m above sea level, a derating of 1 % per 100 m must be made. The values in the following tables and the operating characteristics apply to actuators mounted on an aluminium base plate with the following minimum dimensions:

Table 1.2.5

Series	Size	[Unit]	Dimension
BHA	17A	[mm]	300 x 300 x 15
	20A	[mm]	300 x 300 x 15
	25A	[mm]	350 x 350 x 18

- Actuator data

BHA-17A-AO, BHA-20A-AO, BHA-25A-AU

Actuators with 680 VDC maximum stationary DC bus voltage

Table 1.2.6

Actuator	Symbol [Unit]	17A		20A			25A		
Stator winding		AO		AO			AU		
Motor feedback system		SZE/ MZE / SZB / MZB / MHS / MIH		SZE/ MZE / SZB / MZB / MHS / MIH			SZE/ MZE / SZB / MZB / MHS / MHH		
Ratio	i	50	100	50	100	160	50	100	160
Maximum output torque	T_{MAX} [Nm]	44	70	73	107	120	127	204	229
Maximum output speed SIH, MIH	n_{MAX} [rpm]	146	73	130	65	41	112	56	35
Maximum output speed SZE, MZE, SZB, MZB, MHS	n_{MAX} [rpm]	120	60	120	60	37.5	112	56	35
Maximum current	I_{MAX} [A_{rms}]	2.8	2.2	4.5	3.3	2.4	4.1	3.2	2.4
Continuous stall torque	T_0 [Nm]	34	51	44	64	64	72	140	140
Continuous stall current	I_0 [A_{rms}]	1.9	1.4	2.5	1.8	1.2	2.2	2.1	1.3
No load starting current	I_{NLSC} [A_{rms}]	0.11	0.11	0.14	0.13	0.14	0.12	0.11	0.11
No load current constant (20 °C)	K_{INL} [10^{-3}A/rpm]	5.24	10.02	6.59	12.57	19.65	6.10	11.90	18.20
No load current constant (90 °C)	K_{INL} [10^{-3}A/rpm]	1.90	3.63	2.21	4.22	6.60	1.90	3.70	5.70
Torque constant (Motor)	K_T [Nm/A_{rms}]	0.38		0.38			0.74		
AC voltage constant (L-L, 20 °C)	K_E [V_{rms}/1000 rpm]	25.7		25.7			49.1		
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	680[1)]		680[1)]			680[1)]		
Mechanical time constant MZB, without brake (20 °C)	T_M [ms]	5.3		5.7			4.2		
Electrical time constant (20 °C)	T_E [ms]	1.6		1.6			2.6		
Maximum motor speed SIH, MIH	n_{MAX} [rpm]	7300		6500			5600		
Maximum motor speed SZE, MZE, SZB, MZB, MHS	n_{MAX} [rpm]	6000		6000			5600		
Rated motor speed	n_N [rpm]	3500		3500			3500		
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	4.00		4.00			5.84		
Rotary field inductance	L_d [mH]	3.10		3.10			7.50		
Number of pole pairs	p	8		8			8		
Brake voltage	$U_{Br.}$ [V_{DC}]	24 ±10 %		24 ±10 %			24 ±10 %		
Brake holding torque	$T_{Br.}$ [Nm]	36	70	36	72	120	72	144	229
Brake power consumption	$P_{BR.}$ [W]	9.6		9.6			9.6		
Brake opening time	t_O [ms]	15		15			18		
Brake closing time	t_C [ms]	15		15			18		
Weight without brake	m [kg]	2.5		2.8			3.8		
Weight with brake	m [kg]	2.8		3.3			4.4		
Hollow shaft diameter	d_h [mm]	18		18			27		
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	21	31	33	52	52	51	87	87
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000		2000			2000		

1) In general, actuators with an Ax winding can also be operated on DC links with a nominal voltage > 680 V_{DC}. The lifetime of an insulation system is significantly influenced by the environment. Possible overvoltages at the motor terminals can be influenced by the length of the motor cable and the voltage slope of the servo controller. These overvoltages lead to partial discharges in the insulation system and can significantly reduce the lifetime of the insulation system. An assessment can only be made in the customer's environment. The manufacturer is not aware of any failures to date that can be attributed to a higher DC link voltage.

You will find more information on this in the Engineering data chapter.

BHA-17A-DB, BHA-20A-DB, BHA-25A-DD

Actuators with 48 VDC maximum stationary DC bus voltage

Table 1.2.7

Actuator	Symbol [Unit]	17A		20A			25A		
Stator winding		DB		DB			DD		
Motor feedback system		SZE/ MZE / SZB / MZB / MHS / MIH		SZE/ MZE / SZB / MZB / MHS / MIH			SZE/ MZE / SZB / MZB / MHS / MHH		
Ratio	i	50	100	50	100	160	50	100	160
Maximum output torque	T_{MAX} [Nm]	44	70	73	107	120	127	204	229
Maximum output speed SIH, MIH	n_{MAX} [rpm]	146	73	130	65	41	112	56	35
Maximum output speed SZE, MZE, SZB, MZB, MHS	n_{MAX} [rpm]	120	60	120	60	37.5	112	56	35
Maximum current	I_{MAX} [A_{rms}]	19.0	15.3	30.9	22.7	16.5	42.2	33.5	24.3
Continuous stall torque	T_0 [Nm]	34	51	44	64	64	72	140	140
Continuous stall current	I_0 [A_{rms}]	13.3	9.8	17.2	12.3	7.9	22.7	21.5	13.7
No load starting current	I_{NLSC} [A_{rms}]	0.78	0.75	1.00	0.90	0.96	1.27	1.10	1.15
No load current constant (20 °C)	K_{INL} [10^{-3}A/rpm]	35.88	68.30	46.10	86.60	134.20	63.90	124.40	189.70
No load current constant (90 °C)	K_{INL} [10^{-3}A/rpm]	12.96	24.70	15.40	29.00	45.00	20.00	39.00	59.60
Torque constant (Motor)	K_T [Nm/A_{rms}]	0.06		0.06			0.07		
AC voltage constant (L-L, 20 °C)	K_E [V_{rms}/1000 rpm]	3.8		3.8			4.7		
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	48		48			48		
Mechanical time constant MZB, without brake (20 °C)	T_M [ms]	5.6		7.1			5.0		
Electrical time constant (20 °C)	T_E [ms]	1.2		1.2			2.3		
Maximum motor speed SIH, MIH	n_{MAX} [rpm]	7300		6500			5600		
Maximum motor speed SZE, MZE, SZB, MZB, MHS	n_{MAX} [rpm]	6000		6000			5600		
Rated motor speed	n_N [rpm]	3500		3500			3500		
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	0.100		0.100			0.064		
Rotary field inductance	L_d [mH]	0.060		0.060			0.075		
Number of pole pairs	p	8		8			8		
Brake voltage	$U_{Br.}$ [V_{DC}]	24 ±10 %		24 ±10 %			24 ±10 %		
Brake holding torque	$T_{Br.}$ [Nm]	36	70	36	72	120	72	144	229
Brake power consumption	$P_{BR.}$ [W]	9.6		9.6			9.6		
Brake opening time	t_O [ms]	15		15			18		
Brake closing time	t_C [ms]	15		15			18		
Weight without brake	m [kg]	2.5		2.8			3.8		
Weight with brake	m [kg]	2.8		3.3			4.4		
Hollow shaft diameter	d_h [mm]	18		18			27		
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	21	31	33	52	52	51	87	87
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000		2000			2000		

You will find more information on this in the Engineering data chapter.

• Moment of inertia

Table 1.2.8

	Symbol [Unit]	17A		20A			25A		
Motor feedback system		**SZB / MZB / MHS**							
Ratio		50	100	50	100	160	50	100	160
Moment of inertia at output side									
Moment of inertia without brake	J_{OUT} [kgm²]	0.325	1.300	0.350	1.400	3.584	0.655	2.620	6.707
Moment of inertia with brake	J_{OUT} [kgm²]	0.375	1.500	0.400	1.600	4.096	0.730	2.920	7.475
Moment of inertia at motor side									
Moment of inertia without brake	J [kgm²x10⁻⁴]	1.30		1.40			2.62		
Moment of inertia with brake	J [kgm²x10⁻⁴]	1.50		1.60			2.92		
Motor feedback system		**SZE / MZE**							
Ratio		50	100	50	100	160	50	100	160
Moment of inertia at output side									
Moment of inertia without brake	J_{OUT} [kgm²]	0.450	1.800	0.450	1.800	4.608	0.780	3.120	7.987
Moment of inertia with brake	J_{OUT} [kgm²]	0.475	1.900	0.500	2.000	5.120	0.855	3.420	8.755
Moment of inertia at motor side									
Moment of inertia without brake	J [kgm²x10⁻⁴]	1.80		1.80			3.12		
Moment of inertia with brake	J [kgm²x10⁻⁴]	1.90		2.00			3.42		
Motor feedback system		**SIH / MIH**					**SHH/MHH**		
Ratio		50	100	50	100	160	50	100	160
Moment of inertia at output side									
Moment of inertia without brake	J_{OUT} [kgm²]	0.225	0.900	0.250	1.000	2.560	0.690	2.760	7.066
Moment of inertia with brake	J_{OUT} [kgm²]	0.275	1.100	0.300	1.200	3.072	0.765	3.060	7.834
Moment of inertia at motor side									
Moment of inertia without brake	J [kgm²x10⁻⁴]	0.90		1.00			2.76		
Moment of inertia with brake	J [kgm²x10⁻⁴]	1.10		1.20			3.06		

• Performance characteristics

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.2.1 **BHA-17A-50-AO**

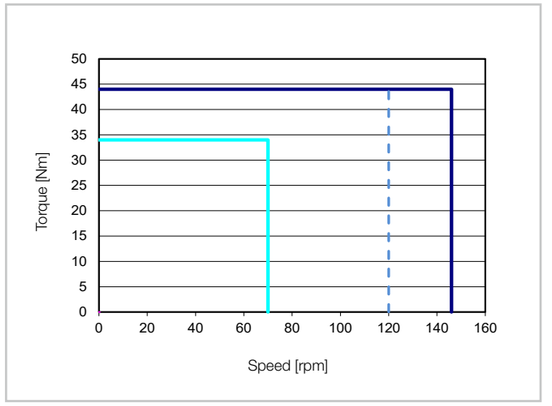


Illustration 1.2.2 **BHA-17A-100-AO**

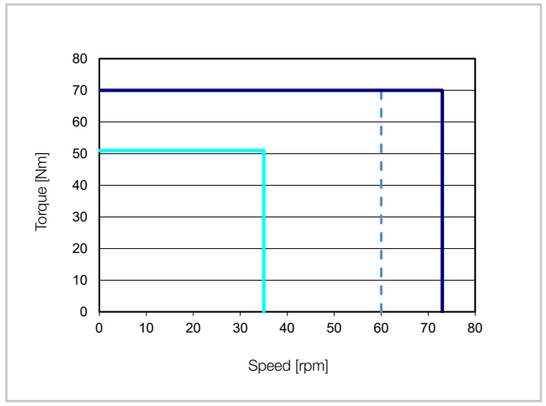


Illustration 1.2.3 **BHA-20A-50-AO**

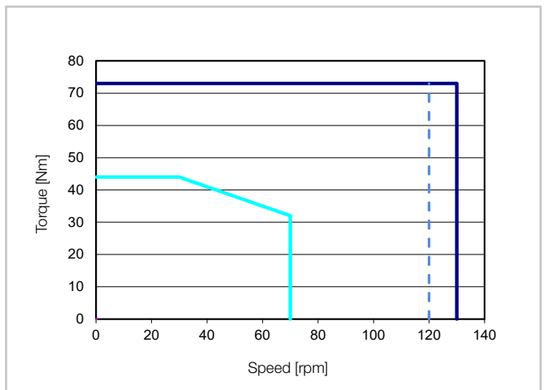


Illustration 1.2.4 **BHA-20A-100-AO**

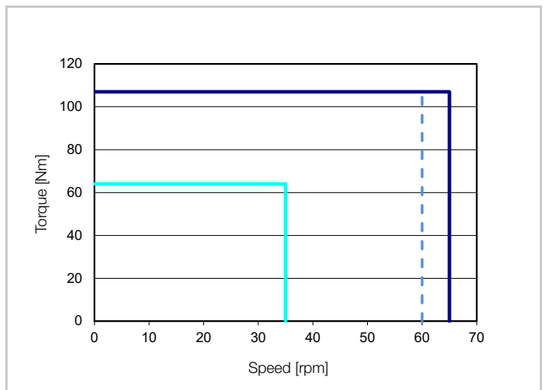
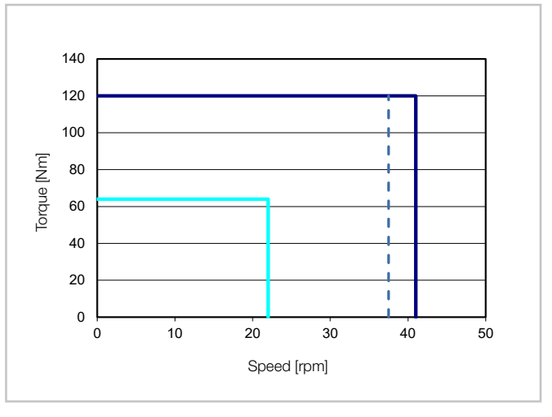


Illustration 1.2.5 **BHA-20A-160-AO**



U_M = 230 ... 400 VAC
Intermittent duty
Continuous duty
Limit speed reduction motor feedback system

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.2.6

BHA-25A-50-AU

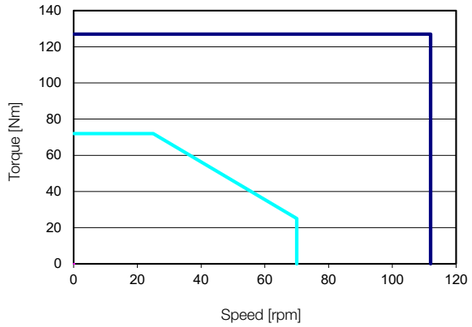


Illustration 1.2.7

BHA-25A-100-AU

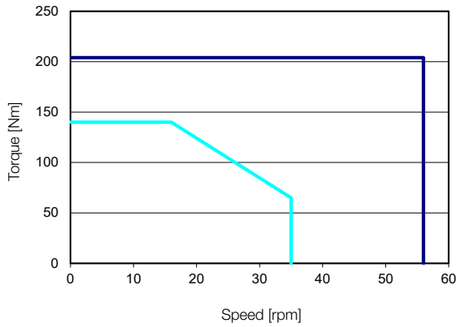


Illustration 1.2.8

BHA-25A-160-AU

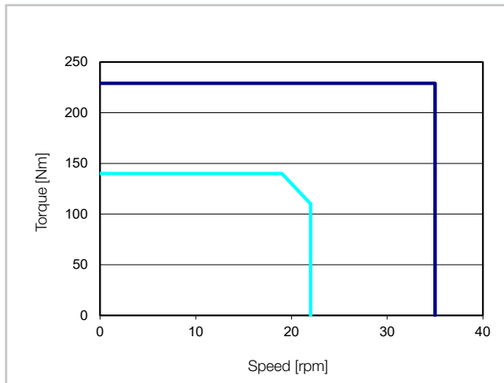


Illustration 1.2.9

BHA-17A-50-DB

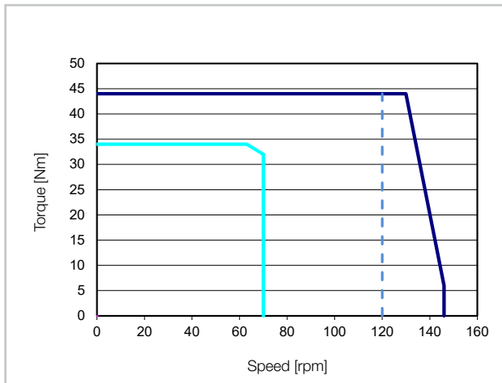


Illustration 1.2.10

BHA-17A-100-DB

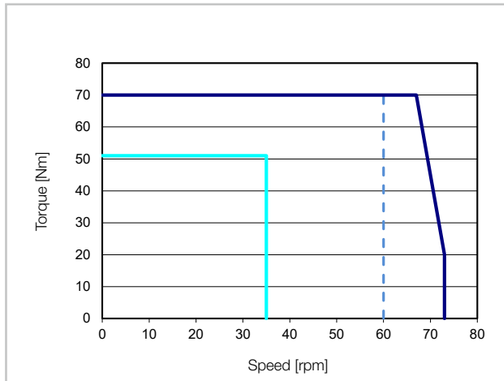
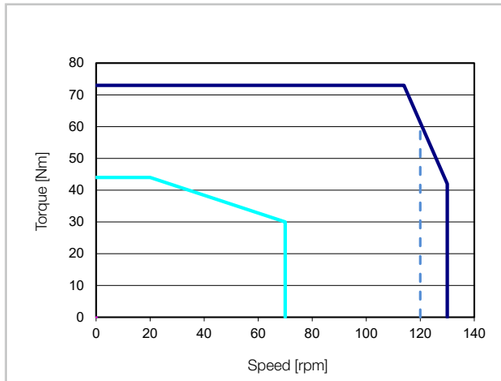


Illustration 1.2.11

BHA-20A-50-DB



U_M = 400 VAC for AU variants and 34 VAC for DB/DD variants
Intermittent duty — Continuous duty — Limit speed reduction motor feedback system - - -

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.2.12

BHA-20A-100-DB

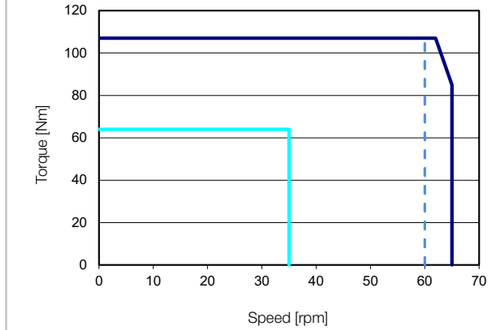


Illustration 1.2.13

BHA-20A-160-DB

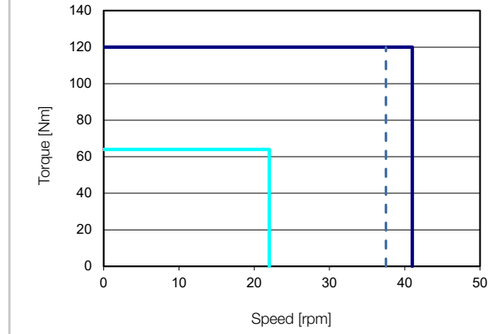


Illustration 1.2.14

BHA-25A-50-DD

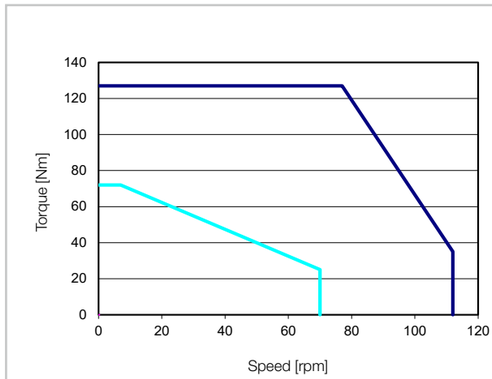


Illustration 1.2.15

BHA-25A-100-DD

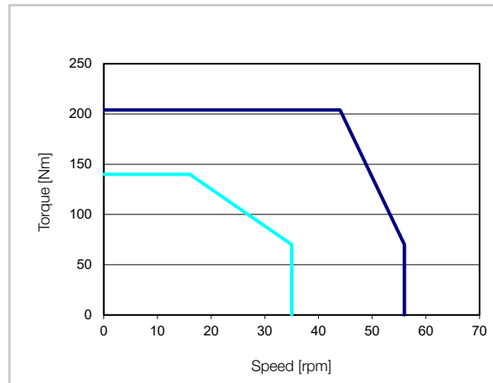
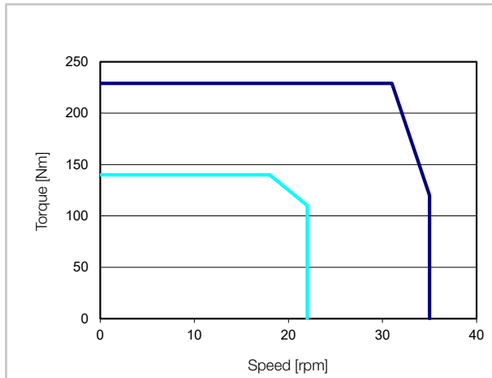


Illustration 1.2.16

BHA-25A-160-DD



U_M = 34 VAC
Intermittent duty — Continuous duty — Limit speed reduction motor feedback system - - -

- Dimensions

Illustration 1.2.17

BHA-17A-SZB [mm]

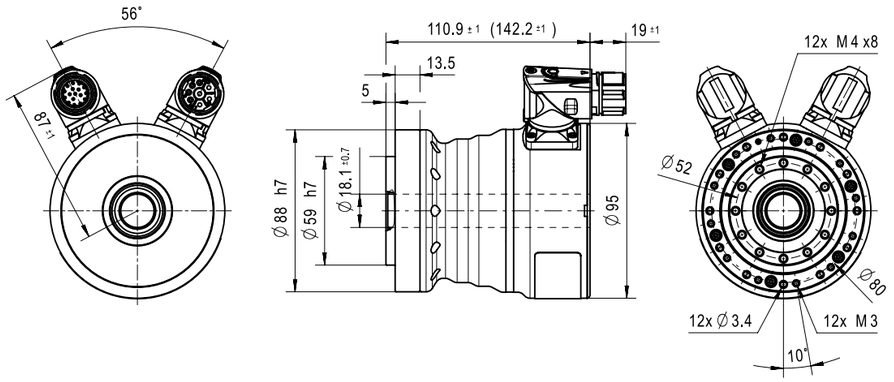


Illustration 1.2.18

BHA-17A-MZB/MHS [mm]

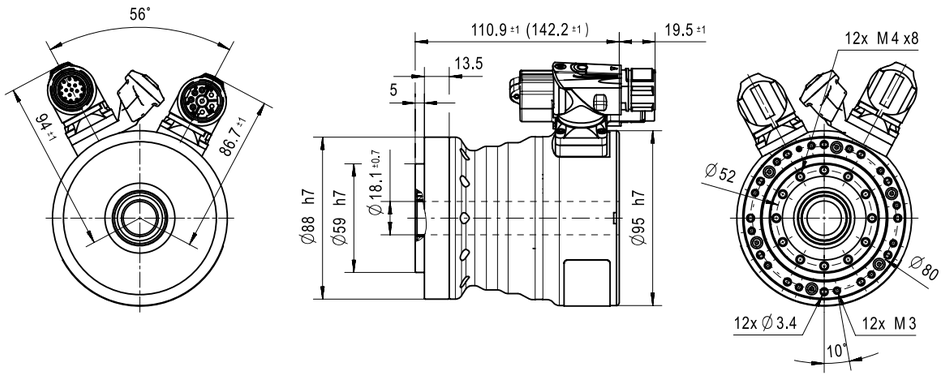


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Illustration 1.2.19

BHA-17A-SIH/SZE/MIH [mm]

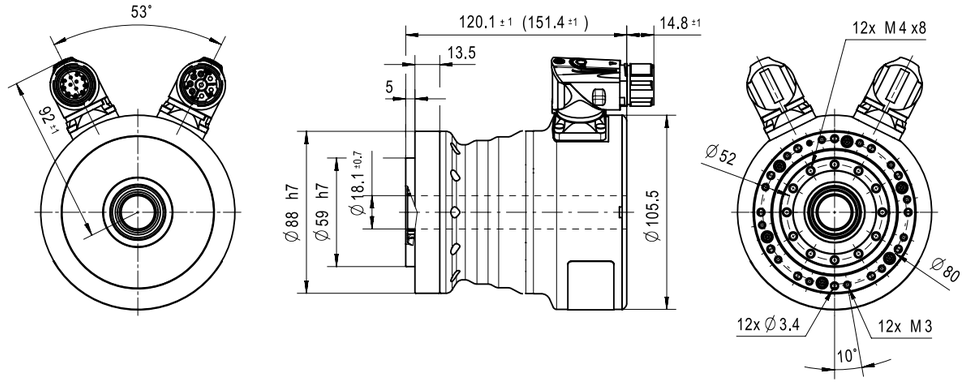

Illustration 1.2.20

BHA-17A-MZE [mm]

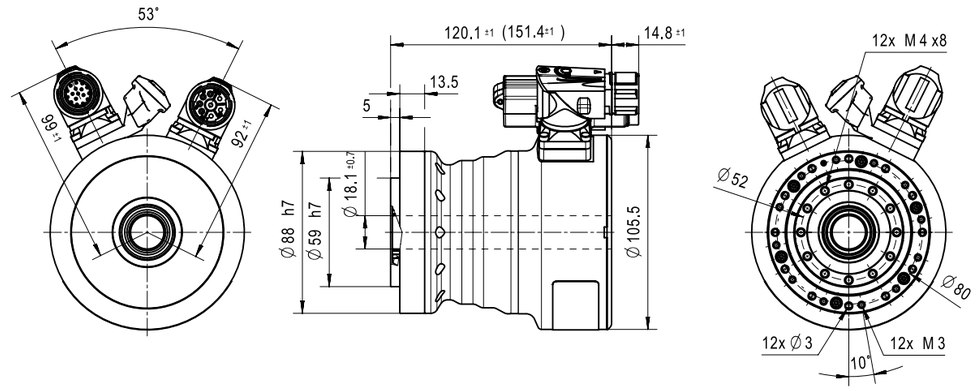

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Illustration 1.2.21

BHA-20A-SZB [mm]

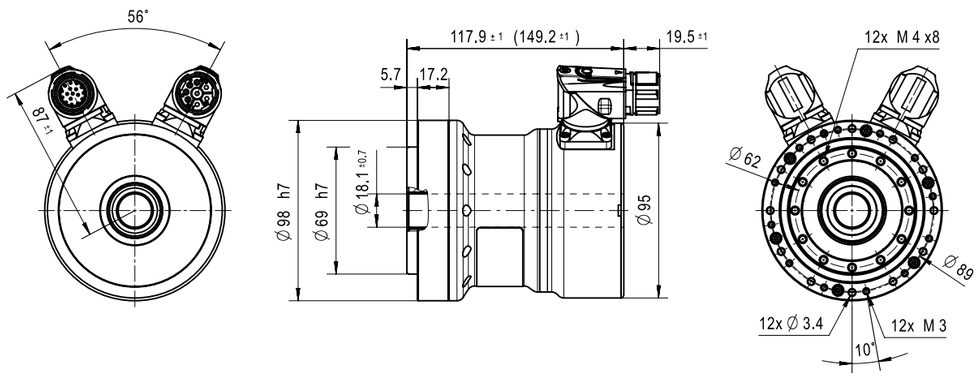
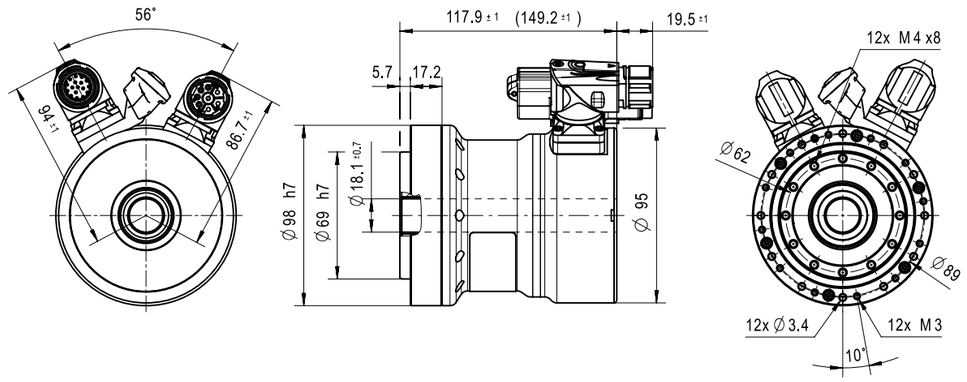


Illustration 1.2.22

BHA-20A-MZB/MHS [mm]



CAD drawings for download: www.harmonicdrive.co.uk

Illustration 1.2.23

BHA-20A-SIH/SZE/MIH [mm]

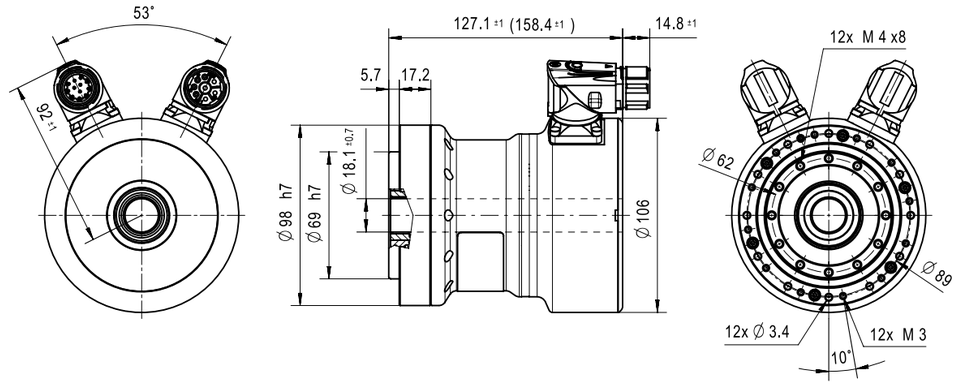
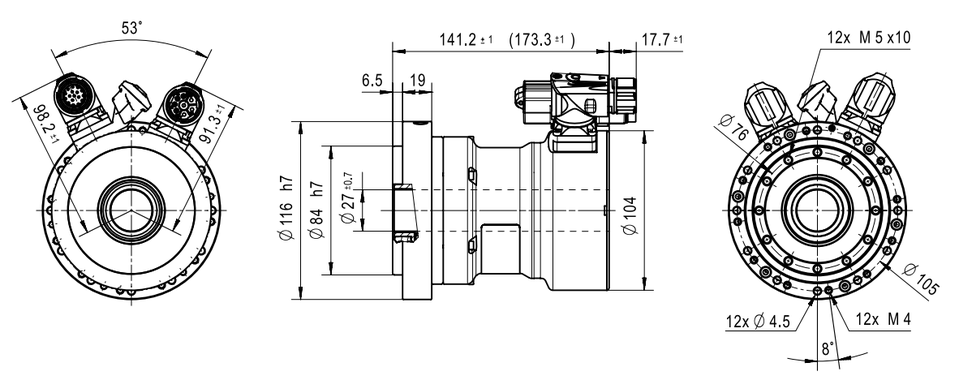


Illustration 1.2.24

BHA-20A-MZE [mm]



CAD drawings for download: www.harmonicdrive.co.uk

Illustration 1.2.25

BHA-25A-SZB [mm]

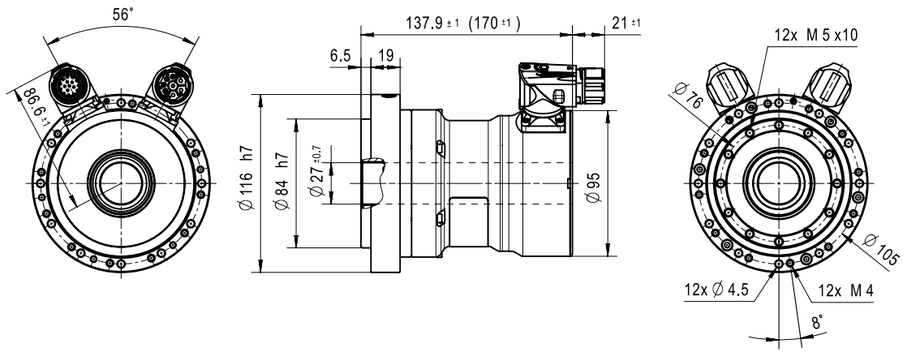


Illustration 1.2.26

BHA-25A-MZB/MHS [mm]

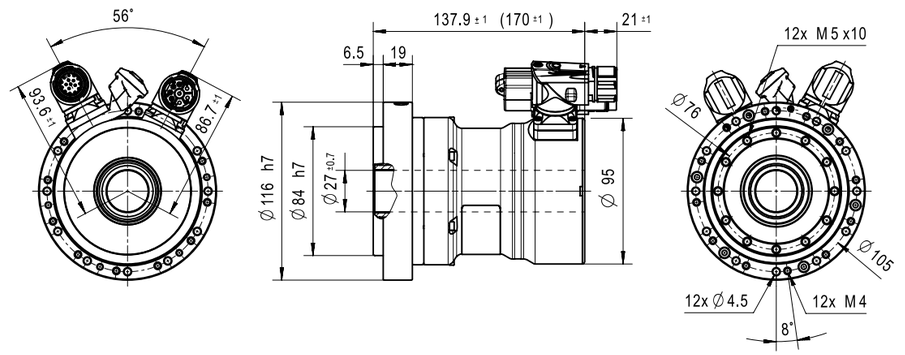
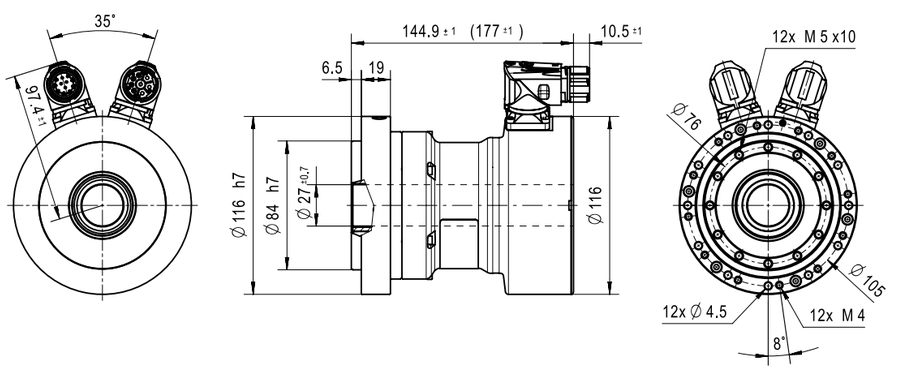


Illustration 1.2.27

BHA-25A-SHH/MHH [mm]



CAD drawings for download: www.harmonicdrive.co.uk

Illustration 1.2.28

BHA-25A-SZE [mm]

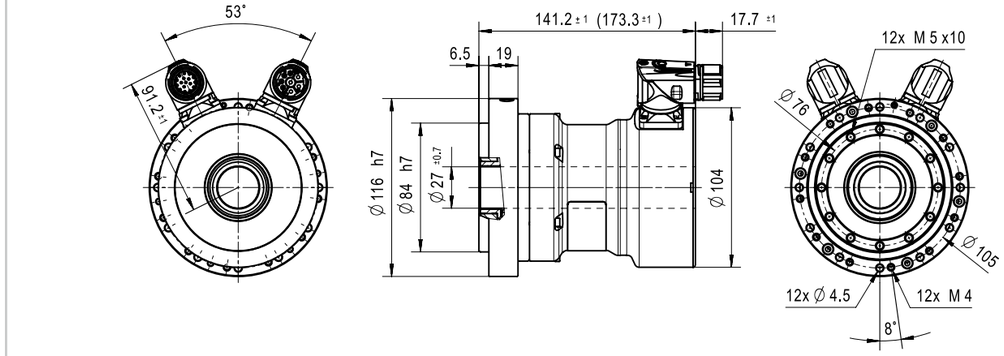
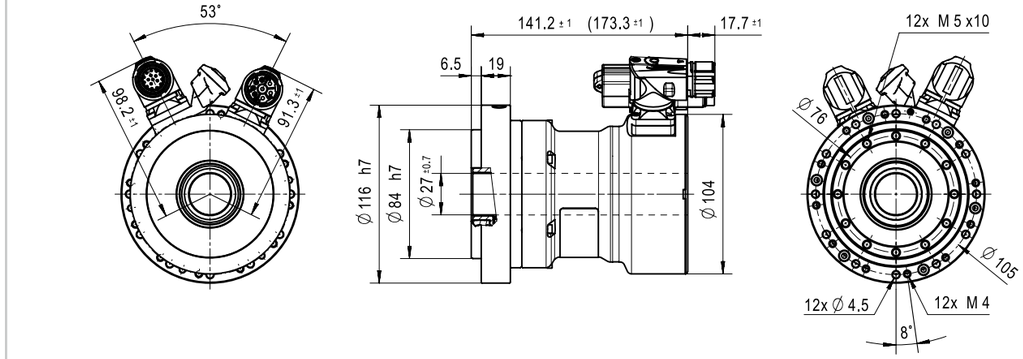


Illustration 1.2.29

BHA-25A-MZE [mm]



Gear characteristics

• Accuracy

Table 1.2.9

	Symbol [Unit]	17A	20A/25A
Ratio	i [ ]	≥ 50	≥ 50
Transmission accuracy	[arcmin]	< 1.5	< 1.0
Repeatability	[arcmin]	< ±0.1	< ±0.1
Hysteresis loss	[arcmin]	< 1.0	< 1.0
Lost Motion	[arcmin]	< 1.0	< 1.0

• Torsional stiffness

Table 1.2.10

	Symbol [Unit]	17A		20A		25A	
Limit torques	T_1 [Nm]	3.9		7		14	
	T_2 [Nm]	12		25		48	
Ratio	i [ ]	**50**	**> 50**	**50**	**> 50**	**50**	**> 50**
Torsional stiffness	K_3 [x 10^3 Nm/rad]	13	16	23	29	44	57
	K_2 [x 10^3 Nm/rad]	11	14	18	25	34	50
	K_1 [x 10^3 Nm/rad]	8.1	10.0	13.0	16.0	25.0	31.0

You will find more information on this in the Engineering data chapter.

Output bearing

Our servo actuators incorporate a high stiffness output bearing. This specially developed bearing can withstand high axial forces and radial forces as well as tilting moments. The reduction gear is therefore protected from external loads, so guaranteeing a long life and consistent performance. The integration of an output bearing also serves to reduce subsequent design and production cost, by removing the need for an additional output bearing in many applications.

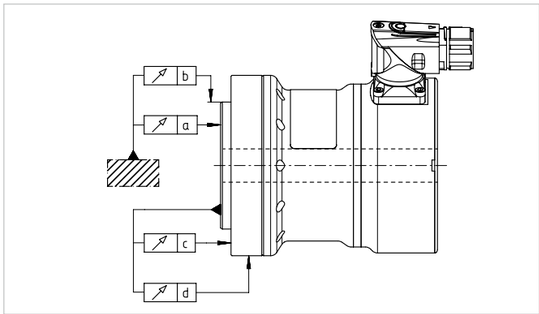
• Performance data

Table 1.2.11

	Symbol [Unit]	17A	20A	25A
Bearing type[1]		C[6]	C[6]	C
Pitch circle diameter	d_p [m]	0.0592	0.0700	0.0889
Pitch circle diameter[2]	R [m]	0.0136	0.0162	0.0182
Dynamic load rating	C [N]	10700	21000	24800
Static load rating	C_0 [N]	14800	27700	37500
Permissible dynamic tilting moment[3,4]	M [Nm]	114	172	254
Tilting moment stiffness[5]	K_B [Nm/arcmin]	40	70	114
Permissible axial force[4]	F_a [N]	2286	4486	5298
Permissible radial force[4]	F_r [N]	1532	3006	3550

1) Bearing type C = Cross roller bearing; F = Four point contact bearing
2) Distance between the centre of the rolling bearing and the screw mounting surface on the output side, see chapter Actuator dimensioning.
3) These values are valid for moving gears. They are not based on the equation for lifetime of the output bearing but on the maximum allowable deflection of the Harmonic Drive® Gear Component Set. The values indicated in the table must not be exceeded even if the lifetime equation of the bearing permits higher values.
4) These data are valid for **M**: $F_a = 0$, $F_r = 0$ I **F_a**: M = 0, $F_r = 0$ I **F_r**: M = 0, $F_a = 0$
5) The value of tilting moment stiffness is the average value (± 20 %).
6) Alternatively, a four point contact bearing can be used.

Illustration 1.2.30



• Tolerances

Table 1.2.12

	[Unit]	17A/20A/25A
a	[mm]	0.01
b	[mm]	0.01
c	[mm]	0.01
d	[mm]	0.01

Temperature sensors

A temperature sensor is integrated into the motor winding for winding protection where the speed is greater than zero. For applications with high load at zero speed, additional protection (for example I2t monitoring) is recommended.

Table 1.2.13

Sensor type	Quantity	Parameter	Symbol [Unit]	Limit value	
				Warning	Switch off
PT 1000	1	Temperature	T [°C]	105	115

Battery box

Battery box for multi-turn absolute motor feedback systems MZE, MHS and MZB

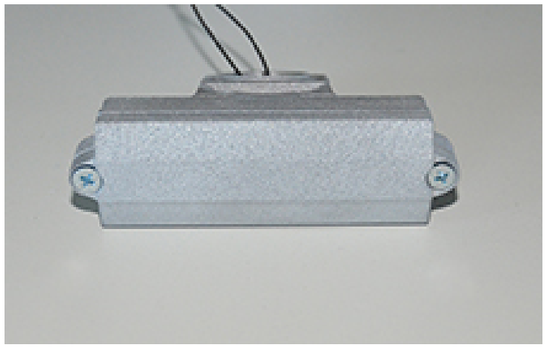
The battery box may only be opened for service purposes!

The battery box is an accessory for operating the multi-turn absolute motor feedback systems MZE, MHS and MZB. It contains the necessary battery to buffer the position data when the power supply is switched off.

If the battery voltage fails or is interrupted and the power supply fails or is interrupted at the same time, the reported position will be incorrect after the system is switched on again!

The buffer battery may only be replaced when the actuator is energised. This means that the actuator - in particular the encoder - must be connected to a switched on servo controller while the battery is being replaced. In this case, the servo controller takes over the power supply. Otherwise, the encoder loses its stored data and therefore its function.
Only the recommended battery may be used.

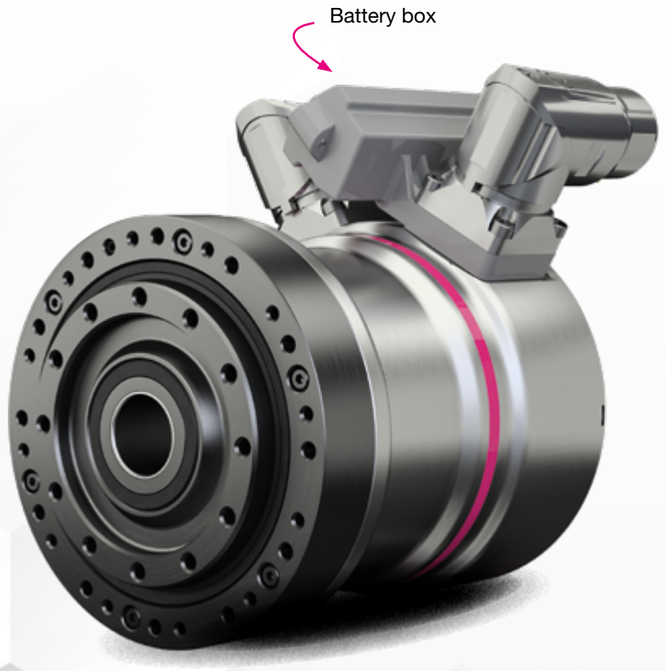
Illustration 1.2.31



Recommended battery: Lithium thionyl chloride
3.6 V / ≥ 2.0 Ah / AA
Tadiran SL-360S

Reset error bit and warning bit

The motor feedback systems MZB, MHS and MZE monitor the connected battery and, in addition to the position values, also provide status information of the connected battery via the communication interface. The functionality and behaviour depend on the encoder type and the selected communication interface.
All systems require an immediate exchange of the battery after sending warning or error messages!
By doing that the specific requirements of each encoder type must be considered.
The battery type should be select based on the advice of the encoder manufacturer.
Error bit and warning bit are reset via encoder protocol.



Electrical connections

• BHA-xxA-LA-SZE/MZE

Motor connector

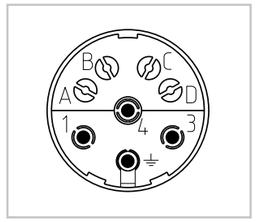
Table 1.2.14

Motor connector	8 / M23 x 1 (TE-Intercontec, Series 923)
Design	rotatable ± 110°
Version	SpeedTec

Table 1.2.15

Connector pin	1	2	3	4	A	B	C	D
Motor phase	U	PE	W	V	BR+	BR-	Temp+	Temp-

Illustration 1.2.32



Encoder connector

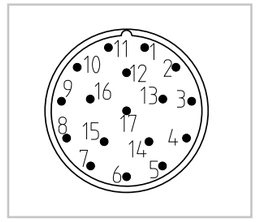
Table 1.2.16

Encoder connector	17 / M23 x 1 (TE-Intercontec, Series 623)
Design	rotatable ± 110°
Version	SpeedTec

Table 1.2.17

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Signal	-	-	Data+	-	Clock+	-	GND	-	-	Up	-	-	Data-	Clock-	-	-	-

Illustration 1.2.33



• BHA-xxA-LA-SZB/MZB

Motor connector

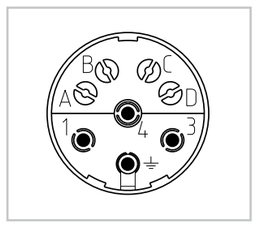
Table 1.2.18

Motor connector	8 / M23 x 1 (TE-Intercontec, Series 923)
Design	rotatable ± 110°
Version	SpeedTec

Table 1.2.19

Connector pin	1	2	3	4	A	B	C	D
Motor phase	U	PE	W	V	BR+	BR-	Temp+	Temp-

Illustration 1.2.34



Encoder connector

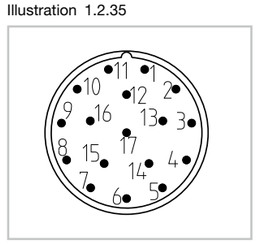
Table 1.2.20

Encoder connector	17 / M23 x 1 (TE-Intercontec, Series 623)
Design	rotatable ± 110°
Version	SpeedTec

Table 1.2.21

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Signal	-	-	SLO+	-	MA+	-	GND	-	-	Up	-	-	SLO-	MA-	-	-	-

Illustration 1.2.35



• BHA-xxA-LB-SIH/MIH

Motor connector

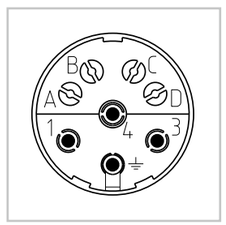
Table 1.2.22

Motor connector	8 / M23 x 1 (TE-Intercontec, Series 923)
Design	rotatable ± 110°
Version	SpeedTec

Table 1.2.23

Connector pin	1	2	3	4	A	B	C	D
Motor phase	U	PE	W	V	BR+	BR-	Temp+	Temp-

Illustration 1.2.36



Encoder connector

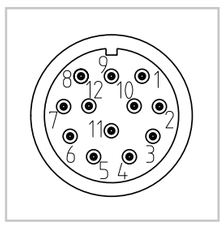
Table 1.2.24

Encoder connector	12 / M23 x 1 (TE-Intercontec, Series 623)
Design	rotatable ± 110°
Version	SpeedTec

Table 1.2.25

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12
Signal	Us	GND	SIN+	REFSIN	Data+	Data-	COS+	REFCOS	-	-	-	-

Illustration 1.2.37



• BHA-xxA-LA-MHS

Motor connector

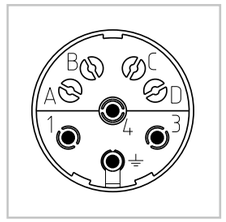
Table 1.2.26

Motor connector	8 / M23 x 1 (TE-Intercontec, Series 923)
Design	rotatable ± 110°
Version	SpeedTec

Table 1.2.27

Connector pin	1	2	3	4	A	B	C	D
Motor phase	U	PE	W	V	BR+	BR-	Temp+	Temp-

Illustration 1.2.38



Encoder connector

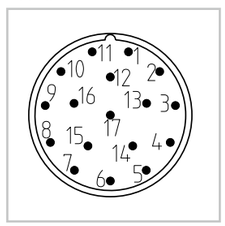
Table 1.2.28

Encoder connector	17 / M23 x 1 (TE-Intercontec, Series 623)
Design	rotatable ± 110°
Version	SpeedTec

Table 1.2.29

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Signal	COS+	REFCOS	Data+	-	Clock+	-	GND	-	-	Up	SIN+	REFSIN	Data-	Clock-	Sense -	Sense +	-

Illustration 1.2.39



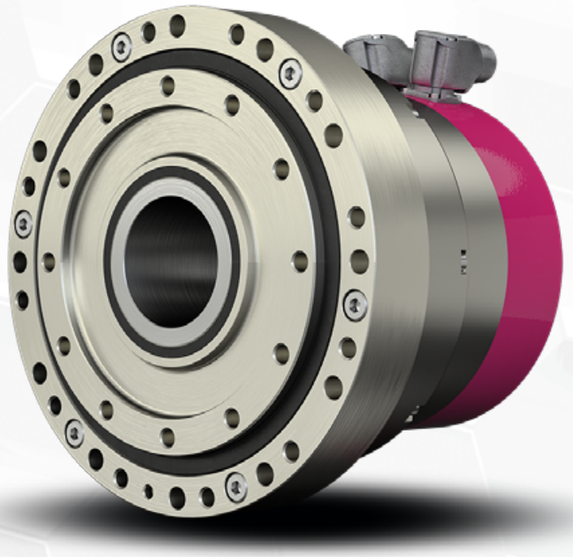
Product description

Highest power density combined with maximum flexibility

The CanisDrive® Series Servo Actuators combine an adaptable and compact synchronous servo motor winding, 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 the industrial sector.
The CanisDrive-14A ... 40A product generation is equipped with the KTY-84-130 temperature sensor and the CobaltLine® Gear.
The CanisDrive-14B ... 40B generation is equipped with the temperature sensor PT1000 and the CSG Gear of the same power.
The CanisDrive-50A and 58A generation is equipped with the temperature sensor PT1000 and the HFUC Gear.

Features

- Outstanding, lifelong precision
- Large hollow shaft
- Various feedback systems
- Integrated, tilt resistant output bearing
- Third party controller compatibility
- High corrosion protection



Ordering code

Table 1.3.1

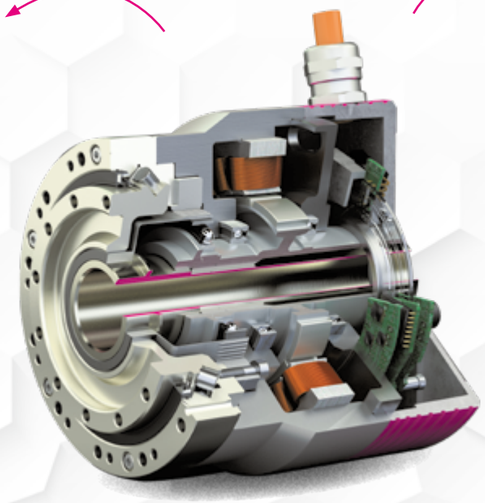
Ordering code	CanisDrive	-	20	A	-	100	-	AO	-	H	-	MZE	-	B	-	EC	-	K	-	UL	-	SP
CanisDrive® Series																						
Size (corresponds to the pitch circle diameter of the Flexspline toothing in inches x 10)			14 17 20 25 32 40 50 58																			
Product generation A: Size 14 … 58 B: Size 14 … 40				A/B																		
Ratio						30 50 80 100 120 160																
Motor winding type																						
DC voltage link 48 VDC, voltage constant 3.3 Vrms/1000 rpm								FB														
DC voltage link 48 VDC, voltage constant 5 Vrms/1000 rpm								FD														
DC voltage link 100 VDC, voltage constant 11 Vrms/1000 rpm								FG														
DC voltage link 48 VDC, voltage constant 4.2 Vrms/1000 rpm								DC														
DC voltage link 48 VDC, voltage constant 5.1 Vrms/1000 rpm								DD														
DC voltage link 48 VDC, voltage constant 10.1 Vrms/1000 rpm								DF														
DC voltage link 48 VDC, voltage constant 12 Vrms/1000 rpm								DG														
DC voltage link 560 VDC, voltage constant 23 Vrms/1000 rpm								AM														
DC voltage link 560 VDC, voltage constant 25 Vrms/1000 rpm								AO														
DC voltage link 560 VDC, voltage constant 37 Vrms/1000 rpm								AR														
DC voltage link 560 VDC, voltage constant 53 Vrms/1000 rpm								AU														
DC voltage link 560 VDC, voltage constant 108 Vrms/1000 rpm								AX														
Connector version																						
Motor connector M23 6-pol.; Encoder connector M23; cable outlet										H												
Motor connector M23 8-pol.; Encoder connector M23; cable outlet										L												
Motor connector M17 8-pol.; Encoder connector M17; cable outlet										N												
Motor connector M17 8-pol.; Encoder connector M17; housing connector										E												
Motor connector M23 6-pol.; Encoder connector M23; housing connector										F												
Motor connector M23 8-pol.; Encoder connector M23; housing connector										M												
Hybrid connector 9-pol., 915-itec (TE: EGA201N)										I												
Motor cable, Encoder cable, open cable ends										O												
Motor feedback system																						
Incremental encoder (2048 increments; RS422)												DCO										
EnDat 2.2 Singleturn absolute encoder ECI-119 (19 bit Singleturn)												SZE										
EnDat 2.1 Singleturn absolute encoder ECI-119 (32 SinCos 19 bit Singleturn)												SIE										
HIPERFACE® Singleturn absolute encoder SES70 (32 SinCos, 10 bit Singleturn)												SIH										
HIPERFACE® Singleturn absolute encoder SES70 (64 SinCos, 10 bit Singleturn)												SHH										
BiSS-C Singleturn absolute encoder FFB (16 bit Singleturn)												SZB										
SSI Multi-turn absolute encoder (128 SinCos, 17 bit Singleturn, 13 bit Multi-turn battery buffered)												MGS										
EnDat 2.2 Multi-turn absolute encoder EBI-135 (19 bit Singleturn, 16 bit Multi-turn battery buffered)												MZE										
HIPERFACE® Multi-turn absolute encoder SEM70 (32 SinCos, 10 bit Singleturn / 12 bit Multi-turn mech.)												MIH										
HIPERFACE® Multi-turn absolute encoder SEM90, (64 SinCos, 10 bit Singleturn / 12 bit Multi-turn mech.)												MHH										
BiSS-C Multi-turn absolute encoder FFB (16 bit Singleturn, 16 bit Multi-turn battery buffered)												MZB										
SSI Multi-turn absolute encoder FFB (64 SinCos, 16 bit Singleturn, 12 bit Multi-turn battery buffered)												MHS										
HIPERFACE DSL® Multi-turn absolute encoder SEM (10 bit Singleturn, 12 bit Multi-turn mech., single cable solution)												MZD										
Option holding brake														B								
With holding brake 24 V														B								
Without holding brake (Field remains empty)														[ ]								
Option sensor																EC						
Option sensor (Singleturn absolute EnDat encoder system at gear output)																EC						
Without option (Field remains empty)																[ ]						
Option cable/connector																		K				
With cable/connector (axial cable outlet)																		K				
Without option (Field remains empty)																		[ ]				
Option UL certification																				UL		
With UL certification (Actuator is CE and UL certified, limited continuous operating range)																				UL		
Without UL certification (Field remains empty, actuator is compliant with EU directives)																				[ ]		
Customised design																						[ ]
Standard design (Field remains empty)																						[ ]
Customised design (on request)																						SP

Please refer to the table of possible combinations

Designation of motor feedback system

Table 1.3.2

Example: ECI119	S	Z	E
Type			
Singleturn absolute	S		
Multi-turn absolute	M		
Incremental encoder	D		
Number of sine cosine periods			
64		H	
32		I	
128		G	
2048		C	
none		Z	
Protocol			
BiSS-C			B
EnDat 2.2/22			E
HIPERFACE®			H
HIPERFACE DSL®			D
SSI			S
none			O



Gear Component Set
CSG or HFUC Technology

- Zero backlash
- Hollow shaft
- Increased power density
- Increased lifetime
- Excellent, lifetime precision

Motor feedback system

- Incremental encoder
- Singleturn or multi-turn absolute encoder

Output bearing

- High load capacity
- Tilt resistant
- Excellent running properties
- Corrosion protected

AC Hollow shaft motor

- Sinus commutated synchronous motor
- Motor winding for different voltage levels
- Winding temperature monitoring with temperature sensor
- Maintenance free

Combinations

Table 1.3.3

Size		14A/B	17A/B	20A/B	25A/B	32A/B	40A/B	50A	58A
Ratio	30	o	o	o	o	o	o	o	o
	50	●	●	●	●	●	●	●	●
	80	o	o	o	o	o	o	o	o
	100	●	●	●	●	●	●	●	●
	120	-	o	o	o	o	o	o	o
	160	-	-	●	●	●	●	●	●
Motor winding type	FB[1]	o	-	-	-	-	-	-	-
	FD[1]	-	o	-	-	-	-	-	-
	FG	-	-	-	o	o	-	-	-
	DC	-	-	o	-	-	-	-	-
	DD	-	-	o	o	o	-	-	-
	DF	-	-	-	o	o	-	-	-
	DG	-	-	-	-	-	o	-	-
	AM	●	-	●	-	-	-	-	-
	AO	-	●	-	-	-	-	-	-
	AR	-	-	-	●	●	-	-	-
	AU	-	-	-	-	-	●	-	-
	AX	-	-	-	-	-	-	●	●
Connector version[2]	H	o	o	●	●	●	●	-	-
	L	o	o	●	●	●	●	-	-
	N	●	●	-	-	-	-	-	-
	E	o	o	-	-	-	-	-	-
	F	-	-	o	o	o	o	o	o
	M	-	-	●	●	●	●	●	●
	O	o	o	o	o	o	o	o	o
	I	-	-	●	●	●	●	●	●
Motor feedback system	DCO	●	●	o	-	-	-	-	-
	SZE	-	-	●	●	●	●	●	●
	SIE	-	-	o	o	o	o	-	-
	SIH	-	o	o	-	-	-	-	-
	SHH	-	-	-	o	o	o	o	o
	SZB[4]	-	o	o	o	o	o	o	o
	MGS	●	●	●	-	-	-	-	-
	MZE	-	-	●	●	●	●	●	●
	MIH	-	●	●	-	-	-	-	-
	MHH[3]	-	-	-	●	●	●	o	o
	MZB[4]	-	o	●	●	●	●	●	o
	MHS[4]	-	o	●	●	●	●	●	o
	MZD[3]	-	-	●	●	●	●	o	o
Option holding brake	B	o	o	o	o	o	o	o	o
Option sensor	EC	-	-	o	o	o	o	-	-
Option cable/connector	K	-	-	o	o	o	o	-	-
Option UL certification	UL	-	-	o	o	o	o	-	-
Option sealing air connection		●	●	o	o	o	o	o	o

● available o on request - not available

1) Not available in combination with plug configuration E
2) Please refer to chapter „Electrical Connections“ in order to find the suitable configuration of motor and encoder connector
3) When using these encoder systems in size 50/58, the hollow shaft is reduced
4) When using these encoder systems in size 58, the hollow shaft is reduced

Technical data

• Features

Table 1.3.4

Motor winding	[Unit]	FB/FD	AM/AO/AR/AU/AX
Machine type		Permanent magnet synchronous motor with concentrated winding	
Magnet material		Neodymium-iron-boron	
Insulation class (EN 60034-1)		F	F
Insulation class for UL certified actuators		-	A
Insulation resistance (500 VDC)	[MΩ]	100	
Insulation voltage (10 s)	[VAC]	1400	2500
Lubrication		Flexolub®-A1	
Degree of protection (EN 60034-5)		IP65 (Shaft seal ring is standard))	
Ambient operating temperature	[°C]	0 … 40	
Ambient storage temperature	[°C]	-20 … 60	
Maximum installation altitude	[m]	4000 above sea level	
Relative humidity	[%]	maximum 80 (without condensation)	
Vibration resistance (DIN IEC 60068 Part 2-6, 10 … 500 Hz)	[g]	5	
Shock resistance (DIN IEC 60068 Part 2-27, 11 ms)	[g]	30	
Corrosion protection (DIN IEC 60068 Part 2-11 Salt spray test)	[h]	16	16
Thermal motor protection CanisDrive-14A … 40A[1)]		1x KTY 84-130 / 1x PTC	
Thermal motor protection CanisDrive-14B … 40B[1)]		1x PT1000[2)] / 1x PTC	
Thermal motor protection CanisDrive-50A und 58A[1)]			1x PT1000[2)]
Gear component set 14A … 40A		CobaltLine-2A	
Gear component set CanisDrive-14B … 40B		CSG-2A	
Gear component set CanisDrive-50A and 58A		HFUC-2A	

[1)] Safe separation according to EN 61800-5-1
[2)] Class B according to EN 60751

• Cooling

Unless otherwise indicated, the values given in the tables refer to an excess winding temperature of 70 K (50 K for UL variants) at an ambient temperature of 40 °C and a maximum installation altitude of 1000 m above sea level. From an installation altitude > 1000 m above sea level, a derating of 1 % per 100 m must be made. The values in the following tables and the operating characteristics apply to actuators mounted on an aluminium base plate with the following minimum dimensions:

Table 1.3.5

Series	Size	[Unit]	Dimension
CanisDrive	14	[mm]	200 x 200 x 6
	17	[mm]	300 x 300 x 15
	20	[mm]	300 x 300 x 15
	25	[mm]	350 x 350 x 18
	32	[mm]	350 x 350 x 18
	40	[mm]	400 x 400 x 20
	50	[mm]	500 x 500 x 25
	58	[mm]	600 x 600 x 30

• Actuator data

CanisDrive-14A, CanisDrive-17A
Actuators with 680 VDC maximum stationary DC bus voltage

Table 1.3.6

Actuator	Symbol [Unit]	14A /B			17A /B			
Stator winding		AM			AO			
Motor feedback system		DCO / MGS			SIH/ SZB/ MGS/ MIH/MZB/ MHS/ DCO			
Ratio	i [ ]	50	80	100	50	80	100	120
Maximum output torque	T_{MAX} [Nm]	23	30	36	44	56	70	70
Maximum output speed	n_{MAX} [rpm]	170	106	85	120	75	60	50
Maximum output speed SIH, MIH, SHH, MHH, MGS, DCO	n_{MAX} [rpm]	-	-	-	146	91	73	61
Maximum current	I_{MAX} [A_{rms}]	1.9	1.6	1.5	3.1	2.3	2.3	1.9
Continuous stall torque[1)] (UL)	T_0 [Nm]	9.0	14.0	14.0	33	35	51	51
Continuous stall current[1)] (UL)	I_0 [A_{rms}]	0.8	0.7	0.6	2.1	1.3	1.5	1.3
No load starting current	I_{NLSC} [A_{rms}]	0.17	0.16	0.17	0.11	0.09	0.09	0.09
No load current constant (20 °C)	K_{INL} [10^{-3}A/rpm]	3.20	5.20	6.10	4.30	7.20	8.50	9.70
No load current constant (90 °C)	K_{INL} [10^{-3}A/rpm]	0.99	1.60	1.87	1.20	2.00	2.40	2.70
Torque constant (Motor)	K_T [Nm/A_{rms}]	0.26			0.37			
AC voltage constant (L-L, 20 °C)	K_E [V_{rms}/1000 rpm]	20.0			25.0			
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	680[2)]			680[2)]			
Mechanical time constant MZB, without brake (20 °C)	T_M [ms]	10.20			4.30			
Electrical time constant (20 °C)	T_E [ms]	1.9			3.4			
Maximum motor speed	n_{MAX} [rpm]	6000			6000			
Maximum motor speed SIH, MIH, SHH, MHH, MGS, DCO	n_{MAX} [rpm]	8500			7300			
Rated motor speed	n_N [rpm]	3500			3500			
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	7.7			4.9			
Rotary field inductance	L_d [mH]	7.5			8.3			
Number of pole pairs	p	5			5			
Brake voltage	$U_{Br.}$ [V_{DC}]	24 ±10 %			24 ±10 %			
Brake holding torque	$T_{Br.}$ [Nm]	23	30	36	23	36	45	54
Brake power consumption	$P_{BR.}$ [W]	14.4			14.4			
Brake opening time	t_O [ms]	10			10			
Brake closing time	t_C [ms]	6			6			
Weight without brake	m [kg]	1.4 (DCO) 2.0 (MGS)			1.9 (DCO) 2.6 (MGS/SIH/MIH)			
Weight with brake	m [kg]	1.7 (DCO) 2.3 (MGS)			2.3 (DCO) 3.0 (MGS/SIH/MIH)			
Hollow shaft diameter	d_h [mm]	12			16			
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	7	10	10	21	29	31	31
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000			2000			

[1)] Values in ( ) apply to the UL variant of the product generation A
[2)] In general, actuators with an Ax winding can also be operated on DC links with a nominal voltage > 680 V_{DC}. The lifetime of an insulation system is significantly influenced by the environment. Possible overvoltages at the motor terminals can be influenced by the length of the motor cable and the voltage slope of the servo controller. These overvoltages lead to partial discharges in the insulation system and can significantly reduce the lifetime of the insulation system. An assessment can only be made in the customer's environment. The manufacturer is not aware of any failures to date that can be attributed to a higher DC link voltage.

You will find more information on this in the Engineering data chapter.

CanisDrive-20A, CanisDrive-25A

Actuators with 680 VDC maximum stationary DC bus voltage

Table 1.3.7

Actuator	Symbol [Unit]	20A/B					25A/B				
Stator winding		AM					AR				
Motor feedback system		SZE / SIE / SIH / SZB / MGS / MZE / MIH MZB / MHS / DCO / MZD					SZE / SIE / SHH / SZB / MZE MHH / MZB / MHS / MZD				
Ratio	i [ ]	50	80	100	120	160	50	80	100	120	160
Maximum output torque	T_{MAX} [Nm]	73	96	107	113	120	127	178	204	217	229
Maximum output speed	n_{MAX} [rpm]	120	75	60	50	38	112	70	56	47	35
Maximum output speed SIH, MIH, SHH, MHH, MGS, DCO	n_{MAX} [rpm]	130	81	65	54	41	112	70	56	47	35
Maximum current	I_{MAX} [A_{rms}]	4.8	4.0	3.6	3.2	2.6	5.7	4.9	4.5	4.0	3.2
Continuous stall torque[1] (UL)	T_0 [Nm]	33 (28)	53 (46)	64 (58)	64 (64)	64 (64)	72 (66)	113 (109)	140 (136)	140 (140)	140 (140)
Continuous stall current[1] (UL)	I_0 [A_{rms}]	2.1 (1.8)	2.1 (1.8)	2.1 (1.8)	1.7 (1.7)	1.3 (1.3)	2.9 (2.7)	2.8 (2.7)	2.8 (2.7)	2.4 (2.4)	1.8 (1.8)
No load starting current	I_{NLSC} [A_{rms}]	0.18	0.17	0.17	0.18	0.19	0.26	0.25	0.27	0.28	0.30
No load current constant (20 °C)	K_{INL} [10^{-3}A/rpm]	8.50	13.00	16.10	18.90	23.90	1.92	6.96	10.50	20.52	37.73
No load current constant (90 °C)	K_{INL} [10^{-3}A/rpm]	2.30	3.50	4.40	5.10	6.40	0.55	1.93	2.87	5.50	9.97
Torque constant (Motor)	K_T [Nm/A_{rms}]	0.35					0.55				
AC voltage constant (L-L, 20 °C)	K_E [V_{rms}/1000 rpm]	23.0					36.4				
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	680[2]					680[2]				
Mechanical time constant MZB, without brake (20 °C)	T_M [ms]	13.60					8.55				
Electrical time constant (20 °C)	T_E [ms]	1.4					2.1				
Maximum motor speed	n_{MAX} [rpm]	6000					5600				
Maximum motor speed SIH, MIH, SHH, MHH, MGS, DCO	n_{MAX} [rpm]	6500					5600				
Rated motor speed	n_N [rpm]	3500					3500				
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	5.9					3.7				
Rotary field inductance	L_d [mH]	4.0					3.9				
Number of pole pairs	p	5					6				
Brake voltage	$U_{Br.}$ [V_{DC}]	24 ±10 %					24 ±10 %				
Brake holding torque	$T_{Br.}$ [Nm]	45	72	90	108	120	90	144	180	216	229
Brake power consumption	$P_{BR.}$ [W]	14.4					21.6				
Brake opening time	t_O [ms]	12					13				
Brake closing time	t_C [ms]	20					15				
Weight without brake	m [kg]	3.2					4.9				
Weight with brake	m [kg]	3.9					6.1				
Hollow shaft diameter	d_h [mm]	18					27				
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	33	44	52	52	52	51	82	87	87	87
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000					2000				

[1] Values in ( ) apply to the UL variant of the product generation A

[2] In general, actuators with an Ax winding can also be operated on DC links with a nominal voltage > 680 V_{DC}. The lifetime of an insulation system is significantly influenced by the environment. Possible overvoltages at the motor terminals can be influenced by the length of the motor cable and the voltage slope of the servo controller. These overvoltages lead to partial discharges in the insulation system and can significantly reduce the lifetime of the insulation system. An assessment can only be made in the customer's environment. The manufacturer is not aware of any failures to date that can be attributed to a higher DC link voltage.

You will find more information on this in the Engineering data chapter.

CanisDrive-32A, CanisDrive-40A

Actuators with 680 VDC maximum stationary DC bus voltage

Table 1.3.8

Actuator	Symbol [Unit]	32A/B					40A/B				
Stator winding		AR					AU				
Motor feedback system		SZE / SIE / SHH / SZB MZE / MHH / MZB / MHS / MZD					SZE / SIE / SHH / MZE / MHH / MZD				
Ratio	i [ ]	50	80	100	120	160	50	80	100	120	160
Maximum output torque	T_{MAX} [Nm]	281	395	433	459	484	523	675	738	802	841
Maximum output speed	n_{MAX} [rpm]	96	60	48	40	30	80	50	40	33	25
Maximum output speed SIH, MIH, SHH, MHH	n_{MAX} [rpm]	96	60	48	40	30	80	50	40	33	25
Maximum current	I_{MAX} [A_{rms}]	12.5	10.5	9.1	8.0	6.4	15.5	11.7	10.1	9.1	7.2
Continuous stall torque[1] (UL)	T_0 [Nm]	79 (68)	123 (107)	154 (133)	185 (160)	247 (213)	134 (114)	223 (190)	279 (238)	335 (286)	446 (380)
Continuous stall current[1] (UL)	I_0 [A_{rms}]	3.3 (2.9)	3.1 (2.7)	3.1 (2.7)	3.1 (2.7)	3.1 (2.7)	3.7 (3.2)	3.7 (3.2)	3.7 (3.2)	3.7 (3.2)	3.7 (3.2)
No load starting current	I_{NLSC} [A_{rms}]	0.35	0.30	0.30	0.30	0.32	0.37	0.30	0.30	0.31	0.32
No load current constant (20 °C)	K_{INL} [10^{-3}A/rpm]	16.5	25.7	29.5	34.3	45.8	21.2	31.6	38.1	44.5	56.7
No load current constant (90 °C)	K_{INL} [10^{-3}A/rpm]	4.23	6.41	7.40	8.62	11.48	4.88	7.20	8.71	10.19	13.00
Torque constant (Motor)	K_T [Nm/A_{rms}]	0.55					0.83				
AC voltage constant (L-L, 20 °C)	K_E [V_{rms}/1000 rpm]	37					53				
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	680[2]					680[2]				
Mechanical time constant MZB, without brake (20 °C)	T_M [ms]	11.00					9.32				
Electrical time constant (20 °C)	T_E [ms]	2.1					2.4				
Maximum motor speed	n_{MAX} [rpm]	4800					4000				
Maximum motor speed SIH, MIH, SHH, MHH	n_{MAX} [rpm]	4800					4000				
Rated motor speed	n_N [rpm]	3500					3000				
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	3.70					2.90				
Rotary field inductance	L_d [mH]	3.9					3.5				
Number of pole pairs	p	6					6				
Brake voltage	$U_{Br.}$ [V_{DC}]	24 ±10%					24 ±10%				
Brake holding torque	$T_{Br.}$ [Nm]	90	144	180	216	288	225	360	450	540	720
Brake power consumption	$P_{BR.}$ [W]	21.6					16.8				
Brake opening time	t_O [ms]	13					35				
Brake closing time	t_C [ms]	15					30				
Weight without brake	m [kg]	7.3					11.9				
Weight with brake	m [kg]	8.4					13.2				
Hollow shaft diameter	d_h [mm]	32.0					39.0				
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	99	153	178	178	178	178	268	345	382	382
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000					2000				

[1] Values in ( ) apply to the UL variant of the product generation A

[2] In general, actuators with an Ax winding can also be operated on DC links with a nominal voltage > 680 V_{DC}. The lifetime of an insulation system is significantly influenced by the environment. Possible overvoltages at the motor terminals can be influenced by the length of the motor cable and the voltage slope of the servo controller. These overvoltages lead to partial discharges in the insulation system and can significantly reduce the lifetime of the insulation system. An assessment can only be made in the customer's environment. The manufacturer is not aware of any failures to date that can be attributed to a higher DC link voltage.

You will find more information on this in the Engineering data chapter.

CanisDrive-50A, CanisDrive-58A
Actuators with 680 VDC maximum stationary DC bus voltage

Table 1.3.9

Actuator	Symbol [Unit]	50A					58A				
Stator winding		AX					AX				
Motor feedback system		SZE / MZE / MZD					SZE / MZE / MZD				
Ratio	i [ ]	50	80	100	120	160	50	80	100	120	160
Maximum output torque	T_{MAX} [Nm]	715	941	980	1080	1180	1020	1480	1590	1720	1840
Maximum output speed	n_{MAX} [rpm]	70	44	35	29	22	60	38	30	25	19
Maximum output speed SIH, MIH, SHH, MHH	n_{MAX} [rpm]	-	-	-	-	-	-	-	-	-	-
Maximum current	I_{MAX} [A_{rms}]	10.6	8.5	7.2	6.6	5.5	15	13.7	11.7	10.5	8.5
Continuous stall torque[1] (UL)	T_0 [Nm]	122	519	666	813	843	177	770	1060	1190	1210
Continuous stall current[1] (UL)	I_0 [A_{rms}]	1.9	4.4	4.5	4.6	3.6	2.7	6.6	7.2	6.8	5.2
No load starting current	I_{NLSC} [A_{rms}]	0.37	0.33	0.33	0.33	0.35	0.55	0.47	0.47	0.47	0.49
No load current constant (20 °C)	K_{INL} [10^{-3}A/rpm]	20.5	29.0	33.2	40.0	51.6	29.9	42.9	48.7	58.3	74.6
No load current constant (90 °C)	K_{INL} [10^{-3}A/rpm]	6.46	9.13	10.46	12.62	16.34	8.51	12.02	13.66	16.37	21.01
Torque constant (Motor)	K_T [Nm/A_{rms}]	1.62					1.62				
AC voltage constant (L-L, 20 °C)	K_E [V_{rms}/1000 rpm]	108					108				
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	680[2]					680[2]				
Mechanical time constant MZB, without brake (20 °C)	T_M [ms]	3.20					4.80				
Electrical time constant (20 °C)	T_E [ms]	5.7					5.7				
Maximum motor speed	n_{MAX} [rpm]	3500					3000				
Maximum motor speed SIH, MIH, SHH, MHH	n_{MAX} [rpm]	-					-				
Rated motor speed	n_N [rpm]	2000					2000				
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	0.94					0.94				
Rotary field inductance	L_d [mH]	2.7					2.7				
Number of pole pairs	p	11					11				
Brake voltage	$U_{Br.}$ [V_{DC}]	24 ±10%					24 ±10%				
Brake holding torque	$T_{Br.}$ [Nm]	585	936	980	1080	1180	585	936	1170	1404	1840
Brake power consumption	$P_{BR.}$ [W]	31.2					31.2				
Brake opening time	t_O [ms]	35					35				
Brake closing time	t_C [ms]	30					30				
Weight without brake	m [kg]	20.6					27.5				
Weight with brake	m [kg]	23.3					30.1				
Hollow shaft diameter	d_h [mm]	55.5					65.5				
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	245	372	470	529	529	353	549	696	745	745
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000					2000				

1) Values in ( ) apply to the UL variant of the product generation A
2) In general, actuators with an Ax winding can also be operated on DC links with a nominal voltage > 680 V_{DC}. The lifetime of an insulation system is significantly influenced by the environment. Possible overvoltages at the motor terminals can be influenced by the length of the motor cable and the voltage slope of the servo controller. These overvoltages lead to partial discharges in the insulation system and can significantly reduce the lifetime of the insulation system. An assessment can only be made in the customer's environment. The manufacturer is not aware of any failures to date that can be attributed to a higher DC link voltage.

You will find more information on this in the Engineering data chapter.

CanisDrive-14A, CanisDrive-17A
Actuators with 100 VDC maximum stationary DC bus voltage

Table 1.3.10

Actuator	Symbol [Unit]	14A/B			17A/B			
Stator winding		FB			FD			
Motor feedback system		DCO / MGS			SIH/ SZB/ MGS/ MZB/ MIH/ MHS/ DCO			
Ratio	i [ ]	50	80	100	50	80	100	120
Maximum output torque	T_{MAX} [Nm]	23	30	36	44	56	70	70
Maximum output speed	n_{MAX} [rpm]	170	106	85	120	75	60	50
Maximum output speed SIH, MIH, MGS	n_{MAX} [rpm]	-	-	-	146	91	73	61
Maximum current	I_{MAX} [A_{rms}]	12.2	9.9	9.6	13.8	10.8	10.8	9.1
Continuous stall torque	T_0 [Nm]	9.0	14.0	14.0	28.0	35.0	51.0	51.0
Continuous stall current	I_0 [A_{rms}]	4.8	4.6	3.8	8.3	6.4	7.4	6.2
No load starting current	I_{NLSC} [A_{rms}]	1.08	1.03	1.04	0.48	0.43	0.44	0.45
No load current constant (20 °C)	K_{INL} [10^{-3}A/rpm]	20.90	33.20	38.80	18.71	33.77	39.59	46.32
No load current constant (90 °C)	K_{INL} [10^{-3}A/rpm]	6.35	10.10	11.80	5.33	9.57	11.22	13.13
Torque constant (Motor)	K_T [Nm/A_{rms}]	0.04			0.07			
AC voltage constant (L-L, 20 °C)	K_E [V_{rms}/1000 rpm]	3.3			5.0			
Maximum steady state DC voltage link	V_{CC} [V_{DC}]	100			100			
Mechanical time constant MZB, without brake (20 °C)	T_M [ms]	21.2			7.3			
Electrical time constant (20 °C)	T_E [ms]	1.3			2.3			
Maximum motor speed	n_{MAX} [rpm]	8500			6000			
Maximum motor speed SIH, MIH, MGS	n_{MAX} [rpm]	-			7300			
Rated motor speed	n_N [rpm]	3500			3500			
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	0.42			0.32			
Rotary field inductance	L_d [mH]	0.27			0.36			
Number of pole pairs	p	5			5			
Brake voltage	$U_{Br.}$ [V_{DC}]	24 ±10%			24 ±10%			
Brake holding torque	$T_{Br.}$ [Nm]	23	30	36	23	36	45	54
Brake power consumption	$P_{BR.}$ [W]	14.4			14.4			
Brake opening time	t_O [ms]	10			10			
Brake closing time	t_C [ms]	6			6			
Weight without brake	m [kg]	1.4 (DCO) 2.0 (MGS)			1.9 (DCO) 2.6 (MGS/SIH/MIH)			
Weight with brake	m [kg]	1.7 (DCO) 2.3 (MGS)			2.3 (DCO) 3.0 (MGS/SIH/MIH)			
Hollow shaft diameter	d_h [mm]	12			16			
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	7	10	10	21	29	31	31
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000			2000			

You will find more information on this in the Engineering data chapter.

• Moment of inertia

Table 1.3.11

	Symbol [Unit]	14A/B			17A/B				20A/B				
Motor feedback system		MGS			MGS				MGS				
Ratio		50	80	100	50	80	100	120	50	80	100	120	160
Moment of inertia at output side													
Moment of inertia without brake	J_{OUT} [kgm²]	0.155	0.397	0.620	0.215	0.550	0.860	1.238	0.350	0.880	1.380	1.990	3.540
Moment of inertia with brake	J_{OUT} [kgm²]	0.175	0.448	0.700	0.235	0.602	0.940	1.354	0.440	1.130	1.760	2.540	4.520
Moment of inertia at motor side													
Moment of inertia without brake	J [kgm²x10⁻⁴]	0.62			0.86				1.38				
Moment of inertia with brake	J [kgm²x10⁻⁴]	0.70			0.94				1.76				
Motor feedback system		DCO			DCO				DCO				
Ratio		50	80	100	50	80	100	120	50	80	100	120	160
Moment of inertia at output side													
Moment of inertia without brake	J_{OUT} [kgm²]	0.068	0.173	0.270	0.130	0.333	0.520	0.749					
Moment of inertia with brake	J_{OUT} [kgm²]	0.088	0.224	0.350	0.150	0.384	0.600	0.864					
Moment of inertia at motor side													
Moment of inertia without brake	J [kgm²x10⁻⁴]	0.27			0.52								
Moment of inertia with brake	J [kgm²x10⁻⁴]	0.35			0.60								
Motor feedback system		-			-				SIE / SZE / MZE				
Ratio		-	-	-	-	-	-	-	50	80	100	120	160
Moment of inertia at output side													
Moment of inertia without brake	J_{OUT} [kgm²]	-	-	-	-	-	-	-	0.460	1.180	1.850	2.660	4.740
Moment of inertia with brake	J_{OUT} [kgm²]	-	-	-	-	-	-	-	0.560	1.430	2.230	3.220	5.720
Moment of inertia at motor side													
Moment of inertia without brake	J [kgm²x10⁻⁴]	-	-	-	-	-	-	-	1.85				
Moment of inertia with brake	J [kgm²x10⁻⁴]	-	-	-	-	-	-	-	2.23				
Motor feedback system					SIH / MIH				SIH / MIH / MZD				
Ratio		-	-	-	50	80	100	120	50	80	100	120	160
Moment of inertia at output side													
Moment of inertia without brake	J_{OUT} [kgm²]	-	-	-	0.137	0.349	0.546	0.786	0.270	0.690	1.080	1.550	2.750
Moment of inertia with brake	J_{OUT} [kgm²]	-	-	-	0.158	0.404	0.631	0.909	0.360	0.930	1.460	2.100	3.730
Moment of inertia at motor side													
Moment of inertia without brake	J [kgm²x10⁻⁴]	-			0.56				1.08				
Moment of inertia with brake	J [kgm²x10⁻⁴]	-			0.63				1.46				
Motor feedback system					SZB / MZB / MHS				SZB / MZB / MHS				
Ratio		-	-	-	-	-	-	-	50	80	100	120	160
Moment of inertia at output side													
Moment of inertia without brake	J_{OUT} [kgm²]	-	-	-	-	-	-	-	0.343	0.879	1.373	1.977	3.515
Moment of inertia with brake	J_{OUT} [kgm²]	-	-	-	-	-	-	-	0.439	1.123	1.755	2.527	4.493
Moment of inertia at motor side													
Moment of inertia without brake	J [kgm²x10⁻⁴]	-			-				1.373				
Moment of inertia with brake	J [kgm²x10⁻⁴]	-			-				1.755				

Table 1.3.12

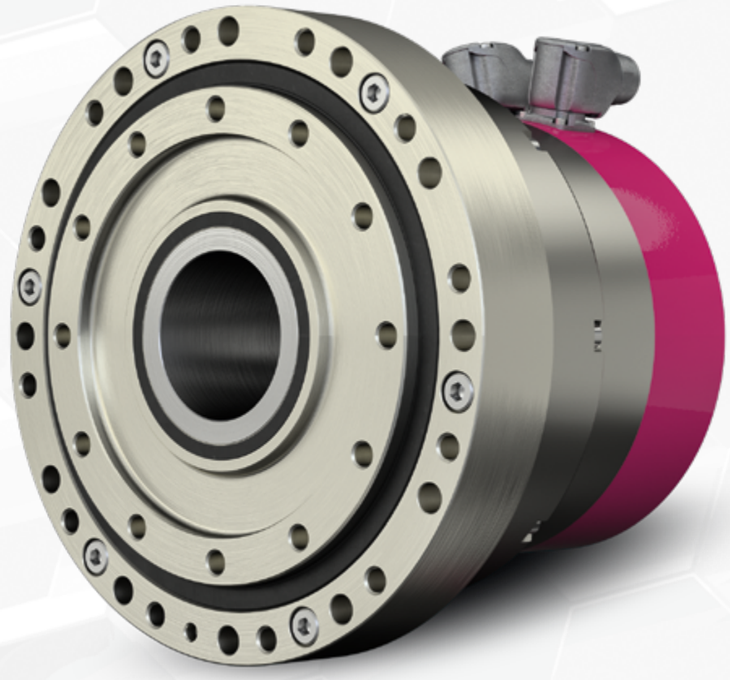
	Symbol [Unit]	25A/B					32A/B				
Motor feedback system		SIE / SZE / MZE					SIE / SZE / MZE				
Ratio		50	80	100	120	160	50	80	100	120	160
Moment of inertia at output side											
Moment of inertia without brake	J_{OUT} [kgm²]	1.020	2.620	4.090	5.890	10.460	1.570	4.010	6.260	9.010	16.000
Moment of inertia with brake	J_{OUT} [kgm²]	1.440	3.690	5.760	8.300	14.750	1.880	4.810	7.520	10.800	19.300
Moment of inertia at motor side											
Moment of inertia without brake	J [kgm²x10⁻⁴]	4.09					6.26				
Moment of inertia with brake	J [kgm²x10⁻⁴]	5.76					7.52				
Motor feedback system		SHH / MHH / MZD					SHH / MHH / MZD				
Ratio		50	80	100	120	160	50	80	100	120	160
Moment of inertia at output side											
Moment of inertia without brake	J_{OUT} [kgm²]	0.930	2.390	3.730	5.370	9.540	1.440	3.670	5.740	8.270	14.700
Moment of inertia with brake	J_{OUT} [kgm²]	1.350	3.460	5.400	7.780	13.830	1.750	4.480	7.00	10.10	17.900
Moment of inertia at motor side											
Moment of inertia without brake	J [kgm²x10⁻⁴]	3.73					5.74				
Moment of inertia with brake	J [kgm²x10⁻⁴]	5.40					7.00				
Motor feedback system		SZB / MZB / MHS					SZB / MZB / MHS				
Ratio		50	80	100	120	160	50	80	100	120	160
Moment of inertia at output side											
Moment of inertia without brake	J_{OUT} [kgm²]	0.956	2.448	3.825	5.508	9.792	1.324	3.388	5.294	7.623	13.553
Moment of inertia with brake	J_{OUT} [kgm²]	1.375	3.519	5.499	7.919	14.077	1.638	4.194	6.553	9.436	16.776
Moment of inertia at motor side											
Moment of inertia without brake	J [kgm²x10⁻⁴]	3.825					5.294				
Moment of inertia with brake	J [kgm²x10⁻⁴]	5.499					6.553				

Table 1.3.13

	Symbol [Unit]	40A/B				
Motor feedback system		**SIE / SZE / MZE**				
Ratio		50	80	100	120	160
Moment of inertia at output side						
Moment of inertia without brake	J_{OUT} [kgm^2]	3.330	8.530	13.300	19.200	34.100
Moment of inertia with brake	J_{OUT} [kgm^2]	3.800	9.730	15.200	21.900	38.900
Moment of inertia at motor side						
Moment of inertia without brake	J [kgm^{2}x10^{-4}]	13.30				
Moment of inertia with brake	J [kgm^{2}x10^{-4}]	15.20				
Motor feedback system		**SHH / MHH / MZD**				
Ratio		50	80	100	120	160
Moment of inertia at output side						
Moment of inertia without brake	J_{OUT} [kgm^2]	3.250	8.320	13.000	18.700	33.300
Moment of inertia with brake	J_{OUT} [kgm^2]	3.700	9.470	14.80	21.30	37.900
Moment of inertia at motor side						
Moment of inertia without brake	J [kgm^{2}x10^{-4}]	13.00				
Moment of inertia with brake	J [kgm^{2}x10^{-4}]	14.80				

Table 1.3.14

	Symbol [Unit]	50A					58A				
Motor feedback system		**SZE / MZE / MZD**					**SZE / MZE / MZD**				
Ratio		50	80	100	120	160	50	80	100	120	160
Moment of inertia at output side											
Moment of inertia without brake	J_{OUT} [kgm^2]	16.200	41.500	64.900	93.400	166.100	23.200	59.300	92.700	133.400	237.200
Moment of inertia with brake	J_{OUT} [kgm^2]	18.200	46.600	72.800	104.900	186.500	25.400	65.000	101.500	146.100	259.800
Moment of inertia at motor side											
Moment of inertia without brake	J [kgm^{2}x10^{-4}]	64.90					92.70				
Moment of inertia with brake	J [kgm^{2}x10^{-4}]	72.80					101.50				



• Performance characteristics

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.3.1 **CanisDrive-14A/B-AM-50**

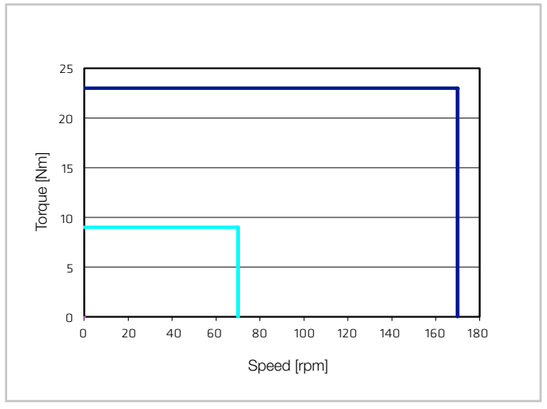


Illustration 1.3.2 **CanisDrive-14A/B-AM-80**

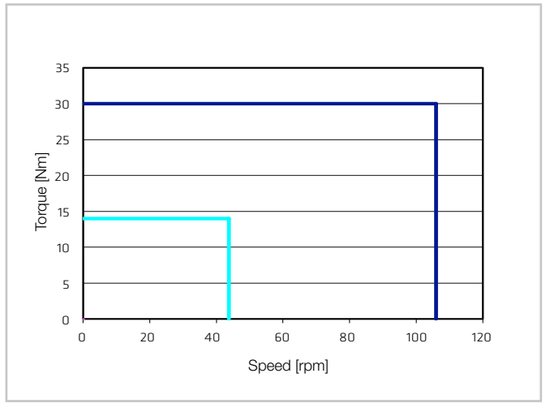
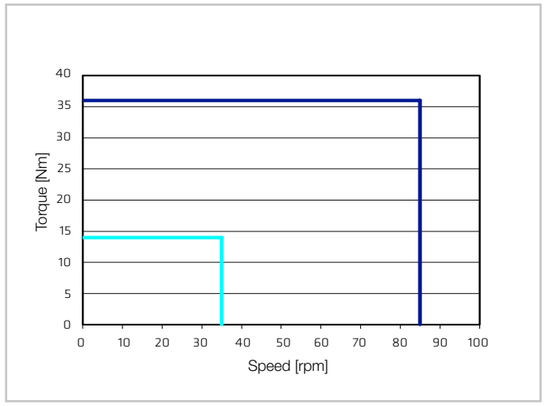


Illustration 1.3.3 **CanisDrive-14A/B-AM-100**



Intermittent duty —— Continuous duty —— U_M = 230 ... 400 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.3.4 **CanisDrive-14A/B-FB-50**

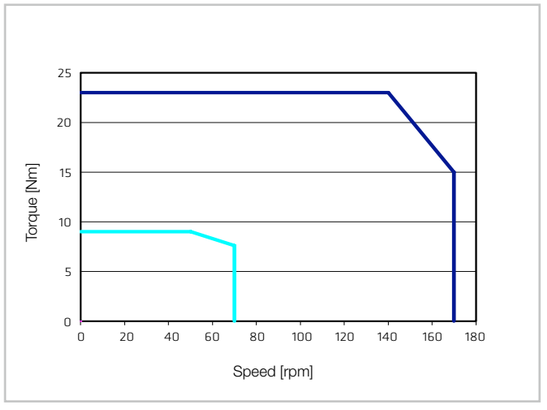


Illustration 1.3.5 **CanisDrive-14A/B-FB-80**

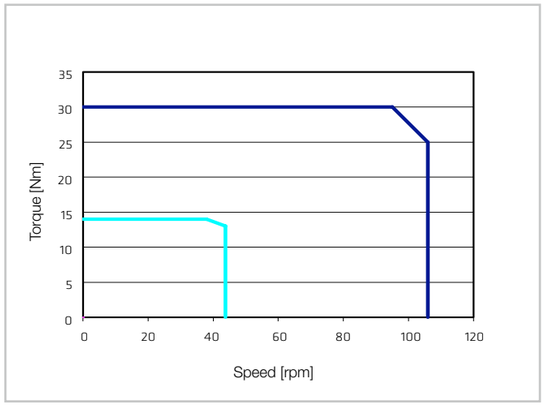
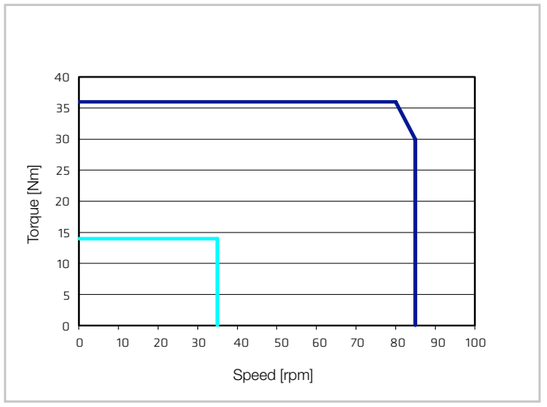


Illustration 1.3.6 **CanisDrive-14A/B-FB-100**



Intermittent duty —— Continuous duty —— U_M = 34 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.3.7 **CanisDrive-17A/B-AO-50**

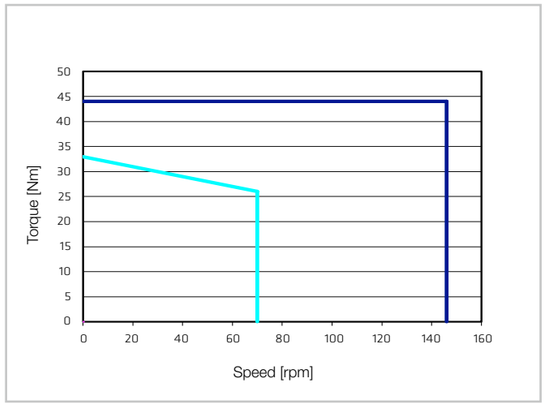


Illustration 1.3.8 **CanisDrive-17A/B-AO-80**

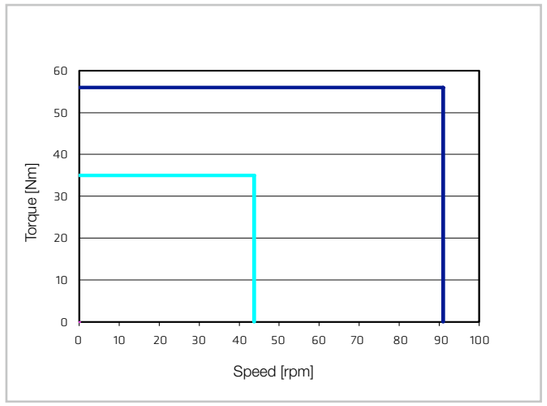


Illustration 1.3.9 **CanisDrive-17A/B-AO-100**

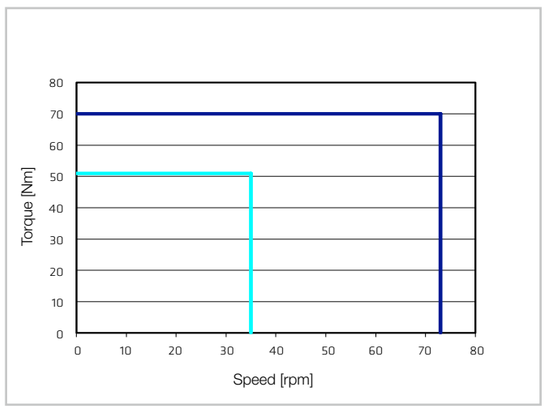
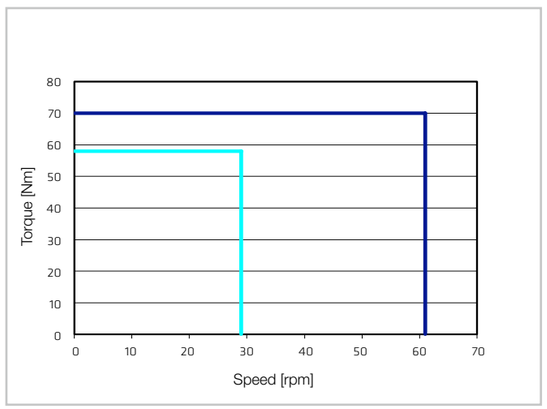


Illustration 1.3.10 **CanisDrive-17A/B-AO-120**



Intermittent duty —— Continuous duty —— U_M = 230 ... 400 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.3.11 **CanisDrive-17A/B-FD-50**

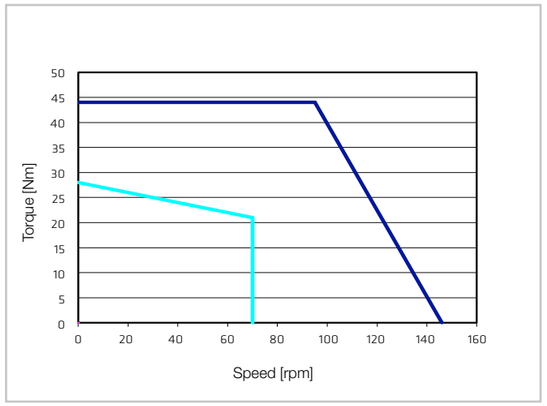


Illustration 1.3.12 **CanisDrive-17A/B-FD-80**

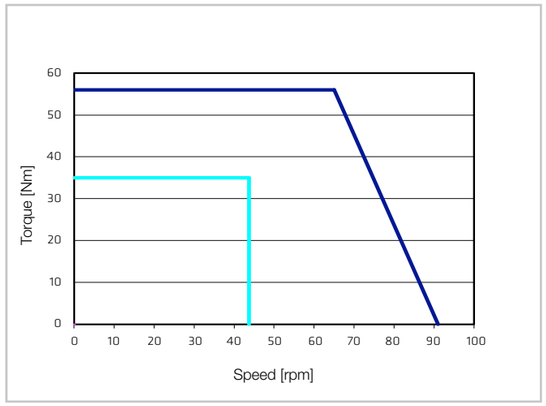


Illustration 1.3.13 **CanisDrive-17A/B-FD-100**

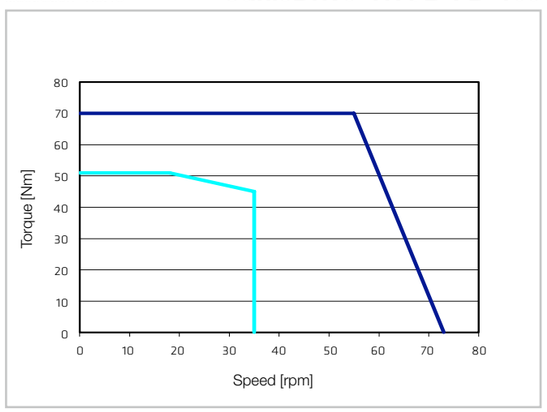
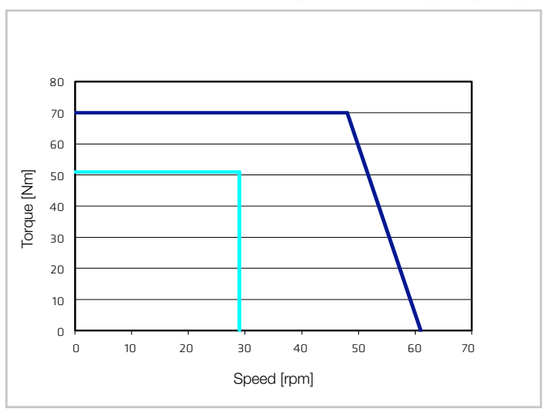


Illustration 1.3.14 **CanisDrive-17A/B-FD-120**



Intermittent duty —— Continuous duty —— U_M = 34 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.3.15 **CanisDrive-20A/B-AM-50**

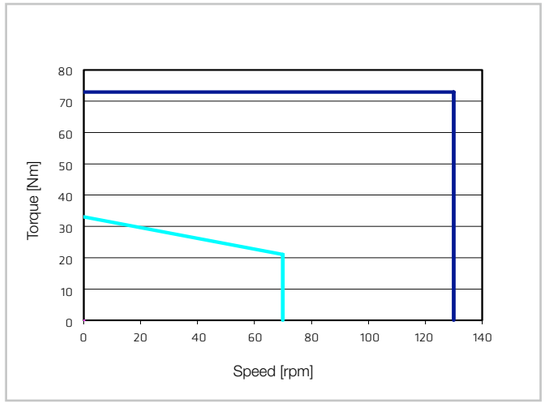


Illustration 1.3.16 **CanisDrive-20A/B-AM-80**

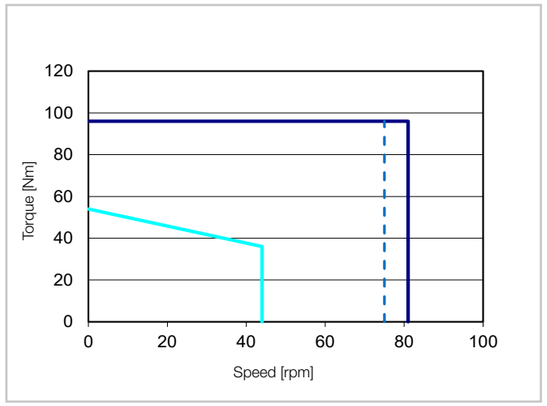


Illustration 1.3.17 **CanisDrive-20A/B-AM-100**

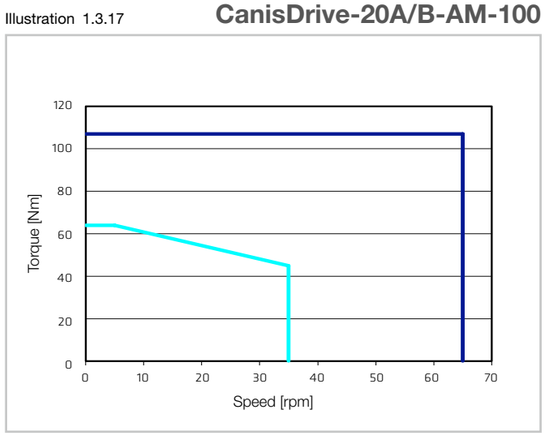


Illustration 1.3.18 **CanisDrive-20A/B-AM-120**

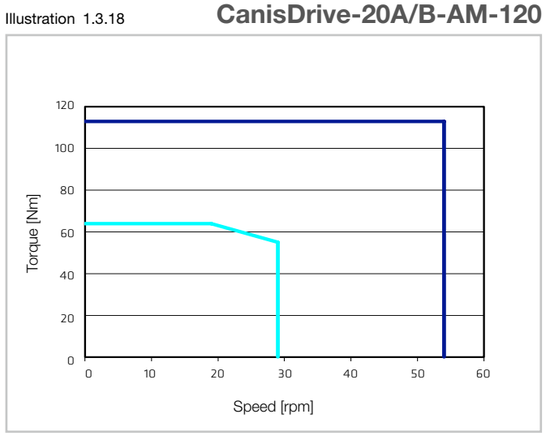
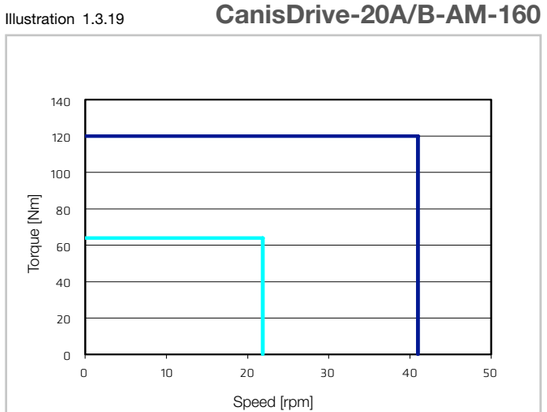


Illustration 1.3.19 **CanisDrive-20A/B-AM-160**



Intermittent duty —— Continuous duty —— U_M = 230 ... 400 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.3.20 **CanisDrive-20A-50-AM-UL**

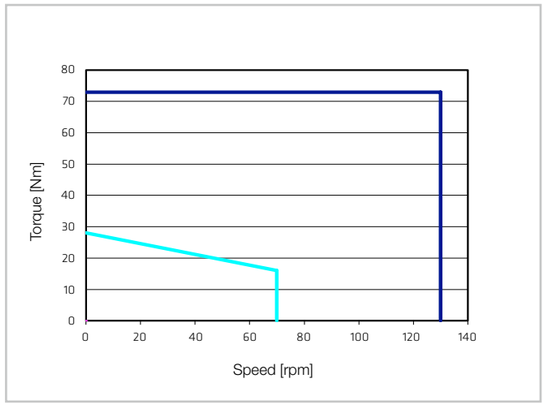


Illustration 1.3.21 **CanisDrive-20A-80-AM-UL**

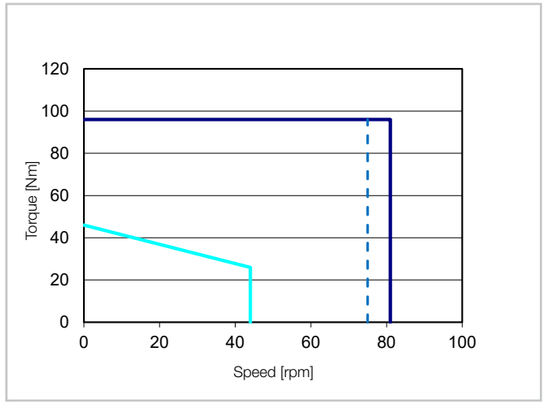


Illustration 1.3.22 **CanisDrive-20A-100-AM-UL**

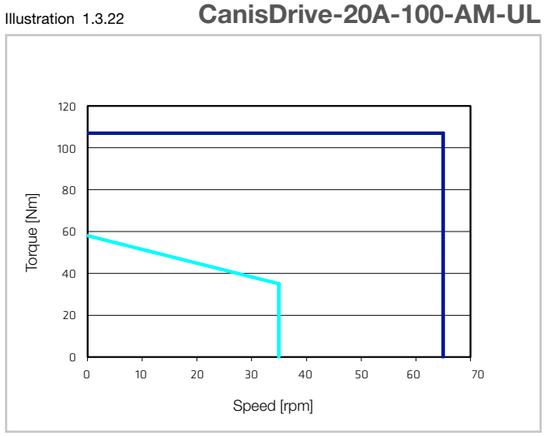


Illustration 1.3.23 **CanisDrive-20A-120-AM-UL**

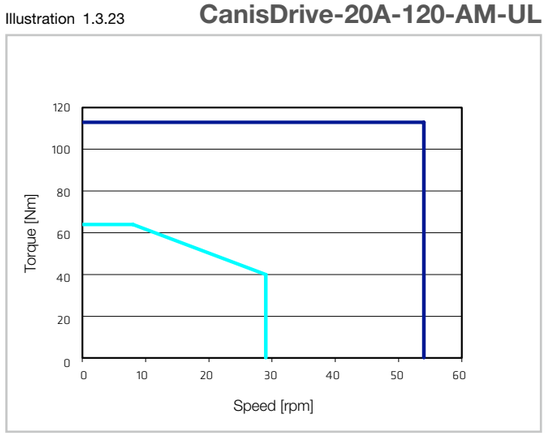
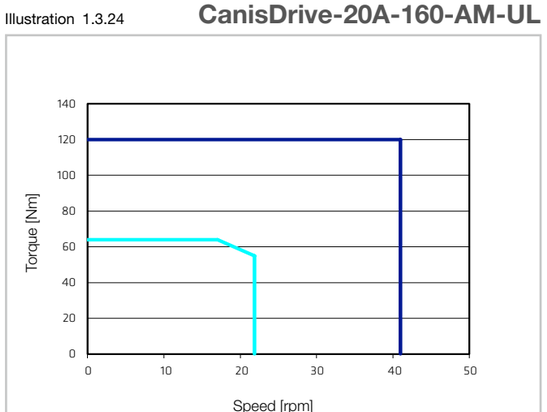


Illustration 1.3.24 **CanisDrive-20A-160-AM-UL**



Intermittent duty —— Continuous duty —— U_M = 230 ... 400 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.3.25

CanisDrive-25A/B-AR-50

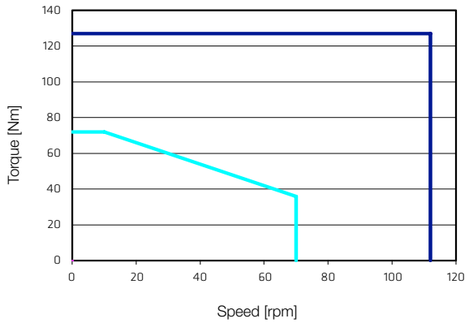


Illustration 1.3.26

CanisDrive-25A/B-AR-80

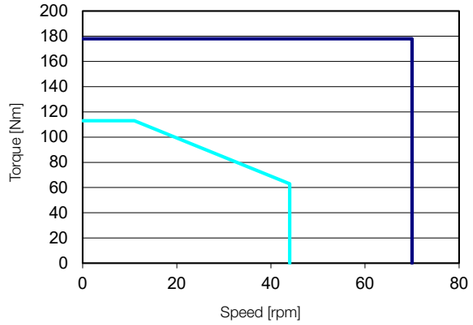


Illustration 1.3.27

CanisDrive-25A/B-AR-100

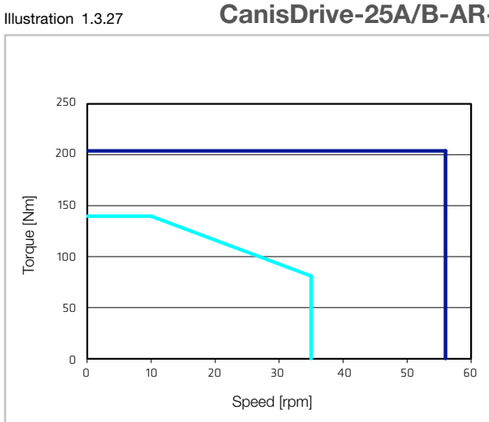


Illustration 1.3.28

CanisDrive-25A/B-AR-120

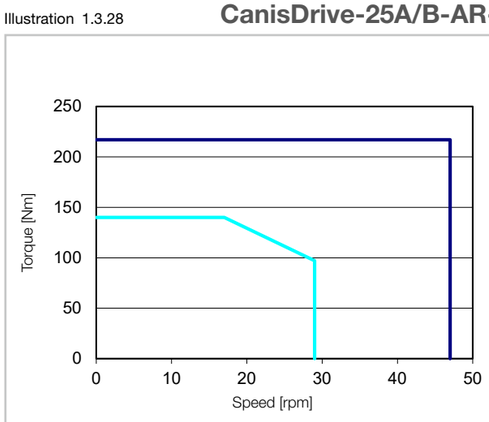
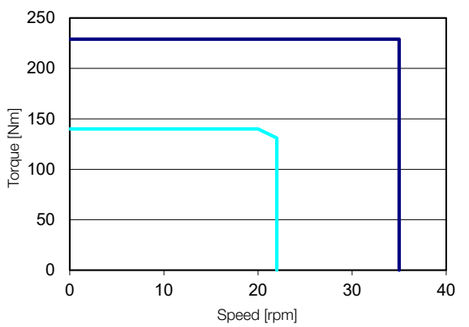


Illustration 1.3.29

CanisDrive-25A/B-AR-160



Intermittent duty ——— Continuous duty ——— U_M = 400 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.3.30

CanisDrive-25A-50-AR-UL

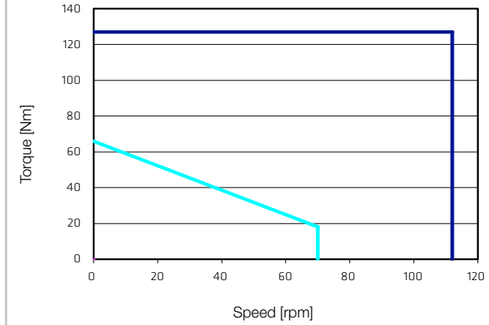


Illustration 1.3.31

CanisDrive-25A-80-AR-UL

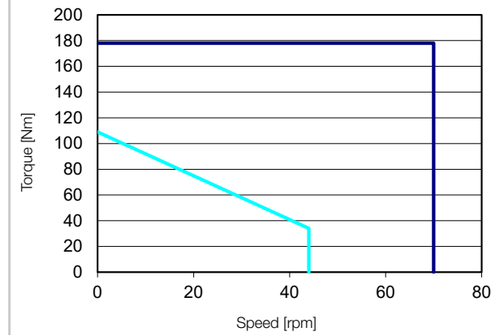


Illustration 1.3.32

CanisDrive-25A-100-AR-UL

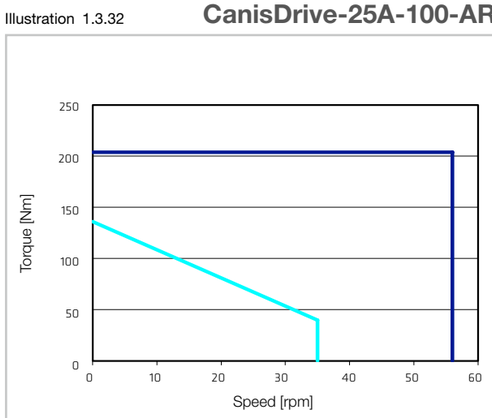


Illustration 1.3.33

CanisDrive-25A-120-AR-UL

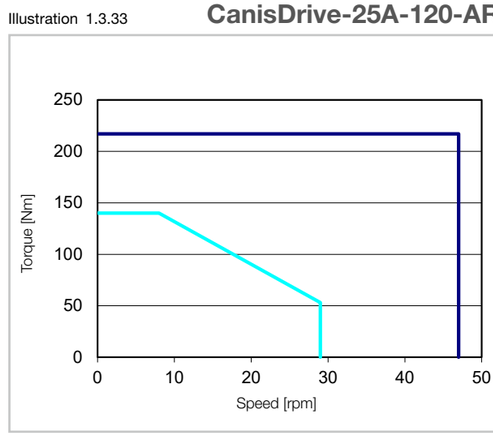
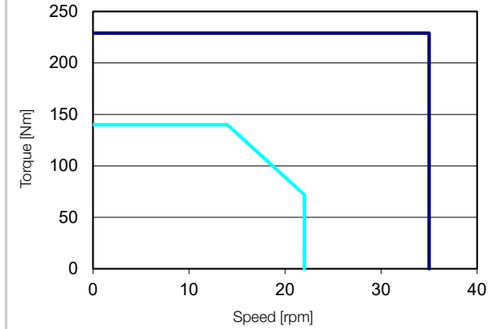


Illustration 1.3.34

CanisDrive-25A-160-AR-UL



Intermittent duty ——— Continuous duty ——— U_M = 400 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.3.35 **CanisDrive-32A/B-AR-50**

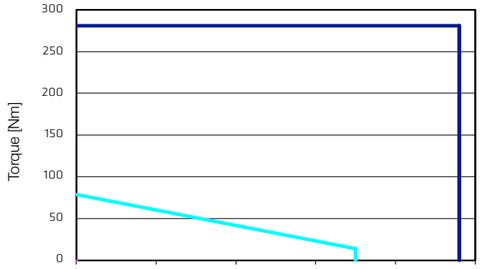


Illustration 1.3.36 **CanisDrive-32A/B-AR-80**

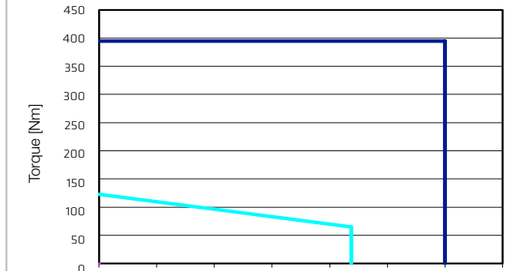


Illustration 1.3.37 **CanisDrive-32A/B-AR-100**

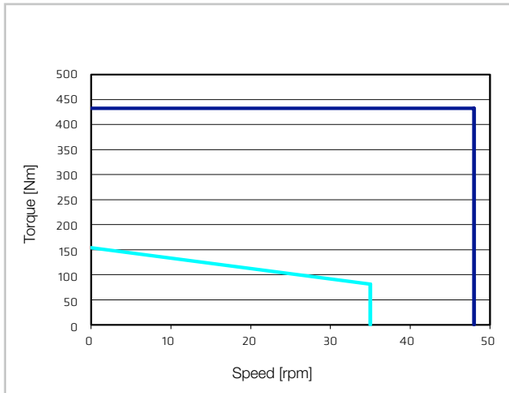


Illustration 1.3.38 **CanisDrive-32A/B-AR-120**

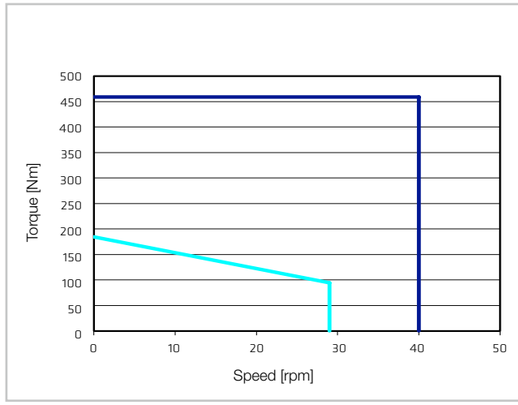
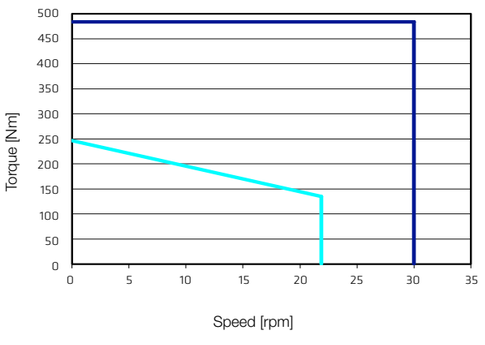


Illustration 1.3.39 **CanisDrive-32A/B-AR-160**



Intermittent duty —— Continuous duty —— U_M = 400 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.3.40 **CanisDrive-32A-50-AR-UL**

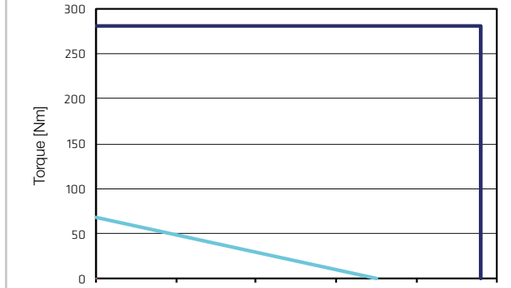


Illustration 1.3.41 **CanisDrive-32A-80-AR-UL**

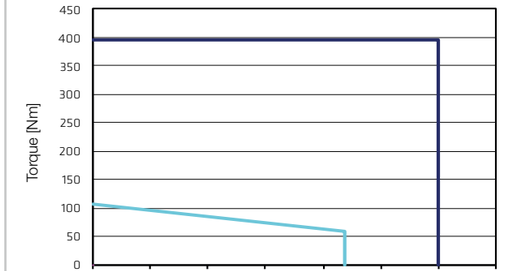


Illustration 1.3.42 **CanisDrive-32A-100-AR-UL**

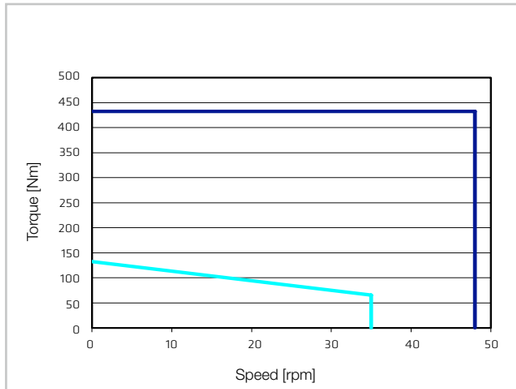


Illustration 1.3.43 **CanisDrive-32A-120-AR-UL**

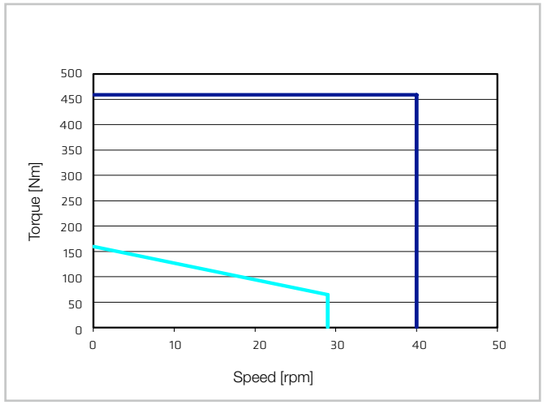
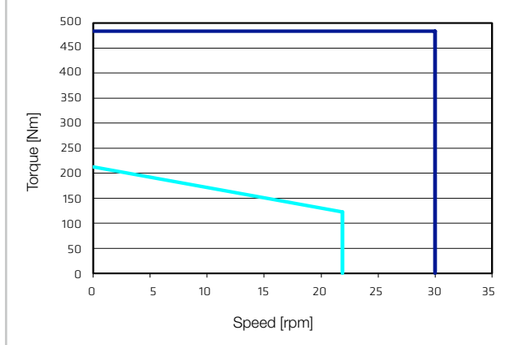


Illustration 1.3.44 **CanisDrive-32A-160-AR-UL**



Intermittent duty —— Continuous duty —— U_M = 400 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.3.45 **CanisDrive-40A/B-AU-50**

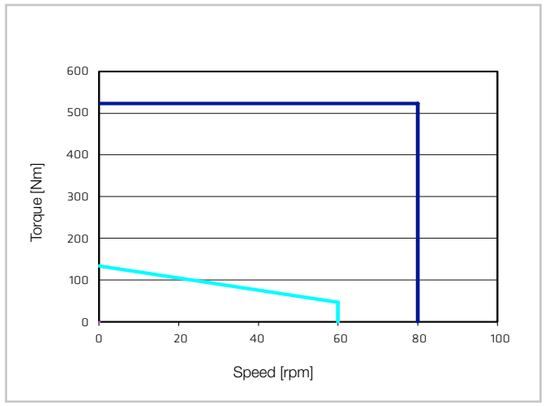


Illustration 1.3.46 **CanisDrive-40A/B-AU-80**

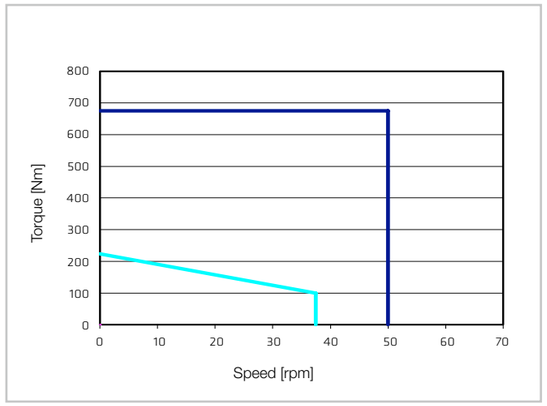


Illustration 1.3.47 **CanisDrive-40A/B-AU-100**

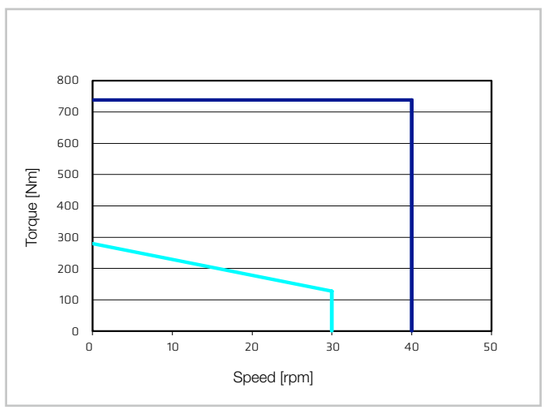


Illustration 1.3.48 **CanisDrive-40A/B-AU-120**

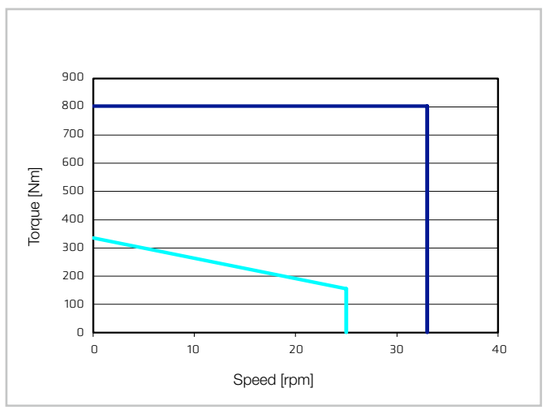
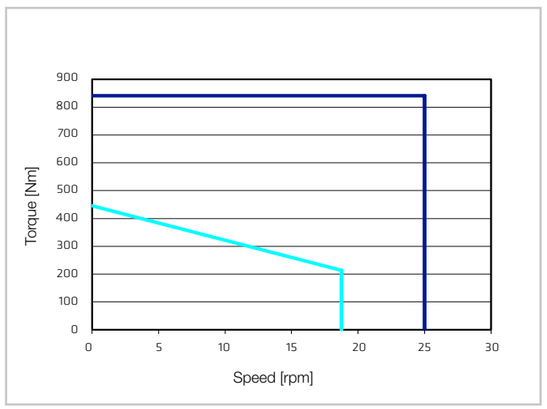


Illustration 1.3.49 **CanisDrive-40A/B-AU-160**



Intermittent duty ——— Continuous duty ——— U_M = 400 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.3.50 **CanisDrive-40A-50-AU-UL**

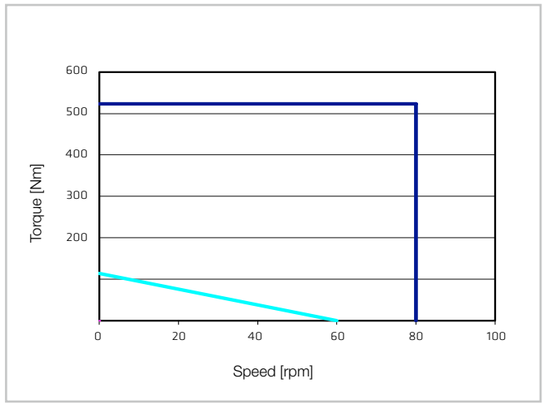


Illustration 1.3.51 **CanisDrive-40A-80-AU-UL**

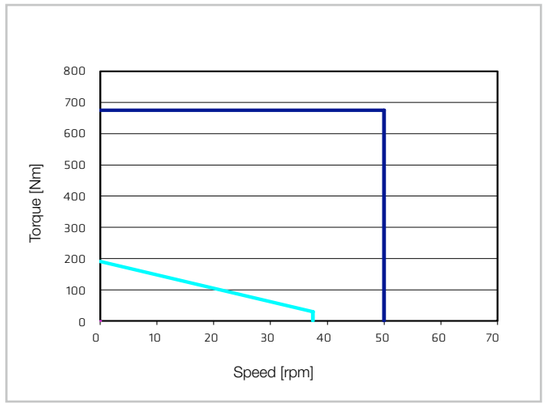


Illustration 1.3.52 **CanisDrive-40A-100-AU-UL**

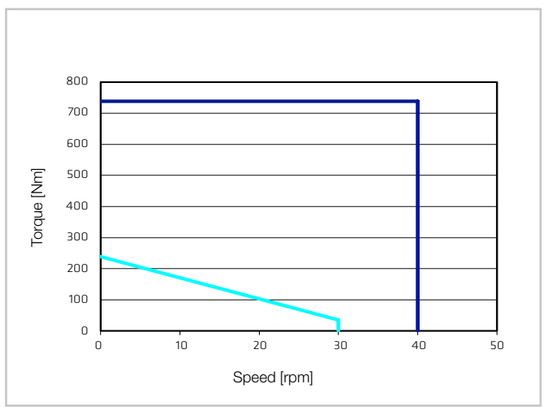


Illustration 1.3.53 **CanisDrive-40A-120-AU-UL**

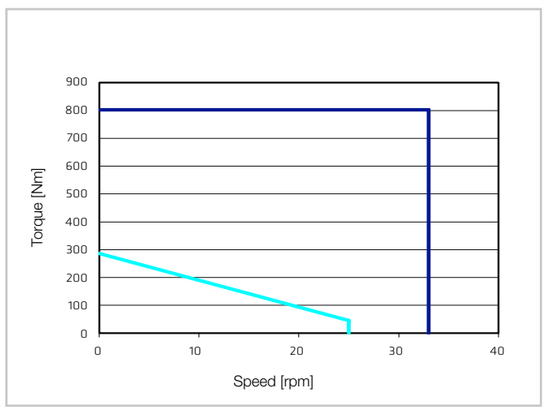
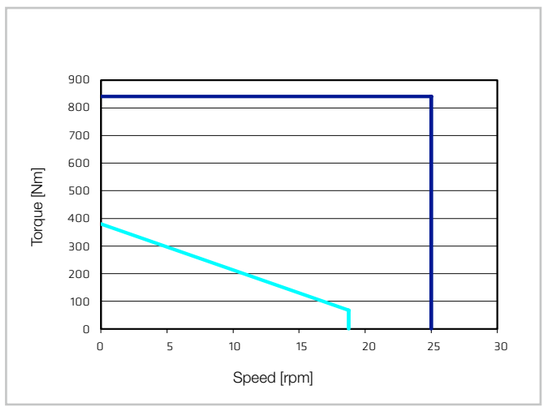


Illustration 1.3.54 **CanisDrive-40A-160-AU-UL**



Intermittent duty ——— Continuous duty ——— U_M = 400 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.3.55 **CanisDrive-50A-50-AX**

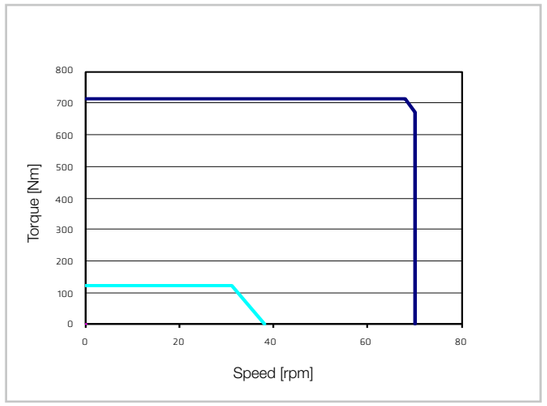


Illustration 1.3.56 **CanisDrive-50A-80-AX**

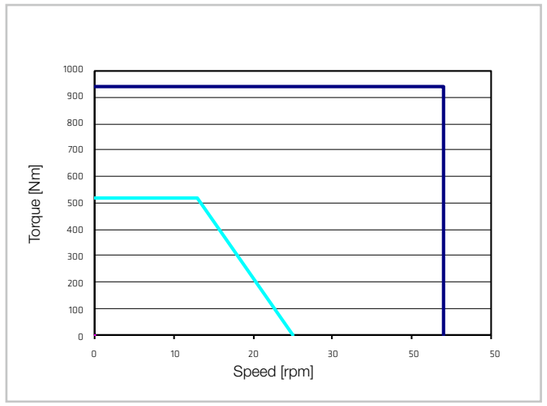


Illustration 1.3.57 **CanisDrive-50A-100-AX**

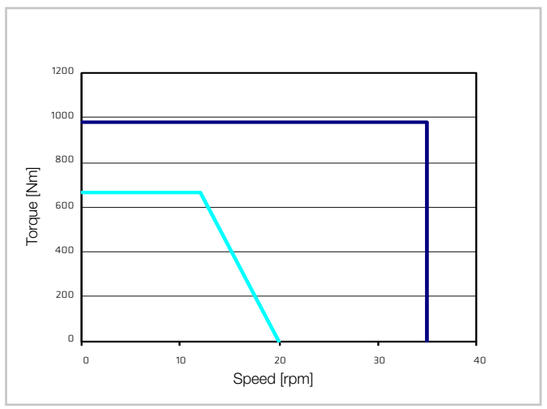


Illustration 1.3.58 **CanisDrive-50A-120-AX**

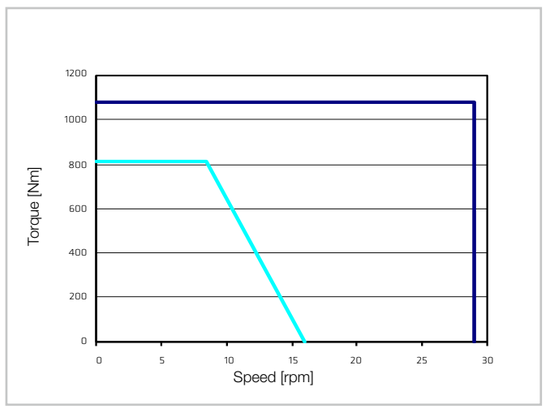
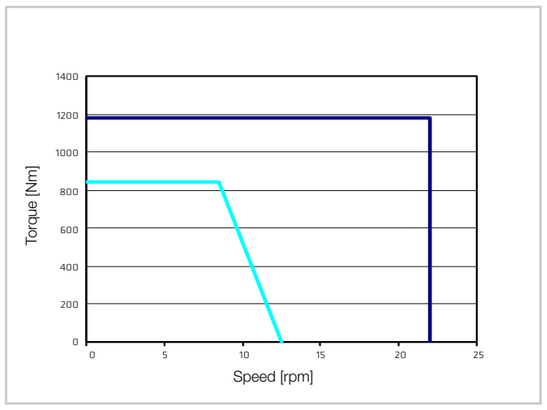


Illustration 1.3.59 **CanisDrive-50A-160-AX**



Intermittent duty ——— Continuous duty ——— U_M = 400 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.3.60 **CanisDrive-58A-50-AX**

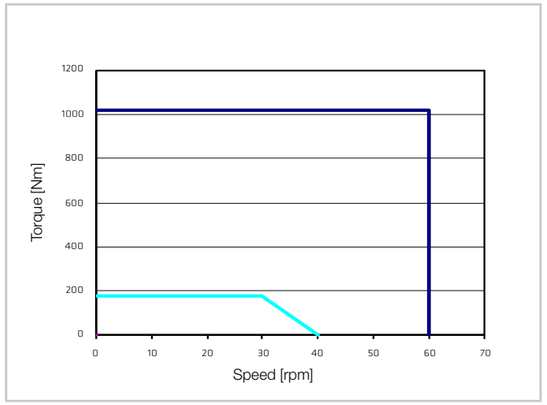


Illustration 1.3.61 **CanisDrive-58A-80-AX**

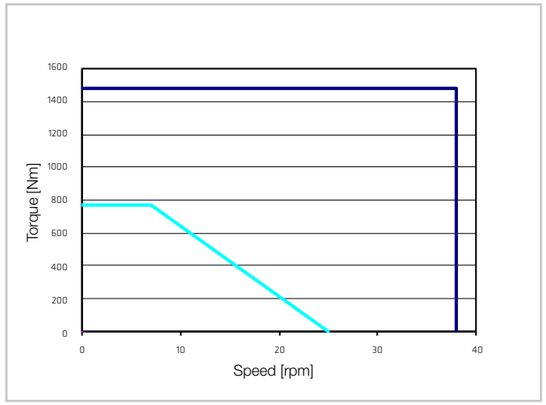


Illustration 1.3.62 **CanisDrive-58A-100-AX**

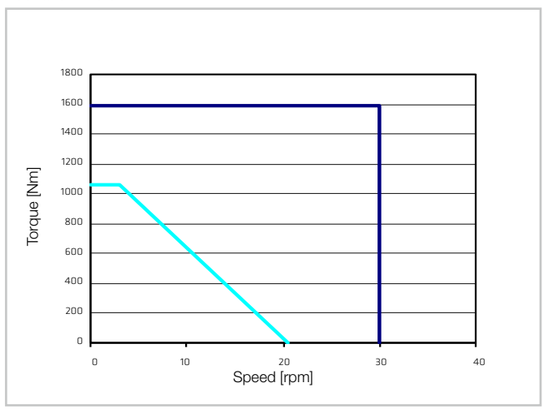


Illustration 1.3.63 **CanisDrive-58A-120-AX**

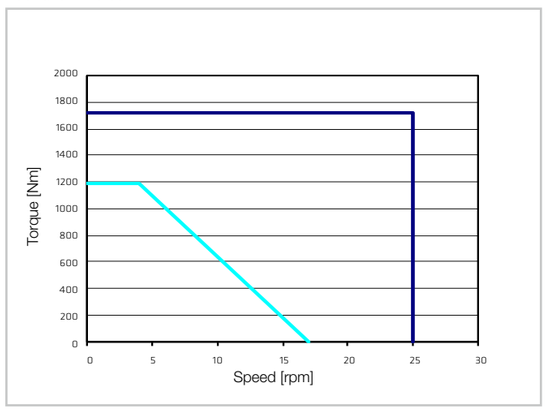
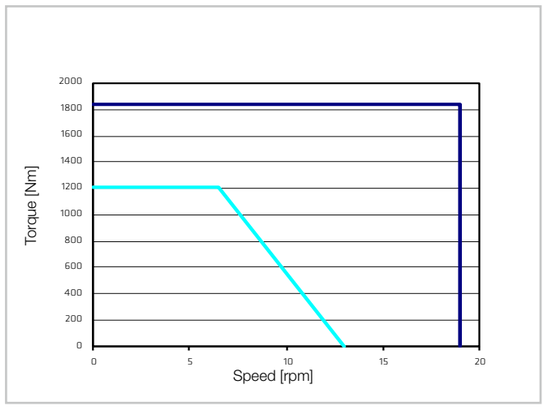


Illustration 1.3.64 **CanisDrive-58A-160-AX**



Intermittent duty ——— Continuous duty ——— U_M = 400 VAC

- Dimensions

Illustration 1.3.65

CanisDrive-14A/B-FB-E [mm]

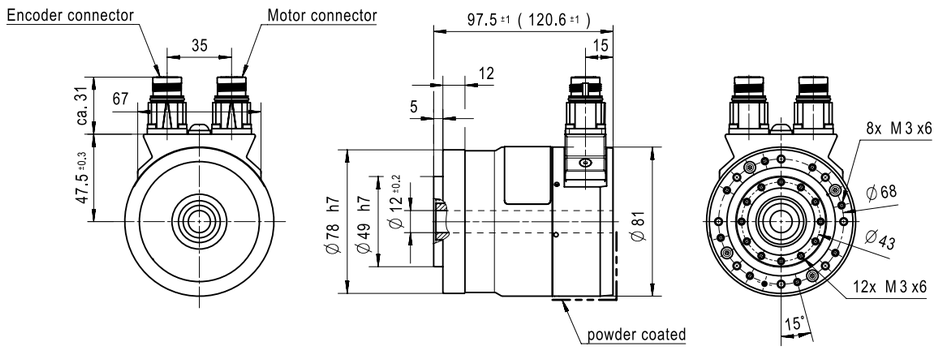


Illustration 1.3.66

CanisDrive-14A/B-AM [mm]

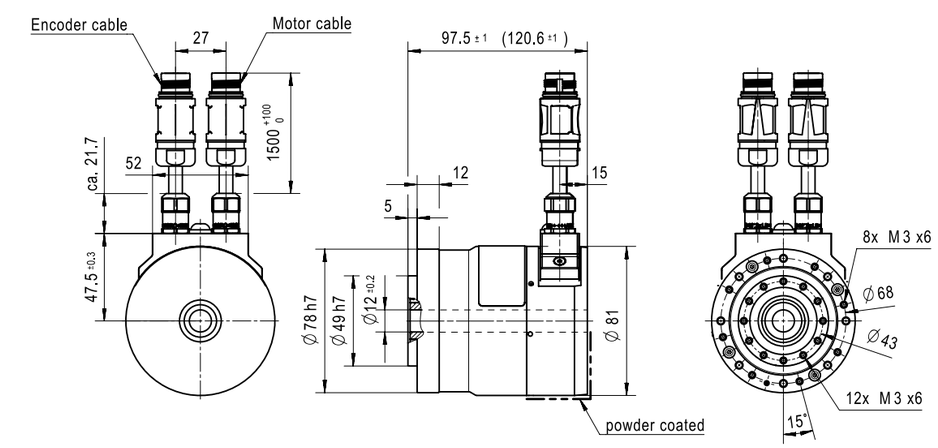


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Illustration 1.3.67

CanisDrive-17A/B-FD-E [mm]

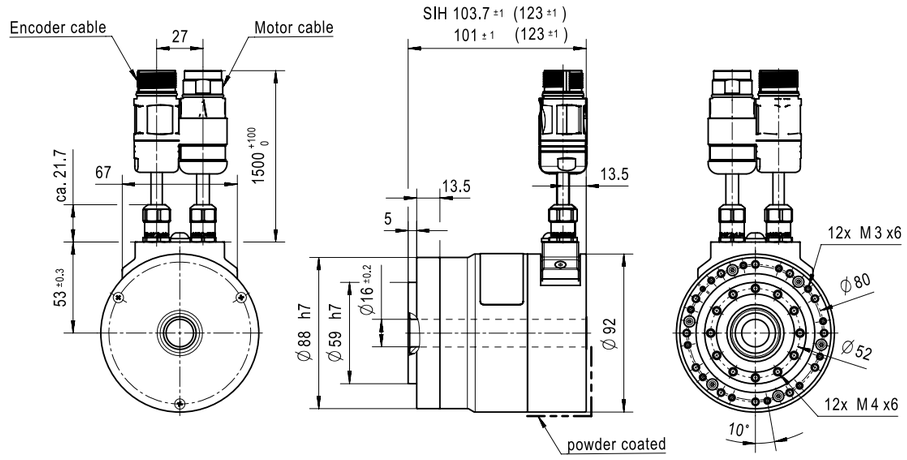

Illustration 1.3.68

CanisDrive-17A/B-AO [mm]

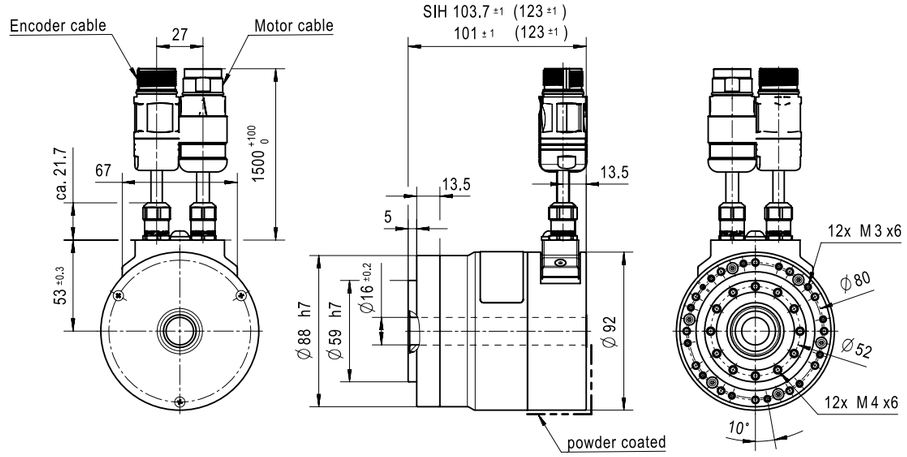

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Illustration 1.3.69

CanisDrive-20A/B [mm]

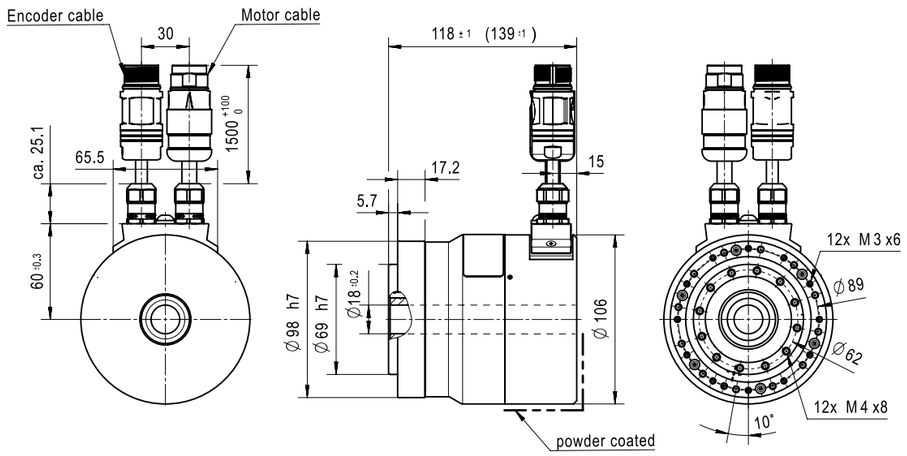

Illustration 1.3.70

CanisDrive-20A/B-MZD [mm]

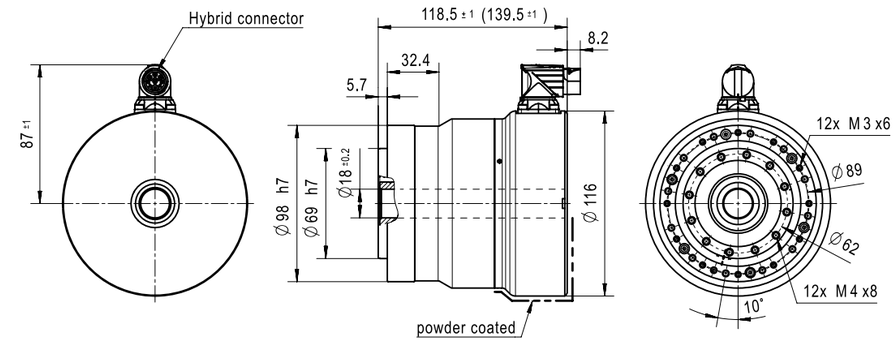

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Illustration 1.3.71

CanisDrive-25A/B [mm]

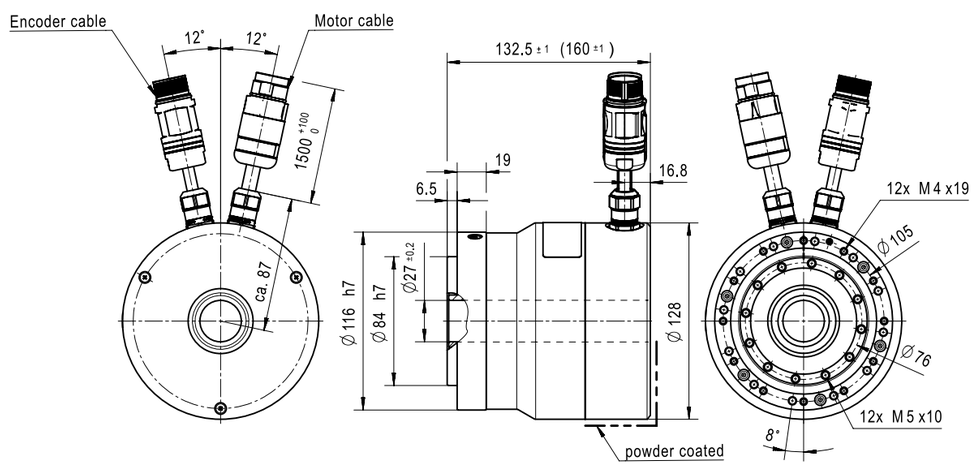

Illustration 1.3.72

CanisDrive-25A/B-MZD [mm]

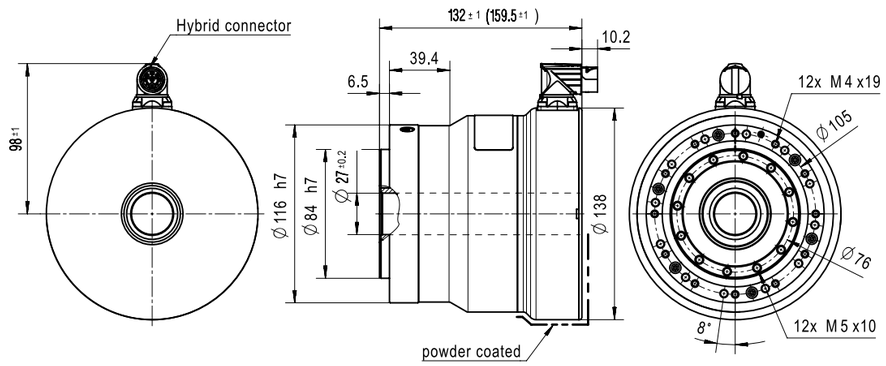

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Illustration 1.3.73

CanisDrive-32A/B [mm]

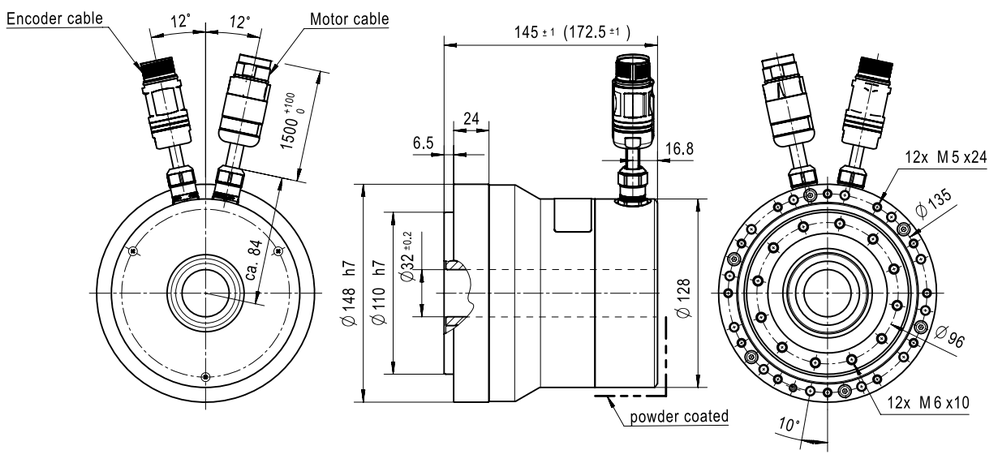

Illustration 1.3.74

CanisDrive-32A/B-MZD [mm]

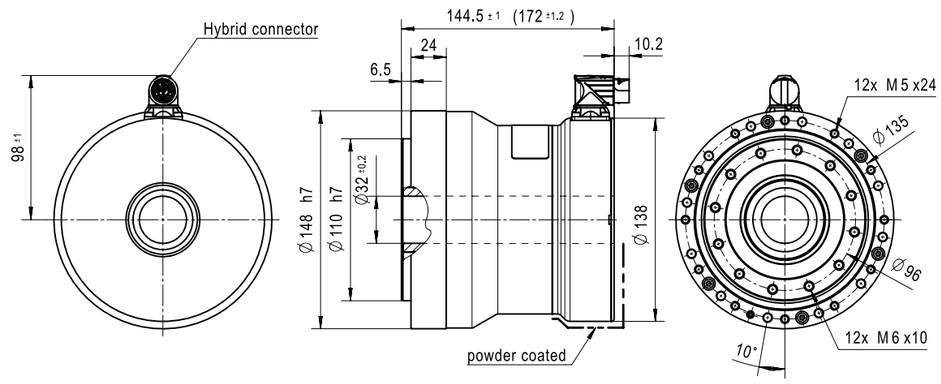

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Illustration 1.3.75

CanisDrive-40A/B [mm]

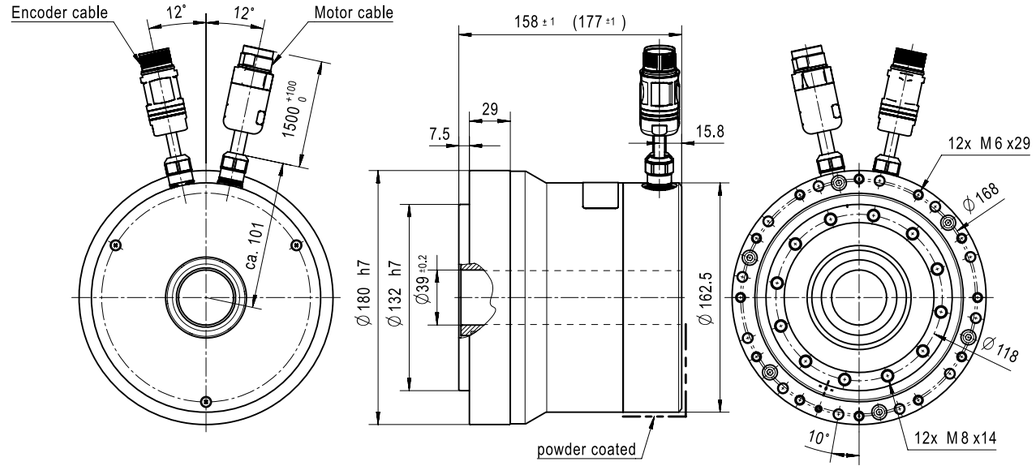

Illustration 1.3.76

CanisDrive-40A/B-MZD [mm]

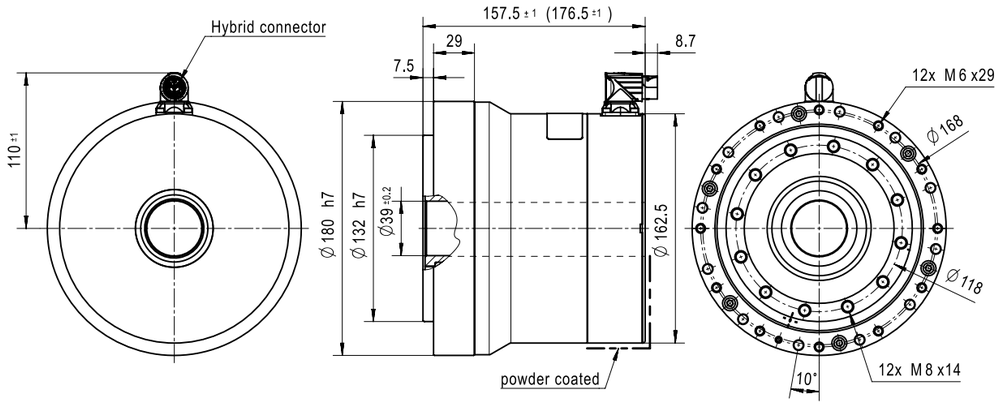

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Illustration 1.3.77

CanisDrive-50A [mm]

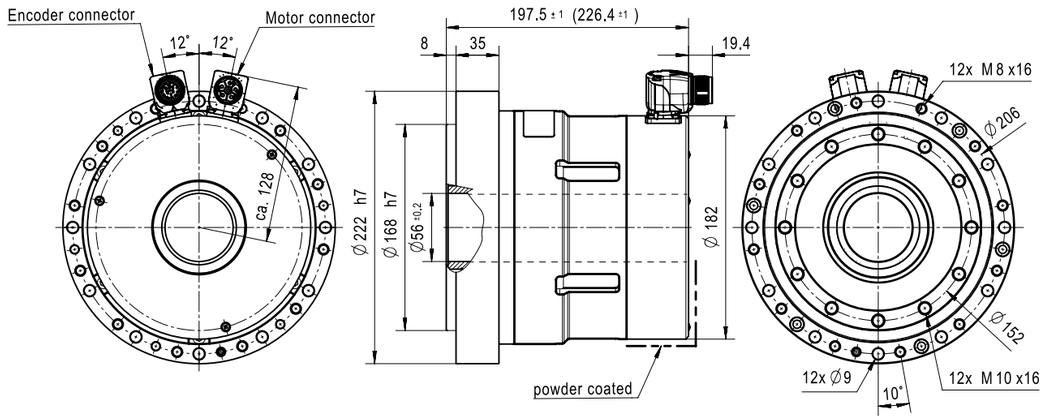

Illustration 1.3.78

CanisDrive-50A-MZD [mm]

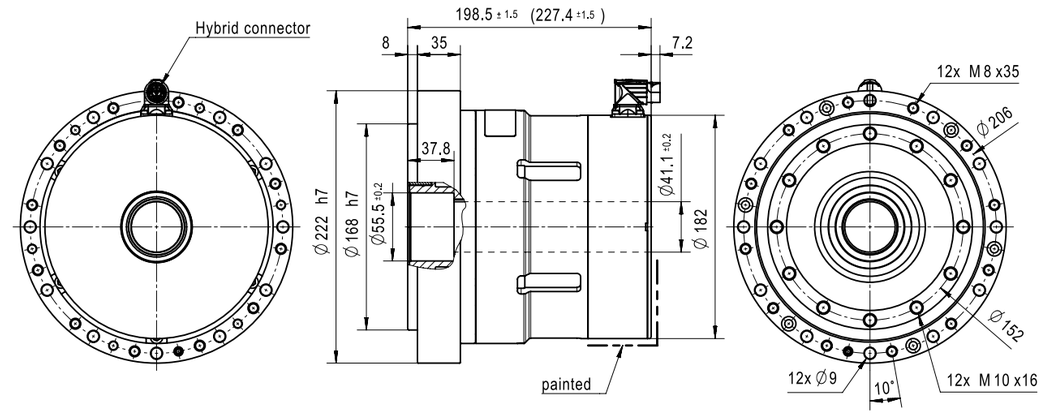

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Illustration 1.3.79

CanisDrive-58A [mm]

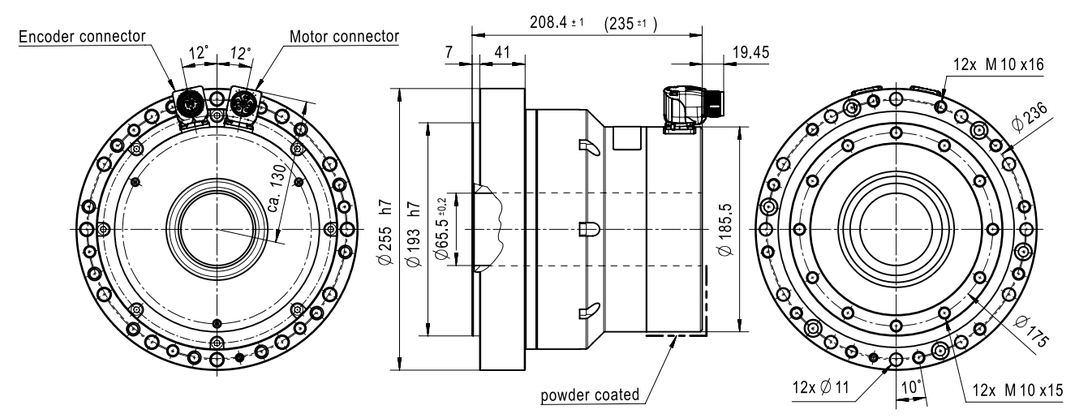
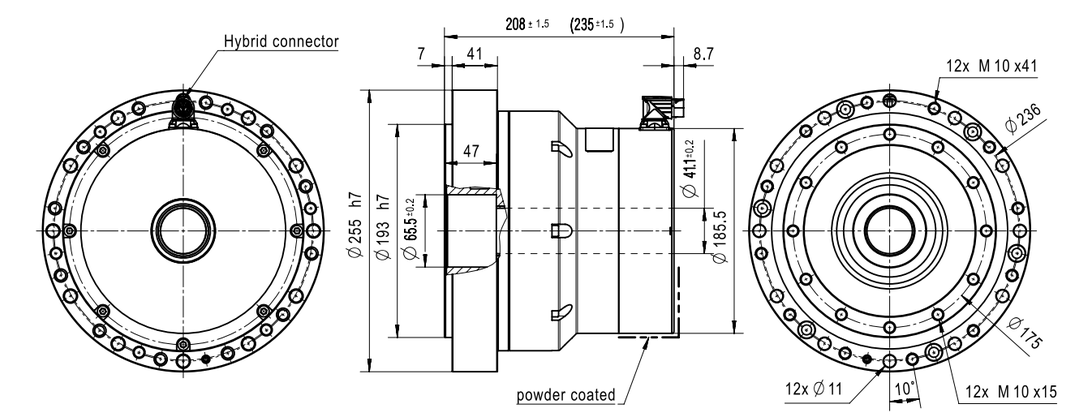


Illustration 1.3.80

CanisDrive-58A-MZD [mm]



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Gear characteristics

• Accuracy

Table 1.3.15

	Symbol [Unit]	14		17		20		25	
Ratio	i [ ]	**50**	**> 50**	**50**	**> 50**	**50**	**> 50**	**50**	**> 50**
Transmission accuracy	[arcmin]	< 1.5	< 1.5	< 1.5	< 1.5	< 1.0	< 0.8	< 1.0	< 0.8
Repeatability	[arcmin]	< ±0.1		< ±0.1		< ±0.1		< ±0.1	
Hysteresis loss	[arcmin]	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lost motion	[arcmin]	< 1.0		< 1.0		< 1.0		< 1.0	

Table 1.3.16

	Symbol [Unit]	32		40		50		58	
Ratio	i [ ]	**50**	**> 50**	**50**	**> 50**	**50**	**> 50**	**50**	**> 50**
Transmission accuracy	[arcmin]	< 1.0	< 0.8	< 0.7	< 0.5	< 0.7	< 0.5	< 0.7	< 0.5
Repeatability	[arcmin]	< ±0.1		< ±0.1		< ±0.1		< ±0.1	
Hysteresis loss	[arcmin]	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0
Lost motion	[arcmin]	< 1.0		< 1.0		< 1.0		< 1.0	

• Torsional stiffness

Table 1.3.17

	Symbol [Unit]	14		17		20		25	
Limit torques	T_1 [Nm]	2		3.9		7		14	
	T_2 [Nm]	6.9		12.0		25.0		48.0	
Ratio	i [ ]	**50**	**> 50**	**50**	**> 50**	**50**	**> 50**	**50**	**> 50**
Torsional stiffness	K_3 [x 10^3 Nm/rad]	5.7	7.1	13.0	16.0	23.0	29.0	44.0	57.0
	K_2 [x 10^3 Nm/rad]	4.7	6.1	11.0	14.0	18.0	25.0	34.0	50.0
	K_1 [x 10^3 Nm/rad]	3.4	4.7	8.1	10.0	13.0	16.0	25.0	31.0

Table 1.3.18

	Symbol [Unit]	32		40		50		58	
Limit torques	T_1 [Nm]	29		54		108		168	
	T_2 [Nm]	108		196		382		598	
Ratio	i [ ]	**50**	**> 50**	**50**	**> 50**	**50**	**> 50**	**50**	**> 50**
Torsional stiffness	K_3 [x 10^3 Nm/rad]	98	120	180	230	340	440	540	710
	K_2 [x 10^3 Nm/rad]	78	110	140	200	280	400	440	610
	K_1 [x 10^3 Nm/rad]	54	67	100	130	200	250	310	400

You will find more information on this in the Engineering data chapter.

Output bearing

Our servo actuators incorporate a high stiffness output bearing. This specially developed bearing can withstand high axial and radial forces as well as tilting moments. The reduction gear is therefore protected from external loads, so guaranteeing a long life and consistent performance. The integration of an output bearing also serves to reduce subsequent design and production cost, by removing the need for an additional output bearing in many applications.

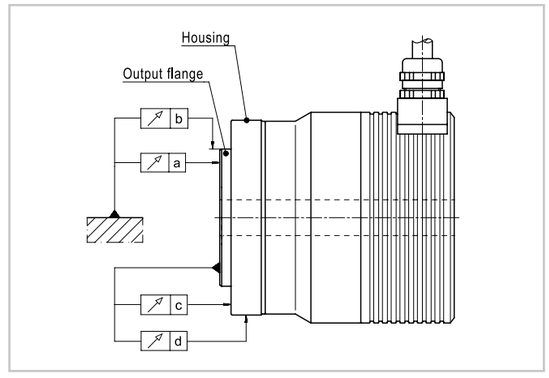
• Performance data

Table 1.3.19

	Symbol [Unit]	14	17	20	25	32	40	50	58
Bearing type[1]		C[5]	C[6]	C[6]	C	C	C	C	C
Pitch circle diameter	d_p [m]	0.0465	0.0592	0.0700	0.0889	0.1135	0.1340	0.1710	0.1940
Offset[2]	R [m]	0.0128	0.0136	0.0162	0.0182	0.0201	0.0258	0.0281	0.0291
Dynamic load rating	C [N]	9500	10700	21000	24800	43800	48500	81600	87400
Static load rating	C_0 [N]	11700	14800	27700	37500	68600	82900	164000	188000
Permissible dynamic tilting moment[3,4]	M [Nm]	73	114	172	254	578	886	1558	2222
Tilting moment stiffness[5]	K_B [Nm/arcmin]	23	40	70	114	350	522	1020	1550
Permissible axial force[4]	F_a [N]	2030	2286	4486	5298	9357	10361	20830	22218
Permissible radial force[4]	F_r [N]	1360	1532	3006	3550	6269	6942	13956	14886

1) Bearing type C = Cross roller bearing; F = Four point contact bearing
2) Distance between the centre of the rolling bearing and the screw mounting surface on the output side. See chapter Actuator dimensioning.
3) These values are valid for moving gears. They are not based on the equation for lifetime of the output bearing but on the maximum allowable deflection of the Harmonic Drive® Gear Component Set. The values indicated in the table must not be exceeded even if the lifetime equation of the bearing permits higher values.
4) These data are valid for **M**: $F_a = 0$. $F_r = 0$ I **F_a**: M = 0. $F_r = 0$ I **F_r**: M = 0. $F_a = 0$
5) The value of tilting moment stiffness is the average value (± 20 %).
6) Alternatively, a four point contact bearing can be used.

Illustration 1.3.81



• Tolerances

Table 1.3.20

	[Unit]	14	17	20	25	32	40	50	58
a	[mm]	0.010	0.010	0.010	0.010	0.012	0.012	0.015	0.015
b	[mm]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
c	[mm]	0.010	0.010	0.010	0.010	0.012	0.012	0.015	0.015
d	[mm]	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Temperature sensors

For winding protection at speed > 0, temperature sensors are integrated in the motor winding. For applications with high loads at n = 0, additional protection (for example I2t monitoring) is recommended.

Table 1.3.21

Sensor type	Parameter	T_{Nat} [°C]
PTC	Rated response temperature	120 (CanisDrive-14A ... 17A) 145 (CanisDrive-20A ... 40A)

PTC thermistors are well suited as winding protection because of their very high positive temperature coefficient at nominal response temperature T_{Nat}).

Due to the working principle of PTC the winding can only be protected against overheating.

Illustration 1.3.82

Characteristic PTC

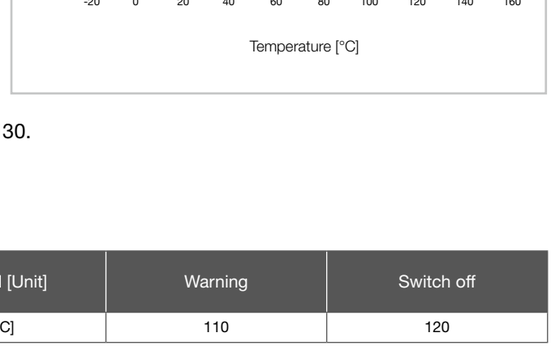


Table 1.3.22

Sensor type	Parameter	Symbol [Unit]	Warning	Switch off
KTY 84-130	Temperature	T [°C]	110	120
			90 (UL version)	100 (UL version)

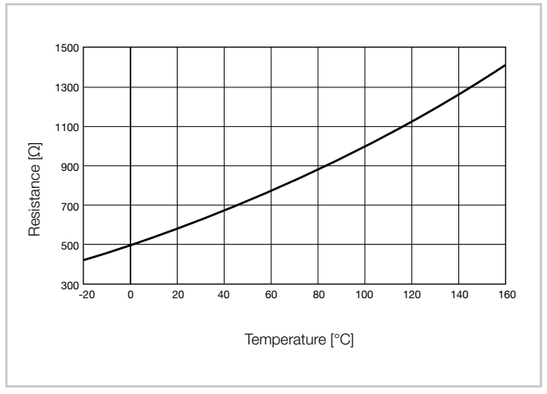
When using the KTY 84-130, the values given in the table must be parameterised in the servo controller or an external evaluation device.
For actuators with UL mark, the temperature limits for warning and shutdown must be observed.

The KTY sensor is used to measure the temperature and monitor the motor development.

When using the KTY, it is possible to also protect the gear grease from impermissible temperatures.

Illustration 1.3.83

Characteristic KTY 84-130



In sizes 50 and 58, a PT1000 is used instead of the KTY 84-130.

Recommended control shafts

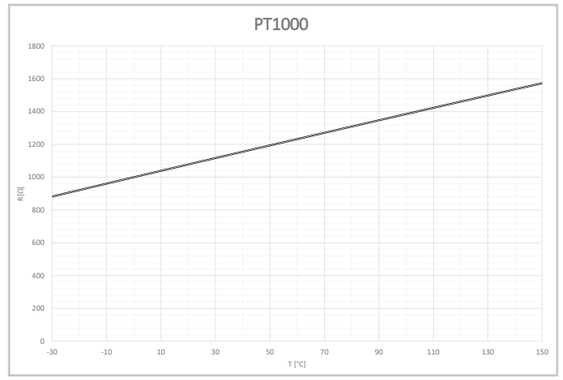
Table 1.3.23

Sensor type	Parameter	Symbol [Unit]	Warning	Switch off
PT1000	Temperature	T [°C]	110	120

When using the PT1000, the values specified in the table in the table must be parameterised in the servo controller or an external
evaluation device must be parameterised.
The PT1000 sensor is used to measure temperature and monitor motor development.
When using the PT1000, it is also possible to protect the gear grease from impermissible temperatures.

Illustration 1.3.84

Characteristic PT1000



Battery box

Battery box for multi-turn absolute motor feedback system MZE

The battery box is an accessory for operating the multi-turn absolute motor feedback system MZE and serves to buffer the position data when the power supply is switched off.
The battery box is intended for installation in the control cabinet. A corresponding protective circuit is integrated to protect against wiring errors.

Illustration 1.3.85

Battery box mat. no. 1024385

The battery is not included in the scope of delivery.

Recommended battery: Lithium thionyl chloride
3.6V / ≥ 2.0Ah / AA
for example Tadiran SL-760S

Illustration 1.3.86

Exploded view

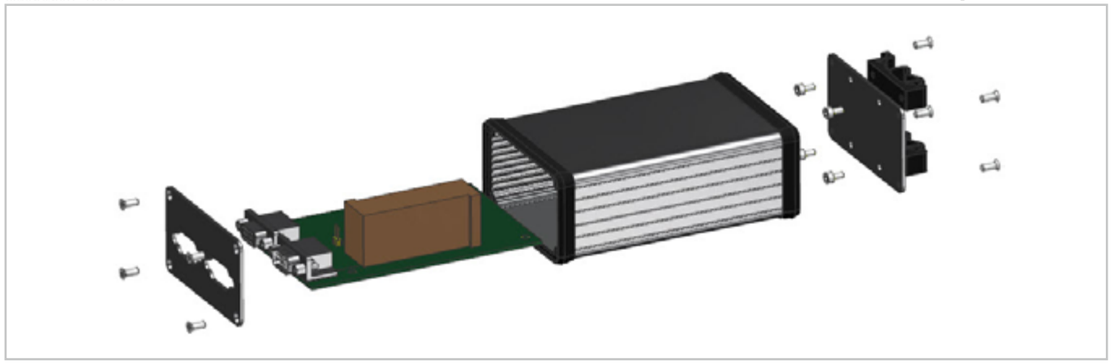
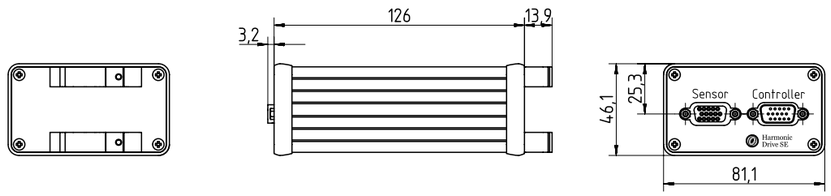


Illustration 1.3.87

Dimensions



Mounting: DIN mounting rail 35 mm

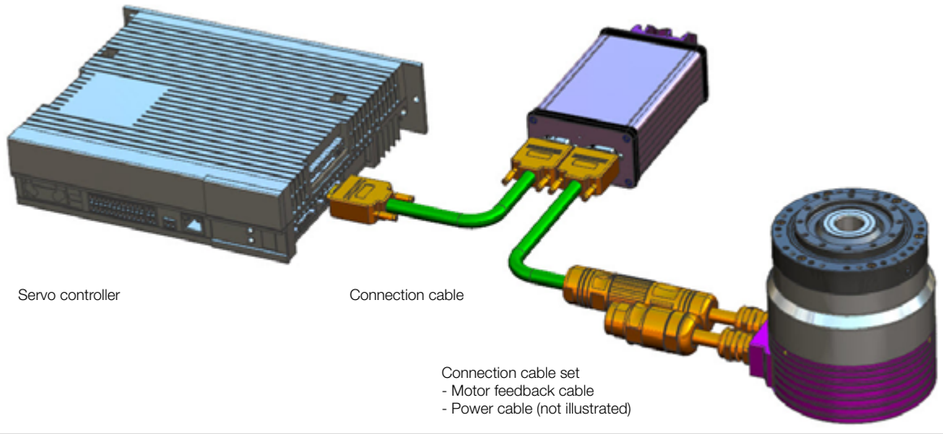
Table 1.3.24

Connection assignment

	Sensor 15. pol. sub D socket	Battery		Controller 15. pol. sub D connector
1	–		1	–
2	–		2	–
3	U_P		3	U_P
4	DATA +		4	DATA +
5	DATA -		5	DATA -
6	–		6	–
7	UBAT+	UBAT+	7	-
8	UBAT- (0V / GND)	UBAT-	8	UBAT- (0V / GND)
9	Temp -		9	Temp -
10	Temp +		10	Temp +
11	–		11	–
12	Sense +		12	Sense +
13	Sense -		13	Sense -
14	CLOCK +		14	CLOCK +
15	CLOCK -		15	CLOCK -

Illustration 1.3.88

Motor feedback wiring



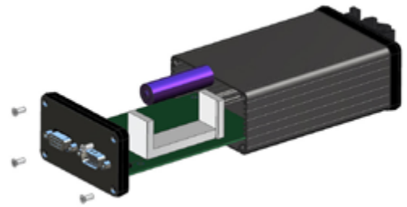
Battery replacement

To guarantee that the absolute encoder position is maintained when the battery is replaced, the following requirements must be ensured:

- the supply voltage of the motor feedback system by the drive controller is available
- the motor feedback system is connected to the servo controller

If the battery voltage fails or is interrupted and the power supply fails or is interrupted at the same time, the provided position will be incorrect after switching on again!
Undefined positioning processes can cause injuries to persons or damage to system parts.

- Open the cover of the battery box
- Pull out the circuit board with battery
- Remove the old battery and dispose of it in accordance with the applicable regulations
- Insert new battery
- Insert circuit board with battery
- Close the cover of the battery box
- Reset error and warning bit



The motor feedback systems MZB, MHS and MZE monitor the connected battery and, in addition to the position values, also provide status information of the connected battery via the communication interface.
The functionality and behaviour depend on the encoder type and the selected communication interface.
All systems require an immediate exchange of the battery after sending warning or error messages!
By doing that, the specific requirements of each encoder type must be considered.
The battery type should be select based on the advice of the encoder manufacturer.
Error bit and warning bit are reset via encoder protocol.

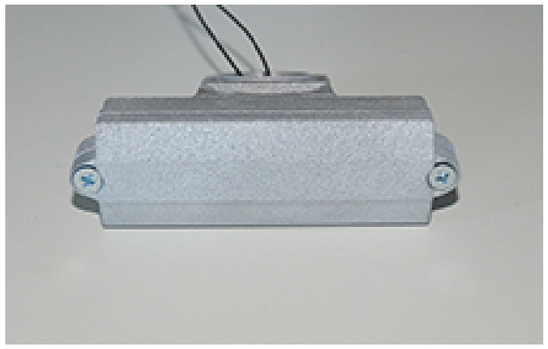
Note:
For correct control of the motor feedback system MZE (Heidenhain EBI135), the EnDat specification and the EnDat “Application Notes” from Heidenhain for battery buffered encoders must be observed.

- Motor feedback systems MZB/MHS

The battery box may only be opened for service purposes!

The buffer battery may only be replaced when the actuator is energised. This means that the actuator - in particular the encoder - must be connected to a switched on servo controller while the battery is being replaced. In this case, the servo controller takes over the power supply. Otherwise, the encoder loses its stored data and therefore its function.
Only the recommended battery may be used.

Illustration 1.3.89



Recommended battery: Lithium thionyl chloride
3,6 V / ≥ 2,0 Ah / AA
Tadiran SL-360S

Electrical connections

• Motor connector

Connector version M23 8-pole: Ordering code L or M

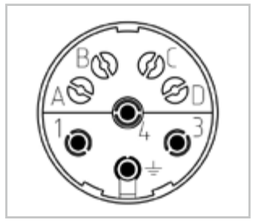
Table 1.3.25

Motor connector	8 / M23 x 1 (Phoenix, SF Series)
Cable coupling	8 / M23 x 1 / Material no. 303549
Outer diameter	26 mm
Length	60 mm

Table 1.3.26

Connector pin	1	2	3	4	A	B	C	D
Motor phase	U	PE	W	V	BR+	BR-	Temp+ PTC	Temp- PTC

Illustration 1.3.90



Connector version M23 6-pole: Ordering code H or F

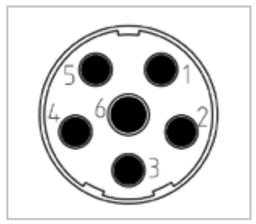
Table 1.3.27

Motor connector	6 / M23 x 1 (Phoenix, SF Series)
Cable coupling	6 / M23 x 1 / Material no. 301193
Outer diameter	26 mm
Length	60 mm

Table 1.3.28

Connector pin	1	2	3	4	5	6
Motor phase	U	V	PE	BR+	BR-	W

Illustration 1.3.91



Connector version M17 8-pole: Ordering code N or E

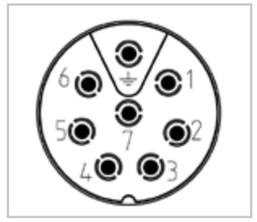
Table 1.3.29

Motor connector	8 / M17 x 1 (Phoenix, SF Series)
Cable coupling	8 / M17 x 1 / Material no. 1011445
Outer diameter	22 mm
Length	50 mm

Table 1.3.30

	14A ... 17A							
Connector pin	1	6	7	PE	3	4	2	5
Motor phase	U	W	V	PE	BR+	BR-	Temp PTC	Temp PTC

Illustration 1.3.92



Connector version iTec 9-pole hybrid plug: Ordering code I

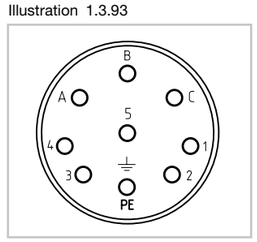
Table 1.3.31

Connector	915 itec (EGA201N, TE connectivity)
Outer diameter	20.5 mm
Length	56.6 mm

Table 1.3.32

Connector pin	A	B	C	1	2	3	4	5	PE
Motor phase	U	W	V	Brake+	Brake-	DSL+	DSL-	-	PE

Illustration 1.3.93



• Encoder connector

DCO: Incremental encoder (2048 increments), RS422

Table 1.3.33

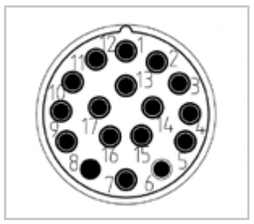
Encoder connector	17 / M17 x 1 (Phoenix, RF Series)
Cable coupling	17 / M17 x 1 / Material no. 1011446

Table 1.3.34

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Signal	U+	U-	V+	V-	W+	W-	GND	Up	Z+	Z-	A+	A-	B+	B-	Temp+[1)]	Temp-[1)]	-

1) Not available for actuators with cable outlet (plug connector version 'N')

Illustration 1.3.94



SZE: EnDat 2.2 singleturn absolute encoder ECI-119 (fully digital)

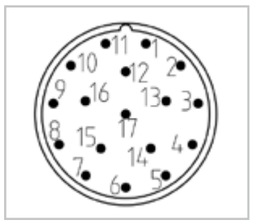
Table 1.3.35

Encoder connector	17 / M23 x 1 (Phoenix, RF Series)
Cable coupling	17 / M23 x 1 / Material no. 270199
Outer diameter	26 mm
Length	60 mm

Table 1.3.36

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Signal	-	-	DATA+	-	CLOCK+	-	0V	Temp+	Temp-	+Up	-	-	DATA-	CLOCK-	Sense-	Sense+	Inner-shield

Illustration 1.3.95



SIE: EnDat 2.1 singleturn absolute encoder ECI-119 (32 SinCos)

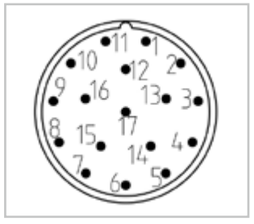
Table 1.3.37

Encoder connector	17 / M23 x 1 (Phoenix, RF Series)
Cable coupling	17 / M23 x 1 / Material no. 270199
Outer diameter	26 mm
Length	60 mm

Table 1.3.38

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Signal	A+ COS+	A- COS-	DATA+	-	CLOCK+	-	GND	Temp+	Temp-	Up	B+ SIN+	B- SIN-	DATA-	CLOCK-	Sense-	Sense+	Inner-shield

Illustration 1.3.96



SIH: HIPERFACE® singleturn absolute encoder SES70 (32 SinCos)
MIH: HIPERFACE® multi-turn absolute encoder SEM70 (32 SinCos)
SHH: HIPERFACE® singleturn absolute encoder SES90 (64 SinCos)
MHH: HIPERFACE® multi-turn absolute encoder SEM90 (64 SinCos)

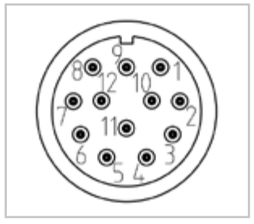
Table 1.3.39

Encoder connector	12 / M23 x 1 (Phoenix, RF Series)
Cable coupling	12 / M23 x 1 / Material no. 305068
Outer diameter	26 mm
Length	60 mm

Table 1.3.40

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12
Signal	Us	GND	+SIN	REFSIN	DATA+	DATA-	+COS	REFCOS	Temp+	Temp-	-	-

Illustration 1.3.97



SZB: BiSS-C singleturn absolute encoder FFB (fully digital)
MZB: BiSS-C multi-turn absolute encoder FFB (fully digital)

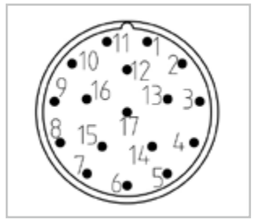
Table 1.3.41

Encoder connector	17 / M23 x 1 (TE-Connectivity, 623 Series)
Cable coupling	17 / M23 x 1
Outer diameter	26 mm
Length	60 mm

Table 1.3.42

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Signal	-	-	DATA+	-	CLOCK+	-	GND	Temp +	Temp +	Up	-	-	DATA-	CLOCK-	-	-	-

Illustration 1.3.98



MGS: SSI multi-turn absolute encoder GEL2311 A (128 SinCos)

Version M17

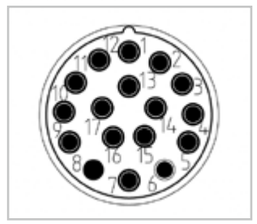
Table 1.3.43

Encoder connector	17 / M17 x 1 (Phoenix, RF Series)
Cable coupling	17 / M17 x 1 / Material no. 1011446
Outer diameter	22 mm
Length	50 mm

Table 1.3.44

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Signal	A+ COS+	A- COS-	DATA+	-	CLOCK+	-	GND	Temp+	Temp-	Up	B+ SIN+	B- SIN-	DATA-	CLOCK-	GND Sensor	Up Sensor	-

Illustration 1.3.99



Version M23

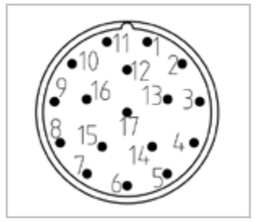
Table 1.3.45

Encoder connector	17 / M23 x 1 (Phoenix, RF Series)
Cable coupling	17 / M23 x 1 / Material no. 270199
Outer diameter	26 mm
Length	60 mm

Table 1.3.46

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Signal	A+ COS+	A- Cos-	DATA+	-	CLOCK+	-	GND	Temp+	Temp-	Up	B+ SIN+	B- SIN-	DATA-	CLOCK-	Sense-	Sense+	Inner-shield

Illustration 1.3.100



MZE: EnDat 2.2 multi-turn absolute encoder EBI-135 (fully digital)

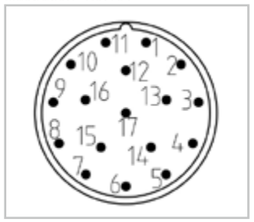
Table 1.3.47

Encoder connector	17 / M23 x 1 (Phoenix, RF Series)
Cable coupling	17 / M23 x 1 / Material no. 270199
Outer diameter	26 mm
Length	60 mm

Table 1.3.48

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Signal	-	-	DATA+	UBAT+	CLOCK+	UBAT-	0V	Temp+	Temp-	+Up	-	-	DATA-	CLOCK-	Sense-	Sense+	Inner-shield

Illustration 1.3.101



MHS: SSI multiturn absolute encoder FFB (64 SinCos)

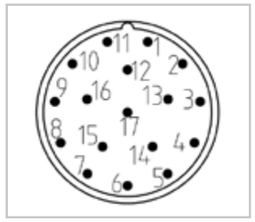
Table 1.3.49

Encoder connector	17 / M23 x 1 (TE-Connectivity Serie 623)
Cable coupling	17 / M23 x 1
Outer diameter	26 mm
Length	60 mm

Table 1.3.50

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Signal	A+ COS+	A- COS-	DATA+	-	CLOCK+	-	GND	Temp+	Temp-	Up	B+ SIN+	B- SIN-	DATA-	CLOCK-	Sense-	Sense+	-

Illustration 1.3.102



MZD: HIPERFACE DSL® multiturn absolute encoder (fully digital)

For the MZD-variant there is only one hybrid connector. A separate encoder connector does not exist. For the pinout please refer to Illustration 1.3.93.

Options

• Position measuring system Option EC

The hollow shaft servo actuators are ideally suited for adapting a singleturn absolute measuring system to the gearbox output side.

The singleturn absolute measuring system type ECN 113 is connected to the gearbox output by means of a torsionally stiff hollow shaft.

Table 1.3.51

Ordering code	Symbol [Unit]	EC
Manufacturer designation		ECN 113
Protocol		EnDat 2.1 / 01
Power supply[1)]	U_b [VDC]	5 ±5 %
Current consumption (max., without load)[1)]	I [mA]	180
Incremental signals	U_{pp} [V_{ss}]	1
Signal form		sinusoidal
Number of pulses	n_1 [SIN / COS]	2048
Absolute position / revolution (at motor side)[2)]		8192
Accuracy[1)]	[arcsec]	±20

1) Source: Manufacturer
2) Increasing position values with direction of rotation CW of the output flange (when looking at the flange from the front)

The encoder system is connected via a signal connector as standard. Before commissioning, the compatibility of the measuring system with the evaluation device must be checked. The measuring system contains electrostatically sensitive components. Observe ESD measures.

Table 1.3.52

Encoder connector	17 / M23 x 1 (Phoenix, RF Series)
Cable coupling	17 / M23 x 1 / Material no. 270199
Outer diameter	26 mm
Length	60 mm

Illustration 1.3.103

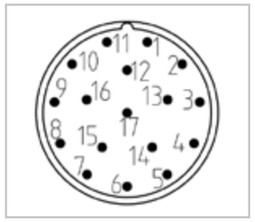
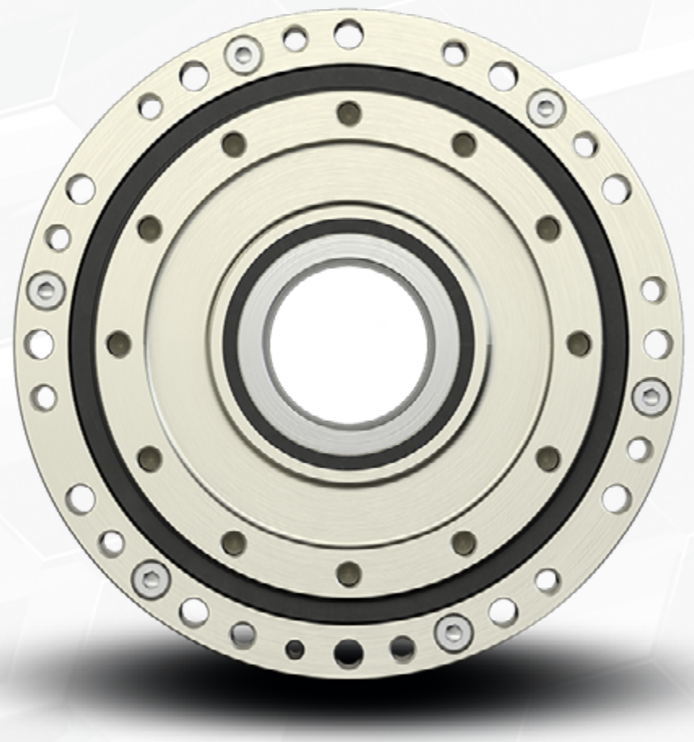


Table 1.3.53

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Signal	Up Sensor	-	-	GND Sensor	-	-	Up	CLOCK+	CLOCK-	GND	Inner-shield	B+	B-	DATA+	A+	A-	DATA-
Connecting cable																	
SINAMICS S 120 (SMC20)	6FX8002-2CH00-1xx0																



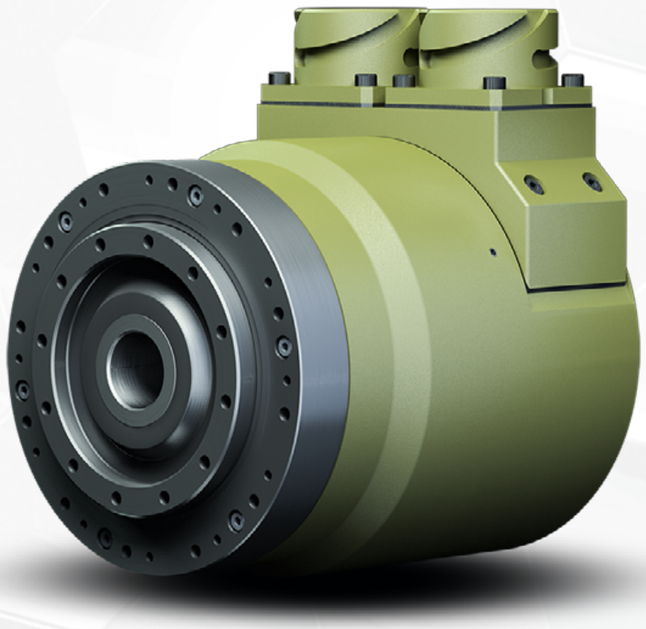
Product description

Largest hollow shaft for extreme environmental conditions

The AlopexDrive Series Servo Actuators with central hollow shaft are especially suited for mobile applications. Designed with synchronous servo motor and a CPU-H Gear with output bearing, and with its high degree of protection and excellent corrosion resistance, this actuator is ideally suited for use in extreme environmental conditions and low temperatures.

Features

- Outstanding, lifelong precision
- Suitable for extreme environmental conditions
- Large hollow shaft
- Integrated, tilt resistant output bearing
- Different feedback systems
- High corrosion protection



The AlopexDrive Servo Actuators are a result of years of experience within projects with particularly critical environmental conditions. All actuators are designed on the basis of the respective requirements and operating conditions. The resulting portfolio today comprises six sizes in a wide variety of customised configurations.

The main representatives from this product range are shown here and provide an overview of the possible configurations. The AlopexDrive Actuators can be adapted to the respective requirements to the following extent:

Flexible combinations of the sub assemblies

- Gears (Harmonic Drive® Strain Wave Gears or Planetary Gears)
- Tribological systems and suitable lubricants for extended temperature range
- Servo motors (with hollow shaft or solid shaft, specifically adapted motor constants)
- Holding brake (electric or optional with manual release)
- Motor feedback systems (at motor side or additional at gear output)
- Surface coating
- Electrical connection (connector, cable)

Variable configurations can be done within the range of the given sub assemblies

Gears

- Zero backlash precision gears according to the Harmonic Drive® Principle
  - HFUC Series, as a proven and reliable basis
  - CSG Series, latest technical standard with increased output torque
- Planetary gears with reduced play < 1 minute of arc
  - HPG Series, as a proven and reliable basis
  - HPG-R Series, latest technical standard with increased output torque requirements

Servo motors

- Short design with larger outer diameter and hollow shaft or longer slimmer design with solid shaft
- Adaptation of the motor constants (K_E, K_T) to the required performance (torque, speed) and the electrical boundary conditions based on the control technology used.
- Integration of temperature sensors for monitoring the winding temperature in the form of single or triple sensors (e.g. PTC, KTY, PT1000)
- Integration of control devices into the actuator
- Integration of slip rings for rotations without limitation

Motor feedback systems

- Resolver for extreme requirements on mechanical robustness and wide temperature range
- Incremental or singleturn absolute encoders in different versions, accuracies and operating principles (optical, magnetic, inductive, capacitive)
- Sensor interfaces: Incremental A/B/Z RS-422, SSI/BISS Protocol, etc.
- Dual systems consisting of separate motor side and output side encoders

Coatings/Materials

- High strength aluminium, stainless steel 1.4571, titanium
- Corrosion protected output bearings
- Actuator housing surface with Surtec650
- Actuator housing anodised or custom painted

Electrical connection

- Cable with/without connector
- Direct mounting plug

Qualifications

The product platform has been tested in orientation to typical applications with regard to harsh environmental conditions. Here is an excerpt from the EMC test methods used:

Requirements	Standard	Applied Limit
Radiated Emissions		
MIL-STD-461F	RE102	Limit for Navy Mobile & Army
Radiated Susceptibility		
MIL-STD-461F	RS103	Level for Army Ground
Conducted Susceptibility		
MIL-STD-461F	CS114	Level for Army Ground
	CS115	Level for all applications
	CS116	Level for all applications

Ordering code

Table 1.4.1

Ordering code	AlopexDrive -	32	A	- 100	- DD	- M	- ROO	- B	- SXS	- K	- SP
AlopexDrive Series											
Size (corresponds to the pitch circle diameter of the Flexspline toothing in inches x 10)		14 17 20 25 32 40									
Product generation			A								
Ratio				30 50 80 100 120 160							
Motor winding type											
DC voltage link 100 VDC, voltage constant 3 Vrms/1000 rpm					FB						
DC voltage link 100 VDC, voltage constant 5 Vrms/1000 rpm					FD						
DC voltage link 100 VDC, voltage constant 11 Vrms/1000 rpm					FG						
DC voltage link 48 VDC, voltage constant 4,2 Vrms/1000 rpm					DC						
DC voltage link 48 VDC, voltage constant 5,1 Vrms/1000 rpm					DD						
DC voltage link 48 VDC, voltage constant 10,1 Vrms/1000 rpm					DF						
DC voltage link 48 VDC, voltage constant 12 Vrms/1000 rpm					DG						
Connector version											
Front panel connector for motor and encoder						M					
Cable outlet						O					
Customised connectors, e. g. ITT-Canon (= Field remains empty)						[ ]					
Motor feedback system at motor side											
Resolver 1 pole pair							ROO				
Incremental encoder (2048 Increments; RS-422)							DCO[1)]				
SSI Multi-turn absolute encoder FFB (64 SinCos, 16 bit Singleturn, 12 bit Multi-turn battery buffered)							MHS[1)]				
BiSS-C Singleturn absolute encoder FFB (16 bit Singleturn)							SZB[1)]				
BiSS-C Mult-iturn absolute encoder FFB (16 bit Singleturn, 16 bit Multi-turn battery buffered)							MZB[1)]				
Option Holding brake											
With holding brake 24V								B			
Without holding brake (= Field remains empty)								[ ]			
Feedback option on output side											
SSI Singleturn absolute encoder (Singleturn resolution 17-21 bit) output side									SXS		
no option (= Field remains empty)									[ ]		
Option Cable/Connector											
With cable/connector (axial cable outlet)										K	
No option (= Field remains empty)										[ ]	
Customised design											
Standard design (Field remains empty)											[ ]
Customised design (on request)											SP

Please refer to the table of possible combinations
1) A check of the conditions prior to the use is mandatory

Designation of motor feedback system

Table 1.4.2

Example: Resolver	R	O	O
Type			
Resolver	R		
Singleturn absolute	S		
Multi-turn absolute	M		
Incremental encoder	D		
Number of sine cosine periods			
1		O	
64		H	
2048		C	
none		X	
Protocol			
BiSS-C			B
SSI			S
none			O

Combinations

Table 1.4.3

Size		14A	17A	20A	25A	32A	40A
Ratio	30	o	o	o	o	o	o
	50	●	●	●	●	●	●
	80	o	o	o	o	o	o
	100	●	●	●	●	●	●
	120	-	o	o	o	o	o
	160	-	-	●	●	●	●
Motor winding type	FB	●	-	-	-	-	-
	FD	-	●	-	-	-	-
	FG	-	-	-	●	●	-
	DC	-	-	●	-	-	-
	DD	-	-	●	●	●	●
	DF	-	-	-	●	●	
	DG	-	-	-	-	-	●
Connector version	M	●	●	●	●	●	●
	O	o	o	o	o	o	o
Motor feedback system	ROO	●	●	●	●	●	●
	DCO	●	●	●	-	-	-
	MHS	-	●	●	●	●	-
	SZB	-	●	●	●	●	-
	MZB	-	●	●	●	●	-
Option Holding brake	B	o	o	o	o	o	o
Option Sensor	SXS	-	o	o	●	●	●
Option Cable/connector in axial direction	K	-	-	o	o	o	o
Sealing air connection		o	o	o	o	o	o

● available o on request - not available

Technical data

• Features

Table 1.4.4

Motor winding	[Unit]	Dx	Fx
Machine type		Permanent magnet synchronous motor	
Magnet material		Neodymium-iron-boron	
Insulation class (EN 60034-1)		F	F
Insulation resistance (500 VDC)	[MΩ]	100	
Insulation voltage (10 s)	[VAC]	600	1400
Lubrication		Flexolub®-A1 (optional Berulub)	
Degree of protection (EN 60034-5)		IP65 (Shaft seal ring is standard)	
Ambient operating temperature	[°C]	-40 … +65	
Ambient storage temperature	[°C]	-40 … +65	
Maximum installation altitude	[m]	4000 above sea level	
Relative humidity	[%]	maximum 80 (without condensation)	
Vibration resistance according to AECTP 400 Annex B401 [2]		according to figure B-4 (tracked vehicle)	
Shock resistance according to MIL-STD-810G, method 516.6 [2]		40 g according to procedure 1 - functional shock	
Corrosion protection (DIN IEC 60068 Part 2-11) Salt spray test)	[h]	16	
Temperature sensors (available versions) [1]		KTY 84-130 PTC-116K13-XX °C PT-1000 (DIN EN 60751)	
Gear component set		HFUC-2A (Optional CSG-2A)	

1) Safe separation according to EN 61800-5-1
2) The vibration and shock tests according to the MIL standard were carried out on an AlopexDrive with resolver as the feedback system.

• Cooling

Unless otherwise indicated, the values given in the tables refer to an overtemperature of the winding of 50 K at an ambient temperature of 65 °C and a maximum installation altitude of 1000 m above sea level. From an installation altitude > 1000 m above sea level, a derating of 1 % per 100 m must be made. The values in the following tables and the operating characteristics apply to drives mounted on an aluminium base plate with the following minimum dimensions:

Table 1.4.5

Series	Size	[Unit]	Dimension
AlopexDrive	14A	[mm]	200 x 200 x 6
	17A	[mm]	300 x 300 x 15
	20A	[mm]	300 x 300 x 15
	25A	[mm]	350 x 350 x 18
	32A	[mm]	350 x 350 x 18
	40A	[mm]	400 x 400 x 20

• Actuator data

AlopexDrive-14A, AlopexDrive-17A, AlopexDrive-20A

Actuators with 48 VDC-DC voltage link

Table 1.4.6

Actuator	Symbol [Unit]	14A		17A		20A		
Stator winding		FB		FD		DC		
Motor feedback system		Resolver		Encoder		Encoder		
Required motor terminal voltage	U_{LL} [V_{rms}]	34		34		34		
Ratio	i	50	100	50	100	50	100	160
Maximum output torque	T_{MAX} [Nm]	18	28	34	54	56	82	92
Maximum output speed	n_{MAX} [rpm]	170	85	140	70	130	65	41
Maximum current	I_{MAX} [A_{rms}]	9.8	7.8	11.2	9.0	21.0	15.8	11.9
Continuous stall torque	T_0 [Nm]	6.9	11.0	26.0	39.0	34.0	49.0	49.0
Continuous stall current	I_0 [A_{rms}]	3.3	2.7	7.7	5.8	11.7	8.4	5.5
No load starting current (20 °C)	I_{NLSC} [A_{rms}]	0.56	0.56	0.61	0.60	1.02	1.03	1.15
No load starting current (0 °C)	I_{NLSC} [A_{rms}]	0.71	0.77	0.85	0.94	1.46	1.66	1.97
No load starting current (-20 °C)	I_{NLSC} [A_{rms}]	1.11	1.36	1.67	2.10	3.02	3.98	5.03
No load starting current (-40 °C)	I_{NLSC} [A_{rms}]	2.85	4.11	6.96	10.12	12.94	19.21	25.49
No load current constant (-20 °C)	K_{INL} [10^{-3}A/rpm]	176.35	281.26	213.58	393.81	479.92	814.94	1226.90
No load current constant (20 °C)	K_{INL} [10^{-3}A/rpm]	38.79	57.37	30.20	56.42	68.05	113.13	169.13
No load current constant (90 °C)	K_{INL} [10^{-3}A/rpm]	14.79	21.11	9.85	18.37	17.63	28.64	42.49
Torque constant (motor)	K_T [Nm/Arms]	0.047		0.076		0.064		
AC voltage constant (L-L, 20 °C)	K_E [V_{rms}/1000 rpm]	3.3		5.0		4.3		
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	100		100		48		
Mechanical time constant without brake (20 °C)	T_M [ms]	10.8		10.8		7.4		
Electrical time constant (20 °C)	T_E [ms]	1.3		2.3		1.4		
Maximum motor speed	n_{MAX} [rpm]	8500		7300		6500		
Rated motor speed	n_N [rpm]	3500		3500		3500		
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	0.42		0.32		0.18		
Rotary field inductance	L_d [mH]	0.27		0.36		0.13		
Number of pole pairs	p	5		5		5		
Brake voltage	$U_{Br.}$ [V_{DC}]	21...30				18…32		
Brake holding torque	$T_{Br.}$ [Nm]	22.5	45.0	22.5	45.0	45.0	90.0	144.0
Brake power consumption	$P_{BR.}$ [W]	13		13		11		
Brake opening time	t_O [ms]	10		10		12		
Brake closing time	t_C [ms]	6		6		20		
Weight without brake	m [kg]	1.9		3.6		3.7		
Weight with brake	m [kg]	2.1		4.0		4.4		
Hollow shaft diameter	d_h [mm]	12		16		18		
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	5.4	7.8	16.0	24.0	25.0	40.0	40.0
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000		2000		2000		

You will find more information on this in the Engineering data chapter.

AlopexDrive-25A, AlopexDrive-32A, AlopexDrive-40A

Actuators with 48 VDC-DC voltage link

Table 1.4.7

Actuator	Symbol [Unit]	25A			32A			40A		
Stator winding		DD			DD			DD		
Motor feedback system		Resolver			Encoder			Encoder		
Required motor terminal voltage	U_{LL} [V_{rms}]	34			34			34		
Ratio	i	50	100	160	50	100	160	50	100	160
Maximum output torque	T_{MAX} [Nm]	98	157	176	216	333	372	300	568	647
Maximum output speed	n_{MAX} [rpm]	112	56	35	96	48	30	80	40	25
Maximum current	I_{MAX} [A_{rms}]	31.6	25.7	19.4	64.4	50.2	36.7	90.0	89.0	66.0
Continuous stall torque	T_0 [Nm]	55.0	108.0	108.0	65.1	140.0	216.0	116.6	241.4	383.9
Continuous stall current	I_0 [A_{rms}]	16.1	15.5	10.1	19.5	19.5	19.2	36.4	36.3	36.1
No load starting current (20 °C)	I_{NLSC} [A_{rms}]	1.60	1.64	1.85	2.10	1.90	2.09	4.21	3.85	4.24
No load starting current (0 °C)	I_{NLSC} [A_{rms}]	2.33	2.71	3.25	2.69	2.84	3.38	5.41	5.76	6.84
No load starting current (-20 °C)	I_{NLSC} [A_{rms}]	5.03	6.76	8.64	4.70	6.09	7.89	9.48	12.31	15.91
No load starting current (-40 °C)	I_{NLSC} [A_{rms}]	23.31	35.04	46.81	15.43	23.59	32.29	31.11	47.56	65.05
No load current constant (-20 °C)	K_{INL} [10^{-3}A/rpm]	811.70	1543.00	2364.10	890.61	1883.00	2784.20	2003.10	3551.40	5540.70
No load current constant (20 °C)	K_{INL} [10^{-3}A/rpm]	112.11	211.91	323.59	145.72	309.52	455.83	326.41	572.20	834.25
No load current constant (90 °C)	K_{INL} [10^{-3}A/rpm]	30.92	58.20	88.65	38.79	82.72	121.27	86.01	148.47	214.47
Torque constant (motor)	K_T [Nm/Arms]	0.078			0.078			0.075		
AC voltage constant (L-L, 20 °C)	K_E [V_{rms}/1000 rpm]	5.1			5.1			4.9		
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	48			48			48		
Mechanical time constant without brake (20 °C)	T_M [ms]	5.5			11.4			9.8		
Electrical time constant (20 °C)	T_E [ms]	2.2			2.2			2.7		
Maximum motor speed	n_{MAX} [rpm]	5600			4800			4000		
Rated motor speed	n_N [rpm]	3500			3500			3000		
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	0.07			0.07			0.03		
Rotary field inductance	L_d [mH]	0.08			0.08			0.04		
Number of pole pairs	p	6			6			6		
Brake voltage	$U_{Br.}$ [V_{DC}]	18…32			18…32			18...32		
Brake holding torque	$T_{Br.}$ [Nm]	90.0	180.0	288.0	90.0	180.0	288.0	225.0	450.0	720.0
Brake power consumption	$P_{BR.}$ [W]	15			15			19		
Brake opening time	t_O [ms]	13			13			25		
Brake closing time	t_C [ms]	15			15			35		
Weight without brake	m [kg]	6.4			8.2			11.7		
Weight with brake	m [kg]	7.6			9.4			13.8		
Hollow shaft diameter	d_h [mm]	27			32			39		
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	39	67	67	76	137	137	137	265	294
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000			2000			2000		

You will find more information on this in the Engineering data chapter.

• Moment of inertia

Table 1.4.8

	Symbol [Unit]	14A		17A		20A		
Motor feedback system		Resolver		Encoder		Encoder		
Ratio		50	100	50	100	50	100	160
Moment of inertia at output side								
Moment of inertia without brake	J_{OUT} [kgm^2]	0.095	0.380	0.325	1.300	0.280	1.120	2.867
Moment of inertia with brake	J_{OUT} [kgm^2]	0.115	0.460	0.345	1.380	0.348	1.390	3.558
Moment of inertia at motor side								
Moment of inertia without brake	J [kgm^2x10^{-4}]	0.38		1.30		1.12		
Moment of inertia with brake	J [kgm^2x10^{-4}]	0.46		1.38		1.39		

Table 1.4.9

	Symbol [Unit]	25A			32A			40A		
Motor feedback system		Resolver			Encoder			Encoder		
Ratio		50	100	160	50	100	160	50	100	160
Moment of inertia at output side										
Moment of inertia without brake	J_{OUT} [kgm^2]	0.795	3.180	8.141	1.648	6.590	16.870	3.075	12.300	31.488
Moment of inertia with brake	J_{OUT} [kgm^2]	0.970	3.880	9.933	2.085	8.340	21.350	3.550	14.200	36.352
Moment of inertia at motor side										
Moment of inertia without brake	J [kgm^2x10^{-4}]	3.18			6.59			12.30		
Moment of inertia with brake	J [kgm^2x10^{-4}]	3.88			8.34			14.20		

• Performance characteristics

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.4.1 **AlopexDrive-14A-50-FB**

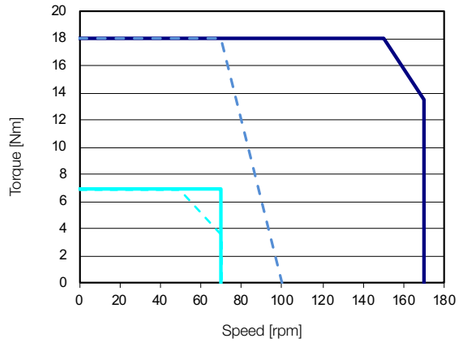


Illustration 1.4.2 **AlopexDrive-14A-100-FB**

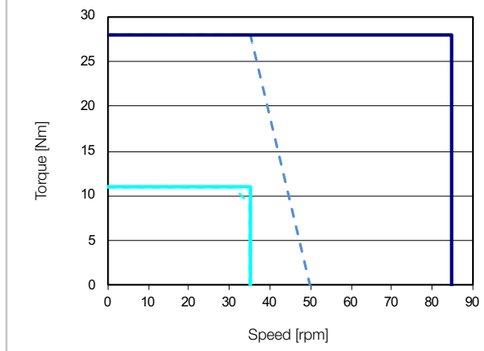


Illustration 1.4.3 **AlopexDrive-17A-50-FD**

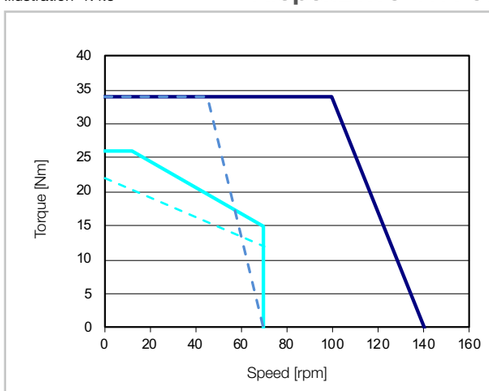


Illustration 1.4.4 **AlopexDrive-17A-100-FD**

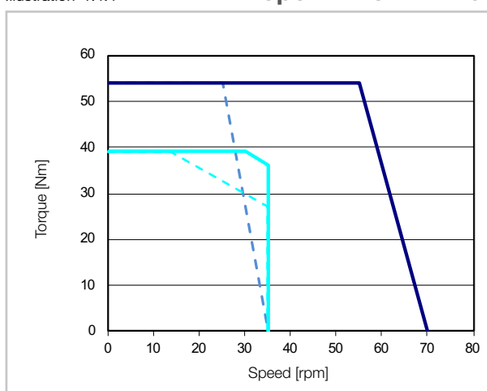


Illustration 1.4.5 **AlopexDrive-20A-50-DC**

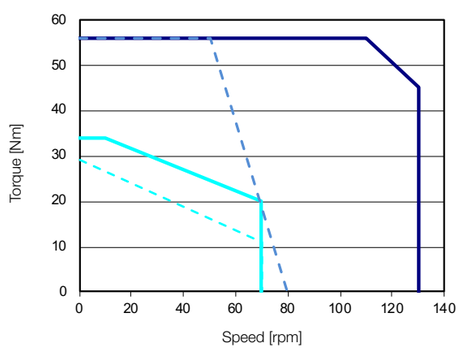
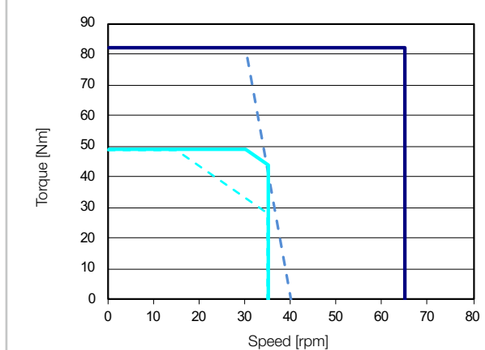


Illustration 1.4.6 **AlopexDrive-20A-100-DC**



U_M = 34 VAC
Intermittent duty

Continuous duty at 40 °C
Continuous duty at 65 °C
Limit speed reduction U_M = 18 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.4.7 **AlopexDrive-20A-160-DC**

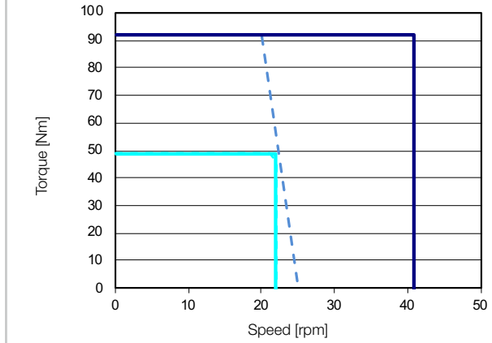


Illustration 1.4.8 **AlopexDrive-25A-50-DD**

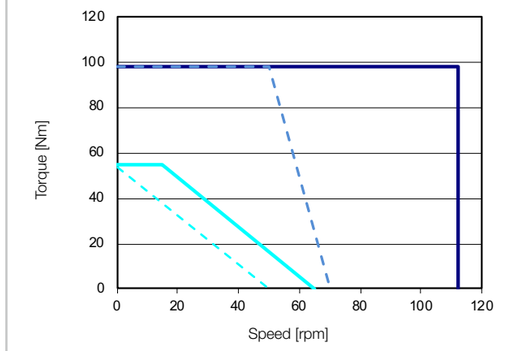


Illustration 1.4.9 **AlopexDrive-25A-100-DD**

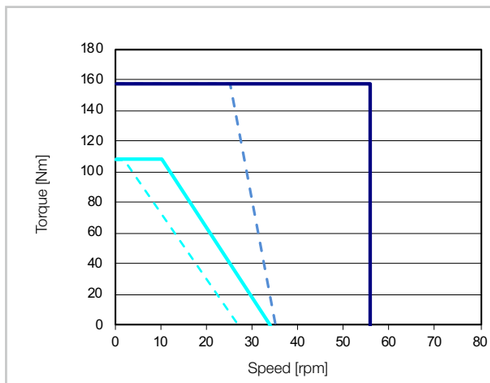


Illustration 1.4.10 **AlopexDrive-25A-160-DD**

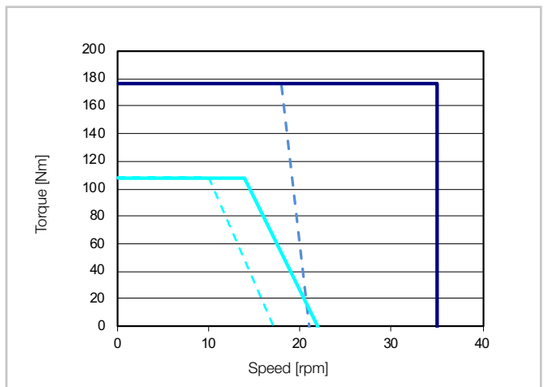


Illustration 1.4.11 **AlopexDrive-32A-50-DD**

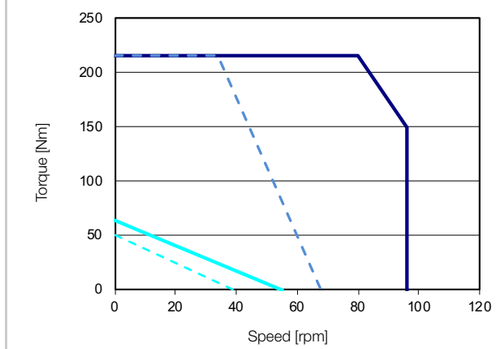
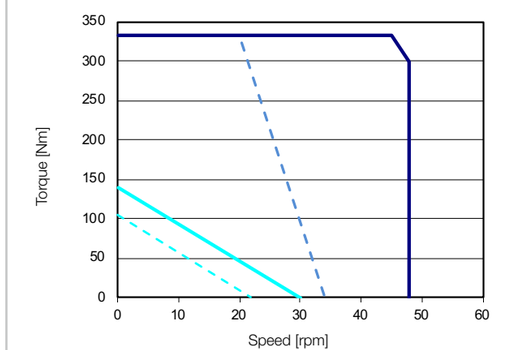


Illustration 1.4.12 **AlopexDrive-32A-100-DD**



U_M = 34 VAC
Intermittent duty

Continuous duty at 40 °C
Continuous duty at 65 °C
Limit speed reduction U_M = 18 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 1.4.13 **AlopexDrive-32A-160-DD**

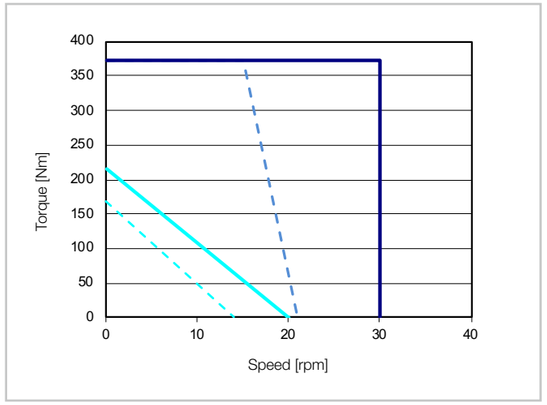


Illustration 1.4.14 **AlopexDrive-40A-50-DD**

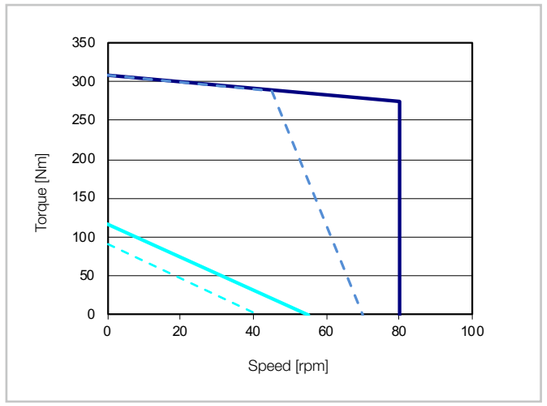


Illustration 1.4.15 **AlopexDrive-40A-100-DD**

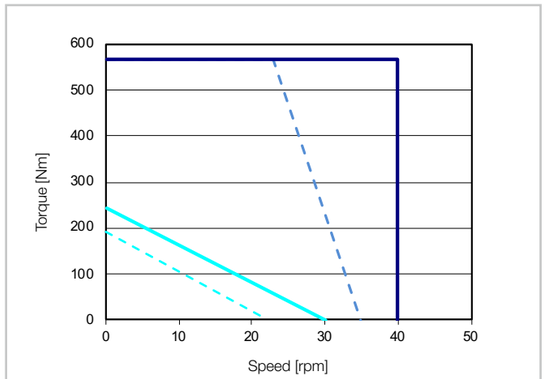
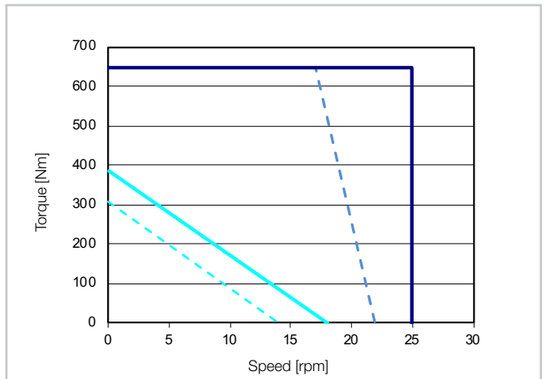


Illustration 1.4.16 **AlopexDrive-40A-160-DD**



U_M = 34 VAC
Intermittent duty

Continuous duty at 40 °C
Continuous duty at 65 °C

Limit speed reduction U_M = 18 VAC

• Dimensions

Illustration 1.4.17 **AlopexDrive-14A [mm]**

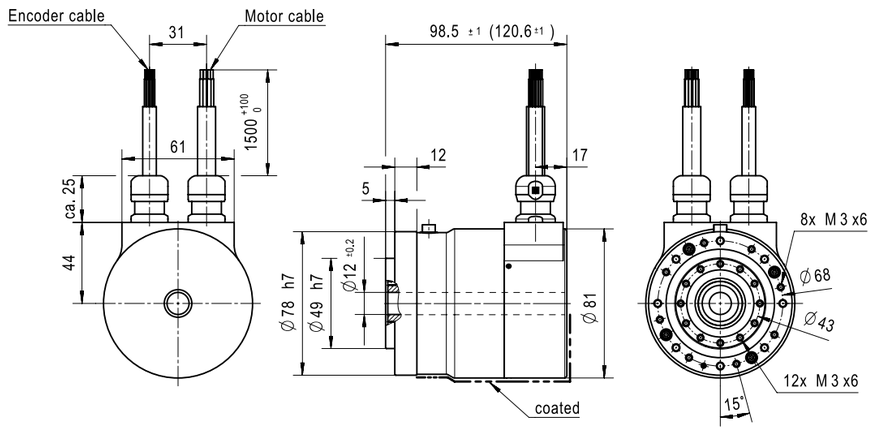
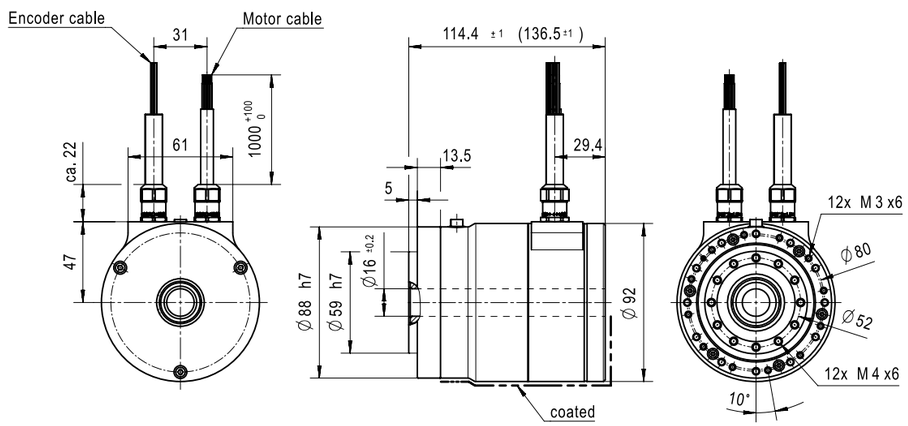


Illustration 1.4.18 **AlopexDrive-17A [mm]**



CAD drawings for download: www.harmonicdrive.co.uk

Illustration 1.4.19

AlopexDrive-20A [mm]

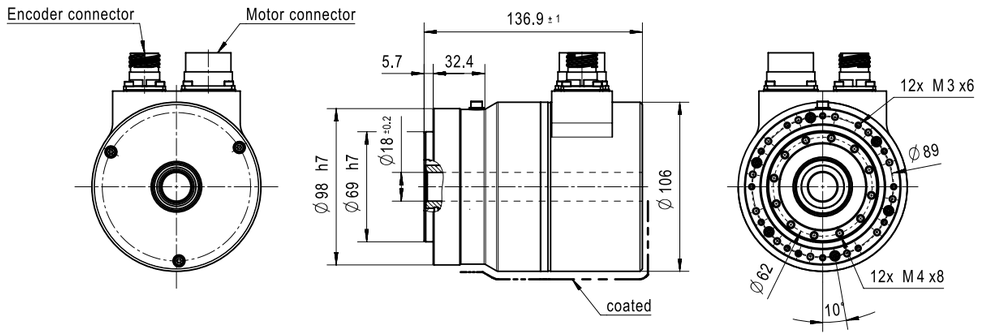
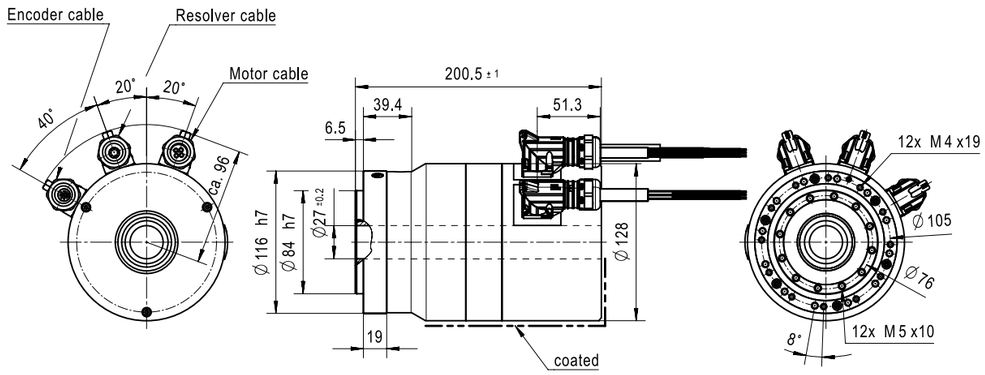


Illustration 1.4.20

AlopexDrive-25A [mm]



CAD drawings for download: www.harmonicdrive.co.uk

Illustration 1.4.21

AlopexDrive-32A [mm]

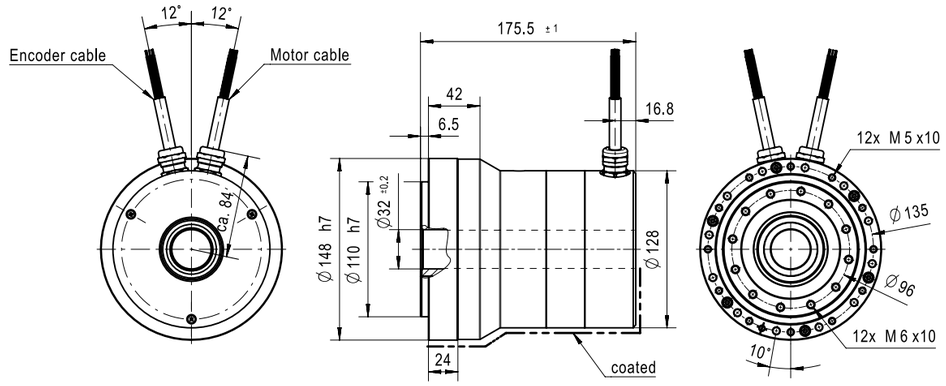
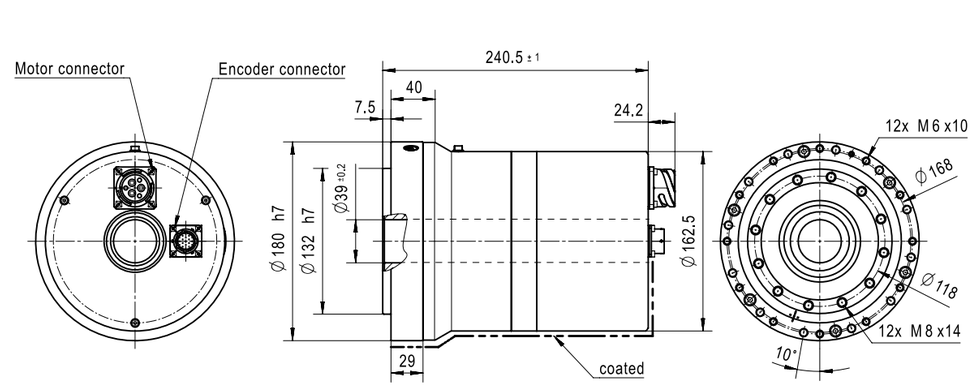


Illustration 1.4.22

AlopexDrive-40A [mm]



CAD drawings for download: www.harmonicdrive.co.uk

Gear characteristics

• Accuracy

Table 1.4.10

	Symbol [Unit]	14A		17A		20A		25A		32A		40A
Ratio	i [ ]	30	≥ 50	30	≥ 50	30	≥ 50	30	≥ 50	30	≥ 50	≥ 50
Transmission accuracy	[arcmin]	< 2.0	< 1.5	< 1.5	< 1.5	< 1.5	< 1.0	< 1.5	< 1.0	< 1.5	< 1.0	< 1.0
Repeatability	[arcmin]	< ±0.1		< ±0.1		< ±0.1		< ±0.1		< ±0.1		< ±0.1
Hysteresis loss	[arcmin]	< 3	< 1	< 3	< 1	< 3	< 1	< 3	< 1	< 3	< 1	< 1
Lost motion	[arcmin]	< 1		< 1		< 1		< 1		< 1		< 1

• Torsional stiffness

Table 1.4.11

	Symbol [Unit]	14A			17A			20A		
Limit torques	T_1 [Nm]	2.0			3.9			7.0		
	T_2 [Nm]	6.9			12.0			25.0		
Ratio	i [ ]	30	50	> 50	30	50	> 50	30	50	> 50
Torsional stiffness	K_3 [x 10^3 Nm/rad]	3.4	5.7	7.1	6.7	13.0	16.0	11.0	23.0	29.0
	K_2 [x 10^3 Nm/rad]	2.4	4.7	6.1	4.4	11.0	14.0	7.1	18.0	25.0
	K_1 [x 10^3 Nm/rad]	1.9	3.4	4.7	3.4	8.1	10.0	5.7	13.0	16.0

Table 1.4.12

	Symbol [Unit]	25A			32A			40A	
Limit torques	T_1 [Nm]	14.0			29.0			54.0	
	T_2 [Nm]	48.0			108.0			196.0	
Ratio	i [ ]	30	50	> 50	30	50	> 50	50	> 50
Torsional stiffness	K_3 [x 10^3 Nm/rad]	21.0	44.0	57.0	49.0	98.0	120.0	180.0	230.0
	K_2 [x 10^3 Nm/rad]	13.0	34.0	50.0	30.0	78.0	110.0	140.0	200.0
	K_1 [x 10^3 Nm/rad]	10.0	25.0	31.0	24.0	54.0	67.0	100.0	130.0

You will find more information on this in the Engineering data chapter.

Output bearing

Our servo actuators incorporate a high stiffness output bearing. This specially developed bearing can withstand high axial and radial forces as well as tilting moments. The reduction gear is therefore protected from external loads, so guaranteeing a long life and consistent performance. The integration of an output bearing also serves to reduce subsequent design and production cost, by removing the need for an additional output bearing in many applications.

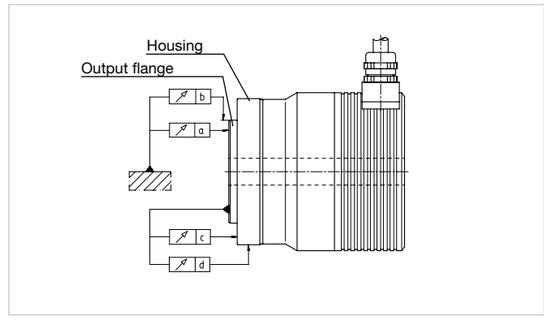
• Performance data

Table 1.4.13

	Symbol [Unit]	14A	17A	20A	25A	32A	40A
Bearing type[1]		C[6]	C[6]	C[6]	C	C	C
Pitch circle diameter	d_p [m]	0.0465	0.0592	0.0700	0.0889	0.1135	0.1340
Offset[2]	R [m]	0.0128	0.0136	0.0162	0.0182	0.0201	0.0258
Dynamic load rating	C [N]	9500	10700	21000	24800	43800	48500
Static load rating	C_0 [N]	11700	14800	27700	37500	68600	82900
Permissible dynamic tilting moment[3,4]	M [Nm]	73	114	172	254	578	886
Tilting moment stiffness[5]	K_B [Nm/arcmin]	23	40	70	114	350	522
Permissible axial force[4]	F_a [N]	2030	2286	4486	5298	9357	10361
Permissible radial force[4]	F_r [N]	1360	1532	3006	3550	6269	6942

1) Bearing type C = Cross roller bearing; F = Four point contact bearing
2) Distance between the centre of the rolling bearing and the screw mounting surface on the output side, see chapter Actuator dimensioning.
3) These values are valid for moving gears. They are not based on the equation for lifetime of the output bearing but on the maximum allowable deflection of the Harmonic Drive® Gear Component Set. The values indicated in the table must not be exceeded even if the lifetime equation of the bearing permits higher values.
4) These data are valid for **M**: $F_a = 0$, $F_r = 0$ I **F_a**: M = 0, $F_r = 0$ I **F_r**: M = 0, $F_a = 0$
5) The value of tilting moment stiffness is the average value (± 20 %).
6) Alternatively, a four point contact bearing can be used.

Illustration 1.4.23



• Tolerances

Table 1.4.14

	[Unit]	14A	17A	20A	25A	32A	40A
a	[mm]	0.010	0.010	0.010	0.010	0.012	0.012
b	[mm]	0.010	0.010	0.010	0.010	0.010	0.010
c	[mm]	0.010	0.010	0.010	0.010	0.012	0.012
d	[mm]	0.010	0.010	0.010	0.010	0.010	0.010

Temperature sensors

Temperature sensors are integrated in the motor windings for winding protection at speed > 0.
For applications with high loads at n = 0, additional protection (for example I^2t monitoring) is recommended.
Various temperature sensors are available and can be used for specific applications.

Table 1.4.15

Sensor type	Parameter	T_{NAT} [°C]
PTC 1	Rated response temperature	120
PTC 2	Rated response temperature	145

PTC thermistors are well suited as winding protection because of their very high positive temperature coefficient at rated response temperature (T_{Nat}).

Due to the working principle of PTC the winding can only be protected against overheating.

Illustration 1.4.24

Characteristic PTC

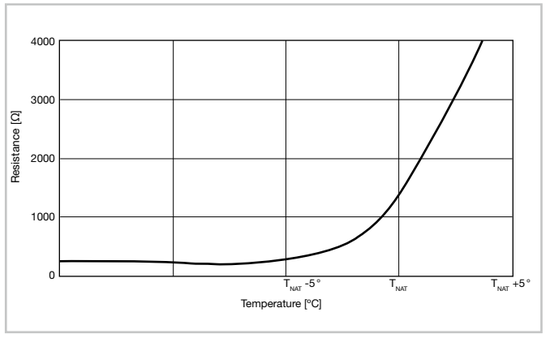


Table 1.4.16

Sensor type	Parameter	Symbol [Unit]	Warning	Switch off
KTY-84-130	Temperature	T [°C]	110	120
PT-1000 (DIN EN 60751)	Temperature	T [°C]	110	120

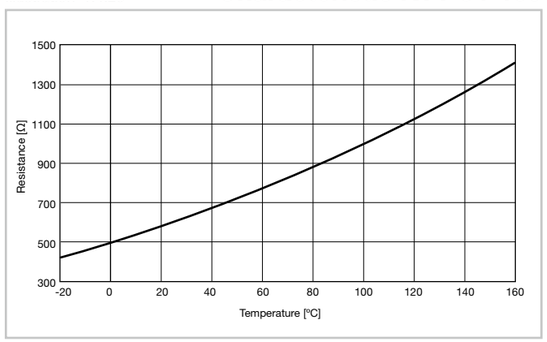
When using the KTY 84-130, the values given in the table must be parameterised in the servo controller or an external evaluation device.

The KTY sensor is used to measure the temperature and monitor the motor winding.

When using the KTY, it is possible to also protect the gear grease from impermissible temperatures.

Illustration 1.4.25

Characteristic KTY 84-130



Motor feedback systems

Due to the sometimes high demands on reliability and robustness, the motor feedback systems are to be selected in close consultation with Harmonic Drive SE. Only a few possible sensors are shown here, which have proven themselves in practice.
In many cases resolvers or suitable incremental encoders are mounted on the motor shaft and additional absolute encoders are mounted on the gear output side.
The sensors on the motor shaft are usually used for commutation, current control and speed control.
The sensors on the gear output side are typically used for position control.

- Motor feedback system ROO

Resolver

Table 1.4.17

Ordering code	Symbol [Unit]	ROO				
Manufacturer´s designation		RE				
Power supply[1]	U_b [VAC]	7				
Power consumption (max., without load)[1]	I [mA]	50				
Input frequency	f [kHz]	5 … 10				
Pole pairs		1				
Transmission ratio[1]	ü [ ]	0.5 ±10 %				
Temperature range	T [°C]	- 55 ~ + 155				
Accuracy[1]	[arcmin]	±10				
Resolution incremental (at motor side)[2]	[inc]	2048				
Resolution (output side)[2]		Gear ratio				
	i [ ]	**50**	**80**	**100**	**120**	**160**
	[arcsec]	13	8	7	6	4

1) Source: Manufacturer
2) For interpolation with 11 bit
Further electrical parameters are available on request.

- Motor feedback system SXS

Singleturn absolute motor feedback system with SSI interface

Table 1.4.18

Ordering code	Symbol [Unit]	SXS		
Manufacturer´s designation		z.B. INC-XX-100		
Protocol		SSI without SinCos periods		
Power supply	U_b [V_{DC}]	optional 5, 12, 24		
Power consumption	I [mA]	100		
Absolute position values per revolution		optional 17 … 21 bit		
Repeatability	Cts.	±1		
Gear ratio		**50**	**100**	**160**
Resolution of absolute value on output side (gear output) at 17 bit sensor resolution	[arcsec]	0.1978	0.0989	0.0618
Resolution of absolute value on output side (gear output) with 21 bit sensor resolution	[arcsec]	0.0124	0.0062	0.0039

Depending on the requirements and the prevailing environmental conditions, motor feedback systems can also be used, which were originally designed for industrial applications.
Further systems are described in chapter 1.6. For the selection of the systems and verification of the boundary conditions, consultation with Harmonic Drive SE is required.

Electrical connections

• Motor connector

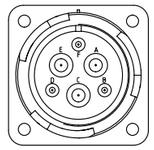
Table 1.4.19

Connector with bayonet fitting front wall mounting	ITT/Canon CA3102
Outer diameter	Ø 34,2 mm
Length	23 mm from housing

Table 1.4.20

Connector pin	A	B	C	D	E	F	Shield
Signal	Phase U	Brake +	Phase V	Brake -	Phase W	Encoder connector, Pin G [1)]	Housing

Illustration 1.4.26



• Encoder connector

Table 1.4.21

Connector with bayonet fitting front wall mounting	Amphenol MS3120
Outer diameter	Ø 22,3 mm
Length	13,3 mm from housing

Table 1.4.22

Connector pin	A	M	H	T	S	V
Signal	+24 VDC	GND	Clock+	Clock-	Data-	Data

Illustration 1.4.27

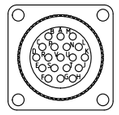


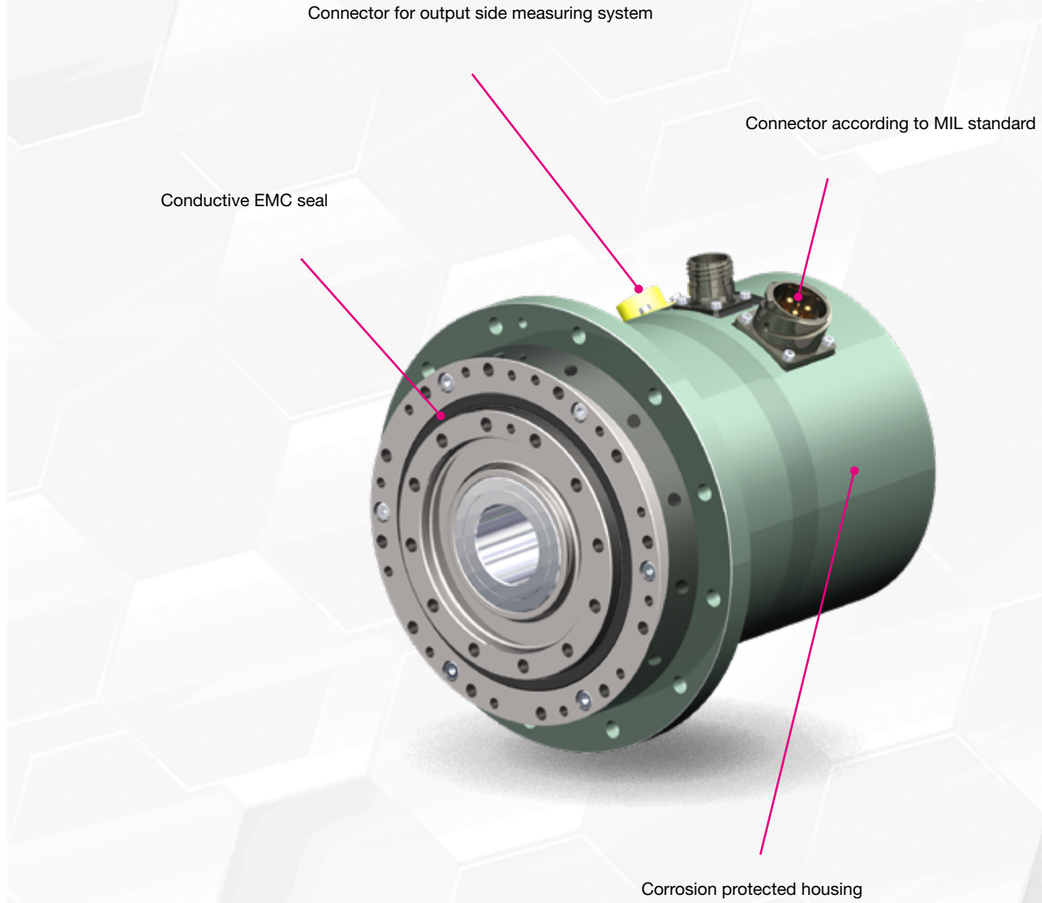
Table 1.4.23

Connector pin	C	D	L	K	U	J
Signal	Zero Set	Zero Reset	S1 (Sin+)	S3 (Sin-)	S2 (Cos+)	S4 (Cos-)

Table 1.4.24

Connector pin	P	B	R	E	F	G
Signal	R1 (Ref+)	R2 (Ref-)	Temp+ (KTY)	Temp- (KTY)	Inner shield	Motor connector, Pin F [1)]

1) Check whether both plugs are plugged in.



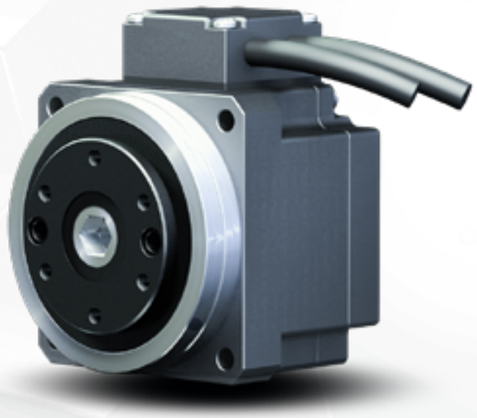
Product description

Compact mini servo actuator

The FHA-C Mini Series Servo Actuators consist of a synchronous servo motor and backlash free gear with output bearing. The tilt resistant output bearing can allow direct attachment of high payloads without the necessity of further support bearing and therefore provides a cost effective and space saving design essential for small installation space. For motor feedback, either an incremental RS-422 or a multi-turn absolute EnDat 2.2/22 are available.

Features

- Compact, lightweight design
- Integrated, tilt resistant output bearing
- Outstanding, lifelong precision
- Various feedback systems
- High dynamics
- Compact construction



Ordering code

Table 1.5.1

Ordering code	FHA	-	8	C	-	100	-	D200	-	E	KM1	-	UL	-	SP
FHA Series															
Size			8												
(corresponds to the pitch circle diameter			11												
of the Flexspline toothing in inches x 10)			14												
Product generation				C											
Ratio						30									
						50									
						100									
Motor feedback system															
Incremental encoder (2000 Increments; RS-422)								D200							
EnDat 2.2 Multi-turn absolute encoder															
(19 bit Singleturn, 16 bit multi-turn battery buffered)								MZE							
Motor winding type															
DC voltage link 320 VDC (= Field remains empty)										[ ]					
DC voltage link 48 VDC										E					
Connector version/Cable outlet															
Motor connector ytec 9-pol.; encoder connector ytec 12-pol., housing connector											Y				
Cable outlet at rear, 1.0 meter cable length											KM1				
Cable outlet at rear, 0.3 meter cable length											K				
Cable outlet at the side, 1.0 meter cable length											M1				
Cable outlet at the side, 0.3 meter cable length											[ ]				
Option UL certification															
With UL certification (only for E variants/48 VDC available)													UL		
Without UL certification (= Field remains empty, actuator is compliant with EU directives)													[ ]		
Customised design															
Standard design (Field remains empty)															[ ]
Customised design (on request)															SP

Combinations

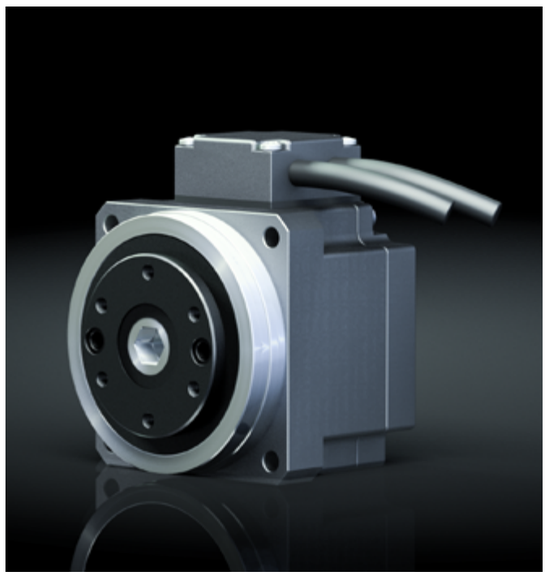
Table 1.5.2

Size		8C	11C	14C
Ratio	30	●	●	●
	50	●	●	●
	100	●	●	●
Motor feedback system	D200	●	●	●
	MZE	●	●	●
Motor winding type	E[2]	●	●	●
	-	●	●	●
Connector version/cable outlet	Y[1]	●	●	●
	KM1	o	o	o
	K	o	o	o
	M1	o	o	o
	-	●	●	●
Option UL certification	UL	o	o	o
Option holding brake		-	-	-

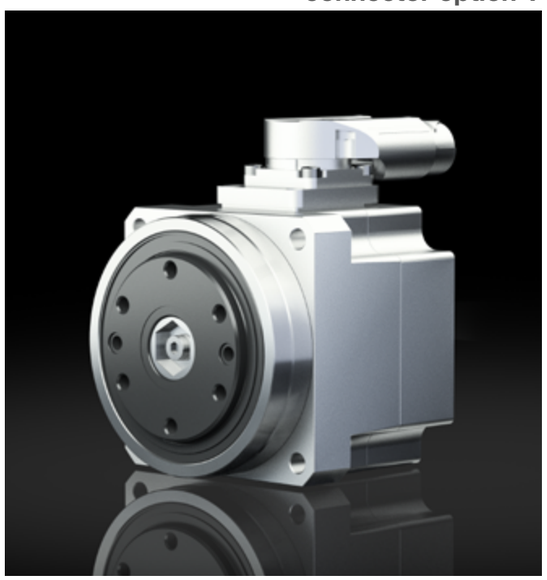
● available o on request - not available

[1] Only in conjunction with motor feedback MZE
[2] UL certified actuators on request

FHA-C Mini with cable outlet at the side



FHA-C Mini with connector option Y



Technical data

• Features

Table 1.5.3

Motor winding	[Unit]	E	-
Machine type		Permanent magnet synchronous motor with concentrated winding	
Magnet material		Neodymium-iron-boron	
Insulation class (EN 60034-1)		B	B
Insulation resistance (500 VDC)	[MΩ]	100	
Insulation voltage (10 s)	[VAC]	500	1500
Lubrication		SK-2	
Degree of protection (EN 60034-5)		IP44	
Ambient operating temperature	[°C]	0 … 40	
Ambient storage temperature	[°C]	-20 … 60	
Maximum installation altitude	[m]	4000 above sea level	
Relative humidity	[%]	maximum 80 (without condensation)	
Vibration resistance (DIN IEC 60068 Teil 2-6, 10 … 500 Hz)	[g]	2.5	
Shock resistance (DIN IEC 60068 Teil 2-27, 11 ms)	[g]	30	
Corrosion protection (DIN IEC 60068 Teil 2-11 Salt spray test)	[h]	-	
Temperature sensors		-	-
Gear component set		HFUC-2A	

• Cooling

Unless otherwise indicated, the values given in the tables refer to an overtemperature of the winding of 50 K at an ambient temperature of 40 °C and a maximum installation altitude of 1000 m above sea level. From an installation altitude > 1000 m above sea level, a deration of 1 % per 100 m must be made. The values in the following tables and the operating characteristics apply to drives mounted on an aluminium base plate with the following minimum dimensions:

Table 1.5.4

Series	Size	[Unit]	Dimension
FHA	8C	[mm]	150 x 150 x 6
	11C	[mm]	150 x 150 x 6
	14C	[mm]	200 x 200 x 6

• Actuator data

FHA-C Mini
Actuators with 320 VDC maximum stationary DC bus voltage

Table 1.5.5

Actuator	Symbol [Unit]	8C			11C			14C		
Stator winding		-			-			-		
Motor feedback system		D200, MZE			D200, MZE			D200, MZE		
Ratio	i	30	50	100	30	50	100	30	50	100
Maximum output torque	T_{MAX} [Nm]	1.8	3.3	4.8	4.5	8.3	11.0	9	18	28
Maximum output speed	n_{MAX} [rpm]	200	120	60	200	120	60	200	120	60
Maximum current	I_{MAX} [A_{rms}]	0.61	0.64	0.48	1.50	1.60	1.10	2.90	3.20	2.40
Continuous stall torque	T_0 [Nm]	0.75	1.50	2.00	1.80	2.90	4.20	3.50	4.70	6.80
Continuous stall current	I_0 [Arms]	0.31	0.34	0.26	0.74	0.69	0.54	1.27	1.06	0.85
No load starting current	I_{NLSC} [Arms]	0.12	0.12	0.12	0.27	0.25	0.22	0.44	0.41	0.40
Torque constant (motor)	K_T [Nm/A_{rms}]	0.14			0.14			0.15		
AC voltage constant (L-L, 20 °C)	K_E [V_{rms}/1000 rpm]	9.8			9.8			10.6		
Maximum steady state DC link voltage	V_{CC} [V_{DC}]	320			320			320		
Mechanical time constant D200 (20 °C)	T_M [ms]	6.8			4.4			4.0		
Electrical time constant (20 °C)	T_E [ms]	0.4			0.9			1.3		
Maximum motor speed	n_{MAX} [rpm]	6000			6000			6000		
Rated motor speed	n_N [rpm]	3500			3500			3000		
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	28.0			7.4			2.8		
Rotary field inductance	L_d [mH]	8.55			4.8			2.7		
Number of pole pairs	p	5			5			5		
Weight (MZE)	m [kg]	0.4 (0.5)			0.6 (0.7)			1.2 (1.3)		
Hollow shaft diameter (MZE)	d_h [mm]	6.2 (-)			8.0 (-)			13.5 (-)		
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	0.9	1.8	2.4	2.2	3.5	5.0	4.0	5.4	7.8
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000			2000			2000		

The values in ( ) refer to the motor feedback system MZE

FHA-C Mini
Actuators with 48 VDC maximum stationary DC bus voltage

Table 1.5.6

Actuator	Symbol [Unit]	8C			11C			14C		
Stator winding		E			E			E		
Motor feedback system		D200, MZE			D200, MZE			D200, MZE		
Ratio	i	30	50	100	30	50	100	30	50	100
Maximum output torque	T_{MAX} [Nm]	1.8	3.3	4.8	4.5	8.3	11.0	9.0	18.0	28.0
Maximum output speed	n_{MAX} [rpm]	200	120	60	200	120	60	200	120	60
Maximum current	I_{MAX} [A_{rms}]	3.0	3.3	2.4	7.8	8.2	5.6	14.8	16.4	12.3
Continuous stall torque	T_0 [Nm]	0.75	1.50	2.00	1.80	2.90	4.20	3.50	4.70	6.80
Continuous stall current	I_0 [Arms]	1.60	1.70	1.30	3.70	3.50	2.80	6.50	5.40	4.40
No load starting current	I_{NLSC} [Arms]	0.66	0.55	0.56	1.45	1.27	1.18	2.13	2.04	2.06
Torque constant (motor)	K_T [Nm/A_{rms}]	0.027			0.026			0.029		
AC voltage constant (L-L, 20 °C)	K_E [V_{rms}/1000 rpm]	2.0			1.8			2.0		
Maximum steady state DC link voltage	V_{CC} [V_{DC}]	48			48			48		
Mechanical time constant D200 (20 °C)	T_M [ms]	6.7			5.6			5.4		
Electrical time constant (20 °C)	T_E [ms]	0.4			0.6			0.9		
Maximum motor speed	n_{MAX} [rpm]	6000			6000			6000		
Rated motor speed	n_N [rpm]	3500			3500			3000		
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	1.08			0.38			0.14		
Rotary field inductance	L_d [mH]	0.330			0.165			0.090		
Number of pole pairs	p	5			5			5		
Weight (MZE)	m [kg]	0.4 (0.5)			0.6 (0.7)			1.2 (1.3)		
Hollow shaft diameter (MZE)	d_h [mm]	6.2 (-)			8.0 (-)			13.5 (-)		
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	0.9	1.8	2.4	2.2	3.5	5.0	4.0	5.4	7.8
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000			2000			2000		

The values in ( ) refer to the motor feedback system MZE

• Moment of inertia

Table 1.5.7

	Symbol [Unit]	8C			11C			14C		
Motor feedback system		**D200**			**D200**			**D200**		
Ratio		30	50	100	30	50	100	30	50	100
Moment of inertia at output side										
Moment of inertia	J_{OUT} [kgm^2]	0.003	0.007	0.029	0.006	0.017	0.067	0.018	0.050	0.200
Moment of inertia at motor side										
Moment of inertia	J [kgm^2x10^{-4}]	0.029			0.067			0.200		
Motor feedback system		**MZE**			**MZE**			**MZE**		
Ratio		30	50	100	30	50	100	30	50	100
Moment of inertia at output side										
Moment of inertia without brake	J_{OUT} [kgm^2]	0.003	0.007	0.029	0.006	0.017	0.069	0.019	0.054	0.215
Moment of inertia at motor side										
Moment of inertia without brake	J [kgm^2x10^{-4}]	0.029			0.069			0.215		

• Performance characteristics

The performance curves shown are valid for the specified ambient temperature (operation) and provided that the motor terminal voltage is at least 220 VAC for the standard version and 18 VAC for the E version.

Illustration 1.5.1 **FHA-8C-30**

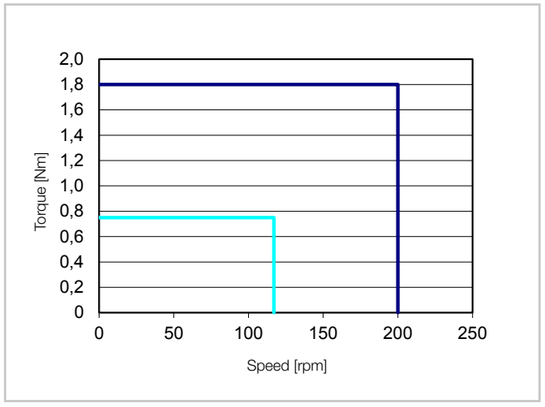


Illustration 1.5.2 **FHA-8C-50**

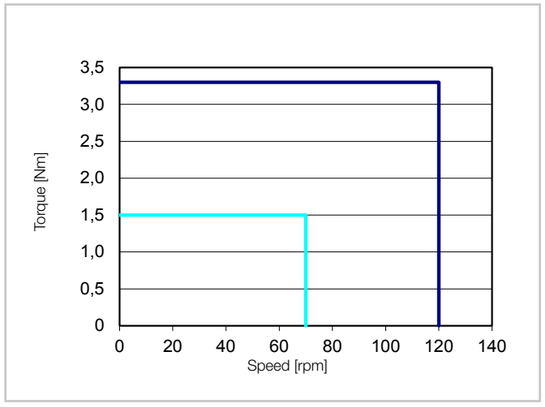


Illustration 1.5.3 **FHA-8C-100**

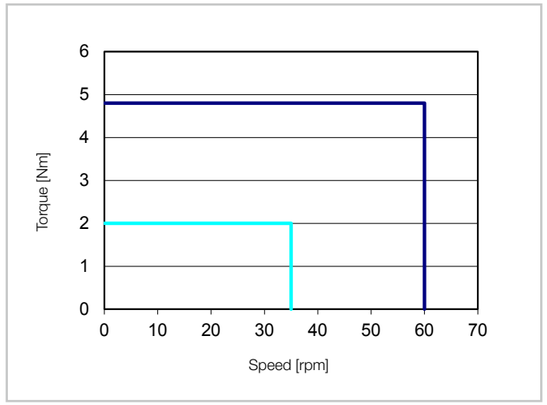


Illustration 1.5.4 **FHA-11C-30**

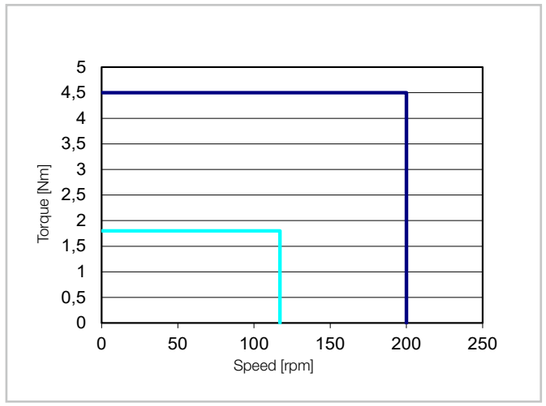


Illustration 1.5.5 **FHA-11C-50**

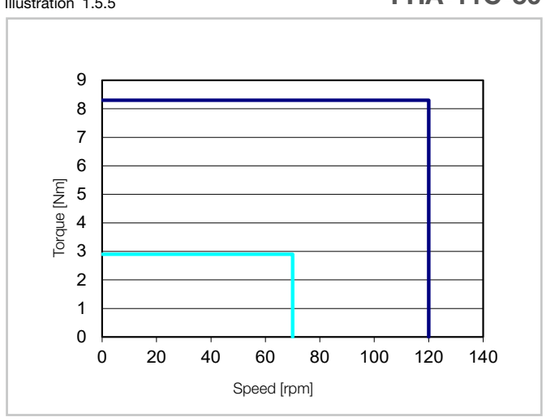
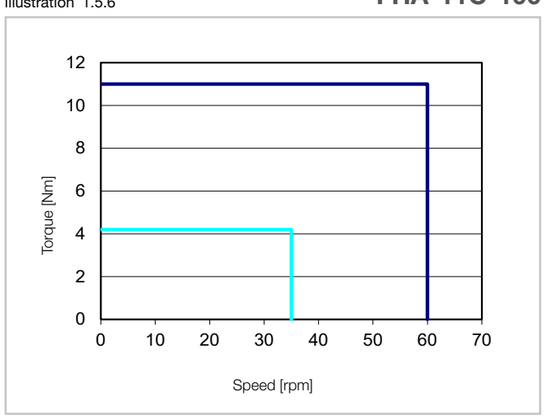


Illustration 1.5.6 **FHA-11C-100**



Intermittent duty ——— Continuous duty ———

The performance curves shown are valid for the specified ambient temperature (operation) and provided that the motor terminal voltage is at least 220 VAC for the standard version and 18 VAC for the E version.

Illustration 1.5.7 **FHA-14C-30**

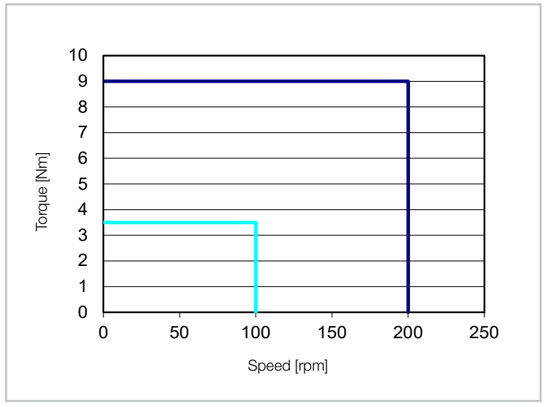


Illustration 1.5.8 **FHA-14C-50**

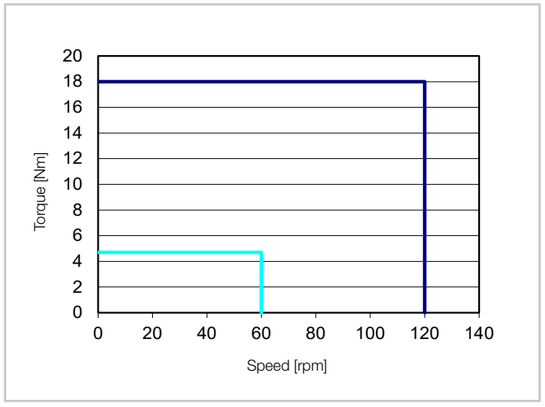
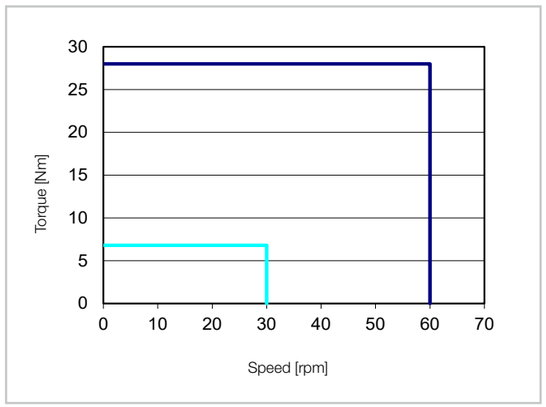


Illustration 1.5.9 **FHA-14C-100**



Intermittent duty ——— Continuous duty ———

• Dimensions

Illustration 1.5.10

FHA-8C Mini-D200 [mm]

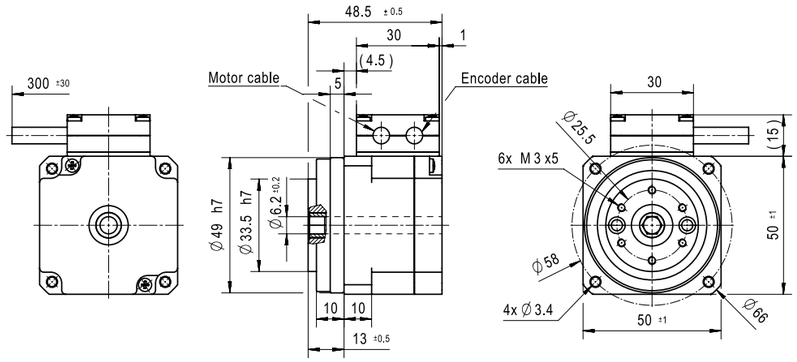


Illustration 1.5.11

FHA-8C Mini-D200-K [mm]

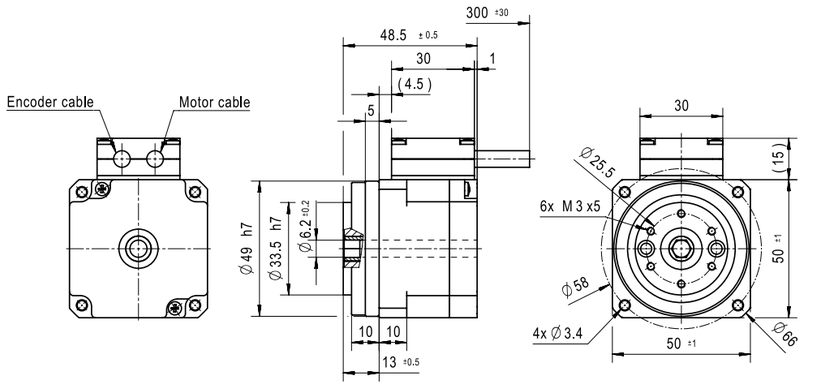
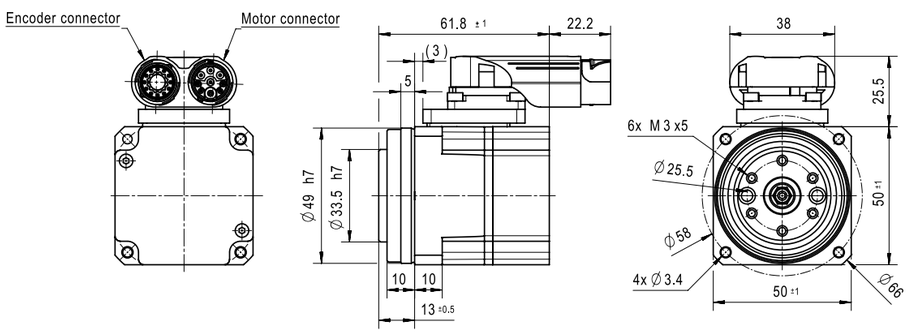


Illustration 1.5.12

FHA-8C Mini-MZE [mm]



CAD drawings for download: www.harmonicdrive.co.uk

Illustration 1.5.13

FHA-11C Mini-D200 [mm]

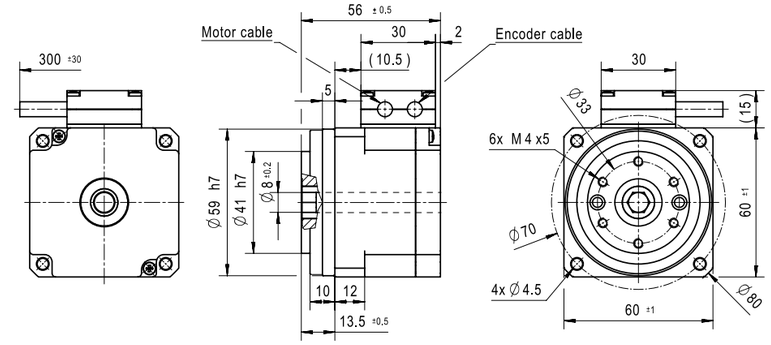


Illustration 1.5.14

FHA-11C Mini-D200-K [mm]

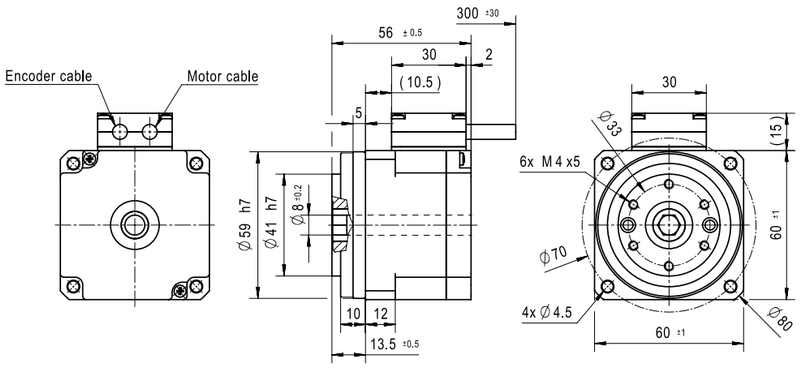
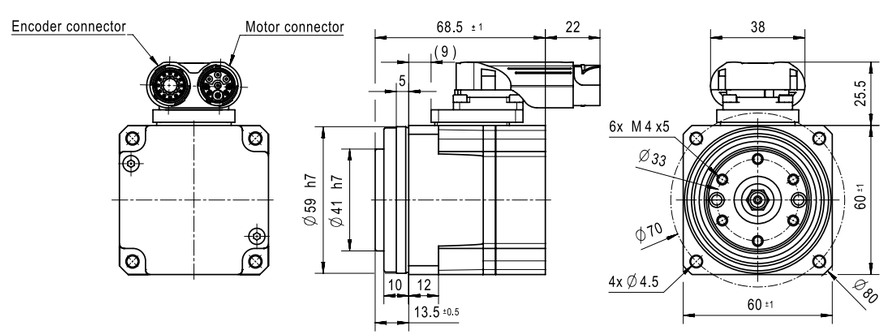


Illustration 1.5.15

FHA-11C Mini-MZE [mm]



CAD drawings for download: www.harmonicdrive.co.uk

Illustration 1.5.16

FHA-14C Mini-D200 [mm]

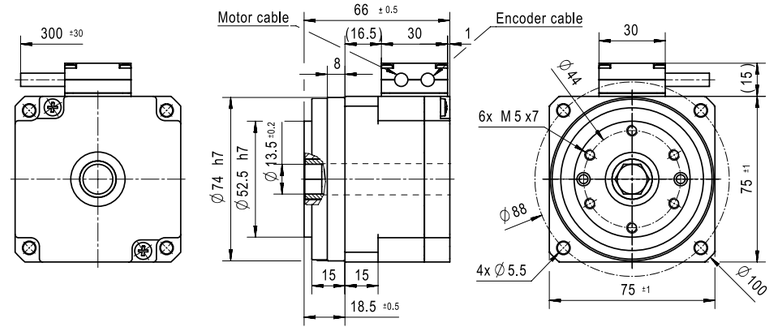


Illustration 1.5.17

FHA-14C Mini-D200-K [mm]

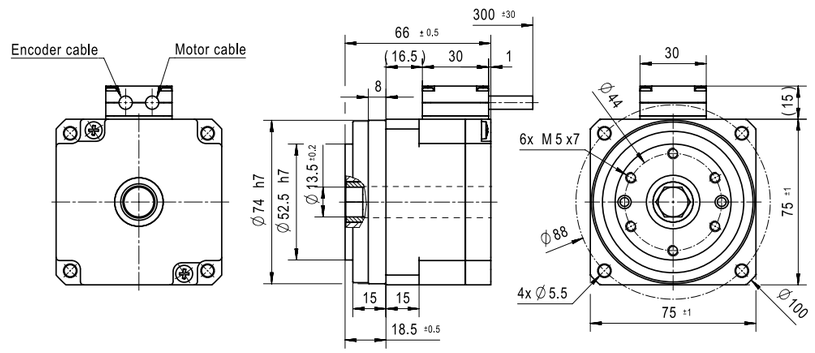
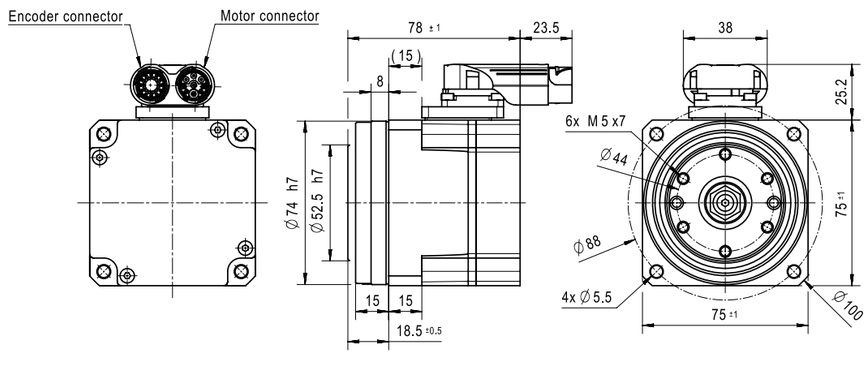


Illustration 1.5.18

FHA-14C Mini-MZE [mm]



CAD drawings for download: www.harmonicdrive.co.uk

Gear characteristics

• Accuracy

Table 1.5.8

	Symbol [Unit]	8C			11C			14C		
Ratio	i [ ]	30	50	100	30	50	100	30	50	100
Transmission accuracy	[arcmin]	< 2.5	< 2.0	< 2.0	< 2.0	< 1.5	< 1.5	< 2.0	< 1.5	< 1.5
Repeatability	[arcmin]	< ± 0.1	< ± 0.1	< ± 0.1	< ± 0.1	< ± 0.1	< ± 0.1	< ± 0.1	< ± 0.1	< ± 0.1
Hysteresis loss	[arcmin]	< 3.0	< 3.0	< 2.0	< 3.0	< 2.0	< 2.0	< 3.0	< 2.0	< 2.0
Lost motion	[arcmin]	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0	< 1.0

• Torsional stiffness

Table 1.5.9

	Symbol [Unit]	8C			11C			14C		
Limit torques	T_1 [Nm]	0.29			0.80			2.00		
	T_2 [Nm]	0.75			2.00			6.90		
Ratio	i [ ]	30	50	100	30	50	100	30	50	100
Torsional stiffness	K_3 [x 10^3 Nm/rad]	0.54	0.84	1.20	1.60	3.20	4.40	3.40	5.70	7.10
	K_2 [x 10^3 Nm/rad]	0.44	0.67	1.00	1.30	3.00	3.40	2.40	4.70	6.10
	K_1 [x 10^3 Nm/rad]	0.34	0.44	0.91	0.84	2.20	2.70	1.90	3.40	4.70

Output bearing

Our servo actuators incorporate a high stiffness output bearing. This specially developed bearing can withstand high axial and radial forces as well as tilting moments. The reduction gear is therefore protected from external loads, so guaranteeing a long life and consistent performance. The integration of an output bearing also serves to reduce subsequent design and production cost, by removing the need for an additional output bearing in many applications.

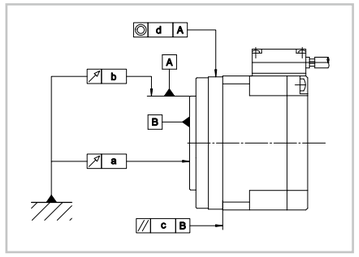
• Performance data

Table 1.5.10

	Symbol [Unit]	8C	11C	14C
Bearing type[1)]		C	C	C
Pitch circle diameter	d_p [mm]	35.0	42.5	54.0
Offset[2)]	R [mm]	12.9	14.0	14.0
Dynamic load rating	C [N]	5800	6500	7400
Static load rating	C_0 [N]	8000	9900	12800
Permissible dynamic tilting moment[3,4)]	M [Nm]	15	40	75
Tilting moment stiffness[5)]	K_B [Nm/arcmin]	5.8	11.8	23.5
Permissible axial force[4)]	F_a [N]	200	300	500
Permissible radial force[4)]	F_r [N]	1163	2857	5357

1) Bearing type C = Cross roller bearing; F = Four point bearing
2) Distance between the centre of the rolling bearing and the screw mounting surface on the output side, see chapter Actuator dimensioning.
3) These values are valid for moving gears. They are not based on the equation for lifetime of the output bearing but on the maximum allowable deflection of the Harmonic Drive® Gear Component Set. The values indicated in the table must not be exceeded even if the lifetime equation of the bearing permits higher values.
4) These data are valid for **M**: $F_a = 0$, $F_r = 0$ I $\mathbf{F}_a$: $M = 0$, $F_r = 0$ I $\mathbf{F}_r$: $M = 0$, $F_a = 0$
5) The value of tilting moment stiffness is the average value (± 20 %).

Illustration 1.5.19



• Tolerances

Table 1.5.11

	Symbol [Unit]	8C	11C	14C
a	[mm]	0.010	0.010	0.010
b	[mm]	0.010	0.010	0.010
c	[mm]	0.040	0.040	0.040
d	[mm]	0.040	0.040	0.040

Temperature sensors

Due to the compact design of the Series FHA-C Mini, no temperature sensors are integrated for motor protection. The control unit used must protect the actuator from overload.

Battery box

Battery box for multi-turn absolute motor feedback system MZE

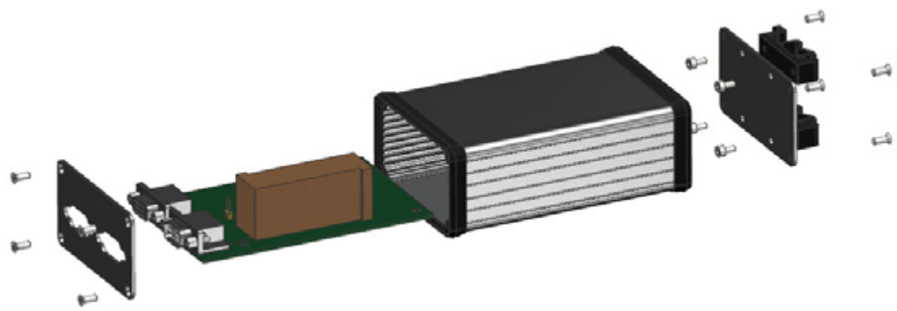
The battery box is an accessory for operating the multi-turn absolute motor feedback system MZE and serves to buffer the position data when the power supply is switched off. The battery box is intended for installation in the control cabinet. A corresponding protective circuit is integrated to protect against wiring errors.

Illustration 1.5.20 **Battery box mat.-no. 1024385**

The battery is not included in the scope of delivery.

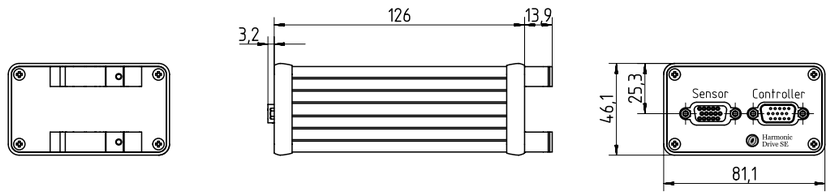
Recommended battery: Lithium thionyl chloride
3.6V / ≥ 2.0Ah / AA
for example Tadiran SL-760S

Illustration 1.5.21 **Exploded view**



Dimensions

Illustration 1.5.22



Mounting: DIN mounting rail 35 mm

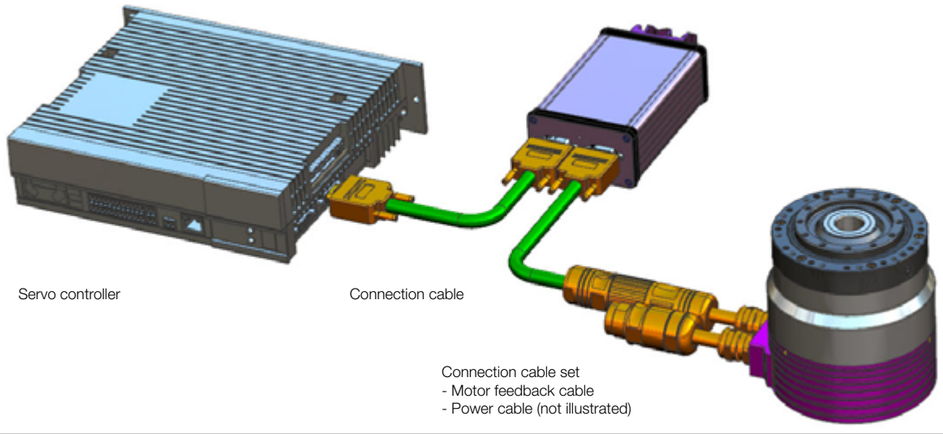
Connection assignment

Illustration 1.5.23

	Sensor 15. pol. sub D socket	Battery		Controller 15. pol. sub D socket
1	–		1	–
2	–		2	–
3	U_P		3	U_P
4	DATA +		4	DATA +
5	DATA -		5	DATA -
6	–		6	–
7	UBAT+	UBAT+	7	-
8	UBAT- (0V / GND)	UBAT-	8	UBAT- (0V / GND)
9	Temp -		9	Temp -
10	Temp +		10	Temp +
11	–		11	–
12	Sense +		12	Sense +
13	Sense -		13	Sense -
14	CLOCK +		14	CLOCK +
15	CLOCK -		15	CLOCK -

Motor feedback wiring

Illustration 1.5.24



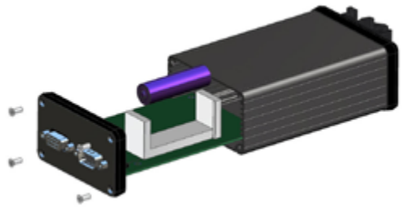
Battery replacement

To guarantee that the absolute encoder position is maintained when the battery is replaced, the following requirements must be ensured:

- the supply voltage of the motor feedback system by the drive controller is available
- the motor feedback system is connected to the servo controller

If the battery voltage fails or is interrupted and the power supply fails or is interrupted at the same time, the provided position will be incorrect after switching on again!
Undefined positioning processes can cause injuries to persons or damage to system parts.

- Open the cover of the battery box
- Pull out the circuit board with battery
- Remove the old battery and dispose of it in accordance with the applicable regulations
- Insert new battery
- Insert circuit board with battery
- Close the cover of the battery box
- Reset error and warning bit



The motor feedback system MZE monitors the connected battery and, in addition to the position values, also provide status information of the connected battery via the communication interface.
The functionality and behaviour depend on the encoder type and the selected communication interface.
An immediate exchange of the battery is required after sending warning or error messages!
By doing that the specific requirements of each encoder type must be considered.
The battery type should be select based on the advice of the encoder manufacturer.
Error bit and warning bit are reset via encoder protocol.

For correct control of the motor feedback system MZE (Heidenhain EBI135), the EnDat specification and the EnDat Application Notes from Heidenhain for battery buffered encoders must be observed.

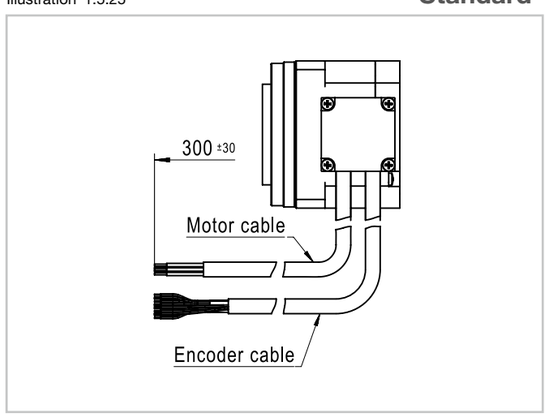
For correct control of the motor feedback system MZE (Heidenhain EBI135), the EnDat specification and the EnDat Application Notes from Heidenhain for battery buffered encoders must be observed.

Electrical connections

• FHA-xC-D200

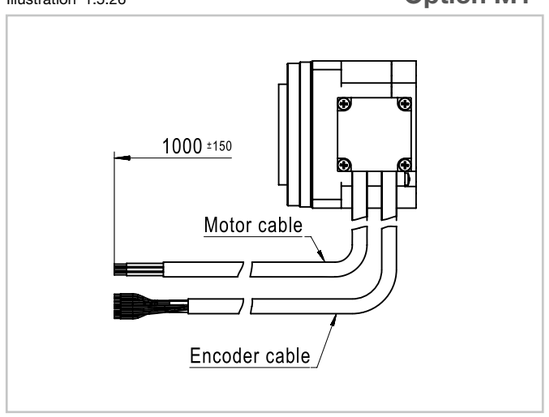
Cable configuration “Standard”

Illustration 1.5.25



Cable configuration “Option M1”

Illustration 1.5.26



Motor and encoder cables are not suitable for moving routing!

Table 1.5.12

Motor phase	U	V	W	PE
Wire colour	red	white	black	green-yellow
Cross section	AWG 24 (FHA-8C / FHA-11C) AWG 20 (FHA-14C)			
Minimum bending radius	40 mm at static installation 80 mm at dynamic installation			

Table 1.5.13

D200 Signal	A+	A-	B+	B-	Z+	Z-	U+	U-	V+	V-	W+	W-	GND	Up
Wire colour	green	dark green	grey	white	yellow	trans-parent	brown	magenta	blue	light blue	orange	pink	black	red
Cross section	AWG 29												AWG 29	
Minimum bending radius	40 mm at static installation 80 mm at dynamic installation													

• FHA-xC-MZE-Y

Table 1.5.14

Motor connector	TE-Intercontec ytec®
Cable coupling	TE-Intercontec springtec® Housing: ESTB-202-NN00-34-0500-000 Socket 9 x 61.251.11

Illustration 1.5.27

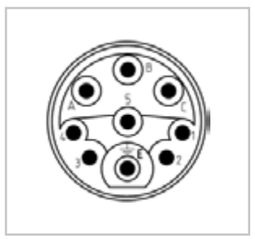


Table 1.5.15

Connector pin	A	B	C	PE	1	2	3	4	5
Motor phase	U	V	W	PE	–	–	–	–	–

Table 1.5.16

Encoder connector	TE-Intercontec ytec®
Cable coupling	TE-Intercontec springtec® Housing: ESTB-002-NN00-33-0001-000 Socket 12 x 60.252.11

Illustration 1.5.28

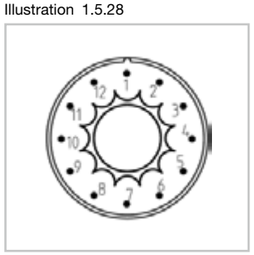


Table 1.5.17

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12
Signal	Up+	DATA+	DATA-	CLOCK+	CLOCK-	UBAT-	GND	–	–	–	–	UBAT+

Product description

Design and mode of operation

For optimal operation of permanent magnet excitated synchronous motors (“servo motors”), the current rotor angle must be known. Motor feedback systems of different designs and based on different sensor principles are used to measure the rotor angle.

The motor feedback systems mainly provide absolute position information that is unique over one revolution (“singleturn”) or even several revolutions (“multi-turn”). The multi-turn information can be provided by using a buffer battery or a mechanical gear. Standard interfaces ensure that the actuator can be operated on the drive controllers of nearly all well known manufacturers. Typical interfaces allow bidirectional communication between the drive controller and the feedback system. In this way, they also create the possibility of using a digital nameplate, which can support the commissioning. The drive controllers use the feedback signal for current, speed and position control.

- **Current control / Commutation**

The field oriented current control (“vector control”) requires the current position of the rotor and ensures that the motor delivers maximum torque at a given current.

- **Speed control**

In the drive controller, the position signal of the motor feedback system is digitally differentiated. In this way, the actual speed value is formed as an input variable for the speed controller.

- **Position control**

The position control ensures that a desired position is achieved with high accuracy and precision. Point-to-point movements can be carried out, but two or more axes can also be synchronised with each other.
When using motor feedback systems with multi-turn functionality, a regular reference run after switching on the machine can be omitted.

- **Resolution**

The resolution of the motor feedback systems describes the number of positions that can be distinguished within one revolution. In systems with additional analogue sine / cosine signals, the resolution is additionally increased by interpolation of these signals in the drive controller. Typical interpolation value is ten to twelve bits.

- **Accuracy**

Accuracy describes the deviation between the measured value and the true value and is defined for Harmonic Drive SE as the difference between maximum and minimum deviation (“peak-to-peak value”).

It should be noted that the specification for accuracy and resolution generally refer to the motor shaft. In relation to the gear output, the resolution is additionally increased by the gear ratio. The absolute accuracy of the motor feedback system at the motor shaft is of secondary relevance for the user. The system accuracy of the actuator results from the interaction with the transmission accuracy of the gear.

Ordering code

Table 1.6.1

Function	Motor feedback system						
	Operating principle	Multi-turn type	Increments / Sine	Interface	Encoder designation	Code	
Inkremental	Optical	-	2048 Inc.	A,B,Z + U,V,W (RS-422)	EBG	DCO	
Inkremental	Optical	-	2000 Inc.	A,B,Z + U,V,W (RS-422)	D200	D200	
Singleturn absolute	Inductive	-	32 SinCos	EnDat 2.1	ECI119	SIE	
Singleturn absolute	Inductive	-	-	EnDat 2.2	ECI119	SZE	
Singleturn absolute	Inductive	-	-	EnDat 2.2	ECI4010	SZE	
Multi-turn absolute	Inductive	Battery	-	EnDat 2.2	EBI135	MZE	
Multi-turn absolute	Inductive	Battery	-	EnDat 2.2	EBI4010	MZE	
Multi-turn absolute	Inductive	Battery	-	EnDat 2.2	EBI1135	MZE	
Singleturn absolute	Magnetic	-	-	BiSS-C	Flex Feedback (by HDSE)	SZB	
Multi-turn absolute	Magnetic	Battery	-	BiSS-C	Flex Feedback (by HDSE)	MZB	
Multi-turn absolute	Magnetic	Battery	64 SinCos	SSI + SinCos	Flex Feedback (by HDSE)	MHS	
Multi-turn absolute	Magnetoresistive	v	128 SinCos	SSI + SinCos	GEL2311B	MGSi	
Singleturn absolute	Capacitive	-	32 SinCos	HIPERFACE®	SES70	SIH	
Multi-turn absolute	Capacitive	Gear	32 SinCos	HIPERFACE®	SEM70	MIH	
Singleturn absolute	Capacitive	-	64 SinCos	HIPERFACE®	SES90	SHH	
Multi-turn absolute	Capacitive	Gear	64 SinCos	HIPERFACE®	SEM90	MHH	
Multi-turn absolute	Capacitive	Gear	-	HIPERFACE DSL®	SEM70/90	MZD	

Combinations

Table 1.6.2

Function	Actuator / (Series and Size)													
	BHA			CanisDrive®								FHA-C Mini		
	17	20	25	14	17	20	25	32	40	50	58	8	11	14
Inkremental	-	-	-	●	●	●	-	-	-	-	-	-	-	-
Inkremental	-	-	-	-	-	-	-	-	-	-	-	●	●	●
Singleturn absolute	-	-	-	-	-	●	●	●	●	-	-	-	-	-
Singleturn absolute	●	●	●	-	-	●	●	●	●	-	-	-	-	-
Singleturn absolute	-	-	-	-	-	-	-	-	-	●	●	-	-	-
Multi-turn absolute	●	●	●	-	-	●	●	●	●	-	-	-	-	-
Multi-turn absolute	-	-	-	-	-	-	-	-	-	●	●	-	-	-
Multi-turn absolute	-	-	-	-	-	-	-	-	-	-	-	●	●	●
Singleturn absolute	●	●	●	-	o	o	o	o	o	o	o	-	-	-
Multi-turn absolute	●	●	●	-	o	●	●	●	●	●	o	-	-	-
Multi-turn absolute	●	●	●	-	o	●	●	●	●	●	o	-	-	-
Multi-turn absolute	-	-	-	●	●	●	-	-	-	-	-	-	-	-
Singleturn absolute	o	o	-	-	o	o	-	-	-	-	-	-	-	-
Multi-turn absolute	●	●	-	-	●	●	-	-	-	-	-	-	-	-
Singleturn absolute	-	-	o	-	-	-	o	o	o	-	-	-	-	-
Multi-turn absolute	-	-	●	-	-	-	●	●	●	-	-	-	-	-
Multi-turn absolute	-	-	-	-	-	●	●	●	●	o	o	-	-	-

● available o on request - not available

Technical data

- Motor feedback system MGSi (CanisDrive-14A ... 20A)

Multi-turn absolute motor feedback system with incremental SIN / COS signals and SSI data interface

Table 1.6.3

Ordering Code	Symbol [Unit]	MGSi (CanisDrive-14A ... 20A)				
Manufacturer's designation		GEL				
Protocol		SSI (binary)				
Power supply[1]	U_b [V_{DC}]	5 ... 30				
Current consumption (without load)[1]	P [W]	0.1				
Current consumption buffering (at 25 °C)[1]	I [µA]	10				
Power on time[1]	t [s]	< 0.1				
Incremental signals	U_{pp} [V_{ss}]	1				
Signal form		sinusoidal				
Number of pulses	n_1	128				
SSI data word length		29 bit				
Absolute position / revolution (motor side)[3]		131072 (17 bit)				
Number of revolutions		4096 (12 bit) battery buffered (Internal battery available)				
Typical battery lifetime[4]	[a]	10				
Accuracy[1]	[arcsec, p2p]	±720				
Ratio	i [ ]	50	80	100	120	160
Resolution absolute (output side)	[arcsec]	0.2	0.2	0.1	0.1	0.1
Number of revolutions (output side)		81	51	40	34	25
Resolution incremental (motor side)[2]	inc [ ]	524288				
Ratio	i [ ]	50	80	100	120	160
Resolution incremental (output side)[2]	[arcsec]	0.049	0.031	0.025	0.021	0.015

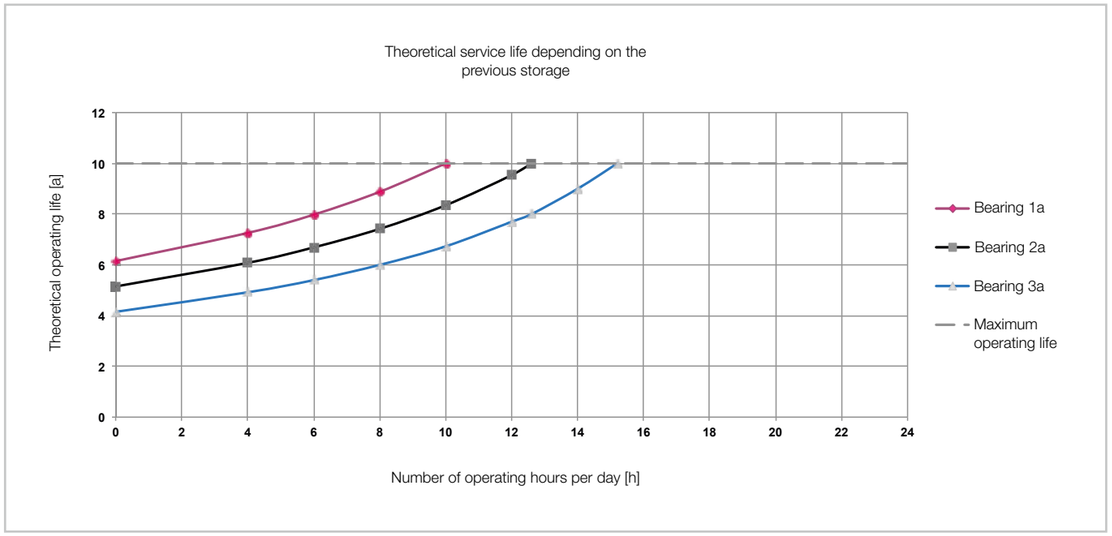
1) Source: Manufacturer
2) With a controller internal resolution of the A/D converter of 12 bit
3) Increasing position values with direction of rotation
   - CW direction of motor shaft (view from front of the motor shaft)
   - CCW direction of the output flange
4) Typical battery lifetime at 10 h/day in normal operation, battery temperature 25 °C and 1 %/a self discharge

The internal battery cannot be replaced.
Use as a singleturn absolute motor feedback system is not intended.

Battery life

Depending on the application, a theoretical battery life results, depending on the previous storage time of the drive system and the daily operating time.

Illustration 1.6.1



Even if the theoretical battery life analysis shows long service life for your application, we recommend the replacement of the encoder system at the latest 10 years after delivery.

If the battery voltage fails or is interrupted and the power supply fails or is interrupted at the same time, the provided position will be incorrect after switching on again!
Undefined positioning processes can cause injuries to persons or damage to system parts.

• Motor feedback system SZB (BHA-17A ... 25A, CanisDrive-17A ... 32A)

Singleturn absolute motor feedback with BiSS-C protocol

Table 1.6.4

Ordering code	Symbol [Unit]	SZB (BHA-17A ... 25A, CanisDrive-20A ... 32A)				
Manufacturer's designation		FlexFeedback				
Protocol		BiSS-C				
Power supply	U_b [V_{DC}]	5V ±10 %				
Current consumption (without load)	I [mA]	85				
Current consumption buffering (at 25 °C)[1]	I [µA]	-				
Power on time	t [s]	-				
Incremental signals	U_{pp} [V_{ss}]	-				
Signal form		-				
Number of pulses	n_1	-				
BiSS data word length		24				
Absolute position / revolution (motor side)[2]		65536 (16 bit)				
Number of revolutions		-				
Available memory	[Bytes]	1536				
Accuracy	[arcsec]	540				
Ratio	i [ ]	50	80	100	120	160
Resolution absolute (output side)	[arcsec]	0.4	0.2	0.2	0.2	0.1
Number of revolutions (output side)		-	-	-	-	-

1) Valid when the supply voltage is switched off at standstill
2) Increasing position values with direction of rotation
   - CW direction of motor shaft (view from front of the motor shaft)
   - CCW direction of the output flange

Table 1.6.5

	Multi-turn	Singleturn	Error[1]	Warning[1]	CRC
Structure of BiSS Protocol	-	16 Bit	1 Bit	1 Bit	6 Bit

1) Error Bit and Warning Bit low active

• Motor feedback system MZB (BHA-17A ... 25A, CanisDrive-20A ... 32A)

Multi-turn absolute motor feedback with BiSS-C protocol

Table 1.6.6

Ordering code	Symbol [Unit]	MZB (BHA-17A ... 25A, CanisDrive-20A ... 32A)				
Manufacturer's designation		FlexFeedback				
Protocol		BiSS-C				
Power supply	U_b [V_{DC}]	5V ±10 %				
Current consumption (without load)	I [mA]	85				
Current consumption buffering (at 25 °C)[1]	I [µA]	15				
Power on time	t [s]	-				
Incremental signals	U_{pp} [V_{ss}]	-				
Signal form		-				
Number of pulses	n_1	-				
BiSS data word length		40				
Absolute position / revolution (motor side)[2]		65536 (16 bit)				
Number of revolutions		65536 (16 bit) battery buffered				
Recommended buffer battery		Lithium thionyl chloride, Tadiran SL-360/S 3.6V / ≥ 2.0 Ah				
Typical battery lifetime[3]	[a]	16				
Available memory	[Bytes]	1536				
Accuracy	[arcsec]	540				
Ratio	i [ ]	50	80	100	120	160
Resolution absolute (output side)	[arcsec]	0.4	0.2	0.2	0.2	0.1
Number of revolutions (output side)		1310	819	655	546	409

1) Valid when the supply voltage is switched off at standstill
2) Increasing position values with direction of rotation
   - CW direction of motor shaft (view from front of the motor shaft)
   - CCW direction of the output flange
3) Typical battery lifetime at 10 h/day in normal operation, battery temperature 25 °C and 1 %/a self discharge

Table 1.6.7

	Multi-turn	Singleturn	Error[1]	Warning[1]	CRC
Structure of BiSS Protocol	16 Bit	16 Bit	1 Bit	1 Bit	6 Bit

1) Error Bit and Warning Bit low active

Depending on the application, a theoretical battery life results, depending on the previous storage time of the drive system and the daily operating time.

Illustration 1.6.2

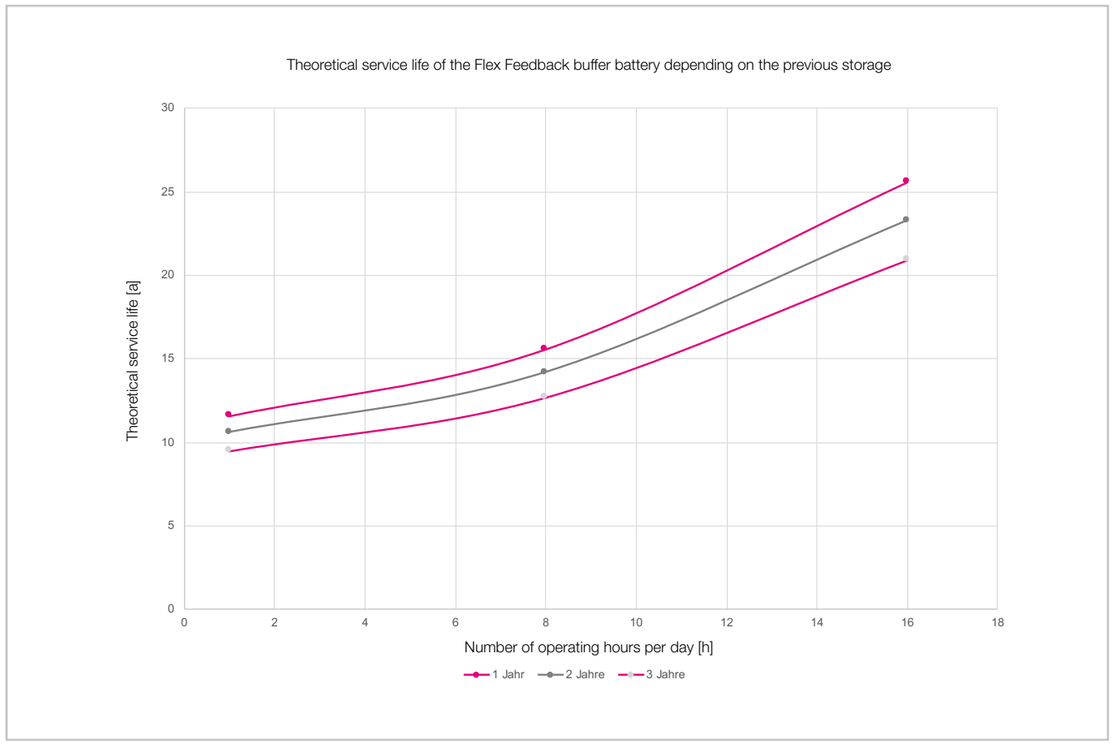


Illustration 1.6.3

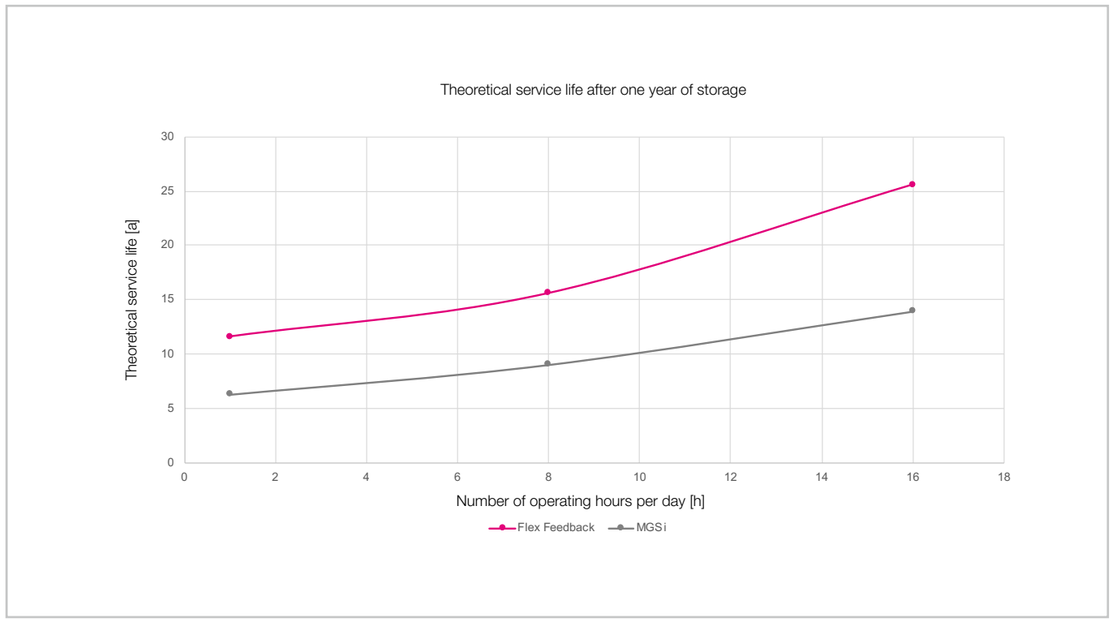
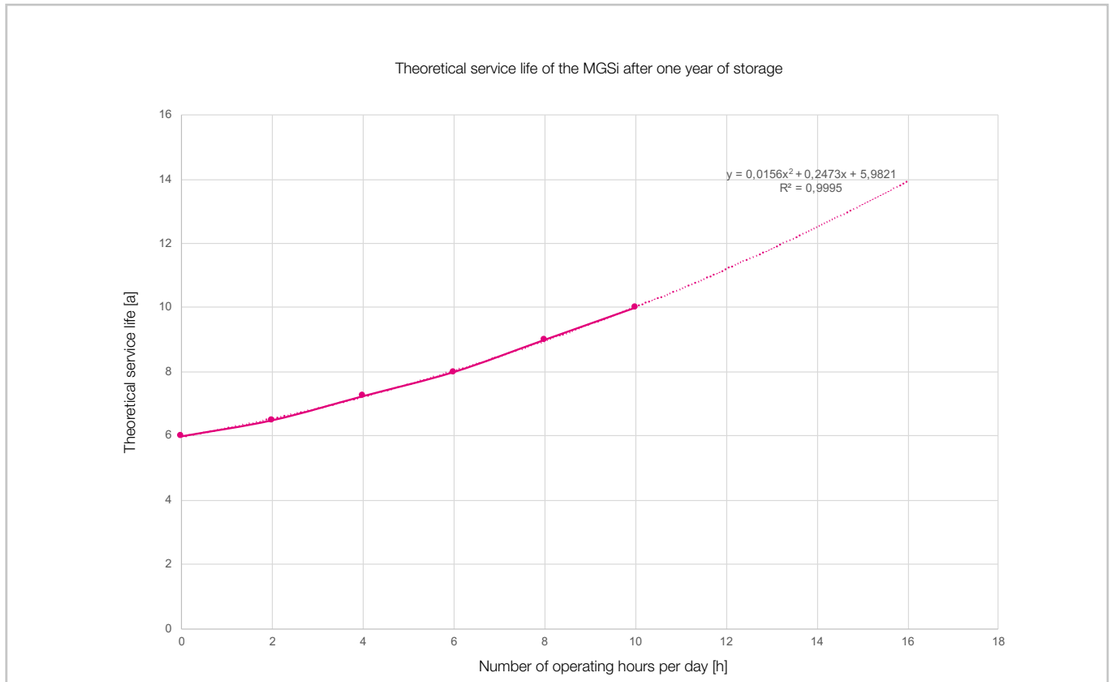


Illustration 1.6.4



Even if the theoretical battery life analysis shows long service life for your application, we recommend the replacement of the encoder system at the latest 10 years after delivery.
If the battery voltage fails or is interrupted and the power supply fails or is interrupted at the same time, the provided position will be incorrect after switching on again!

Undefined positioning processes can cause injuries to persons or damage to system parts.

• Motor feedback system MHS (BHA-17A ... 25A, CanisDrive-20A ... 32A)

Singleturn absolute motor feedback system with incremental SIN / COS signals and SSI data interface

Table 1.6.8

Ordering code	Symbol [Unit]	MHS (BHA-17A ... 25A, CanisDrive-20A ... 32A)				
Manufacturer's designation		FlexFeedback				
Protocol		SSI (binary)				
Power supply	U_b [V_{DC}]	5 ±10%				
Current consumption (without load)	I [mA]	85.0				
Current consumption buffering (at 25 °C)[4]	I [µA]	15				
Power on time	t [s]					
Incremental signals	U_{pp} [V_{ss}]	1				
Signal form		sinusoidal				
Number of pulses	n_1	64				
SSI data word length		29 bit[5]				
Absolute position / revolution (motor side)[3]		65536 (16 bit)				
Number of revolutions		4096 (12 bit) battery buffered (external battery necessary)				
Recommended buffer battery		Lithium thionyl chloride, Tadiran SL-360/S 3.6V / ≥ 2.0 Ah				
Typical battery lifetime[3]	[a]	10				
Accuracy[1]	[arcsec, p2p]	720				
Ratio	i [ ]	50	80	100	120	160
Resolution absolute (output side)	[arcsec]	0.40	0.25	0.20	0.16	0.12
Number of revolutions (output side)		82	51	41	34	26
Resolution incremental (motor side)[1]	inc [ ]	262144				
Ratio	i [ ]	50	80	100	120	160
Resolution incremental (output side)[1]	[arcsec]	0.099	0.062	0.049	0.041	0.031

1) With a controller internal resolution of the A/D converter of 12 bit
2) Increasing position values with direction of rotation
   - CW direction of motor shaft (view from front of the motor shaft)
   - CCW direction of the output flange
3) Typical battery lifetime at 10 h/day in normal operation, battery temperature 25 °C and 1 %/a self discharge
4) Applies when the supply voltage is switched off at standstill
5) Including one error bit

If the battery voltage fails or is interrupted and the power supply fails or is interrupted at the same time, the provided position will be incorrect after switching on again!
Undefined positioning processes can cause injuries to persons or damage to system parts.

Battery life
Depending on the application, a theoretical battery life results, depending on the previous storage time of the drive system and the daily operating time.

Please see chapter Motor feedback system MZB (BHA-17A ... 25A, CanisDrive-20A ... 32A).

• Motor feedback system SIE (CanisDrive 20A ... 40A)

Singleturn absolute motor feedback system with incremental SIN / COS signals and EnDat data interface

Table 1.6.9

Ordering code	Symbol [Unit]	SIE (CanisDrive-20A ... 40A)				
Manufacturer's designation		ECI 119				
Protocol		EnDat 2.1 / 01				
Power supply[1]	U_b [V_{DC}]	3.6 ... 14				
Current consumption (typ. at 5 VDC, without load)[1]	I [mA]	80				
Incremental signals	U_{pp} [V_{ss}]	0.8 ... 1.2				
Signal form		sinusoidal				
Number of pulses	n_1	32				
Absolute position / revolution (motor side)[3]		524288 (19 bit)				
Number of revolutions		-				
Accuracy[1]	[arcsec]	±90				
Ratio	i [ ]	50	80	100	120	160
Resolution absolute (output side)	[arcsec]	0.05	0.04	0.03	0.03	0.02
Number of revolutions (output side)		-	-	-	-	-
Resolution incremental (motor side)[2]	inc [ ]	131072				
Ratio	i [ ]	50	80	100	120	160
Resolution incremental (output side)[2]	[arcsec]	0.20	0.12	0.10	0.08	0.06

1) Source: Manufacturer
2) With a controller internal resolution of the A/D converter of 12 bit
3) Increasing position values with direction of rotation
   - CW direction of motor shaft (view from front of the motor shaft)
   - CCW direction of the output flange

The commutation offset must be determined during initial commissioning.

• Motor feedback system DCO (CanisDrive-14A ... 20A)

Incremental motor feedback system with square wave signals, reference signal and commutation signals (RS-422 standard)

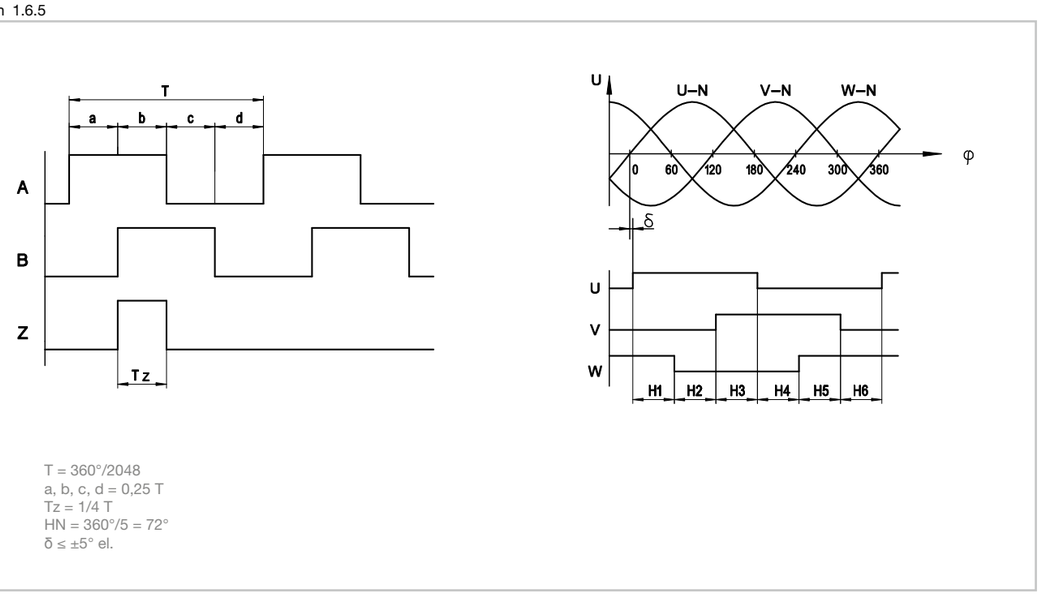
Table 1.6.10

Ordering code	Symbol [Unit]	DCO (CanisDrive-14A ... 20A)				
Manufacturer‘s designation		EBG				
Power supply[1)]	U_b [V_{DC}]	5 ±10 %				
Current consumption (max., without load)[1)]	I [mA]	40				
Incremental signals		RS-422				
Signal form		Rectangle				
Number of pulses	n_1 [A / B]	2048				
Commutation signals		RS-422				
Signal form		Rectangle				
Number of pulses	n_2 [U / V / W]	5				
Reference signal	n_3 [Z]	1				
Accuracy[1)]	[arcsec]	±600				
Resolution incremental (motor side)[2)]	[qc]	8192				
Ratio	i [ ]	50	80	100	120	160
Resolution incremental (output side)[2)]	[arcsec]	3.2	2.0	1.6	1.4	1.0

1) Source: Manufacturer
2) For quadruple edge evaluation (quadcounting)

Signal wave form

Illustration 1.6.5



T = 360°/2048
a, b, c, d = 0,25 T
Tz = 1/4 T
HN = 360°/5 = 72°
δ ≤ ±5° el.

Valid for direction of rotation
- CW direction of motor shaft (with a view of the motor shaft from the front)
- CCW direction of the output flange

• Motor feedback system D200 (FHA-8C ... 14C)

Incremental motor feedback system with square wave signals, reference signal and commutation signals (RS-422 standard)

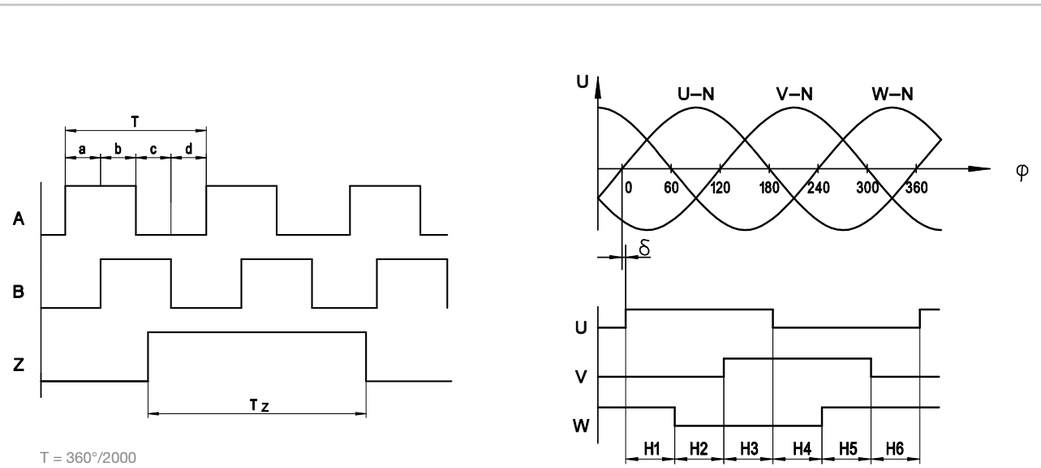
Table 1.6.11

Ordering code	Symbol [Unit]	D200 (FHA-8C ... 14C)		
Manufacturer‘s designation		-		
Power supply [1)]	U_b [V_{DC}]	5 ± 5 %		
Current consumption (max., without load) [1)]	I [mA]	250		
Incremental signals		RS-422		
Signal form		Rectangle		
Number of pulses	n_1 [A / B]	2000		
Commutation signals		RS-422		
Signal form		Rectangle		
Number of pulses	n_2 [U / V / W]	5		
Commutation signals	n_3 [Z]	1		
Accuracy [1)]	[arcsec]	-		
Resolution incremental (motor side) [2)]	[qc]	8000		
Ratio	i [ ]	30	50	100
Resolution incremental (output side) [2)]	[arcsec]	5.4	3.3	1.7

1) Source: Manufacturer
2) For quadruple edge evaluation (quadcounting)

Signal wave form

Illustration 1.6.6



T = 360°/2000
a, b, c, d = 0,25 T ±0,15 T
Tz = T ±0,5 T
HN = 360° / 5 / 6 = 12°
δ ≤ ± 3° el.

Valid for clockwise direction of rotation looking at the output flange.

- Motor feedback system MZE (FHA-8C ... 14C)

Multi-turn absolute motor feedback system with EnDat 2.2/22 data interface

Table 1.6.12

Ordering code	Symbol [Unit]	MZE		
Manufacturer‘s designation		EBI 1135		
Protocol		EnDat 2.2 / 22		
Power supply [1]	U_b [V_{DC}]	3.6 … 14		
Current consumption operational (typ. at 5 VDC, without load)[1]	I [mA]	80		
Current consumption buffering (at 25 °C)[1] [2]	I [mA]	12		
Incremental signals	U_{pp} [V_{ss}]	-		
Signal form		-		
Number of pulses	n_1	-		
Absolute position / revolution (motor side)[3]		262144 (18 bit)		
Number of revolutions		65536 (16 bit) battery buffered (external battery necessary)		
Recommended buffer battery		Lithium thionyl chloride 3.6V / ≥2.0Ah Tadiran SL-760A Size: AA		
Typical battery lifetime[4]	[a]	10		
Battery replacement interval	[a]	10		
Accuracy[1]	[arcsec]	±120		
Resolution (motor side)	[arcsec]	4.94		
Ratio	i [ ]	30	50	100
Resolution absolute (output side)	[arcsec]	0.165	0.099	0.049
Number of revolutions (output side)		2184	1310	655

1) Source: Manufacturer
2) Source: Manufacturer. Applies when the supply voltage is switched off at standstill
3) Increasing position values with direction of rotation
   - CW direction of motor shaft (view from front of the motor shaft)
   - CCW direction of the output flange
4) Typical battery lifetime at 10 h/day in normal operation, battery temperature 25 °C and 1%/a self discharge

If the battery voltage fails or is interrupted and the power supply fails or is interrupted at the same time, the provided position will be incorrect after switching on again!
Undefined positioning processes can cause injuries to persons or damage to system parts.

Cannot be used with Siemens SINAMICS S120 servo controllers!

An external battery supply is required to operate the battery-buffered multi-turn absolute motor feedback system MZE. A battery box MZE is available for this purpose. The handling of the battery box MZE and the electrical connection assignment can be found in chapter 3 „Servo controller & cables“.

The typical service life 10 a of the buffer battery applies at a battery temperature of 25 °C, 1 %/a self discharge and a use of 10 h/day in normal operation. In order to achieve a long service life of the buffer battery, the main supply Ub must be applied to the measuring device during or directly after connecting the buffer battery. This ensures that the device is fully initialised after a completely de-energised state. Otherwise, a significantly increased battery power consumption of the measuring device is to be expected until the main voltage is applied for the first time.

- Motor feedback system MZE (BHA-17A … 25A, CanisDrive-20A … 58A)

Multi-turn absolute motor feedback system with EnDat 2.2/22 data interface

Table 1.6.13

Ordering code	Symbol [Unit]	MZE (BHA-17A … 25A, CanisDrive-20A … 40A)				
Manufacturer‘s designation		EBI 135				
Protocol		EnDat 2.2/22				
Power supply	U_b [V_{DC}]	3.6 … 14				
Current consumption operational (without load)[1]	I [mA]	75				
Current consumption buffering (at 25 °C)[1] [2]	I [mA]	12				
Power on time	t [s]	-				
Incremental signals	U_{pp} [V_{ss}]	-				
Signal form		-				
Number of pulses	n_1	-				
Absolute position / revolution (motor side)[3]		262144 (19 bit)				
Number of revolutions		65536 (16 bit) battery buffered (external battery necessary)				
Recommended buffer battery		Lithium thionyl chloride, Tadiran SL-760A, size: AA 3.6V / ≥ 2.0 Ah				
Typical battery lifetime[4]	[a]	10				
Battery replacement interval	[a]	10				
Accuracy[1]	[arcsec]	±90				
Ratio	i [ ]	50	80	100	120	160
Resolution absolute (output side)	[arcsec]	0.049	0.031	0.025	0.021	0.015
Number of revolutions (output side)		1311	819	655	546	410

Table 1.6.14

Ordering code	Symbol [Einheit]	MZE (CanisDrive-50A … 58A)				
Manufacturer‘s designation		EBI 4010				
Protocol		EnDat 2.2/22				
Power supply	U_b [V_{DC}]	3.6 ~ 14				
Current consumption operational (without load)[1]	I [mA]	95				
Current consumption buffering (at 25 °C)[1] [2]	I [mA]	25				
Power on time	t [s]	-				
Incremental signals	U_{pp} [V_{ss}]	-				
Signal form		-				
Number of pulses	n_1	-				
Absolute position / revolution (motor side)[3]		1048576 (20 bit)				
Number of revolutions		65536 (16 bit) battery buffered (external battery necessary)				
Typical battery lifetime[4]	[a]	10				
Battery replacement interval	[a]	10				
Accuracy[1]	[arcsec]	±25				
Resolution absolute (output side)		Ratio				
	i [ ]	50	80	100	120	160
	[arcsec]	0.025	0.015	0.012	0.010	0.008
Number of revolutions (output side)		1311	819	655	546	410

1) Source: Manufacturer
2) Source: Manufacturer. Applies when the supply voltage is switched off at standstill
3) Increasing position values with direction of rotation
   - CW direction of motor shaft (view from front of the motor shaft)
   - CCW direction of the output flange
4) Typical battery lifetime at 10 h/day in normal operation, battery temperature 25 °C and 1%/a self discharge

• Motor feedback system SZE (CanisDrive-20A ... 58A, BHA-17A ... 25A)

Singleturn absolute motor feedback system with EnDat 2.2 / 22 data interface

Table 1.6.15

Ordering Code	Symbol [Unit]	SZE (CanisDrive-20 … 40) (BHA-17A ... 25A)					SZE (CanisDrive-50 … 58)				
Manufacturer's designation		ECI 119					ECI 4010				
Protocol		EnDat 2.2 / 22					EnDat 2.2 / 22				
Power supply[1]	U_b [V_{DC}]	3.6 … 14					3.6 … 14				
Current consumption operational (typ. at 5 V, without load)[1]	I [mA]	75					95				
Current consumption buffering (at 25 °C)[1] [2]	I [µA]	-					-				
Incremental signals	U_{pp} [V_{ss}]	-					-				
Signal form		-					-				
Number of pulses	n_1	-					-				
Absolute position / revolution (motor side)[3]		524288 (19 bit)					1048576 (20 bit)				
Number of revolutions		-					-				
Accuracy[1]	[arcsec]	±90					±25				
Resolution (motor side)	[arcsec]	2.47					1.24				
Ratio	i [ ]	50	80	100	120	160	50	80	100	120	160
Resolution absolute (output side)	[arcsec]	0.049	0.031	0.025	0.021	0.015	0.025	0.015	0.012	0.010	0.008
Number of revolutions (output side)		–	–	–	–	–	–	–	–	–	–

1) Source: Manufacturer
2) Source: Manufacturer. Applies when the supply voltage is switched off at standstill.
3) Increasing position values with direction of rotation
- CW direction of motor shaft (view from front of the motor shaft)
- CCW direction of the output flange

• Motor feedback system SIH / SHH (CanisDrive-17A ... 40A, BHA-17A ... 25A)

Singleturn absolute motor feedback system with incremental SIN / COS signals and HIPERFACE® data interface

Table 1.6.16

Ordering code	Symbol [Unit]	SIH (CanisDrive-17A ... 20A, BHA-17A ... 25A)					SHH (CanisDrive-25A ... 40A)				
Manufacturer's designation		SES70					SES90				
Protocol		HIPERFACE®					HIPERFACE®				
Power supply[1]	U_b [V_{DC}]	7 … 12					7 … 12				
Current consumption (typ. at 7 VDC, without load)[1]	I [mA]	150					150				
Incremental signals	U_{pp} [V_{ss}]	1					1				
Signal form		sinusoidal					sinusoidal				
Number of pulses	n_1	32					64				
Absolute position / revolution (motor side)[3]		1024 (10 bit)					1024 (10 bit)				
Number of revolutions		-					-				
Available memory	[Bytes]	2048					2048				
Accuracy[1]	[arcsec]	±100					±72				
Ratio	i [ ]	50	80	100	120	160	50	80	100	120	160
Resolution absolute (output side)	[arcsec]	25.3	15.8	12.7	10.5	7.9	25.3	15.8	12.7	10.5	7.9
Number of revolutions (output side)		-	-	-	-	-	-	-	-	-	-
Resolution incremental (motor side)[2]	inc [ ]	131072					262144				
Ratio	i [ ]	50	80	100	120	160	50	80	100	120	160
Resolution incremental (output side)[2]	[arcsec]	0.20	0.12	0.10	0.08	0.06	0.10	0.06	0.05	0.04	0.03

1) Source: Manufacturer (Recommendation 11 V)
2) With a controller internal resolution of the A/D converter of 12 bit
3) Increasing position values with direction of rotation
- CW direction of motor shaft (view from front of the motor shaft)
- CCW direction of the output flange

The commutation offset must be determined during initial commissioning.

• Motor feedback system MIH / MHH (CanisDrive-17A ... 40A, BHA-17A ... 25A)

Multi-turn absolute motor feedback system with incremental SIN / COS signals and HIPERFACE® data interface

Table 1.6.17

Ordering Code	Symbol [Unit]	MIH (CanisDrive-17A ... 20A, BHA-17A ... 25A)					MHH (CanisDrive-25A ... 40A)				
Manufacturer's designation		SEM70					SEM90				
Protocol		HIPERFACE®					HIPERFACE®				
Power supply[1]	U_b [V_{DC}]	7 ... 12					7 ... 12				
Current consumption (typ. at 7 VDC, without load)[1]	I [mA]	150					150				
Incremental signals	U_{pp} [V_{ss}]	1					1				
Signal form		sinusoidal					sinusoidal				
Number of pulses	n_1	32					64				
Absolute position / revolution (motor side)[3]		1024 (10 bit)					1024 (10 bit)				
Number of revolutions		4096 (12 bit) mechanical multi-turn					4096 (12 bit) mechanical multi-turn				
Available memory	[Bytes]	2048					2048				
Accuracy[1]	[arcsec]	±100					±72				
Ratio	i [ ]	50	80	100	120	160	50	80	100	120	160
Resolution absolute (output side)	[arcsec]	25.3	15.8	12.7	10.5	7.9	25.3	15.8	12.7	10.5	7.9
Number of revolutions (output side)		81	51	40	34	25	81	51	40	34	25
Resolution incremental (motor side)[2]	inc [ ]	131072					262144				
Ratio	i [ ]	50	80	100	120	160	50	80	100	120	160
Resolution incremental (output side)[2]	[arcsec]	0.20	0.12	0.10	0.08	0.06	0.10	0.06	0.05	0.04	0.03

1) Source: Manufacturer (Recommendation 11 V)
2) With a controller internal resolution of the A/D converter of 12 bit
3) Increasing position values with direction of rotation
   - CW direction of motor shaft (view from front of the motor shaft)
   - CCW direction of the output flange

The commutation offset must be determined during initial commissioning.

• Motor feedback system MZD (CanisDrive-20A ... 58A)

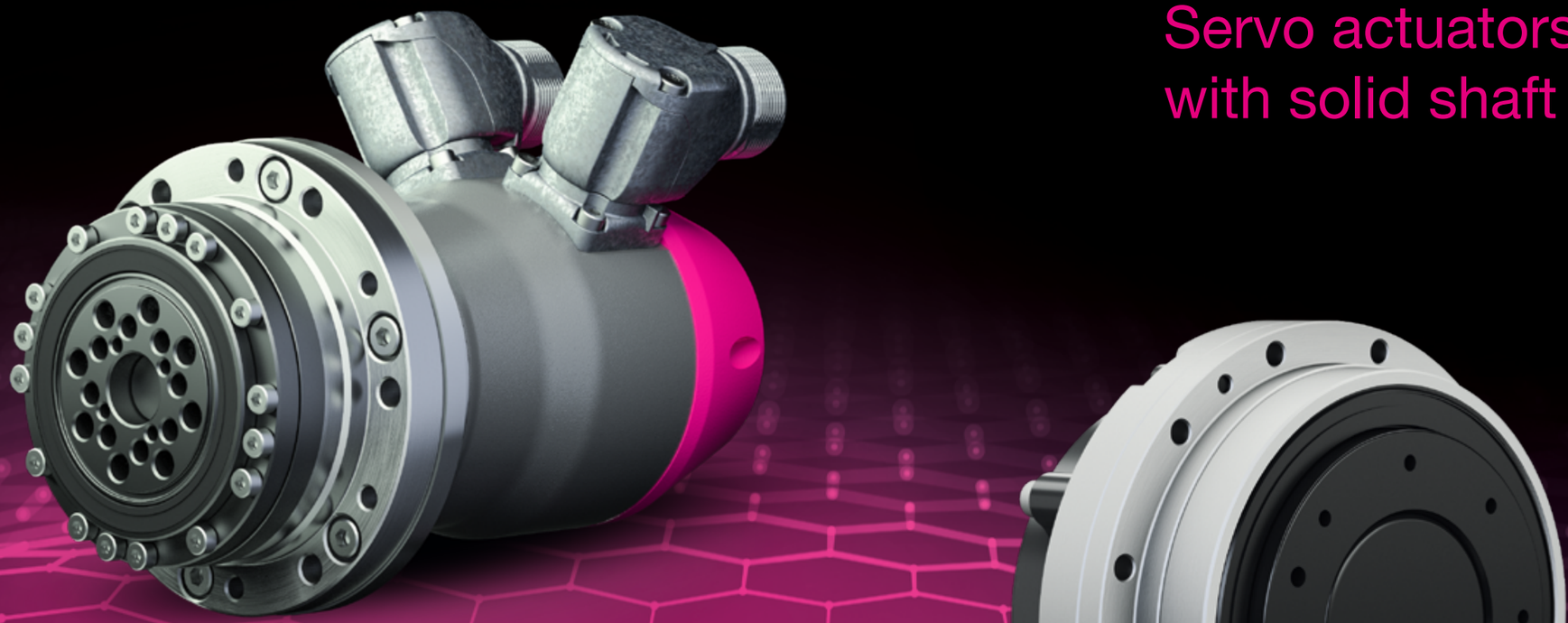
Multi-turn absolute motor feedback system with HIPERFACE DSL® data interface

Table 1.6.18

Ordering Code	Symbol [Unit]	MZD					
Manufacturer's designation		SEM70 | SEM90 + AD-HF2DSL02					
Protocol		HIPERFACE DSL®					
Power supply	U_b [V_{DC}]	7 ... 12					
Current consumption (without load)[1]	I [mA]	80					
Power on time	t [s]	≤ 1.3					
Absolute position / revolution (motor side)[2]		CanisDrive-20A/25A: 262.144 (18 Bit, SEM70) CanisDrive-32A~58A: 524.288 (19 Bit, SEM90)					
Number of revolutions		4096 (12 bit)					
Accuracy[1]	[arcsec]	CanisDrive-20A/25A: ±100 (SEM70) CanisDrive-32A ... 58A: ±72 (SEM90)					
Resolution absolute (output side)		Gear ratio					
	i [ ]	30	50	80	100	120	160
CanisDrive-20A/25A	[arcsec]	0.165	0.099	0.062	0.049	0.041	0.031
CanisDrive-32A ... 58A	[arcsec]	0.082	0.049	0.031	0.025	0.021	0.015
Number of revolutions (output side)		137	82	51	41	34	26

1) Source: Manufacturer
2) Increasing position values with direction of rotation
   - CW direction of motor shaft (view from front of the motor shaft)
   - CCW direction of the output flange

Servo actuators with solid shaft



SERVO ACTUATORS WITH SOLID SHAFT

Series	LynxDrive	FLA
		
Product focus	Extensive combination options and customer specific specific adaptations for industrial applications	High standardisation Reduced variance
Design	slim design	very short / compact
Torque capacity and lifetime	●●	●
Small outer diameter	●●●	●
Short design	●	●●●
Tilting moment output bearing	●●	●
Low weight	●●	●●●
Chapter / Page	2.1 / 176	2.2 / 206
Key data		
Hollow shaft diameter [mm]	-	-
Maximum torque [Nm]	9 ... 1534	1.8 ... 33
Maximum speed [rpm]	22 ... 283	80 ... 500
Outer diameter [mm]	73 ... 190	71 ... 100
Length [mm]	126 ... 288	40 ... 52
Configurations		
Sizes	14 17 20 25 32 40 50	11 14 17 20
Ratio **(Preference types)**	Size 14-32: 30 **50** 80 **100** 120 **160**	**50** 8 9
Winding	560 VDC	24/48 VDC
Encoder	HIPERFACE® EnDat 2.1/2.2 SinCos Resolver DRIVE-CLiQ	Hall sensors
Connections	Connector M23 90° angled rotatable Radial cable outlet possible Customised pinout possible	Cable outlet Cable outlet with connector possible
Controller integrated	-	-
Brake	Permanent magnet	-
Lubricant	Flexolub®-A1	4BNo.2
Temperature range	0 ... +40 °C	0 ... +40 °C
Protection class	IP65	IP40
Surface finish	Corrosion protection	-

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

●●● perfect ●● optimal ● good

Content

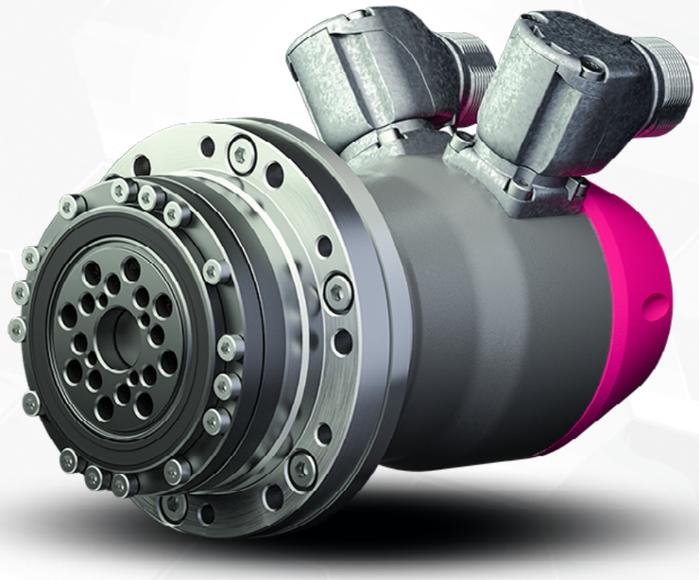
Product description

Compact design with high corrosion protection

The LynxDrive Servo Actuators are designed with concentrated winding technology - this reduces the motor length and, in combination with the encapsulated stator, results in a compact servo actuator. These servo actuators with backlash free gears and output bearings are especially suitable for positioning tasks with very high demands on dynamics, compactness and accuracy.

Features

- Compact, lightweight design
- Small outer diameter
- High corrosion protection
- Outstanding, lifelong precision
- Various feedback systems
- Third party controller compatibility



Ordering code

Table 2.1.1

Ordering code	LynxDrive	-	20	D	-	100	-	AO	-	F	-	MEE	-	B-UL	-	SP
LynxDrive Series																
Size (corresponds to the pitch circle diameter of the Flexspline toothing in inches x 10)			14 17 20 25 32 40 50													
Product generation				D												
Ratio						30 50 80 100 120 160										
Motor winding type																
DC voltage link 560 VDC, voltage constant 26 V rms/1000 rpm								AO								
DC voltage link 560 VDC, voltage constant 38 V rms/1000 rpm								AR								
DC voltage link 560 VDC, voltage constant 46 V rms/1000 rpm								AT								
DC voltage link 560 VDC, voltage constant 80,5 V rms/1000 rpm								AW								
Connector version																
6-pole motor connector, M23										F						
8-pole motor connector, M23										M						
6-pole motor connector M23, 12-pole encoder connector M12 (prepared for DRIVE-CLiQ converter)										J						
Motor feedback system																
Resolver single pole pair	ROO															
HIPERFACE® Multi-turn absolute encoder SKM36 (128 SinCos Singleturn / 4096 Multi-turn)	MGH															
EnDat 2.2 Multi-turn absolute encoder EQN-1125 (512 SinCos Singleturn / 8192 Multi-turn)	MEE															
EnDat 2.1 Multi-turn absolute encoder EQI-1130 (16 SinCos Singleturn / 4096 Multi-turn)	MKE															
EnDat 2.2 Multi-turn absolute encoder EQN-1135 (8 388 608 cts. Singleturn / 4096 Multi-turn)	MZE															
Transmission of the winding temperature via the encoder protocol	MZET															
Option holding brake																
With holding brake 24 V											B					
Without holding brake (Field remains empty)											[ ]					
UL certified											UL					
Customised design																
Standard design (Field remains empty)																[ ]
Customised design (on request)																SP

Please note the table of possible combinations

Designation of motor feedback system

Table 2.1.2

Example: SKM36	M	G	H
Type			
Multi-turn absolute	M		
Resolver	R		
Number of sine cosine periods			
512		E	
128		G	
16		K	
1		O	
no SinCos periods		Z	
Protocol			
EnDat 2.1 oder EnDat 2.2			E
HIPERFACE®			H
Without protocol			O

Combinations

Table 2.1.3

Size		14D	17D	20D	25D	32D	40D	50D
Ratio	30	o	o	o	o	o	-	-
	50	●	●	●	●	●	●	-
	80	o	o	o	o	o	o	●
	100	●	●	●	●	●	●	o
	120	-	o	o	o	o	o	o
	160	-	-	●	●	●	●	o
Motor winding type	AO	●	●	●	-	-	-	-
	AR	-	-	-	●	●	-	-
	AT	-	-	-	-	-	●	-
	AW	-	-	-	-	-	●	●
Connector version	F	●	●	●	●	●	●	●
	M	●	●	●	●	●	●	●
	J	●	●	●	●	●	●	●
Motor feedback system[1)]	ROO	o	o	o	o	o	o	o
	MGH	●	●	●	●	●	●	●
	MEE	●	●	●	●	●	●	●
	MKE	●	●	●	●	●	●	●
	MZE/MZET	-	●	●	●	●	●	●
Option holding brake	B	o	o	o	o	o	o	o

● available o on request - not available

[1)] The following motor feedback systems are preferably only available in combination with the following connector versions:

MZE	connector versions F (6-pole M23 motor connector M23) or M (8-pole M23 motor connector)	Example: LynxDrive-xxD-xx-Ax-F-MZE; LynxDrive-xxD-xx-Ax-M-MZE
MZET	connector version J (6-pole M23 motor connector and M12 encoder connector (prepared for EIB converter to DriveCLiQ)	Example: LynxDrive-xxD-xx-Ax-J-MZET
MGH	connector version M (8-pole M23 motor connector)	Example: LynxDrive-xxD-xx-Ax-M-MGH
MKE	connector version F (6-pole M23 motor connector)	Example: LynxDrive-xxD-xx-Ax-F-MKE
MEE	connector version F (6-pole M23 motor connector)	Example: LynxDrive-xxD-xx-Ax-F-MEE

Technical data

• Features

Table 2.1.4

LynxDrive	[Unit]	
Machine type		Permanent magnet synchronous motor with concentrated winding
Magnet material		Neodymium-iron-boron
Insulation class (EN 60034-1)		F
Insulation resistance (500 VDC)	MΩ	100
Insulation voltage (10 s)	VAC	2500
Lubrication		Ratio 30: Harmonic Drive® Grease Flexolub®-A1 Ratio ≥50: Harmonic Drive® Grease 4B No.2
Degree of protection (EN 60034-5)		IP65 (Shaft seal ring is standard)
Ambient operating temperature	°C	0 … 40
Ambient storage temperature	°C	-20 … 60
Maximum installation altitude	m	4000 above sea level
Relative humidity (without condensation)	%	maximum 80
Vibration resistance (DIN IEC 60068 Teil 2-6, 10 … 500 Hz)	g	5
Shock resistance (DIN IEC 60068 Teil 2-27, 11 ms)	g	30
Corrosion protection (DIN IEC 60068 Teil 2-11 Salt spray test)	h	-
Temperature sensors		DIN PT1000, class B[1)] DIN-PTC release characteristics 120 °C (PTC 116-K13-120 C°)[1)]
Gear component set		Ratio 30: HFUC-2A Ratio ≥ 50: CSG-2A

[1)] Safe separation according to EN61800-5-1

• Cooling

Unless otherwise indicated, the values given in the tables refer to an overtemperature of the winding of 70 K at an ambient temperature of 40 °C and a maximum installation altitude of 1000 m above sea level. From an installation altitude > 1000 m above sea level, a derating of 1 % per 100 m must be made. The values in the following tables apply to actuators mounted on an aluminium base plate with the following dimensions:

Table 2.1.5

Series	Size	[Unit]	Dimension
LynxDrive	14	[mm]	200 x 200 x 6
	17	[mm]	300 x 300 x 15
	20	[mm]	300 x 300 x 15
	25	[mm]	350 x 350 x 18
	32	[mm]	350 x 350 x 18
	40	[mm]	400 x 400 x 20
	50	[mm]	600 x 600 x 30

• Actuator data

LynxDrive-14D, LynxDrive-17D
Actuators with 680 VDC maximum stationary DC bus voltage

Table 2.1.6

Actuator	Symbol [Unit]	14D				17D				
Stator winding		AO				AO				
Motor feedback system		ROO / MGH / MEE / MKE / MZE / MZET				ROO / MGH / MEE / MKE / MZE / MZET				
Ratio	i	30	50	80	100	30	50	80	100	120
Maximum output torque	T_{MAX} [Nm]	9	23	30	36	16	44	56	70	70
Maximum output speed	n_{MAX} [rpm]	283	170	106	85	243	146	91	73	61
Maximum current	I_{MAX} [A_{rms}]	1.1	1.5	1.2	1.2	1.8	2.8	2.2	2.2	1.9
Continuous stall torque	T_0 [Nm]	7	9	14	14	12	34	35	51	51
Continuous stall current	I_0 [A_{rms}]	0.7	0.6	0.5	0.4	1.3	2.0	1.3	1.5	1.2
No load starting current	I_{NLSC} [A_{rms}]	0.13	0.13	0.14	0.15	0.12	0.12	0.11	0.11	0.11
No load current constant (20 °C)	K_{INL} [10^{-3}A/rpm]	1.66	2.93	4.52	5.54	2.17	4.02	6.16	7.54	8.83
No load current constant (90 °C)	K_{INL} [10^{-3}A/rpm]	0.68	1.20	1.85	2.28	0.79	1.47	2.25	2.76	3.24
Torque constant (Motor)	K_T [Nm/A_{rms}]	0.38				0.38				
AC voltage constant (L-L, 20 °C)	K_E [V_{RMS}/1000 rpm]	26				26				
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	680[1)]				680[1)]				
Mechanical time constant, without brake (20 °C)	T_M [ms]	1.9				2.2				
Electrical time constant (20 °C)	T_E [ms]	1.9				1.9				
Maximum motor speed	n_{MAX} [rpm]	8500				7300				
Rated motor speed	n_N [rpm]	3500				3500				
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	7.2				7.2				
Rotary field inductance	L_d [mH]	7				7				
Number of pole pairs	p	5				5				
Brake voltage	$U_{Br.}$ [V_{DC}]	24 ±10 %				24 ±10 %				
Brake holding torque	$T_{Br.}$ [Nm]	9	23	30	36	16	44	56	70	70
Brake power consumption	$P_{BR.}$ [W]	11				11				
Brake opening time	t_O [ms]	25				25				
Brake closing time	t_C [ms]	6				6				
Weight without brake	m [kg]	2.2				2.3				
Weight with brake	m [kg]	2.6				2.7				
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	4	7	10	10	8.8	21	29	31	31
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000				2000				

[1)] In general, actuators with an Ax winding can also be operated on DC links with a nominal voltage > 680 V_{DC}. The lifetime of an insulation system is significantly influenced by the environment. Possible overvoltages at the motor terminals can be influenced by the length of the motor cable and the voltage slope of the servo controller. These overvoltages lead to partial discharges in the insulation system and can significantly reduce the lifetime of the insulation system. An assessment can only be made in the customer's environment. The manufacturer is not aware of any failures to date that can be attributed to a higher DC link voltage.

You will find more information on this in the Engineering data chapter.

LynxDrive-20D, LynxDrive-25D
Actuators with 680 VDC maximum stationary DC bus voltage

Table 2.1.7

Actuator	Symbol [Unit]	20D						25D					
Stator winding		AO						AR					
Motor feedback system		ROO / MGH / MEE / MKE / MZE / MZET						ROO / MGH / MEE / MKE / MZE / MZET					
Ratio	i	30	50	80	100	120	160	30	50	80	100	120	160
Maximum output torque	T_{MAX} [Nm]	27	73	96	107	113	120	50	127	178	204	217	229
Maximum output speed	n_{MAX} [rpm]	217	130	81	65	54	41	160	96	60	48	40	30
Maximum current	I_{MAX} [A_{rms}]	3.1	4.8	3.8	3.4	2.9	2.4	3.5	5.0	4.3	4.0	3.5	2.8
Continuous stall torque	T_0 [Nm]	19.0	33.0	54.0	64.0	64.0	64.0	38	72	113	140	140	140
Continuous stall current	I_0 [A_{rms}]	2.0	2.0	2.0	1.9	1.6	1.2	2.6	2.8	2.7	2.6	2.2	1.7
No load starting current	I_{NLSC} [A_{rms}]	0.16	0.16	0.14	0.14	0.14	0.14	0.18	0.16	0.14	0.14	0.14	0.14
No load current constant (20 °C)	K_{INL} [10^{-3}A/rpm]	6.25	6.73	10.20	12.30	14.35	18.42	3.13	5.96	9.32	11.42	13.51	17.65
No load current constant (90 °C)	K_{INL} [10^{-3}A/rpm]	0.97	1.75	2.63	3.17	3.70	4.75	1.02	1.97	3.08	3.78	4.48	5.85
Torque constant (Motor)	K_T [Nm/A_{rms}]	0.38						0.58					
AC voltage constant (L-L, 20 °C)	K_E [V_{RMS}/1000 rpm]	26						38.4					
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	680[1)]						680[1)]					
Mechanical time constant, without brake (20 °C)	T_M [ms]	3.0						1.7					
Electrical time constant (20 °C)	T_E [ms]	1.9						3.8					
Maximum motor speed	n_{MAX} [rpm]	6500						4800					
Rated motor speed	n_N [rpm]	3500						3500					
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	7.2						2.4					
Rotary field inductance	L_d [mH]	7						4.5					
Number of pole pairs	p	5						7					
Brake voltage	$U_{Br.}$ [V_{DC}]	24 ±10 %						24 ±10 %					
Brake holding torque	$T_{Br.}$ [Nm]	27	73	96	107	113	120	50	127	178	204	217	229
Brake power consumption	$P_{BR.}$ [W]	11						11					
Brake opening time	t_O [ms]	25						25					
Brake closing time	t_C [ms]	6						6					
Weight without brake	m [kg]	2.6						4.5					
Weight with brake	m [kg]	3.0						5.0					
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	15.0	33.0	44.0	52.0	52.0	52.0	27	51	82	87	87	87
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000						2000					

[1)] In general, actuators with an Ax winding can also be operated on DC links with a nominal voltage > 680 V_{DC}. The lifetime of an insulation system is significantly influenced by the environment. Possible overvoltages at the motor terminals can be influenced by the length of the motor cable and the voltage slope of the servo controller. These overvoltages lead to partial discharges in the insulation system and can significantly reduce the lifetime of the insulation system. An assessment can only be made in the customer's environment. The manufacturer is not aware of any failures to date that can be attributed to a higher DC link voltage.

You will find more information on this in the Engineering data chapter.

LynxDrive-32D, LynxDrive-40D
Actuators with 680 VDC maximum stationary DC bus voltage

Table 2.1.8

Actuator	Symbol [Unit]	32D						40D				
Stator winding		AR						AT				
Motor feedback system		ROO / MGH / MEE / MKE / MZE / MZET						ROO / MGH / MEE / MKE				
Ratio	i	30	50	80	100	120	160	50	80	100	120	160
Maximum output torque	T_{MAX} [Nm]	100	272	395	433	459	484	523	675	738	802	841
Maximum output speed	n_{MAX} [rpm]	160	96	60	48	40	30	80	50	40	33	25
Maximum current	I_{MAX} [A_{rms}]	6.9	10.0	9.3	8.2	7.3	5.9	20.2	15.0	12.9	11.6	9.0
Continuous stall torque	T_0 [Nm]	61	109	180	224	269	281	182	300	375	450	586
Continuous stall current	I_0 [A_{rms}]	4.2	4.2	4.1	4.1	4.1	3.3	6.1	6.1	6.1	6.0	5.9
No load starting current	I_{NLSC} [A_{rms}]	0.28	0.25	0.20	0.20	0.20	0.21	0.48	0.37	0.35	0.35	0.35
No load current constant (20 °C)	K_{INL} [10^{-3}A/rpm]	5.39	10.45	16.73	20.19	23.96	31.96	22.4	32.2	38.6	45.1	57.1
No load current constant (90 °C)	K_{INL} [10^{-3}A/rpm]	1.44	2.95	4.71	5.69	6.75	8.86	6.9	10.0	12.0	14.1	17.9
Torque constant (Motor)	K_T [Nm/A_{rms}]	0.60						0.68				
AC voltage constant (L-L, 20 °C)	K_E [V_{RMS}/1000 rpm]	38.4						46.3				
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	680[1)]						680[1)]				
Mechanical time constant, without brake (20 °C)	T_M [ms]	2.4						3.2				
Electrical time constant (20 °C)	T_E [ms]	3.8						3.9				
Maximum motor speed	n_{MAX} [rpm]	4800						4000				
Rated motor speed	n_N [rpm]	3500						3000				
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	2.4						1.3				
Rotary field inductance	L_d [mH]	4.5						2.5				
Number of pole pairs	p	7						7				
Brake voltage	$U_{Br.}$ [V_{DC}]	24 ±10 %						24 ±10 %				
Brake holding torque	$T_{Br.}$ [Nm]	100	203	324	405	459	484	405	648	738	802	841
Brake power consumption	$P_{BR.}$ [W]	12						18				
Brake opening time	t_O [ms]	35						40				
Brake closing time	t_C [ms]	7						7				
Weight without brake	m [kg]	6.5						9.1				
Weight with brake	m [kg]	7.1						10.1				
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	54	99	153	178	178	178	178	268	345	382	382
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000						2000				

[1)] In general, actuators with an Ax winding can also be operated on DC links with a nominal voltage > 680 V_{DC}. The lifetime of an insulation system is significantly influenced by the environment. Possible overvoltages at the motor terminals can be influenced by the length of the motor cable and the voltage slope of the servo controller. These overvoltages lead to partial discharges in the insulation system and can significantly reduce the lifetime of the insulation system. An assessment can only be made in the customer's environment. The manufacturer is not aware of any failures to date that can be attributed to a higher DC link voltage.

You will find more information on this in the Engineering data chapter.

LynxDrive-50D
Actuators with 680 VDC maximum stationary DC bus voltage

Table 2.1.9

Actuator	Symbol [Unit]	50D			
Stator winding		AW			
Motor feedback system		ROO / MGH / MEE / MKE / MZE / MZET			
Ratio	i	80	100	120	160
Maximum output torque	T_{MAX} [Nm]	1223	1274	1404	1534
Maximum output speed	n_{MAX} [rpm]	44	35	29	22
Maximum current	I_{MAX} [A_{rms}]	13.8	11.7	10.8	8.9
Continuous stall torque	T_0 [Nm]	537	670	802	1059
Continuous stall current	I_0 [A_{rms}]	6.0	6.0	6.0	5.9
No load starting current	I_{NLSC} [A_{rms}]	0.35	0.35	0.35	0.36
No load current constant (20 °C)	K_{INL} [10^{-3}A/rpm]	36.4	44.6	53.4	69.4
No load current constant (90 °C)	K_{INL} [10^{-3}A/rpm]	12.8	15.8	18.8	24.4
Torque constant (Motor)	K_T [Nm/A_{rms}]	1.21			
AC voltage constant (L-L, 20 °C)	K_E [V_{RMS}/1000 rpm]	80.5			
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	680[1)]			
Mechanical time constant, without brake (20 °C)	T_M [ms]	2.5			
Electrical time constant (20 °C)	T_E [ms]	7.2			
Maximum motor speed	n_{MAX} [rpm]	3500			
Rated motor speed	n_N [rpm]	2500			
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	1.4			
Rotary field inductance	L_d [mH]	4.9			
Number of pole pairs	p	7			
Brake voltage	$U_{Br.}$ [V_{DC}]		24 ±10 %		
Brake holding torque	$T_{Br.}$ [Nm]	648	810	972	1296
Brake power consumption	$P_{BR.}$ [W]	18			
Brake opening time	t_O [ms]	40			
Brake closing time	t_C [ms]	7			
Weight without brake	m [kg]	16.1			
Weight with brake	m [kg]	17.2			
Rated torque gear component set for calculating the Wave Generator lifetime	T_N [Nm]	484	611	688	688
Rated speed gear component set for calculating the Wave Generator lifetime	n_N [rpm]	2000			

[1)] In general, actuators with an Ax winding can also be operated on DC links with a nominal voltage > 680 V_{DC}. The lifetime of an insulation system is significantly influenced by the environment. Possible overvoltages at the motor terminals can be influenced by the length of the motor cable and the voltage slope of the servo controller. These overvoltages lead to partial discharges in the insulation system and can significantly reduce the lifetime of the insulation system. An assessment can only be made in the customer's environment. The manufacturer is not aware of any failures to date that can be attributed to a higher DC link voltage.

You will find more information on this in the Engineering data chapter.

• Moment of inertia

Table 2.1.10

	Symbol [Unit]	14D				17D				
Motor feedback system		ROO / MGH / MEE / MKE / MZE / MZET				ROO / MGH / MEE / MKE / MZE / MZET				
Ratio		30	50	80	100	30	50	80	100	120
Moment of inertia at output side										
Moment of inertia without brake	J_{OUT} [kgm^2]	0.023	0.063	0.16	0.25	0.027	0.074	0.189	0.296	0.426
Moment of inertia with brake	J_{OUT} [kgm^2]	0.028	0.078	0.198	0.31	0.034	0.093	0.239	0.373	0.537
Moment of inertia at motor side										
Moment of inertia without brake	J [kgm^{2}x10^{-4}]	0.25				0.3				
Moment of inertia with brake	J [kgm^{2}x10^{-4}]	0.31				0.37				

Table 2.1.11

	Symbol [Unit]	20D						25D					
Motor feedback system		ROO / MGH / MEE / MKE / MZE / MZET											
Ratio		30	50	80	100	120	160	30	50	80	100	120	160
Moment of inertia at output side													
Moment of inertia without brake	J_{OUT} [kgm^2]	0.035	0.099	0.252	0.394	0.567	1.009	0.147	0.407	1.043	1.629	2.346	4.170
Moment of inertia with brake	J_{OUT} [kgm^2]	0.039	0.109	0.279	0.436	0.628	1.116	0.167	0.463	1.184	1.850	2.664	4.736
Moment of inertia at motor side													
Moment of inertia without brake	J [kgm^{2}x10^{-4}]	0.39						1.6					
Moment of inertia with brake	J [kgm^{2}x10^{-4}]	0.44						1.9					

Table 2.1.12

	Symbol [Unit]	32D						40D				
Motor feedback system		ROO / MGH / MEE / MKE / MZE / MZET						ROO / MGH / MEE / MKE / MZE / MZET				
Ratio		30	50	80	100	120	160	50	80	100	120	160
Moment of inertia at output side												
Moment of inertia without brake	J_{OUT} [kgm^2]	0.202	0.560	1.434	2.241	3.227	5.737	1.965	5.030	7.860	11.320	20.120
Moment of inertia with brake	J_{OUT} [kgm^2]	0.221	0.616	1.576	2.462	3.545	6.303	2.068	5.293	8.270	11.910	21.170
Moment of inertia at motor side												
Moment of inertia without brake	J [kgm^{2}x10^{-4}]	2.2						7.86				
Moment of inertia with brake	J [kgm^{2}x10^{-4}]	2.5						8.27				

Table 2.1.13

	Symbol [Unit]	50D			
Motor feedback system		ROO / MGH / MEE / MKE / MZE / MZET			
Ratio		80	100	120	160
Moment of inertia at output side					
Moment of inertia without brake	J_{OUT} [kgm^2]	11.50	17.90	25.80	45.90
Moment of inertia with brake	J_{OUT} [kgm^2]	11.80	18.50	26.60	47.40
Moment of inertia at motor side					
Moment of inertia without brake	J [kgm^{2}x10^{-4}]	17.9			
Moment of inertia with brake	J [kgm^{2}x10^{-4}]	18.5			

• Performance characteristics

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 2.1.1 **LynxDrive-14D-30**

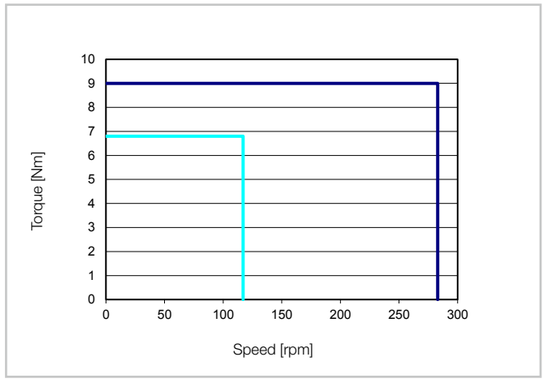


Illustration 2.1.2 **LynxDrive-14D-50**

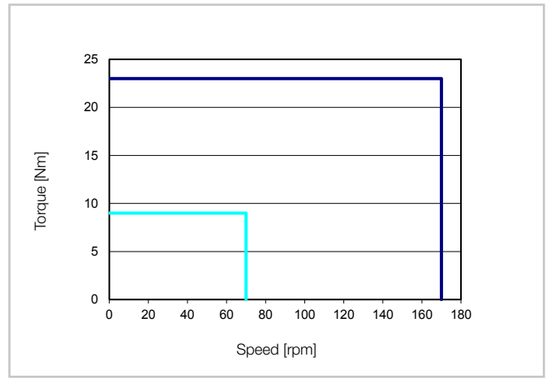


Illustration 2.1.3 **LynxDrive-14D-80**

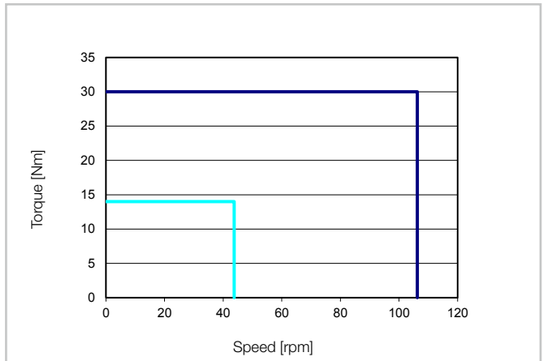
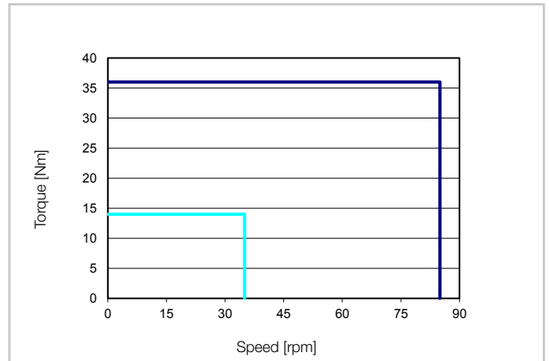


Illustration 2.1.4 **LynxDrive-14D-100**



U_M = 230 ... 400 VAC
Intermittent duty ——— Continuous duty ———

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 2.1.5 **LynxDrive-17D-30**

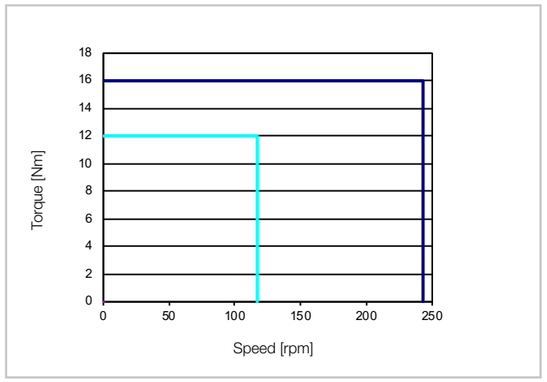


Illustration 2.1.6 **LynxDrive-17D-50**

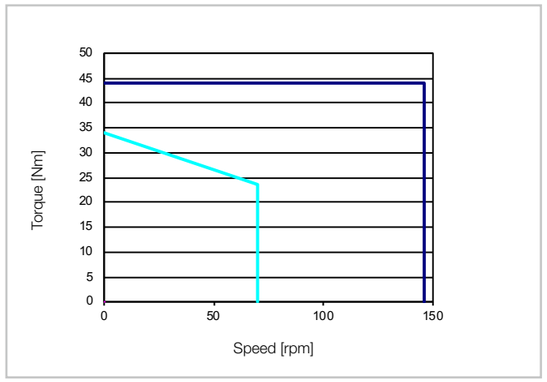


Illustration 2.1.7 **LynxDrive-17D-80**

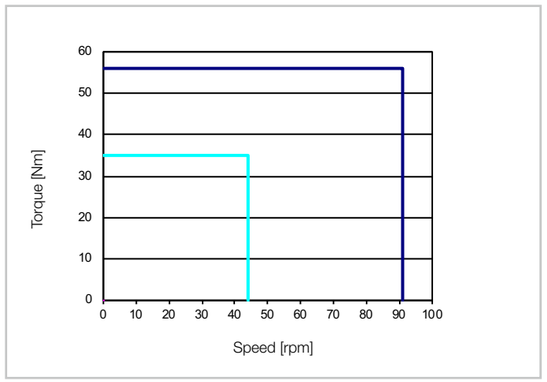


Illustration 2.1.8 **LynxDrive-17D-100**

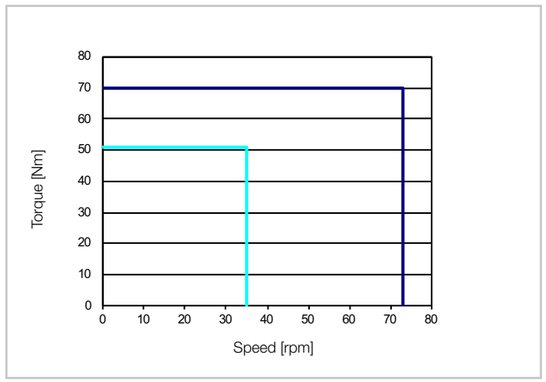
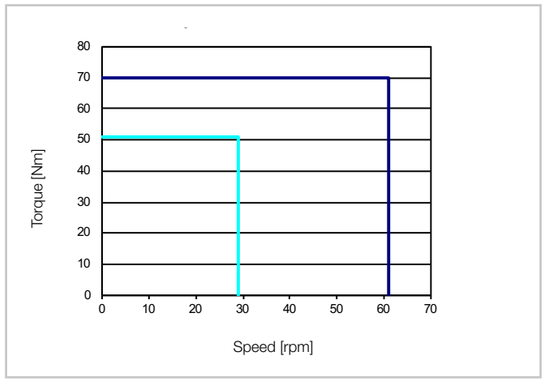


Illustration 2.1.9 **LynxDrive-17D-120**



U_M = 230 ... 400 VAC
Intermittent duty
Continuous duty

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 2.1.10 **LynxDrive-20D-30**

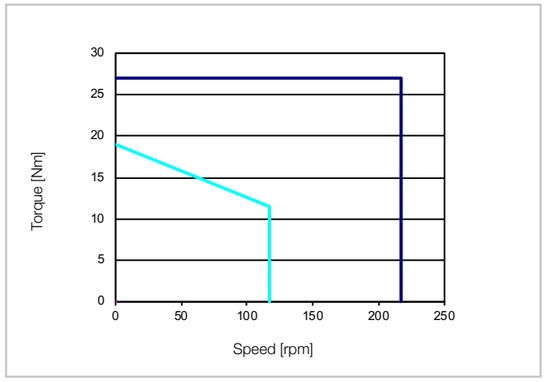


Illustration 2.1.11 **LynxDrive-20D-50**

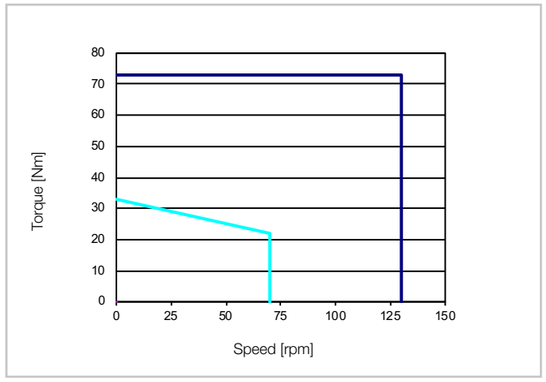


Illustration 2.1.12 **LynxDrive-20D-80**

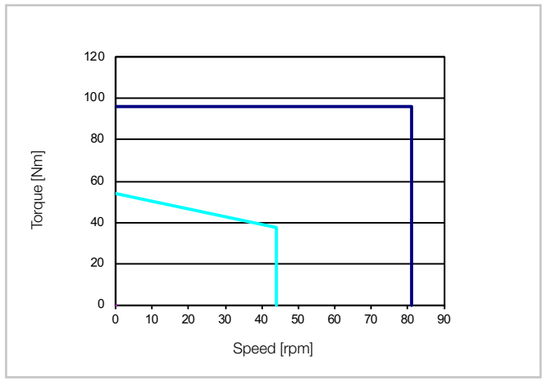


Illustration 2.1.13 **LynxDrive-20D-100**

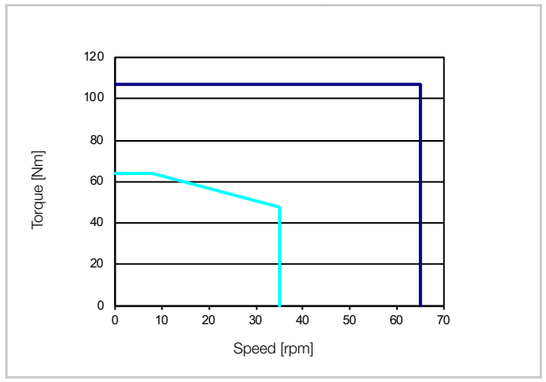


Illustration 2.1.14 **LynxDrive-20D-120**

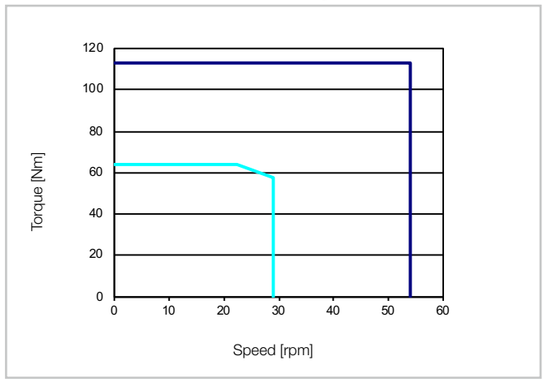
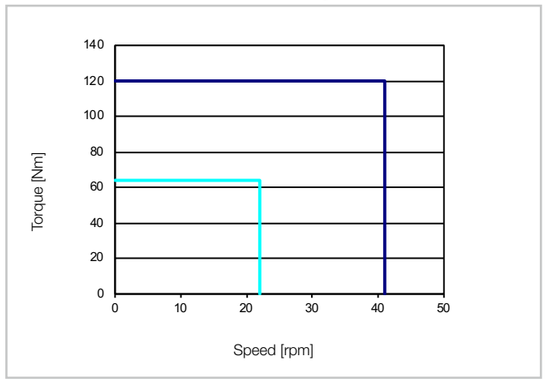


Illustration 2.1.15 **LynxDrive-20D-160**



U_M = 230 ... 400 VAC
Intermittent duty
Continuous duty
Voltage limit in overload operation with reduced mains supply with 230 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 2.1.16 **LynxDrive-25D-30**

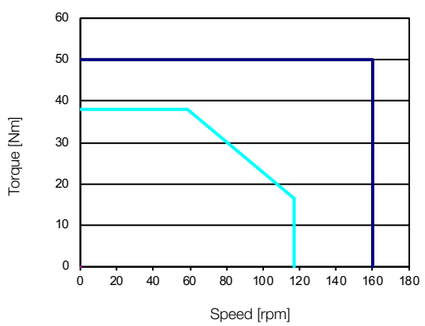


Illustration 2.1.17 **LynxDrive-25D-50**

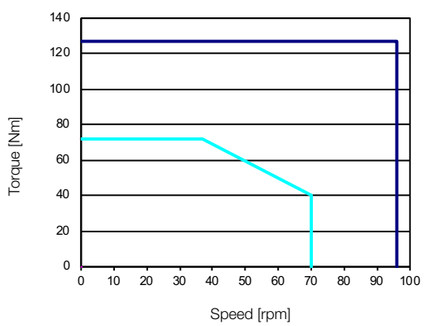


Illustration 2.1.18 **LynxDrive-25D-80**

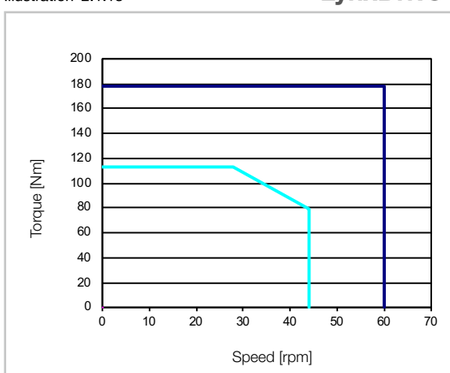


Illustration 2.1.19 **LynxDrive-25D-100**

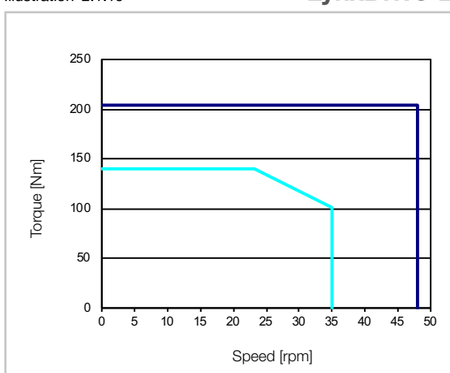


Illustration 2.1.20 **LynxDrive-25D-120**

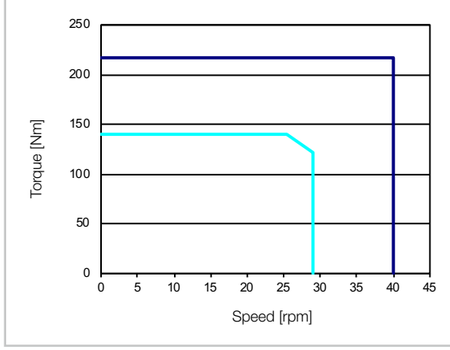
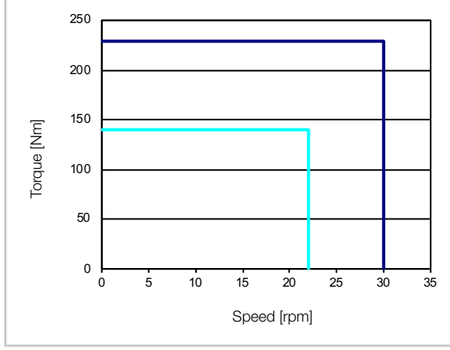


Illustration 2.1.21 **LynxDrive-25D-160**



U_M = 230 ... 400 VAC
Intermittent duty
Continuous duty

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 2.1.22 **LynxDrive-32D-30**

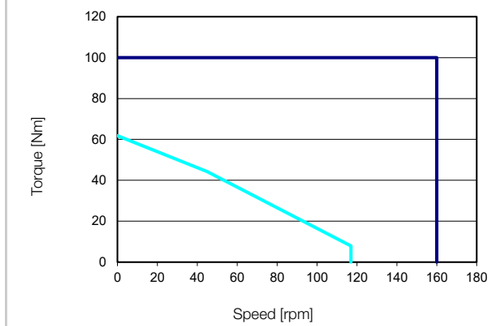


Illustration 2.1.23 **LynxDrive-32D-50**

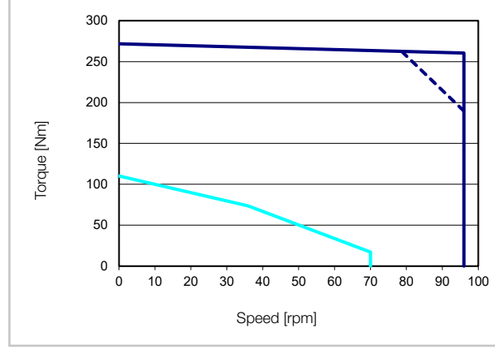


Illustration 2.1.24 **LynxDrive-32D-80**

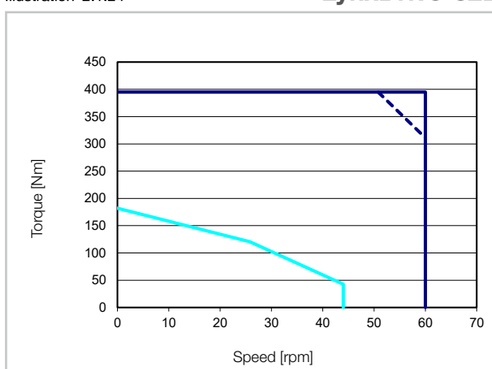


Illustration 2.1.25 **LynxDrive-32D-100**

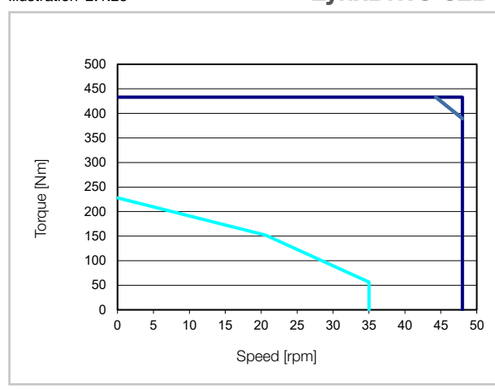


Illustration 2.1.26 **LynxDrive-32D-120**

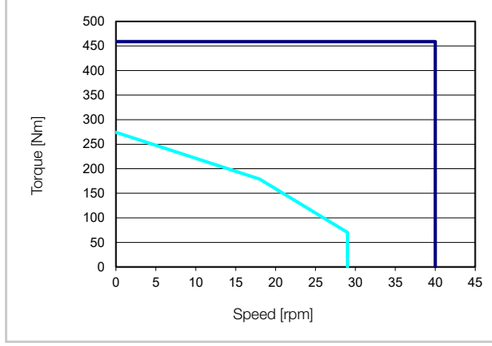
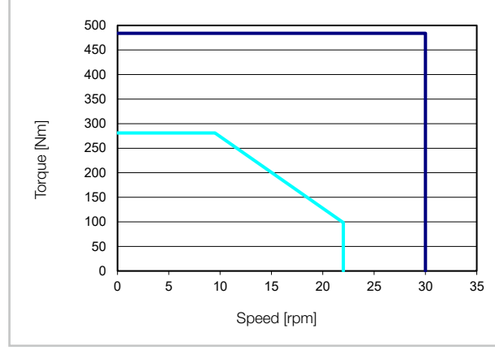


Illustration 2.1.27 **LynxDrive-32D-160**



U_M = 230 ... 400 VAC
Intermittent duty
Continuous duty
Voltage limit in overload operation with reduced mains supply with 230 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 2.1.28

LynxDrive-40D-50

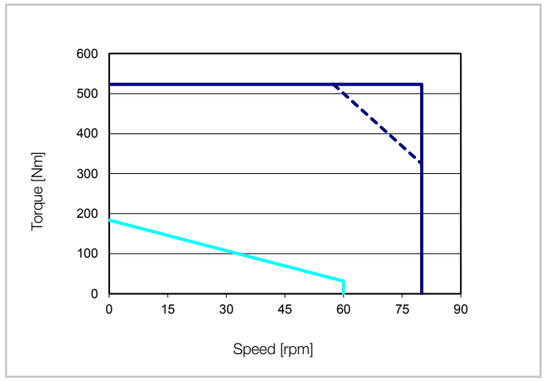


Illustration 2.1.29

LynxDrive-40D-80

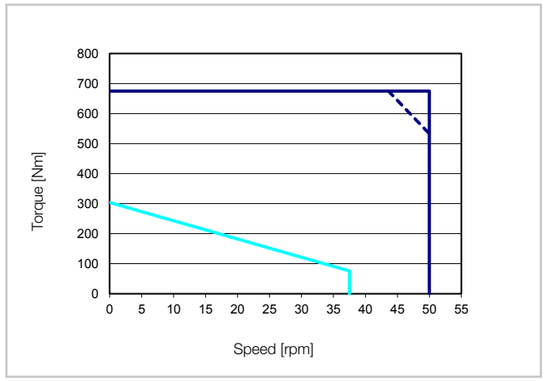


Illustration 2.1.30

LynxDrive-40D-100

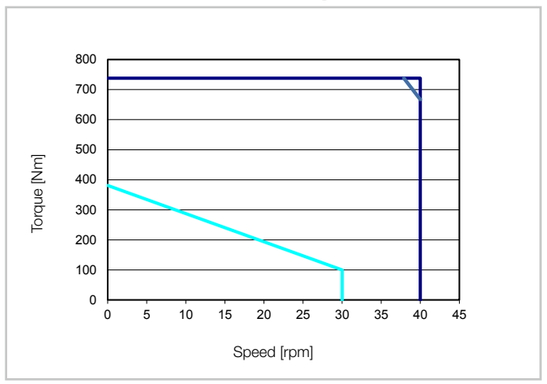


Illustration 2.1.31

LynxDrive-40D-120

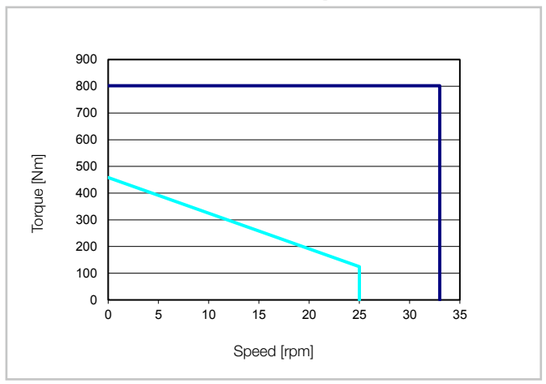
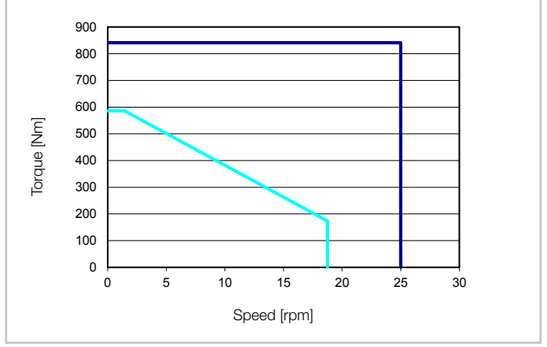


Illustration 2.1.32

LynxDrive-40D-160



U_M = 400 VAC
Intermittent duty
Continuous duty

Voltage limit in overload operation with reduced mains supply with 230 VAC

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 2.1.33

LynxDrive-50D-80

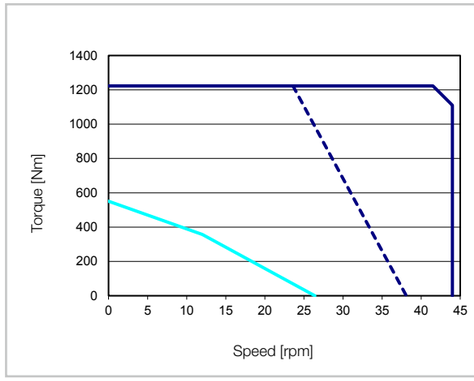


Illustration 2.1.34

LynxDrive-50D-100

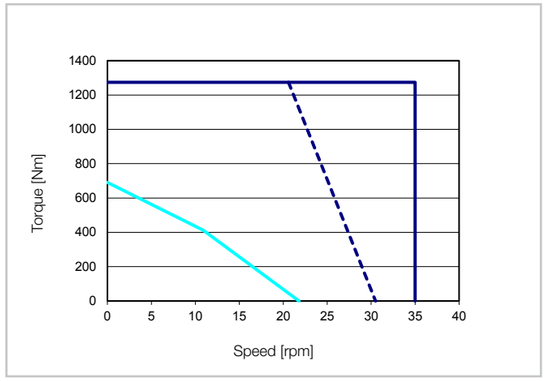


Illustration 2.1.35

LynxDrive-50D-120

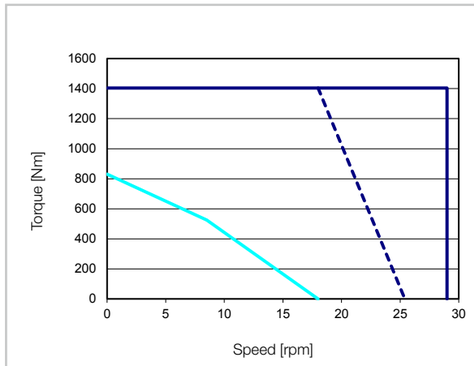
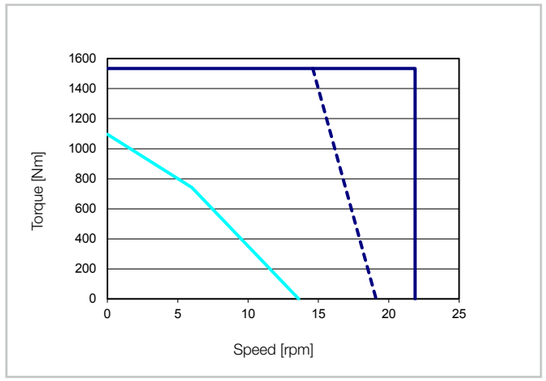


Illustration 2.1.36

LynxDrive-50D-160



U_M = 400 VAC
Intermittent duty

Continuous duty

- Dimensions

Illustration 2.1.37

LynxDrive-14D [mm]

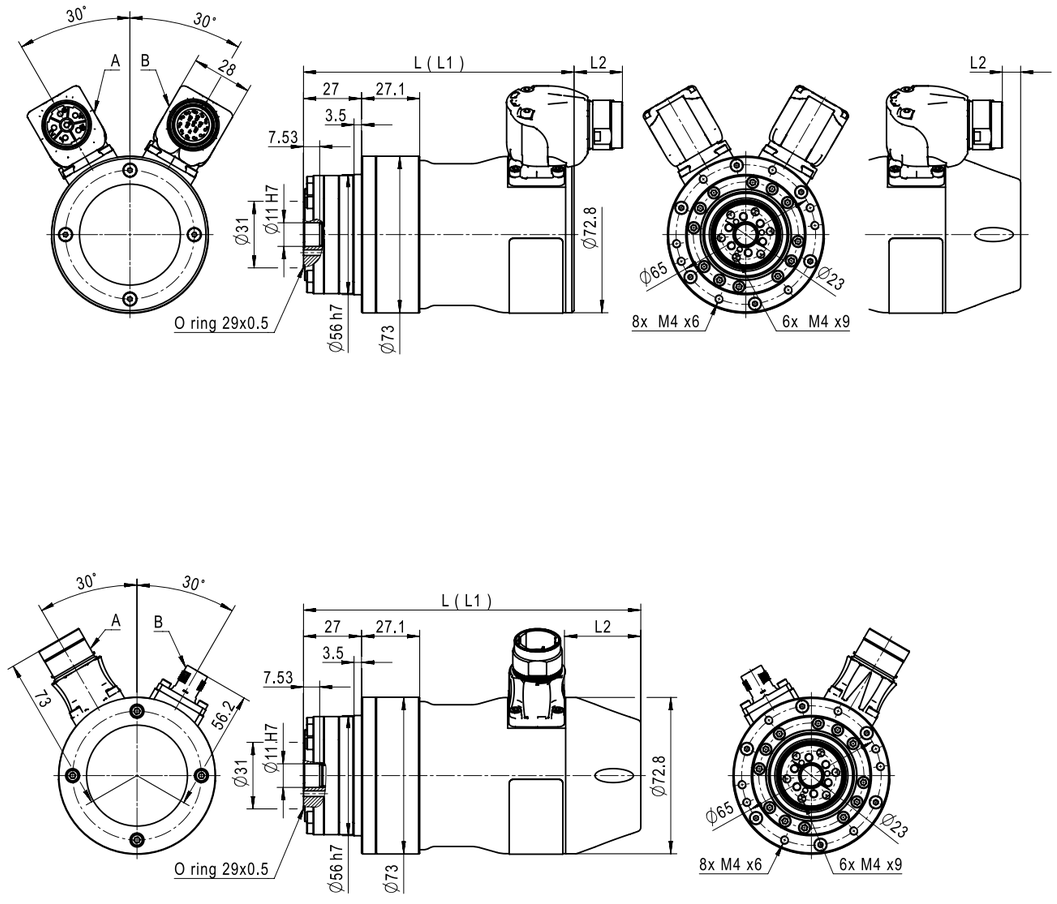


Illustration 2.1.38

	Symbol [Unit]	14D	
Motor feedback system		ROO / MKE	MGH / MEE
Length without brake	L [mm]	126	157
Length with brake	L1 [mm]	160	191
Connector protrusion[1)]	L2 [mm]	23	-8

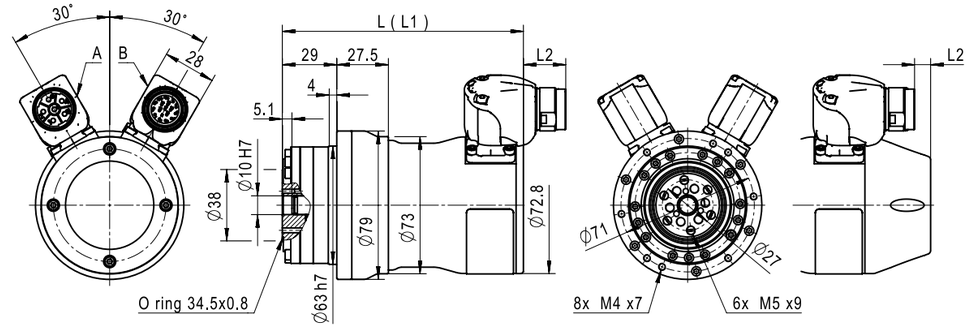
[1)] A negative value of L2 indicates that the connectors do not extend beyond the motor length.

CAD drawings for download: www.harmonicdrive.co.uk

Table 2.1.14

LynxDrive-17D [mm]

Connector configuration F or M



Connector configuration J (only possible with MZET)

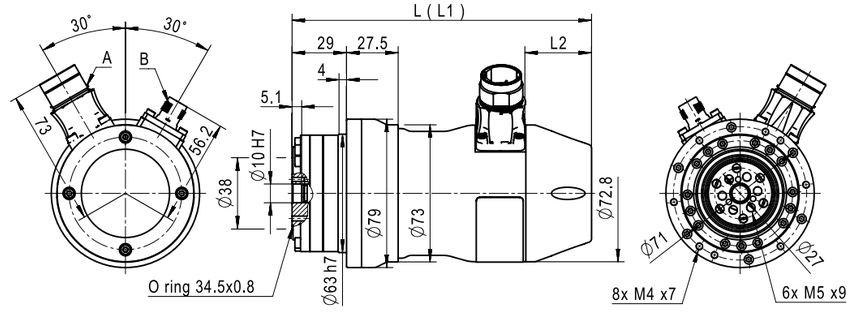


Table 2.1.15

	Symbol [Unit]	17D		
Motor feedback system		ROO / MKE	MGH / MEE / MZE	MZET
Length without brake	L [mm]	129	160	160
Length with brake	L1 [mm]	162	193	193
Connector protrusion[1)]	L2 [mm]	23	-8	-35

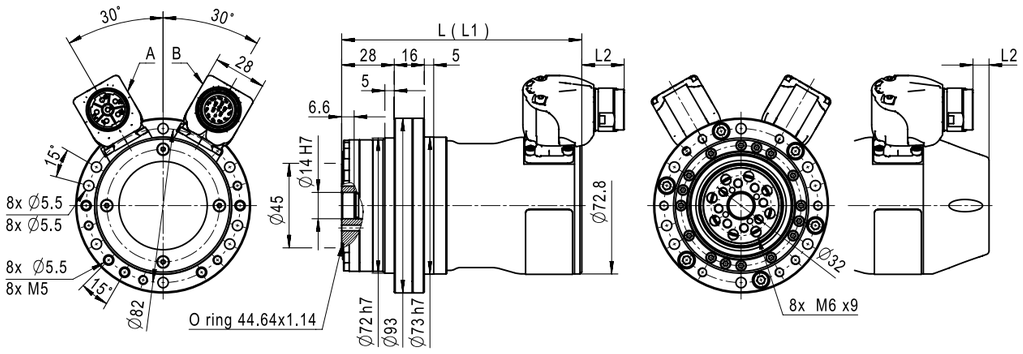
[1)] A negative value of L2 indicates that the connectors do not extend beyond the motor length.

CAD drawings for download: www.harmonicdrive.co.uk

Illustration 2.1.39

LynxDrive-20D [mm]

Connector configuration F or M



Connector configuration J (only possible with MZET)

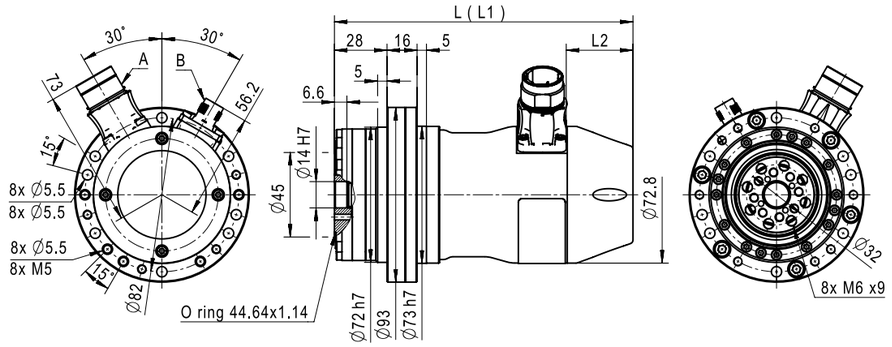


Illustration 2.1.40

	Symbol [Unit]	20D		
Motor feedback system		ROO / MKE	MGH / MEE / MZE	MZET
Length without brake	L [mm]	128	159	159
Length with brake	L1 [mm]	162	193	193
Connector protrusion[1)]	L2 [mm]	23	-8	-35

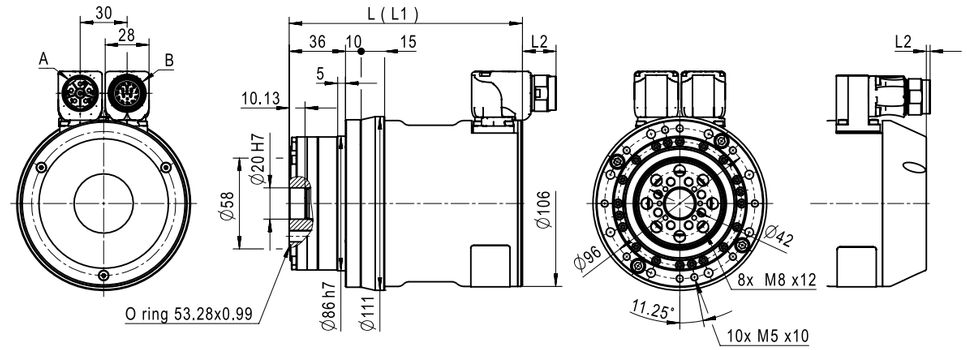
[1)] A negative value of L2 indicates that the connectors do not extend beyond the motor length.

CAD drawings for download: www.harmonicdrive.co.uk

Illustration 2.1.41

LynxDrive-25D [mm]

Connector configuration F or M



Connector configuration J (only possible with MZET)

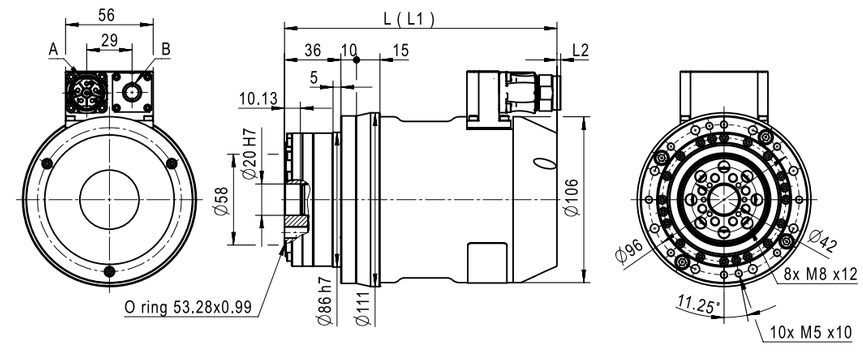


Table 2.1.16

	Symbol [Unit]	25D		
Motor feedback system		ROO / MKE	MGH / MEE / MZE	MZET
Length without brake	L [mm]	149	174	174
Length with brake	L1 [mm]	188	213	213
Connector protrusion[1)]	L2 [mm]	22	-8	3

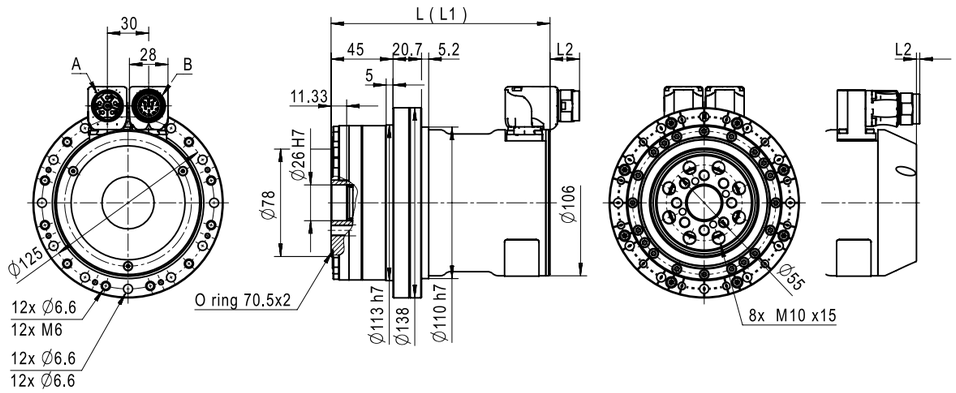
[1)] A negative value of L2 indicates that the connectors do not extend beyond the motor length.

CAD drawings for download: www.harmonicdrive.co.uk

Illustration 2.1.42

LynxDrive-32D [mm]

Connector configuration F or M



Connector configuration J (only possible with MZET)

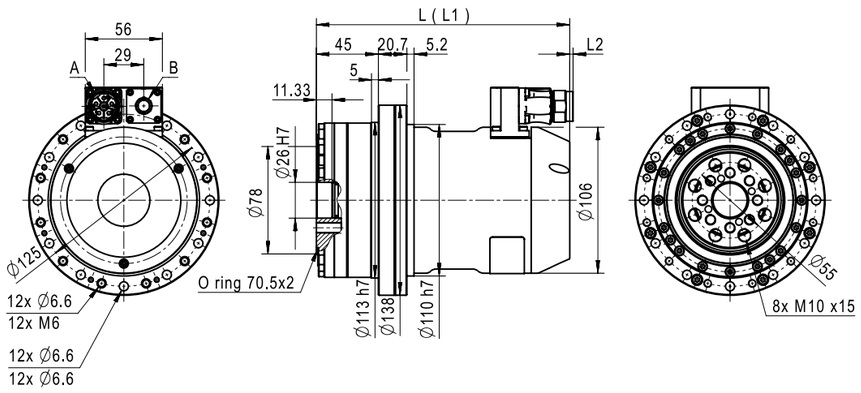


Illustration 2.1.43

	Symbol [Unit]	32D		
Motor feedback system		ROO / MKE	MGH / MEE / MZE	MZET
Length without brake	L [mm]	159	184	184
Length with brake	L1 [mm]	198	223	223
Connector protrusion[1)]	L2 [mm]	22	-3	3

[1)] A negative value of L2 indicates that the connectors do not extend beyond the motor length.

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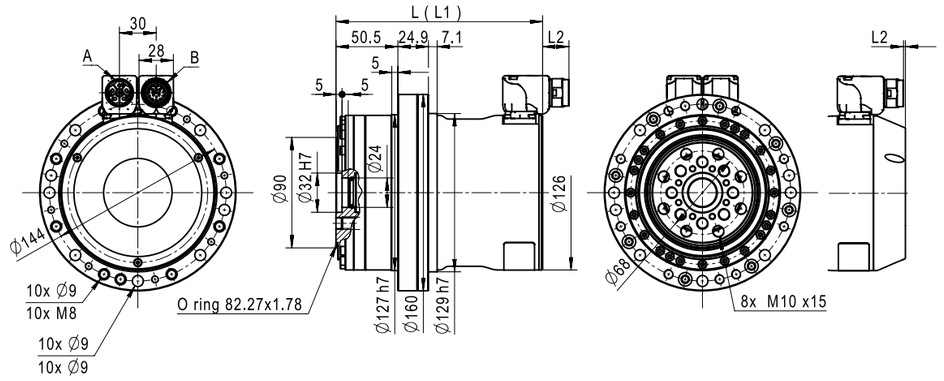
Table 2.1.17

LynxDrive-40D [mm]



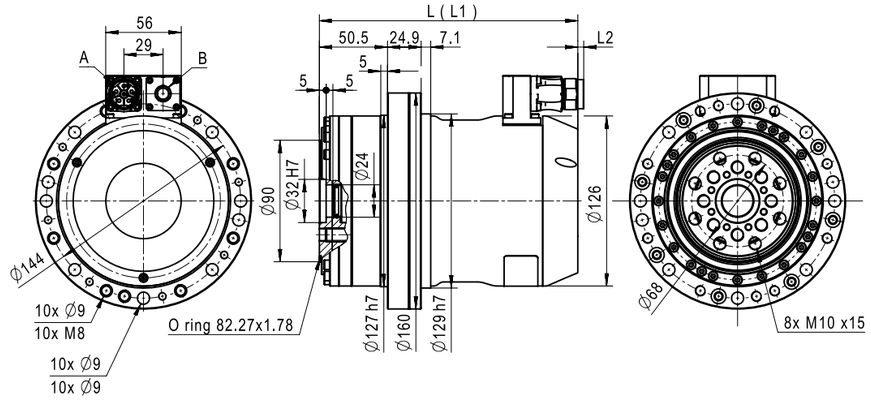


Table 2.1.18

	Symbol [Unit]	40D	
Motor feedback system		ROO / MKE	MGH / MEE / CCO
Length without brake	L [mm]	169	192
Length with brake	L1 [mm]	208	231
Connector protrusion[1)]	L2 [mm]	22	-2

[1)] A negative value of L2 indicates that the connectors do not extend beyond the motor length.

CAD drawings for download: www.harmonicdrive.co.uk

Illustration 2.1.44

LynxDrive-50D [mm]

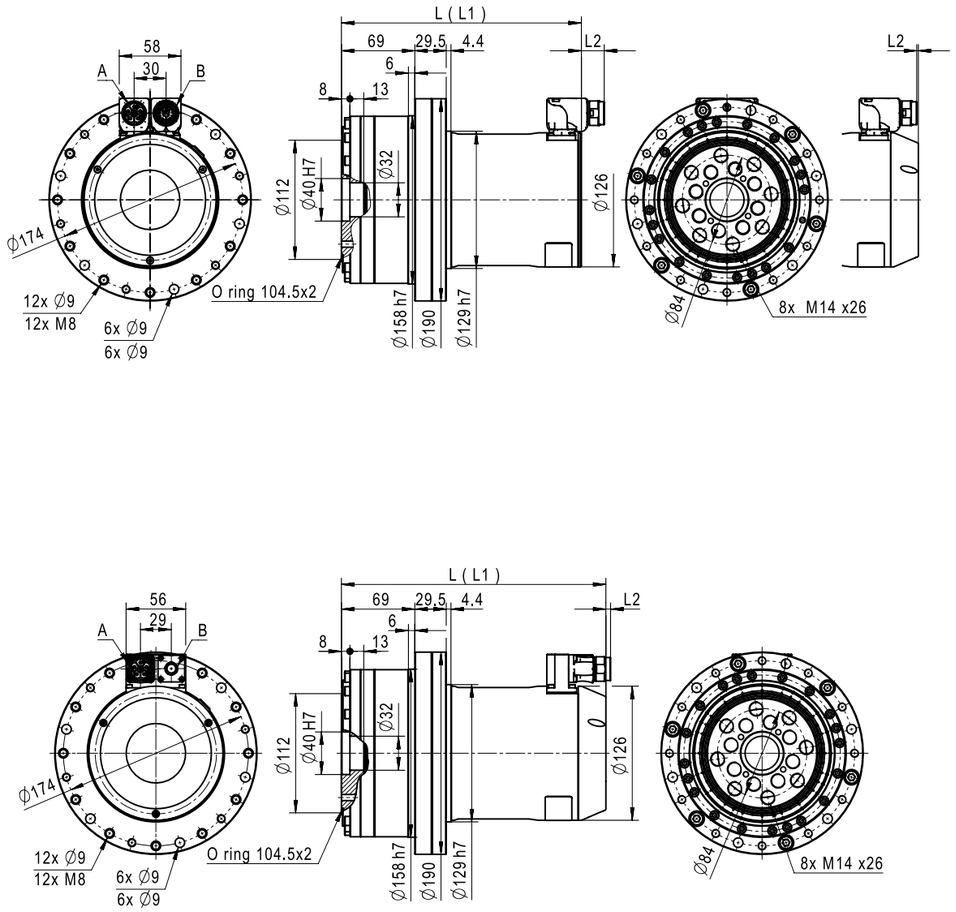


Table 2.1.19

	Symbol [Unit]	50D	
Motor feedback system		ROO / MKE	MGH / MEE
Length without brake	L [mm]	226	249
Length with brake	L1 [mm]	265	288
Connector protrusion[1)]	L2 [mm]	22	-2

1) A negative value of L2 indicates that the connectors do not extend beyond the motor length.

CAD drawings for download: www.harmonicdrive.co.uk

Gear characteristics

• Accuracy

Table 2.1.20

	Symbol [Unit]	14D		17D		20D		25D		32D		40D	50D
Ratio	i [ ]	30	≥ 50	30	≥ 50	30	≥ 50	30	≥ 50	30	≥ 50	≥ 50	≥ 80
Transmission accuracy	[arcmin]	< 2.0	< 1.5	< 1.5	< 1.5	< 1.5	< 1.0	< 1.5	< 1.0	< 1.5	< 1.0	< 1.0	< 1.0
Repeatability	[arcmin]	< ±0.1		< ±0.1		< ±0.1		< ±0.1		< ±0.1		< ±0.1	< ±0.1
Hysteresis loss	[arcmin]	< 3	< 1	< 3	< 1	< 3	< 1	< 3	< 1	< 3	< 1	< 1	< 1
Lost motion	[arcmin]	< 1		< 1		< 1		< 1		< 1		< 1	< 1

• Torsional stiffness

Table 2.1.21

	Symbol [Unit]	14D			17D			20D			25D			32D			40D		50D	
Limit torques	T_1 [Nm]	2.0			3.9			7.0			14.0			29.0			54.0		108.0	
	T_2 [Nm]	6.9			12.0			25.0			48.0			108.0			196.0		382.0	
Ratio	i [ ]	30	50	> 50	30	50	> 50	30	50	> 50	30	50	> 50	30	50	> 50	50	> 50	50	> 50
Torsional stiffness	K_3 [x 10^4 Nm/rad]	0.34	0.57	0.71	0.67	1.30	1.60	1.10	2.30	2.90	2.10	4.40	5.70	4.90	9.80	12.00	180.00	23.00	34.00	44.00
	K_2 [x 10^4 Nm/rad]	0.24	0.47	0.61	0.44	1.10	1.40	0.71	1.80	2.50	1.30	3.40	5.00	3.00	7.80	11.00	14.00	20.00	28.00	40.00
	K_1 [x 10^4 Nm/rad]	0.19	0.34	0.47	0.34	0.81	1.00	0.57	1.30	1.60	1.00	2.50	3.10	2.40	5.40	6.70	10.00	13.00	20.00	25.00

You will find more information on this in the Engineering data chapter.

Output bearing

Our servo actuators incorporate a high stiffness output bearing. This specially developed bearing can withstand high axial forces and radial forces as well as tilting moments. The reduction gear is therefore protected from external loads, so guaranteeing a long life and consistent performance. The integration of an output bearing also serves to reduce subsequent design and production cost, by removing the need for an additional output bearing in many applications.

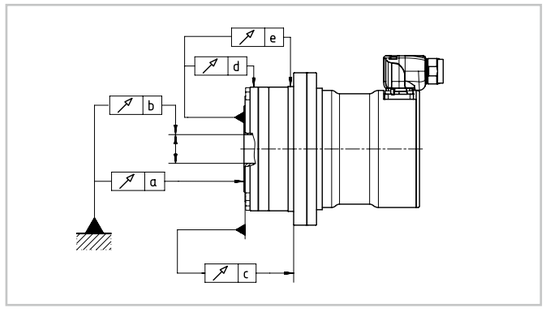
• Performance data

Table 2.1.22

	Symbol [Unit]	14D	17D	20D	25D	32D	40D	50D
Bearing type[1]		C	C	C	C	C	C	C
Pitch circle diameter	d_p [m]	0.035	0.043	0.050	0.062	0.080	0.096	0.119
Offset[2]	R [m]	0.0095	0.0095	0.0095	0.0115	0.0130	0.0145	0.0180
Dynamic load rating	C [N]	4700	5290	5780	9600	15000	21300	34800
Static load rating	C_0 [N]	6070	7550	9000	15100	25000	36500	60200
Permissible dynamic tilting moment[3,4]	M [Nm]	41	64	91	156	313	450	759
Tilting moment stiffness[5]	K_B [Nm/arcmin]	13	23	37	70	157	265	497
Permissible axial force[4]	F_a [N]	1004	1130	1235	2051	3205	4550	7435
Permissible radial force[4]	F_r [N]	673	757	827	1374	2147	3049	4981

1) Bearing type C = Cross roller bearing; F = Four point contact bearing
2) Distance between the centre of the rolling bearing and the screw mounting surface on the output side, see chapter Actuator dimensioning.
3) These values are valid for moving gears. They are not based on the equation for lifetime of the output bearing but on the maximum allowable deflection of the Harmonic Drive® Gear Component Set. The values indicated in the table must not be exceeded even if the lifetime equation of the bearing permits higher values.
4) These data are valid for M: $F_a = 0$, $F_r = 0$ I F_a: M = 0, $F_r = 0$ I F_r: M = 0, $F_a = 0$
5) The value of tilting moment stiffness is the average value (± 20 %).

Illustration 2.1.45



• Tolerances

Table 2.1.23

	Symbol [Unit]	14D	17D	20D	25D	32D	40D	50D
a	[mm]	0.010	0.010	0.010	0.015	0.015	0.015	0.015
b	[mm]	0.010	0.012	0.012	0.013	0.013	0.015	0.015
c	[mm]	0.024	0.026	0.038	0.045	0.056	0.060	0.069
d	[mm]	0.010	0.010	0.010	0.010	0.010	0.015	0.015

Motor feedback systems

For all following encoders, the counting direction of the encoder is positive when the output shaft rotates counterclockwise (when looking at the output shaft). The background for the counterclockwise rotation of the output shaft is the internal reversal of the direction of rotation by the strain wave gear of the LynxDrive Actuator.

• Motor feedback system MEE

Multi-turn absolute motor feedback system with incremental SIN / COS signals and EnDat data interface

Table 2.1.24

Ordering code	Symbol [Unit]	MEE					
Manufacturer´s designation		EQN-1125					
Protocol		EnDat 2.2					
Power supply[1]	U_b [V_{DC}]	3.6 - 14					
Current consumption (typ. bei 5 V_{DC})	I [mA]	140 (max.)					
Incremental signals	u_{pp} [V_{ss}]	1					
Signal form		sinusoidal					
Number of pulses	n_1 [SIN / COS]	512					
Absolute postion values / revolution (at motor side)[2]		8192 (13 bit)					
Number of revolutions		4096 (12 bit)					
Accuracy[1]	[arcsec]	± 60					
Gear ratio	i [ ]	30	50	80	100	120	160
Resolution absolute value (output side)	[arcsec]	5.27	3.16	1.98	1.58	1.32	0.99
Resolution incremental (at motor side)[3]	inc [ ]	2.097.152 (512 x 12 bit)					
Gear ratio	i [ ]	30	50	80	100	120	160
Resolution incremental (output side)[3]	[arcsec]	0.021	0.012	0.008	0.006	0.005	0.004

1) Source: Manufacturer
2) Increasing position values with direction of rotation
- CW of the motor shaft (looking at the motor shaft from the front)
- CCW of the output flange
3) With a controller resolution of the A/D converter of 12 bit (= 12 bit x 512 SinCos)

• Motor feedback system MZE / MZET

Multi-turn absolute motor feedback system with EnDat data interface

Table 2.1.25

Ordering code	Symbol [Unit]	MZE / MZET					
Manufacturer´s designation		EQN-1135					
Protocol		EnDat 2.2/22					
Functional safety according to manufacturer's instructions[1]		Systematic suitability of the encoder for safety related applications: As an input system for monitoring functions SIL 1 according to EN 61508 (further test basis: IEC 61800-5-3) Category 2, PL c according to EN ISO 13849-1:2015 As an input system for control loop functions SIL 2 according to EN 61508 (further test basis: IEC 61800-5-3) Category 3, PL d according to EN ISO 13849-1:2015 Safe in singleturn operation					
Motor encoder connection		Fault exclusion in accordance with EN 61800-5-2					
Power supply	U_b [V_{DC}]	3.6 ~ 14					
Current consumption (without load)[2]	I [mA]	105 @ 5 VDC					
Power On time	t [s]	-					
Incremental signals	U_{pp} [V_{ss}]	-					
Signal form		-					
Number of pulses	n_1	-					
Absolute position values / revolution (motor side)[3]		8388608 (23 bit)					
Number of revolutions		4096 (12 bit)					
Accuracy[2]	[arcsec]	±60					
Resolution absolute value (output side)		Gear ratio					
	i [ ]	30	50	80	100	120	160
	[arcsec]	0.0051	0.0031	0.0019	0.0015	0.0013	0.0010
Number of revolutions (output side)		137	82	51	41	34	26

[1] The encoder is securely attached to the housing and motor shaft in accordance with the manufacturer's specifications (for accelerations ≤ 300m/s²).
Using the actuator for safety functions requires the user to certify it in the end application, including the gear, for the specific application.
[2] Source: Manufacturer
[3] Increasing position values with direction of rotation
- CW of the motor shaft (looking at the motor shaft from the front)
- CCW of the output flange

• Motor feedback system MKE

Multi-turn absolute motor feedback system with incremental SIN / COS signals and EnDat data interface

Table 2.1.26

Ordering code	Symbol [Unit]	MKE					
Manufacturer´s designation		EQI-1130					
Protocol		EnDat 2.1					
Power supply[1]	U_b [V_{DC}]	4.75 - 10					
Current consumption (typ. bei 5 V_{DC})	I [mA]	100					
Incremental signals	u_{pp} [V_{ss}]	1					
Signal form		sinusoidal					
Number of pulses	n_1 [SIN / COS]	16					
Absolute postion values / revolution (at motor side) [2]		262144 (18 bit)					
Number of revolutions		4096 (12 bit)					
Accuracy[1]	[arcsec]	± 280					
Gear ratio	i [ ]	30	50	80	100	120	160
Resolution absolute value (output side)	[arcsec]	0.16	0.10	0.06	0.05	0.04	0.03
Resolution incremental (at motor side)[3]	inc [ ]	65.536 (16 x 12 bit)					
Gear ratio	i [ ]	30	50	80	100	120	160
Resolution incremental (output side)[3]	[arcsec]	0.66	0.40	0.25	0.20	0.16	0.12

[1] Source: Manufacturer
[2] Increasing position values with direction of rotation
- CW of the motor shaft (looking at the motor shaft from the front)
- CCW of the output flange
[3] With a controller resolution of the A/D converter of 12 bit (= 12 bit x 16 SinCos)

• Motor feedback system MGH

Multi-turn absolute motor feedback system with incremental SIN / COS signals and HIPERFACE® data interface

Table 2.1.27

Ordering code	Symbol [Unit]	MGH					
Manufacturer´s designation		SKM-36					
Protocol		HIPERFACE®					
Power supply[1]	U_b [V_{DC}]	typically 8 (Range 7 ... 12)					
Current consumption (typ. bei 5 V_{DC})	I [mA]	60					
Incremental signals	u_{pp} [V_{ss}]	0.8 - 1.1					
Signal form		sinusoidal					
Number of pulses	n_1 [SIN / COS]	128					
Absolute postion values / revolution (at motor side)[2]		4096 (12 bit)					
Number of revolutions		4096 (12 bit)					
Accuracy[1]	[arcsec]	± 80					
Gear ratio	i [ ]	30	50	80	100	120	160
Resolution absolute value (output side)	[arcsec]	10.5	6.3	4.0	3.2	2.6	2.0
Resolution incremental (at motor side)[3]	inc [ ]	524.288					
Gear ratio	i [ ]	30	50	80	100	120	160
Resolution incremental (output side)[3]	[arcsec]	0.082	0.049	0.031	0.025	0.021	0.015

[1] Source: Manufacturer
[2] Increasing position values with direction of rotation
- CW of the motor shaft (looking at the motor shaft from the front)
- CCW of the output flange
[3] With a controller resolution of the A/D converter of 12 bit (= 12 bit x 128 SinCos)

• Motor feedback system ROO

Resolver

Table 2.1.28

	Symbol [Unit]	ROO					
Manufacturer´s designation		RE-15-1-J03					
Protocol		without protocol					
Power supply	U_b [V_{AC}]	7V ±10 %					
Current consumption (typ. bei 5 V_{DC})	I [mA]	58 (bei 7 V und 5 kHz) 36 (bei 7 V und 10 kHz)					
Number of sine signals / Revolution		1					
Transfer ratio		0.5 +/- 0.05					
Signal form		sinusoidal					
Accuracy[1]	[arcsec]	± 600					
Resolution incremental (at motor side)[2]	inc [ ]	4096					
Gear ratio	i [ ]	30	50	80	100	120	160
Resolution incremental (output side)[2]	[arcsec]	10.5	6.3	4.0	3.2	2.6	2.0

[1] Source: Manufacturer
[2] With a controller resolution of the A/D converter of 12 bit

Electrical connections

• Motor connection

Table 2.1.29

Type	Version F						Version M							
Stift	1	2	3	4	5	6	1	2	3	4	A	B	C	D
Connection	U	V	PE	BR+[1]	BR-[1]	W	U	PE	W	V	Temp.+[2]	Temp.-[2]	BR+[1]	BR-[1]
Type	6-pole rotatable angle socket M23						8-pole rotatable angle socket M23							

[1] Holding brake
[2] Temperature sensor (PTC)

• Connection motor feedback

Table 2.1.30

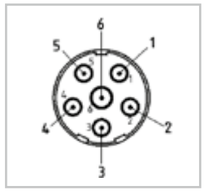
Pin	ROO RE-15	MGH SKM-36	MEE EQN-1125	MKE EQI-1130	MZE EQN-1135	J-MZET EQN-1135
	Signal					
1	SIN	+Us (7 ... 12 VDC)	A+	A+	n.a./n.c.[1]	Sense -
2	REF SIN	GND	A-	A-	n.a./n.c.[1]	Sense +
3	n.a./n.c.[1]	SIN	Daten/Data+	Daten/Data+	Daten/Data+	Daten/Data+
4	n.a./n.c.[1]	REF SIN	n.a./n.c.[1]	n.a./n.c.[1]	n.a./n.c.[1]	Daten/Data-
5	n.a./n.c.[1]	Daten/Data+	Takt/Clock+	Takt/Clock+	Takt/Clock+	GND
6	n.a./n.c.[1]	Daten/Data-	n.a./n.c.[1]	n.a./n.c.[1]	n.a./n.c.[1]	Takt/Clock-
7	Vss-	COS	GND	GND	GND	Takt/Clock+
8	Temp.+	REF COS	Temp.+	Temp.+	Temp.+	Ub: +3.6~14 VDC
9	Temp.-	Temp.+	Temp.-	Temp.-	Temp.-	n.a./n.c.[1]
10	Vss+	Temp.-	Ub: +3.6~14 VDC	Ub: +4.75~10 VDC	Ub: +3.6~14 VDC	n.a./n.c.[1]
11	COS	n.a./n.c.[1]	B+	B+	n.a./n.c.[1]	n.a./n.c.[1]
12	REF COS	n.a./n.c.[1]	B-	B-	n.a./n.c.[1]	n.a./n.c.[1]
13	n.v./n.a.[2]	n.v./n.a.[2]	Daten/Data-	Daten/Data-	Daten/Data-	n.v./n.a.[2]
14	n.v./n.a.[2]	n.v./n.a.[2]	Takt/Clock-	Takt/Clock-	Takt/Clock-	n.v./n.a.[2]
15	n.v./n.a.[2]	n.v./n.a.[2]	Sense -	Sense -	Sense -	n.v./n.a.[2]
16	n.v./n.a.[2]	n.v./n.a.[2]	Sense +	Sense +	Sense +	n.v./n.a.[2]
17	n.v./n.a.[2]	n.v./n.a.[2]	n.a./n.c.[1]	n.a./n.c.[1]	n.a./n.c.[1]	n.v./n.a.[2]
Housing	Shield	Shield	Shield	Shield	Shield	Shield
Type	12-pole rotatable angle socket M23		17-pole rotatable angle socket M23			12-pole connector M12

[1] Not connected
[2] Not available

Motor connector

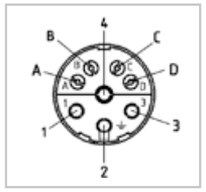
Version H/F

Illustration 2.1.46



Version L/M

Illustration 2.1.47



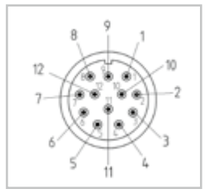
Encoder connector

MEE/MKE/MZE

Illustration 2.1.48

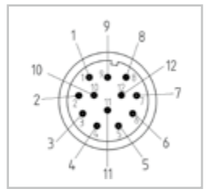
MGH

Illustration 2.1.49



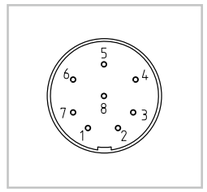
ROO

Illustration 2.1.50



J-MZET

Illustration 2.1.51



Product description

Ultra flat and ultra light

The FLA ultra flat and ultra light series of servo actuators combine high precision and high performance transmission with a compact and highly efficient DC brushless motor. They are available with a highly dynamic and efficient Harmonic Planetary Gear or with a high precision and high torque Harmonic Drive® Strain Wave Gear. Due to its short, compact design, the FLA is used where space and weight are the highest priorities.

Features

- Compact and light
- Integrated, tilt resistant output bearing
- Optimally matched components
- Short design
- Low noise
- Excellent efficiency

Ordering code

Table 2.2.1

Ordering code	FLA	-	17	A	-	50FB	-	H	-	24	-	SP
FLA Series												
Size (corresponds to the pitch circle diameter of the Flexspline toothing in inches x 10)			11 14 17 20									
Product generation				A								
Ratio/Gear type i = 8 Harmonic Planetary Gear i = 9 Harmonic Planetary Gear i = 50 Harmonic Drive® Strain Wave Gear						8HP 9HP 50FB						
Hall sensor								H				
DC voltage link 24 V 48 V										24 48		
Customised design Standard design (Field remains empty) Customised design (on request)												[ ] SP

Combinations

Table 2.2.2

Size		11A	14A	17A	20A
Ratio/Gear type	8HP	●	●	-	-
	9HP	-	-	●	●
	50FB	●	●	●	●
	100	-	-	-	-
DC voltage link	24 V	●	●	●	●
	48 V	●	●	●	●

● available o on request - not available

Technical data

• Features

Table 2.2.3

Motor winding	[Unit]	
Machine type		Permanent magnet synchronous motor
Magnet material		Neodymium-iron-boron
Insulation class (EN 60034-1)		A
Insulation resistance (500 VDC)	[MΩ]	100
Insulation voltage (6 s)	[VAC]	1500
Lubrication		4BNo.2
Degree of protection (EN 60034-5)		IP40
Ambient operating temperature	[°C]	0 … 40
Ambient storage temperature	[°C]	-20 … 60
Maximum installation altitude	[m]	1000 above sea level
Relative humidity (without condensation)	[%]	<80
Vibration resistance	[g]	2.5 (10 to 400 Hz)
Shock resistance	[g]	30
Corrosion protection (DIN IEC 60068 Teil 2-11 Salt spray test)	[h]	-
Overheat protection		-
Gear component set		FBS/Harmonic Planetary Gear

• Cooling

Unless otherwise indicated, the values given in the tables refer to an overtemperature of the winding of 70 K at an ambient temperature of 40 °C and a maximum installation altitude of 1000 m above sea level. The values in the following tables and the operating characteristics apply to actuators mounted on an aluminium base plate with the following minimum dimensions:

Table 2.2.4

Series	Size	[Unit]	Dimension
FLA	11A	[mm]	220 x 220 x 8
	14A	[mm]	250 x 250 x 10
	17A	[mm]	280 x 280 x 12
	20A	[mm]	300 x 300 x 15

• Actuator data

FLA-11A-HP-24, FLA-14A-HP-24, FLA-17A-HP-24, FLA-20A-HP-24

Actuators with 24 VDC maximum stationary DC bus voltage and Harmonic Planetary Gear

Table 2.2.5

Actuator	Symbol [Unit]	11A	14A	17A	20A
Motor feedback system		Hall sensor	Hall sensor	Hall sensor	Hall sensor
Ratio	i	8	8	9	9
Maximum output torque	T_{MAX} [Nm]	1.8	3.7	7.3	12.1
Maximum output speed	n_{MAX} [rpm]	500	500	500	400
Maximum current	I_{MAX} [A_{rms}]	8.7	18.0	26.2	31.4
Continuous stall torque	T_0 [Nm]	0.6	1.2	3.0	4.1
Continuous stall current	I_0 [A_{rms}]	3.0	6.0	10.4	10.7
Torque constant (motor)	K_T [Nm/A_{rms}]	0.026	0.038	0.043	0.057
AC voltage constant (L-L, 20 °C)	K_E [V_{RMS}/1000 rpm]	4.9	4.5	4.9	6.2
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	60	60	60	60
Mechanical time constant (20 °C)	T_M [ms]	1.4	1.0	0.9	0.9
Electrical time constant (20 °C)	T_E [ms]	1.07	1.64	2.00	2.33
Maximum motor speed	n_{MAX} [rpm]	4000	4000	4500	3600
Rated motor speed	n_N [rpm]	800	800	900	900
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	0.90	0.22	0.10	0.06
Rotary field inductance	L_d [mH]	0.72	0.27	0.15	0.10
Number of pole pairs	p	5	5	5	8
Weight	m [kg]	0.39	0.62	0.87	1.06
Rated torque gear component set	T_N [Nm]	0.6	1.2	3.0	4.1
Rated speed gear component set	n_N [rpm]	100	100	100	100

You will find more information on this in the Engineering data chapter.

FLA-11A-HP-48, FLA-14A-HP-48, FLA-17A-HP-48, FLA-20A-HP-48

Actuators with 48 VDC maximum stationary DC bus voltage and Harmonic Planetary Gear

Table 2.2.6

Actuator	Symbol [Unit]	11A	14A	17A	20A
Motor feedback system		Hall sensor	Hall sensor	Hall sensor	Hall sensor
Ratio	i	8	8	9	9
Maximum output torque	T_{MAX} [Nm]	1.8	3.7	7.3	12.1
Maximum output speed	n_{MAX} [rpm]	500	500	500	400
Maximum current	I_{MAX} [A_{rms}]	4.5	9.6	13.6	17.8
Continuous stall torque	T_0 [Nm]	0.6	1.2	3.0	4.1
Continuous stall current	I_0 [A_{rms}]	1.6	3.0	5.3	6.0
Torque constant (motor)	K_T [Nm/A_{rms}]	0.049	0.053	0.066	0.080
AC voltage constant (L-L, 20 °C)	K_E [V_{RMS}/1000 rpm]	9.5	9.0	9.7	11.4
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	60	60	60	60
Mechanical time constant (20 °C)	T_M [ms]	1.5	0.8	0.8	0.8
Electrical time constant (20 °C)	T_E [ms]	1.06	2.06	2.73	2.44
Maximum motor speed	n_{MAX} [rpm]	4000	4000	4500	3600
Rated motor speed	n_N [rpm]	800	800	900	900
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	3.30	0.70	0.30	0.18
Rotary field inductance	L_d [mH]	2.65	1.08	0.61	0.33
Number of pole pairs	p	5	5	5	8
Weight	m [kg]	0.39	0.62	0.87	1.06
Rated torque gear component set	T_N [Nm]	0.6	1.2	3.0	4.1
Rated speed gear component set	n_N [rpm]	100	100	100	100

You will find more information on this in the Engineering data chapter.

FLA-11A-FB-24, FLA-14A-FB-24, FLA-17A-FB-24, FLA-20A-FB-24

Actuators with 24 VDC maximum stationary DC bus voltage and Harmonic Drive® Strain Wave Gear

Table 2.2.7

Actuator	Symbol [Unit]	11A	14A	17A	20A
Motor feedback system		Hall sensor	Hall sensor	Hall sensor	Hall sensor
Ratio	i	50	50	50	50
Maximum output torque	T_{MAX} [Nm]	6.7	11.2	23.0	33.0
Maximum output speed	n_{MAX} [rpm]	100	100	100	80
Maximum current	I_{MAX} [A_{rms}]	6.0	9.7	18.4	19.2
Continuous stall torque	T_0 [Nm]	1.7	2.6	7.9	13.0
Continuous stall current	I_0 [A_{rms}]	1.9	3.0	6.8	8.7
Torque constant (motor)	K_T [Nm/A_{rms}]	0.019	0.018	0.024	0.031
AC voltage constant (L-L, 20 °C)	K_E [V_{RMS}/1000 rpm]	4.9	4.5	4.9	6.2
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	60	60	60	60
Mechanical time constant (20 °C)	T_M [ms]	2.2	1.6	1.6	1.3
Electrical time constant (20 °C)	T_E [ms]	1.07	1.45	2.00	2.33
Maximum motor speed	n_{MAX} [rpm]	5000	5000	5000	4000
Rated motor speed	n_N [rpm]	3000	3000	3000	2500
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	0.90	0.22	0.10	0.06
Rotary field inductance	L_d [mH]	0.72	0.27	0.15	0.10
Number of pole pairs	p	5	5	5	8
Weight	m [kg]	0.42	0.72	0.94	1.17
Rated torque gear component set	T_N [Nm]	1.7	2.6	7.9	13.0
Rated speed gear component set	n_N [rpm]	60	60	60	45

You will find more information on this in the Engineering data chapter.

FLA-11A-FB-48, FLA-14A-FB-48, FLA-17A-FB-48, FLA-20A-FB-48

Actuators with 48 VDC maximum stationary DC bus voltage and Harmonic Drive® Strain Wave Gear

Table 2.2.8

Actuator	Symbol [Unit]	11A	14A	17A	20A
Motor feedback system		Hall sensor	Hall sensor	Hall sensor	Hall sensor
Ratio	i	50	50	50	50
Maximum output torque	T_{MAX} [Nm]	6.7	11.2	23.0	33.0
Maximum output speed	n_{MAX} [rpm]	100	100	100	80
Maximum current	I_{MAX} [A_{rms}]	3.1	4.8	9.4	10.7
Continuous stall torque	T_0 [Nm]	1.7	2.6	7.9	13.0
Continuous stall current	I_0 [A_{rms}]	1.0	1.5	3.4	5.1
Torque constant (motor)	K_T [Nm/A_{rms}]	0.036	0.036	0.049	0.054
AC voltage constant (L-L, 20 °C)	K_E [V_{RMS}/1000 rpm]	9.5	9.0	9.7	11.4
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	52.8	52.8	52.8	52.8
Mechanical time constant (20 °C)	T_M [ms]	2.4	1.3	1.2	1.2
Electrical time constant (20 °C)	T_E [ms]	1.06	2.06	2.73	2.44
Maximum motor speed	n_{MAX} [rpm]	5000	5000	5000	4000
Rated motor speed	n_N [rpm]	3000	3000	3000	2500
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	3.30	0.70	0.30	0.18
Rotary field inductance	L_d [mH]	2.65	1.08	0.61	0.33
Number of pole pairs	p	5	5	5	8
Weight	m [kg]	0.42	0.72	0.94	1.17
Rated torque gear component set	T_N [Nm]	1.7	2.6	7.9	13.0
Rated speed gear component set	n_N [rpm]	60	60	60	45

You will find more information on this in the Engineering data chapter.

• Moment of inertia

Table 2.2.9

	Symbol [Unit]	11A		14A		17A		20A	
Ratio/Gear		8HP	50FB	8HP	50FB	9HP	50FB	9HP	50FB
Moment of inertia output side	J_{OUT} [kgm^2]	0.00013	0.00730	0.00039	0.01900	0.00100	0.04800	0.00260	0.12000
Moment of inertia at motor side	J [kgm^2x10^{-4}]	0.017		0.044		0.117		0.311	

• Performance characteristics

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 2.2.1 **FLA-11A-08HP-H-24**

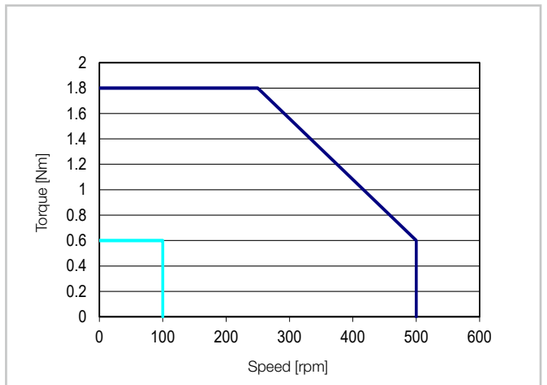


Illustration 2.2.2 **FLA-11A-08HP-H-48**

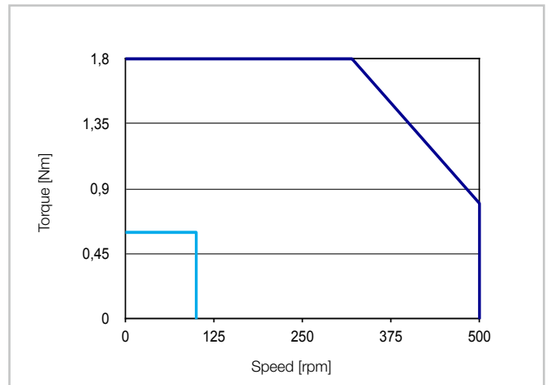


Illustration 2.2.3 **FLA-11A-50FB-H-24**

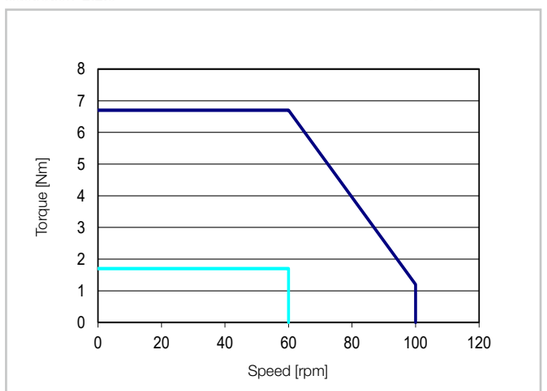


Illustration 2.2.4 **FLA-11A-50FB-H-48**

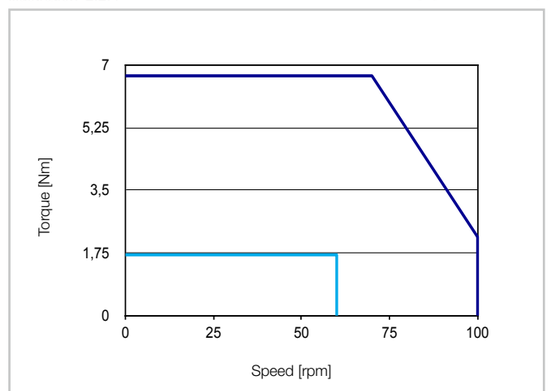


Illustration 2.2.5 **FLA-14A-08HP-H-24**

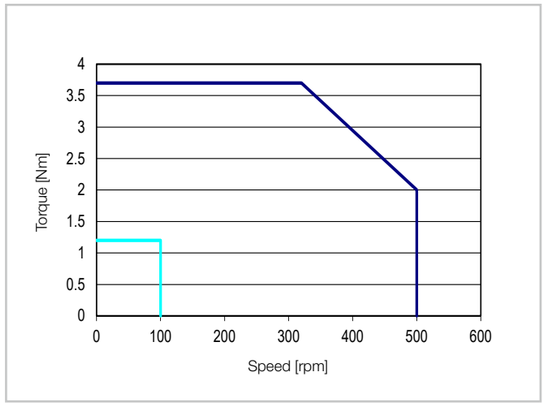
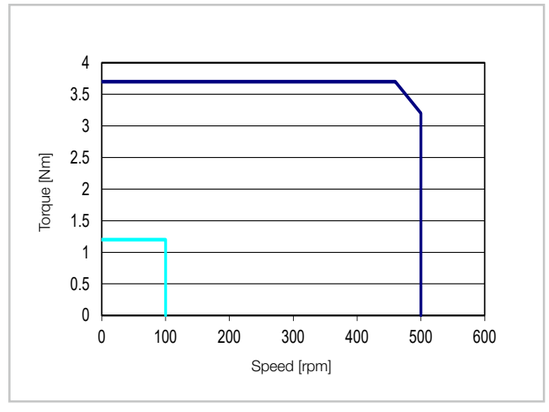


Illustration 2.2.6 **FLA-14A-08HP-H-48**



U_M = 17 VAC for 24 V version, 34 VAC for 48 V version
Intermittent duty ——— Continuous duty ———

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 2.2.7 **FLA-14A-50FB-H-24**

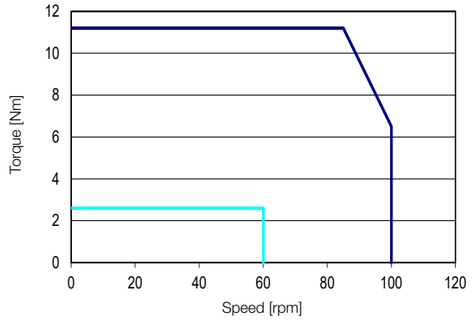


Illustration 2.2.8 **FLA-14A-50FB-H-48**

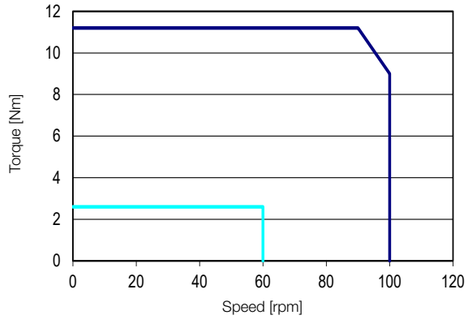


Illustration 2.2.9 **FLA-17A-09HP-H-24**

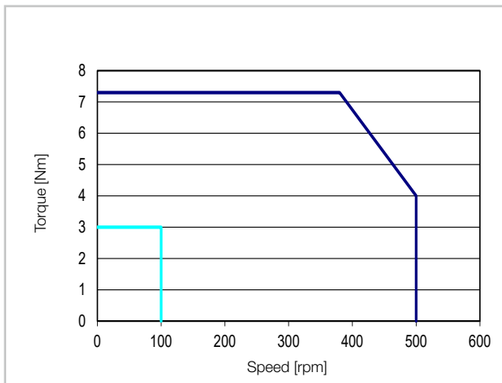


Illustration 2.2.10 **FLA-17A-09HP-H-48**

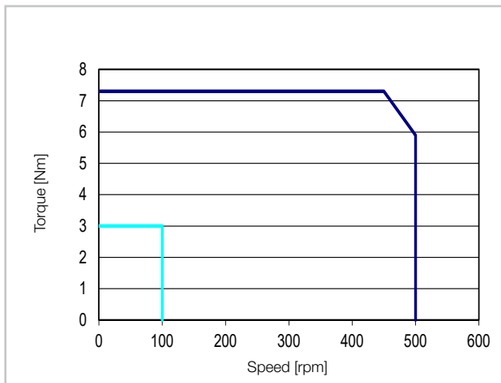


Illustration 2.2.11 **FLA-17A-50FB-H-24**

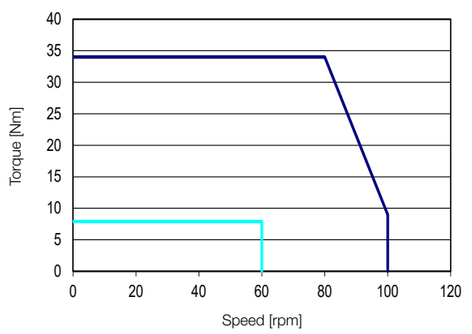
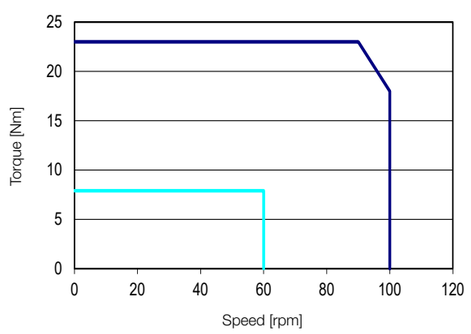


Illustration 2.2.12 **FLA-17A-50FB-H-48**



U_M = 17 VAC for 24 V version, 34 VAC for 48 V version
Intermittent duty ——— Continuous duty ———

The performance curves shown are valid for the specified ambient temperature (operation) and the specified motor terminal voltage U_M.

Illustration 2.2.13 **FLA-20A-09HP-H-24**

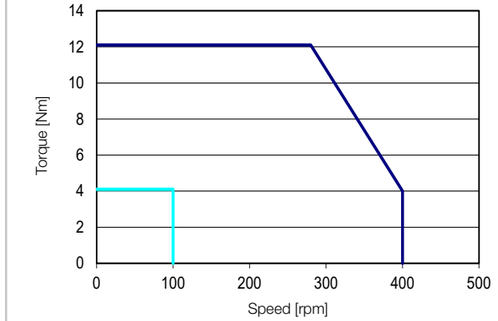


Illustration 2.2.14 **FLA-20A-09HP-H-48**

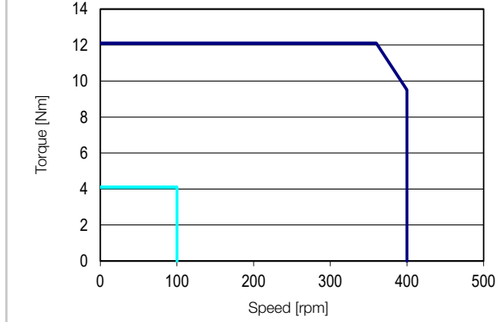


Illustration 2.2.15 **FLA-20A-50FB-H-24**

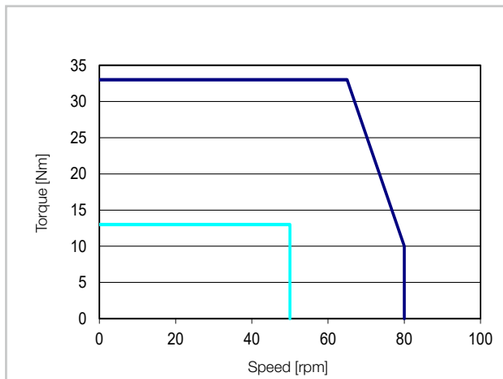
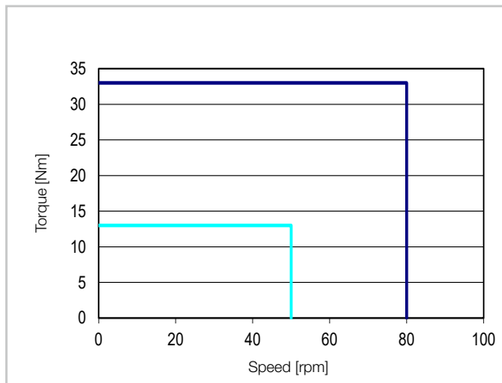


Illustration 2.2.16 **FLA-20A-50FB-H-48**



U_M = 17 VAC for 24 V version, 34 VAC for 48 V version
Intermittent duty ——— Continuous duty ———

• Dimensions

Illustration 2.2.17

FLA-11A-HP [mm]

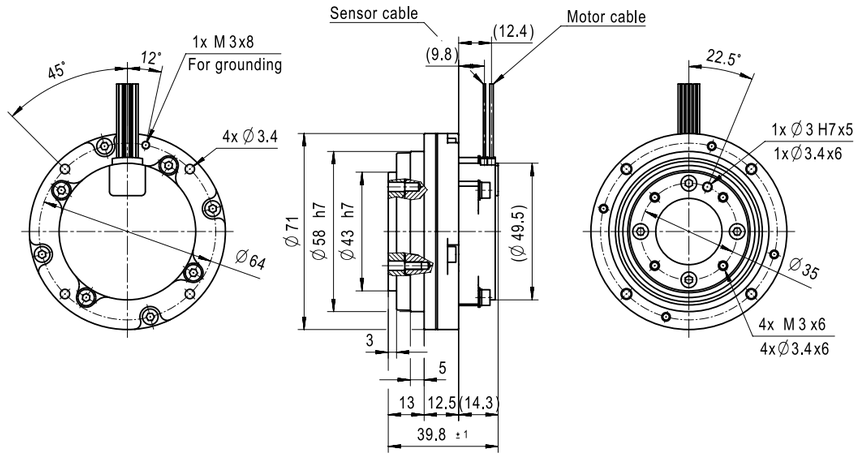


Illustration 2.2.18

FLA-11A-FB [mm]

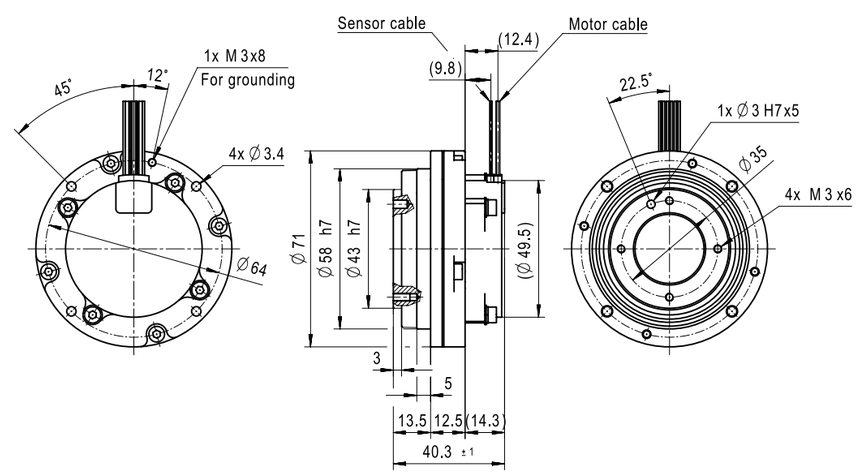


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Illustration 2.2.19

FLA-14A-HP [mm]

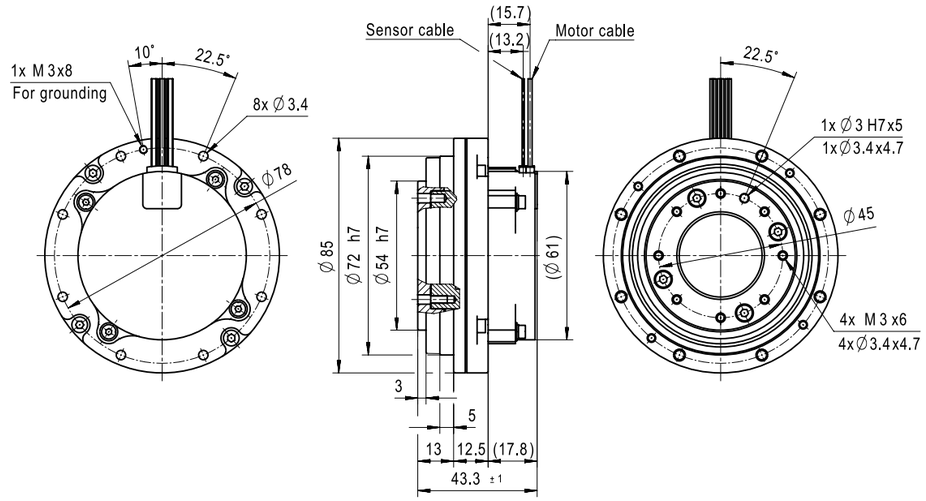

Illustration 2.2.20

FLA-14A-FB [mm]

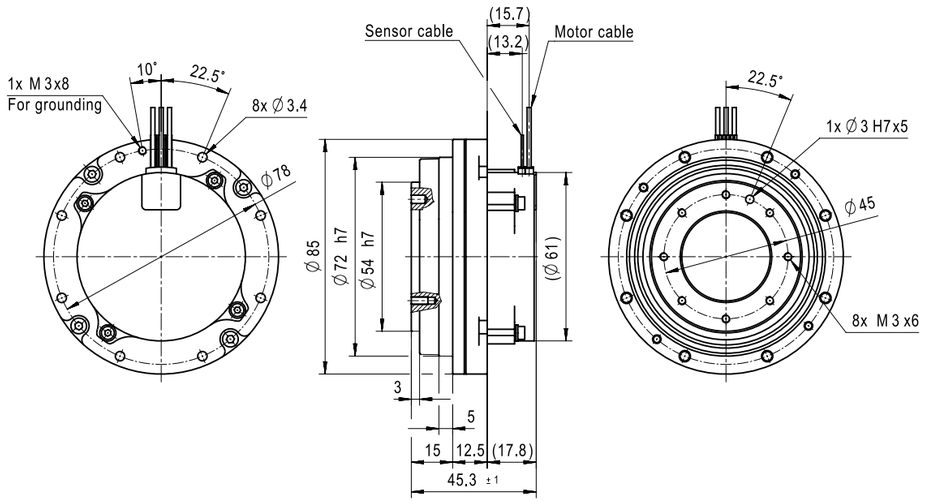

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Illustration 2.2.21

FLA-17A-HP [mm]

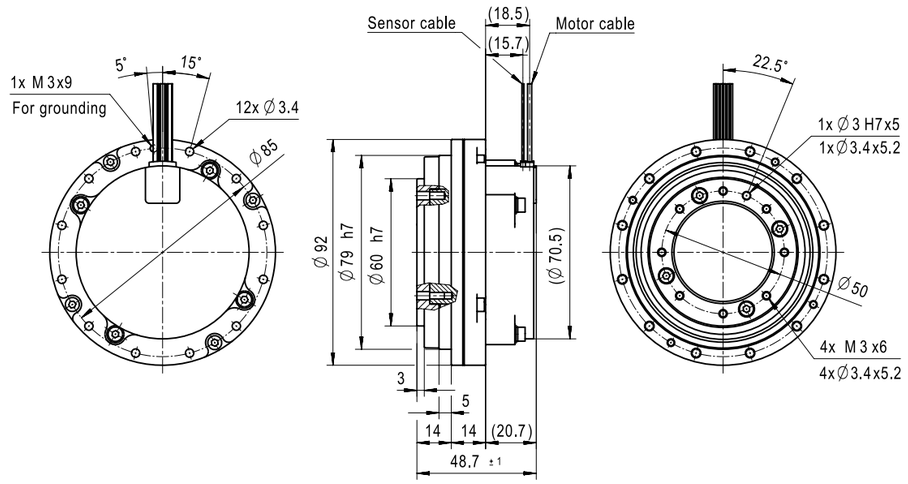

Illustration 2.2.22

FLA-17A-FB [mm]

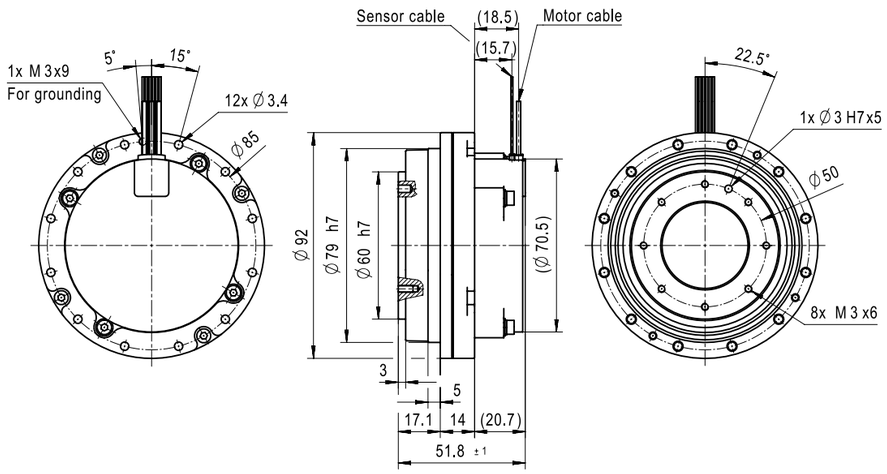

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Illustration 2.2.23

FLA-20A-HP [mm]

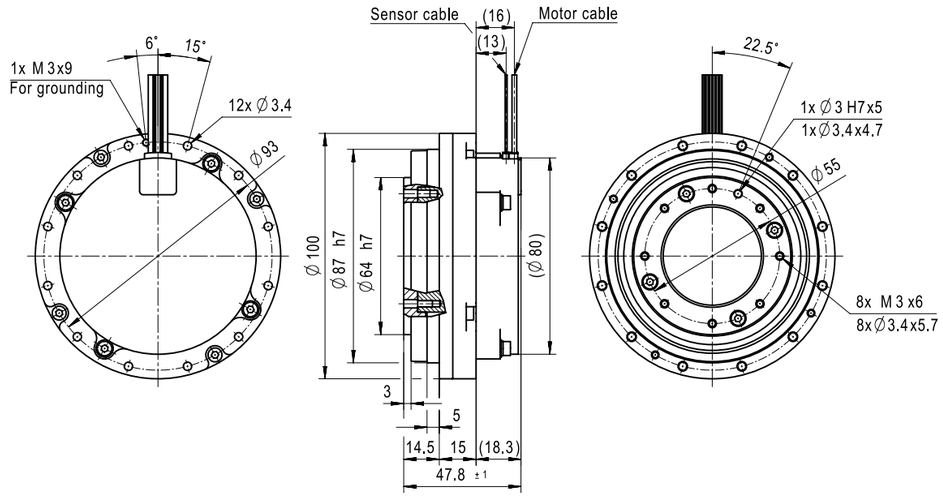
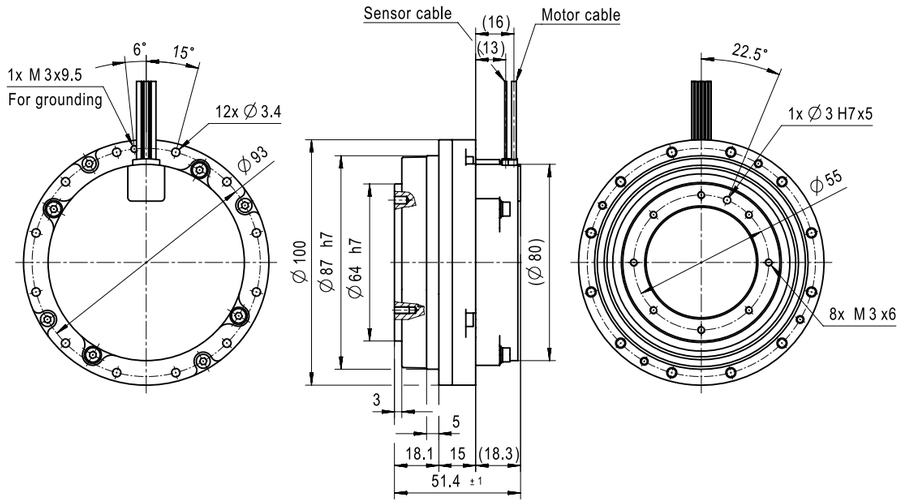


Illustration 2.2.24

FLA-20A-FB [mm]



CAD drawings for download: www.harmonicdrive.co.uk

Gear characteristics

Detailed information on other parameters (e.g. torsional stiffness and positioning accuracy) is available on request.

Output bearing

The servo actuators are equipped with a compact output bearing. This bearing, specially developed for the actuator, absorbs axial and radial forces as well as tilting moments. It prevents the gear from tilting, so that a long service life and consistent accuracy are achieved. For the user, the integration of this output bearing means a significant reduction in design and manufacturing costs, as additional external bearing points do not need to be provided for many applications.

• Performance data

Table 2.2.10

	Symbol [Unit]	11A-HP	11A-FB	14A-HP	14A-FB	17A-HP	17A-FB	20A-HP	20A-FB
Bearing type		Deep groove ball bearing							
Offset	R [m]	13.5	11.4	13.5	11.4	14.0	12.5	14.5	13.0
Dynamic tilting moment	$M_{dyn\ (max)}$ [Nm]	1.2	1.2	1.6	1.6	2.0	2.0	2.4	2.4
Tilting moment stiffness	K_B [Nm/arcmin]	0.58	0.58	0.96	0.96	1.28	1.28	1.48	1.48
Dynamic axial force	$F_{A\ dyn\ (max)}$ [N]	29	29	78	78	171	171	318	318

• Tolerances

Illustration 2.2.25

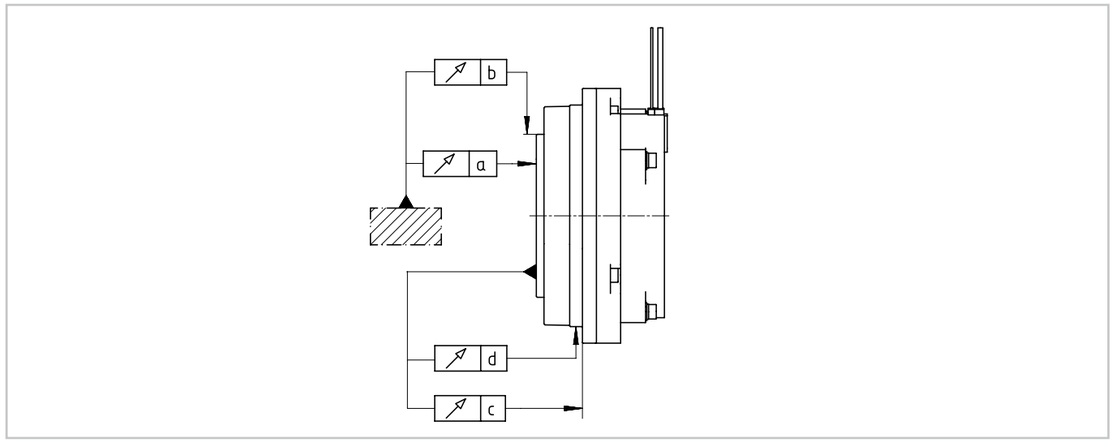


Table 2.2.11

	[Unit]	11A-HP	11A-FB	14A-HP	14A-FB	17A-HP	17A-FB	20A-HP	20A-FB
a	[mm]	0.03	0.05	0.03	0.05	0.03	0.05	0.03	0.05
b	[mm]	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
c	[mm]	0.05	0.09	0.05	0.09	0.05	0.09	0.05	0.09
d	[mm]	0.03	0.05	0.03	0.05	0.03	0.05	0.03	0.05

Motor feedback system

• Specifications

Table 2.2.12

	Symbol [Unit]	11A	14A	17A	20A
Motor feedback system		Hall sensor			
Output type		Open collector output			
Input voltage	U [V]	DC 5 ±5 %			
Resolution	[P/R]	30	30	30	48

Attention: The starting current must not exceed 10 mA. External pull up resistor required.

• Resolution

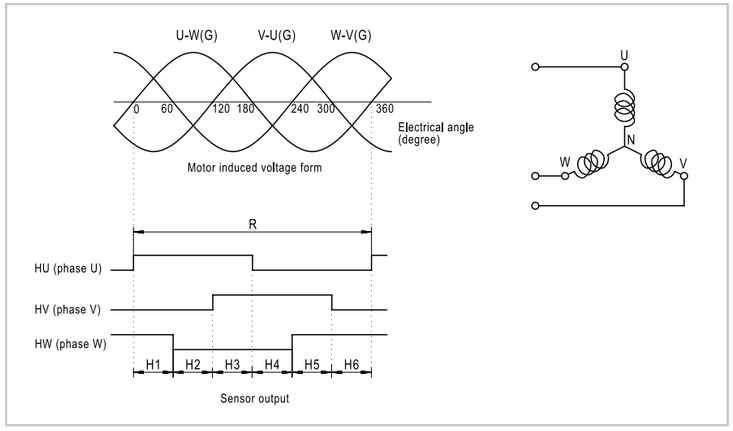
Table 2.2.13

	Symbol [Unit]	11A		14A		17A		20A	
Ratio	i	**8**	**50**	**8**	**50**	**9**	**50**	**9**	**50**
Output shaft resolution	[P/R]	240	1500	240	1500	270	1500	432	2400
Angular resolution per pulse	[°]	1.50	0.24	1.50	0.24	1.40	0.24	0.90	0.15

Signal phases

The phase connections between the Hall sensor outputs U, V, and W are as follows:

Illustration 2.2.26



• Feature

Table 2.2.14

	11A ... 17A	20A
Hn	**12°**	**7,5°**
R	72°	45°

Represented by the mechanical angle of the motor shaft.

Temperature sensor

The actuators of the FLA Series have an internal temperature sensor. This can be used for monitoring and protection against overheating.

Table 2.2.15

	Symbol [Unit]	11A	14A	17A	20A
Sensor		Thermistor			
Input voltage	U_{in} [V]	DC 5 ±5 %			
Application area	T_{Amb} [°C]	40 - 100			
Characteristic of the measured temperature		Measured temperature [°C] = 132.9 - (Output voltage [V]) x 23.1			
Error tolerance	T_{err} [K]	±6			

Caution: As soon as the Hall sensors are powered, voltage is also present at the thermistor output.
When the thermistor is not in use, the stranded wire end must be insulated.

Electrical connections

• Motor strands

Table 2.2.16

Colour	Name
Red	Motor phase U
White	Motor phase V
Black	Motor phase W

• Dimensioning motor strands

Table 2.2.17

	[Unit]	11A	14A	17A	20A
Outer diameter	[mm]	1.70	1.70	1.86	2.17
Conductor size		AWG22	AWG22	AWG20	AWG18

• Sensor strands

Table 2.2.18

Colour	Signal	Note
Red	+5 V	Power supply +5 V
Black	0V	Power supply 0 V (GND)
White	HU	Hall sensor output (Phase U)
Green	HV	Hall sensor output (Phase V)
Blue	HW	Hall sensor output (Phase W)
Yellow	TH	Thermistor output

• Dimensioning sensor strands

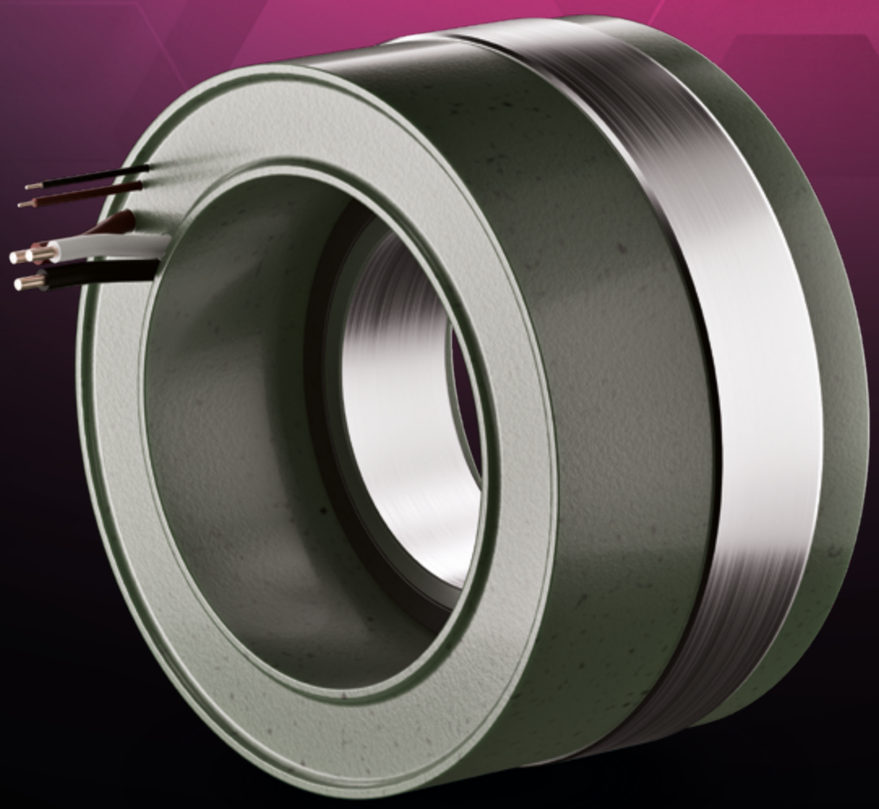
Table 2.2.19

Size	[Unit]	All sizes
Outer diameter	[mm]	0.81
Conductor size		AWG26

Attention:

- FLA Series Actuators have a tapped hole for a grounding wire instead of a ground cable. When grounding, refer to the illustrated specifications for the requirements of the tapped hole for a grounding wire. If not grounded, a malfunction may occur due to noise or other causes.
- Incorrect wiring such as a reversed power input connection may cause a malfunction or failure.
- As soon as the Hall sensors are powered, voltage is also present at the thermistor output.
- When the thermistor is not in use, the stranded wire end must be insulated.

Frameless motors



Content

FRAMELESS MOTORS

Series	BHK
	
Product focus	High level of standardisation Cost optimised High load sizes
Design	short / compact
Torque capacity and lifetime	●●●
Small outer diameter	●
Short design	●●
Tilting moment output bearing	-
Low weight	●●
Chapter / Page	3.1 / Page 227
Key data	
Hollow shaft diameter [mm]	37.6
Maximum torque [Nm]	3 … 6
Maximum speed [rpm]	5600 … 7300
Outer diameter [mm]	72
Length [mm]	40 … 51.9
Configurations	
Sizes	0100 0200
Ratio **(Preference types)**	-
Winding	24/48 VDC 560 VDC
Encoder	-
Connections	open strands
Controller integrated	-
Brake	-
Lubricant	-
Temperature range	0 ... +40 °C
Protection class	IP00
Surface finish	-

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

Product description

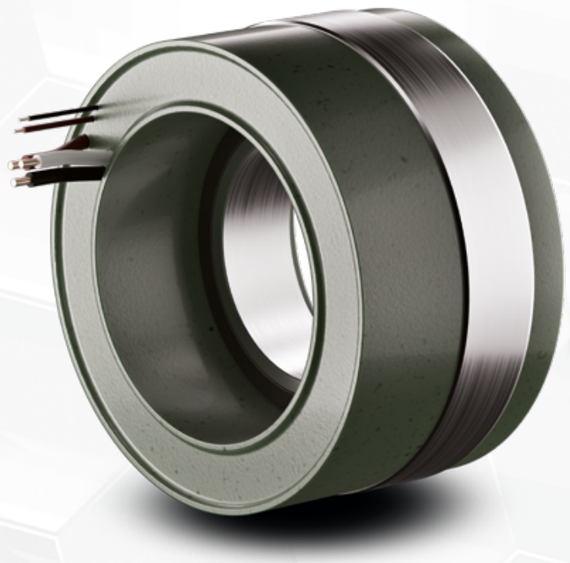
Highest power density

The frameless motors in the BHK series are characterised by their high overload capacity combined with a low dead weight and low moment of inertia.

The frameless motors in the BHK series impress with their high degree of compactness, overload capacity and dynamics. With their large inner bore, they are ideal for hollow shaft drives.
However, very short installation lengths can also be achieved in solid shaft motors with these installation kits.

Features

- Stator ready for connection
- High power density due to segmented stator winding
- Short design
- Small outer diameter
- Large hollow shaft
- Customising know-how in Germany
- Complete production in Germany



Ordering code

Table 3.1.1

Ordering code	BHK	- 0100	A	- AO	- 40	- T1	- 0	- 0
BHK Series								
Size								
Continuous stall torque 1 Nm		0100						
Continuous stall torque 2 Nm		0200						
Product generation			A					
Motor winding type								
Winding type AO (DC voltage link 560 V, Voltage constant 27, 2 V rms/1000 rpm)				AO				
Winding type DB (DC voltage link 48 V, Voltage constant 4 V rms/1000 rpm)				DB				
Winding type AU (DC voltage link 560 V, Voltage constant 49,1 V rms/1000 rpm)				AU				
Winding type DD (DC voltage link 48 V, Voltage constant 4,7 V rms/1000 rpm)				DD				
Length								
40 mm					40			
52 mm					52			
Temperature sensor								
PT1000						T1		
Option Motor feedback system								
None (zero)							0	
Placeholder for future options							[ ]	
Option UL Certification								
No UL certification (standard = zero)	0							
With UL certification (restricted operating range)	UL							
Customised design								
Standard design (Field remains empty)	[ ]							
Customised design (on request)	SP							

Please refer to Table 3.1.2 for the possible combinations.

Combinations

Table 3.1.2

Size		0100A	0200A
Motor winding type	AO	●	-
	DB	●	-
	AU	-	●
	DD	-	●
Length	40	●	-
	52	-	●
Temperature sensor	PT1000	●	●
Option UL Certification	UL	o	o

● available o on request - not available

Technical data

• Features

Table 3.1.3

Motor winding	[Unit]	AO/AU	DB/DD
Machine type		Permanent magnet synchronous motor with concentrated winding	
Magnet material		Neodymium-iron-boron	
Insulation class (EN 60034-1)		F	F
Insulation resistance (500 VDC)	MΩ	100	
Insulation voltage (10 s)	VAC	2500	720
Ambient operating temperature	°C	0 … 40	
Ambient storage temperature	°C	-20 … 60	
Maximum permissible winding temperature	°C	115	
Nominal installation height (above sea level)	m	< 1000	
Maximum installation attitude (above sea level)	m	4000	
Relative humidity	%	max. 80 non-condensing	
Vibration resistance (DIN IEC 60068 Part 2-6, 10 ... 500 Hz)	g	5.0	
Shock resistance (DIN IEC 60068 Part 2-27, 11 ms)	g	30	
Thermal motor protection		1 x PT1000[1)]	

1) Safe separation according to EN 61800-5-1

• Cooling

Unless otherwise labelled, the values given in the tables refer to a winding overtemperature of 65 K at an ambient temperature of 40 °C and a maximum installation attitude of 1000 m above sea level. From an installation altitude > 1000 m above sea level, a power reduction of 1 % per 100 m must be applied.

The continuous output of the frameless motors depends on the cooling surface and the cooling system.

• Motor data

Table 3.1.4

Frameless motor	Symbol [Unit]	0100A		0200A	
Stator winding		AO	DB	AU	DD
Maximum output torque	T_{MAX} [Nm]	3.0	2.0	6.0	3.0
Maximum speed	n_{MAX} [rpm]	7300		5600	
Maximum current	I_{MAX} [A_{rms}]	8.0	40.0	10.0	40.0
Rated stall torque	T_0 [Nm]	1.0	1.0	2.0	1.5
Rated stall current	I_0 [A_{rms}]	2.5	17.5	2.6	20.0
Torque constant (motor)	K_T [Nm/A_{rms}]	0.390	0.058	0.750	0.073
AC voltage constant (L-L, 20 °C)	KE [V_{RMS}/1000 rpm]	25.7	3.8	49.1	4.7
Motor constant (20°C)	k_M [Nm/sqrt(W)]	0.164	0.144	0.260	0.236
Maximum steady-state DC link voltage	V_{CC} [V_{DC}]	680[1)]	48	680[1)]	48
Electrical time constant (20 °C)	T_E [ms]	1.55	1.20	2.57	2.34
Resistance (L-L, 20 °C)	R_{L-L} [Ω]	4.000	0.107	5.800	0.064
Rotary field inductance	L_d [mH]	3.10	0.06	7.50	0.08
Number of pole pairs	p	8			
Stator weight	m [kg]	0.28	0.28	0.45	0.45
Rotor weight	m [kg]	0.08	0.08	0.15	0.15
Moment of inertia rotor	J [kg cm^2]	0.395		0.753	
Length of stator (without connecting cable)	L [mm]	40.0		51.9	
Rotor length	l [mm]	14.0		26.7	
Outer diameter of stator	D [mm]	72		72	
Inner diameter of rotor	d_h [mm]	37.6		37.6	

1) In general, motors with an Ax winding can also be operated on DC links with a nominal voltage > 680 V_{DC}. The lifetime of an insulation system is significantly influenced by the environment. Possible overvoltages at the motor terminals can be influenced by the length of the motor cable and the voltage slope of the servo controller. These overvoltages lead to partial discharges in the insulation system and can significantly reduce the lifetime of the insulation system. An assessment can only be made in the customer's environment. The manufacturer is not aware of any failures to date that can be attributed to a higher DC link voltage.

• Electrical connections

Table 3.1.5

Motor winding type	AO/AU			DB/DD		
Motor phase	U	V	W	U	V	W
Wire colour	red	black	white	red	black	white
Cross section	AWG 20 (A winding), corresponds to 0.52 mm^2			AWG 14 (D winding), corresponds to 2.08 mm^2		
Minimum bending radius	Fixed installation 10 mm			Fixed installation 14 mm		

Table 3.1.6

Temperature sensor leads		
Wire colour	red	white
Cross section	AWG 26, corresponds to 0.13 mm^2	
Minimum bending radius	Fixed installation 6 mm	

• Performance characteristics

The power curves shown are valid for the specified ambient operating temperature (operation) and the specified motor terminal voltage U_M.

Illustration 3.1.1 **BHK-0100A-AO**

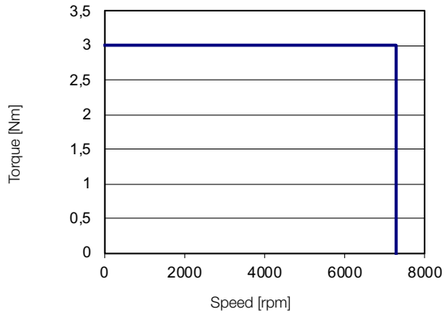


Illustration 3.1.2 **BHK-0100A-DB**

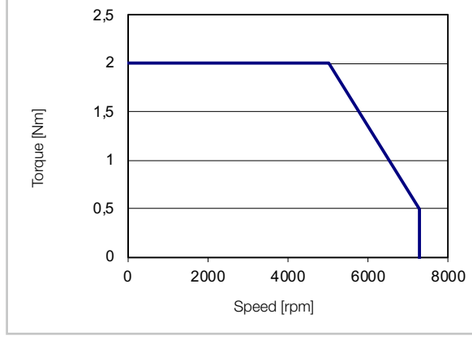


Illustration 3.1.3 **BHK-0200A-AU**

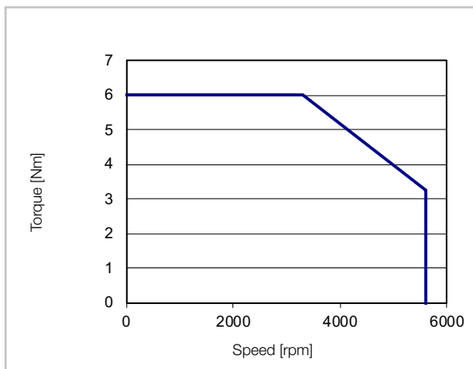
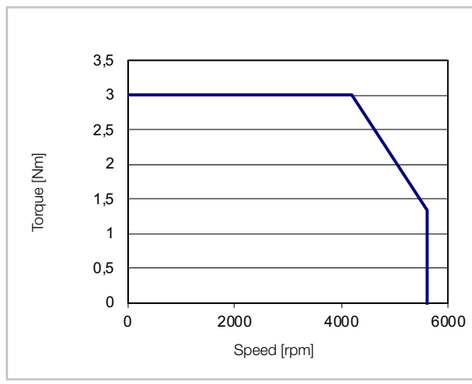


Illustration 3.1.4 **BHK-0200A-DD**



U_M = 230 ... 400 VAC
Intermittent duty ——— Continuous duty ———

• Dimensions

Illustration 3.1.5 **BHK-0100A [mm]**

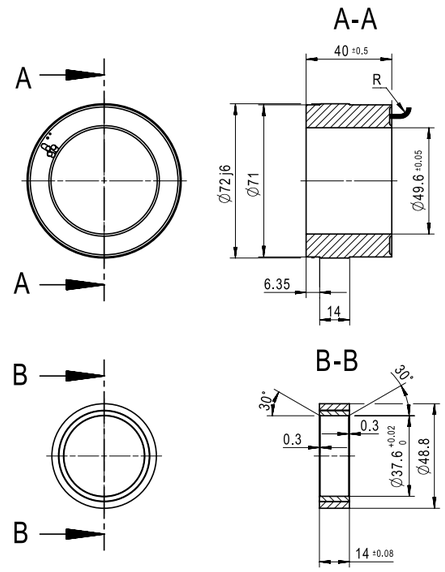
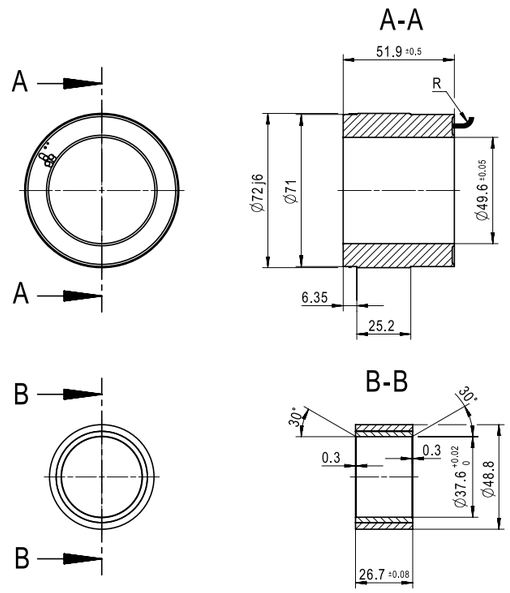
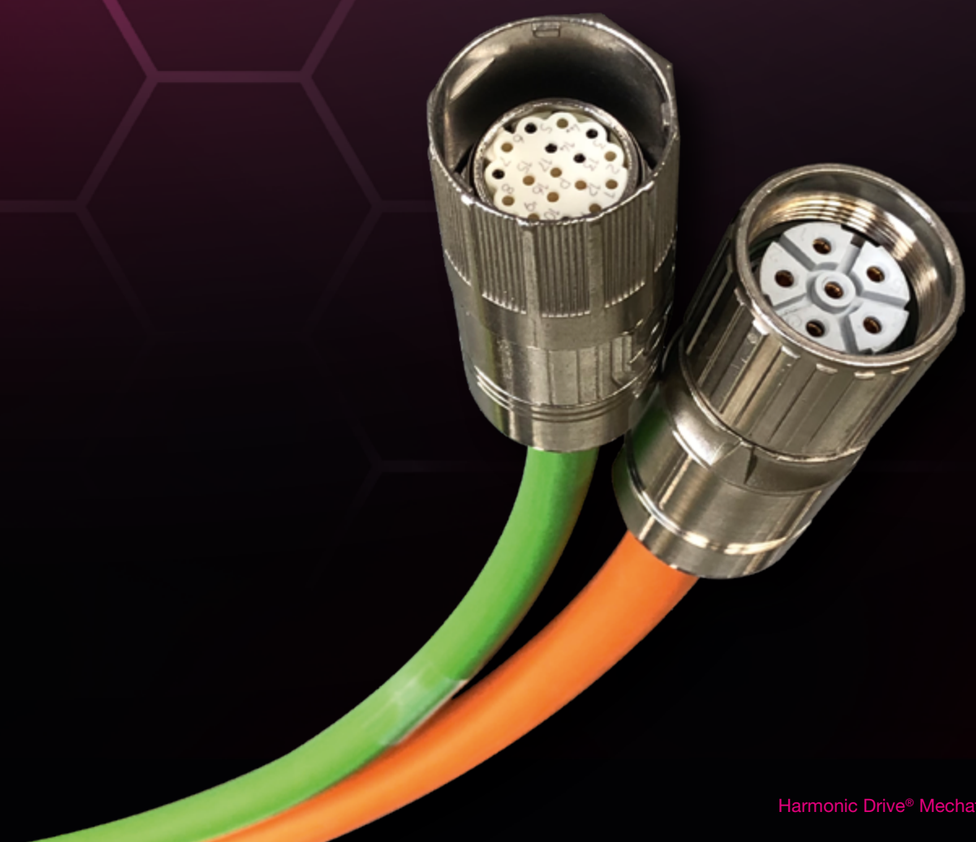


Illustration 3.1.6 **BHK-0200A [mm]**



CAD drawings for download: www.harmonicdrive.co.uk

Servo controller, accessories & cables



Content

Product description

Universal servo controller

The YukonDrive Servo Controller is predestined for operation on superimposed CNC controls with cyclical setpoint input via bus systems. The modularity of the YukonDrive Series ensures optimum integration of the servo axis into the machine process at all times. Whether via high speed fieldbus communication on a central machine controller or with decentralised motion control intelligence in the drive controller - the YukonDrive Servo Controller masters both with flying colours. Optimised for the lower power range, the YukonDrive Servo Controller offers the highest power density in four compact designs.

The integration of high speed fieldbus systems and common encoder interfaces such as the digital EnDat 2.2 or HIPERFACE DSL® interface shows that flexibility is paramount. Extensive motion control functions offer a wide range of possible solutions.
Completely pluggable connections ensure fast assembly and commissioning. We have also thought about the safety of your machine. With its SIL 3 certified STO function, the YukonDrive can be integrated into your safety concept.

Ordering code

Table 4.1.1

Ordering code	YukonDrive	-	1022	-	B	-	E	-	O	-	SP
YukonDrive Series											
Size											
Size 2			102								
Size 3			103								
Size 4			104								
Supply voltage											
1 x 230 V AC or 3 x 230 V AC				1							
3 x 400 V AC				2							
Peak current											
9 A (1 x 230 V AC and 3 x 230 V AC)					A						
6 A (3 x 400 V AC)					B						
11,8 A (1 x 230 V AC) / 17,7 A (3 x 230 V AC)					C						
10,5 A (3 x 400 V AC)					D						
16 A (1 x 230 V AC) / 24 A (3 x 230 V AC)					E						
19,5 A (3 x 400 V AC)					F						
Option 1: Field bus option											
EtherCAT							A				
Sercos II							B				
Sercos III							C				
CANopen							D				
PROFIBUS							E				
PROFINET IRT							F				
Option 2: Technology option											
TTL encoder simulation / master encoder									A		
TTL encoder with commutation signals									B		
Second encoder input (Sin/Cos; EnDat2.2; EnDat2.1; SSI)									C		
Without option 2									O		
Customised design											
Customised design on request											SP

Please refer to the table of possible combinations.

Combinations

Table 4.1.2

Size		1021-A	1022-B	1031-C	1032-D	1041-E	1042-F
Supply voltages	230 V AC	●		●		●	
	400 V AC		●		●		●

• Features

Table 4.1.3

YukonDrive	Symbol [Unit]	
Pollution level		2
Mounting method[1)]		Built in device, only for vertical mounting in a control cabinet with min. protection class IP4x
Protection class (EN 60034-5)		IP20 with the exception of the clamps (IP00)
Ambient operating temperature	°C	-10 … +40
Ambient storage temperature	°C	-25 … +55
Maximum installation altitude (above sea level)	m	2000 above sea level
Relative humidity (without condensation)	%	5 ... 95
Vibration resistance during transport (EN 61800-2, IEC 60721-3-2 Klasse 2M1)	g	1 at 9 … 200 Hz 1.5 at 200 … 500 Hz
Shock resistance during transport (EN 61800-2, IEC 60721-2-2 class 2M1) Drop height of the packed unit	m	max. 0.25
Vibration limits in operation (EN 61800-2, IEC 60721-3-3 class 3M1)[1)]	mm	0.3 at 2 … 9 Hz

[1)] Note: The units are intended for stationary use only.

• Cooling

Unless otherwise indicated, the values given in the following tables refer to an ambient temperature of 40 °C and a maximum altitude of ambient temperature of 40 °C and a maximum installation altitude of 1000 m above sea level. From an installation altitude > 1000 m above sea level, a derating of 1% per 100 m must be made.

Technical data YukonDrive -1021/-1031/-1041

Table 4.1.4

Designation	-1021	-1031	-1041
Output motor side[1]			
Voltage	3-phase U_{Mains}		
Continuous current effective (I_N)[2]	3 A	5.9 A	8 A
Peak current (A_{eff})	see Table 4.1.6 and Table 4.1.7		
Rotary field frequency	0 ... 400 Hz		
Switching frequency of the output stage	4, 8, 16 kHz		
Input line side			
Supply voltage	(1 x 230 V AC / 3 x 230 V AC) -20 %/+15 %		
Device connection power[1] (with line choke)	1.3 kVA	2.6 kVA	3.5 kVA
Current[1] (with line choke)	5,4 A 3.3 A	10,6 A 6.5 A	14,4 A 8.8 A
Asymmetry of the supply voltage	±3 % max.		
Frequency	50/60 Hz ±10 %		
Power loss at I_N[1]	75 W	150W	200 W
Brake chopper power electronics			
Peak braking power with internal braking resistor	400 W at 550 Ω PTC) [4]	1.5 kW at 100 Ω [5]	1.7 kW at 90 Ω [5]
Minimum ohmic resistance of an externally installed braking resistor	72 Ω	72 Ω [3]	72 Ω [3]

[1] Values referred to supply voltage 230 V AC and switching frequency 8 kHz
[2] For rated current please note table 3.1.6 and table 3.1.7!
[3] Connection of an ext. braking resistor is not permitted for units with int. braking resistor!
[4] Braking resistor is always integrated. The connection of an external resistor is permissible.
[5] Option

For more information on the brake chopper switch on threshold, please refer to the YukonDrive Manual on our website www.harmonicdrive.co.uk.

Technical data YukonDrive -1022/-1032/-1042

Table 4.1.5

Designation	-1022	-1032	-1042
Output motor side[1]			
Voltage	3-phase U_{Mains}		
Continuous current effective (I_N)[2]	2 A	3.5 A	6.5 A
Peak current (A_{eff})	6 A	10.5 A	19.5 A
Rotary field frequency	0 ... 400 Hz		
Switching frequency of the output stage	4, 8, 16 kHz		
Input mains side			
Supply voltage	(3 x 400 V AC / 3 x 460 V AC / 3 x 480 V AC) ±10 %		
Device connection power[1] (with line choke)	1,5 kVA	2,7 kVA	5,0 kVA
Current[1] (with line choke)	2.2 A	3.9 A	7.2 A
Asymmetry of the supply voltage	±3 % max.		
Frequency	50/60 Hz ±10 %		
Power loss at I_N[1]	42 W	80 W	150 W
Brake chopper power electronics			
Peak braking power with internal braking resistor	2400 W at 7500 Ω (PTC) [4]	1 kW at 420 Ω [5]	4.7 kW at 90 Ω [5]
Minimum ohmic resistance of an externally installed braking resistor	230 Ω	180 Ω [3]	72 Ω [3]

[1] Values referred to supply voltage 230 V AC and switching frequency 8 kHz
[2] For rated current please note table 3.1.6 and table 3.1.7!
[3] Connection of an ext. braking resistor is not permitted for units with int. braking resistor!
[4] Braking resistor is always integrated. The connection of an external resistor is permissible.
[5] Option

For more information on the brake chopper switch on threshold, please refer to the YukonDrive Manual on our website www.harmonicdrive.co.uk.

Current load capacity

The maximum permissible rated currents and peak currents depend on the supply voltage, the motor cable length, the power stage switching frequency and the ambient temperature.

- YukonDrive for 1 x 230 V / 3 x 230 V

Rated current and peak current size 2 to 4 (1 x 230 V AC / 3 x 230 V AC)

Table 4.1.6

Device	Switching frequency of the output stage	Ambient temperature	Rated current	Peak current			
				200 % (2 I_N)		300 % (3 I_N)	
	[kHz]	max. [°C]	I_N [A_{eff}]	[A_{eff}]	for time [s]	[A_{eff}]	for time [s]
-1021	4	45	3.0	6.0	10	9.0	0.08
	8	40	3.0	6.0		9.0[1)]	
	16	40	2.0	4.0		9.0[1)]	
-1031	4	45	5.9	11.8	10	17.7[2)]	0.08[2)]
	8	40				17.7[1)2)]	
	16	40				17.7[1)2)]	
-1041	4	45	8.0	16.0	10	24.0[2)]	0.08[2)]
	8	40	8.0	16.0		24.0[1)2)]	
	16	40	5.4	10.8		16.2[1)2)]	

[1)] Automatic frequency switching of the power amplifier to 4 kHz.
[2)] When feeding in with 1 x 230 V, the recommended line choke must be used

Specifications apply to a motor cable length ≤ 10 m. Maximum permissible motor cable length 30 m.

- YukonDrive for 3 x 400/460/480 V

Rated current and peak current size 2 to 4 (3 x 400/460/480 V AC)

Table 4.1.7

Device	Switching frequency of the output stage	Ambient temperature	Rated current I_N [A_{eff}]			Peak current[2)]			
						200 % (2 I_N)		300 % (3 I_N)	
	[kHz]	max. [°C]	at 400 V	at 460 V	at 480 V	[A_{eff}]	for time [s]	[A_{eff}]	for time [s]
-1022	4	45	2.0	2.0	2.0	4.0	10	6.0	0.08
	8	40	2.0	2.0	1.7	4.0		6.0[1)]	
	16	40	0.7	0.7	–	1.4		2.8[1)]	
-1032	4	45	5.5	4.8	4.6	7.0	10	10.5	0.08
	8	40	3.5	3.5	2.6	7.0		10.5[1)]	
	16	40	2.2	1.3	–	4.4		6.6[1)]	
-1042	4	45	8.5	7.4	7.0	13.0	10	19.5	0.08
	8	40	6.5	6.5	6.5	13.0		19.5[1)]	
	16	40	4.0	2.4	1.9	8.0		12.0[1)]	

[1)] Automatic frequency switching of the power amplifier to 4 kHz.
[2)] When feeding in with 1 x 230 V, the recommended line choke must be used

Specifications apply to a motor cable length ≤ 10 m. Maximum permissible motor cable length 30 m.

Dimensions

Illustration 4.1.1 **Size 2, 3, 4 [mm]**

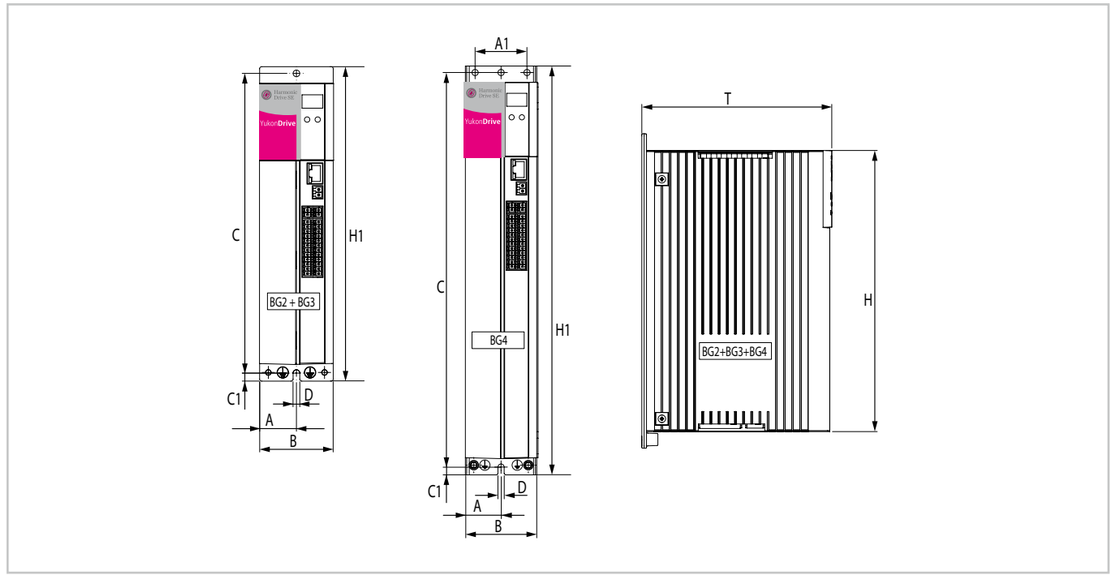


Table 4.1.8 **[mm]**

	[Unit]	Size 2	Size 3	Size 4
		-1021 -1022	-1031 -1032	-1041 -1042
Weight	[kg]	1.0	1.5	2.8
B (Width)	[mm]	55		
H (Height) [1)]	[mm]	210		290
T (Depth) [1)]	[mm]	142	189	235.5
A	[mm]	27.5		
A1	[mm]	–	–	40
C	[mm]	225		305
C1	[mm]	5		
D	[mm]	4.8		
H1	[mm]	235		315
Screws		2 x M4		4 x M4

[1)] without clamps / connectors

Layout

In Illustration 4.1.2 the respective positions of the plugs and terminals are marked with an abbreviation. The explanations can be found in Table 4.1.9.

Illustration 4.1.2

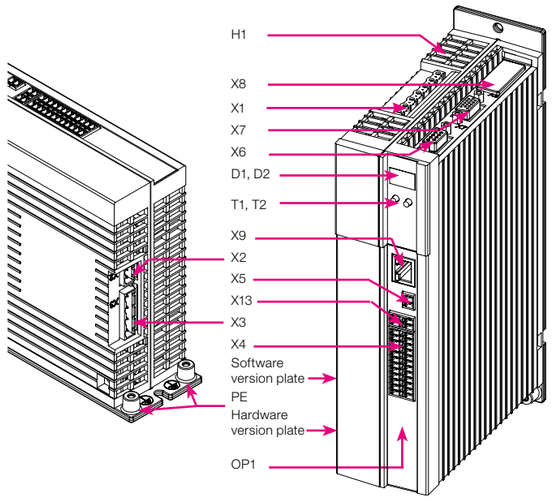


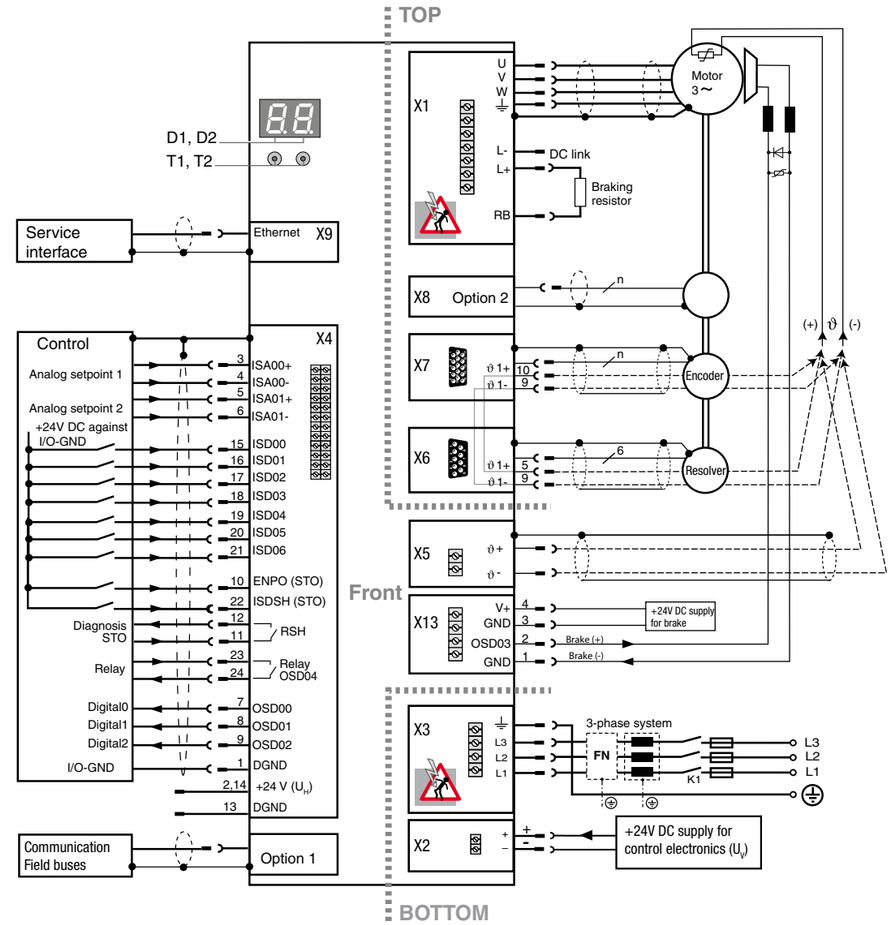
Table 4.1.9

Key to YukonDrive Design

No.	Designation
D1, D2	7-segment display
H1	DC link voltage indicator LED
OP1	Installation space for option 1 (Communication)
PE	Protective conductor connection
T1, T2	Pushbuttons
X1	Power connection
X2	Connection of control supply UV
X3	AC line connection
X4	Control terminals
X5	Motor temperature monitoring
X6	Resolver connection
X7	Connection for high-resolution encoders
X8	Option 2 (Technology)
X9	Ethernet interface
X13	Connection of motor brake

Connection diagram

Illustration 4.1.3



Line chokes

• Ordering code

Table 4.2.1

Ordering code	LR3	2	-	14	-	UR
LR3 Series						
Power supply						
One phase 230 V		2				
Three phase 400 V		4				
Current carrying capacity rated current [A]						
4 A (only in combination with LR34-)				4		
6 A (only in combination with LR34-)				6		
8 A (only in combination with LR34-)				8		
14 A (only in combination with LR32-)				14		
UR authorisation						UR

• Technical data

Table 4.2.2

	LR32.14-UR	LR34.xxx-UR
Line voltage	1 x 230 V, -20 % +15 %, 50/60 Hz [1]	3 x 460 V -25 % +10 %, 50/60 Hz [1]
Overload factor	1.8 x IN for 40 s	2.0 x IN for 30 s
Ambient temperature	-25 °C to +45 °C, with power reduction up to 60 °C (1.3 % per °C)	
Mounting altitude	up to 1000 m, with power reduction up to 2000 m (6 % per 1000 m)	
Relative humidity	15 ... 95 %, condensation is not permitted	
Storage temperature	-25 °C … +70 °C	
Protection class	IP00	
Short circuit voltage	U_K 4% (corresponds to 9.2 V at 230 V)	U_K 4 % (corresponds to 9.24 V at 400 V) applies to line chokes with IN = 4.0 A to 32 A
Permissible degree of contamination	P2 according to EN 61558-1	
Thermal design	$I_{eff} \leq I_N$	$I_{eff} \leq I_N$
UL Recognition	Version LR3X.xxx-UR has UL Recognition for the markets in the USA and Canada	

[1] At a line frequency of 60 Hz, the power loss increases by approx. 5 - 10%.

• Permitted combinations of line choke and servo controller

Table 4.2.3

Article designation	YukonDrive					
	1021	1031	1041	1022	1032	1042
LR32.14-UR	●	●	●		-	-
LR34.4-UR	-	-	-	●	-	-
LR34.6-UR	-	-	-	-	●	-
LR34.8-UR	-	-	-	-	-	●

● available o on request - not available

• Single phase line chokes

Table 4.2.4

Article designation	[Unit]	LR32.14-UR
Rated current	[A]	14.0
Short circuit voltage U_K	[%]	4.0
Total power loss	[W]	23.0
Inductance	[mH]	2.1
Weight	[kg]	2.0
CU weight	[kg]	0.3
Connection	[mm²]	4.0

Illustration 4.2.1

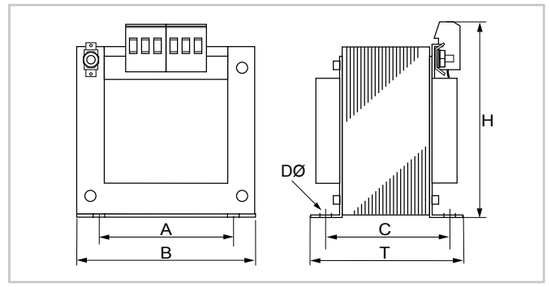


Table 4.2.5

[mm]

Dimensions	Width	Height	Depth	A	C	D Ø
LR32.14-UR	85	98	80	64	64	5,8 x 11

• Three phase line chokes

Table 4.2.6

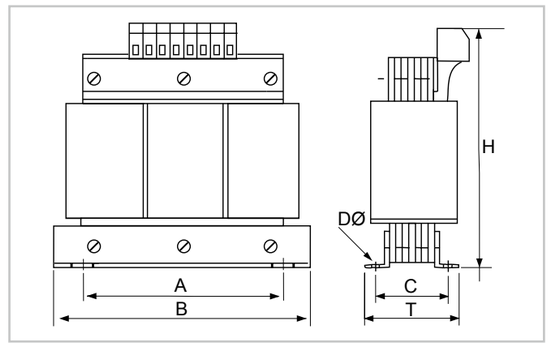
Article designation	[Unit]	LR34.4-UR	LR34.6-UR	LR34.8-UR
Rated current	[A]	4.2	6.0	8.0
Short circuit voltage U_K	[%]	4		
Total power loss	[W]	16	22	29
Inductance	[mH]	7.00	4.88	3.66
Weight	[kg]	2.5		
CU weight	[kg]	0.4	0.8	1.0
Connection	[mm²]	4		

Table 4.2.7

[mm]

Dimensions	Width	Height	Depth	A	C	D Ø
LR34.4-UR	125	130	75	100	55	5
LR34.6-UR						
LR34.8-UR						

Illustration 4.2.2



Braking resistors

• Ordering code

Table 4.2.8

Ordering code	BR	-	200	.	03	.	540	-	UR
BR Series									
Resistance value in Ohm									
260 Ohm			260						
200 Ohm			200						
90 Ohm			090						
Continuous power in watts (roughly rounded)									
100 watts					01				
200 watts					02				
300 watts					03				
1000 watts					10				
IP degree of protection									
IP 54 (without mechanical contact protection)							450		
IP 65 (without mechanical contact protection)							560		
UR authorisation									UR

• Technical data

Table 4.2.9

	according to Illustration 4.2.3	according to Illustration 4.2.4	according to Illustration 4.2.5	according to Illustration 4.2.6
Surface temperature	>250 °C			
Contact protection	no			
Voltage	maximum 970 V DC			
High voltage resistance	4000 V DC			
Temperature monitoring	via bimetal switch (switching capacity 0.5 A / 230 V)			
Approvals	CE conform; UL Recognition			
Connection	1 m length of PTFE insulated stranded wire			Connection box with PG cable outlet (M12 x 1.5 and M25 x 1.5)

• Permitted combinations of braking resistor and servo controller

Table 4.2.10

Article designation	YukonDrive					
	1021	1031	1041	1022	1032	1042
BR-260.01.540-UR	●	●	●	●	●	●
BR-260.02.540-UR	●	●	●	●	●	●
BR-200.01.540-UR	●	●	●	-	●	●
BR-200.02.540-UR	●	●	●	-	●	●
BR-200.03.540-UR	●	●	●	-	●	●
BR-090.01.540-UR	●	●	●	-	-	●
BR-090.02.540-UR	●	●	●	-	-	●
BR-090.03.540-UR	●	●	●	-	-	●
BR-090.10.650-UR	●	●	●	-	-	●

● available o on request - not available

Table 4.2.11

Article designation		[Unit]	BR-260.01.540-UR	BR-260.02.540-UR	BR-200.01.540-UR	BR-200.02.540-UR	BR-200.03.540-UR
Continuous power		[W]	35	150	35	150	300
Resistance		[Ohm+/-10%]	260	260	200	200	200
Peak power	390 V DC	[W]	580	580	760	760	760
	650 V DC		1620	1620	2100	2100	2100
	750 V DC		2160	2160	2800	2800	2800
Protection class			IP54	IP54	IP54	IP54	IP54
Connection	Power		AWG 16	AWG 14	AWG 16	AWG 14	AWG 14
	Bimetal protector		AWG 18	AWG 18	AWG 18	AWG 18	AWG 18
Illustration			Illustration 4.2.3	Illustration 4.2.4	Illustration 4.2.3	Illustration 4.2.4	Illustration 4.2.5

Table 4.2.12

Article designation		[Unit]	BR-090.01.540-UR	BR-090.02.540-UR	BR-090.03.540-UR	BR-090.10.650-UR
Continuous power[1)]		[W]	35	150	300	1000
Resistance		[Ohm+/-10%]	90	90	90	90
Peak power	390 V DC	[W]	1690	1690	1690	1690
	650 V DC		4690	4690	4690	4690
	750 V DC		6250	6250	6250	6250
Protection class			IP54	IP54	IP54	P65
Connection	Power		AWG 16	AWG 14	AWG 14	max. AWG 6
	Bimetal protector		AWG 18	AWG 18	AWG 18	max. AWG 12
Illustration			Illustration 4.2.3	Illustration 4.2.4	Illustration 4.2.5	Illustration 4.2.6

1) For cycle times of max. 150 s, the required nominal continuous power can be calculated using the following formula:
Nominal continuous power (W) = max. pulse duration (s) x peak power (W) / cycle time (s)

Illustration 4.2.3

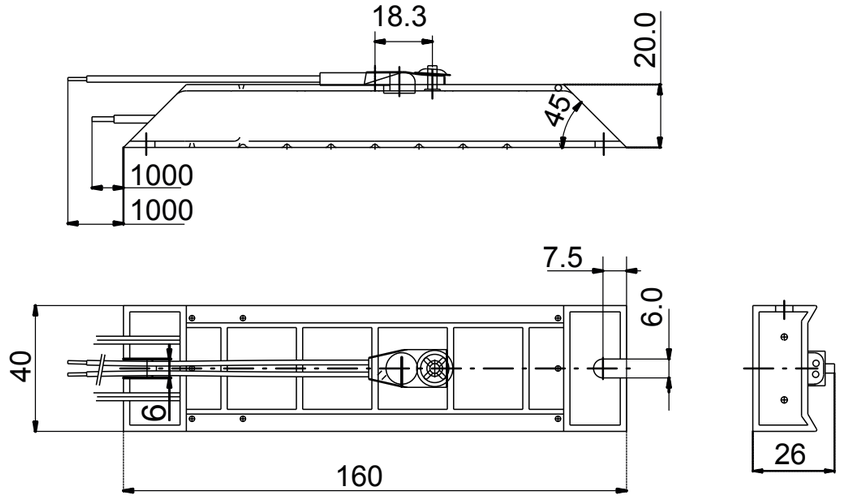


Illustration 4.2.4

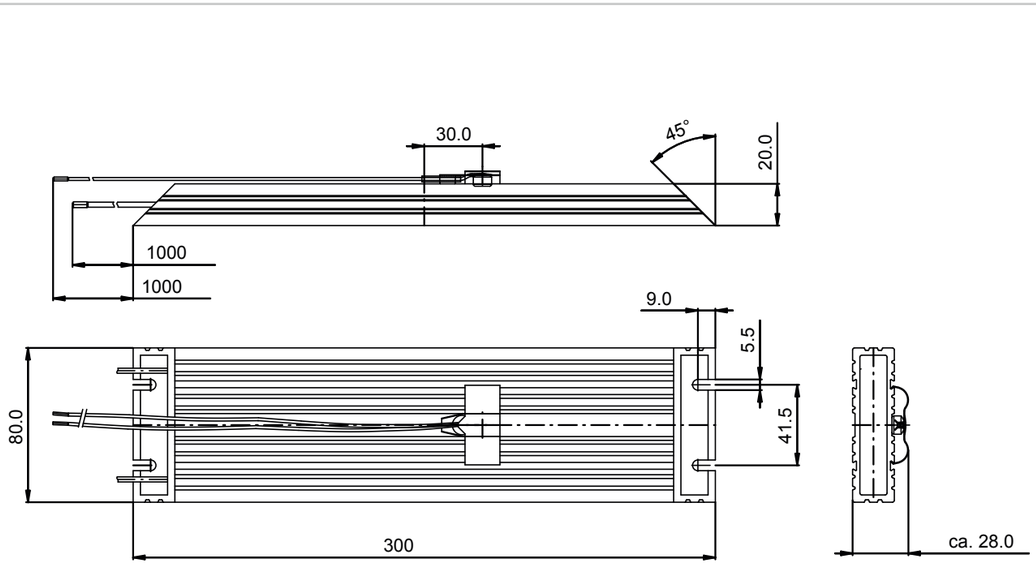


Illustration 4.2.5

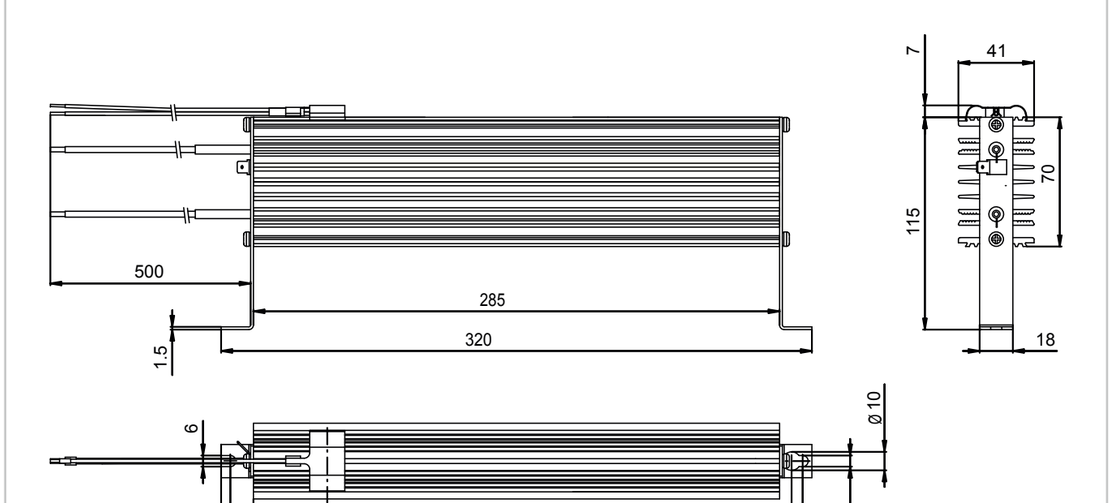
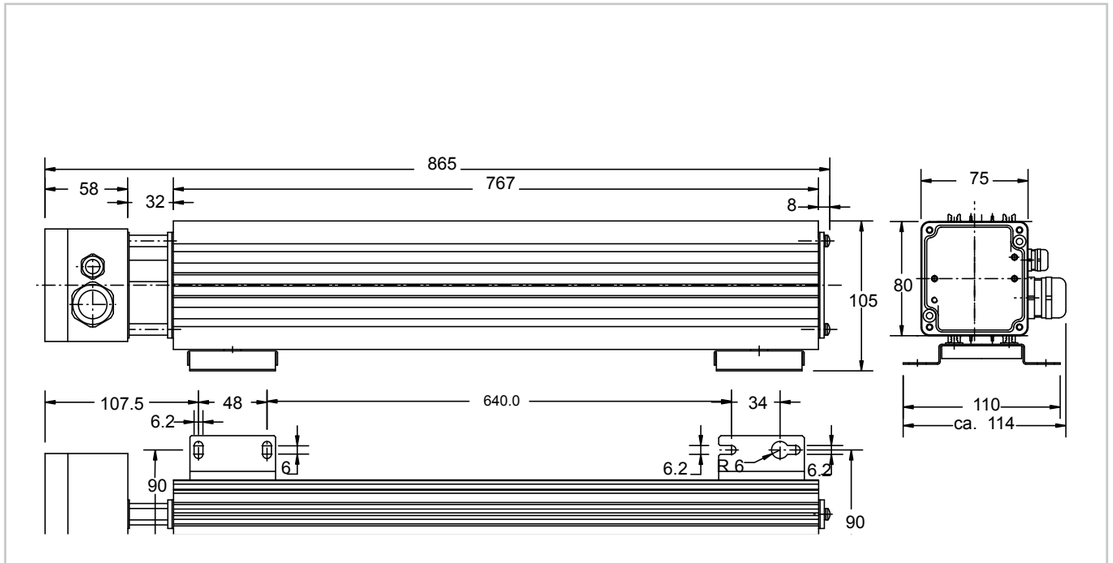


Illustration 4.2.6



Line filter

• Ordering code

Table 4.2.13

Ordering code	EMC	-	14	.	2	-	1Ph	,	UR
EMC Series									
Rated current									
5 A			5						
8 A			8						
11 A			11						
14 A			14						
17 A			17						
Version 2					2				
Number of phases									
Single phase version							1Ph		
Three phase version							3Ph		
UR authorisation									UR

• Technical data

Table 4.2.14

Features	EMCxx.x-1Ph, UR	EMCxx.x-3Ph, UR
Rated voltage	1 x 230 V AC +10 % bei 50/60 Hz	3 x 480 V AC +10 % bei 50/60 Hz
Overload	2 times for 10 seconds, repeatable after 6 minutes[1)]	
Ambient temperature	max. 45 °C	
IEC climate category	25/085/21	
Degree of protection connections	IP00	
Approvals	IEC 60939, UL 508	IEC 60939, UL 1238, UL 508
Radio interference suppression according to EN 61800-3 - Residential area -	Motor cable length up to 10 m permissible	
Radio interference suppression according to EN 61800-3- Industrial area -	Motor cable length up to 30 m permissible	
Connections	Input: touch protected terminals (IP20), output: stranded wire	

1) Prerequisite: Mounting the line filters vertically on a bare metal base plate

• Line filter combinations

Table 4.2.15

	EMC-5	EMC-8	EMC-11	EMC-14	EMC-19
Single phase (1Ph)		•		•	•
Three phase (3Ph)	•		•		

• Single phase line filter

Suitable for YukonDrive servo controllers

Table 4.2.16

	[Unit]	-1021	-1031	-1041
Article designation		EMC8.2-1Ph.UR	EMC14.2-1Ph.UR	EMC19.2-1Ph.UR
Rated current	[A]	8	14	19
Power loss	[W]	2.5	5.8	6.1
Leakage current[1)]	[mA]	7.9		
Contact current[2)]	[mA]	15		
Weight	[kg]	0.60	0.65	0.75

1) Effective value of the leakage current in accordance with EN 60939 (2009) at 50 Hz and rated voltage. The leakage current may be increased by the device to be suppressed.
2) Peak value measurement with measuring circuit according to EN 60990 at 50 Hz and rated voltage.
N: Peak value of the contact current occurring in normal operation with an interrupted protective conductor. If the touch current is > 3.5 mA, the line filter must have a fixed connection in accordance with EN 50178.
F: Peak value of the worst case contact current in the event of a fault with an interrupted PE conductor and an interrupted N conductor.

• Three phase line filter

Suitable for YukonDrive servo controllers

Table 4.2.17

	[Unit]	-1021	-1022	-1032	-1031	-1041	-1042
Article designation		EMC5.2-3Ph, UR			EMC11.2-3Ph, UR		
Rated current	[A]	5			11		
Power loss	[W]	2			7		
Leakage current[1)]	[mA]	1.7			1.7		
Contact current[2)]	[mA]	2.30			0.70		
Weight	[kg]	0.75			0.70		

1) Leakage current (Ieff) according to EN 60939 (2009) at 50 Hz and rated voltage with 2% unbalance. The leakage current can be increased by the device to be suppressed.
2) Peak value measurement with measuring circuit according to IEC 60990 at 50 Hz and rated voltage with 2% unbalance.

• Single phase line filter dimensions

Table 4.2.18

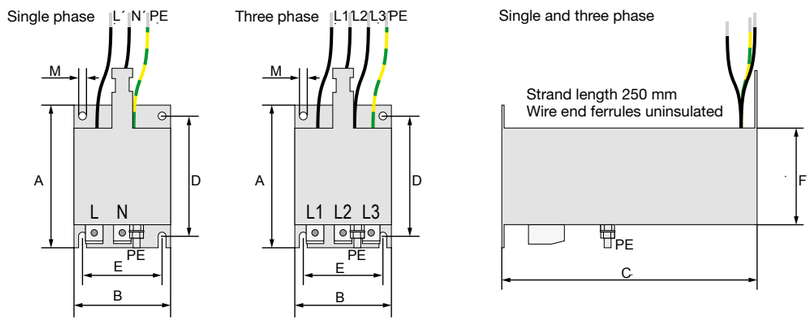
Article designation		[Unit]	EMC8.2-1Ph, UR	EMC14.2-1Ph, UR	EMC19.2-1Ph, UR
Dimensions	A	[mm]	81		
	B		55		
	C		145		
	D		68		
	E		45		
	F		55		
	M Ø		4		
PE			M4		
Input	Clamping range	[mm²]	0.2 - 4.0		
	Tightening torque	[Nm]	0.6 - 0.8		
Output strand cross section			AWG 16	AWG 16	AWG 14

• Three phase line filter dimensions

Table 4.2.19

Article designation		[Unit]	EMC5.2-3Ph, UR	EMC11.2-3Ph, UR
Dimensions	A	[mm]	81	
	B		55	
	C		145	
	D		68	
	E		45	
	F		55	
	M Ø		4	
PE			M4	
Input	Clamping range	[mm²]	0.2 - 4.0	
	Tightening torque	[Nm]	0.6 - 0.8	
Output strand cross section			AWG 16	

Illustration 4.2.7



Introduction to cable description

For an easy assignment of the suitable power cable as well as the suitable encoder cable, you will find a tabular overview of all available cables for the actuators of the BHA, CanisDrive®, LynxDrive and FHA-C Mini series right at the beginning of this chapter. In this matrix, the possible combinations are listed according to actuator, encoder system and the required power cable and encoder cable.

- How to select your system cables

Please select your actuator in the corresponding column of the matrix. In the first matrix you can read the required power cable. In the second matrix you will find the corresponding encoder cable according to the motor feedback system you have chosen.

Below, in the first half of the chapter, you will find the data sheets of the available power cables; in the second half, the data sheets of the encoder cables are listed.

The power cables are designed with flying leads on the controller side and can be easily adapted to the servo controller.

The current load capacity of the motor power cables is designed in accordance with DIN VDE 0298, Part 4 for flexible installation on open cable trays at an ambient temperature of up to 40 °C and a resulting cable temperature of up to 70 °C.
Deviating conditions as well as country specific regulations, standards and conditions must be taken into account when dimensioning.

The encoder cables are available in up to three different versions on the controller side: As standard, the encoder cables are supplied with flying leads, optionally also with straight D-Sub connector or partly also with 45° angled D Sub connector for the YukonDrive Servo Controller.

Important notice:

On motor side, the connectors are offered in the versions M23, M17 and Y-Tec.
To ensure a safe contacting, the connectors of the same manufacturer must always be used on the cable side as well as on the motor side. Therefore, the cables are divided into two different connector types (A or B). Type A stands for the Phoenix Series; type B stands for the manufacturer TE-Intercontec.

Your advantages when using the system cables from Harmonic Drive SE:

- Tested quality matched to the actuators
- Longterm experience in design and shielding
- Tested EMC resistance of the Harmonic Drive® Cable
- Colouring according to Desina
- Maintaining system responsibility when using actuators, cables and servo controllers from Harmonic Drive SE

Cable matrix

Which cable for which actuator?
These two tables list the possible combinations according to actuator, encoder system, the required power cable (Power) and the matching encoder cable (Feedback).

• Cable assignment Power (APC2)

Table 4.3.1

BHA		CanisDrive®										LynxDrive	FHA-C Mini	Technical features / Order code
560 VDC	48 VDC	48 VDC		560 VDC								560 VDC	48/320 VDC	
17 … 25	17 … 25	14	17	14	17	20	25	32	40	50	58	14 … 50	8 … 14	
•					•	•	•	•	•	•				M23 / 8-pole (Pinning standard) / 0,75 mm² (I_N = 10,4 A) Code: **APC2-10-8M23-B-BT-0-xxx-00** BHA: Standard CanisDrive®: only with feedback systems MHS / MZB / SZB
	•													M23 / 8-pole (Pinning standard) / 2,5 mm² (I_N = 22,6 A) Code: **APC2-23-8M23-B-BT-0-xxx-00**
		•	•											M17 / 8-pole (Pinning standard) / 0,75 mm² (I_N = 10,4 A) Code: **APC2-10-8M17-A-BT-0-xxx-00**
				•	•	•	•	•	•					M23 / 8-pole (Pinning standard) / 0,75 mm² (I_N = 10,4 A) Code: **APC2-10-8M23-A-BT-0-xxx-00**
												•		M23 / 8-pole (Pinning Sonder 2) / 0,75 mm² (I_N = 10,4 A) Code: **APC2-10-8M23-A-BT-2-xxx-00**
				•	•	•	•	•	•	•	•	•		M23 / 6-pole (Pinning standard) / 0,75 mm² (I_N = 10,4 A) Code: **APC2-10-6M23-A-B0-0-xxx-00**
					•	•	•	•	•	•				M23 / 6-pole (Pinning standard) / 0,75 mm² (I_N = 10,4 A) only with feedback system MHS / MZB / SZB on CanisDrive® Code: **APC2-10-6M23-B-B0-0-xxx-00**
													•	Spring-Tec / 9-pole (Pinning special 1) / 0,75 mm² (I_N = 10,4 A) Code: **APC2-10-9STC-B-00-1-xxx-00**
													•	M23 / 8-pole (Pinning special 1) / 0,75 mm² (I_N = 10,4 A) Code: **APC2-10-8M23-A-00-1-xxx-00**

• Cable assignment Feedback (AFC2)

Table 4.3.2

BHA	CanisDrive®										LynxDrive	FHA-C Mini	Technical features / Order code
48/560 VDC	48 VDC	560 VDC									560 VDC	48/320 VDC	
17 … 25	14	17	14	17	20	25	32	40	50	58	14 … 50	8 … 14	
•				•	•	•	•	•	•				M23 / 17-pole / Pinning BiSS / EnDat / SSI (fully digital) Biss-C encoder, SZE (ECI119), MZE (EBI135), SZB, MZB u. MHS (Flex Feedback) (all BHAs); MHS / MZB / SZB (CanisDrive-17 ... 50) Code: **AFC2-F-17M23-B-xxx-00**
•													M23 / 12-pole / Pinning HIPERFACE® HIPERFACE® (MIH, SIH) Code: **AFC2-H-12M23-B-xxx-00**
			•	•	•	•	•				•		M23 / 12-pole / Pinning HIPERFACE® MIH, SIH (CanisDrive-17 … 20), MHH, SHH (CanisDrive-25 … 40); MGH (LynxDrive) Code: **AFC2-H-12M23-A-xxx-0x**
				•	•	•	•	•	•				M23 / 17-pole / Pinning EnDat fully digital with battery box MZE (EBI135 / EBI4010) Code: **AFC2-BE-17M23-A-xxx-01**
												•	Spring-Tec / 12-pole / Pinning EnDat fully digital with battery box MZE (EBI1135) Code: **AFC2-BE-12STC-B-xxx-01**
				•	•	•	•	•	•			•	D-Sub / 15-pole / Pinning for battery box to controller D-SUB cable from battery box to controller Code: **AFC2-BE-15DS3-X-xxx-0x**
			•	•	•	•	•	•	•		•		M23 / 17-pole / Pinning EnDat / SSI (with SinCos tracks + Sense + Temp) SIE (CanisDrive-20 … 40); MGSi (CanisDrive-14 … 20); SZE (CanisDrive-20 … 58); MEE, MKE (LynxDrive) Code: **AFC2-F-17M23-A-xxx-0x**
	•	•											M17 / 17-pole / Pinning EnDat / SSI with SinCos tracks + Sense + Temp) MGSi @ 48V Code: **AFC2-F-17M17-A-xxx-00**
	•	•	•	•	•							• [1]	M17 / 17-pole / Pinning for incremental encoder DCO (CanisDrive®); D200 (only FHA-C Mini) Code: **AFC2-T-17M17-A-xxx-00**
											•		M23 / 17-pole / Pinning SinCos encoder CCO Code: **AFC2-S-17M23-A-xxx-00**
											•		M23 / 12-pole / Pinning resolver ROO Code: **AFC2-R-12M23-A-xxx-0x**

[1] D200 only in combination with flying leads, therefore no pluggable cable necessary.

The technical data of the encoder cables can be found from page 271.

Ordering code

- Power cable APC2 (Actuator Power Cable)

Table 4.3.3

Ordering code	APC2	-	10	-	8M23	-	A	-	BT	-	0	-	050	-	00
Actuator Power Cable Generation 2															
Ampacity rated current in A (values roanded)															
10,4 A (4 x 0,75 mm² Conductor cross section)			10												
22,6A (4 x 2,5 mm² Conductor cross section)			23												
Connection plug motor side															
M23 connector 8-pole; plug design female					8M23										
M23 connector 6-pole; plug design female					6M23										
M17 connector 8-pole; plug design female					8M17										
Spring-Tec connector 9-pole; design female (mate plug for Y-TEC)					9STC										
Connector type															
Phoenix: SF Series							A								
TE-Intercontec: 923 Series (M23), 917 (M17), 915 (Spring-Tec M15)							B								
Brake and thermal monitoring															
with strands for holding brake and thermosensor (standard)									BT						
with strands only for holding brake									B0						
without strands holding brake without strands thermal sensor									00						
Version pinout connector on motor side															
Standard version											0				
Pinout Special 1 (only for FHA-C Mini)											1				
Pinout Special 2 (only for LynxDrive with 8-pole M23 connection)											2				
Further special pinouts are counted up											...				
Cable length in decimetres															
3 m													030		
5 m													050		
10 m													100		
15 m													150		
Cable end assembled on the controller side for:															
Open cable strands according to drawing (standard)															00
...															...
Bosch Rexroth on request															10
Beckhoff on request															12
ELMO Gold Cello on request															14
… further customised assemblies are counted up on request															...

Note:
The above table does not show all available combinations, but only represents the ordering code.
The available cables for the corresponding actuators are listed on the following pages.

Attention:
To ensure a secure contact connection, connectors from the same manufacturer must always be used on both the cable and motor sides. For this reason, the cables are divided into two different connector types (A or B). Type A stands for the Phoenix Series; type B stands for the manufacturer TE-Intercontec.

Ordering code

- Encoder cable AFC2 (Actuator Feedback Cable)

Table 4.3.4

Ordering code	AFC2	-	H	-	12M23	-	A	-	050	-	00
Actuator Feedback Cable Generation 2											
Encoder feedback cable for:											
Encoder MZE with battery box			BE								
BiSS, SSI oder EnDat fully digital or with SinCos + Sense			F								
HIPERFACE®			H								
Resolver			R								
SinCos			S								
Incremental encoder			T								
Connector motorside											
M23 connector 17-pole; plug design female					17M23						
M23 connector 12-pole; plug design female					12M23						
M17 connector 17-pole; plug design female					17M17						
Spring-Tec connector 12-pole; design female (mate plug for Y-TEC)					12STC						
D-SUB connector 15-pole (3-row); Connection battery box => Controller					15DS3						
Connector type											
Phoenix: RF Series (M23), ST (M17)							A				
TE-Intercontec: 623 Series (M23), 617 (M17), 615 Spring-Tec (M15)							B				
Other connector type (e.g. motor side D-SUB connector (15DS3))							X				
Cable length in decimetres											
3 m									030		
5 m									050		
10 m									100		
15 m									150		
Cable end assembled on the controller side for:											
Open cable strands; not pre assembled => standard											00
YukonDrive or battery box; Connector straight outgoing											01
YukonDrive; Connector 45° angular											02
Extension cable (motor plug and motor female - only on request)											03
…											...
Bosch Rexroth (connector straight) on request											10
Beckhoff (connector 45°) on request											12
ELMO Gold Cello on request											14
… further customised assemblies are counted up on request											...

Note:
The above table does not show all available combinations, but only represents the ordering code.
The available cables for the corresponding actuators are listed on the following pages.

Attention:
To ensure a secure contact connection, connectors from the same manufacturer must always be used on both the cable and motor sides. For this reason, the cables are divided into two different connector types (A or B). Type A stands for the Phoenix Series; type B stands for the manufacturer TE-Intercontec.

The ordering code of the encoder cables can also be found at the beginning of the technical data of the encoder cables on page 271.

Cable APC2-10-8M23-B-BT-0-xxx-00

Power cable 0.75 mm²: Suitable for actuators with type B connectors (TE-Intercontec) with 8-pole M23 power connector; pinout of the power connector: Standard

Compatible with the following actuators: BHA, all sizes in 560 V version, CanisDrive® with MHS, MZB and SZB motor feedback systems

Illustration 4.3.1

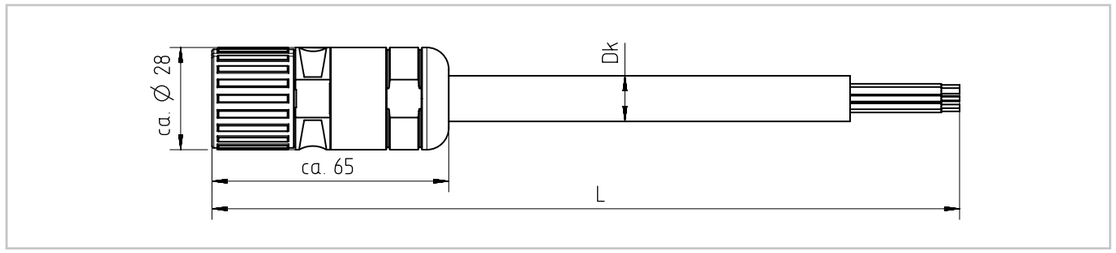


Table 4.3.5

Connector motor side (A side)	PIN A side	Signal	Colour B side	Version B side
	1	U	U1	flying leads
	2	PE	gn/ye	
	3	W	W3	
	4	V	V2	
	A	Brake+	5	
	B	Brake-	6	
	C	Temp+	7	
	D	Temp-	8	
M23 Connector / 8-pole, Version female, Screw connection Speedtec, TE-Intercontec 923 Series	Housing	Shield	...	

Table 4.3.6

Technical data	APC2-10-8M23-B-BT-0-xxx-00
Temperature range in drag chain	-25 °C ... +80 °C
Temperature range motionless	-50 °C ... +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	600 V (in accordance with VDE 0298-3) / 1000 V (in accordance with UL)
Rated current	10.4 A eff
Environmental compatibility	RoHS-conform, halogen free, silicone free, CFC-free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	in accordance with DIN EN 50363-10-2, Class 3
Drag chain capable	yes
Diameter cable (Dk)	12 mm
Diameter connector A side	28 mm
Min. bending radius fixed installation	4 x Dk
Min. bending radius for flexible installation	12.5 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	5.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 10989 and 21223, 1000 V, 80 °C
Cable weight	192 g/m

Table 4.3.7

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
APC2-10-8M23-B-BT-0-030-00	3 m	1052134
APC2-10-8M23-B-BT-0-050-00	5 m	1052135
APC2-10-8M23-B-BT-0-100-00	10 m	1052136
APC2-10-8M23-B-BT-0-150-00	15 m	1052137

Cable APC2-23-8M23-B-BT-0-xxx-00

Power cable 2.5 mm²: Suitable for actuators with connectors of type B (TE-Intercontec) with 8-pole M23 power connector; pinout of the power connector: Standard

Compatible with the following actuators: BHA, all sizes in version 48 V

Illustration 4.3.2

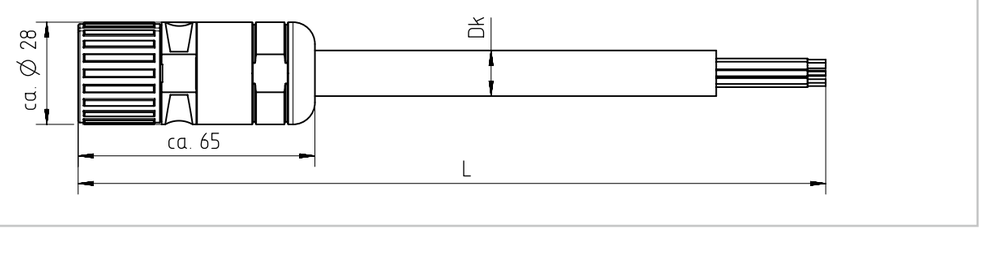


Table 4.3.8

Connector motor side (A side)	PIN A side	Signal	Colour B side	Version B side
	1	U	1	flying leads
	2	PE	gn/ye	
	3	W	3	
	4	V	2	
	A	Brake+	5	
	B	Brake-	6	
	C	Temp+	7	
	D	Temp-	8	
M23 Connector / 8-pole, Version female, Screw connection Speedtec, TE-Intercontec 923 Series	Housing	Shield	-	

Table 4.3.9

Technical data	APC2-23-8M23-B-BT-0-xxx-00
Temperature range in drag chain	-20 °C ... +80 °C
Temperature range motionless	-40 °C ... +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	600 V (in accordance with VDE 0298-3) / 1000 V (in accordance with UL)
Rated current	22.6 A eff
Environmental compatibility	RoHS-conform, halogen free, silicone free, CFC-free
Flame retardant	according to IEC 60332-1, UL94V2, CSA FT1
Material of cable sheath	PUR
Oil resistance cable sheath	according to HD 505.2.1, VDE 0472 Part 802 Kl. A/B
Drag chain capable	yes
Diameter cable (Dk)	14.5 +/- 0.5 mm
Diameter connector A side	28 mm
Min. bending radius fixed installation	k. A.
Min. bending radius for flexible installation	10 x Dk
Maximum acceleration	k. A.
Number of bending cycles	k. A.
Torsion	no torsion permissible
Approvals	CE; UL AWM Style 21223; CSA AWM Style 20234, 1000 V, 80 °C
Cable weight	336 g/m

Table 4.3.10

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
APC2-23-8M23-B-BT-0-030-00	3 m	1052138
APC2-23-8M23-B-BT-0-050-00	5 m	1052139
APC2-23-8M23-B-BT-0-100-00	10 m	1052140
APC2-23-8M23-B-BT-0-150-00	15 m	1052141

Cable APC2-10-8M17-A-BT-0-xxx-00

Power cable 0.75 mm²: Suitable for actuators with connectors of type A (Phoenix SF Series) with 8-pole M17 power connector; pinout of the power connector: Standard

Compatible with the following actuators: CanisDrive®, sizes 14 and 17 in version 48 V

Illustration 4.3.3

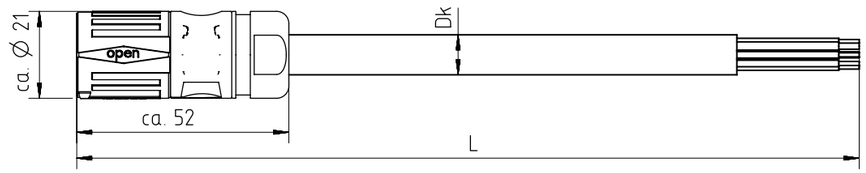


Table 4.3.11

Connector motor side (A side)	PIN A side	Signal	Colour B side	Version B side
	1	U	U1	flying leads
	2	Temp+	7	
	3	Brake+	5	
	4	Brake-	6	
	5	Temp-	8	
	6	W	W3	
	7	V	V2	
	PE	PE	gn/ye	
M17 Connector / 8-pole, Version female, Phoenix SF Series	Housing	Shield	-	

Table 4.3.12

Technical data	APC2-10-8M17-A-BT-0-xxx-00
Temperature range in drag chain	-25 °C ... +80 °C
Temperature range motionless	-50 °C ... +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	600 V (in accordance with VDE 0298-3) / 1000 V (in accordance with UL)
Rated current	10.4 A eff
Environmental compatibility	RoHS-conform, halogen free, silicone free, CFC-free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	in accordance with DIN EN 50363-10-2, Class 3
Drag chain capable	yes
Diameter cable (Dk)	12 mm
Diameter connector A side	21 mm
Min. bending radius fixed installation	4 x Dk
Min. bending radius for flexible installation	12.5 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	5.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 10989 and 21223, 1000 V, 80 °C
Cable weight	192 g/m

Table 4.3.13

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
APC2-10-8M17-A-BT-0-030-00	3 m	1052142
APC2-10-8M17-A-BT-0-050-00	5 m	1052143
APC2-10-8M17-A-BT-0-100-00	10 m	1052144
APC2-10-8M17-A-BT-0-150-00	15 m	1052145

Cable APC2-10-8M23-A-BT-0-xxx-00

Power cable 0.75 mm²: Suitable for actuators with connectors of type A (Phoenix SF Series) with 8-pole M23 power connector; pinout of the power connector: Standard

Compatible with the following actuators: CanisDrive®, sizes 14 to 40 in version 560 V with 8-pole connector M23

Illustration 4.3.4

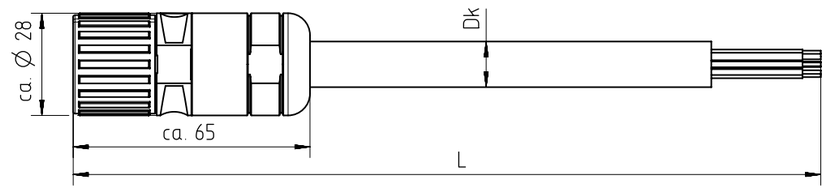


Table 4.3.14

Connector motor side (A side)	PIN A side	Signal	Colour B side	Version B side
	1	U	U1	flying leads
	2	PE	gn/ye	
	3	W	W3	
	4	V	V2	
	A	Brake+	5	
	B	Brake-	6	
	C	Temp+	7	
	D	Temp-	8	
M23 Connector / 8-pole, Version female, Phoenix SF Series	Housing	Shield	-	

Table 4.3.15

Technical data	APC2-10-8M23-A-BT-0-xxx-00
Temperature range in drag chain	-25 °C ... +80 °C
Temperature range motionless	-50 °C ... +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	600 V (in accordance with VDE 0298-3) / 1000 V (in accordance with UL)
Rated current	10.4 A eff
Environmental compatibility	RoHS-conform, halogen free, silicone free, CFC-free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	in accordance with DIN EN 50363-10-2, Class 3
Drag chain capable	yes
Diameter cable (Dk)	12 mm
Diameter connector A side	28 mm
Min. bending radius fixed installation	4 x Dk
Min. bending radius for flexible installation	12.5 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	5.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 10989 and 21223, 1000 V, 80 °C
Cable weight	192 g/m

Table 4.3.16

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
APC2-10-8M23-A-BT-0-030-00	3 m	1052146
APC2-10-8M23-A-BT-0-050-00	5 m	1052147
APC2-10-8M23-A-BT-0-100-00	10 m	1052148
APC2-10-8M23-A-BT-0-150-00	15 m	1052149

Cable APC2-10-8M23-A-BT-2-xxx-00

Power cable 0.75 mm²: Suitable for actuators with connectors of type A (Phoenix SF Series) with 8-pole M23
Power connector; pinout of the power connector: “Special 2” (only for LynxDrive)

Compatible with the following actuators: LynxDrive, all sizes with 8-pole connector M23

Illustration 4.3.5

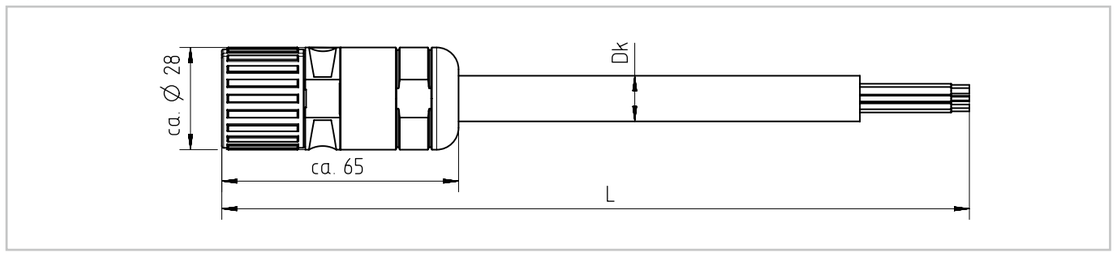


Table 4.3.17

Connector motor side (A side)	PIN A side	Signal	Colour B side	Version B side
 M23 Connector / 8-pole, Version female, Phoenix SF Series	1	U	U1	flying leads
	2	PE	gn/ye	
	3	W	W3	
	4	V	V2	
	A	Temp+	5	
	B	Temp-	6	
	C	Brake+	7	
	D	Brake-	8	
	Housing	Shield	-	

Table 4.3.18

Technical data	APC2-10-8M23-A-BT-2-xxx-00
Temperature range in drag chain	-25 °C bis +80 °C
Temperature range motionless	-50 °C bis +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	600 V (in accordance with VDE 0298-3) / 1000V (in accordance with UL)
Rated current	10.4 A eff
Environmental compatibility	RoHS-conform, halogen free, silicone free, CFC-free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	in accordance with DIN EN 50363-10-2, Class 3
Drag chain capable	yes
Diameter cable (Dk)	12 mm
Diameter connector A side	28 mm
Min. bending radius fixed installation	4 x Dk
Min. bending radius for flexible installation	12.5 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	5.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 10989 and 21223, 1000 V, 80 °C
Cable weight	192 g/m

Table 4.3.19

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
APC2-10-8M23-A-BT-2-030-00	3 m	1052150
APC2-10-8M23-A-BT-2-050-00	5 m	1052151
APC2-10-8M23-A-BT-2-100-00	10 m	1052152
APC2-10-8M23-A-BT-2-150-00	15 m	1052153

Cable APC2-10-6M23-A-B0-0-xxx-00

Power cable 0.75 mm²: Suitable for actuators with connectors of type A (Phoenix SF Series) with 6-pole M23
Power connector; pinout of the power connector: Standard (compatible with Siemens)

Compatible with the following actuators: CanisDrive®, all sizes in version 560 V with 6-pole connector M23, LynxDrive, all sizes with 6-pole connector M23

Illustration 4.3.6

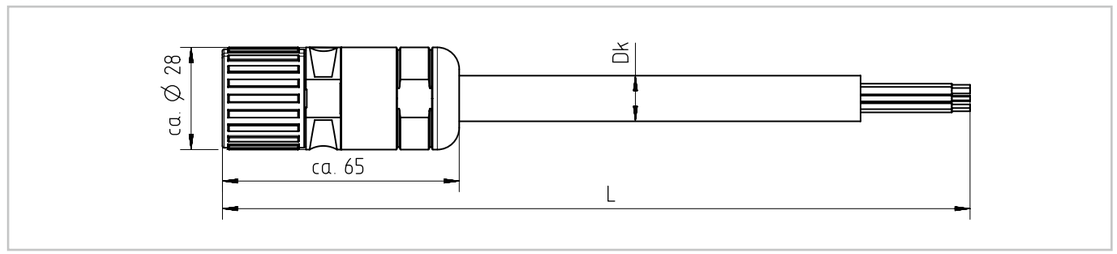


Table 4.3.20

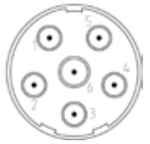
Connector motor side (A side)	PIN A side	Signal	Colour B side	Version B side
 M23 Connector / 6-pole, Version female, Phoenix SF Series	1	U	U1	flying leads
	2	V	V2	
	3	PE	gn/ye	
	4	Brake+	5	
	5	Brake-	6	
	6	W	W3	
	Housing	Shield	-	

Table 4.3.21

Technical data	APC2-10-6M23-A-B0-0-xxx-00
Temperature range in drag chain	-25 °C bis +80 °C
Temperature range motionless	-50 °C bis +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	600 V (in accordance with VDE 0298-3) / 1000 V (in accordance with UL)
Rated current	10.4 A eff
Environmental compatibility	RoHS-conform, halogen free, silicone free, CFC-free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	in accordance with DIN EN 50363-10-2, Class 3
Drag chain capable	yes
Diameter cable (Dk)	12 mm
Diameter connector A side	28 mm
Min. bending radius fixed installation	4 x Dk
Min. bending radius for flexible installation	12.5 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	5.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 10989 and 21223, 1000 V, 80 °C
Cable weight	192 g/m

Table 4.3.22

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
APC2-10-6M23-A-B0-0-030-00	3 m	1052154
APC2-10-6M23-A-B0-0-050-00	5 m	1052155
APC2-10-6M23-A-B0-0-100-00	10 m	1052156
APC2-10-6M23-A-B0-0-150-00	15 m	1052157

Cable APC2-10-6M23-B-B0-0-xxx-00

Power cable 0.75 mm²: Suitable for actuators with connectors of type B (TE-Intercontec) with 6-pole M23
Power connector; pinout of the power connector: Standard (compatible with Siemens)

Compatible with the following actuators: CanisDrive®, only with motor feedback systems MHS, MZB and SZB

Illustration 4.3.7

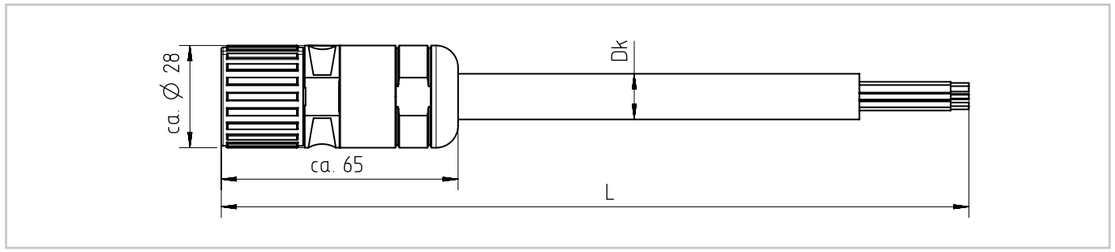


Table 4.3.23

Connector motor side (A side)	PIN A side	Signal	Colour B side	Version B side
 M23 Connector / 6-pole, Version female, TE-Intercontec Serie 923	1	U	U1	flying leads
	2	V	V2	
	3	PE	gn/ye	
	4	Brake+	5	
	5	Brake-	6	
	6	W	W3	
	Housing	Shield	-	

Table 4.3.24

Technical data	APC2-10-6M23-B-B0-0-xxx-00
Temperature range in drag chain	-25 °C ... +80 °C
Temperature range motionless	-50 °C ... +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	600 V (in accordance with VDE 0298-3) / 1000 V (in accordance with UL)
Bemessungstrom	10.4 A eff
Environmental compatibility	RoHS-conform, halogen free, silicone free, CFC-free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	in accordance with DIN EN 50363-10-2, Class 3
Drag chain capable	yes
Diameter cable (Dk)	12 mm
Diameter connector A side	28 mm
Min. bending radius fixed installation	4 x Dk
Min. bending radius for flexible installation	12.5 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	5.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 10989 and 21223, 1000V, 80 °C
Cable weight	192 g/m

Table 4.3.25

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
APC2-10-6M23-B-B0-0-030-00	3 m	1052158
APC2-10-6M23-B-B0-0-050-00	5 m	1052159
APC2-10-6M23-B-B0-0-100-00	10 m	1052160
APC2-10-6M23-B-B0-0-150-00	15 m	1052161

Cable APC2-10-9STC-B-00-1-xxx-00

Power cable 0.75 mm²: Suitable for actuators with 9-pole Spring-Tec connector.
Pinout of the power connector: Special 1 (only for FHA-C Mini)

Compatible with the following actuators: FHA-C Mini

Illustration 4.3.8

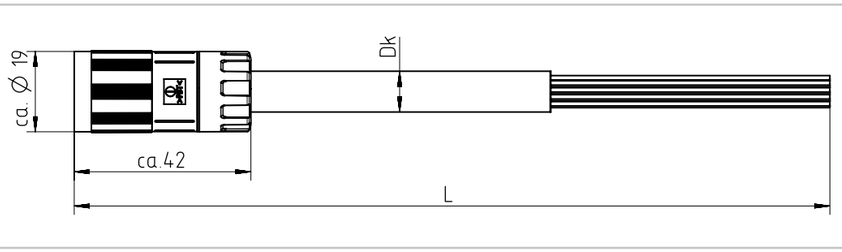


Table 4.3.26

Connector motor side (A side)	PIN A side	Signal	Colour B side	Version B side
 Spring-Tec Connector / 9-pole, Version female, TE-Intercontec Serie 915	A	U	U1	flying leads
	B	V	V2	
	C	W	W3	
	PE	PE	gn/ye	
	1	-	-	
	2	-	-	
	3	-	-	
	4	-	-	
	5	-	-	
	Housing	Shield	-	

Table 4.3.27

Technical data	APC2-10-9STC-B-00-1-xxx-00
Temperature range in drag chain	-25 °C ... +80 °C
Temperature range motionless	-50 °C ... +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	600 V (in accordance with VDE 0298-3) / 1000 V (in accordance with UL)
Rated current	10.4 A eff
Environmental compatibility	RoHS-conform, halogen free, silicone free, CFC-free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	in accordance with DIN EN 50363-10-2, Class 3
Drag chain capable	yes
Diameter cable (Dk)	10,3 mm
Diameter connector A side	28 mm
Min. bending radius fixed installation	4 x Dk
Min. bending radius for flexible installation	7,5 x Dk
Maximum acceleration	10 m/s²
Number of bending cycles	11.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 21223 oder 20234, 1000 V, 80 °C
Cable weight	138 g/m

Table 4.3.28

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
APC2-10-9STC-B-00-1-030-00	3 m	1052162
APC2-10-9STC-B-00-1-050-00	5 m	1052163
APC2-10-9STC-B-00-1-100-00	10 m	1052164
APC2-10-9STC-B-00-1-150-00	15 m	1052165

Cable APC2-10-8M23-A-00-1-xxx-00

Power cable 0.75 mm²: Suitable for actuators with connectors of type A (Phoenix SF Series) with 8-pole M23
Power connector Pinout of the power connector: Special 1 (only for FHA-C Mini)

Compatible with the following actuators: FHA-C Mini with 8-pole connector M23

Illustration 4.3.9

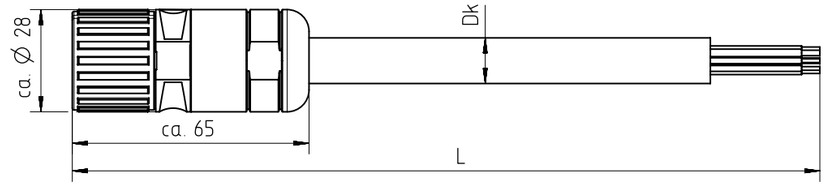


Table 4.3.29

Connector motor side (A side)	PIN A side	Signal	Colour B side	Version B side
 M23 Connector / 8-pole, Version female Phoenix SF Series	1	U	U1	flying leads
	2	PE	gn/ye	
	3	W	V2	
	4	V	W3	
	A	-	-	
	B	-	-	
	C	-	-	
	D	-	-	
	Housing	Shield	-	

Table 4.3.30

Technical data	APC2-10-8M23-A-00-1-xxx-00
Temperature range in drag chain	-25 °C bis +80 °C
Temperature range motionless	-50 °C bis +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	600 V (in accordance with VDE 0298-3) / 1000 V (in accordance with UL)
Rated current	10.4 A eff
Environmental compatibility	RoHS-conform, halogen free, silicone free, CFC-free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	in accordance with DIN EN 50363-10-2, Class 3
Drag chain capable	yes
Diameter cable (Dk)	10,3 mm
Diameter connector A side	28 mm
Min. bending radius fixed installation	4 x Dk
Min. bending radius for flexible installation	7.5 x Dk
Maximum acceleration	10 m/s²
Number of bending cycles	10.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 21223 oder 20234, 1000 V, 80 °C
Cable weight	138 g/m

Table 4.3.31

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
APC2-10-8M23-A-00-1-030-00	3 m	1052166
APC2-10-8M23-A-00-1-050-00	5 m	1052167
APC2-10-8M23-A-00-1-100-00	10 m	1052168
APC2-10-8M23-A-00-1-150-00	15 m	1052169

Ordering code

- Encoder cable AFC2 (Actuator Feedback Cable)

Table 4.3.32

Ordering code	AFC2	-	H	-	12M23	-	A	-	050	-	00
Actuator Feedback Cable Generation 2											
Encoder feedback cable for:											
Encoder MZE with battery box			BE								
BiSS, SSI oder EnDat fully digital or with SinCos + Sense			F								
HIPERFACE®			H								
Resolver			R								
SinCos			S								
Incremental encoder			T								
Connector motorside											
M23 connector 17-pole; plug design female					17M23						
M23 connector 12-pole; plug design female					12M23						
M17 connector 17-pole; plug design female					17M17						
Spring-Tec connector 12-pole; design female (mate plug for Y-TEC)					12STC						
D-SUB connector 15-pole (3-row); Connection battery box => Controller					15DS3						
Connector type											
Phoenix: RF Series (M23), ST (M17)							A				
TE-Intercontec: 623 Series (M23), 617 (M17), 615 Spring-Tec (M15)							B				
Other connector type (e.g. motor side D-SUB connector (15DS3))							X				
Cable length in decimetres											
3 m									030		
5 m									050		
10 m									100		
15 m									150		
Cable end assembled on the controller side for:											
Open cable strands; not pre assembled => standard											00
YukonDrive or battery box; Connector straight outgoing											01
YukonDrive; Connector 45° angular											02
Extension cable (motor plug and motor female - only on request)											03
…											...
Bosch Rexroth (connector straight) on request											10
Beckhoff (connector 45°) on request											12
ELMO Gold Cello on request											14
… further customised assemblies are counted up on request											...

Note:
The above table does not show all available combinations, but only represents the ordering code.
The available cables for the corresponding actuators are listed on the following pages.

Attention:
To ensure a secure contact connection, connectors from the same manufacturer must always be used on both the cable and motor sides. For this reason, the cables are divided into two different connector types (A or B). Type A stands for the Phoenix Series; type B stands for the manufacturer TE-Intercontec.

Cable AFC2-F-17M23-B-xxx-00

Encoder cable FlexFeedback: Suitable for BISS encoders, EnDat encoders fully digital as well as EnDat or SSI encoders with SinCos tracks on actuators with type B connectors (TE-Inercontec); e.g. BHA. This cable is also to be used also be used when using the MHS encoder on the CanisDrive®.

Compatible with the following encoders: SZE, MZE, SZB, MZB, MHS (BHA Series), MHS (CanisDrive® Series)

Illustration 4.3.10

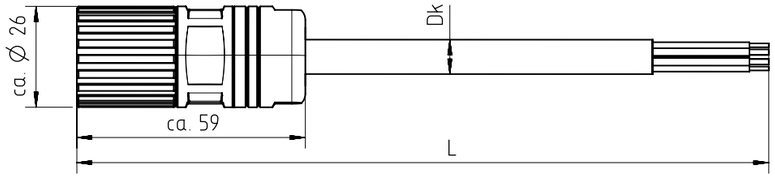


Table 4.3.33

Connector motor side (A side)	PIN A side	Signal EnDat / SSI	Signal Biss	Colour B side	Version B side
	1	Cos+/A+	-	bn	flying leads
	2	Cos-/A-	-	bk	
	3	Data+	SLO+	og	
	4	-	-	-	
	5	Clock+	MA+	gy	
	6	-	-	-	
	7	GND	GND	bn/bu	
	8	Temp+	Temp+	gn/bk	
	9	Temp-	Temp-	gn/rd	
	10	Up	Up	bn/rd	
	11	Sin+/B+	-	ye	
	12	Sin-/B-	-	gn	
	13	Data-	SLO-	rd	
	14	Clock-	MA-	bu	
	15	Sense-	Sense-	ye/bn	
	16	Sense+	Sense+	gn/bn	
	17	-	-	-	
M23 Connector / 17-pole, Version female, Screw connection Speedtec, TE-Intercontec 623 Series	Housing	Shield	Shield	-	

Table 4.3.34

Technical data	AFC2-F-17M23-B-xxx-00
Temperature range in drag chain	-25 °C ... +80 °C
Temperature range motionless	-50 °C ... +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	50 V
Environmental compatibility	RoHS-conform, halogen free, silicone free CFC-free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	in accordance with DIN EN 50363-10-2, Class 3
Drag chain capable	yes
Diameter cable (Dk)	12 mm
Diameter connector A side	26 mm
Min. bending radius fixed installation	4 x Dk
Min. bending radius for flexible installation	10 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	5.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 20233, 300 V, 80 °C
Cable weight	192 g/m

Table 4.3.35

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-F-17M23-B-030-00	3 m	1052170
AFC2-F-17M23-B-050-00	5 m	1052171
AFC2-F-17M23-B-100-00	10 m	1052172
AFC2-F-17M23-B-150-00	15 m	1052173

Cable AFC2-H-12M23-B-xxx-00

Encoder cable HIPERFACE®: Suitable for HIPERFACE® encoders on actuators with type B connectors (TE-Intercontec); e. g. BHA.

Compatible with the following encoders: MIH, SIH

Illustration 4.3.11

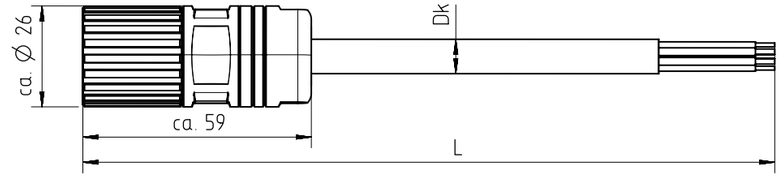


Table 4.3.36

Connector motor side (A side)	PIN A side	Signal	Colour B side	Version B side
	1	Up = 7-12 V	bn/rd	flying leads
	2	GND	bn/bu	
	3	Sin+	ye	
	4	Refsin	gn	
	5	Data+	og	
	6	Data-	rd	
	7	Cos+	bn	
	8	Refcos	bk	
	9	Temp+	gy	
	10	Temp-	bu	
	11	-	-	
	12	-	-	
M23 Connector / 12-pole, Version female Screw connection Speedtec, TE-Intercontec 623 Series	Housing	Shield	-	

Table 4.3.37

Technical data	AFC2-H-12M23-B-xxx-00
Temperature range in drag chain	-25 °C ... +80 °C
Temperature range motionless	-50 °C ... +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	50 V
Environmental compatibility	RoHS-conform, halogen free, silicone free, CFC-free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	in accordance with DIN EN 50363-10-2, Class 3
Drag chain capable	yes
Diameter cable (Dk)	10.5 mm
Diameter connector A side	26 mm
Min. bending radius fixed installation	5 x Dk
Min. bending radius for flexible installation	12.5 x Dk
Maximum acceleration	30 m/s²
Number of bending cycles	5.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 20233, 300 V, 80 °C
Cable weight	124 g/m

Table 4.3.38

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-H-12M23-B-030-00	3 m	1052174
AFC2-H-12M23-B-050-00	5 m	1052175
AFC2-H-12M23-B-100-00	10 m	1052176
AFC2-H-12M23-B-150-00	15 m	1052177

Cable AFC2-H-12M23-A-xxx-0x

Encoder cable HIPERFACE®: Suitable for HIPERFACE® encoders on actuators with type A connectors (Phoenix series RF); e.g. CanisDrive® or LynxDrive. This HIPERFACE® encoder cable is available in three versions: 00: with open wires on the controller side, 01: with straight D-Sub connector on the controller side for YukonDrive, 02: with 45° angled D-Sub connector on the controller side for YukonDrive.

Compatible with the following encoders: MIH, SIH, MHH, SHH (CanisDrive® Series) and MGH (LynxDrive Series)

Illustration 4.3.12

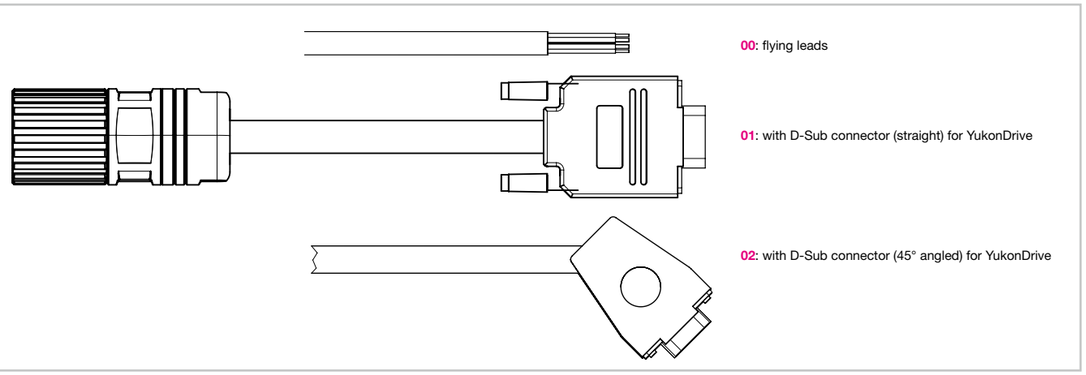


Table 4.3.39

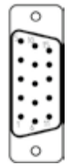
Connector motor side (A side)	Pin A side	Signal	Pin B side -01 / -02	Colour B side -00	Version B side
	1	Up = 7-12 V	3	bn/rd	
	2	GND	8	bn/bu	
	3	Sin+	11	ye	
	4	Refsin	6	gn	
	5	Data+	4	og	
	6	Data-	5	rd	
	7	Cos+	2	bn	
	8	Refcos	1	bk	
	9	Temp+	10	gy	
	10	Temp-	9	bu	
	11	-	-	-	
	12	-	-	-	
M23 Connector / 12-pole, Version female, Phoenix Serie RF	Housing	Shield	Housing	-	D-Sub-Connector Version male or flying leads

Table 4.3.40

Technical data	AFC2-H-12M23-A-xxx-0x
Temperature range in drag chain	-25 °C ... +80 °C
Temperature range motionless	-50 °C ... +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	50 V
Environmental compatibility	RoHS-conform, halogen free, silicone free CFC-free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	in accordance with DIN EN 50363-10-2, Class 3
Drag chain capable	yes
Diameter cable (Dk)	10.5 mm
Diameter connector A side	26 mm
Min. bending radius fixed installation	5 x Dk
Min. bending radius for flexible installation	12.5 x Dk
Maximum acceleration	30 m/s²
Number of bending cycles	5.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 10467 and 20233, 300 V, 80 °C
Cable weight	124 g/m

Table 4.3.41

Ordering code with flying leads on the controller side	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-H-12M23-A-030-00	3 m	1052178
AFC2-H-12M23-A-050-00	5 m	1052179
AFC2-H-12M23-A-100-00	10 m	1052180
AFC2-H-12M23-A-150-00	15 m	1052181

Table 4.3.42

Ordering code with straight connector	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-H-12M23-A-030-01	3 m	1052182
AFC2-H-12M23-A-050-01	5 m	1052183
AFC2-H-12M23-A-100-01	10 m	1052184
AFC2-H-12M23-A-150-01	15 m	1052185

Table 4.3.43

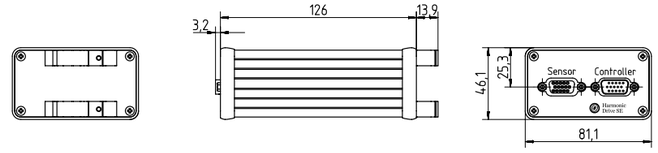
Ordering code with angled connector 45°	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-H-12M23-A-030-02	3 m	1052186
AFC2-H-12M23-A-050-02	5 m	1052187
AFC2-H-12M23-A-100-02	10 m	1052188
AFC2-H-12M23-A-150-02	15 m	1052189

Connection cable for the battery box

For the operation of the fully digital multi-turn encoders of the type MZE (EnDat), the connection to the battery box is required. This supplies the encoder with voltage when it is switched off and thus ensures that the absolute position is maintained.

Illustration 4.3.13

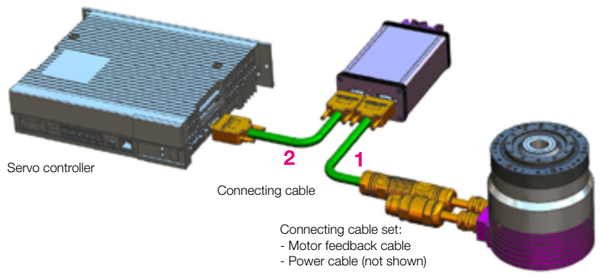
Dimensions



Mounting: DIN mounting rail 35 mm

Illustration 4.3.14

Wiring motor feedback



1. Connection cable for CanisDrive®: **AFC2-BE-17M23-A-xxx-01**
   Connection cable for FHA-C Mini: **AFC2-BE-12STC-B-xxx-01**
2. Connection cable battery box to controller: **AFC2-BE-15DS3-xxx-0x**

Cable AFC2-BE-17M23-A-xxx-01

Encoder cable EnDat with external battery box: Suitable for EnDat encoder fully digital on actuators with type A (Phoenix) connectors. Connecting cable from CanisDrive® to battery box.

Compatible with the following encoders: MZE (CanisDrive® Series)

Illustration 4.3.15

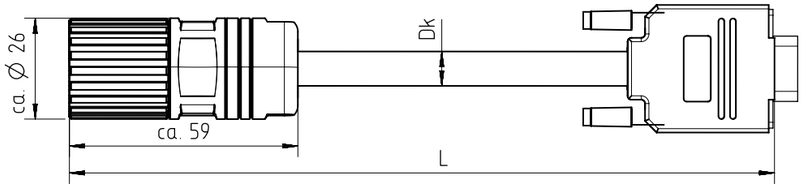


Table 4.3.44

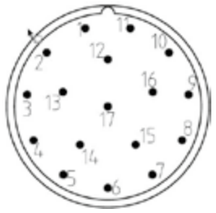
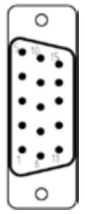
Connector motor side (A side)	PIN A side	Signal EnDat	Pin B side	Version B side
	1	-	-	
	2	-	-	
	3	Data+	4	
	4	Ubat+	7	
	5	Clock+	14	
	6	Ubat-	8	
	7	GND	8	
	8	Temp+	10	
	9	Temp-	9	
	10	Ub	3	
	11	-	-	
	12	-	-	
	13	Data-	5	
	14	Clock-	15	
	15	Sense-	13	
	16	Sense+	12	
	17	InnenShield	1	
	Housing	Shield	Housing	
M23 Connector / 17-pole, Version female, Phoenix-Serie RF				D-Sub High Density Version pin

Table 4.3.45

Technical data	AFC2-BE-17M23-A-xxx-01
Temperature range in drag chain	-30 °C bis +80 °C
Temperature range motionless	-40 °C bis +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	30 V
Environmental compatibility	RoHS-conform, halogen free, silicone free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	oil, hydrolysis and microbe resistant
Drag chain capable	yes
Diameter cable (Dk)	8.9 mm
Diameter connector A side	26 mm
Min. bending radius fixed installation	6 x Dk
Min. bending radius for flexible installation	10 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	11.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 20233 and 20236, 300 V, 80 °C
Cable weight	120 g/m

Table 4.3.46

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-BE-17M23-A-030-01	3 m	1052190
AFC2-BE-17M23-A-050-01	5 m	1052191
AFC2-BE-17M23-A-100-01	10 m	1052192
AFC2-BE-17M23-A-150-01	15 m	1052193

Cable AFC2-BE-12STC-B-xxx-01

Encoder cable EnDat with external battery box: Suitable for EnDat encoder fully digital on actuators with type B connectors (Spring-Tec from TE). Connecting cable from FHA-C Mini to battery box.

Compatible with the following encoders: MZE (FHA-C Mini Series)

Illustration 4.3.16

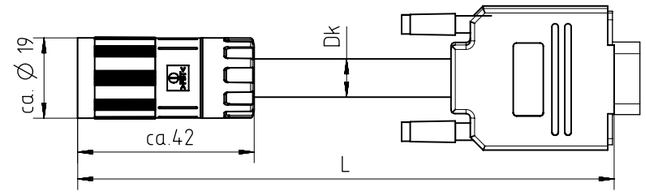


Table 4.3.47

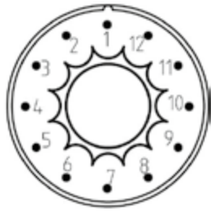
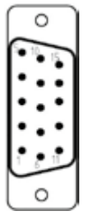
Connector motor side (A side)	Pin A side	Signal EnDat	Pin B side	Version B side
	1	Ub	3	
	2	Data+	4	
	3	Data-	5	
	4	Clock+	14	
	5	Clock-	15	
	6	Ubat-	8	
	7	GND	8	
	8	-	-	
	9	-	-	
	10	-	-	
	11	-	-	
	12	Ubat+	7	
	Housing	Shield	Housing	
Spring-Tec Connector / 12-pole, Version female, TE-Intercontec				D-Sub High Density Version pin

Table 4.3.48

Technical data	AFC2-BE-12STC-B-xxx-01
Temperature range in drag chain	-30 °C bis +80 °C
Temperature range motionless	-40 °C bis +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	30 V
Environmental compatibility	RoHS-conform, halogen free, silicone free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	oil, hydrolysis and microbe resistant
Drag chain capable	yes
Diameter cable (Dk)	8.9 mm
Diameter connector A side	19 mm
Min. bending radius fixed installation	6 x Dk
Min. bending radius for flexible installation	10 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	11.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 20233 and 20236, 300 V, 80 °C
Cable weight	120 g/m

Table 4.3.49

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-BE-12STC-B-030-01	3 m	1052194
AFC2-BE-12STC-B-050-01	5 m	1052195
AFC2-BE-12STC-B-100-01	10 m	1052196
AFC2-BE-12STC-B-150-01	15 m	1052197

Cable AFC2-BE-15DS3-X-xxx-0x

Encoder cable EnDat fully digital for connecting battery box and servo controller. Lengths 0.5 m, 1 m, 2 m;
Assembled on the battery side with D-SUB connector.
Controller side without assembly = flying leads: **Ordering code AFC2-BE-15DS3-xxx-00**
Controller side assembled with D-SUB connector for YukonDrive: **Ordering code AFC2-BE-15DS3-xxx-01**

Compatible with the following encoders: MZE

Illustration 4.3.17

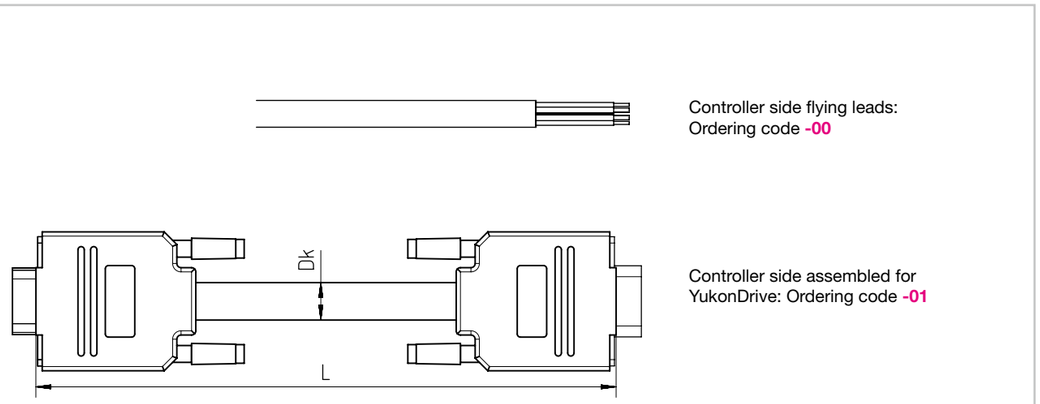


Table 4.3.50

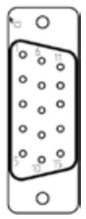
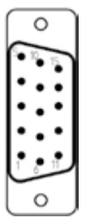
Connector motor side (A side)	Pin A side	Signal EnDat	Pin B side -01	Colour B side -00	Version B side
	1	Inner Shield	1	-	
	2	-	2	-	
	3	Ub	3	bn/rd (0.5 mm²)	
	4	Data+	4	gn	
	5	Data-	5	ye	
	6	-	6	-	
	7	-	7	-	
	8	GND	8	bn/bu (0.5 mm²)	
	9	Temp-	9	bu	
	10	Temp+	10	gy	
	11	-	11	-	
	12	Sense+	12	wh/ye	
	13	Sense-	13	wh/bk	
	14	Clock+	14	rd	
D-Sub High Density, Version female	15	Clock-	15	og	D-Sub High Density Version pin or flying leads
	Housing	Shield	Shield	-	

Table 4.3.51

Technical data	AFC2-BE-15DS3-X-xxx-0x
Temperature range in drag chain	-30 °C bis +80 °C
Temperature range motionless	-40 °C bis +80 °C
Protection class	IP20
Rated voltage	30 V
Environmental compatibility	RoHS-conform, halogen free, silicone free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	oil, hydrolysis and microbe resistant
Drag chain capable	yes
Diameter cable (Dk)	8.9 mm
Min. bending radius fixed installation	6 x Dk
Min. bending radius for flexible installation	10 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	11.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 20233 and 20236, 300 V, 80 °C
Cable weight	120 g/m

Table 4.3.52

Ordering code with flying leads on the controller side	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-BE-15DS3-X-005-00	0.5 m	1052213
AFC2-BE-15DS3-X-010-00	1 m	1052214
AFC2-BE-15DS3-X-020-00	2 m	1052215

Table 4.3.53

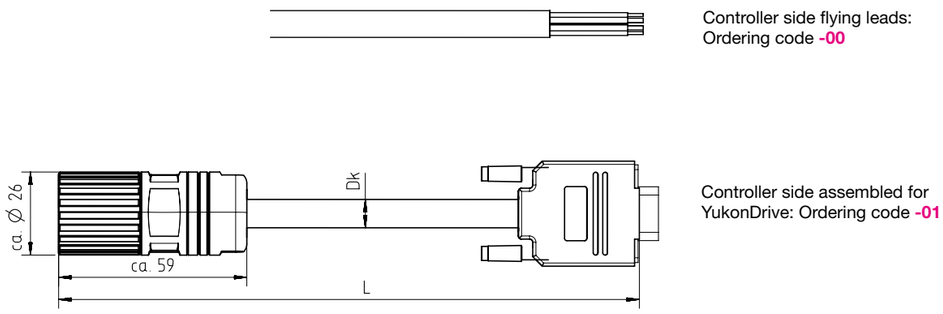
Ordering code with straight connector on the controller side	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-BE-15DS3-X-005-01	0.5 m	1052216
AFC2-BE-15DS3-X-010-01	1 m	1052217
AFC2-BE-15DS3-X-020-01	2 m	1052218

Cable AFC2-F-17M23-A-xxx-0x

Encoder cable FlexFeedback: Suitable for EnDat or SSI encoders with SinCos tracks, sense and temp leads on actuators with type A connectors (Phoenix RF Series); e.g. CanisDrive® or LynxDrive.
This encoder cable is available in two versions:
-00: With flying leads on the controller side
-01: Controller side with straight outgoing D-Sub connector for YukonDrive

Compatible with the following encoders:
SIE (CanisDrive-20 … 40 Series)
SZE (CanisDrive-20 … 58 Series)
MGSi (CanisDrive-14 … 20 Series in 560 V-Version)
MEE, MKE (LynxDrive Series)

Illustration 4.3.18



Controller side flying leads:
Ordering code **-00**

Controller side assembled for
YukonDrive: Ordering code **-01**

Table 4.3.54

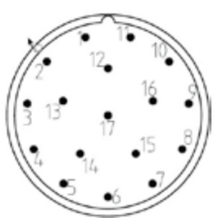
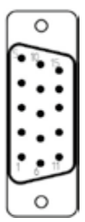
Connector motor side (A side)	Pin A side	Signal EnDat / SSI	Pin B side -01	Colour B side -00	Version B side
	1	Cos+/A+	2	bn	
	2	Cos-/A-	1	bk	
	3	Data+	4	og	
	4	-	-	-	
	5	Clock+	14	gy	
	6	-	-	-	
	7	GND	8	bn/bu	
	8	Temp+	10	gn/bk	
	9	Temp-	9	gn/rd	
	10	Up	3	bn/rd	
	11	Sin+/B+	11	ye	
	12	Sin-/B-	6	gn	
	13	Data-	5	rd	
	14	Clock-	15	bu	
	15	Sense-	13	ye/bn	
	16	Sense+	12	gn/bn	
	17	-	-	-	
Connector M23 / 17-pole, Version female, Phoenix-Serie RF	Housing	Shield	Shield	-	D-Sub High Density Version male or flying leads

Table 4.3.55

Technical data	AFC2-F-17M23-A-xxx-0x
Temperature range in drag chain	-25 °C bis +80 °C
Temperature range motionless	-50 °C bis +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	50 V
Environmental compatibility	RoHS-conform, halogen free, silicone free, CFC-free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	in accordance with DIN EN 50363-10-2, Class 3
Drag chain capable	yes
Diameter cable (Dk)	12 mm
Diameter connector A side	26 mm
Min. bending radius fixed installation	4 x Dk
Min. bending radius for flexible installation	10 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	5.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 20233, 300 V, 80 °C
Cable weight	192 g/m

Table 4.3.56

Ordering code with flying leads on the controller side	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-F-17M23-A-030-00	3 m	1052250
AFC2-F-17M23-A-050-00	5 m	1052251
AFC2-F-17M23-A-100-00	10 m	1052252
AFC2-F-17M23-A-150-00	15 m	1052253

Table 4.3.57

Ordering code with straight connector on the controller side	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-F-17M23-A-030-01	3 m	1052254
AFC2-F-17M23-A-050-01	5 m	1052255
AFC2-F-17M23-A-100-01	10 m	1052256
AFC2-F-17M23-A-150-01	15 m	1052257

Cable AFC2-F-17M17-A-xxx-00

Encoder cable FlexFeedback: Suitable for EnDat or SSI encoders with SinCos tracks, Sense and Temp strands on actuators with type A connectors (Phoenix ST Series); e.g. CanisDrive® in 48 V version

Compatible with the following encoders: MGSi (CanisDrive® Series in the 48 V version)

Illustration 4.3.19

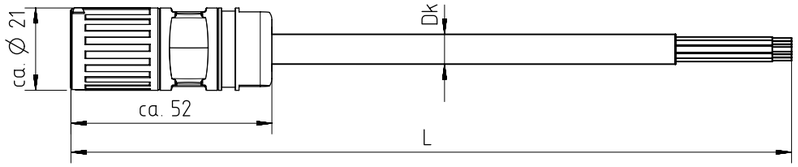


Table 4.3.58

Connector motor side (A side)	PIN A side	Signal EnDat / SSI	Colour B side	Version B side
	1	Cos+/A+	bn	flying leads
	2	Cos-/A-	bk	
	3	Data+	og	
	4	-	-	
	5	Clock+	gy	
	6	-	-	
	7	GND	bn/bu	
	8	Temp+	gn/bk	
	9	Temp-	gn/rd	
	10	Up	bn/rd	
	11	Sin+/B+	ye	
	12	Sin-/B-	gn	
	13	Data-	rd	
	14	Clock-	bu	
	15	Sense-	ye/bn	
	16	Sense+	gn/bn	
	17	-	-	
Connector M17 / 17-pole, Version female, Phoenix ST Series	Housing	Shield	-	

Table 4.3.59

Technical data	AFC2-F-17M17-A-xxx-00
Temperature range in drag chain	-25 °C ... +80 °C
Temperature range motionless	-50 °C ... +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	50 V
Environmental compatibility	RoHS-conform, halogen free, silicone free, CFC-free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	in accordance with DIN EN 50363-10-2, Class 3
Drag chain capable	yes
Diameter cable (Dk)	12 mm
Diameter connector A side	26 mm
Min. bending radius fixed installation	4 x Dk
Min. bending radius for flexible installation	10 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	5.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 20233, 300 V, 80 °C
Cable weight	192 g/m

Table 4.3.60

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-F-17M17-A-030-00	3 m	1052258
AFC2-F-17M17-A-050-00	5 m	1052259
AFC2-F-17M17-A-100-00	10 m	1052260
AFC2-F-17M17-A-150-00	15 m	1052261

Cable AFC2-T-17M17-A-xxx-00

Incremental encoder cable: Suitable for incremental encoders on actuators with type A connectors (Phoenix ST Series); e.g. CanisDrive® in 48 V version and 560 V version up to size 20.

Compatible with the following encoders: DCO (CanisDrive-14 ... 20 Series)

Illustration 4.3.20

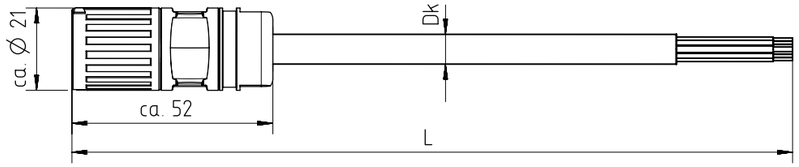


Table 4.3.61

Connector motor side (A side)	PIN A side	Signal	Colour B side	Version B side
	1	U+	bn/gy	flying leads
	2	U-	bn/ye	
	3	V+	bu	
	4	V-	gy	
	5	W+	wh/bk	
	6	W-	wh/ye	
	7	GND	bn/bu (0.5 mm²)	
	8	+5V	bn/rd (0.5 mm²)	
	9	Z+ (Index+)	rd	
	10	Z- (Index-)	og	
	11	A+	ye	
	12	A-	gn	
	13	B+	bk	
	14	B-	bn	
	15	Temp+	gn/bk	
	16	Temp-	gn/rd	
	17	-	-	
Connector M17 / 17-pole, Version female, Phoenix ST Series	Housing	Shield	-	

Table 4.3.62

Technical data	AFC2-T-17M17-A-xxx-00
Temperature range in drag chain	-30 °C ... +80 °C
Temperature range motionless	-40 °C ... +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	30 V
Environmental compatibility	RoHS-conform, halogen free, silicone free and cadmium free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	oil, hydrolysis and microbe resistant
Drag chain capable	yes
Diameter cable (Dk)	9.6 mm
Diameter connector A side	21 mm
Min. bending radius fixed installation	6 x Dk
Min. bending radius for flexible installation	10 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	11.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 20233 and 20236, 300 V, 80 °C
Cable weight	138 g/m

Table 4.3.63

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-T-17M17-A-030-00	3 m	1052262
AFC2-T-17M17-A-050-00	5 m	1052263
AFC2-T-17M17-A-100-00	10 m	1052264
AFC2-T-17M17-A-150-00	15 m	1052265

Cable AFC2-S-17M23-A-xxx-00

SinCos encoder cable: Suitable for incremental sine/cosine encoders with commutation signals and reference signal at actuators with type A connectors (Phoenix ST Series); e.g. LynxDrive.

Compatible with the following encoders: CCO (LynxDrive Series)

Illustration 4.3.21

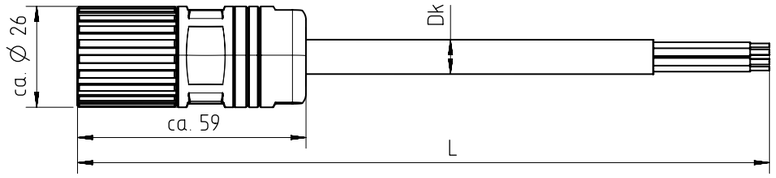


Table 4.3.64

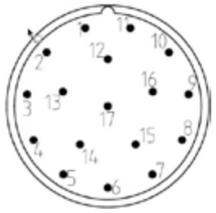
Connector motor side (A side)	PIN A side	Signal	Colour B side	Version B side
	1	A+	ye	flying leads
	2	A-	gn	
	3	R+	rd	
	4	D-	wh/ye	
	5	C+	bu	
	6	C-	gy	
	7	GND	bn/bu (0.5 mm²)	
	8	Temp+	gn/bk	
	9	Temp-	gn/rd	
	10	Ub 5V	bn/rd (0.5 mm²)	
	11	B+	bk	
	12	B-	bn	
	13	R-	og	
	14	D+	wh/bk	
	15	Sense-	bn/ye	
	16	Sense+	bn/gy	
	17	-	-	
Connector M23 / 17-pole, Version female, Phoenix ST Series	Housing	Shield	-	

Table 4.3.65

Technical data	AFC2-S-17M23-A-xxx-00
Temperature range in drag chain	-30 °C bis +80 °C
Temperature range motionless	-40 °C bis +80 °C
Protection class	plugged IP66 (Connector A side)
Rated voltage	30 V
Environmental compatibility	RoHS-conform, halogen free, silicone free and cadmium free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	oil, hydrolysis and microbe resistant
Drag chain capable	yes
Diameter cable (Dk)	9.6 mm
Diameter connector A side	21 mm
Min. bending radius fixed installation	6 x Dk
Min. bending radius for flexible installation	10 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	11.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 20233 and 20236
Cable weight	138 g/m

Table 4.3.66

Ordering code	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-T-17M23-A-030-00	3 m	1052266
AFC2-T-17M23-A-050-00	5 m	1052267
AFC2-T-17M23-A-100-00	10 m	1052268
AFC2-T-17M23-A-150-00	15 m	1052269

Cable AFC2-R-12M23-A-xxx-0x

Encoder cable resolver: Suitable for resolvers on actuators with type A connectors (Phoenix series ST); e.g. LynxDrive. This resolver cable is available in two variants: **-00**: with flying leads on the controller side, **-01**: with straight outgoing D-Sub connector on the controller side, assembled for YukonDrive.

Compatible with the following encoders: ROO (LynxDrive Series)

Illustration 4.3.22

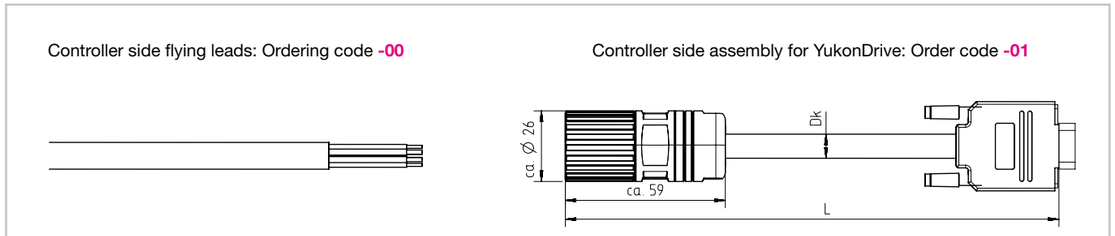


Table 4.3.67

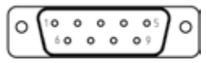
Connector motor side (A side)	Pin A side	Signal	Pin B side -01	Colour B side -00	Version B side
	1	Sin+ (S2)	1	ye	
	2	Sin- (S4)	2	gn	
	3	-	-	bn/bu (0.5 mm²)	
	4	-	-	bn/rd (0.5 mm²)	
	5	-	-	bu	
	6	-	-	gy	
	7	VSS- (R2)	7	og	
	8	Temp+	5	wh/ye	
	9	Temp-	9	wh/bk	
	10	VSS+ (R1)	6	rd	
	11	Cos+ (S1)	3	bk	
	12	Cos- (S3)	8	gn	
Connector M23 / 12-pole, Version female, Phoenix ST Series	Housing	Shield	Shield	-	D-Sub High Density Version male or flying leads

Table 4.3.68

Technical data	AFC2-R-12M23-A-xxx-0x
Temperature range in drag chain	-30 °C bis +80 °C
Temperature range motionless	-40 °C bis +80 °C
Protection class	IP20
Rated voltage	30V
Environmental compatibility	RoHS-conform, halogen free, silicone free
Flame retardant	according to IEC 60332-1-2
Material of cable sheath	PUR
Oil resistance cable sheath	oil, hydrolysis and microbe resistant
Drag chain capable	yes
Diameter cable (Dk)	8.9 mm
Min. bending radius fixed installation	6 x Dk
Min. bending radius for flexible installation	10 x Dk
Maximum acceleration	50 m/s²
Number of bending cycles	11.000.000
Torsion	no torsion permissible
Approvals	CE; UL/CSA AWM Style 20233 and 20236, 300 V, 80 °C
Cable weight	120 g/m

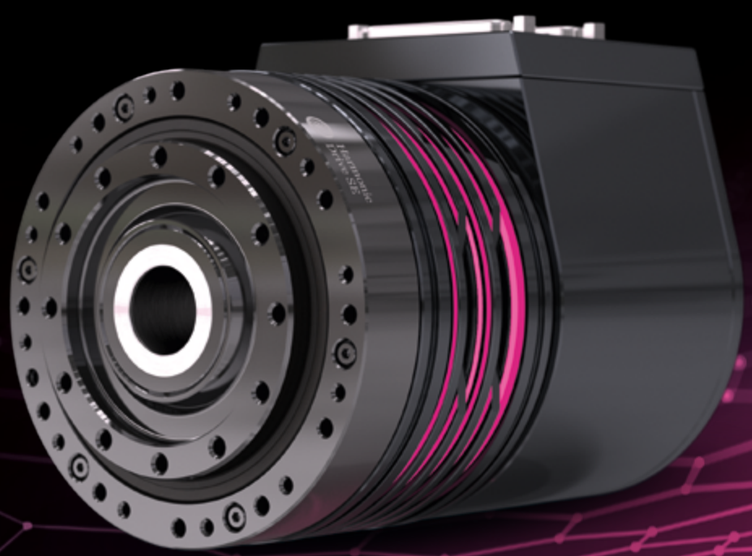
Table 4.3.69

Ordering code with flying leads on the controller side	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-R-12M23-A-030-00	3 m	1052272
AFC2-R-12M23-A-050-00	5 m	1052274
AFC2-R-12M23-A-100-00	10 m	1052275
AFC2-R-12M23-A-150-00	15 m	1052276

Table 4.3.70

Ordering code with straight connector on the controller side	Length (L) Tolerance: +0.1 m / -0	Material number
AFC2-R-12M23-A-030-01	3 m	1052277
AFC2-R-12M23-A-050-01	5 m	1052278
AFC2-R-12M23-A-100-01	10 m	1052279
AFC2-R-12M23-A-150-01	15 m	1052280

Engineering data Harmonic Drive® Servo Actuators



$$n_{in\ av} = i \cdot n_{out\ av}$$

Content

General

Notes for the user

At the beginning of the engineering process of your drive project with Harmonic Drive® Products we would like to point out general technical boundary conditions and special safety instructions as well as give recommendations for the design. You will also find a glossary explaining the technical parameters of our products.

This documentation is intended for planners and project engineers of the machine manufacturers. It can assist in the selection and calculation of gears, servo actuators and systems as well as accessories.

Notes on storage

Please keep this document for the entire life of the product, up to its disposal. Please hand over the documentation when reselling the product.

Additional documentation

Engineering data documentation for our drive systems will also be required. Harmonic Drive SE provides the complete documentation for its products on its website in PDF format.

www.harmonicdrive.co.uk

Third party systems

Documentation for parts supplied by third party suppliers, associated with Harmonic Drive® Components, is not included in our standard documentation and should be requested directly from these manufacturers.

Before commissioning servo actuators and servo motors from Harmonic Drive SE with servo drives, we advise you to obtain the relevant documents for each device.

Safety Instructions

Please take note of the information and instructions in this document. Customised products may differ in technical detail. If in doubt, we recommend to contact the manufacturer, giving the type designation and serial number for clarification.

- Description of safety warning symbols

Table 5.1

Symbol	Explanation
DANGER	Indicates an imminent hazardous situation. If this is not avoided, death or serious injury could occur.
WARNING	Indicates a possible hazard. Care should be taken or death or serious injury may result.
ATTENTION	Indicates a possible hazard. Care should be taken or slight or minor injury may result.
INFO	This is not a safety symbol. This symbol indicates important information.
	Warning of a general hazard. The type of hazard is determined by the specific warning text.
	Warning of dangerous electrical voltage and its effects.
	Warning of hot surfaces.
	Warning of suspended loads.
	Precautions when handling electrostatic sensitive components.
	Warning of electromagnetic environmental compatibility.
	Warning of magnetic field.
	Risk of crushing and hand injuries.
	Warning of cutting danger.
	Chemical danger

- Danger

⚠ DANGER

Electric servo actuators and motors have dangerous live and rotating parts. All work during connection, operation, repair and disposal must be carried out by qualified personnel as described in the standards EN 50110-1 and IEC 60364! Before starting any work, and especially before opening covers, the actuator must be properly isolated. In addition to the main circuits, the user also has to pay attention to any auxilliary power supply circuits.

Observing the five safety rules:

- Disconnect mains
- Prevent reconnection
- Test for absence of harmful voltages
- Ground and short circuit
- Cover or close off nearby live parts

The measures taken above must only be withdrawn when the work has been completed and the device is fully assembled. Improper handling can cause damage to persons and property. The respective national, local and factory specific regulations must be adhered to.

⚠ ATTENTION

The surface temperature of products exceed 55 °C. The hot surfaces should not be touched.

Cables must not come into direct contact with hot surfaces.

⚠ DANGER

Electric, magnetic and electromagnetic fields are dangerous, in particular for persons with heart pacemaker, implants or similiar. Vulnerable individuals must not be in the close proximity of the product.

⚠ DANGER

Actuators in motion can cause severe hand injuries and lead to risk of crushing.

⚠ DANGER

Built in holding brakes are not functionally safe by themselves, particularly with unsupported vertical axes. Functional safety can only be achieved with additional, external mechanical brakes.

⚠ ATTENTION

Use suitable lifting equipment to move and lift products with a weight > 20 kg.

⚠ DANGER

Risk of injury due to improper handling of batteries.

Observing the battery safety rules:

- do not insert batteries in reverse. Observe the + and - marks on the battery and on the electrical device
- do not short circuit
- do not recharge
- do not force open or damage
- do not expose to fire, water or high temperature
- remove and discard exhausted batteries from the electrical device immediately
- keep batteries out of reach of children. If swallowed, seek medical assistance immediately

⚠ ATTENTION

Strong attraction/repulsion forces occur in the immediate vicinity of the ring magnet of the BHK motor kits. This can lead to uncontrolled movements. This can result in pinching, crushing and shearing injuries as well as damage to the rotor.

⚠ ATTENTION

It may be necessary to use cleaning agents and adhesives during the assembly process of the BHK motor kits. The safety instructions in the safety data sheets for the cleaning agent or adhesive used must be observed.

⚠ ATTENTION

The stators of the BHK motor kits are molded. Due to the shrinkage of the potting material during hardening, sharp edges may occur. To avoid cuts, please wear protective gloves when working on the stators.

⚠ WARNING

The successful and safe operation of products requires proper transport, storage and assembly as well as correct operation and maintenance.

Injury caused by moving or ejected parts:

Contact with moving parts or output elements and the ejection of loose parts (e.g. feather keys) out of the motor enclosure can result in severe injury or death.

- Remove or carefully secure any loose parts
- Do not touch any moving parts
- Protect against all moving parts using the appropriate safety guards

Unexpected movement of machines caused by inactive safety instructions:

Inactive or non adapted safety functions can trigger unexpected machine movements that may result in serious injury or death.

- Observe the information in the appropriate product documentation before commissioning
- Carry out a safety inspection for functions relevant to safety on the entire system, including all safety related components
- Make sure the safety functions relevant to your product are applied
- Perform regular function tests
- Only use the system productively after having correctly executed the safety relevant functions

INFO

Special versions of products may differ in the specification from the standard. Further applicable data from data sheets, catalogues and offers of the special version have to be considered.

• Intended use

Harmonic Drive® Products are intended for industrial or commercial applications.

Typical areas of application are robotics and handling, machine tools, semiconductor, medical equipment, wood working machines, mobile systems, packaging and food machines and similar machines.

The products may only be operated within the operating ranges and environmental conditions shown in the documentation (altitude, degree of protection, temperature range, etc).

Before commissioning of systems and machines including Harmonic Drive® Products, compliance with the Machinery Directive must be established.

• Improper use

The use of products outside the areas of application mentioned above or beyond the operating areas or environmental conditions described in the documentation is considered as improper use.

If unsuitable products are installed or used in safety-relevant applications, unintended operating states can occur in the application that can cause personal injury and/or material damage. The product may only be used in safety-relevant applications if this use is expressly specified in the product documentation. Harmonic Drive SE accepts no liability for damage caused by improper use. The risks associated with improper use lie solely with the user.

• Use in special application areas

The use of the products in one of the following application areas requires a risk assessment and approval by Harmonic Drive SE.

- Aerospace
- Areas at risk of explosion
- Machines specially constructed or used for a nuclear purpose whose breakdown might lead to the emission of radio activity
- Vacuum
- Household devices
- Medical equipment
- Devices which interact directly with the human body
- Machines or equipment for transporting or lifting people
- Special devices for use in fairgrounds or amusement parks

Declaration of conformity

• Servo actuators

The Harmonic Drive® Servo Actuators described here in comply with the Low Voltage Directive.
In accordance with the Machinery Directive, Harmonic Drive® Servo Actuators are electrical equipment for the use within certain voltage limits as covered by the Low Voltage Directive and thus excluded from the scope of the Machinery Directive. Commissioning is prohibited until the final product conforms to the Machinery Directive.

According to the EMC directive Harmonic Drive® Servo Actuators are inherently benign equipment, unable to generate electromagnetic disturbance or to be affected by such disturbance.

The conformity to the EU directives of equipment, plant and machinery in which Harmonic Drive® Servo Actuators are installed must be provided by the user before taking the device into operation.

Equipment, plant and machinery with inverter driven motors must satisfy the protection requirements of the EMC directive. It is the responsibility of the user to ensure that the installation is carried out correctly.

• Integrated systems

According to the Machinery Directive, Harmonic Drive® Integrated Systems are partly completed machinery. The necessary documents (e.g. Declaration of Incorporation) are available on request. The integrated systems also conform to the EMC Directive.

Conformity with the applicable EU directives of equipment, installations and machinery in which Harmonic Drive® Integrated Systems are installed must be established by the user before commissioning.

Labelling, Guidelines and Regulations

• CE-Marking

With the CE marking, the manufacturer or EU importer declares in accordance with EU regulation, that the product meets the applicable requirements of the EU harmonization legislation.

• RoHS EU Directive

The RoHS EU Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

• Classification of Harmonic Drive® Mechatronic Products in the applicable directives and regulations

Table 5.2

Actuator Series	Winding type (DC link voltage)	Directive					
		RoHS 2011/65/EU	REACH 1907/2006/EG	Low voltage 2014/35/EU	EMC 2014/30/EU	Machine 2006/42/EG	Electrical Safety (USA) UL-1004-1/6
IHD	48 V	o	o	-	● 1)	●	-
BHA	560 V	o	o	●	-	-	● 3)
BHA	48 V	o	o	-	-	-	-
CanisDrive®	560/100 V	o	o	●	-	-	● 2)
FHA-C Mini	320 V	o	o	●	-	-	-
FHA-C Mini	48 V	o	o	-	-	-	●
AlopexDrive	48/100 V	depending on the product configuration and the technical requirements					-
LynxDrive	560 V	o	o	●	-	-	● 3)
FLA	48 V	o	o	-	-	-	-

● available o on request - not available

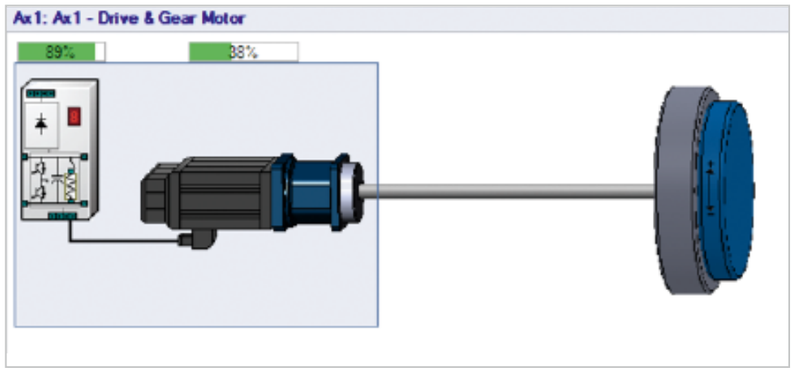
1) The operating modes digital command via the fieldbus interfaces were tested.
2) Only feasible for sizes 20 ... 40
3) In preparation
● Declaration of conformity available
o An EU conformity check is available on request.
As a rule, only RoHS- and REACH-compliant materials and components are used in the standard products.

Actuator dimensioning

• Actuator 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.

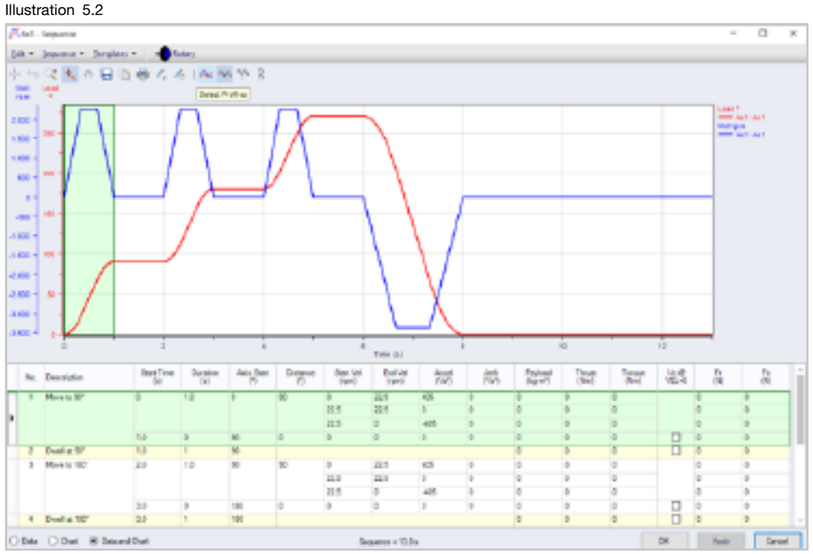
Illustration 5.1



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, if 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.

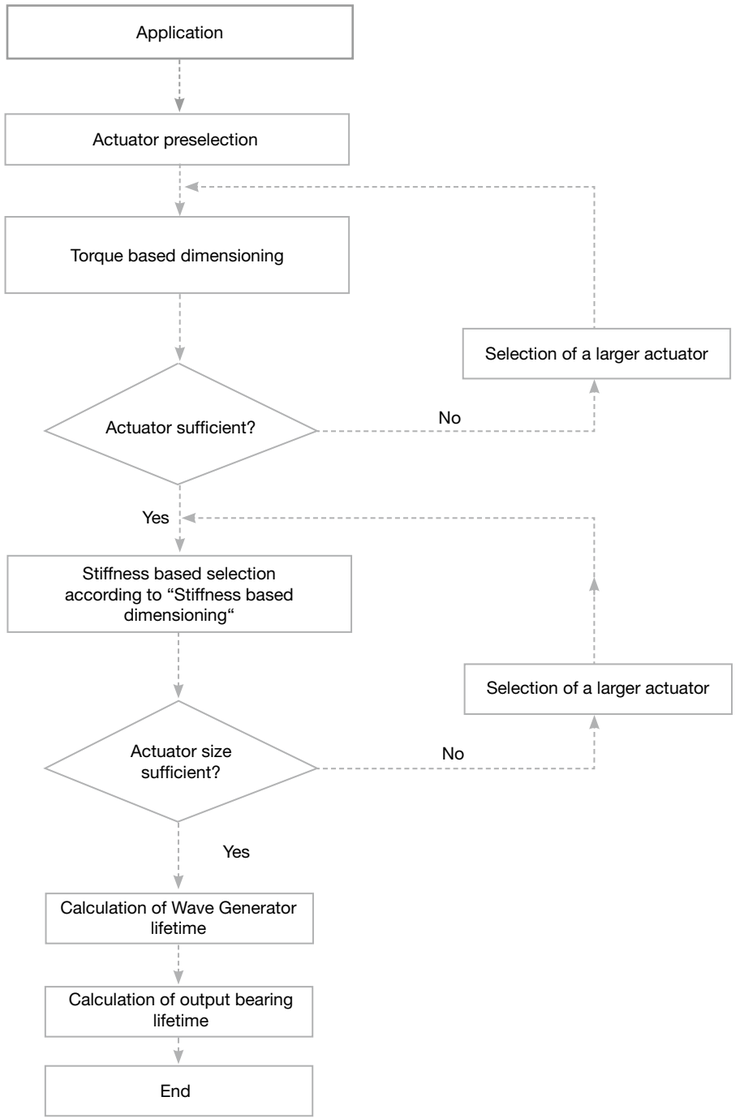
On request, you will receive a detailed list of all calculation results as well as the parts list of the selected drive components for your application.

Illustration 5.2



• Dimensioning diagram

In principle, both torque and stiffness requirements should be taken into account in the design. For example, in robotics applications, the required torques are more decisive for the gear size, but the torsional stiffness necessary for the process is often decisive in machine tool constructions. In addition, both the service life and the static safety should be calculated for the output bearings. We therefore recommend that the design is carried out according to the following diagram.



We will be glad to support you with your design. Please contact our sales department.

- Torque based dimensioning

Checking the permissible loads

Table 5.3

Application load data		
Torque (Stage 1 ... n)	$T_1 ... T_n$	[Nm]
Duty time (Stage 1 ... n)	$t_1 ... t_n$	[s]
Operating cycle	t_o	[s]
Idle time	t_p	[s]
Load torque (i. e. friction)	T_L	[Nm]
Load speed	n_2	[rpm]
Load moment of inertia	J_L	[kgm²]
Required lifetime Wave Generator bearing	$L_{10requi.}$	[h]

Table 5.4

Key figures of the actuator		
Maximum torque	T_{max}	[Nm]
Maximum speed	n_{max}	[rpm]
Moment of inertia	J_{out}	[kgm²]

Equation 5.1

Preselection of the servo actuator based on the load data

$n_2 \leq n_{max}$

$J_L \leq K \cdot J_{out}$

$K \leq 3$ for dynamic applications

$K > 3 ... \leq 10$ for less dynamic applications

K: Ratio of the moment of inertia of the load to the moment of inertia of the actuator.

Equation 5.2

Checking the permissible maximum torque

$T_1 \leq T_{max}$

Illustration 5.4

Review T_{rms} / n_{av} within the performance curve for continuous operation, review T_1 / n_2 within the performance curve for intermittent operation

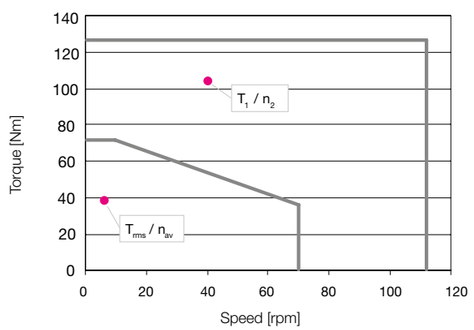
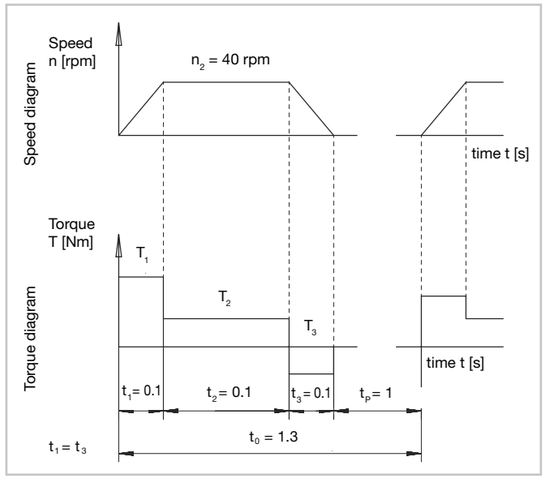


Illustration 5.3



Validation of the speed cycle using the load curve and preselection of the servo actuator

Equation 5.3

Calculation of the acceleration torque

$$T_1 = T_L + \frac{2\pi}{60} \cdot \frac{(J_{out} + J_L) \cdot n_2}{t_1}$$

Note: For servo actuators, the actuator moment of inertia must also be taken into account.

Equation 5.4

Calculation of the rms torque

$$T_{rms} = \sqrt[2]{\frac{T_1^2 \cdot t_1 \cdot T_2^2 \cdot t_2 + \cdots + T_n^2 \cdot t_n}{t_1 + t_2 + \cdots + t_n + t_p}}$$

Equation 5.5

Calculation of the average speed

$$n_{av} = \frac{|n_1| \cdot t_1 + |n_2| \cdot t_2 + \ldots + |n_n| \cdot t_n}{t_1 + t_2 + \ldots + t_n + t_p}$$

Equation 5.6

Calculation of the duty cycle

$$ED = \frac{t_1 + t_2 + \ldots + t_n}{t_1 + t_2 + \ldots + t_n + t_p} \cdot 100\%$$

Equation 5.7

Checking the lifetime of the Wave Generator ball bearing

Calculated lifetime

L_{10} > required lifetime $L_{10erf.}$

Validation the lifetime of the Wave Generator ball bearing

Calculation example

The torque based dimensioning should be based on a reference cycle which represents a typical load on the gear including acceleration and deceleration phases.

Application load data		
J_L = 1.3 kgm²	t_0 = 1.3 s	n_p = 0.2 s
t_1 = 0.1 s	$L_{10requi.}$ = 7000 s	K ≤ 3
t_2 = 0.1 s	n_1 = 3 s	T_L = 5 Nm
t_3 = 0.1 s	n_2 = 0.4 s	
t_p = 1.0 s	n_3 = 0.15s	

Key figures of the actuator			
Pre selected actuator	CanisDrive-25A-50		
Maximum torque	T_{max}	=	127 Nm
Maximum speed	n_{max}	=	112 rpm
Moment of inertia	J_{out}	=	1.02 kgm²

Preselection of the servo actuator based on the load data

$n_2 = 40$ rpm ≤ $n_{max} = 112$ rpm ✓

$J_L = 1.3$ kgm² ≤ 3 · $J_{out} = 1.02$ kgm² ✓

K ≤ 3 for dynamic applications

Validation of the speed dycle using the load curve

Checking the permissible maximum torque

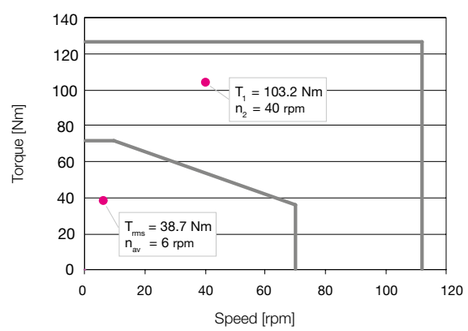
$T_1 = 103.2$ Nm ≤ $T_{max} = 127$ Nm ✓

Calculation of the acceleration torque

$$T_1 = 5 \text{ Nm} + \frac{2\pi}{60} \cdot \frac{(1.3 \text{ kgm}^2 + 1.02 \text{ kgm}^2) \cdot 40 \text{ rpm}}{0.1 \text{ s}} = 103.2 \text{ Nm}$$

Note: For servo actuators the input moment of inertia must also be taken into consideration!

Review T_{rms} / n_{av} within the performance curve for continuous operation, review T_1 / n_2 within the performance curve for inermittent operation ✓



Calculation of the rms torque

$T_2 = T_L = 5$ Nm

$T_3 = T_L - (T_1 - T_L) = -93.2$ Nm

$$T_{rms} = \sqrt[2]{\frac{(103.2 \text{ Nm})^2 \cdot 0.1 \text{ s} + (5 \text{ Nm})^2 \cdot 0.1 + (-93.2 \text{ Nm})^2 \cdot 0.1 \text{ s}}{1.3 \text{ s}}} = 38.7 \text{ Nm}$$

Calculation of the average speed

$$n_{av} = \frac{20 \text{ rpm} \cdot 0.1 \text{ s} + 40 \text{ rpm} \cdot 0.1 \text{ s} + 20 \text{ rpm} \cdot 0.1 \text{ s}}{1.3 \text{ s}} = 6 \text{ rpm}$$

Calculation of the duty cycle

$$ED = \frac{0.1 \text{ s} + 0.1 \text{ s} + 0.1 \text{ s}}{1.3 \text{ s}} \cdot 100\% = 23\ \%$$

Checking the lifetime of the Wave Generator ball bearing

$L_{10} = 21477$ h > $L_{10erf.} = 7000$ h ✓

Validation the lifetime of the Wave Generator ball bearing

$$L_{10} = \frac{10000 \text{ h} \cdot 2000 \text{ rpm}}{300 \text{ rpm}} \cdot \left(\frac{51 \text{ Nm}}{38.7 \text{ Nm}}\right)^3 = 21477 \text{ h}$$

• Lifetime of the Wave Generator ball bearing

The lifetime calculation of gears and servo actuators based on the strain wave gear principle refers to the lifetime of the Wave Generator ball bearing. The nominal torques at nominal speed given in the performance data tables are based on the nominal life Ln of the Wave Generator ball bearing.

The expected life can be determined at a given average input speed $n_{in\,av}$ and given average output torque T_{av} using Equation 5.8. The lifetime L_{50} indicates the calculated lifetime at 50 % failure probability, L_{10} at 10 % failure probability.

Equation 5.8

$$L_{10} = L_n \frac{n_N}{n_{in\,av}} \left(\frac{T_N}{T_{av}}\right)^3$$

Checking the lifetime of the Wave Generator ball bearing

$L_{10} = 21477\ h > L_{10erf.} = 7000\ h$ ✓

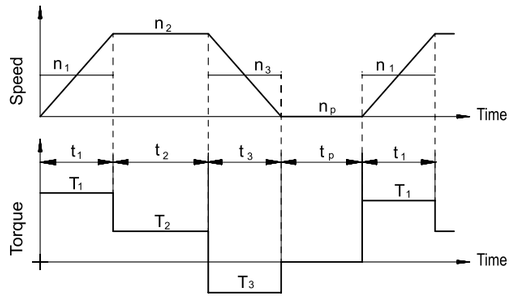
Table 5.5

Harmonic Drive® Series	Nominal lifetime L_n [h]	Rated speed n_N [rpm]
CanisDrive®, AlopexDrive, BHA, IHD, LynxDrive (i > 30)	10000	2000
FHA-C Mini, LynxDrive (i=30)	7000	2000

The average output speed can be calculated with equation 300.5 and the average input speed can be calculated with Equation 5.10.

Application load data		
Torque (Step 1 ... n)	$T_1 \dots T_n$	[Nm]
Load time (Step 1 ... n)	$t_1 \dots t_n$	[s]
Break time	t_p	[s]
Output speed (Step 1 ... n)	$n_1 \dots n_n$	[rpm]
Maximum torque	T_{max}	[Nm]
Average torque	T_{av}	[Nm]
Maximum output speed	$n_{out\,max}$	[rpm]
Maximum input speed	$n_{in\,max}$	[rpm]
Gear data (Actuator)		
Rated torque	T_n	[rpm]
Rated speed	n_n	[Nm]
Nominal lifetime of Wave Generator ball bearing	L_n	[h]

Illustration 5.5



Equation 5.9

$$T_{av} = \sqrt[3]{\frac{|n_1 \cdot T_1^3| \cdot t_1 + |n_2 \cdot T_2^3| \cdot t_2 + \dots + |n_n \cdot T_n^3| \cdot t_n}{|n_1| \cdot t_1 + |n_2| \cdot t_2 + \dots + |n_n| \cdot t_n}}$$

Equation 5.10

$$n_{out\,av} = \frac{|n_1| \cdot t_1 + |n_2| \cdot t_2 + \dots + |n_n| \cdot t_n}{t_1 + t_2 + \dots + t_n + t_p}$$

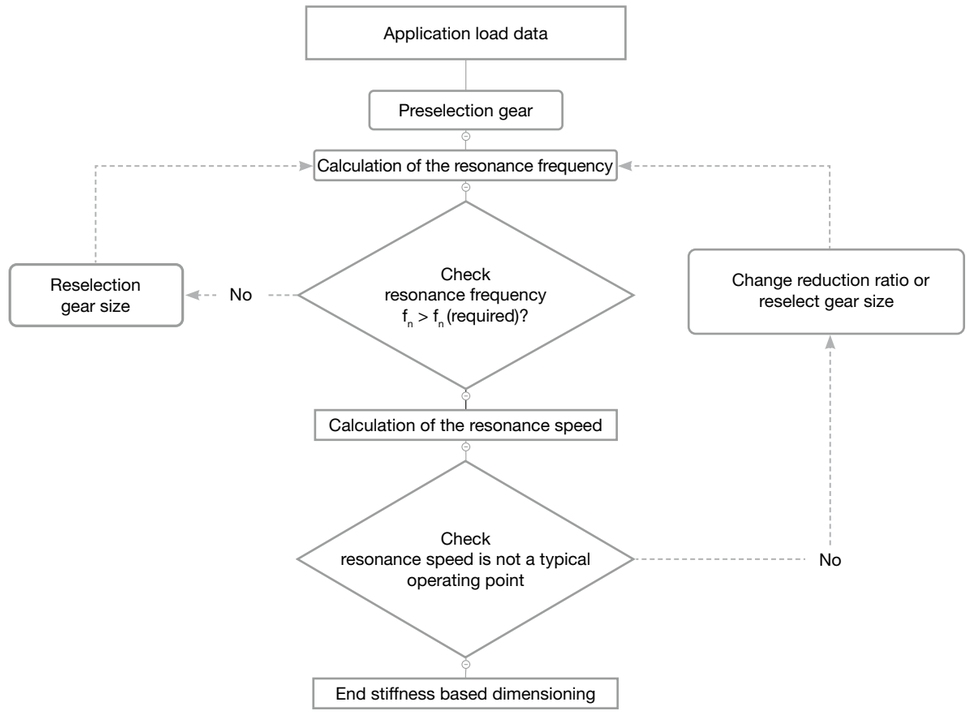
Equation 5.11

$$n_{in\,av} = i \cdot n_{out\,av}$$

• Stiffness based dimensioning

Selection procedure

In addition to the "torque based dimensioning" selection procedure, we recommend performing a stiffness based dimensioning, which evaluates the ratio of the load moment of inertia to the stiffness of the gear and compares it to the application requirements.



Calculation of the resonance frequency

Assuming that the stiffness of housing structure adapted to the gear is high compared to the gear stiffness, the resonance frequency of the system can be estimated with the following equation.**

Equation 5.12

$$f_n = \frac{1}{2\pi} \sqrt{\frac{K_1}{J}}$$

Table 5.6

Symbol	[Unit]	Designation	Note
f_n	[Hz]	Resonance frequency	
K_1	[Nm/arcmin]	Torsional stiffness gear K_1	See corresponding product chapter „Torsional stiffness“
J	[kgm²]	Load moment of inertia	From application

To reduce vibrations of the system, the calculated resonance frequency should not fall below the following recommended minimum resonance frequencies depending on the application.

** If the stiffness of the housing structure adapted to the gear has a not negligible influence on the vibration behaviour, or if the load moment of inertia is variable over time (e.g. with mechanically coupled axles), please contact your Harmonic Drive SE sales contact. With the help of the multiple body simulation, these influences on the vibration behaviour of your drive solution can be mapped.

Table 5.7

Application	Recommended minimum resonance frequency f_n [Hz]
Slowly rotating turntables, base axes of slow moving welding robots (not laser welding), slowly rotating welding turntables, gantry robot axes	≥ 4
Base axes of revolute robots, hand axes of revolute robots with low requirements regarding dynamic performance, tool revolvers, tool magazines, swivelling and positioning axes in medical and measuring devices	≥ 8
Standard applications in general mechanical engineering, tilting axes, palette changers, highly dynamic tool changers, -revolvers and -magazines, hand axes of revolute robots, scara robots, gantry robots, polishing robots, dynamic welding turntables, base axes of welding robots (laser welding), swivelling and positioning axes of medical equipment	≥ 15
B / C axes in 5 axis grinding machines, welding robot hand axes (laser welding), milling heads for plastics machining	≥ 20
C axes in turning machines, milling heads light metal machining, milling heads wood machining (chipboards etc.)	≥ 25
Milling heads woodworking (hardwood etc.)	≥ 30

Calculation of the resonance speed

The resonance frequency of the drive system is the frequency at which the system tends to oscillate. The Harmonic Drive® Gear itself causes two amplitudes of vibration for each Wave Generator revolution. With this, the resonance speed of the system can be calculated.

Equation 5.13

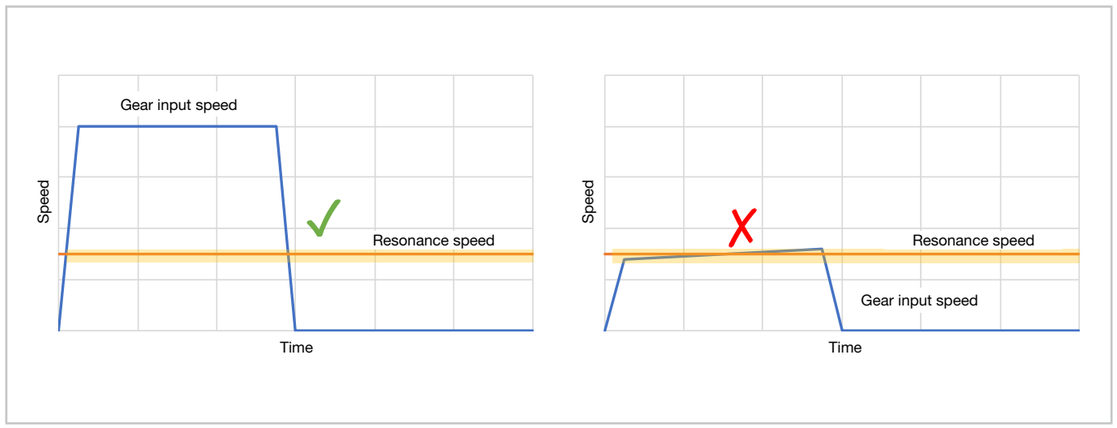
$$n_n\ [min^{-1}] = \frac{f_n[Hz]}{2} \cdot 60$$

Table 5.8

Symbol	[Unit]	Meaning
n_n	[rpm]	Resonance speed
f_n	[Hz]	Resonance frequency

The resonance speed should either not be exceeded during operation, or it should be run through quickly, see Illustration 5.6. If possible, operating points of the system in the resonance speed range should be avoided. The resonance speed can be influenced with the help of the gear reduction ratio or the gear size.

Illustration 5.6



Selection example

The following is a selection example for a milling head application in woodworking.

Table 5.9

Preselected actuator (Torque based dimensioning)	CanisDrive-40A-120-2A-GR
Torsional stiffness K_t of the actuator	$130 \cdot 10^3$ Nm/rad
Planned application	Milling head woodworking
Output side moment of inertia	7 kgm²
Recommended min. resonance frequency (from Table 5.7)	30 Hz

Equation 5.14

$$f_n = \frac{1}{2\pi}\sqrt{\frac{130 \cdot 10^3\ Nm/rad}{7\ kgm^2}} = 21.7\ Hz$$

According to stiffness based dimensioning, this size is too small for the application. Selecting the larger actuator CanisDrive-50A-120-2A-GR results in the following resonance frequency.

Equation 5.15

$$f_n = \frac{1}{2\pi}\sqrt{\frac{250 \cdot 10^3\ Nm/rad}{7\ kgm^2}} = 30.1\ Hz$$

Due to the stiffness based dimensioning, the CanisDrive-50A-120 actuator is recommended.

The resonance speed at the gear input (motor side) is:

Equation 5.16

$$n_n\ [rpm] = \frac{30.1}{2} \cdot 60 = 903\ rpm$$

This speed should be passed through quickly during acceleration and deceleration or be outside the used speed range.

• Calculation of the torsional angle

The torsional angle of the gear or servo actuator under load can be calculated as follows:

Equation 5.17

$$\text{For } T \le T_1: \quad \varphi = \frac{T}{K_1}$$

Equation 5.18

$$\text{For } T_1 < T \le T_2 \quad \varphi = \frac{T_1}{K_1} + \frac{T - T_1}{K_2}$$

Equation 5.19

$$\text{For } T > T_2: \quad \phi = \frac{T_1}{K_1} + \frac{T_2 - T_1}{K_2} + \frac{T - T_2}{K_3}$$

Table 5.10

Symbol	[Unit]	Designation	Note
φ	[rad]	Angle	
T	[Nm]	Load torque	
T_1	[rpm]	Limit torque 1	See chapter "Torsional stiffness" of corresponding product
T_2	[rpm]	Limit torque 2	See chapter "Torsional stiffness" of corresponding product
K_1	[Nm/rad]	Torsional stiffness until limit torque T_1	See chapter "Torsional stiffness" of corresponding product
K_2	[Nm/rad]	Torsional stiffness until limit torque T_2	See chapter "Torsional stiffness" of corresponding product
K_3	[Nm/rad]	Torsional stiffness above limit torque T_2	See chapter "Torsional stiffness" of corresponding product

Calculation example

Table 5.11

Actuator	CanisDrive-32A-100-2UH
Load torque T	60 Nm
T_1	29 Nm
T_2	108 Nm
K_1	$67 \cdot 10^3$ Nm/rad
K_2	$110 \cdot 10^3$ Nm/rad
K_3	$120 \cdot 10^3$ Nm/rad

Equation 5.20

$$\text{For } T_1 < T \le T_2$$

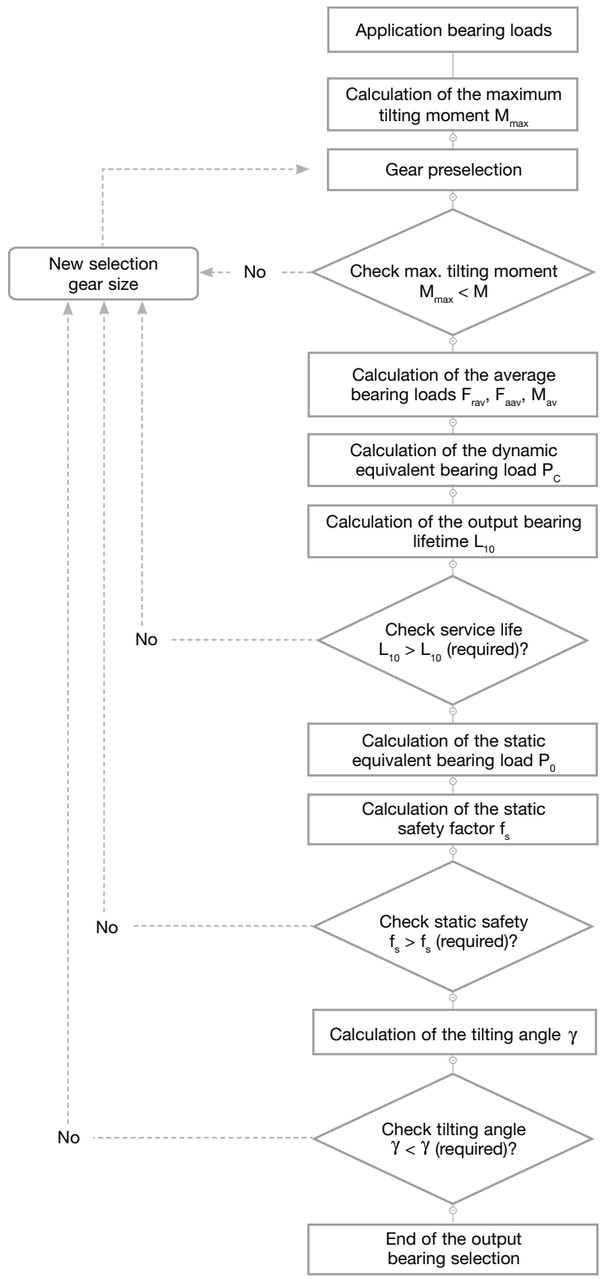
$$\varphi = \frac{29\ \text{Nm}}{67 \cdot 10^3\ \text{Nm/rad}} + \frac{60\ \text{Nm} - 29\ \text{Nm}}{110 \cdot 10^3\ \text{Nm/rad}} = 7.15 \cdot 10^{-4}\ \text{rad} = 2.5\ \text{arcmin}$$

with

$$\varphi\ [\text{arcmin}] = \varphi\ [\text{rad}]\ \frac{180}{\pi} \cdot 60$$

• Selection of the output bearing

Selection procedure



Dynamic load capacity

Calculation of the maximum tilting moment

The tilting moment is calculated from the radial force and the axial force acting on the output bearing. The permissible dynamic tilting moment of the bearing results from the permissible tilting angle of the gear component set in operation.

Illustration 5.7

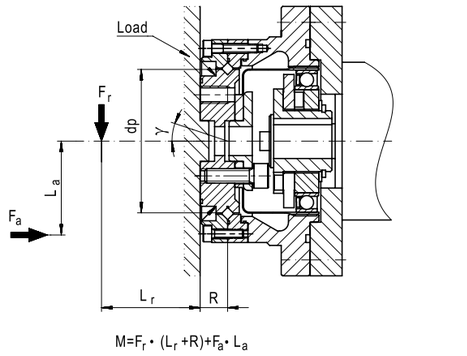


Table 5.12

Symbol	[Unit]	Designation
M_{max}		Max. dynamic tilting moment
$F_{(r\ max)}$	[N]	Max. dynamic radial force
$F_{(a\ max)}$	[N]	Max. dynamic axial force
L_r, L_a	[mm]	Distances according to Illustration 5.7
R	[mm]	Distance bearing centre / output flange, See chapter „Output bearing“

Equation 5.21

$$M_{max} = F_{r\,max} \cdot (L_r + R) + F_{a\,max} \cdot L_a$$

Calculation of the average bearing loads

Illustration 5.8

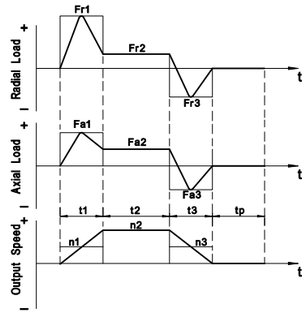


Table 5.13

Symbol	[Unit]	Designation
$F_{r\,av}$	[N]	Average radial force
$F_{a\,av}$	[N]	Average axial force
M_{av}	[Nm]	Average tilting moment
$t_{1...n}$	[s]	Duration of phase 1…n
$F_{r\,1...n}$	[N]	Radial force in phase 1 … n
$F_{a\,1...n}$	[N]	Axial force in phase 1 … n
$n_{1...n}$	[rpm]	Speed in phase 1…n

Determination of the average radial force

Equation 5.22

$$F_{r\,av} = \left(\frac{|n_1| \cdot t_1 (|F_{r1}|)^B + |n_2| \cdot t_2 (|F_{r2}|)^B + \ldots + |n_n| \cdot t_n (|F_{rn}|)^B}{|n_1| \cdot t_1 + |n_2| \cdot t_2 + \ldots + |n_n| \cdot t_n} \right)^{\frac{1}{B}}$$

Determination of the average axial force

Equation 5.23

$$F_{a\,av} = \left(\frac{|n_1| \cdot t_1 (|F_{a1}|)^B + |n_2| \cdot t_2 (|F_{a2}|)^B + \ldots + |n_n| \cdot t_n (|F_{an}|)^B}{|n_1| \cdot t_1 + |n_2| \cdot t_2 + \ldots + |n_n| \cdot t_n} \right)^{\frac{1}{B}}$$

Determination of the average tilting moment

Equation 5.24

$$M_{av} = \left(\frac{|n_1| \cdot t_1 (|M_1|)^B + |n_2| \cdot t_2 (|M_2|)^B + \ldots + |n_n| \cdot t_n (|M_n|)^B}{|n_1| \cdot t_1 + |n_2| \cdot t_2 + \ldots + |n_n| \cdot t_n} \right)^{\frac{1}{B}}$$

Determination of the average output speed

Equation 5.25

$$n_{av} = \frac{|n_1|\, t_1 + |n_2|\, t_2 + \ldots + |n_n|\, t_n}{|n_1| \cdot t_1 + |n_2| \cdot t_2 \ldots |n_n| \cdot t_n}$$

Calculation of the dynamic equivalent bearing load

Axial and radial force factors

The axial and radial force factors evaluate the influence of the axial force on the bearing load.

Table 5.14

Symbol	x	y
$\frac{F_{a\,av}}{F_{r\,av} + 2 \cdot M_{av} / d_p} > 1.5$	1	0.45
$\frac{F_{a\,av}}{F_{r\,av} + 2 \cdot M_{av} / d_p} \leq 1.5$	0,67	0.67

Table 5.15

Symbol	[Unit]	Designation	Note
$F_{r\,av}$	[N]	Average radial force	See chapter “Calculation of the average bearing loads“
$F_{a\,av}$	[N]	Average axial force	See chapter “Calculation of the average bearing loads“
M_{av}	[Nm]	Average tilting moment	See chapter “Calculation of the average bearing loads“
d_p	[mm]	Pitch circle diameter output bearing	See corresponding product chapter, “Output bearing“

Dynamic equivalent bearing load

A composite radial, axial and tilting moment load is replaced by the dynamic equivalent bearing load, which causes the same stress in the bearing.

Equation 5.26

$$P_C = x \cdot \left(F_{r\,av} + \frac{2M_{av}}{d_p} \right) + y \cdot F_{a\,av}$$

Table 5.16

Symbol	[Unit]	Designation	Note
P_C	[N]	Dynamic equivalent bearing load	See equation
$F_{r\,av}$	[N]	Average radial force	See chapter „Calculation of the average bearing loads“
$F_{a\,av}$	[N]	Average axial force	See chapter “Calculation of the average bearing loads“
M_{av}	[Nm]	Average tilting moment	See chapter “Calculation of the average bearing loads“
d_p	[mm]	Pitch circle diameter output bearing	See corresponding product chapter, “Output bearing“

Calculation of output bearing life

Lifetime at continuous operation

At continuous operation, but also at dynamic cycles where the dynamic bearing loads have been converted to an average bearing load, the following equation can be used to calculate the life of the output bearing.

Equation 5.27

$$L_{10} = \frac{10^6}{60 \cdot n_{av}} \cdot \left(\frac{C}{f_w \cdot P_c} \right)^B$$

Table 5.17

Symbol	[Unit]	Designation	Note
L_{10}	[h]	Calculated lifetime of the output bearing for 10 % failure probability	See Equation 5.27
n_{av}	[N]	Average output speed	From application
C	[N]	Dynamic load rating	See corresponding product chapter "Output bearing"
f_w	-	Operating factor	See Table 5.19
P_C	[N]	Equivalent dynamic bearing load	See Equation 5.26
B	-	Bearing type exponent	See Table 5.20

Calculation of the output bearing lifetime

Life at oscillating motion

At oscillating motion with an constant oscillating cycle, the following equation can be used.

Equation 5.28

$$L_{10} = \frac{10^6}{60 \cdot n_1} \cdot \frac{180}{\varphi} \cdot \left(\frac{C}{f_w \cdot P_c}\right)^B$$

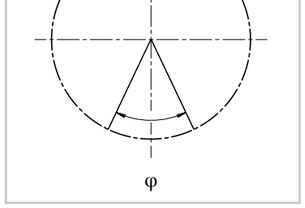
Table 5.18

Symbol	[Unit]	Designation	Note
L_{10}	[h]	Calculated lifetime of the output bearing for 10% failure probability	See Equation 5.28
n_1	[N]	Number of oscillations per minute	From application
φ	[°]	Oscillating angle	From application
C	[N]	Dynamic load rating	See corresponding product chapter "Output bearing"
f_w	-	Operating factor	See Equation 5.29
P_c	[N]	Dynamic equivalent load	See Equation 5.27
B	-	Bearing type exponent	See Table 5.21

Oscillating angle

At oscillating angles < 5° fretting corrosion may occur due to insufficient lubrication. In this case please contact our sales engineer for countermeasures.

Illustration 5.9



Operating factor

The operating factor takes into account the influence of the load conditions on the bearing lifetime.

Table 5.19

Load conditions	Operating factor f_w [ ]
No impact loads or vibrations	1.0 ... 1.2
Normal loads	1.2 ... 1.5
Impact loads or vibrations	1.5 ... 3.0

Bearing type exponent

The bearing type exponent takes into account the type of output bearing on the bearing life.

Table 5.20

Bearing type	Bearing type exponent B [ ]
Cross roller bearing	$\frac{10}{3}$
Four point contact bearing	3

Static load capacity

In the case of a static load on the output bearing or to evaluate an overload case with a stationary or slowly rotating load, the static safety factor is calculated with the following equation:

Equation 5.29

$$f_s = \frac{C_0}{P_0}$$

Table 5.21

Symbol	[Unit]	Designation	Note
f_s	-	Static safety factor	See Table 5.24
C_0	[N]	Static load rating	See corresponding product chapter "Output bearing"
P_0	[N]	Static equivalent bearing load	See Table 5.23

Equation 5.30

$$P_0 = F_{r\,max} + \frac{2M_{max}}{d_p} + 0.44\,F_{a\,max}$$

Table 5.22

Symbol	[Einheit]	Designation	Note
P_0	[N]	Static equivalent bearing load	See Equation 5.27
$F_{r\,max}$	[N]	Static radial force	From application
M_{max}	[Nm]	Static tilting moment	From application
d_p	[m]	Pitch circle diameter output bearing	See corresponding product chapter "Output bearing"
$F_{a\,max}$	[N]	Static axial force	From application

Table 5.23

Operating conditions of the bearing	Recommended static safety factor f_s [ ]
Normal operating conditions	≥1.5
In case vibrations or impacts are expected	≥2
For the highest demands on transmission accuracy	≥3

Tilting angle at the loaded output bearing

The output bearing can tilt under the influence of a tilting moment. The requirements of the application may result in a limit value for the permissible tilting. In these cases, the expected tilting angle should be calculated. If the expected tilting angle is too high for the application, a larger gear size with higher output bearing tilting stiffness should be selected.

Equation 5.31

$$\gamma = \frac{M}{K_B}$$

Table 5.24

Symbol	[Unit]	Designation	Note
γ	[arcmin]	Tilting angle at the loaded output bearing	See Table 5.25
M	[Nm]	Tilting moment on the output bearing	From application
K_B	[Nm/arcmin]	Tilting stiffness of the output bearing	See corresponding product chapter "Output bearing“

- Lubrication

Influence of the lubricant on the performance data

Harmonic Drive® Products achieve the specified performance data and characteristics with the lubricants named in the catalogue in the standard ambient temperature range (0 °C to 40 °C). Harmonic Drive SE can only give a warranty for the data stated in the catalogue if the Harmonic Drive® Greases approved for the respective product used. Lubricants and lubricant quantities other than those recommended by Harmonic Drive SE should be qualified by means of prototype tests if required.
When using lubricants that are not recommended in the catalogue or approved in writing for the application, the warranty claim is lost.
Depending on the actuator, size and temperature range of the application, the appropriate Harmonic Drive® Grease should be selected. The assigned standard lubricant is indicated in the respective product chapter.

Harmonic Drive® Grease SK-2
This grease was developed as a standard lubricating grease especially for the smaller actuators.

Harmonic Drive® Grease Flexolub®-A1
This grease features excellent wear resistance and efficiency and is well suited for operation at lower operating temperatures. It is the standard lubricant for the CanisDrive range.

Harmonic Drive® Grease 4BNo.2
This grease features high load capacity and good efficiency and can be used within a wide operating temperature range. It is a special lubricant that is used for high service life requirements in the BHA and IHD performance enhanced actuators.

Attention!!
The Harmonic Drive® Greases Flexolub-A1 and 4BNo.2 become relatively fluid during operation. When using these greases, the construction must therefore be oil tight. Due to the special properties of these greases, a small amount of base oil leakage at the radial shaft seals cannot be completely excluded.

Table 5.25

Feature	SK-2	Flexolub®-A1	4B No.2
Operating temperature range	0 °C … +40 °C	-40 °C … +70 °C	-10 °C … +70 °C
Base oil	Mineral oil	PAO/ Ester oil	Synthetic oil
Thickener	Lithium soap	Lithium soap	Polyurea
Consistency class (NLGI)	2	1	1.5
Base oil viscosity (40 °C; 100 °C)	37 ; 5.9 mm^2/s	25 ; 5.2 mm^2/s	50 ; 12 mm^2/s
Drop point	198 °C	180 °C	247 °C
Colour	green	beige	light yellow
Max. storage time in hermeticallly sealed container	5 years		
Lifetime	o	●	●
Wear resistance	o	●	●
Low temperature performance	△	●	o
High temperature performance	△	o	●
Leakage safety	●	△	o

● excellent o good △ should be checked depending on the application

Safety data sheets and technical data sheets are available on our website in the downloads section.

Instructions for the use of Harmonic Drive® Greases

The Harmonic Drive® greases are ideally suited for the lubrication of Harmonic Drive® Products.
The following measures can improve the life of the lubricant:

1. During lubrication
   The consistency of Harmonic Drive® Greases are firmer during storage than during operation. Note, however, that the consistency may vary due to the storage time. Before lubricating, you should swirl the grease to soften the consistency.

2. Running in process
   The running in process before the gear is fully loaded softens the grease and promotes an ideal distribution of the grease in the gear and the contact surfaces to be lubricated. The running in process is particularly important for Harmonic Drive® Grease 4BNo.2.

Therefore, the following running in process is recommended:
- Operate the actuator/gear for a period of about 20 minutes or longer without load or with a very low load. Select the largest possible output rotation angle.
- For this purpose, select an input speed of ideally about 1000 rpm
  (but not higher than 3000 rpm at the maximum).
- Keep the internal operating temperature below 80 °C. Take care to avoid a steep rise in temperature during the running in process. Flanging the gear to the surrounding structure improves the dissipation of heat generated and avoids excessive heating of the lubricant.

Please contact us if you have any questions regarding the handling of the Harmonic Drive® Greases.

Glossary

AC Voltage constant k_{EM} [V_{rms} / 1000 rpm]
Effective value of the induced motor voltage measured at the motor terminals at a speed of 1000 rpm and an operating temperature of 20 °C.

Ambient operating temperature [°C]
Specifies the temperature range permitted for normal operation.

Average input speed (grease lubrication) $n_{av\ (max)}$ [rpm]
Maximum permissible average gear input speed for grease lubrication. The applications average input speed must be lower than the permitted average input speed of the gear.

Brake closing time t_C [ms]
Delay time to close the brake.

Brake holding torque T_{BR} [Nm]
Torque the actuator can withstand when the brake is applied, with respect to the output.

Brake opening time t_O [ms]
Delay time for opening the brake.

Brake voltage U_{Br} [VDC]
Supply voltage of the holding brake.

Buckling torque
When a highly excessive torque (16 to 17 times rated torque) is applied to the output with the input stationary, the Flexspline may experience plastic deformation, eventually leading to a rupture at the bottom of the Flexspline. This is defined as buckling torque. When the Flexspline buckles, early failure of the Harmonic Drive® Gear will occur. The values for buckling torque can be provided on demand by Harmonic Drive SE.

Continuous stall current I_0 [A_{rms}]
Effective value of the motor phase current to produce the stall torque.

Continuous stall torque T_0 [Nm]
Allowable actuator stall torque.

Dynamic axial force $F_{A\ dyn\ (max)}$ [N]
With the bearing rotating, this is the maximum allowable axial force with no additional radial forces or tilting moments applied.

Dynamic load rating C [N]
Maximum dynamic load that can be absorbed by the output bearing before permanent damage may occur.

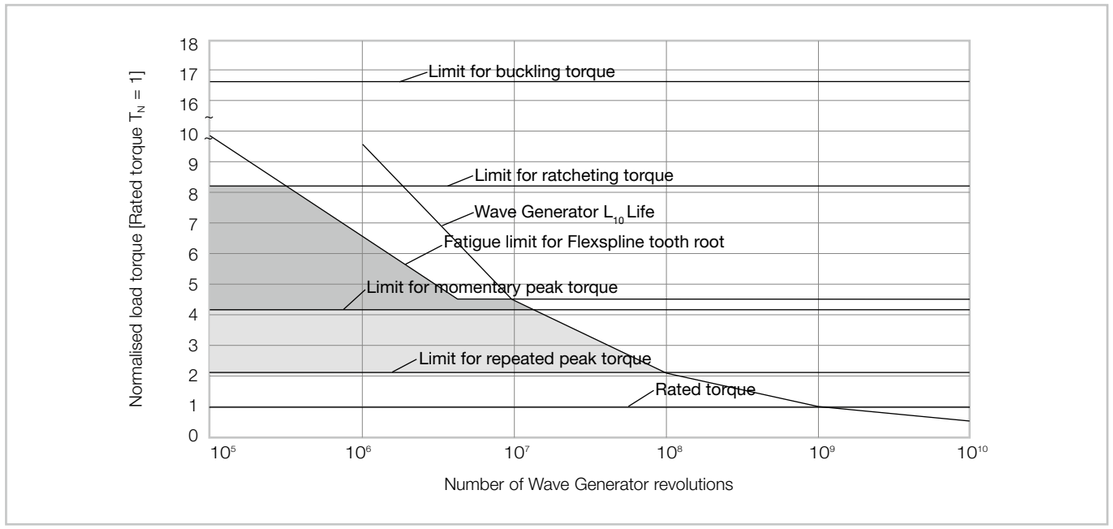
Dynamic radial force $F_{R\ dyn\ (max)}$ [N]
With the bearing rotating, this is the maximum allowable radial force with no additional axial forces or tilting moments applied.

Dynamic tilting moment $M_{dyn\ (max)}$ [Nm]
With the bearing rotating, this is the maximum allowable tilting moment with no additional axial forces or radial forces applied. This value is not based on the equation for lifetime calculation of the output bearing but on the maximum allowable deflection of the Harmonic Drive® Component Set. This value must not be exceeded even if the lifetime calculation of the bearing permits higher values.

Electrical time constant τ_e [s]
The electrical time constant is the time required for the current to reach 63 % of its final value.

Explanation of technical data

Illustration 5.10

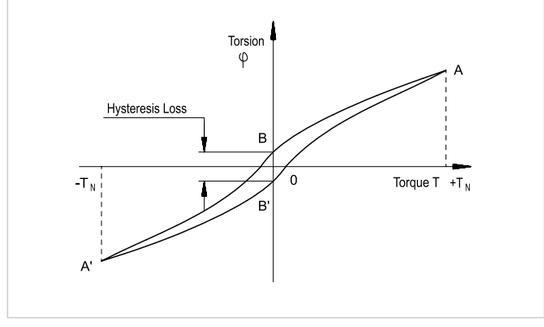


Hollow shaft diameter d_H [mm]
Free inner diameter of the axial hollow shaft.

Hysteresis loss (Harmonic Drive® Gears)
When a torque is applied to the output of a Harmonic Drive® Gear with the input locked, the torque-torsion relationship measured at the output typically follows, starting from point 0, the successive points the hysteresis curve A-B-A'-B'-A (see figure). The value of the displacement B-B' is defined as the hysteresis loss.

Inductance (L-L) L_{L-L} [mH]
Inductance between two motor terminals.

Illustration 5.11



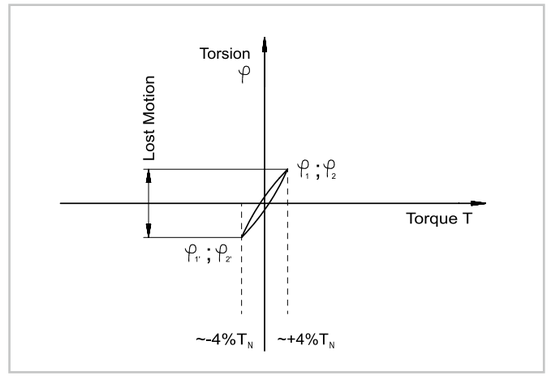
T_N = Rated output torque
φ = Output rotation angle

Lost Motion (Harmonic Drive® Gears) [arcmin]
Harmonic Drive® Gears exhibit zero backlash in the teeth. Lost motion is the term used to characterise the torsional stiffness in the low torque region.

The illustration shows the angle of rotation φ measured against the applied output torque as a hysteresis curve with the Wave Generator locked. The lost motion measurement of the gear is taken with an output torque of about ±4 % of the rated torque.

Maximum current I_{max} [A]
The maximum current is the maximum current that can be applied for a short period.

Illustration 5.12



Maximum DC bus voltage $U_{DC\ (max)}$ [VDC]
The maximum DC bus power supply for the correct operation of the actuator. This value may only be exceeded for a short period during the braking or deceleration phase.

Maximum motor speed n_{max} [rpm]
The maximum allowable motor speed.

Maximum output speed n_{max} [rpm]
The maximum output speed. Due to heating issues, this may only be momentarily applied during the operating cycle. The maximum output speed can occur any number of times as long as the calculated average speed is within the permissible continuous operation duty cycle.

Maximum output torque T_{max} [Nm]
Specifies the maximum allowable acceleration and deceleration torques. For highly dynamic processes, this is the maximum torque available for a short period. The maximum torque can be parameterised by the control unit where the maximum current can be limited. The maximum torque can be applied as often as desired, as long as the calculated average torque is within the permissible continuous operation duty cycle.

Mechanical time constant τ_m [s]
The mechanical time constant is the time required to reach 63 % of its maximum rated speed in a no-load condition.

Momentary peak torque T_M [Nm]
In the event of an emergency stop or collision, the Harmonic Drive® Gear may be subjected to a brief momentary peak torque. The magnitude and frequency of this peak torque should be kept to a minimum and under no circumstances should the momentary peak torque occur during the normal operating cycle. The allowable number of momentary peak torque events can be calculated with the equations given in chapter "selection procedure".

Moment of inertia J [kgm²]
Mass moment of inertia at motor side.

Moment of inertia J_{out} [kgm²]
Mass moment of inertia with respect to the output.

Motor terminal voltage (Fundamental wave only) U_M [V_{rms}]
Required fundamental wave voltage to achieve the specified performance. Additional power losses can lead to restriction of the maximum achievable speed.

No load running current I_{NLRC} [A]
The no load running current is determined by following equation and depends on the operating temperature of the actuator:
$I_{NLRC} = I_{NLSC} + K_{INL} \cdot n_{OUT}$ means: No-load starting current + speed depending current consumption with:

I_{NLRC} = No load running current in A_{rms}
K_{INL} = No load current constant at a defined temperature in A_{rms}/rpm
n_{OUT} = Output speed in rpm

Nominal service life L_{10h} [h]
Service life of the Wave Generator ball bearing at rated torque and rated speed for a failure probability of 10 %.

Number of pole pairs p
Number of magnetic pole pairs on the rotor of the motor.

Offset R [m or mm]
Distance between output bearing centre and point of application of load.

Pitch circle diameter output bearing d_p [m] or [mm]
Pitch circle diameter of the output bearing rolling element raceway.

Protection class IP
The degree of protection according to EN 60034-5 provides suitability for various environmental conditions.

Ratcheting torque
When excessive torque (8 to 9 times rated torque) is applied while the gear is in motion, the teeth between the Circular Spline and Flexspline may not engage properly. This phenomenon is called ratcheting and the value at which this occurs is called ratcheting torque. Ratcheting may cause the Flexspline to become non concentric with the Circular Spline (Dedoidal, see also chapter Assembly Instructions). Operating in this condition may result in shortened life and a Flexspline fatigue failure. The values for ratcheting torque can be provided on demand by Harmonic Drive SE.

Rated motor speed n_N [rpm]
The motor speed which can be continuously maintained when driven at rated torque T_N, when mounted on a suitably dimensioned heat sink.

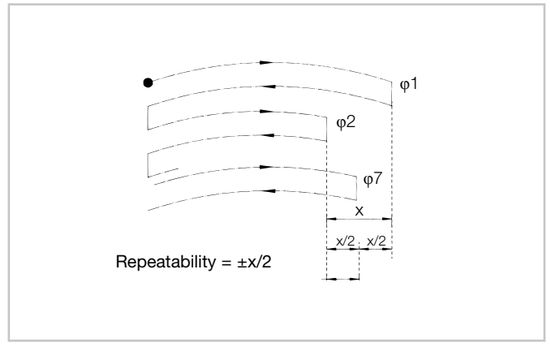
Rated speed n_N [rpm], gear
The rated speed is a reference speed for the calculation of the gear life. When loaded with rated torque and running at rated speed the Wave Generator Bearing will reach the nominal service life L_{10h} with 10 % probability of failure.

Rated torque T_N [Nm], gear
The rated torque is a reference torque for the calculation of the gear life. When loaded with rated torque and running at rated speed the Wave Generator Bearing will reach the nominal service life L_{10h} with 10 % probability of failure.

Ratio i [ ]
The ratio is the reduction of input speed to the output speed.
Note for Harmonic Drive® Gears: In the standard drive arrangement, the Wave Generator is the drive element while the Flexspline is the driven element and the Circular Spline is fixed to the housing. Since the direction of rotation of the input (Wave Generator) is opposite to the output (Flexspline), a negative ratio must be considered.

Repeatability [arcmin]
The repeatability of the gear describes the position difference measured during repeated movement to the same desired position from the same direction. The repeatability is defined as half the value of the maximum difference measured, preceded by a ± sign.

Illustration 5.13



Repeated peak torque T_R [Nm]
Specifies the maximum allowable acceleration and deceleration torque. During the normal operating cycle the repeatable peak torque T_R must not be exceeded. The repeated peak torque can be applied as often as desired, as long as the application's average torque is lower than the permitted average torque of the gear.

Resistance (L-L, 20 °C) R_{L-L} [Ω]
Winding resistance measured between two conductors at a winding temperature of 20 °C.

Size
The frame size is derived from the pitch circle diameter of the gear teeth in inches multiplied by 10.

Static load rating C_0 [N]
Maximum static load that can be absorbed by the output bearing before permanent damage may occur.

Static tilting moment M_0 [Nm]
With the bearing stationary, this is the maximum allowable radial force with no additional axial forces or tilting moments applied.

Synchronous inductance L_d [mH]
Sum of main and stray inductance for the single phase equivalent circuit of a permanent magnet synchronous machine. The inductance is calculated based on measurement results of the no load and short circuit experiment.

Tilting moment stiffness K_B [Nm/arcmin]
The ratio of the tilting angle of the output bearing and the applied moment load.

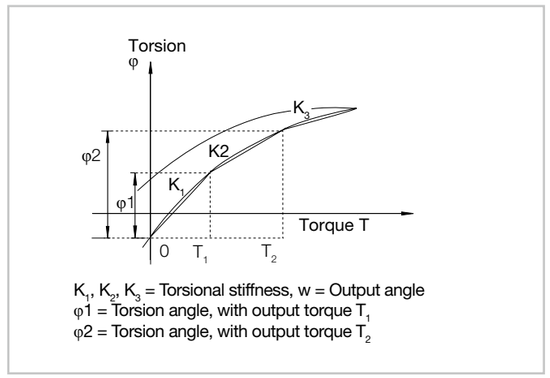
Torque constant (motor) k_{TM} [Nm/A_{rms}]
Quotient of stall torque and stall current.

Torsional stiffness (Harmonic Drive® Gears) K_1, K_2, K_3 [Nm/rad]
The degree of elastic rotation at the output for a given torque with the Wave Generator blocked. The torsional stiffness may be evaluated by dividing the torque-torsion curve into three regions. The torsional stiffness values K1, K2 and K3 are determined by linearization of the curve.

K_1: low torque region $0 \sim T_1$
K_2: middle torque region $T_1 \sim T_2$
K_3: high torque region $> T_3$

The values given for the torsional stiffness K_1, K_2 and K_3 are average values that have been determined during numerous tests. The limit torques T_1 and T_2 and an calculation example for the torsional angle can be found in chapter "torsional stiffness" and "calculation of the torsion angle" of this documentation.

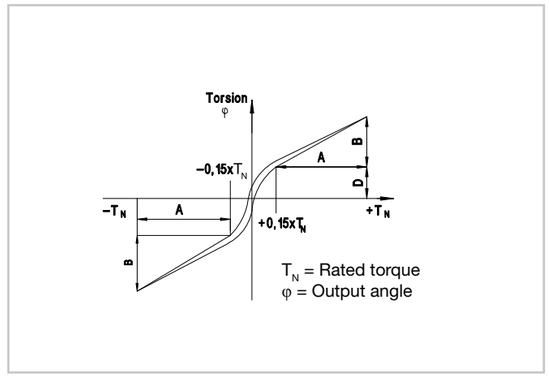
Illustration 5.14



K_1, K_2, K_3 = Torsional stiffness, w = Output angle
φ1 = Torsion angle, with output torque T_1
φ2 = Torsion angle, with output torque T_2

Torsional stiffness (Harmonic Planetary Gears) K3 [Nm/rad]
The degree of elastic rotation at the output for a given torque and blocked input shaft. The torsional rigidity of the Harmonic Planetary Gear describes the rotation of the gear above a reference torque of 15 % of the rated torque. In this area the torsional stiffness is almost linear.

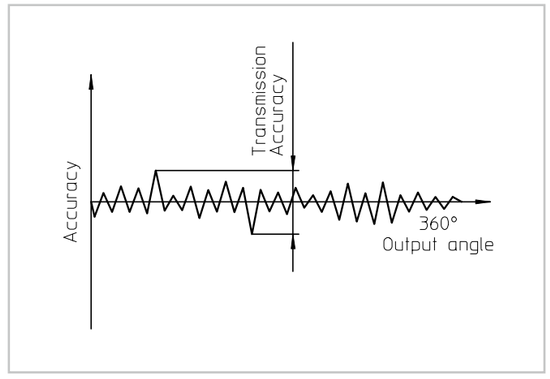
Illustration 5.15



T_N = Rated torque
φ = Output angle

Transmission accuracy [arcmin]
The transmission accuracy of the gear represents the linearity error between input and output angle. The transmission accuracy is measured for one complete output revolution using a high resolution measurement system. The measurements are carried out without direction reversal. The transmission accuracy is defined as the sum of the maximum positive and negative differences between the theoretical and actual output rotation angles.

Illustration 5.16



Weight m [kg]
The weight specified in the catalogue is the net weight without packing and only applies to standard versions.

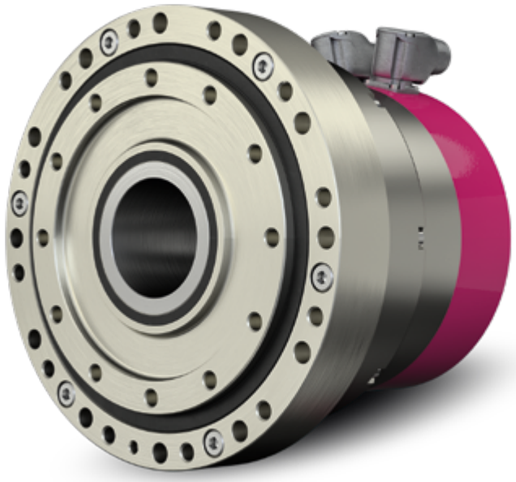
Individual solutions

Within the scope of a large number of customised requirements, special solutions are developed, which are tailored to the individual customer application requirements. These solutions are always achieved in close partnership with the customer and coordinated in detail.

For this purpose, our existing and acclaimed core components are used and, through individual combination or integration, assembled into an actuator which facilitates the solution of the customer's drive application.

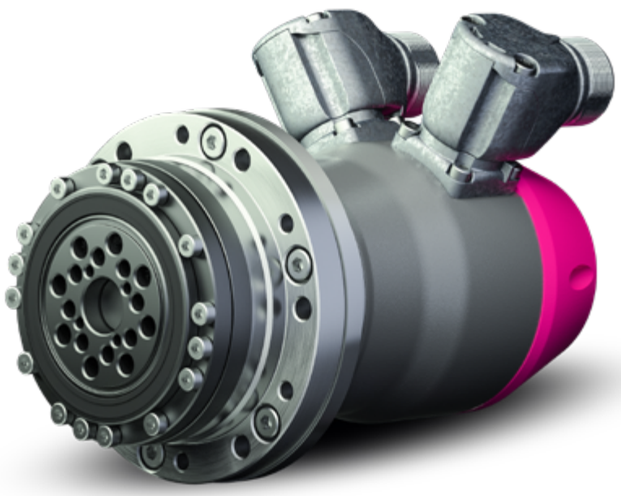
The general conditions for the combination options are set by the product platforms, which have already been described in the individual product chapters and can be summarised below.

Product platforms for customised special solutions



CanisDrive® – Actuators with hollow shaft for industry and automation

The CanisDrive® product platform focuses in particular on the industrial and automation sector. Its high flexibility in terms of motor feedback systems, as well as its extended corrosion resistance, makes it suitable for a wide range of applications.



LynxDrive – Compact actuators with solid shaft

The LynxDrive product platform is characterised by its outstanding compactness and higher dynamics. The solid shaft actuator is suitable for use in industrial environments, as well as for the realisation of safety related applications, through the mounting of certified encoders.

AlopexDrive – Actuators with hollow shaft for special environments

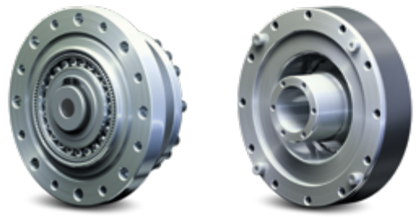
The AlopexDrive product platform combines the performance of the CanisDrive® Actuator with extended qualifications as well as special coatings and special materials for use in harsh or critical environmental conditions. This includes not only individual drive axes, but also complete solutions for the customer.

Component selection

- Gears with output bearing

Increased performance gears with output bearing (CSG/SHG Series)

These gears offer increased performance compared to the original design, covering the largest range of applications and are therefore the standard gears for use in Harmonic Drive® Actuators. They impress with their overload capacity and the particularly tilt resistant output bearings.

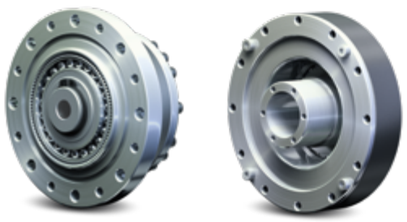


Short design gears with output bearing (CSD/SHD Series)

For applications with increased installation space requirements, the short Harmonic Drive® Gears are available. They are characterised by a short axial length and high power density.

Original gears with output bearing (HFUC/HFUS Series)

The original gears with output bearing are used in particular for very specific customer requirements and when small reduction ratios (i = 30) are required in the range of larger sizes.



For further information see Harmonic Drive® Gear Catalogue.

- Motor windings for 24/48 VDC and 325/560 VDC

A variety of stator windings are available for the different applications and the individual needs in terms of supply voltage.
These can be adapted or optimised with regard to their insulation strength and voltage constant. In addition, a selection of temperature sensors (e.g. PTC, KTY, PT1000) is available.

Please refer to the chapters of the respective product platforms for the technical or electrical parameters.

- Motor feedback systems

With regard to feedback systems, the following technologies are available:
- Incremental encoders (RS422 rectangular, Sine-Cosine)
- Singleturn absolute feedback systems
- Multi-turn absolute feedback systems
- Resolvers (for special environments)
- Dual feedback systems (input and output side)
- Specific systems on request or after technical inspection

There are different interfaces in relation to drive controllers such as for example:
- RS422 rectangular: A, B, Z combined with Hall signals
- Sine-Cosine signals
- SSI with/without Sine-Cosine signals
- HiPERFACE®
- EnDat 2.1/2.2
- BiSS-C
- DRIVE-CLiQ

Please refer to the chapters of the respective product platforms for the technical or electrical parameters.

• Brakes

The brakes are exclusively holding brakes or fail-safe brakes. This means that the actuators are not actively braked, but held at a standstill in an emergency. The holding torque of the brake usually corresponds to at least the maximum output torque of the actuator.

The following main types are available here:
- Holding brakes according to the spring pressure principle 24 VDC (hollow shafts)
- Holding brakes according to the spring pressure principle 18… 32 VDC (hollow shafts)
- Holding brakes according to the permanent magnet principle 24 VDC (solid shafts)
- Special brakes (for example with manual release) after technical inspection

Please refer to the respective chapters for the key data of the standard brakes.

• Drive controller

Basically, there are 3 different possibilities of controller connection:

Integrated
Here, the drive controller is integrated inside the actuator housing, forming a closed system.

Close to the actuator
Positioning close to the actuator is possible if the drive controller can be mounted in the immediate vicinity, in order to exploit space advantages and at the same time to be able to realise decentralised control. The cable connection between the controller and the actuator can be simplified.

External
External positioning, means traditional mounting in the control cabinet of the machine. We will be glad to advise you on the selection of suitable control devices for our actuators.

- Application experience is already available with the following manufacturers:
- INGENIA Motion Control
- ELMO Motion Control
- Siemens, Sinamics S120
- KEBA Automation
- Beckhoff Automation
- Kollmorgen
- Bosch Rexroth
- Metronix
- B&R

etc.

• Housing

The housing of the actuators can be individually adapted within the scope of the projects. The decisive factors here are not only the shape and external dimensions, but also customisation requests such as a sealing air connection, application specific materials as well as special coatings and much more. Furthermore, there is also the possibility to adapt the housing in such a way that systems structures can be realised, for example, for use in pan and tilt systems.

• Environmental conditions

Our actuators are usually certified to protection class IP 65. Higher certifications need to be evaluated upon request and depend heavily on the sealing concept of the system.

Possible combinations

Please contact the sales department as a consultant to achieve your specific solution. The listed combinations are only possible after detailed technical examination and consultation and are not part of the standard portfolio.

Table 6.1

Platform	Gears with output bearing	Motor winding Rated DC link voltage (maximum value) [VDC]		Feedback system motor shaft	Feedback system gear output	Brake	Drive controller/ Control board	Housing	Environmental conditions / Corrosion protection	Connector
CanisDrive®	Increased performance gears with output bearing (CSG/SHG Series)	48 (100)	560 (680)	Singleturn absolute EnDat 2.2 (SZE)	Singleturn absolute Endat 2.1 (EC-Option)	Holding brakes Spring pressure principle 24 VDC	External	Sealing air connection	Protection class IP65	Cable outlet with open strands
				Singleturn absolute EnDat 2.1 (SIE)						Standard connector
	Short design gears with output bearing (CSD/SHD Series)			Multi-turn absolute EnDat 2.2 (MZE)	Singleturn absolute BiSS-C (SZB)			Special housing	Corrosion protection	Customer specific connectors
				Multi-turn absolute HIPERFACE® (MIH) Multi-turn absolute HIPERFACE® (MHH)						
				Multi-turn absolute BiSS-C (MZB)						
	Original gears with output bearing (HFUC/HFUS Series)			Multi-turn absolute SSI + SinCos (MHS)	Other feedback systems also possible on request and check					Customer specific pinout
				Other feedback systems also possible on request and check						
AlopexDrive	Original gears with output bearing (HFUC/HFUS Series)	24/48	100	Singleturn absolute Resolver (ROO)	Singleturn Absolut Encoder SSI (SXS)	Holding brakes Spring pressure principle 24 VDC	Integrated	Sealing air connection	Protection class IP65	Application specific motor and encoder connectors (e.g. ITT/Canon, Amphenol)
				Multi-turn absolute BiSS-C (MZB)				Special housing		
	Increased performance gears with output bearing (CSG/SHG Series)			Multi-turn absolute SSI + SinCos (MHS)	Other feedback systems also possible on request and check		Close to the actuator	Special coating	Higher protection classes on request	
				Dual feedback system A B Z + U V W	Dual feedback system BiSS-C (SSI)	Holding brakes Spring pressure principle 18 … 32 VDC		Special materials	Corrosion protection	
	Short design gears with output bearing (CSD/SHD Series)			Other feedback systems also possible on request and check	Other feedback systems also possible on request and check		External	System structure (Multi axis capability)	Advanced shock/vibration properties	
LynxDrive	Original gears with output bearing (HFUC/HFUS Series)	-	560 (680)	Multi-turn absolute EnDat 2.1 (MKE) Multi-turn absolute EnDat 2.1 (MEE)	-	Holding brakes Permanent magnet principle 24 VDC	External	Special housing	Protection class IP65	Cable outlet with open strands
				Multi-turn Absolute HIPFERACE® (MGH)						Standard connector
	Increased performance gears with output bearing (CSG/SHG Series)			Singleturn absolute Resolver (ROO)						Customer specific connectors
				DRIVE-CLiQ					Corrosion protection	
	Short design gears with output bearing (CSD/SHD Series)			HIPERFACE DSL®						Customer specific pinning
				Other feedback systems also possible on request and check						Single cable solution

Selected examples of customised special actuators

Illustration 6.1

Pan and tilt unit based on the AlopexDrive Actuator

Illustration 6.2

AlopexDrive Actuator including slip ring and fibre optic cable

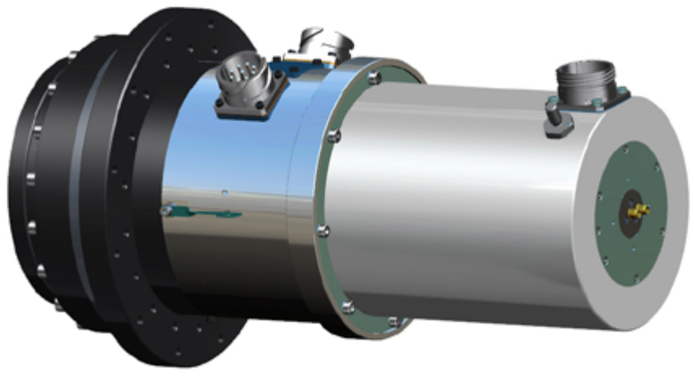


Illustration 6.3

AlopexDrive Actuator with integrated controller, individual surface protection and materials for seawater environments

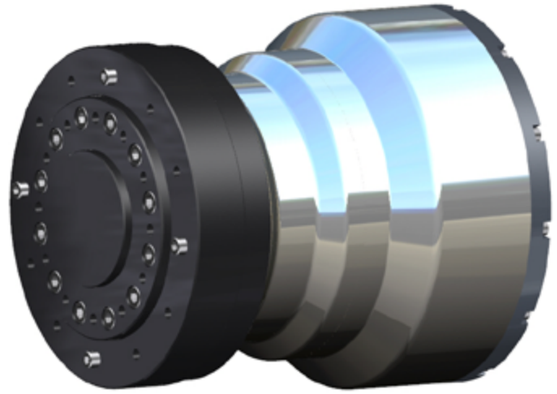
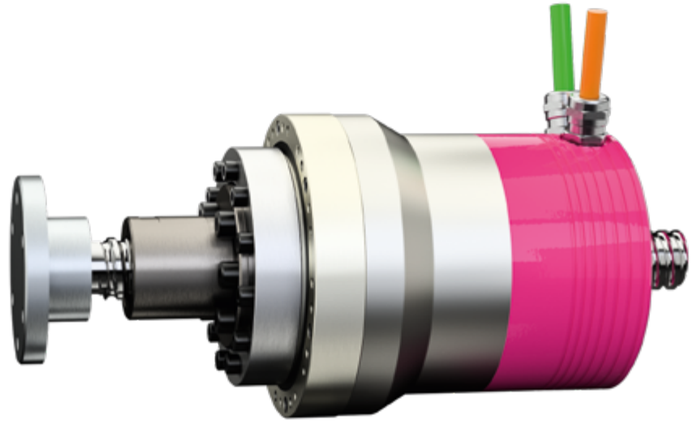


Illustration 6.4

Canis Drive® Actuator with ball screw spindle



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