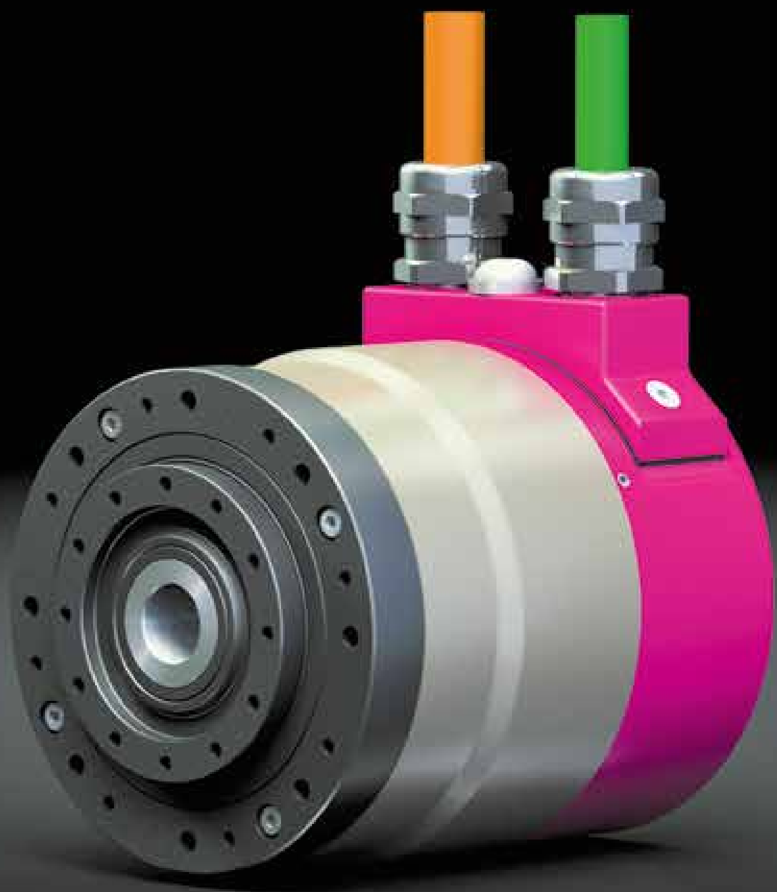
Engineering Data
AC Servo Actuators CHA-C

Harmonic Drive AG



More information on our servo products can be found **HERE**!

Contact us today!

Contents

1. General

About this documentation
This document contains safety instructions, technical data and operation rules for servo actuators and servo motors of Harmonic Drive AG.
The documentation is aimed at planners, project engineers, commissioning engineers and machine manufacturers, offering support during selection and calculation of the servo actuators, servo motors and accessories.

Rules for storage
Please keep this document for the entire life of the product, up to its disposal. Please hand over the documentation when re-selling the product.

Additional documentation
For the configuration of drive systems using the products of Harmonic Drive AG, you may require additional documents. Documentation is provided for all products offered by Harmonic Drive AG and can be found in pdf format on the website.

www.harmonicdrive.de

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 the manufacturers.

Before commissioning servo actuators and servo motors from Harmonic Drive AG with servo drives, we advise you to obtain the relevant documents for each device.

Your feedback
Your experiences are important to us. Please send suggestions and comments about the products and documentation to:

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E-Mail: info@harmonicdrive.de

1.1 Description of Safety Alert Symbols

Symbol	Meaning
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.
ADVICE	Describes a possibly harmful situation. Care should be taken to avoid damage to the system and surroundings.
INFORMATION	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.
	Beware of hot surfaces.
	Beware of suspended loads.
	Precautions when handling electrostatic sensitive components.
	Beware of electromagnetic environmental compatibility.

1.2 Disclaimer and Copyright

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We have checked the contents of this document. Since errors cannot be ruled out entirely, we do not accept liability for mistakes which may have occurred. Notification of any mistake or suggestions for improvements will be gratefully received and any necessary correction will be included in subsequent editions.

2. Safety and Installation Instructions

Please take note of the information and instructions in this document. Specially designed models may differ in technical detail. If in doubt, we strong recommend that you contact the manufacturer, giving the type designation and serial number for clarification.

2.1 Hazards

DANGER

Electric servo actuators and motors have dangerous live and redating parts. All work during connection, operation, repair and disposal must be carried out by qualified personnel as described in the standards EN50110-1 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 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 gears, motors and actuators can exceed 55 degrees Celsius. The hot surfaces should not be touched.

ADVICE

Cables must not come into direct contact with hot surfaces.

DANGER

Electric, magnetic and electromagnetic fields are dangerous, in particular for persons with pacemakers, implants or similiar. Vulnerable groups must not be in the immediate vicinity of the products themselves.

DANGER

Built-in holding brakes alone are not functional safe. Particularly with unsupported vertical axes, the functional safety and security can only be achieved with additional, external mechanical brakes.

DANGER

Danger of injury due to improper handling of batteries.

Observing of the battery safety rules:

- do not insert batteries in reverse. Observe the + and - marks on the battery and on the equipment
- do not short circuit
- do not recharge
- do not open or deform
- do not expose to fire, water or high temperature
- do not leave discharged batteries in equipment
- keep batteries out of the reach of children. In case of ingestion of a battery, seek medical assistance promptly.

WARNING

The successful and safe operation of gears, servo actuators and motors requires proper transport, storage and assembly as well as correct operation and maintenance.

ATTENTION

Use suitable lifting equipment to move and lift gears, servo actuators and motors with a weight > 20 kg.

INFORMATION

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.

2.2 Intended Purpose

The Harmonic Drive® Servo Actuators and Motors are intended for industrial or commercial applications. They comply with the relevant parts of the harmonised EN 60034 standards series.

Typical areas of application are robotics and handling, machine tools, packaging and food machines and similar machines.

The servo actuators and motors may only be operated within the operating ranges and environmental conditions shown in the documentation (altitude, degree of predection, temperature range, etc).

Before plant and machinery which have Harmonic Drive® Servo Actuators and Motors built into them are commissioned, the compliance must be established with the Machinery Directive, Low Voltage Directive and EMC guidelines.

Plant and machinery with inverter driven motors must satisfy the predection requirements in the EMC guidelines. It is the responsibility of the installer to ensure that installation is undertaken correctly.
Signal and power lines must be shielded. The EMC instructions from the inverter manufacturer must be observed in order that installation meets the EMC regulations.

2.3 Non Intended Purpose

The use of servo actuators and motors outside the areas of application mentioned above or, inter alia, other than in the operating areas or environmental conditions described in the documentation is considered as non-intended purpose.

ADVICE

Direct operating from the mains supply is not allowed.

The following areas of application are, inter alia, those considered as non-intended purpose:

- 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
- Machines for domestic use
- Medical equipment which comes into direct contact with the human body
- Machines or equipment for transporting or lifting people
- Special devices for use in annual markets or leisure parks

2.4 Declaration of Conformity

The Harmonic Drive® Servo Actuators and Motors described in the engineering data comply with the Low Voltage Directive. In accordance with the Machinery Directive, Harmonic Drive® Servo Actuators and Motors 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 2014/30/EU Harmonic Drive® Servo Actuators and Motors 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 and Motors 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 prediction requirements in the EMC directive. It is the responsibility of the user to ensure that the installation is undertaken correctly.

Largest hollow shaft with precision output bearing

CHA-C Series Hollow Shaft Servo Actuators combine a synchronous servo motor, Unit from the CPU-H Series, feedback sensor and a high capacity precision output bearing. Available in six sizes with gear ratios between 30 and 160:1, the actuators can provide maximum torques from 27 to 1840 Nm. The output bearing with high tilting capacity often allows direct attachment of heavy payloads without the need for further support, thereby providing simple and space saving design installations.

To adapt to your specific application, the CHA-C Series offers many possible combinations when selecting the motor winding, motor feedback, brake, various sensors and cable as well as connector options. By combining the CHA-C Actuators with the specially adapted YukonDrive® Servo Controllers, it is possible to provide a single source supply for a pre-configured drive system tailored to suit your application. Alternatively, the flexible configuration of the actuator ensures compatibility with almost any servo controller on the market.

The integrated hollow shaft can be used to feed through supply lines or services for additional axes, enabling space saving designs with minimal installation dimensions required. With a reinforced output bearing offering maximum tilting rigidity, the actuators can easily absorb and accurately guide heavy payloads. The accurate positioning of the actuator ensures stable machine characteristics, increased operating reliability and consistent quality. With high protection ratings and corrosion resistance, the series is perfectly suited for use in harsh and demanding environmental conditions.

4. Ordering Code

Table 10.1

Series	Size Version	Ratio							Motor winding	Connector configuration	Motor feedback	Brake	Option 1	Option 2	Special design
CHA	20C	30	**50**	80	**100**	120	160		AM	H	MGS	B	Sensor	Cable/ Connector	According to customer requirements
	25C	30	**50**	80	**100**	120	160		AR	N	SIE				
	32C	30	**50**	80	**100**	120	160		AR		DCO				
	40C	–	**50**	80	**100**	120	160		AU		MZE				
	50C	–	**50**	80	**100**	120	160		AX		SZE				
	58C	–	**50**	80	**100**	120	160		AX						
Ordering code															
CHA	**- 20C**	**-**		**100**		**-**			**AM**	**- H**	**- MGS**	**- B**	**- EC**	**- K**	**- SP**

Variations in **bold print** are available at short notice, subject to prior sale.

Table 10.2

Motor winding		
Size Version	**Ordering code**	**Maximum DC bus voltage**
20C	AM	680 VDC
25C	AR	
32C	AR	
40C	AU	
50C	AX	
58C	AX	

Table 10.3

Connector configuration			
Ordering code	**Motor feedback**	**Motor**	**Motor feedback**
H	MGS SIE MZE SZE	6 pin (M23)	17 pin (M23)
N	DCO	8 pin (M17)	17 pin (M17)

Table 10.4

Motor feedback system		
Ordering code	**Type**	**Protocol**
MGS	Multi-turn absolute	SSI
SIE	Single turn absolute	EnDat® 2.1/01
DCO	Incremental	–
MZE	Multi-turn absolute	EnDat® 2.2/22
SZE	Single turn absolute	EnDat® 2.2/22

Table 10.5

Option 1	
Ordering code	**Description**
EC	Single turn absolute EnDat® encoder system at the gear output

Table 10.6

Option 2	
Ordering code	**Description**
K	Cable outlet axial
–	Standard (cable outlet radial)

5. Combinations

Table 11.1

Size Version		20C	25C	32C	40C	50C	58C
Ratio	30	○	○	○	-	-	-
	50	●	●	●	●	●	●
	80	○	○	○	○	○	○
	100	●	●	●	●	●	●
	120	○	○	○	○	○	○
	160	○	○	○	○	○	○
Motor winding	AM	●	-	-	-	-	-
	AR	-	●	●	-	-	-
	AU	-	-	-	●	-	-
	AX	-	-	-	-	●	●
Connector configuration	H	●	●	●	●	●	●
	N	●	○	○	○	○	○
Motor feedback	MGS	●	●	●	●	●	●
	SIE	●	●	●	●	●	●
	DCO	●	-	-	-	-	-
	MZE	●	●	●	●	●	●
	SZE	●	●	●	●	●	●
Brake	B	●	●	●	●	●	●
Option 1 (Sensor)	EC	●	●	●	●	●	●
Option 2 (Cable/Connector)	K	○	○	○	○	○	○

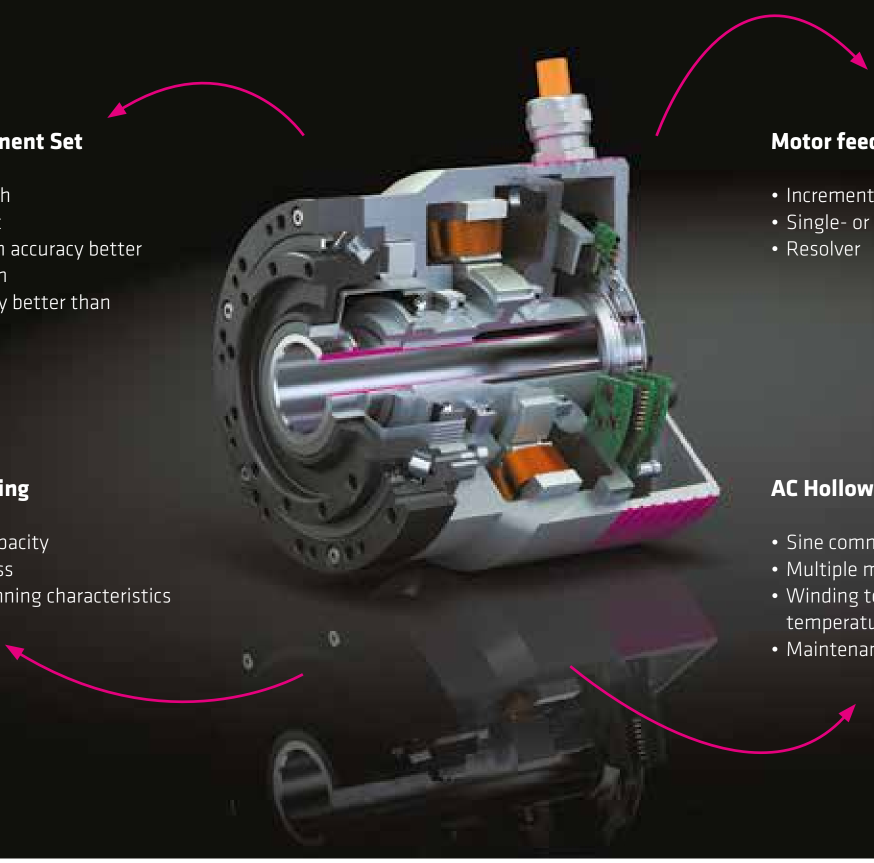
● available ○ on request – not available

Gear Component Set

- Zero backlash
- Hollow shaft
- Transmission accuracy better than 1 arcmin
- Repeatability better than ±6 arcsec

Motor feedback

- Incremental encoder
- Single- or multi-turn absolute encoder
- Resolver



Output bearing

- High load capacity
- High stiffness
- Excellent running characteristics

AC Hollow shaft motor

- Sine commutated hollow shaft AC motor
- Multiple motor winding options
- Winding temperature monitoring with temperature sensor
- Maintenance free

6. Technical Data

6.1 General Technical Data

CHA-xxC

Table 12.1

Insulation class (EN 60034-1)		F
Insulation resistance (500 VDC)	MΩ	100
Insulation voltage (10 s)	V_{rms}	2500
Lubrication		Harmonic Drive® Flexolub A1
Degree of protection (EN 60034-5)		IP65
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 68 Part 2-6, 10 ... 500 Hz)	g	5
Shock resistance (DIN IEC 68 Part 2-27, 18 ms)	g	30
Corrosion protection (DIN IEC 68 Part 2-11 salt spray test)	h	4
Temperature sensors		1 x KTY 84-130 // 1 x PTC

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 12.2

Series	**Size Version**	**Unit**	**Dimensions**
CHA-C	20C	[mm]	300 x 300 x 15
	25C	[mm]	350 x 350 x 18
	32C	[mm]	350 x 350 x 18
	40C	[mm]	400 x 400 x 20
	50C	[mm]	500 x 500 x 25
	58C	[mm]	600 x 600 x 30

6.2 Actuator Data CHA-20C

6.2.1 Tecnical data

Table 13.1

	Symbol [Unit]	CHA-20C					
Motor feedback system		ROO / MGS / SIE / DCO /MZE / SZE					
Ratio	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
Maximum output torque	T_{max} [Nm]	27	56	74	82	87	92
Maximum output speed	n_{max} [rpm]	200	120	75	60	50	38
Maximum current	I_{max} [A_{rms}]	2.9	3.8	3.1	2.8	2.5	2.1
Continuous stall torque	T_0 [Nm]	19	32	47	49	49	49
Continuous stall current	I_0 [A_{rms}]	2.1	2.1	1.9	1.6	1.4	1.0
Maximum DC bus voltage	U_{DCmax} [V_{DC}]	680					
Electrical time constant (20°C)	t_e [ms]	1.4					
Mechanical time constant (20°C) Version ROO	t_m [ms]	8.2					
Mechanical time constant (20°C) Version MGS	t_m [ms]	9.4					
Mechanical time constant (20°C) Version SIE	t_m [ms]	14.3					
Mechanical time constant (20°C) Version DCO	t_m [ms]	7.1					
No load current	I_{NLS} [A_{rms}]	0.19	0.17	0.14	0.14	0.13	0.13
No load running current constant (30°C)	K_{INL} [$x10^{-3}$ A_{rms}/rpm]	2	4	7	8	9	12
No load running current constant (80°C)	K_{INL} [$x10^{-3}$ A_{rms}/rpm]	0.7	2	2	3	4	5
Torque constant (at output)	k_{Tout} [Nm/A_{rms}]	9.9	16.5	26.8	33.4	40.1	53.5
Torque constant (at motor)	k_{TM} [Nm/A_{rms}]	0.36					
AC voltage constant (L-L, 20 °C, at motor)	k_{EM} [V_{rms}/1000 rpm]	23					
Motor terminal voltage (fundamental wave only)	U_M [V_{rms}]	220 ... 430					
Demagnetisation current	I_E [A_{rms}]	7.0					
Maximum motor speed	n_{max} [rpm]	6000					
Rated motor speed	n_N [rpm]	3500					
Resistance (L-L, 20°C)	R_{L-L} [Ω]	5.9					
Inductance (L-L)	L_{L-L} [mH]	8.0					
Number of pole pairs	p [ ]	5					
Weight without brake	m [kg]	3.3 (ROO) 3.1 (SIE / MGS / MZE / SZE) 3.0 (DCO)					
Weight with brake	m [kg]	4.0 (ROO) 3.8 (SIE / MGS / MZE / SZE) 3.7 (DCO)					
Hollow shaft diameter	d_h [mm]	18					

6.2.2 Moment of Inertia

Table 14.1

	Symbol [Unit]	CHA-20C					
Motor feedback system		ROO					
Ratio	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
Moment of Inertia output side							
Moment of inertia without brake	J_{out} [kgm²]	0.108	0.300	0.767	1.199	1.727	3.069
Moment of inertia with brake	J_{out} [kgm²]	0.142	0.395	1.012	1.581	2.277	4.047
Moment of Inertia at motor							
Moment of inertia at motor without brake	J [$x10^{-4}$ kgm²]	1.199					
Moment of inertia at motor with brake	J [$x10^{-4}$ kgm²]	1.581					
Motor feedback system		MGS					
Ratio	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
Moment of Inertia output side							
Moment of inertia without brake	J_{out} [kgm²]	0.124	0.346	0.884	1.382	1.990	3.538
Moment of inertia with brake	J_{out} [kgm²]	0.159	0.441	1.129	1.764	2.540	4.516
Moment of Inertia at motor							
Moment of inertia at motor without brake	J [$x10^{-4}$ kgm²]	1.382					
Moment of inertia at motor with brake	J [$x10^{-4}$ kgm²]	1.764					
Motor feedback system		SIE / MZE / SZE					
Ratio	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
Moment of Inertia output side							
Moment of inertia without brake	J_{out} [kgm²]	0.188	0.522	1.336	2.087	3.005	5.343
Moment of inertia with brake	J_{out} [kgm²]	0.222	0.617	1.580	2.469	3.555	6.321
Moment of Inertia at motor							
Moment of inertia at motor without brake	J [$x10^{-4}$ kgm²]	2.087					
Moment of inertia at motor with brake	J [$x10^{-4}$ kgm²]	2.469					
Motor feedback system		DCO					
Ratio	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
Moment of Inertia output side							
Moment of inertia without brake	J_{out} [kgm²]	0.093	0.258	0.661	1.033	1.488	2.644
Moment of inertia with brake	J_{out} [kgm²]	0.127	0.354	0.906	1.415	2.038	3.622
Moment of Inertia at motor							
Moment of inertia at motor without brake	J [$x10^{-4}$ kgm²]	1.033					
Moment of inertia at motor with brake	J [$x10^{-4}$ kgm²]	1.415					

6.2.3 Technical Data Brake

Table 14.2

	Symbol [Unit]	CHA-20C					
Ratio	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
Brake voltage	U_{Br} [V_{DC}]	24 ±10%					
Brake holding torque (at output)	T_{Br} [Nm]	27	45	72	82	87	92
Brake current to open	I_{OBr} [A_{DC}]	0.6					
Brake current to hold	I_{HBr} [A_{DC}]	0.3					
Number of brake cyles at n = 0 rpm		10000000					
Emergency brake cyles		200					
Opening time	t_O [ms]	110					
Closing time	t_C [ms]	70					

6.2.4 Performance Characteristics

The performance curves shown below are valid for the specified ambient operating temperature if the motor terminal voltage is higher or equal to the values given in the rating tables.

Illustration 15.1 CHA-20C-30

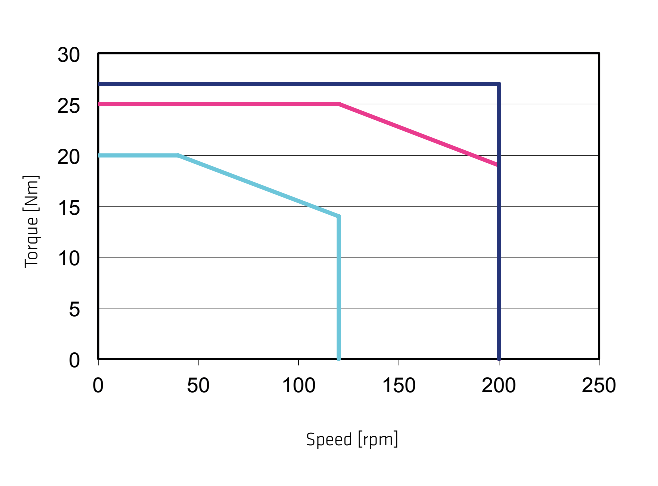


Illustration 15.2 CHA-20C-50

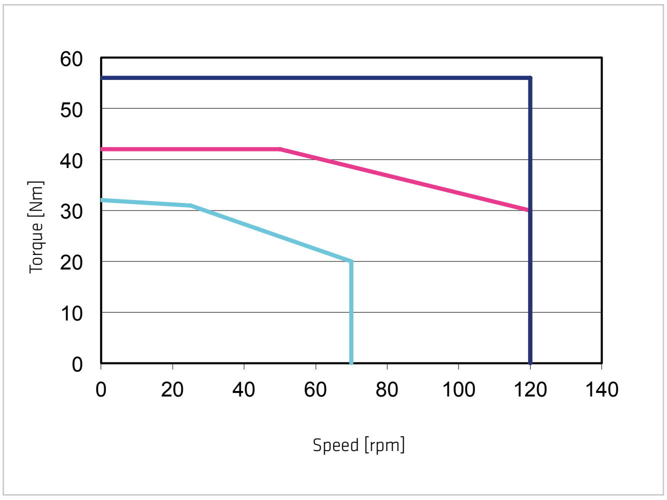


Illustration 15.3 CHA-20C-80

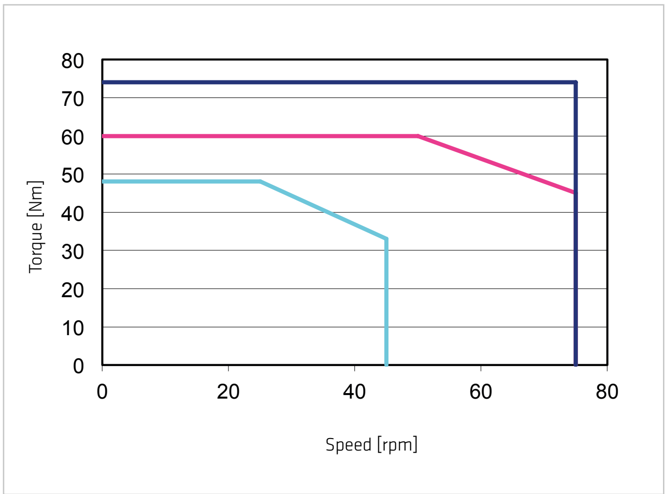


Illustration 15.4 CHA-20C-100

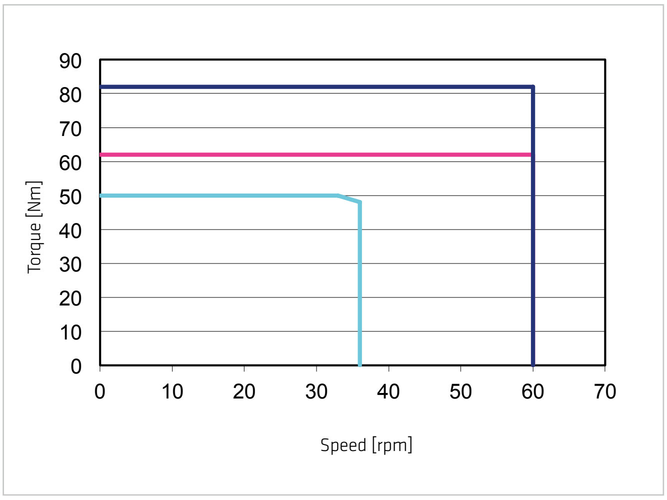


Illustration 15.5 CHA-20C-120

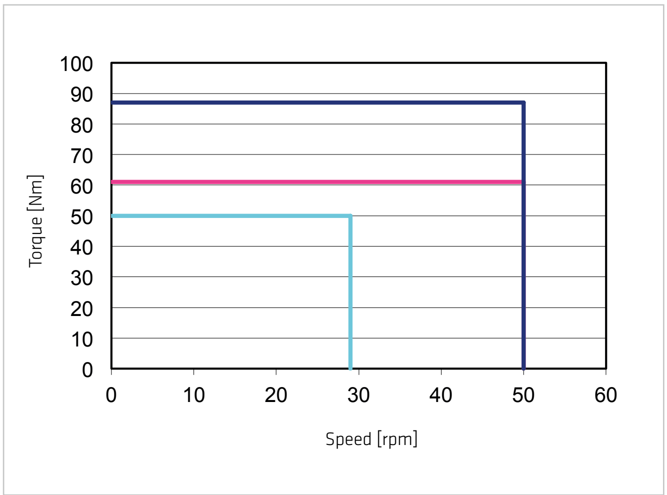
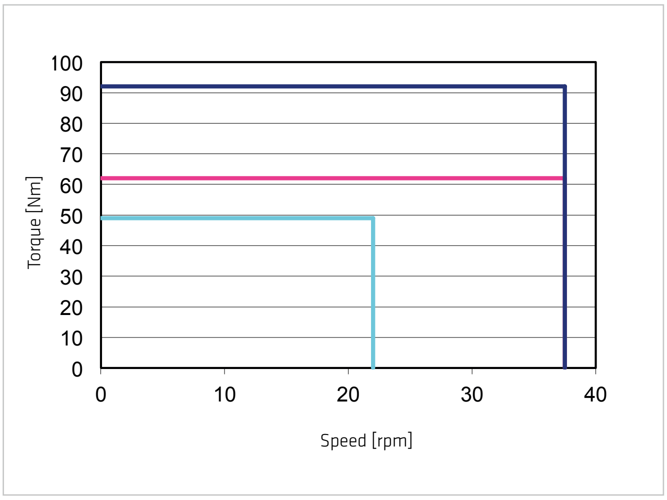


Illustration 15.6 CHA-20C-160



Legend

Intermittent duty —— U_M = 430 VAC —— S3-ED 50% (1 min) ——
Continuous duty —— U_M = 220 VAC - - - - -

6.3 Actuator Data CHA-25C

6.3.1 Tecnical data

Table 16.1

	Symbol [Unit]	CHA-25C					
Motor feedback system		MGS / SIE / MZE / SZE					
Ratio	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
Maximum output torque	T_{max} [Nm]	50	98	137	157	167	176
Maximum output speed	n_{max} [rpm]	187	112	70	56	47	35
Maximum current	I_{max} [A_{rms}]	3.5	4.0	3.4	3.2	2.8	2.2
Continuous stall torque	T_0 [Nm]	38	55	87	108	108	108
Continuous stall current	I_0 [A_{rms}]	2.7	2.3	2.2	2.2	1.9	1.4
Maximum DC bus voltage	U_{DCmax} [V_{DC}]	680					
Electrical time constant (20°C)	t_e [ms]	1.6					
Mechanical time constant (20°C)	t_m [ms]	7.8					
No load current	I_{NLS} [A_{rms}]	0.21	0.19	0.15	0.15	0.15	0.14
No load running current constant (30°C)	K_{INL} [$x10^{-3}$ A_{rms}/rpm]	4	6	10	12	14	19
No load running current constant (80°C)	K_{INL} [$x10^{-3}$ A_{rms}/rpm]	1	2	3	4	5	7
Torque constant (at output)	k_{Tout} [Nm/A_{rms}]	15.5	26.0	42.5	53.1	63.9	85.0
Torque constant (at motor)	k_{TM} [Nm/A_{rms}]	0.55					
AC voltage constant (L-L, 20°C, at motor)	k_{EM} [V_{rms}/1000 rpm]	37					
Motor terminal voltage (fundamental wave only)	U_M [V_{rms}]	220 ... 430					
Demagnetisation current	I_E [A_{rms}]	15					
Maximum motor speed	n_{max} [rpm]	5600					
Rated motor speed	n_N [rpm]	3500					
Resistance (L-L, 20°C)	R_{L-L} [Ω]	3.7					
Inductance (L-L)	L_{L-L} [mH]	6.0					
Number of pole pairs	p [ ]	6					
Weight without brake	m [kg]	4.8					
Weight with brake	m [kg]	6.0					
Hollow shaft diameter	d_h [mm]	27					

6.3.2 Moment of Inertia

Table 17.2

	Symbol [Unit]	CHA-25C					
Motor feedback system		SIE / MZE / SZE					
Ratio	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
Moment of Inertia output side							
Moment of inertia without brake	J_{out} [kgm²]	0.38	1.06	2.72	4.25	6.11	10.9
Moment of inertia with brake	J_{out} [kgm²]	0.53	1.48	3.79	5.92	8.52	15.2
Moment of Inertia at motor							
Moment of inertia at motor without brake	J [$x10^{-4}$ kgm²]	4.246					
Moment of inertia at motor with brake	J [$x10^{-4}$ kgm²]	5.920					

Table 17.3

	Symbol [Unit]	CHA-25C					
Motor feedback system		MGS					
Ratio	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
Moment of Inertia output side							
Moment of inertia without brake	J_{out} [kgm²]	0.37	1.02	2.62	4.10	5.90	10.5
Moment of inertia with brake	J_{out} [kgm²]	0.52	1.44	3.69	5.77	8.31	14.8
Moment of Inertia at motor							
Moment of inertia at motor without brake	J [$x10^{-4}$ kgm²]	4.10					
Moment of inertia at motor with brake	J [$x10^{-4}$ kgm²]	5.77					

6.3.3 Technical Data Brake

Table 17.1

	Symbol [Unit]	CHA-25C					
Ratio	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
Brake voltage	U_{Br} [V_{DC}]	24 ±10%					
Brake holding torque (at output)	T_{Br} [Nm]	54	90	137	157	167	176
Brake current to open	I_{OBr} [A_{DC}]	0.9					
Brake current to hold (10V)	I_{HBr} [A_{DC}]	0.4					
Number of brake cyles at n = 0 rpm		10000000					
Emergency brake cyles		200					
Opening time	t_O [ms]	110					
Closing time	t_C [ms]	70					

6.3.4 Performance Characteristics

The performance curves shown below are valid for the specified ambient operating temperature if the motor terminal voltage is higher or equal to the values given in the rating tables.

Illustration 18.1 CHA-25C-30

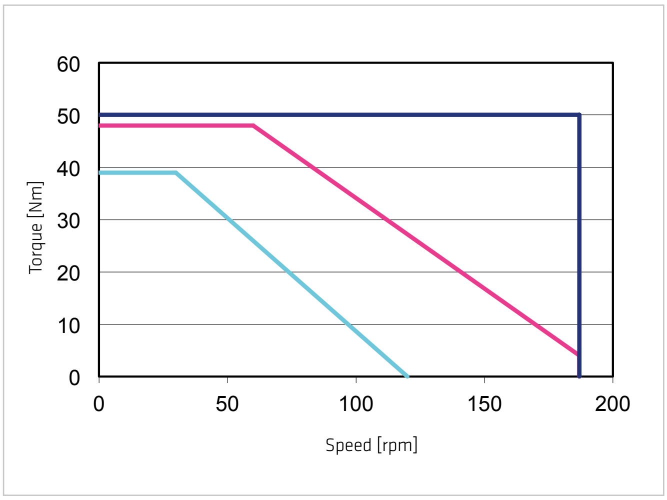


Illustration 18.2 CHA-25C-50

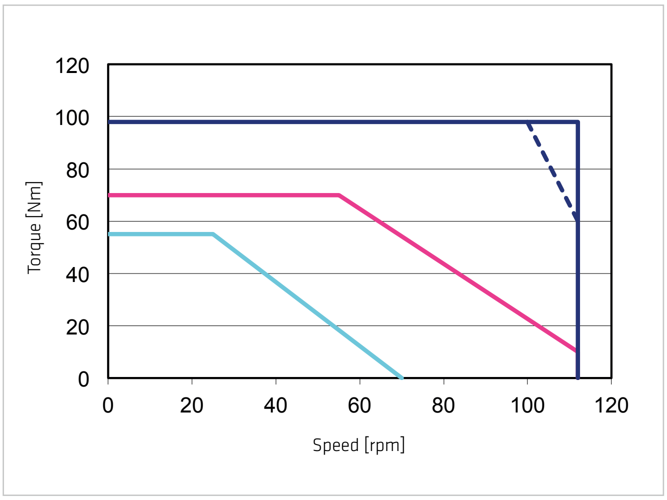


Illustration 18.3 CHA-25C-80

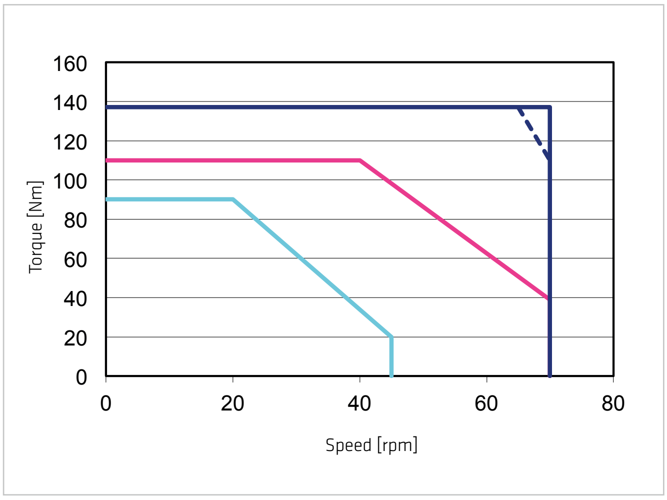


Illustration 18.4 CHA-25C-100

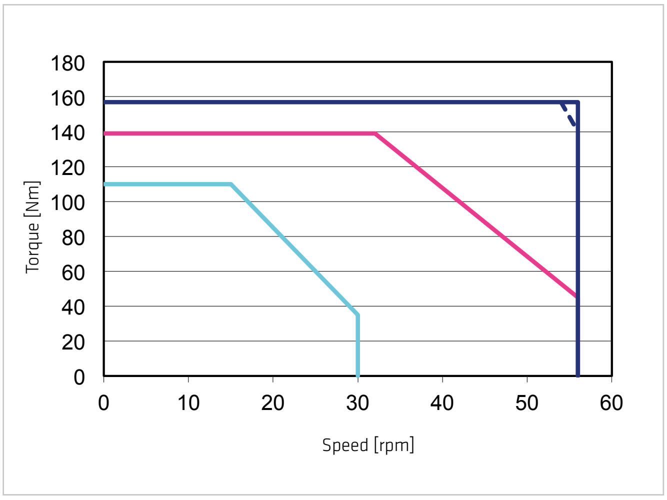


Illustration 18.5 CHA-25C-120

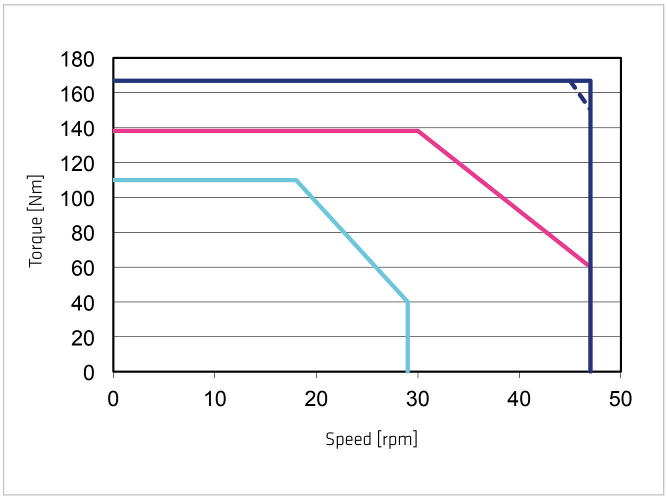
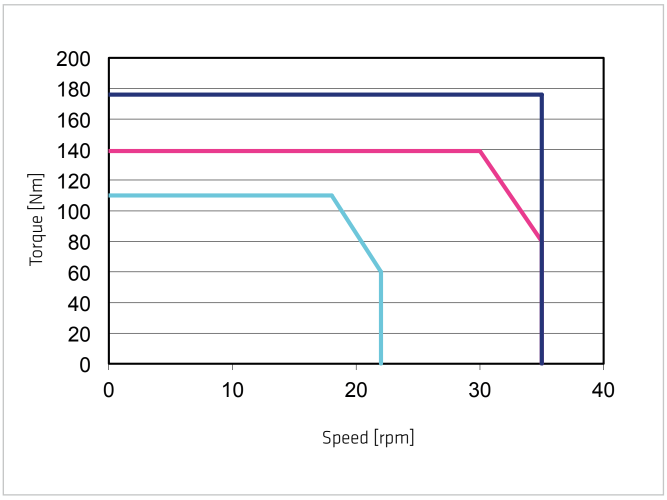


Illustration 18.6 CHA-25C-160



Legend

Intermittent duty ——— U_M = 430 VAC ——— S3-ED 50% (1 min) ———

Continuous duty ——— U_M = 220 VAC - - - - - -

6.4 Actuator Data CHA-32C

6.4.1 Tecnical data

Table 19.1

	Symbol [Unit]	CHA-32C					
Motor feedback system		MGS / SIE / MZE / SZE					
Ratio	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
Maximum output torque	T_{max} [Nm]	100	216	304	333	353	372
Maximum output speed	n_{max} [rpm]	160	96	60	48	40	30
Maximum current	I_{max} [A_{rms}]	7.1	9.8	8.3	7.2	6.3	5.3
Continuous stall torque	T_0 [Nm]	44	71	119	154	179	216
Continuous stall current	I_0 [A_{rms}]	3.2	3.2	3.2	3.2	3.2	2.9
Maximum DC bus voltage	U_{DCmax} [V_{DC}]	680					
Electrical time constant (20°C)	t_e [ms]	1.6					
Mechanical time constant (20°C)	t_m [ms]	11.5					
No load current	I_{NLS} [A_{rms}]	0.30	0.30	0.20	0.20	0.20	0.18
No load running current constant (30°C)	K_{INL} [x10^{-3} A_{rms}/rpm]	6	10	17	21	25	34
No load running current constant (80°C)	K_{INL} [x10^{-3} A_{rms}/rpm]	2	3	6	7	8	11
Torque constant (at output)	k_{Tout} [Nm/A_{rms}]	15.5	25.9	42.1	52.5	63.0	84.5
Torque constant (at motor)	k_{TM} [Nm/A_{rms}]	0.55					
AC voltage constant (L-L, 20°C, at motor)	k_{EM} [V_{rms}/1000 rpm]	37					
Motor terminal voltage (fundamental wave only)	U_M [V_{rms}]	220 ... 430					
Demagnetisation current	I_E [A_{rms}]	15					
Maximum motor speed	n_{max} [rpm]	4800					
Rated motor speed	n_N [rpm]	3500					
Resistance (L-L, 20°C)	R_{L-L} [Ω]	3.7					
Inductance (L-L)	L_{L-L} [mH]	6.0					
Number of pole pairs	p [ ]	6					
Weight without brake	m [kg]	7.3					
Weight with brake	m [kg]	8.4					
Hollow shaft diameter	d_h [mm]	32					

6.4.2 Moment of Inertia

Table 20.2

	Symbol [Unit]	CHA-32C					
Motor feedback system		SIE / MZE / SZE					
Ratio	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
Moment of Inertia output side							
Moment of inertia without brake	J_{out} [kgm^2]	0.56	1.57	4.00	6.26	9.01	16.0
Moment of inertia with brake	J_{out} [kgm^2]	0.68	1.88	4.81	7.52	10.9	19.3
Moment of Inertia at motor							
Moment of inertia at motor without brake	J [$x10^{-4}$ kgm^2]	6.26					
Moment of inertia at motor with brake	J [$x10^{-4}$ kgm^2]	7.52					

Table 20.3

	Symbol [Unit]	CHA-32C					
Motor feedback system		MGS					
Ratio	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
Moment of Inertia output side							
Moment of inertia without brake	J_{out} [kgm^2]	0.55	1.53	3.91	6.11	8.80	15.6
Moment of inertia with brake	J_{out} [kgm^2]	0.66	1.84	4.72	7.37	10.6	18.9
Moment of Inertia at motor							
Moment of inertia at motor without brake	J [$x10^{-4}$ kgm^2]	6.11					
Moment of inertia at motor with brake	J [$x10^{-4}$ kgm^2]	7.37					

6.4.4 Technical Data Brake

Table 20.1

	Symbol [Unit]	CHA-32C					
Ratio	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
Brake voltage	U_{Br} [V_{DC}]	24 ±10%					
Brake holding torque (at output)	T_{Br} [Nm]	54	90	144	180	216	288
Brake current to open	I_{OBr} [A_{DC}]	0.9					
Brake current to hold (10V)	I_{HBr} [A_{DC}]	0.4					
Number of brake cycles at n = 0 rpm		10000000					
Emergency brake cyles		200					
Opening time	t_O [ms]	110					
Closing time	t_C [ms]	70					

6.4.4 Performance Characteristics

The performance curves shown below are valid for the specified ambient operating temperature if the motor terminal voltage is higher or equal to the values given in the rating tables.

Illustration 21.1 CHA-32C-30

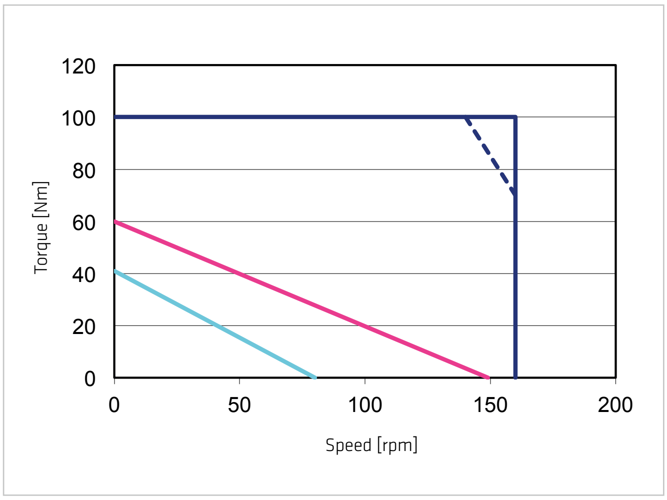


Illustration 21.2 CHA-32C-50

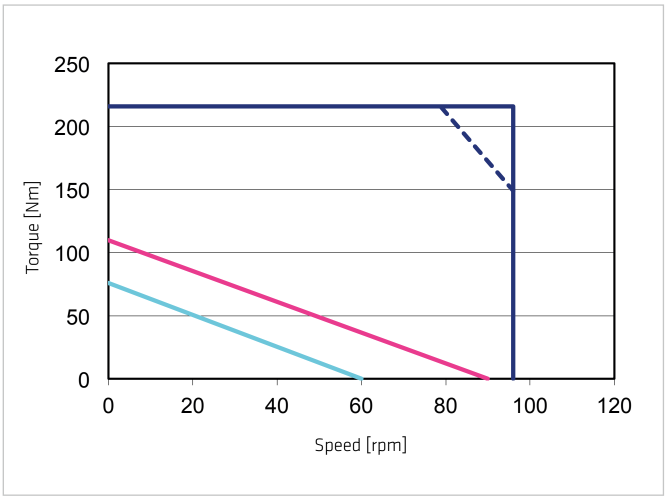


Illustration 21.3 CHA-32C-80

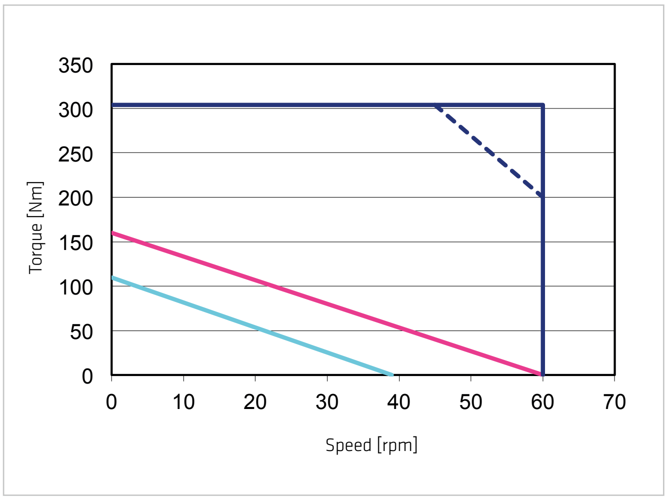


Illustration 21.4 CHA-32C-100

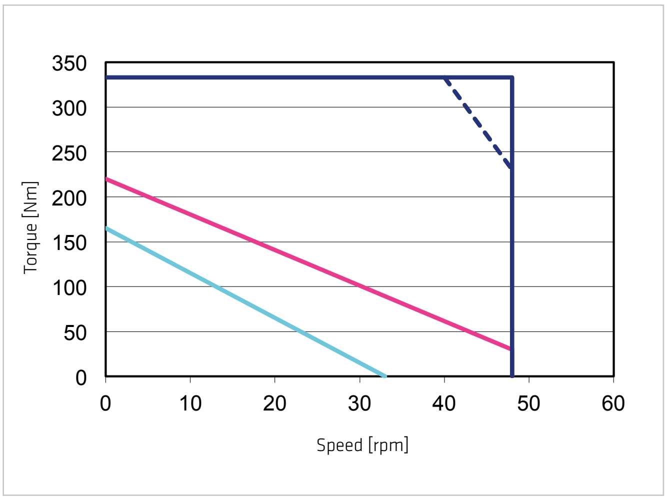


Illustration 21.5 CHA-32C-120

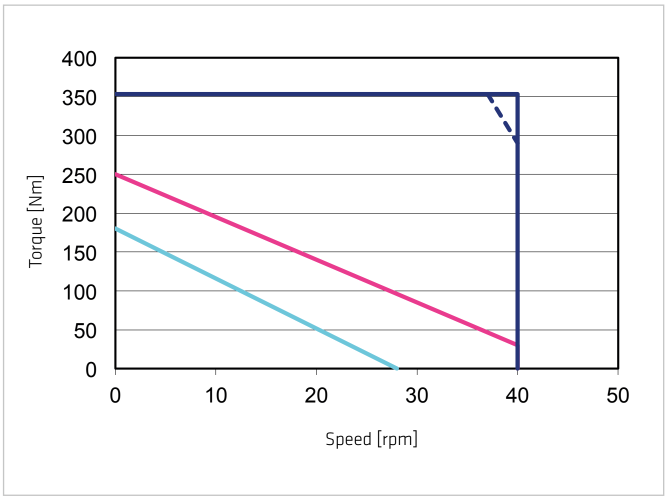
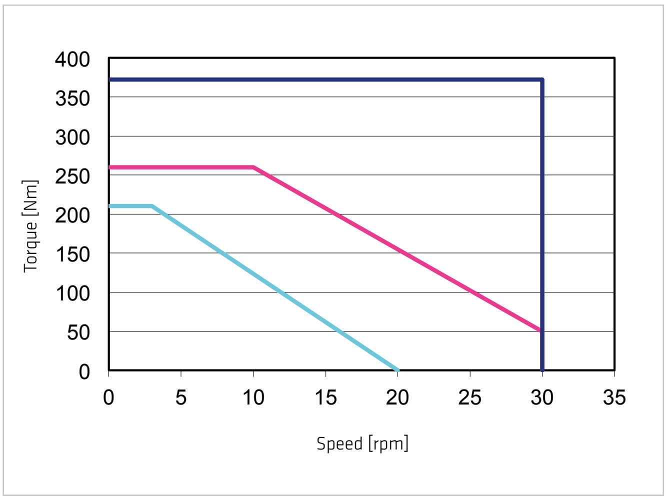


Illustration 21.6 CHA-32C-160



Legend

Intermittent duty ——— U_M = 430 VAC ——— S3-ED 50% (1 min) ———
Continuous duty ——— U_M = 220 VAC - - - - - -

6.5 Actuator Data CHA-40C

6.5.1 Tecnical data

Table 22.1

	Symbol [Unit]	CHA-40C				
Motor feedback system		MGS / SIE / MZE / SZE				
Ratio	i [ ]	**50**	**80**	**100**	**120**	**160**
Maximum output torque	T_{max} [Nm]	402	519	568	617	647
Maximum output speed	n_{max} [rpm]	80	50	40	33	25
Maximum current	I_{max} [A_{rms}]	11.8	9.2	8.1	7.3	5.9
Continuous stall torque	T_0 [Nm]	125	208	260	314	420
Continuous stall current	I_0 [A_{rms}]	3.6	3.6	3.6	3.6	3.6
Maximum DC bus voltage	U_{DCmax} [V_{DC}]	680				
Electrical time constant (20°C)	t_e [ms]	2.1				
Mechanical time constant (20°C)	t_m [ms]	8.4				
No load current	I_{NLS} [A_{rms}]	0.30	0.20	0.20	0.20	0.20
No load running current constant (30°C)	K_{INL} [x10^{-3} A_{rms}/rpm]	13	20	25	30	40
No load running current constant (80°C)	K_{INL} [x10^{-3} A_{rms}/rpm]	4	6	8	10	13
Torque constant (at output)	k_{Tout} [Nm/A_{rms}]	38	62	77	92	123
Torque constant (at motor)	k_{TM} [Nm/A_{rms}]	0.83				
AC voltage constant (L-L, 20°C, at motor)	k_{EM} [V_{rms}/1000 rpm]	53				
Motor terminal voltage (fundamental wave only)	U_M [V_{rms}]	220 ... 430				
Demagnetisation current	I_E [A_{rms}]	18				
Maximum motor speed	n_{max} [rpm]	4000				
Rated motor speed	n_N [rpm]	3000				
Resistance (L-L, 20°C)	R_{L-L} [Ω]	2.9				
Inductance (L-L)	L_{L-L} [mH]	6.0				
Number of pole pairs	p [ ]	6				
Weight without brake	m [kg]	11.9				
Weight with brake	m [kg]	13.2				
Hollow shaft diameter	d_h [mm]	39				

6.5.2 Moment of Inertia

Table 23.2

	Symbol [Unit]	CHA-40C				
Motor feedback system		SIE / MZE /SZE				
Ratio	i [ ]	**50**	**80**	**100**	**120**	**160**
Moment of Inertia output side						
Moment of inertia without brake	J_{out} [kgm²]	3.33	8.53	13.3	19.2	34.1
Moment of inertia with brake	J_{out} [kgm²]	3.80	9.73	15.2	21.9	38.9
Moment of Inertia at motor						
Moment of inertia at motor without brake	J [x10⁻⁴ kgm²]	13.3				
Moment of inertia at motor with brake	J [x10⁻⁴ kgm²]	15.2				

Table 23.3

	Symbol [Unit]	CHA-40C				
Motor feedback system		MGS				
Ratio	i [ ]	**50**	**80**	**100**	**120**	**160**
Moment of Inertia output side						
Moment of inertia without brake	J_{out} [kgm²]	3.78	9.67	15.1	21.8	38.7
Moment of inertia with brake	J_{out} [kgm²]	4.25	10.9	17.0	24.5	43.5
Moment of Inertia at motor						
Moment of inertia at motor without brake	J [x10⁻⁴ kgm²]	15.1				
Moment of inertia at motor with brake	J [x10⁻⁴ kgm²]	17.0				

6.5.3 Technical Data Brake

Table 23.1

	Symbol [Unit]	CHA-40C				
Ratio	i [ ]	**50**	**80**	**100**	**120**	**160**
Brake voltage	U_{Br} [V_{DC}]	24 ±10%				
Brake holding torque (at output)	T_{Br} [Nm]	225	360	450	540	647
Brake current to open	I_{OBr} [A_{DC}]	0.7				
Brake current to hold (10V)	I_{HBr} [A_{DC}]	0.3				
Number of brake cyles at n = 0 rpm		10000000				
Emergency brake cyles		200				
Opening time	t_O [ms]	110				
Closing time	t_C [ms]	70				

6.5.4 Performance Characteristics

The performance curves shown below are valid for the specified ambient operating temperature if the motor terminal voltage is higher or equal to the values given in the rating tables.

Illustration 24.1 CHA-40C-50

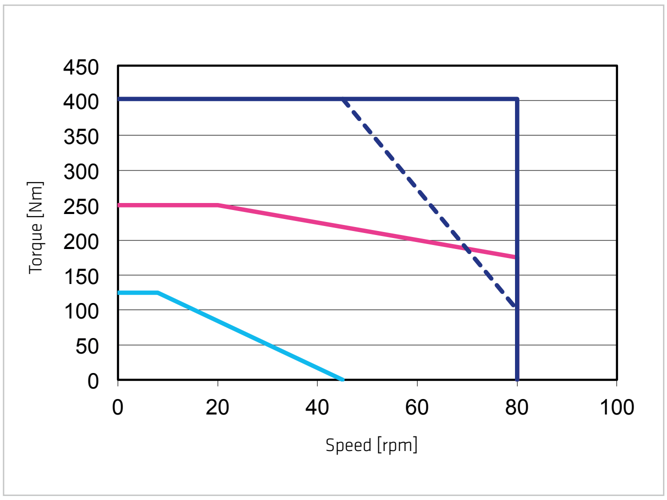


Illustration 24.2 CHA-40C-80

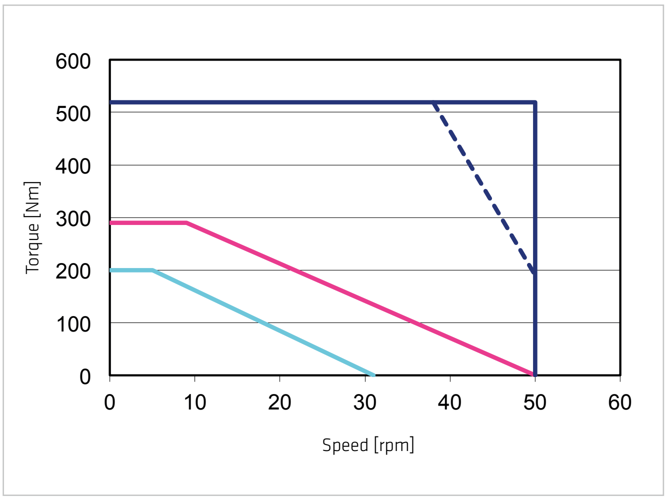


Illustration 24.3 CHA-40C-100

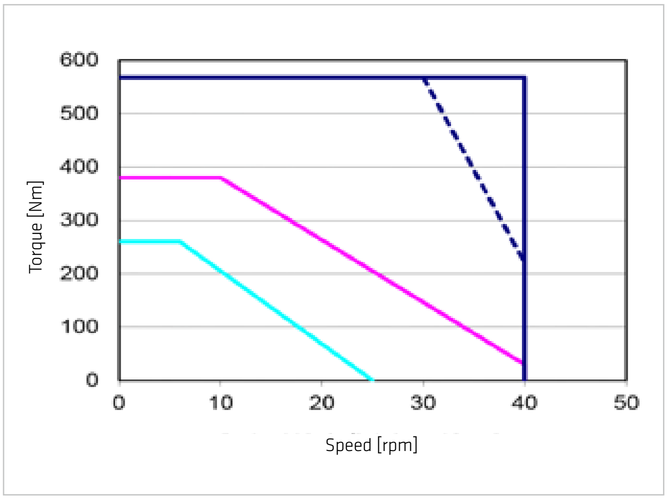


Illustration 24.4 CHA-40C-120

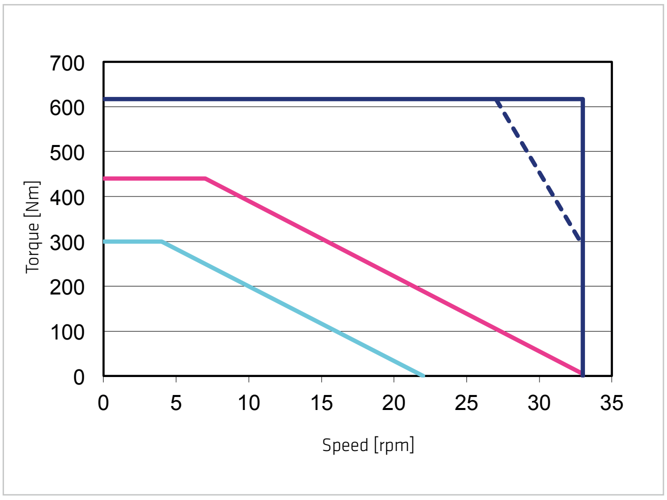
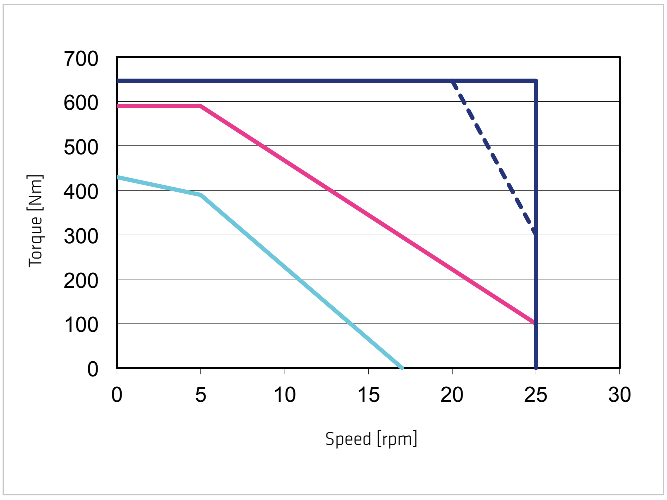


Illustration 24.5 CHA-40C-160



Legend

Intermittent duty ——— U_M = 430 VAC ——— S3-ED 50% (1 min) ———

Continuous duty ——— U_M = 220 VAC - - - - -

6.6 Actuator Data CHA-50C

6.6.1 Tecnical data

Table 25.1

	Symbol [Unit]	CHA-50C				
Motor feedback system		MGS / SIE / MZE / SZE				
Ratio	i [ ]	**50**	**80**	**100**	**120**	**160**
Maximum output torque	T_{max} [Nm]	715	941	980	1080	1180
Maximum output speed	n_{max} [rpm]	70	44	35	30	22
Maximum current	I_{max} [A_{rms}]	10.2	8.3	6.9	6.4	5.3
Continuous stall torque	T_0 [Nm]	194	363	456	550	736
Continuous stall current	I_0 [A_{rms}]	2.9	3.2	3.2	3.2	3.1
Maximum DC bus voltage	U_{DCmax} [V_{DC}]	680				
Electrical time constant (20°C)	t_e [ms]	3.4				
Mechanical time constant (20°C)	t_m [ms]	5.9				
No load current	I_{NLS} [A_{rms}]	0.30	0.20	0.20	0.17	0.16
No load running current constant (30°C)	K_{INL} [x10^{-3} A_{rms}/rpm]	12	20	25	29	39
No load running current constant (80°C)	K_{INL} [x10^{-3} A_{rms}/rpm]	4	6	8	9	12
Torque constant (at output)	k_{Tout} [Nm/A_{rms}]	74	121	145	181	242
Torque constant (at motor)	k_{TM} [Nm/A_{rms}]	1.60				
AC voltage constant (L-L, 20°C, at motor)	k_{EM} [V_{rms}/1000 rpm]	104				
Motor terminal voltage (fundamental wave only)	U_M [V_{rms}]	220 ... 430				
Demagnetisation current	I_E [A_{rms}]	18				
Maximum motor speed	n_{max} [rpm]	3500				
Rated motor speed	n_N [rpm]	2500				
Resistance (L-L, 20°C)	R_{L-L} [Ω]	3.5				
Inductance (L-L)	L_{L-L} [mH]	12				
Number of pole pairs	p [ ]	6				
Weight without brake	m [kg]	19.8				
Weight with brake	m [kg]	21.0				
Hollow shaft diameter	d_h [mm]	42				

6.6.2 Moment of Inertia

Table 26.2

	Symbol [Unit]	CHA-50C				
Motor feedback system		SIE /MZE /SZE				
Ratio	i [ ]	**50**	**80**	**100**	**120**	**160**
Moment of Inertia output side						
Moment of inertia without brake	J_{out} [kgm²]	7.23	18.5	28.9	41.7	74.1
Moment of inertia with brake	J_{out} [kgm²]	7.56	19.3	30.2	43.5	77.4
Moment of Inertia at motor						
Moment of inertia at motor without brake	J [$x10^{-4}$ kgm²]	28,9				
Moment of inertia at motor with brake	J [$x10^{-4}$ kgm²]	30,2				

Table 26.3

	Symbol [Unit]	CHA-50C				
Motor feedback system		MGS				
Ratio	i [ ]	**50**	**80**	**100**	**120**	**160**
Moment of Inertia output side						
Moment of inertia without brake	J_{out} [kgm²]	7.68	19.7	30.7	44.2	78.6
Moment of inertia with brake	J_{out} [kgm²]	8.00	20.5	32.0	46.1	82.0
Moment of Inertia at motor						
Moment of inertia at motor without brake	J [$x10^{-4}$ kgm²]	30.7				
Moment of inertia at motor with brake	J [$x10^{-4}$ kgm²]	32.0				

6.6.3 Technical Data Brake

Table 26.1

	Symbol [Unit]	CHA-50C				
Ratio	i [ ]	**50**	**80**	**100**	**120**	**160**
Brake voltage	U_{Br} [V_{DC}]	24 ±10%				
Brake holding torque (at output)	T_{Br} [Nm]	225	360	450	540	647
Brake current to open	I_{OBr} [A_{DC}]	0.7				
Brake current to hold (10V)	I_{HBr} [A_{DC}]	0.3				
Number of brake cyles at n = 0 rpm		10000000				
Emergency brake cyles		200				
Opening time	t_O [ms]	110				
Closing time	t_C [ms]	70				

6.6.4 Performance Characteristics

The performance curves shown below are valid for the specified ambient operating temperature if the motor terminal voltage is higher or equal to the values given in the ratings table.

Illustration 27.1 CHA-50C-50

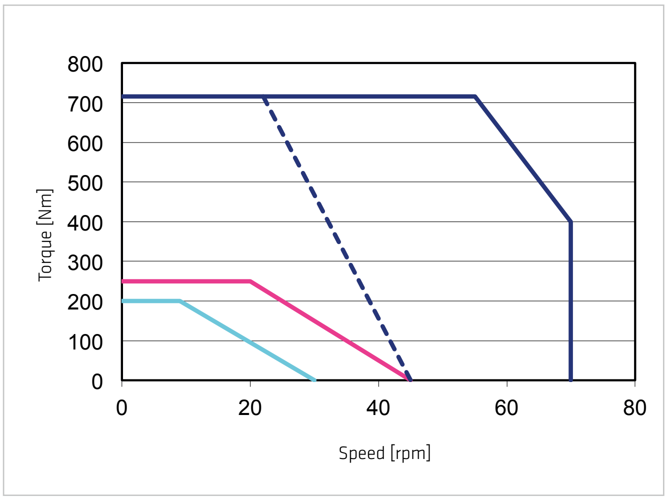


Illustration 27.2 CHA-50C-80

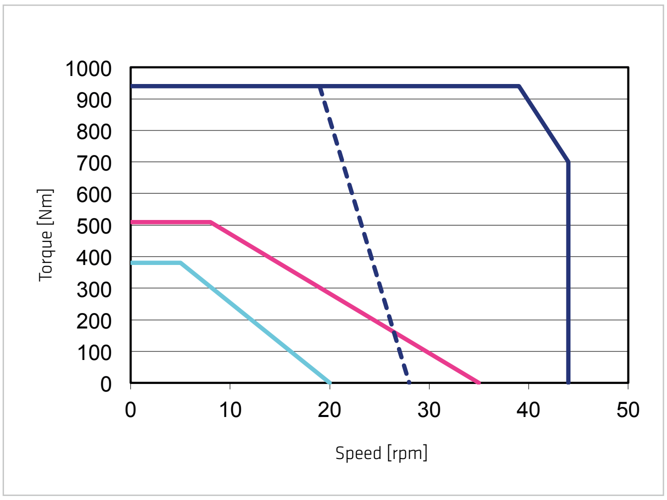


Illustration 27.3 CHA-50C-100

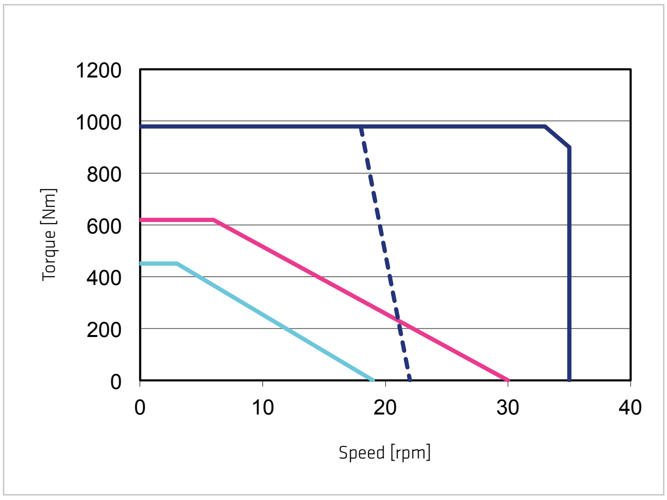


Illustration 27.4 CHA-50C-120

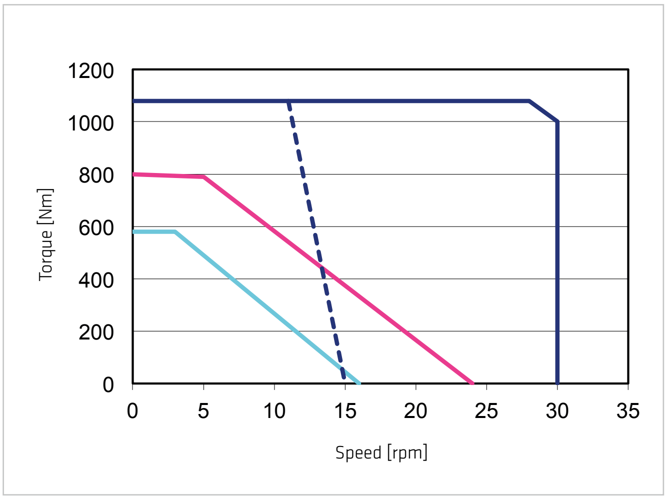
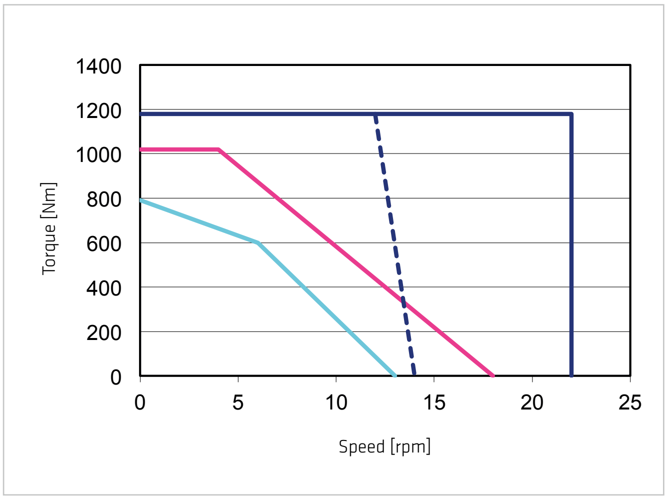


Illustration 27.5 CHA-50C-160



Legend

Intermittent duty ——— U_M = 430 VAC ——— S3-ED 50% (1 min) ———
Continuous duty ——— U_M = 220 VAC - - - - -

6.7 Actuator Data CHA-58C

6.7.1 Tecnical data

Table 28.1

	Symbol [Unit]	CHA-58C				
Motor feedback system		MGS / SIE / MZE / SZE				
Ratio	i [ ]	**50**	**80**	**100**	**120**	**160**
Maximum output torque	T_{max} [Nm]	1020	1480	1590	1720	1840
Maximum output speed	n_{max} [rpm]	60	38	30	25	19
Maximum current	I_{max} [A_{rms}]	14.4	12.8	11.1	10.0	8.1
Continuous stall torque	T_0 [Nm]	280	532	670	805	1080
Continuous stall current	I_0 [A_{rms}]	4.2	4.6	4.6	4.6	4.6
Maximum DC bus voltage	U_{DCmax} [V_{DC}]	680				
Electrical time constant (20°C)	t_e [ms]	3.5				
Mechanical time constant (20°C)	t_m [ms]	5.9				
No load current	I_{NLS} [A_{rms}]	0.40	0.28	0.26	0.25	0.23
No load running current constant (30°C)	K_{INL} [x10^{-3} A_{rms}/rpm]	19	30	38	46	61
No load running current constant (80°C)	K_{INL} [x10^{-3} A_{rms}/rpm]	6	10	12	15	19
Torque constant (at output)	k_{Tout} [Nm/A_{rms}]	75	122	152	183	244
Torque constant (at motor)	k_{TM} [Nm/A_{rms}]	1.70				
AC voltage constant (L-L, 20°C, at motor)	k_{EM} [V_{rms}/1000 rpm]	105				
Motor terminal voltage (fundamental wave only)	U_M [V_{rms}]	220 ... 430				
Demagnetisation current	I_E [A_{rms}]	25				
Maximum motor speed	n_{max} [rpm]	3000				
Rated motor speed	n_N [rpm]	2000				
Resistance (L-L, 20°C)	R_{L-L} [Ω]	2.4				
Inductance (L-L)	L_{L-L} [mH]	9.0				
Number of pole pairs	p [ ]	6				
Weight without brake	m [kg]	27.5				
Weight with brake	m [kg]	28.8				
Hollow shaft diameter	d_h [mm]	42				

6.7.2 Moment of Inertia

Table 29.2

	Symbol [Unit]	CHA-58C				
Motor feedback system		SIE /MZE /SZE				
Ratio	i [ ]	**50**	**80**	**100**	**120**	**160**
Moment of Inertia output side						
Moment of inertia without brake	J_{out} [kgm²]	11.8	30.1	47.1	67.8	120
Moment of inertia with brake	J_{out} [kgm²]	12.1	31.0	48.4	69.6	124
Moment of Inertia at motor						
Moment of inertia at motor without brake	J [x10^{-4} kgm²]	47.1				
Moment of inertia at motor with brake	J [x10^{-4} kgm²]	48.4				

Table 29.3

	Symbol [Unit]	CHA-58C				
Motor feedback system		MGS				
Ratio	i [ ]	**50**	**80**	**100**	**120**	**160**
Moment of Inertia output side						
Moment of inertia without brake	J_{out} [kgm²]	12.2	31.3	48.8	70.3	125
Moment of inertia with brake	J_{out} [kgm²]	12.5	32.1	50.1	72.2	128
Moment of Inertia at motor						
Moment of inertia at motor without brake	J [x10^{-4} kgm²]	48.8				
Moment of inertia at motor with brake	J [x10^{-4} kgm²]	50.1				

6.7.3 Technical Data Brake

Table 29.1

	Symbol [Unit]	CHA-58C				
Ratio	i [ ]	**50**	**80**	**100**	**120**	**160**
Brake voltage	U_{Br} [V_{DC}]	24 ±10%				
Brake holding torque (at output)	T_{Br} [Nm]	450	720	900	1080	1440
Brake current to open	I_{OBr} [A_{DC}]	0.7				
Brake current to hold (10V)	I_{HBr} [A_{DC}]	0.5				
Number of brake cycles at n = 0 rpm		10000000				
Emergency brake cyles		200				
Opening time	t_0 [ms]	110				
Closing time	t_C [ms]	70				

6.7.4 Performance Characteristics

The performance curves shown below are valid for the specified ambient operating temperature if the motor terminal voltage is higher or equal to the values given in the rating tables.

Illustration 30.1 CHA-58C-50

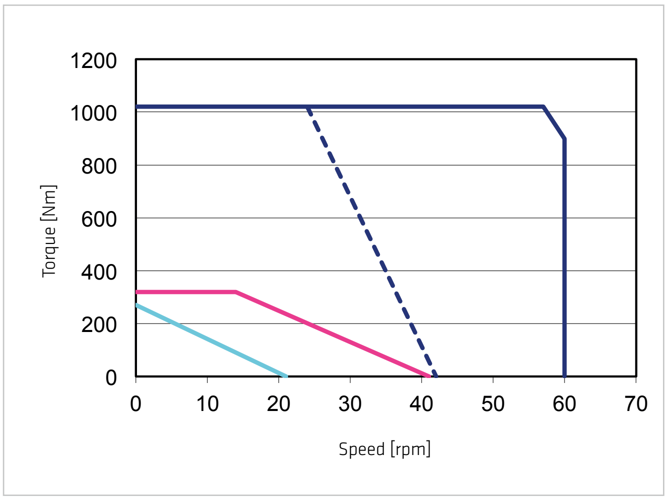


Illustration 30.2 CHA-58C-80

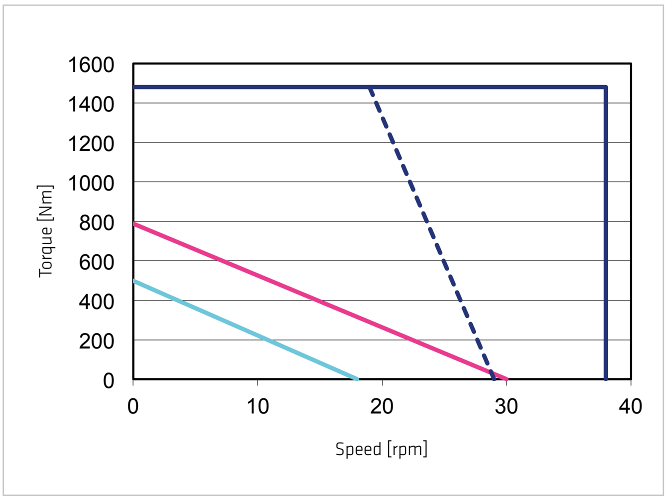


Illustration 30.3 CHA-58C-100

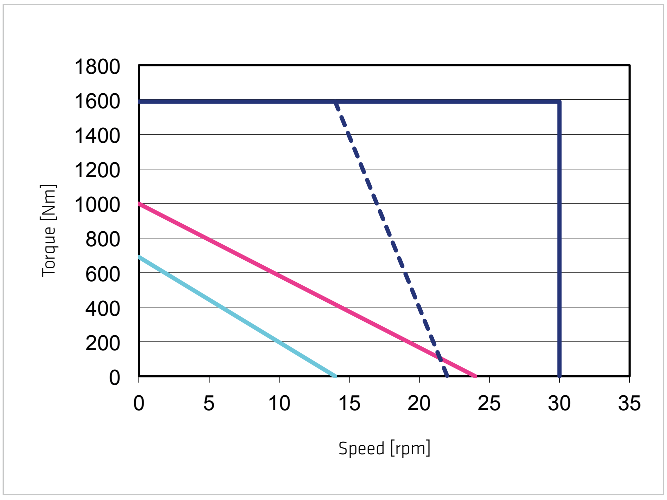


Illustration 30.4 CHA-58C-120

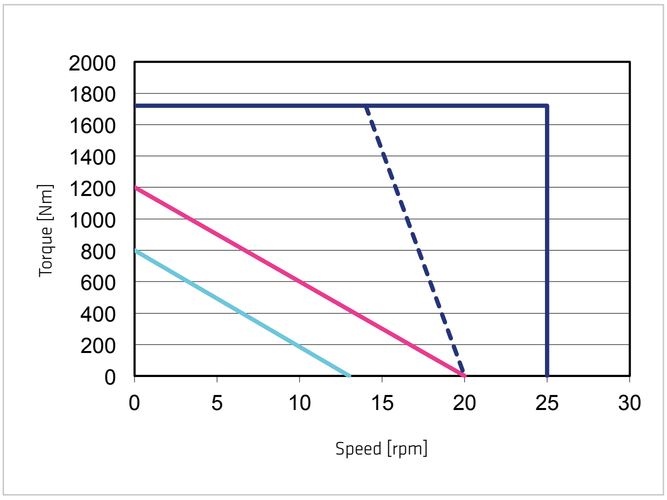
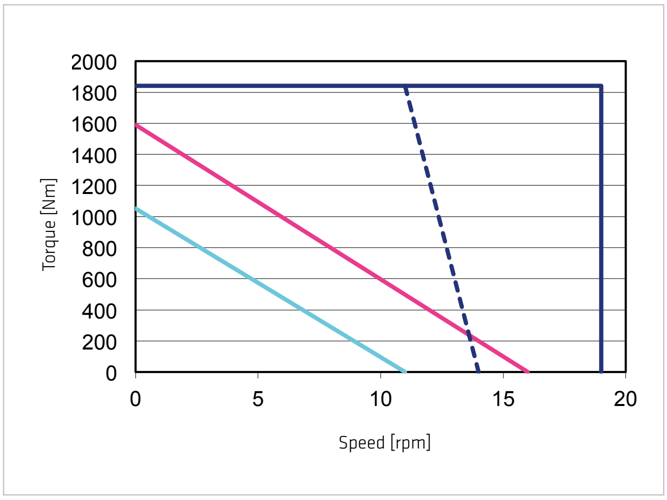


Illustration 30.5 CHA-58C-160



Legend

Intermittent duty ——— U_M = 430 VAC ——— S3-ED 50% (1 min) ———
Continuous duty ——— U_M = 220 VAC - - - - -

6.8 Dimensions

Illustration 31.1 CHA-20C [mm]

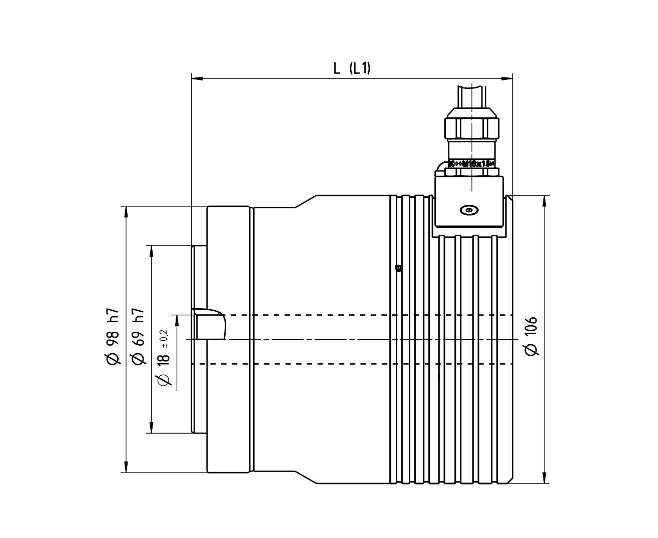


Illustration 31.2 CHA-25C [mm]

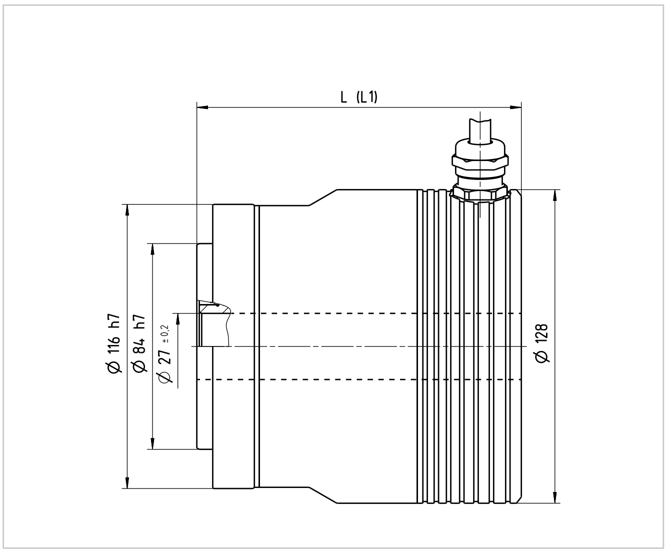


Table 31.3

	Symbol [Unit]	CHA-20C	CHA-25C
Motor feedback system		MGS / SIE / DCO / MZE / SZE	MGS / SIE / MZE / SZE
Length (without brake)	L [mm]	118	132.5
Length (with brake)	L1 [mm]	139	160
Standard cable length	L [m]	1.5	1.5

Illustration 31.4 CHA-32C [mm]

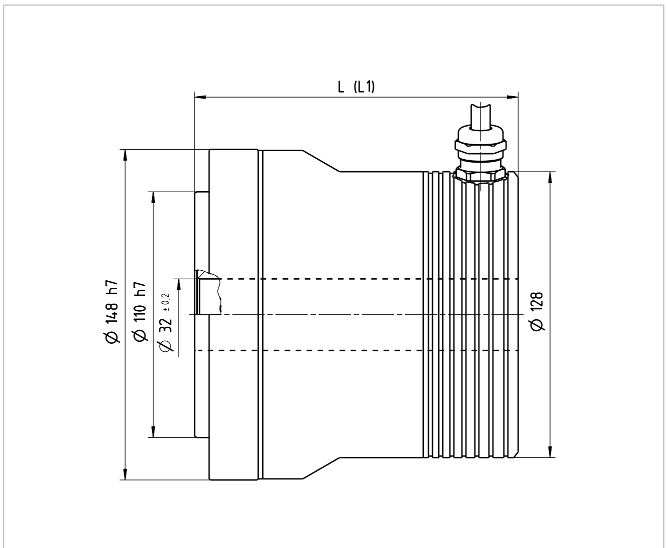


Illustration 31.5 CHA-40C [mm]

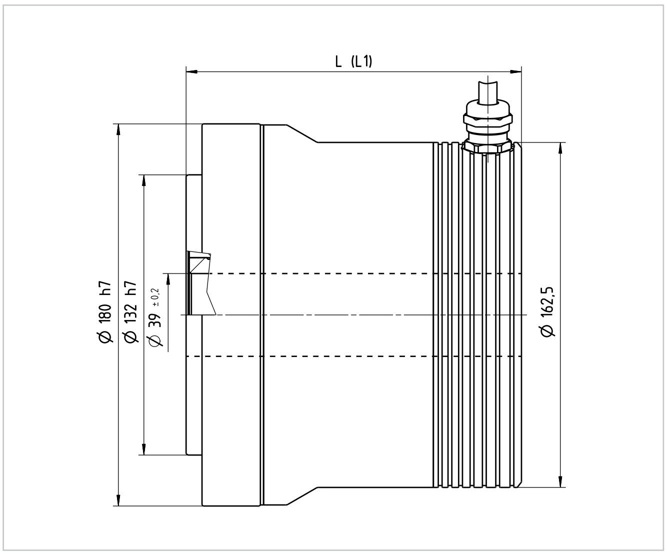


Table 31.6

	Symbol [Unit]	CHA-32C	CHA-40C
Motor feedback system		MGS / SIE / MZE / SZE	MGS / SIE / MZE / SZE
Length (without brake)	L [mm]	145	158
Length (with brake)	L1 [mm]	172.5	177
Standard cable length	L [m]	1.5	1.5

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Illustration 32.1 CHA-50C [mm]

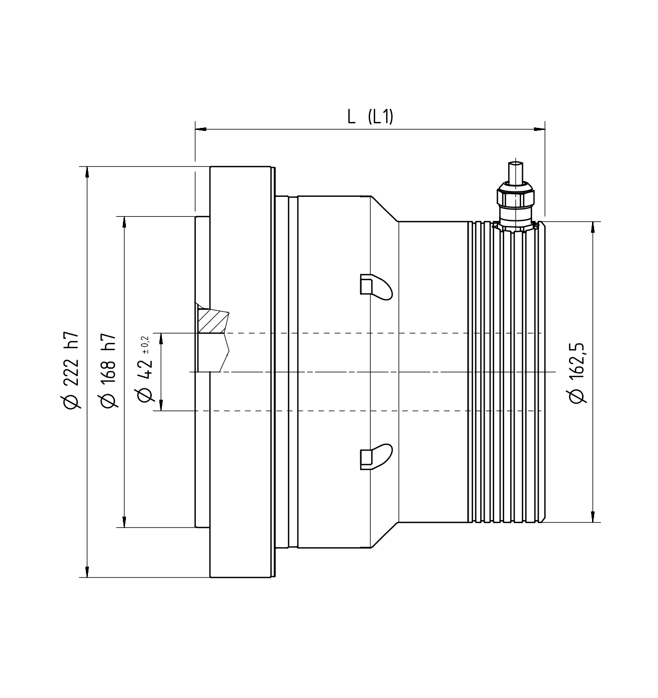


Illustration 32.2 CHA-58C [mm]

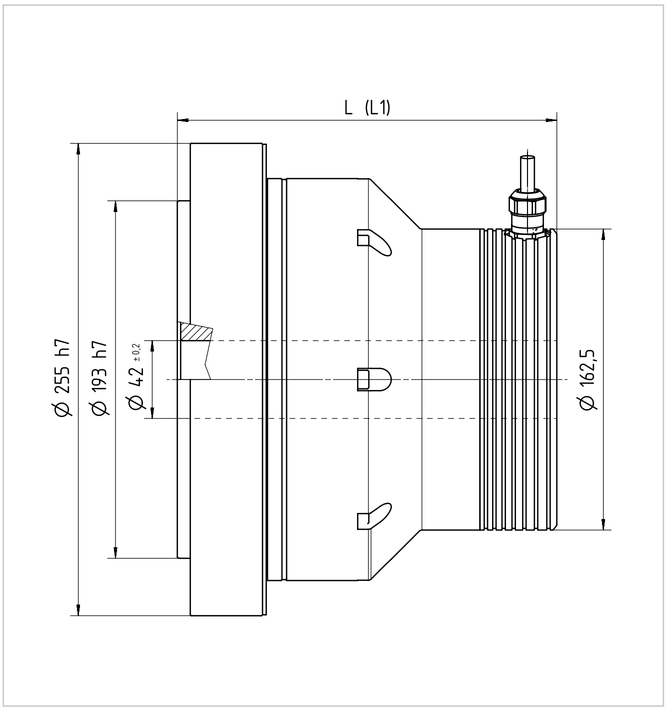


Table 32.3

	Symbol [Unit]	CHA-50C	CHA-58C
Motor feedback system		MGS / SIE / MZE / SZE	MGS / SIE / MZE / SZE
Length (without brake)	L [mm]	189	205
Length (with brake)	L1 [mm]	208	226

6.9 Accuracy

Table 33.1

	Symbol [Unit]	CHA-20C			CHA-25C			CHA-32C		
Ratio	i [ ]	**30**	**50**	**> 50**	**30**	**50**	**> 50**	**30**	**50**	**> 50**
Transmission accuracy	[arcmin]	< 1.5	< 1	< 0.8	< 1.5	< 1	< 0.8	< 1.5	< 1	< 0.8
Repeatability	[arcmin]	< ± 0.1			< ± 0.1			< ± 0.1		
Hysteresis loss	[arcmin]	< 3	< 1	< 1	< 3	< 1	< 1	< 3	< 1	< 1
Lost Motion	[arcmin]	< 1			< 1			< 1		

Table 33.2

	Symbol [Unit]	CHA-40C		CHA-50C		CHA-58C	
Ratio	i [ ]	**50**	**> 50**	**50**	**> 50**	**50**	**> 50**
Transmission accuracy	[arcmin]	< 0.7	< 0.5	< 0.7	< 0.5	< 0.7	< 0.5
Repeatability	[arcmin]	< ± 0.1		< ± 0.1		< ± 0.1	
Hysteresis loss	[arcmin]	< 1	< 1	< 1	< 1	< 1	< 1
Lost Motion	[arcmin]	< 1		< 1		< 1	

6.10 Torsional Stiffness

Table 33.3

	Symbol [Unit]	CHA-20C			CHA-25C			CHA-32C		
T1	[Nm]	7			14			29		
T2	[Nm]	25			48			108		
Ratio	i [ ]	30	50	>50	30	50	>50	30	50	>50
K3	[x10³ Nm/rad]	11	23	29	21	44	57	49	98	120
K2	[x10³ Nm/rad]	7.1	18	25	13	34	50	30	78	110
K1	[x10³ Nm/rad]	5.7	13	16	10	25	31	24	54	67

Table 33.4

	Symbol [Unit]	CHA-40C			CHA-50C		CHA-58C	
T1	[Nm]	54			108		168	
T2	[Nm]	196			382		598	
Ratio	i [ ]	30	50	> 50	50	> 50	50	> 50
K3	[x10³ Nm/rad]	-	180	230	340	440	540	710
K2	[x10³ Nm/rad]	-	140	200	280	400	440	610
K1	[x10³ Nm/rad]	-	100	130	200	250	310	400

6.11 Output Bearing

CHA Series AC hollow shaft Servo Actuators incorporate a high stiffness cross roller bearing to support output loads. This specially developed bearing can withstand high axial and radial forces as well as high tilting moments. The reduction gear is thus 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 costs, by removing the need for an additional output bearing in many applications. Furthermore, installation and assembly of the CHA Servo Actuators are greatly simplified.

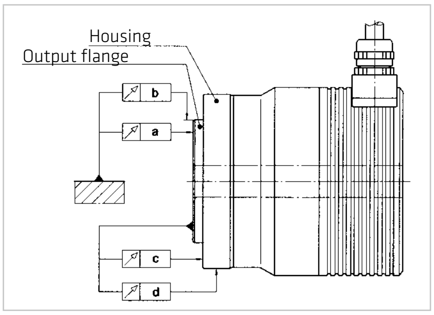
6.11.1 Technical Data

Table 34.1

	Symbol [Unit]	CHA-20C	CHA-25C	CHA-32C	CHA-40C	CHA-50C	CHA-58C
Bearing type [1]		F	C	C	C	C	C
Pitch circle diameter	d_p [m]	0.070	0.088	0.114	0.134	0.171	0.192
Offset	R [m]	0.016	0.018	0.020	0.026	0.028	0.029
Dynamic load rating	C [N]	24200	30000	34500	43300	81600	87400
Stating load rating	C_0 [N]	31000	45000	59000	81600	149000	171000
Dynamic tilting moment [2]	$M_{dyn\,(max)}$ [Nm]	172	254	578	886	1558	2222
Static tilting moment [3]	$M_{0\,(max)}$ [Nm]	603	1050	2242	3645	8493	10944
Tilting moment stiffness [5]	K_B [Nm/arcmin]	70	114	350	522	1020	1550
Dynamic axial load [4]	$F_{A\,dyn\,(max)}$ [N]	15800	19200	22300	42000	56100	57700
Dynamic radial load [4]	$F_{R\,dyn\,(max)}$ [N]	8600	12700	14600	27500	37300	38400

[1] C=Cross roller bearing, F = Four point contact bearing
[2] 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® Component Set. The values indicated in the table must not be exceeded even if the lifetime equation of the bearing permits higher values.
[3] These values are valid for gears at a standstill and for a static load safety factor f_s = 1.8 for size 14 ... 20 and f_s = 1.5 for size 25 ... 58.
[4] These data are valid for n = 15 rpm and L_{10} = 15000 h
[3)4)] These data are only valid if the following conditions are fulfilled:
for M_0: F_a=0 N; F_r=0 N
F_a: M=0 Nm; F_r=0 N
F_r: M=0 Nm; F_a=0 N
[5] Average value

Illustration 34.2



6.11.2 Tolerances

Table 34.3

	Symbol [Unit]	CHA-20C	CHA-25C	CHA-32C	CHA-40C	CHA-50C	CHA-58C
a	[mm]	0.010	0.010	0.012	0.012	0.015	0.015
b	[mm]	0.010	0.010	0.010	0.010	0.010	0.010
c	[mm]	0.010	0.010	0.012	0.012	0.015	0.015
d	[mm]	0.010	0.010	0.010	0.010	0.010	0.010

6.12 Motor Feedback Systems

Design and Operation

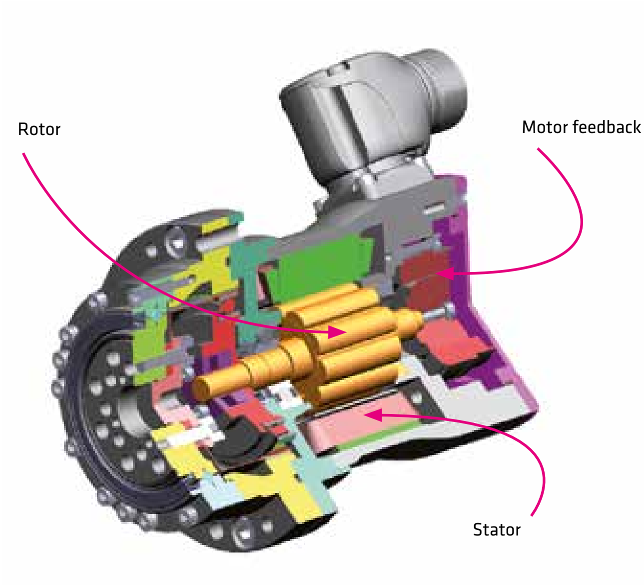
For accurate position setting, the servo motor and its control device are fitted with a measuring device (feedback), which determines the current position (e.g. the angle of redation set for a starting position) of the motor.

This measurement is effected via a redary encoder, e.g. a resolver, an incremental encoder or an absolute encoder. The position controller compares the signal from this encoder with the pre-set position value. If there is any deviation, then the motor is turned in the direction which represents a shorter path to the set value which leads to the deviation being reduced. The procedure repeats itself until the value lies incrementally or approximately within the tolerance limits. Alternatively, the motor position can also be digitally recorded and compared by computer to a set value.

Servo motors and actuators from Harmonic Drive AG use various motor feedback systems which are used as position transducers to fulfil several requirements.

Commutation

Commutation signals or absolute position values provide the necessary information about the rotor position, in order to guarantee correct commutation.



Actual Speed

The actual speed is obtained in the servo controller using the feedback signal, from the cyclical change in position information.

Actual Position

Incremental encoder
The actual signal value needed for setting the position is formed by adding up the incremental position changes. Where incremental encoders have square wave signals, definition of the edge evaluation can be quadrupled (quad counting).
Where incremental encoders have SIN / COS signals, then the definition can be increased by interpolation in the control device.

Absolute encoder
Absolute encoders deliver absolute position information about one (single turn) or several (multi-turn) rotations. This information can on the one hand provide the rotor position for commutation and on the other hand possibly a reference of travel. Where absolute encoders have additional incremental signals, then typically the absolute position information can be read at power up and the incremental signals then evaluated to determine the rotation and actual position value.
Fully digital absolute encoders as motor feedback systems have such a high definition of the absolute value that there is no need for additional incremental signals.

Resolution

In conjunction with the Harmonic Drive AG high precision gears, the output side position can be recorded via the motor feedback system without any additional angle encoders having to be used. The resolution of the motor feedback system can also be multiplied by gear ratio.

Output Side Angle Measurement Devices

Where applications place higher demands on accuracy or need torsion compensation at high torque load, the actual position can also be detected by an additional sensor mounted at the gearbox output side. The adaptation of an output side measurement sytem can be very simply realised for hollow shaft actuators.

6.12.1 MGS (CHA-20C)

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

Table 36.1

Ordering Code	Symbol [Unit]	MGS (CHA-20C)				
Manufacturer's designation		GEL				
Protocol		SSI (binary)				
Power supply[1]	U_b [VDC]	5 ... 30				
Power 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 back up (internal battery available)				
Typical battery service life[4]	[a]	10				
Battery replacement interval	[a]	6				
Accurracy[1]	[arcsec]	± 360				
Resolution of the absolute value (output side)		Gear ratio				
	i [ ]	**50**	**80**	**100**	**120**	**160**
	[arcsec]	0.2	0.2	0.1	0.1	0.1
Number of revolutions (output side)		81	51	40	34	25
Incremental resolution (motor side)[2]	inc [ ]	32768				
Resolution (output side)[2]		Gear ratio				
	i [ ]	**50**	**80**	**100**	**120**	**160**
	[arcsec]	0.79	0.49	0.40	0.33	0.25

[1] Source: Manufacturer.
[2] For interpolation with 8 bit
[3] Increasing position values
- for rotation in clockwise direction, looking at the motor shaft
- for rotation in counter clockwise direction, looking at the output flange

[4] Typical service life with 10 h/day in normal operation, battery temperature 25 °C and a self discharge of 1 %/a.

ADVICE

The internal battery can not be replaced!

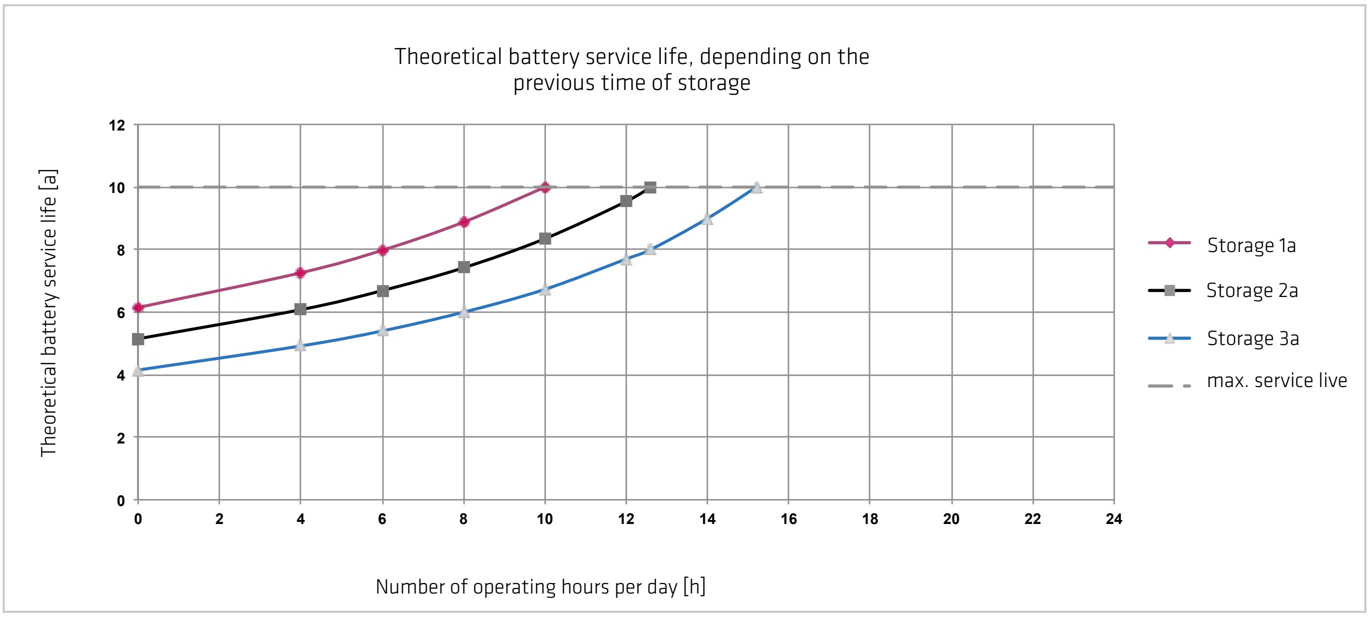
INFORMATION

The use as a single turn absolute motor feedback system is not intended.

Battery lifetime

The theoretical battery service life can be determined based on the previous storage time and the daily time of operating.

Illustration 37.1



ADVICE

Regardless of the results from the theoretical battery service life calculation, we specify to change the complete motor feed-back system latest 10 years after delivery.

⚠ ATTENTION

In case of failure or interruption of the battery voltage and simultaneous failure or interruption of the power supply, the reported position after restarting will be wrong!
Undefined positioning can cause injury to persons or damage to the system.

6.12.2 MGS (CHA-25C ... 58C)

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

Tabelle 38.1

<table>
<tr><th>Ordering Code</th><th>Symbol
[Unit]</th><th colspan="6">MGS
(CHA-25C ... CHA-58C)</th></tr>
<tr><td>Manufacturer's designation</td><td></td><td colspan="6">GEL</td></tr>
<tr><td>Protocol</td><td></td><td colspan="6">SSI (binary)</td></tr>
<tr><td>Power supply [1)]</td><td>U_b [VDC]</td><td colspan="6">5 ... 30</td></tr>
<tr><td>Power consumption (without load) [1)]</td><td>P [W]</td><td colspan="6">0.1</td></tr>
<tr><td>Current consumption buffering (at 25 °C) [1)]</td><td>I [µA]</td><td colspan="6">40</td></tr>
<tr><td>Incremental signals</td><td>u_{pp} [Vss]</td><td colspan="6">1</td></tr>
<tr><td>Signal form</td><td></td><td colspan="6">sinusoidal</td></tr>
<tr><td>Number of pulses</td><td>n_1</td><td colspan="6">128</td></tr>
<tr><td>SSI data word length</td><td></td><td colspan="6">32 bit
(30 bit position data; 1 Error-bit; 1 Warning-bit)</td></tr>
<tr><td>Absolute position / revolution (motor side) [3)]</td><td></td><td colspan="6">131072 (17 bit)</td></tr>
<tr><td>Number of revolutions</td><td></td><td colspan="6">8192 (13 bit)
battery back up
(external battery necessary)</td></tr>
<tr><td>Recommended buffer battery</td><td></td><td colspan="6">Lithium thionyl chloride
3.6 V / ≥2.0 Ah
TADIRAN SL-760 Size: AA</td></tr>
<tr><td>Typical battery service life [4)]</td><td>[a]</td><td colspan="6">8</td></tr>
<tr><td>Battery replacement interval</td><td>[a]</td><td colspan="6">5</td></tr>
<tr><td>Accuracy [1)]</td><td>[arcsec]</td><td colspan="6">± 180</td></tr>
<tr><td rowspan="3">Resolution of the absolute value (output side)</td><td></td><td colspan="6">Gear ratio CHA</td></tr>
<tr><td>i [ ]</td><td>30</td><td>50</td><td>80</td><td>100</td><td>120</td><td>160</td></tr>
<tr><td>[arcsec]</td><td>0.4</td><td>0.2</td><td>0.2</td><td>0.1</td><td>0.1</td><td>0.1</td></tr>
<tr><td>Number of revolutions (output side)</td><td></td><td>273</td><td>163</td><td>102</td><td>81</td><td>68</td><td>51</td></tr>
<tr><td>Incremental resolution (motor side) [2)]</td><td>inc [ ]</td><td colspan="6">32768</td></tr>
<tr><td rowspan="3">Resolution (output side) [2)]</td><td></td><td colspan="6">Gear ratio CHA</td></tr>
<tr><td>i [ ]</td><td>30</td><td>50</td><td>80</td><td>100</td><td>120</td><td>160</td></tr>
<tr><td>[arcsec]</td><td>1.32</td><td>0.79</td><td>0.49</td><td>0.40</td><td>0.33</td><td>0.25</td></tr>
</table>

1) Source: Manufacturer.
2) For interpolation with 8 bit
3) Increasing position values
- for rotation in clockwise direction, looking at the motor shaft
- for rotation in counter clockwise direction, looking at the output flange
4) Typical service life with 10 h/day in normal operation, battery temperature 25 °C and a self discharge of 1 %/a.

⚠ ATTENTION

In case of failure or interruption of the battery voltage and simultaneous failure or interruption of the power supply, the reported position after restarting will be wrong!
Undefined positioning can cause injury to persons or damage to the system.

ADVICE

An external battery power supply is necessary to operate the battery buffered multi-turn absolute motor feedback system MGS for the sizes CHA-25C ... 58C. A battery box MGS is available for this purpose. The handling of the battery box MGS and the electrical connections are described in the chapter "Battery boxes".

6.12.3 SIE

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

Table 39.2

Ordering code	**Symbol [Unit]**	**SIE**					
Manufacturer's designation		ECI 119					
Protocol		EnDat® 2.1/01					
Power supply [1]	U_b [VDC]	3.6 ... 14					
Current consumption (typically @ 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 [SIN / COS]	32					
Absolute position / revolution (motor side) [3]		524288 (19 bit)					
Number of revolutions		-					
Accuracy [1]	[arcsec]	±90					
Resolution of the absolute value (output side)		Gear ratio CHA					
	i [ ]	30	50	80	100	120	160
	[arcsec]	0.09	0.05	0.04	0.03	0.03	0.02
Number of revolutions (at output side)		-	-	-	-	-	-
Incremental resolution (motor side) [2]	inc [ ]	8192					
Resolution (output side) [2]		Gear ratio CHA					
	i [ ]	**30**	**50**	**80**	**100**	**120**	**160**
	[arcsec]	5.27	3.16	1.98	1.58	1.32	0.99

[1] Source: Manufacturer
[2] For interpolation with 11 bit
[3] Increasing position values
- for rotation in clockwise direction, looking at the motor shaft
- for rotation in counter clockwise direction, looking at the output flange

ADVICE

The commutation offset has to be determined during the first setup.

6.12.4 DCO

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

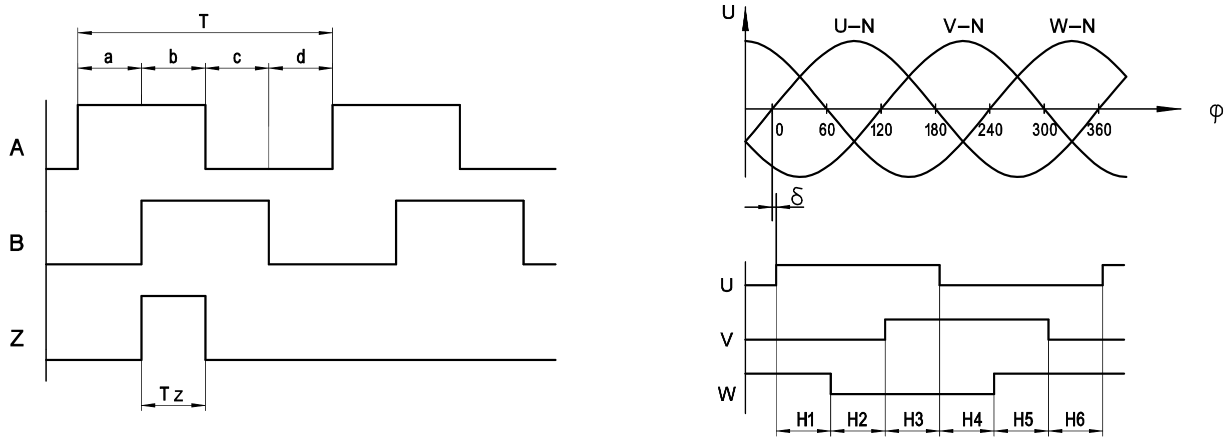
Table 40.1

Ordering code	Symbol [Unit]	DCO					
Manufacturer's designation		EBG					
Power supply [1]	U_b [VDC]	5 ±10%					
Current consumption (without load) [1]	I [mA]	40					
Incremental signals		RS422					
Wave form		square wave					
Number of pulses	n_1 [A / B]	2048					
Commutation signals		RS422					
Signal form		square wave					
Number of pulses	n_2 [U / V / W]	5					
Reference signal	n_3 [Z]	1					
Accuracy [1]	[arcsec]	±600					
Incremental resolution (motor side) [2]	[qc]	8192					
Resolution (output side) [2]		Gear ratio CHA					
	i [ ]	30	50	80	100	120	160
	[arcsec]	5.3	3.2	2.0	1.6	1.4	1.0

[1] Source: Manufacturer
[2] For quadcounting

Signal Wave Form

Illustration 40.2



T = 360° / 2048
a, b, c, d = 0.25 T
T_z = 1/4 T
H_N = 360° / 5 = 72°
d ≤ ±5° el.

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

6.12.5 MZE

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

Table 41.1

Ordering code	Symbol [Unit]	MZE					
Manufacturer's designation		EBI 135					
Protocol		EnDat® 2.2 / 22					
Power supply [1]	U_b [VDC]	3.6 ... 14					
Current consumption (typically @ 5V,without load) [1]	I [mA]	75					
Current consumption buffering (at 25°C) [1] [2]	I [µA]	12					
Incremental signals	u_{pp} [V_{ss}]	-					
Signal form		-					
Number of pulses	n_1	-					
Absolute position / revolution (motor side) [3]		524288 (19 bit)					
Number of revolutions		65536 (16 bit) battery back up (external battery necessary)					
Recommended buffer battery		Lithium thionyl chloride 3,6V / ≥2.0Ah Tadiran SL-760S Size: AA					
Typical battery service life [4]	[a]	10					
Battery replacement interval	[a]	10					
Acurracy [1]	[arcsec]	± 90					
Resolution at motor side	[arcsec]	2.47					
Gear ratio	i [ ]	30	50	80	100	120	160
Resolution of the absolute value (output side)	[arcsec]	0.082	0.049	0.031	0.025	0.021	0.015
Number of revolutions (output side)		2184	1310	819	655	546	409

[1] Source: Manufacturer.
[2] Source: Manufacturer. Valid for power off and standstill
[3] Increasing position values
- for rotation in clockwise direction, looking at the motor shaft
- for rotation in counter clockwise direction, looking at the output flange

[4] Typical service life with 10 h/day in normal operation, battery temperature 25 °C and a self discharge of 1 %/a.

⚠ ATTENTION

In case of failure or interruption of the battery voltage and simultaneous failure or interruption of the power supply, the reported position after restarting will be wrong!
Undefined positioning can cause injury to persons or damage to the system.

ADVICE

Not compatible to Siemens servo controller SINAMICS S120!

ADVICE

An external battery power supply is necessary to operate the battery buffered multiturn absolute motor feedback system MZE. A battery box MZE is available for this purpose. The handling of the battery box MZE and the electrical connections are described in the chapter "Battery boxes".
The typical service life of 10 years for the buffer battery applies to 10 h/day in normal operation, battery temperature 25 °C and a self-discharge of 1 %/a. To achieve a long service life of the buffer battery, the main power supply (U_b) must be connected to the encoder while connecting the backup battery, or directly thereafter, in order for the encoder to become fully initialised after having been completely powerless. Otherwise the encoder will consume a significantly higher amount of battery current until main power is supplied the first time.

6.12.6 SZE

Single turn absolute motor feedback system with EnDat® 2.2/22 data interface

Table 42.1

Ordering code	Symbol [Unit]	SZE					
Manufacturer's designation		ECI 119					
Protocol		EnDat® 2.2 / 22					
Power supply [1]	U_b [VDC]	3.6 ... 14					
Current consumption (typically @ 5V,without load) [1]	I [mA]	75					
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)					
Number of revolutions		-					
Acurracy [1]	[arcsec]	± 90					
Resolution at motor side	[arcsec]	2,47					
Gear ratio	i [ ]	30	50	80	100	120	160
Resolution of the absolute value (output side)	[arcsec]	0.082	0.049	0.031	0.025	0.021	0.015
Number of revolutions (output side)		-	-	-	-	-	-

[1] Source: Manufacturer.
[2] Source: Manufacturer. Valid for power off and standstill
[3] Increasing position values
- for rotation in clockwise direction, looking at the motor shaft
- for rotation in counter clockwise direction, looking at the output flange

ADVICE

Not compatible to Siemens servo controller SINAMICS S120!

6.13 Temperature Sensors

For motor predection at speeds greater than zero, temperature sensors are integrated in the motor windings. For applications with high load where the speed is zero, additional predection (e.g. $I^2 t$ monitoring) is recommended. When using the KTY 84-130 the values given in the table can be parametrised in the servo controller or an external evaluation unit.

Table 43.1

Sensor type	Parameter	T_{Nat} [°C]
PTC	Rated operating temperature	145

PTC thermistors, because of their very high positive temperature coefficient at nominal operating temperature (T_{Nat}), are ideally suited for motor winding predection.

Due to their principle, the PTC sensors should only be used to monitor the winding temperature.

Illustration 43.2 Diagram PTC

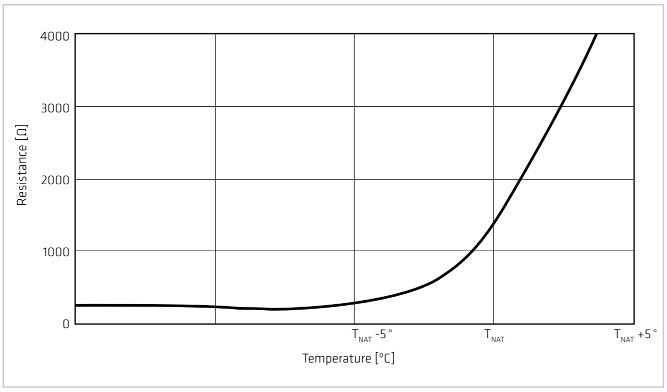


Table 43.3

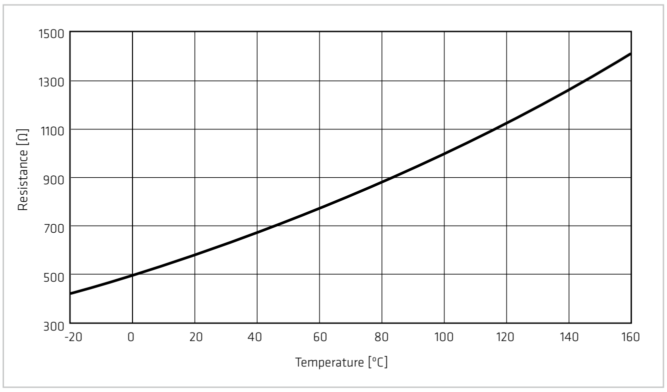
Sensor type	Parameter	Symbol [Unit]	Warning	Shutdown
KTY 84-130	Temperature	T [°C]	80	90
	Resistance	R [Ω]	882 ±3%	940 ±3%

The KTY sensor is used for temperature measurement and monitoring the motor winding.

Because the KTY sensor provides an analogue temperature measurement, it is also possible to predect the actuator grease from temperature overload.

Temperature sensors used in the CHA Actuator Series meet the requirements for safe separation according to EN50178.

Illustration 43.4 Diagram KTY 84-130



6.14 Battery boxes

Battery box for multi-turn absolute motor feedback system MZE

The battery box MZE is an accessory for the sizes CHA-20C ... CHA-58C to operate the multi-turn absolute motor feedback system MZE. It is used 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 for protection against wiring faults.

Illustration 44.1 Battery box Mat.-no. 1024385

ADVICE

The battery is not included!

Recommended battery: Lithium thionyl chloride
3,6V / ≥ 2.0Ah / AA
e.g. Tadiran SL-760S

Illustration 44.2 Explosion view

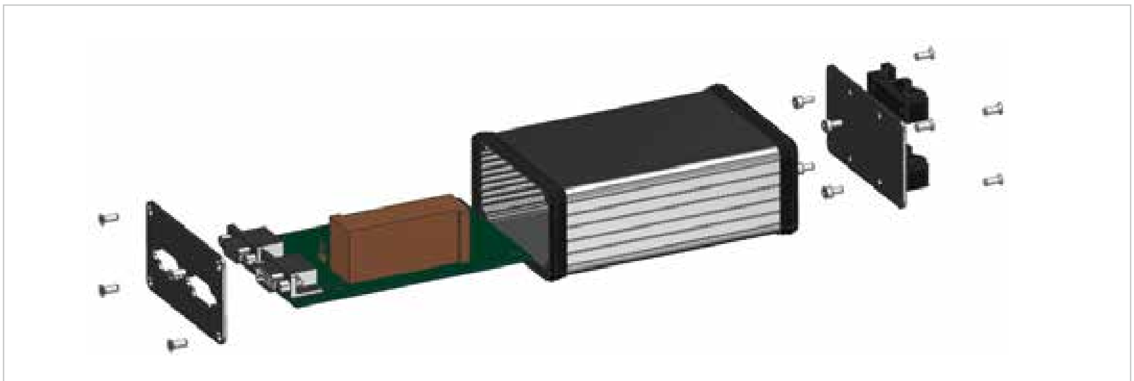
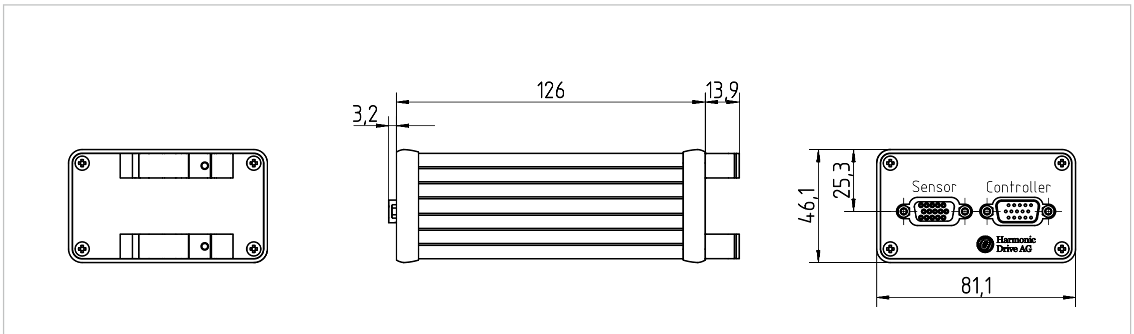


Illustration 44.3 Dimensions



Assembly: DIN mounting rail 35 mm

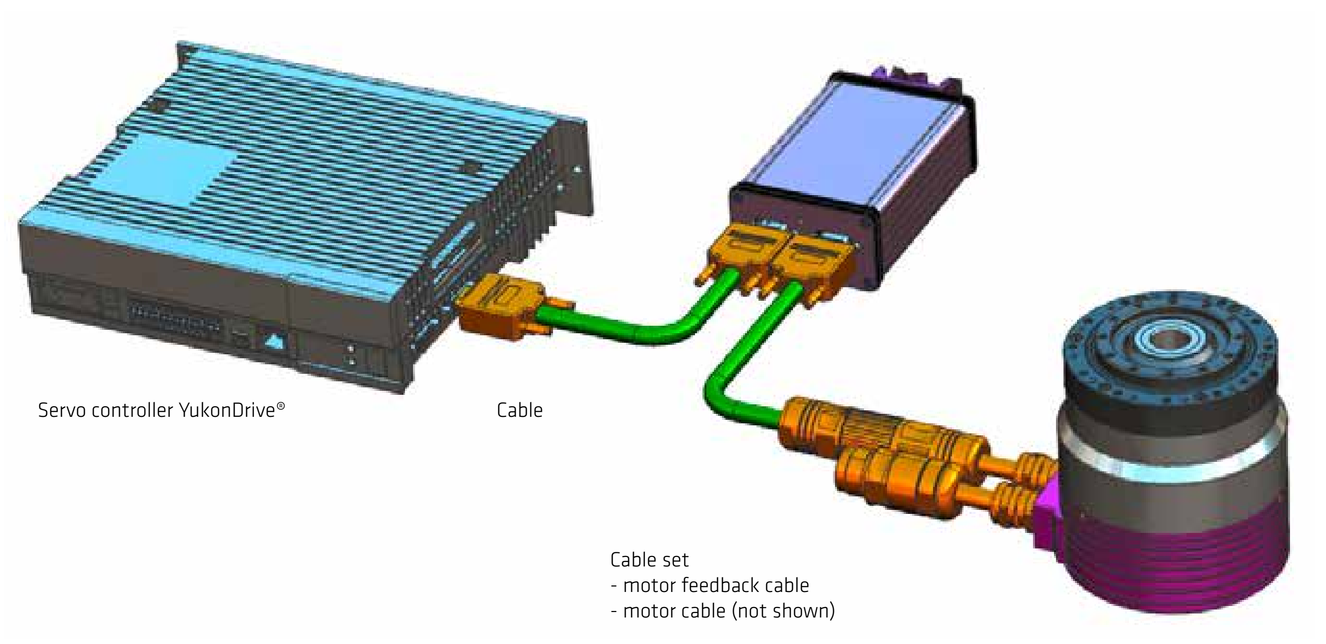
Illustration 45.1

Electrical connection

Sensor 15. pol. Sub D female		Battery	Controller 15. pol. Sub D male	
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 45.2

Wiring motor feedback system



Connecting cable set for the connection to YukonDrive® or third party controller

The connection cable set consists of a motor power cable and a motor feedback cable. The motor feedback cable is connected to the battery box.

Table 46.1

Version	Material number	Length [m]
CHA-H-MZE	1025477	5
	1025478	10
	1025479	15
	1025480	25

Connecting cable from battery box to YukonDrive® X7

Table 46.2

Version	Material number	Length [m]
CHA-H-MZE	1025481	0,5
	1025482	1,0
	1025483	2,0

Connecting cable with flying leads from battery box to third party controller

Table 46.3

Version	Material number	Length [m]
CHA-H-MZE	1025484	0.5
	1025485	1.0
	1025486	2.0

ADVICE

The connector for the battery box is mounted. The connection for the third party controller has flying leads.

Replacing the battery

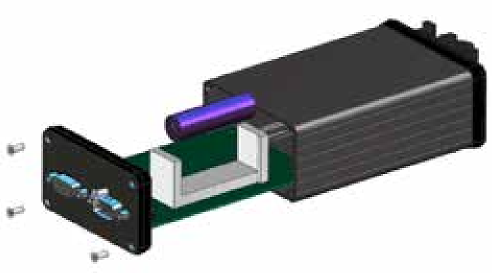
The following preconditions must be ensured in order to maintain the absolute encoder position when replacing the battery.

ADVICE

- The supply voltage of the motor feedback system is provided by the drive controller
- The motor feedback system is connected to the drive controller

⚠ ATTENTION

In case of failure or interruption of the battery voltage and simultaneous failure or interruption of the power supply, the reported position after restarting will be wrong!
Undefined positioning can cause injury to persons or damage to the system.



- Open the cover of the battery box
- Remove the circuit board with the battery
- Remove the old battery and dispose it according to the corresponding directives
- Insert new battery
- Insert the circuit board with the battery
- Close the cover of the battery box
- Reset error and warning bit

Reset error bit and warning bit

The MZE motor feedback system monitors the connected battery and provides, in addition to the position values, also an error bit and a warning bit, which are transmitted via the EnDat® interface.

- Warning „Battery change"
  ≤ 2,8 V ±0,2 V in normal operation mode
- Error message „M power failure"
  ≤ 2,2 V ±0,2 V in battery buffered operation mode (the encoder must be re-referenced)

The warning bit is set when the battery voltage reaches the critical value during operation. After the warning "Battery change" has occurred, the battery must be replaced immediately.

The error message is set with simultaneous failure or interruption of the battery voltage and the voltage supply.

Error bit and warning bit can be reseted via the EnDat® interface.

ADVICE

The EnDat® specification and the EnDat® "Application Notes" from Heidenhain for battery buffered measuring devices must be observed for correct control of the motor feedback system MZE (Heidenhain type EBI135).

Battery box for multi-turn absolute motor feedback system MGS

The battery box MGS is an accessory for the sizes CHA-25C ... CHA-58C to operate the multi-turn absolute motor feedback system MGS. It is used 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 for protection against wiring faults.

Illustration 48.1 Battery box Mat.-no. 1028280

ADVICE

The battery is not included!

Recommended battery: Lithium thionyl chloride
3,6V / ≥ 2.0Ah / AA
e.g. Tadiran SL-760S

Illustration 48.2 Explosion view

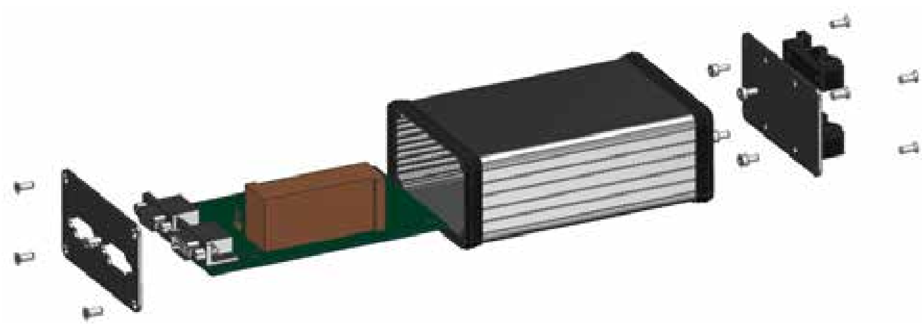
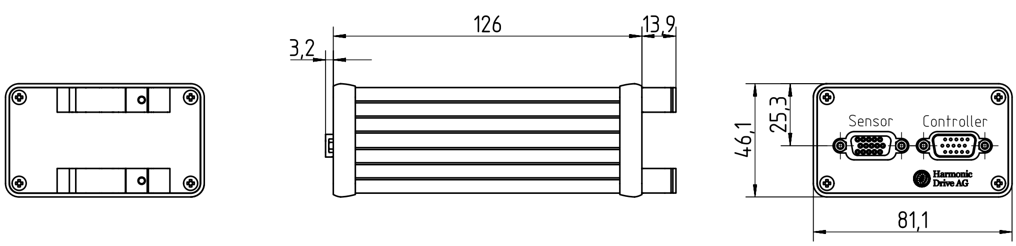


Illustration 48.3 Dimensions



Assembly: DIN mounting rail 35 mm

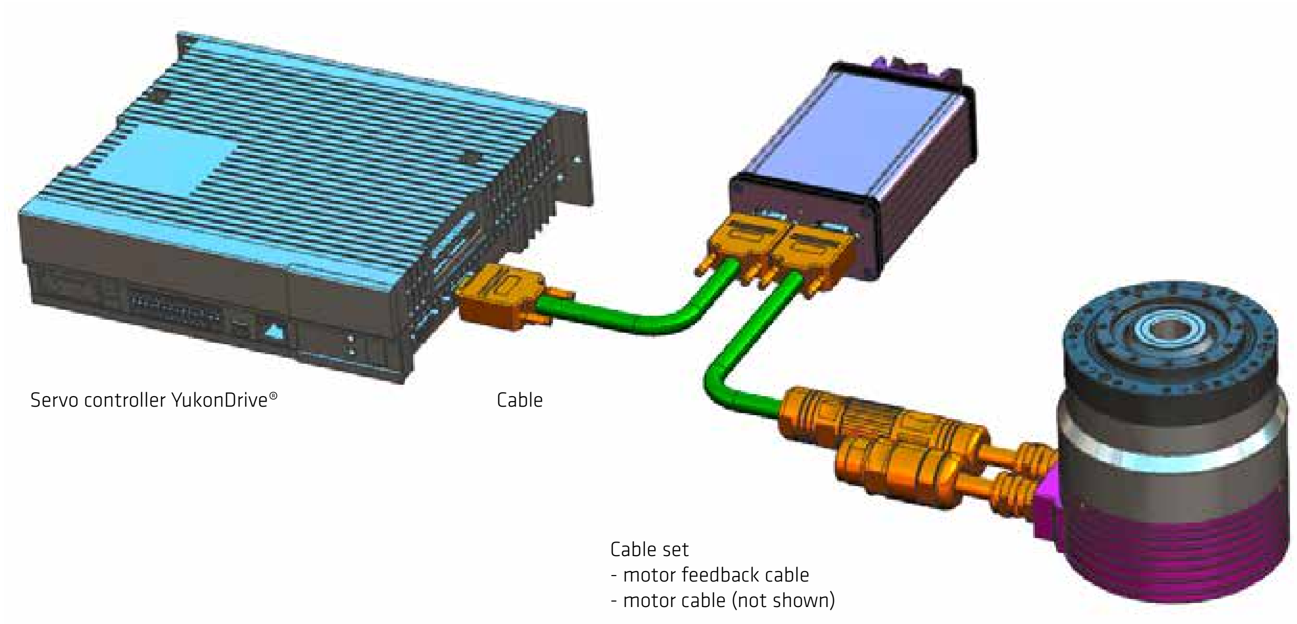
Illustration 49.1

Electrical connection

Sensor 15. pol. Sub D female		Battery	Controller 15. pol. Sub D male	
1	A- (COS-)		1	A- (COS-)
2	A+ (COS+)		2	A+ (COS+)
3	U_P		3	U_P
4	DATA +		4	DATA +
5	DATA -		5	DATA -
6	B- (SIN-)		6	B- (SIN-)
7	UBAT+	UBAT+	7	-
8	UBAT- (0V / GND)	UBAT-	8	UBAT- (0V / GND)
9	Temp -		9	Temp -
10	Temp +		10	Temp +
11	B+ (SIN+)		11	B+ (SIN+)
12	Reset		12	Reset
13	-		13	-
14	CLOCK +		14	CLOCK +
15	CLOCK -		15	CLOCK -

Illustration 49.2

Wiring motor feedback system



Connecting cable set for the connection to YukonDrive® or third party controller

The connection cable set consists of a motor power cable and a motor feedback cable. The motor feedback cable is connected to the battery box.

Table 50.1

Version	Material number	Length [m]
CHA-H-MGS	1082303	5
	1028304	10
	1028305	15

Connecting cable from battery box to YukonDrive® X7

Table 50.2

Version	Material number	Length [m]
CHA-H-MGS	1028311	0.5
	1028310	1.0
	1028312	2.0

Connecting cable with flying leads from battery box to third party controller

Table 50.3

Version	Material number	Length [m]
CHA-H-MGS	1029057	0.5
	1029058	1.0
	1029059	2.0

ADVICE

The connector for the battery box is mounted. The connection for the third party controller has flying leads.

Replacing the battery

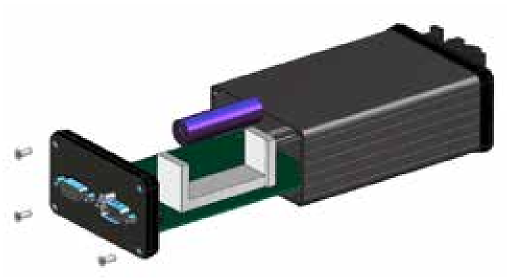
The following preconditions must be ensured in order to maintain the absolute encoder position when replacing the battery.

ADVICE

- The supply voltage of the motor feedback system is provided by the drive controller
- The motor feedback system is connected to the drive controller

⚠ ATTENTION

In case of failure or interruption of the battery voltage and simultaneous failure or interruption of the power supply, the reported position after restarting will be wrong!
Undefined positioning can cause injury to persons or damage to the system.



- Open the cover of the battery box
- Remove the circuit board with the battery
- Remove the old battery and dispose it according to the corresponding directives
- Insert new battery
- Insert the circuit board with the battery
- Close the cover of the battery box
- Reset error and warning bit

Reset error bit and warning bit

The MGS motor feedback system monitors the connected battery and provides, in addition to the position values, also an error bit and a warning bit, which are transmitted via the SSI interface.

The warning bit is set when the battery voltage reaches the critical value during operation. After the warning "Battery change" has occurred, the battery must be replaced immediately.

The error message is set with simultaneous failure or interruption of the battery voltage and the voltage supply.

Error bit and warning bit can be reseted via the "Reset" input. The reset is carried out when the "Reset" button on the battery box is pressed for 3 ... 5 seconds or when the "Reset" input on the motor feedback system is set to GND for 3 ... 5 seconds.

6.15 Electrical Connections

CHA-xxC-H-SIE / MGS

Motor connection

Table 52.1

Motor connector	6 / M23 x 1
Cable plug	6 / M23 x 1 / Mat.-no. 301193
External diameter	ca. 26 mm
Length	ca. 60 mm

Illustration 52.2

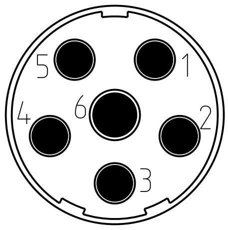


Table 52.3

	CHA-20C / 25C / 32C / 40C / 50C / 58C					
Connector pin	1	2	3	4	5	6
Motor phase	U	V	PE	BR+	BR-	W

Motor feedback connection

Table 52.4

Encoder connector	17 / M23 x 1
Cable plug	17 / M23 x 1 / Mat.-no. 270199
External diameter	ca. 26 mm
Length	ca. 60 mm

Illustration 52.5

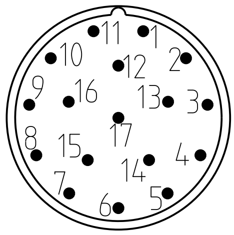


Table 52.6

Connector pin	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
MGS Signal (CHA-20C)	A+ COS+	A- COS-	DATA+	n.c	CLOCK+	n.c	GND	Temp+ KTY	Temp- KTY	Up	B+ SIN+	B- SIN-	DATA-	CLOCK-	GND Sensor	Up Sensor	Inner shield
MGS Signal (CHA-25C ... CHA-58C)	A+ COS+	A- COS-	DATA+	UBAT+	CLOCK+	UBAT-	GND	Temp+ KTY	Temp- KTY	Up	B+ SIN+	B- SIN-	DATA-	CLOCK-	n.c	PRE-SET	Inner shield

Table 52.7

Connector pin	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
SIE Signal	A+ COS+	A- COS-	DATA+	n.c.	CLOCK+	n.c.	GND	Temp+ (KTY)	Temp- (KTY)	Up	B+ SIN+	B- SIN-	DATA-	CLOCK-	GND Sensor	Up Sensor	Inner shield

Connecting cables SINAMICS S120 with SMC modul

Table 53.1

Power Connection	
CHA without brake	6FX8002-5CG01-1xx0
CHA with brake	6FX8002-5DG01-1xx0
Motor feedback	
H-SIE H-MGS (CHA-20C)	6FX8002-2EQ10-1xx0
Motor feedback	
H-MGS (CHA-25C ... 58C)	No standard Siemens cable available!

ADVICE

An external battery power supply is necessary to operate the battery buffered multi-turn absolute motor feedback system MGS for the sizes CHA-25C ... 58C. A battery box MGS is available for this purpose. The handling of the battery box MGS and the electrical connections are described in the chapter "Battery boxes".

Connecting cables with flying leads

Table 53.2

Version	Material number	Length [m]
H-SIE H-MGS (CHA-20C)	308858 308859 308860 308861 308862	5 10 15 20 25
H-MGS (CHA-25C ... 58C)	1028292 1028293 1028294	5 10 15

Connecting cables for the connection to YukonDrive®

Table 53.3

Version	Material number	Length [m]
H-SIE H-MGS (CHA-20C)	314260 314261 314262	3 5 10

Connecting cables for the connection of the CHA-25C ... 58C to the battery box MGS

Table 53.4

Version	Material number	Length [m]
H-MGS (CHA-25C ... 58C)	1028303 1028304 1028305	5 10 15

6.15.1 CHA-xxC-N-DCO

Motor connection

Table 54.1

Motor connector	8 / M17 x 1
Cable plug	8 / M17 x 1 / Mat.-no. 1011445
External diameter	ca. 22 mm
Length	ca. 50 mm

Illustration 54.2

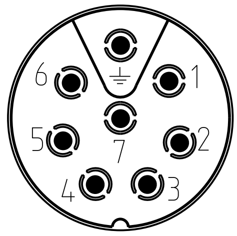


Table 54.3

	CHA-20C							
Connector pin	1	6	7	PE	3	4	2	5
Motor phase	U	W	V	PE	BR+	BR-	Temp PTC	Temp PTC

Motor feedback connection

Table 54.4

Encoder connector	17 / M17 x 1
Cable plug	17 / M17 x 1 / Mat.-no. 1011446
External diameter	ca. 22 mm
Length	ca. 50 mm

Illustration 54.5

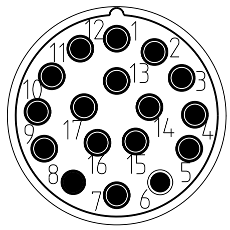


Table 54.6

Connector pin	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
DCO Signal	U+	U-	V+	V-	W+	W-	GND	Up	Z+	Z-	A+	A-	B+	B-

Connecting cables with flying leads

Table 54.7

Version	**Material number**	**Length [m]**
N-DCO	1021178 1021179 1021180	3 5 10

Connecting cables for the connection to YukonDrive®

Table 54.8

Version	**Material number**	**Length [m]**
N-DCO	1021077 1021078 1021079	3 5 10

6.15.2 CHA-xxC-H-MZE /SZE

Motor connection

Table 55.1

Motor connector	6 / M23 x 1
Cable plug	6 / M23 x 1 / Mat.-no. 301193
External diameter	ca. 26 mm
Length	ca. 60 mm

Illustration 55.2

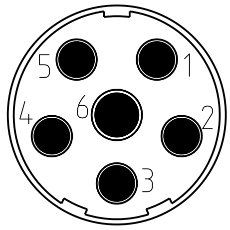


Table 55.3

	CHA-20C / 25C / 32C / 40C / 50C / 58C					
Connector pin	1	2	3	4	5	6
Motor phase	U	V	PE	BR+	BR-	W

Motor feedback connection

Table 55.4

Encoder connector	17 / M23 x 1
Cable plug	17 / M23 x 1 / Mat.-no. 270199
External diameter	ca. 26 mm
Length	ca. 60 mm

Illustration 55.5

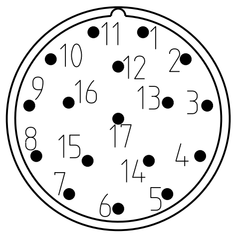


Table 55.6

Connector pin	**1**	**2**	**3**	**4**	**5**	**6**	**7 (15)**	**8**	**9**	**10 (16)**	**11**	**12**	**13**	**14**	**15 (7)**	**16 (10)**	**17**
MZE / SZE	–	–	DATA+	UBAT+	CLOCK+	UBAT-	0V	Temp+ KTY	Temp- KTY	+Up	–	–	DATA-	CLOCK-	Sense-	Sense+	Inner shield

Connecting cables with flying leads

Table 55.7

Version	**Material number**	**Length [m]**
H-MZE H-SZE	1025473	5
	1025474	10
	1025475	15
	1025476	25

Connecting cables for the connection to YukonDrive®

Table 55.8

Version	**Material number**	**Length [m]**
H-MZE [1)] H-SZE	1025477	5
	1025478	10
	1025479	15
	1025482	25

[1)] The motor feedback cable can be used for the connection to the battery box!

Connecting cable battery box to YukonDrive® X7

Table 56.1

Version	Material number	Length [m]
H-MZE	1025481	0.5
	1025482	1.0
	1025483	2.0

Connecting cable battery box to third party drive

Table 56.2

Version	Material number	Length [m]
H-MZE	1025484	0.5
	1025485	1.0
	1025486	2.0

6.16 Cable Specification

Table 56.3

	Symbol [Unit]	CHA-xxC		Cable extension
		Motor cable	Encoder cable MGS / SIE / DCO / MZE / SZE	Motor cable
Material number		270611	1014983	270407
Configuration	[mm²]	(4x0,5 + 2x(2x0,24)	(4x(2x0,15)+2x0,5+4x0,15)	(4x1,5 + 2x(2x0,75)
Rated voltage				
Power conductor	[V]	600 / 1000	-	600 / 1000
Signal conductor	[V]	24 (EN) 1000V (UL/CSA)	30	24 (EN) 1000V (UL/CSA)
Diameter	d [mm]	≤ 9,5	≤ 7,5	≤ 13
Min. bending radius				
Fixed	r [mm]	5 x d	5 x d	5 x d
Movable	r [mm]	10 x d	10 x d	7,5 x d
Max. torsion	[°/m]	-	-	30
Max. traverse velocity	v [m/min]	-	-	180
Maximum acceleration	a [m/s²]	-	-	7
Ambient temperature				
Fixed	[°C]	-30 ... 80		-30 ... 80
Movable	[°C]	-20 ... 70		-20 ... 70
Storage	[°C]	-40 ... 80		-40 ... 80
Jacket	[ ]	PUR		PUR
Oil resistant	[ ]	yes		yes
Color	[ ]	RAL2003 DESINA orange		RAL2003 DESINA orange
Approvals	[ ]	CE / UL / CSA		CE / UL / CSA / RoHS

6.17 Options

6.17.1 Position measuring system option EC

The CHA Hollow Shaft Servo Actuators Series are ideally suited for equipping with a single turn absolute measuring system that can be connected directly to the actuator output.

The ECN113 single turn absolute encoder is connected to the actuator flange by means of a torsionally stiff hollow shaft.

Table 57.1

Ordering code	Symbol	Unit	EC					
Manufacturer's 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 (motor side) [3]			8192					
Accuracy [1]		arcsec	±20					
Resolution of the absolute value (output side)	phi	arcsec	158					
Resolution (output side) [2]	phi	arcsec	2.5	2.5	2.5	2.5	2.5	2.5

[1] Source: Manufacturer
[2] for interpolation with 8 bit
[3] increasing position values for rotation in CW direction, looking at the output flange

The encoder system is connected using a standard signal connector.
The evaluation of the compatibility of the measurement system must be checked prior to commissioning. The measuring system contains electrostatically sensitive components, please observe the ESD measures.

Illustration 57.3

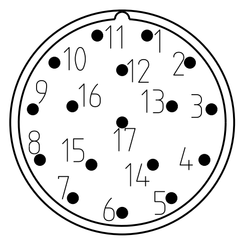


Table 57.2

Encoder connector	17 / M23 x 1
Cable plug	17 / M23 x 1 / Mat.-no. 270199
External diameter	ca. 26 mm
Length	ca. 60 mm

Table 57.4

Connector pin	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Signal	Up Sensor	n.c	n.c	GND Sensor	n.c	n.c	Up	CLOCK +	CLOCK -	GND	Inner shield	B+	B-	DATA +	A+	A-	DATA -
Connecting Cables																	
SINAMICS S 120 (SMC20)	6FX8002-2CH00-1xx0																
YukonDrive®	Mat.-no. 1010747 (3 m; other length on request)																

7. Actuator Selection Procedure

ADVICE

We will be pleased to make a gear calculation and selection on your behalf.

7.1. Selection Procedure and Calculation Example

Flowchart for actuator selection

Equation 58.1

$$T_1 = T_L + \frac{2\pi}{60} \cdot \frac{(J_{out} + J_L) \cdot n_2}{t_1}$$

Equation 58.2

$$T_2 = T_L$$

$$T_3 = T_L - (T_1 - T_L)$$

$$T_{rms} = \sqrt{\frac{T_1^2 \cdot t_1 + T_2^2 \cdot t_2 + T_3^2 \cdot t_3}{t_1 + t_2 + t_3 + t_p}}$$

Equation 58.3

$$n_{av} = \frac{\frac{|n2|}{2} \cdot t_1 + |n2| \cdot t_2 + \frac{|n2|}{2} \cdot t_3}{t_1 + t_2 + t_3 + t_p}$$

Equation 58.4

$$ED = \frac{t_1 + t_2 + t_3}{t_1 + t_2 + t_3 + t_p} \cdot 100\ \%$$

Confirm the type of servo mechanism required: linear motion or rotary motion

Calculate load torque (T_L) and moment of inertia (J_L): Equation 59.3 / Equation 59.5

Determine speed pattern from duty cycle

Tentatively select the required actuator based upon load conditions

Calculate the required acceleration torque (T_1): Equation 58.1

Is the required acceleration torque less than max. output torque of the actuator? — No → back to "Tentatively select the required actuator based upon load conditions"

Yes

Determine the torque pattern and calculate the effective torque (T_{rms}): Equation 58.2

Calculate average Speed (n_{av}): Equation 58.3

Calculate duty factor (ED): Equation 58.4

T_{rms} and n_{av} are inside the Continuous Duty Zone — No → back to "Tentatively select the required actuator based upon load conditions"

Yes

Confirm final selection

Pre selection conditions

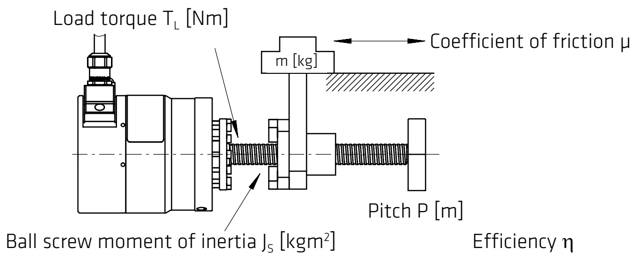
Table 59.1

Load	Confirmation	Catalogue value	Unit
Load max. rotation speed (n_2)	$\leq n_{max}$	Max. output speed	[rpm]
Load moment of inertia (J_L)	$\leq 3J_{Out}$ 1)	Moment of inertia	[kgm²]

1) $J_L \leq 3 \cdot J_{Out}$ is recommended for highly dynamic applications (high responsiveness and accuracy).

Linear horizontal motion

Illustration 59.2



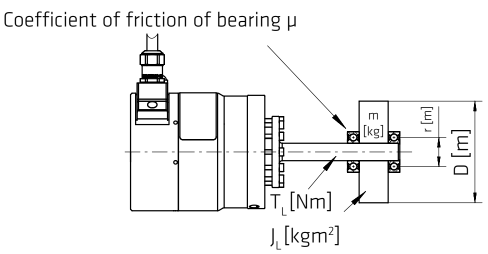
Equation 59.3

$$J_L = J_S + m\left(\frac{P}{2\pi}\right)^2 \ [kgm^2]$$

$$T_L = \frac{\mu \cdot m \cdot P \cdot g}{2\pi \cdot \eta} \ [Nm]$$

Rotary motion

Illustration 59.4

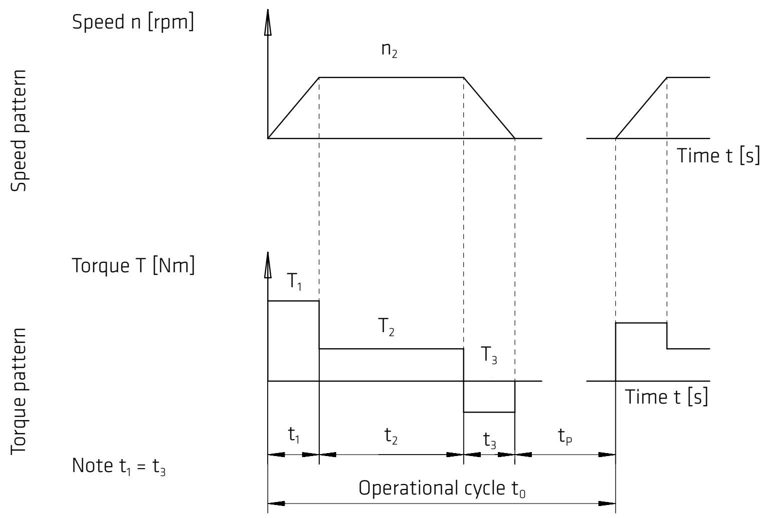


Equation 59.5

$$J_L = \frac{m}{8} \cdot D^2 \ [kgm^2]$$

$$T_L = \mu \cdot m \cdot g \cdot r \ [Nm] \quad g = 9.81 \ [m/s^2]$$

Illustration 59.6



Example of actuator selection

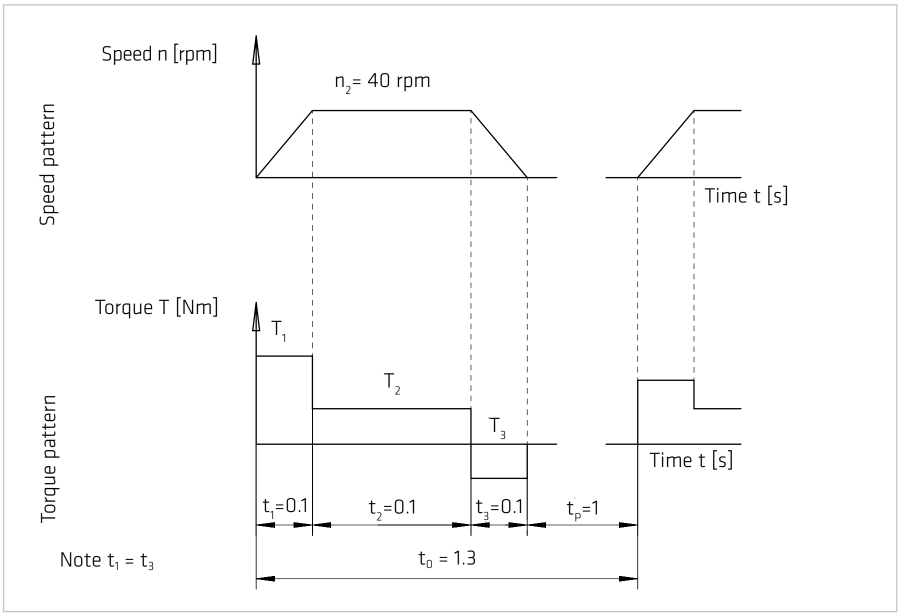
Load Conditions
Assume servo mechanism is used to cyclically position a mass with a horizontal axis of rotation.

Table 60.1

Load rotation speed	n_2 = 40 [rpm]
Load torque (e. g. friction)	T_L = 5 [Nm]
Load inertia	J_L = 1.3 [kgm²]
Speed pattern	
Acceleration; Deceleration	$t_1 = t_3$ = 0.1 [s]
Operate with rated speed	t_2 = 0.1 [s]
Stand still	t_p = 1 [s]
Total cycle time	t_0 = 1.3 [s]

Please note: Each characteristic value should be converted to the value at the output shaft of the actuator.

Illustration 60.2



Actuator data CanisDrive-25A-50

Table 60.3

Max. Torque	T_{max} = 127 [Nm]
Max. Speed	n_{max} = 112 [rpm]
Moment of inertia	J_{Out} = 1.063 [kgm²]

Tentatively select a required actuator based upon load conditions. FHA-25C-50 meets the tentative selection requirements from catalogue value (see rating table)

$n_2 = 40$ rpm $< n_{max} = 112$ rpm
$J_L = 1.3$ kgm² $< 3J_{out} = 3.19$ kgm²

Calculate required acceleration torque (T_1)

$$T_1 = 5 + \frac{2\pi}{60} \cdot \frac{(1.3 + 0.86) \cdot 40}{0.1} = 103.8 \text{ Nm}$$

Confirm: Is the required acceleration torque less than the maximum output torque of the actuator?

$T_1 = 103.8$ Nm $< T_{max} = 127$ Nm

No

Yes

Calculate effective torque (T_{rms})

$T_1 = 103.8$ Nm
$T_2 = T_L = 5$ Nm
$T_3 = T_L - (T_1 - T_L) = -93.8$ Nm

$$T_{rms} = \sqrt{\frac{103.8^2 \cdot 0.1 + 5^2 \cdot 0.1 + (-93.8)^2 \cdot 0.1}{1.3}} = 38.8 \text{ Nm}$$

Calculation of the average speed

$$n_{av} = \frac{\frac{40}{2} \cdot 0.1 + 40 \cdot 0.1 + \frac{40}{2} \cdot 0.1}{1.3}$$

$n_{av} = 6$ rpm

Calculation of the duty factor

$$ED = \frac{0.1 + 0.1 + 0.1}{1.3} \cdot 100\%$$

ED = 23 %

$T_{rms} = 38.8$ Nm
$n_{av} = 6$ rpm

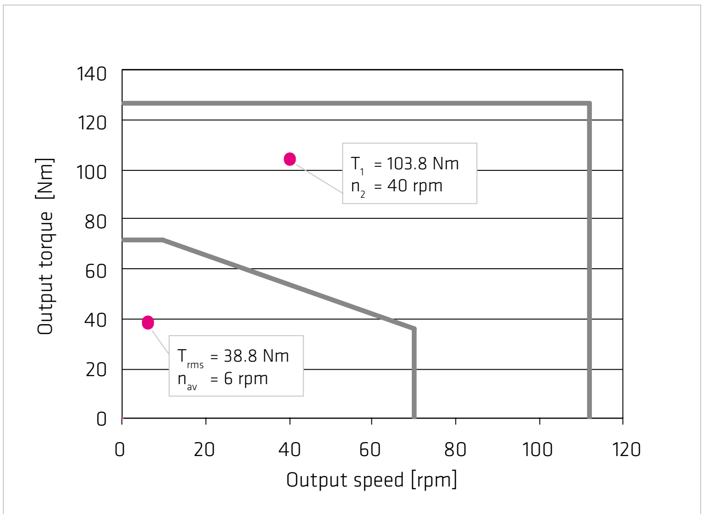
Check according to the performance characteristics

T_{rms} and n_{av} are inside the continuous duty zone

Confirm final selection

Illustration 61.1

CanisDrive-25A-50



7.2 Calculation of the Torsion Angle

Equation 62.1

$$T \leq T_1$$

$$\varphi = \frac{T}{K_1}$$

Equation 62.2

$$T_1 < T \leq T_2$$

$$\varphi = \frac{T_1}{K_1} + \frac{T - T_1}{K_2}$$

Equation 62.3

$$T > T_2$$

$$\varphi = \frac{T_1}{K_1} + \frac{T_2 - T_1}{K_2} + \frac{T - T_2}{K_3}$$

φ = Angle [rad]
T = Torque [Nm]
K = Stiffness [Nm/rad]

Example

$T = 60$ Nm $K_1 = 6.7 \cdot 10^4$ Nm/rad

$T_1 = 29$ Nm $K_2 = 1.1 \cdot 10^5$ Nm/rad

$T_2 = 108$ Nm $K_3 = 1.2 \cdot 10^5$ Nm/rad

$$\varphi = \frac{29\ \text{Nm}}{6.7 \cdot 10^4\ \text{Nm/rad}} + \frac{60\ \text{Nm} - 29\ \text{Nm}}{11 \cdot 10^4\ \text{Nm/rad}}$$

$$\varphi = 7.15 \cdot 10^{-4}\ \text{rad}$$

$$\varphi = 2.5\ \text{arc min}$$

Equation 62.4

$$\varphi\ [\text{arc min}] = \varphi\ [\text{rad}] \cdot \frac{180 \cdot 60}{\pi}$$

7.3 Output Bearing

7.3.1 Lifetime Calculation for Continuous Operation

The operating life of the output bearing can be calculated using equation 63.1.

Equation 63.1

$$L_{10} = \frac{10^6}{60 \cdot n_{av}} \cdot \left(\frac{C}{f_w \cdot P_C}\right)^B$$

with:

L_{10} [h]	=	Operating life
n_{av} [rpm]	=	Average output speed
C [N]	=	Dynamic load rating, see table "Output Bearing Ratings"
P_C [N]	=	Dynamic equivalent load
f_W	=	Operating factor (Table 63.2)

Average output speed

$$n_{av} = \frac{|n_1| t_1 + |n_2| t_2 + \ldots + |n_n| t_n}{t_1 + t_2 + \ldots + t_n + t_p}$$

Table 63.2

Load conditions	f_W
No impact loads or vibrations	1 ... 1.2
Normal rotating, normal loads	1.2 ... 1.5
Impact loads and/or vibrations	1.5 ... 3

7.3.2 Lifetime Calculation for Oscillating Motion

The operating life at oscillating motion can be calculated using equation 63.3.

Equation 63.3

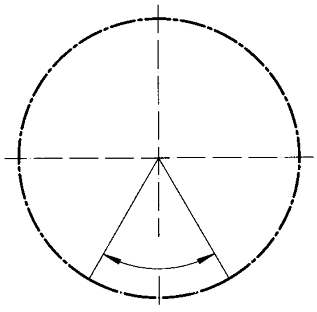
$$L_{OC} = \frac{10^6}{60 \cdot n_1} \cdot \frac{180}{\varphi} \cdot \left(\frac{C}{f_w \cdot P_C}\right)^B$$

with:

L_{OC} [h]	=	Operating life for oscillating motion
n_1 [cpm]	=	Number of oscillations/minute*
C [N]	=	Dynamic load rating. See table "Output Bearing" in the appropriate product chapter
P_C [N]	=	Dynamic equivalent load
φ [Degree]	=	Oscillating angle
f_W	=	Operating factor (Table 63.2)

* one oscillation means 2φ

Illustration 63.4 **Oscillating angle**



At oscillating angles < 5° fretting corrosion may occur due to insufficient lubrication. In this case please contact our sales engineer for counter-measures.

Bearing type of selected products see "Output Bearing Ratings" in the appropriate product chapter.

Table 63.5

Type of bearing	**B**
Cross roller bearing	10/3
Four point bearing	3

Dynamic equivalent load

Equation 64.1

$$P_C = x \cdot \left(F_{rav} + \frac{2M}{dp}\right) + y \cdot F_{aav}$$

Equation 64.2

$$F_{rav} = \left(\frac{|n_1| \cdot t_1 \cdot (|F_{r1}|)^B + |n_2| \cdot t_2 \cdot (|F_{r2}|)^B + \ldots + |n_n| \cdot t_n \cdot (|F_{rn}|)^B}{|n_1| \cdot t_1 + |n_2| \cdot t_2 + \ldots + |n_n| \cdot t_n} \right)^{1/B}$$

Equation 64.3

$$F_{aav} = \left(\frac{|n_1| \cdot t_1 \cdot (|F_{a1}|)^B + |n_2| \cdot t_2 \cdot (|F_{a2}|)^B + \ldots + |n_n| \cdot t_n \cdot (|F_{an}|)^B}{|n_1| \cdot t_1 + |n_2| \cdot t_2 + \ldots + |n_n| \cdot t_n} \right)^{1/B}$$

with:

F_{rav} [N]	=	Radial force
F_{aav} [N]	=	Axial force
d_p [m]	=	Pitch circle
x	=	Radial load factor (Table 64.4)
y	=	Axial load factor (Table 64.4)
M	=	Tilting moment

Table 64.4

Load factors	x	y
$\frac{F_{aav}}{F_{rav} + 2 \cdot M / dp} \leq 1.5$	1	0.45
$\frac{F_{aav}}{F_{rav} + 2 \cdot M / dp} > 1.5$	0.67	0.67

Illustration 64.5

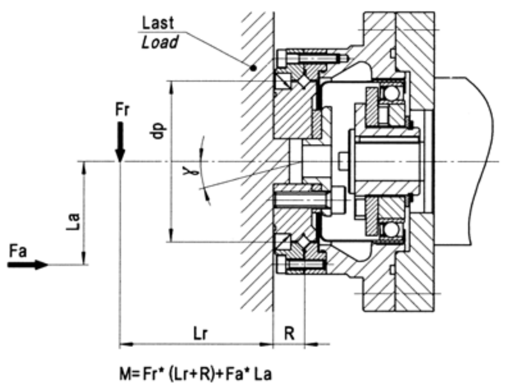
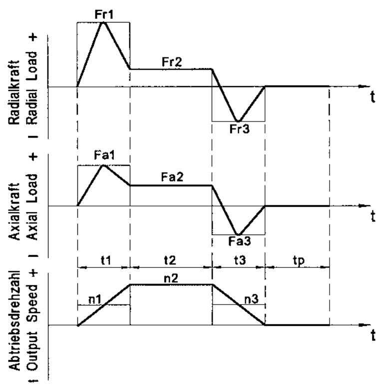


Illustration 64.6



Please note:
F_{rx} represents the maximum radial force.
F_{ax} represents the maximum axial force.
t_p represents the pause time between cycles.

7.3.3 Permissible Static Tilting Moment

In case of static load, the bearing load capacity can be determined as follows:

Equation 65.1

$$f_S = \frac{C_0}{P_0} \quad \text{mit} \quad P_0 = x_0 \left(F_r + \frac{2M}{d_p} \right) + y_0 \cdot F_a$$

and so

Equation 65.2

$$M_0 = \frac{d_p \cdot C_0}{2 \cdot f_S}$$

f_s = Static load safety factor
(f_s = 1,5 ... 3) (Table 65.3)
C_0 = Static load rating
F_r = F_a = 0
x_0 = 1
y_0 = 0.44
P_0 = Static equivalent load
d_p = Pitch circle diameter of the output bearing
M = Moment acting
M_0 = Allowable static overturning moment

Table 65.3

Rotation conditions of bearing	Lower limit value for f_s
Normal	≥ 1.5
Vibrations / Impacts	≥ 2
High transmission accuracy	≥ 3

7.3.4 Angle of Inclination

The angle of inclination of the output flange, as a function of the tilting moment acting on the output bearing, can be calculated by means of equation 65.1:

Equation 65.1

$$\gamma = \frac{M}{K_B}$$

with:
γ [arcmin] = Angle of inclination of the output flange
M [Nm] = Tilting moment acting on the output bearing
K_B [Nm/arcmin] = Moment stiffness of the output bearing

8. Installation and Operation

8.1 Transport and Storage

The transportation of the servo actuators and motors should always be in the original packaging.

If the servo actuators and motors are not put into operation immediately after delivery, they should be stored in a dry, dust and vibration free environment. Storage should be for no longer than 2 years at room temperatures (between +5 °C ... +40 °C) so that the grease life is preserved.

INFORMATION

Tensile forces in the connecting cable must be avoided.

ADVICE

Lithium metal batteries are dangerous goods according to UN3090. Therefore they are generally subject to transport regulations, depending on the transport mode.
The batteries installed in the motor feedback systems do not contain more than 1 g of lithium or lithium alloy and are exempt from dangerous goods regulations.

8.2 Installation

Check the performance and protection and check the suitability of the conditions at the installation site. Take suitable constructive measures to ensure that no liquid (water, drilling emulsion, coolant) can penetrate the output bearing or encoder housing.

ADVICE

The installation must be protected against impact and pressure on the gear.

The mounting must be such that heat loss can be adequately dissipated.

No radial forces and axial forces may act to the protection sleeve of the hollow shaft actuator.

During installation, the actuator must be fitted ensuring the machine housing can be rotated without terminals. Already low terminals may affect the accuracy of the gear and, should this be the case, the installation of the machine housing should be checked.

8.4 Electrical Installation

All work should be carried out with power off.

DANGER

Electric servo actuators and motors have dangerous live and rotating parts. All work during connection, operation, repair and disposal must be carried out only by qualified personnel as described in the standards EN50110-1 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 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.

DANGER

Due to the fact that the motor contains permanent magnets, a voltage is generated at the motor terminals when the rotor is turned.

ADVICE

- The connecting leads should be suitable for the type of use, as well as the voltages and amperages concerned.
- The protective earth must be connected to the terminal marked PE.
- All cables used should be provided with a shield and in addition, the encoder cable should feature twisted pair leads.
- The power supply is switched off before connecting and disconnecting the power connection and signal connections.

ADVICE

Encoders and sensors contain electrostatically sensitive components, observe the ESD measures!

8.5 Commissioning

NOTE

Commissioning must be executed in accordance with the documentation of Harmonic Drive AG.

Before commissioning, please check that:

- The actuator is properly mounted
- All electrical connections and mechanical connections are designed according to requirements
- The protective earth is properly connected
- All attachments (brakes, etc) are operational
- Appropriate measures have been taken to prevent contact with moving and live parts
- The maximum speed n_{max} is specified and cannot be exceeded
- The set up of the drive parameters has been executed
- The commutation is adjusted correctly

⚠ ATTENTION

Check the direction of rotation of the load uncoupled.

In the event of changes in the normal operating behaviour, such as increased temperature, noise or vibration, switch the actuator off. Determine the cause of the problem and contact the manufacturer if necessary. Even if the actuator is only on test, do not put safety equipment out of operation.

This list may not be complete. Other checks may also be necessary.

ADVICE

Due to heat generation from the actuator itself, tests outside the final mounting position should be limited to 5 minutes of continuous running at a motor speed of less than 1000 rpm.

These values should not be exceeded in order to avoid thermal damage to the actuator.

8.6 Overload Protection

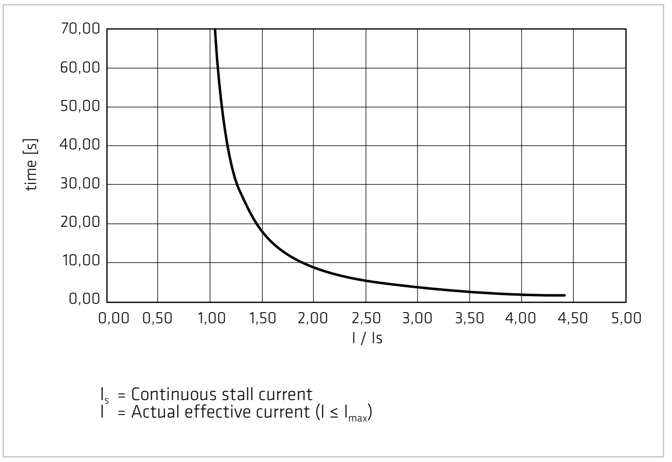
To protect the servo actuators and motors from temperature overload sensors are integrated into the motor windings.

The temperature sensors alone do not guarantee motor protection. Protection against overload of the motor winding is only possible with an input speed > 0. For special applications (eg. load at standstill or very low speed) is an additional overload protection by limiting the overload period.

The built specification of the integrated temperature sensors can be found in the technical data.

In addition, it is recommended to protect the motor winding against overload by the use of I^2t monitoring integrated in the controller. The graph shows an example of the overload characteristic for the I^2t monitoring. The overload factor is the ratio between the actual RMS current and continuous stall current.

Illustration 68.1 Over load characteristic



8.7 Protection against Corrosion and Penetration of Liquids and Debris

The product is fully protected provided that the connectors are correctly attached. Corrosion from the ambient atmosphere (condensation, liquids and gases) at the running surface of the output shaft seal is prevented.

Contact between sharp edged or abrasive objects (cutting chips, splinters, metallic or minerals dusts, etc.) and the output shaft seal must be prevented. Permanent contact between the output shaft seal and a permanent liquid covering should also be prevented.
A change in the operating temperature of a completely sealed actuator can lead to a pressure differential between the outside and the inside temperature of the actuator. This can cause any liquid covering the output shaft seal to be drawn into the housing which could cause corrosive damage.

As a countermeasure, we recommend the use of an additional shaft seal (to be provided by the user) or the maintenance of a constant pressure inside the actuator. Please contact Harmonic Drive AG for further information.

ADVICE

Specification sealing air: constant pressure in the actuator as described above; the supplied air must be dry and filtered with pressure at not more than 10^4 Pa.

8.8 Shutdown and Maintenance

In case of malfunctions or maintenance measures, or to shutdown the motors, proceed as follows:

1. Follow the instructions in the machine documentation.
2. Bring the actuator on the machine to a controlled standstill.
3. Turn off the power and the control voltage on the controller.
4. For motors with a fan unit; turn off the motor protection switch for the fan unit.
5. Turn off the mains switch of the machine.
6. Secure the machine against accidental movement and against unauthorised operation.
7. Wait for the discharge of electrical systems then disconnect all the electrical connections.
8. Secure the motor, and possibly the fan unit, before disassembly against falling or movement then pay attention to the mechanical connections.

DANGER

Risk of death by electric voltages. Work in the area of live parts is extremely dangerous.

- Work on the electrical system may only be performed by qualified electricians. The use of a power tool is absolutely necessary.

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

- Before starting work check with a suitable measuring instrument if there are any parts under residual voltage.(e.g. capacitors, etc.). Wait until the residual voltage is within a save range.

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

Burns from hot surfaces with temperatures of over 100°C

Let the motors cool down before starting work. Cooling times of up to 140 minutes may be necessary.
Wear protective gloves.
Do not work on hot surfaces!

WARNING

Persons and property during maintenance and operation

Never perform maintenance work on running machinery. Secure the system during maintenance against re-starting and unauthorised operation.

Cleaning

Excessive dirt, dust or chips may adversely affect the operation of the device and can, in extreme cases, lead to failure. At regular intervals (latest after one year) you should therefore, clean the device to ensure a sufficient dissipation of the surface heat. Insufficient heat emissions can have undesirable consequences. The lifetime of the device is reduced if temperature overloads occures. Overtemperature can lead to the shutdown of the device.

Checking of electric connections

⚠ DANGER

Lethal electric shock by touching live parts!

In any case of defects of the cable sheath the system must be shut down immediately and the damaged cable should be replaced. Do not make any temporary repairs on the connection cables.

- Connection cord should be periodically checked for damage and replaced if necessary.
- Check optionally installed power chains for defects.
- Protective conductor connections should be in a good condition and tightness checked at regular intervals. Replace if necessary.

Control of mechanical fasteners

The fastening screws and the load of the housing must be checked regularly.

Maintenance intervals for battery backed motor feedback systems

ADVICE

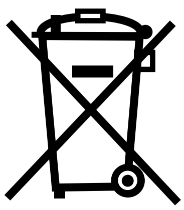
Please note the information on battery life time in the chapter "Motor Feedback Systems"!
Regardless of the results from the theoretical battery life time calculation, we specify to change the complete motor feedback system latest 10 years after delivery.

9. Decommissioning and Disposal

The gears, servo actuators and motors from Harmonic Drive AG contain lubricants for bearings and gears as well as electronic components and printed circuit boards. Since lubricants (greases and oils) are considered hazardous substances in accordance with health and safety regulations, it is necessary to dispose of the products correctly. Please ask for safety data sheet where necessary.

ADVICE

- Batteries do not contain hazardous materials according to EC directives 91/157/EEC, 93/86/EEC, and 2011/65/EU (RoHS directive)
- EC battery directive 2006/66/EC has been implemented by most EC member states,
- According to the EU Battery Directive, Lithium batteries are marked with the symbol of the crossedout wheeled bin (see figure). The symbol reminds the end user that batteries are not permitted to be disposed of with household waste, but must be collected separately.
- A disposal service is offered upon request by Harmonic Drive AG.



10. Glossary

10.1 Technical Data

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]

The intended operating temperature for the operation of the drive.

Average input speed (grease lubrication) $n_{av\ (max)}$ [rpm]

Maximum permissible average gear input speed for grease lubrication.

Average input speed (oil lubrication) $n_{av\ (max)}$ [rpm]

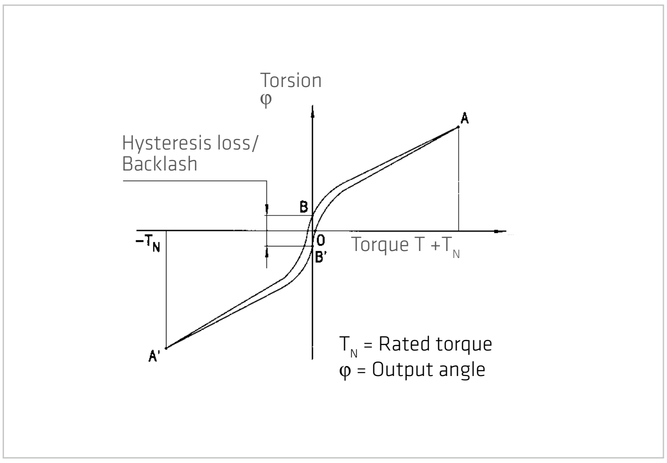
Maximum permissible average gear input speed for oil lubrication.

Average torque T_A [Nm]

When a variable load is applied to the gear, an average torque should be calculated for the complete operating cycle. This value should not exceed the specified T_A limit.

Backlash (Harmonic Planetary gears) [arcmin]

When subjected to the rated torque, Harmonic Planetary gears display characteristics shown in the hysteresis curve. When a torque is applied to the output shaft of the gear with the input shaft locked, the torque-torsion relationship can be measured at the output. Starting from point 0 the graph follows successive points A-B-A'-B'-A where the value B-B' is defined as the backlash or hysteresis.



Brake closing time t_C [ms]

Delay time to close the brake.

Brake current to hold I_{HBr} [A_{DC}]

Current for applying the brake.

Brake current to open I_{OBr} [A_{DC}]

Current required to open 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]

Terminal voltage of the holding brake.

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.

Demagnetisation current I_E [A_{rms}]

Current at which rotor magnets start to demagnetise.

Dynamic axial load $F_{A\ dyn\ (max)}$ [N]

With the bearing rotating, this is the maximum allowable axial load 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 load $F_{R\ dyn\ (max)}$ [N]

With the bearing rotating, this is the maximum allowable radial load 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.

Electrical time constant τ_e [s]

The electrical time constant is the time required for the current to reach 63% of its final value.

Hollow shaft diameter d_H [mm]

Free inner diameter of the continuous axial hollow shaft.

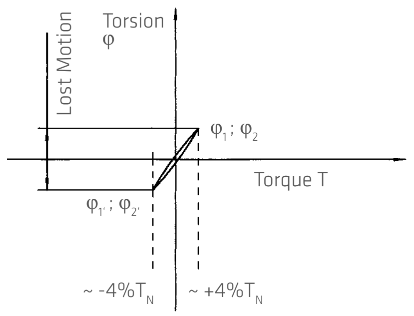
Inductance (L-L) L_{L-L} [mH]

Terminal inductance calculated without taking into account the magnetic saturation of the active motor parts.

Lost Motion (Harmonic Drive® Gearing) [arcmin]

Harmonic Drive® Gearing exhibits 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.

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 hollow shaft diameter $d_{H\ (max)}$ [mm]
For gears with a hollow shaft, this value is the maximum possible diameter of the axial hollow shaft.

Maximum input speed (grease lubrication) $n_{in\ (max)}$ [rpm]
Maximum allowable input speed with grease lubrication.

Maximum input speed (oil lubrication) $n_{in\ (max)}$ [rpm]
Maximum allowable input speed for gearing with oil lubrication.

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.

Maximum power P_{max} [W]
Maximum power output.

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® Gearing may be subjected to a brief collision torque. The magnitude and frequency of this collision torque should be kept to a minimum and under no circumstances should the collision torque occur during the normal operating cycle.

Moment of inertia J [kgm^2]
Mass moment of inertia at motor side.

Moment of inertia J_{in} [kgm^2]
Mass moment of inertia of the gearing with respect to the input.

Moment of inertia J_{out} [kgm^2]
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.

Number of pole pairs p

Number of magnetic pole pairs on the rotor of the motor.

Offset R [m]

Distance between output bearing and contact point of the load.

Pitch circle diameter d_p [m] or [mm]

Pitch circle diameter of the output bearing rolling elements.

Protection IP

The degree of protection according to EN 60034-5 provides suitability for various environmental conditions.

Rated current I_N [A]

RMS value of the sinusoidal current when driven at rated torque and rated speed.

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 power P_N [W]

Output power at rated speed and rated torque.

Rated speed n_N [rpm], Mechanical

The rated speed is a reference speed for the calculation of the gear life. When loaded with the rated torque and running at rated speed the gear will reach the expected operating life L_{50}. The speed n_N is not used for dimensioning the gear.

[rpm]

Product series	n_N
CobaltLine®, HFUC, HFUS, CSF, CSG, CSD, SHG, SHD	2000
PMG size 5	4500
PMG size 8 to 14	3500
HPG, HPGP, HPN	3000

Rated torque T_N [Nm], Servo

The output torque which can be continuously transmitted when driven at rated input speed, when mounted on a suitably dimensioned heat sink.

Rated torque T_N [Nm], Mechanical

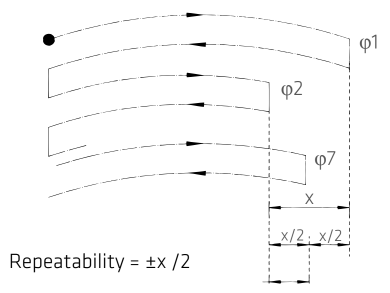
The rated torque is a reference torque for the calculation of the gear life. When loaded with the rated torque and running at rated speed the gear will reach the average life L_{50}. The rated torque T_N is not used for the dimensioning of the gear.

Rated voltage U_N [V_{rms}]
Supply voltage for operation with rated torque and rated speed.

Ratio i [ ]
The ratio is the reduction of input speed to the output speed.

Note for Harmonic Drive® Gears: The standard version has the Wave Generator as the input element, the Flexspline as the output 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 should be used for calculations in which the direction of rotation is to 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.



Repeatable peak torque T_R [Nm]
Specifies the maximum allowable acceleration and braking torques. During the normal operating cycle the repeatable peak torque T_R should not be exceeded.

Resistance (L-L, 20° C) R_{L-L} [Ω]
Winding resistance measured between two conductors at a winding temperature of 20° C.

Size
1) Actuators / Gears with Harmonic Drive® gears or Harmonic Planetary gears
The frame size is derived from the pitch circle diameter of the gear teeth in inches multiplied by 10.

2) CHM Servo motor series
The size of the CHM servo motors is derived from the stall torque in Ncm.

3) Direct drives from the TorkDrive® series
The size of the TorkDrive® series is the outer diameter of the iron core of the stator.

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 load with no additional axial forces or tilting moments applied.

Synchronous inductance L_d [mH]
Sum of air gap inductance and leakage inductance in relation to the single-phase equivalent circuit diagram of the synchronous motor.

Tilting moment stiffness K_B [Nm/arcmin]
Describes the relationship between the tilting angle of the output bearing and an applied moment load.

Torque constant (motor) k_{TM} [Nm/A_{rms}]

Quotient of stall torque and stall current.

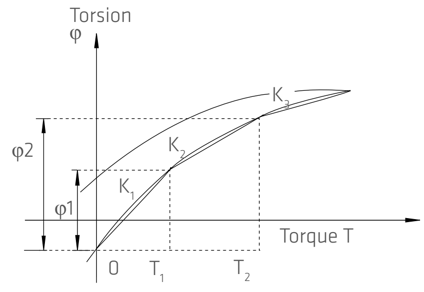
Torque constant (output) k_{Tout} [Nm/A_{rms}]

Quotient of stall torque and stall current, taking into account the transmission losses.

Torsional stiffness (Harmonic Drive® Gears) K_3 [Nm/rad]

The amount of elastic rotation at the output for a given torque with the Wave Generator blocked. The torsional stiffness K_3 describes the stiffness above a defined reference torque where the stiffness is almost linear.

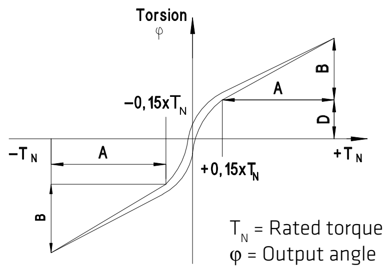
The value given for the torsional stiffness K_3 is an average that has been determined during numerous tests. The limit torques T_1 and T_2 and calculation example for the total torsional angle can be found in sections 3 and 4 of this documentation.



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) K [Nm/rad]

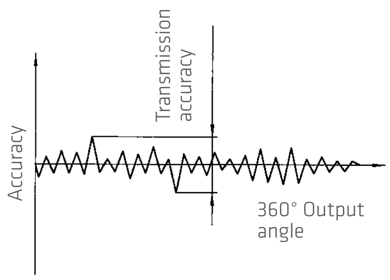
The amount of elastic rotation at the output for a given torque and blocked input shaft. The torsional rigidity of the Harmonic Planetary gear describes the rotation of the gear above a reference torque of 15% of the rated torque. In this area the torsional stiffness is almost linear.



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.



Weight m [kg]

The weight specified in the catalog is the net weight without packing and only applies to standard versions.

10.2 Labelling, Guidelines and Regulations

CE-Marking

With the CE marking, the manufacturer or EU importer declares in accordance with EU regulation, that by affixing the CE mark the product meets the applicable requirements in the harmonization legislation established the Community.

CE

REACH Regulation

REACH is a European Community Regulation on chemicals. REACH stands for Registration, Evaluation, Authorization and Restriction of Chemicals.

REACH
Verordnung
Nr. 1907/2006

RoHS EU Directive

The RoHS EU Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

RoHS
COMPLIANT

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