Engineering Data
AC Servo Motors CHM

More information on our servo products can be found HERE!

Contact us today!
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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](http://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:

Harmonic Drive AG
Marketing and Communications
Hoenbergstraße 14
65555 Limburg / Lahn
Germany
E-Mail: info@harmonicdrive.de
### 1.1 Description of Safety Alert Symbols

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="DANGER" /></td>
<td>Indicates an imminent hazardous situation. If this is not avoided, death or serious injury could occur.</td>
</tr>
<tr>
<td><img src="image" alt="WARNING" /></td>
<td>Indicates a possible hazard. Care should be taken or death or serious injury may result.</td>
</tr>
<tr>
<td><img src="image" alt="ATTENTION" /></td>
<td>Indicates a possible hazard. Care should be taken or slight or minor injury may result.</td>
</tr>
<tr>
<td><img src="image" alt="ADVICE" /></td>
<td>Describes a possibly harmful situation. Care should be taken to avoid damage to the system and surroundings.</td>
</tr>
<tr>
<td><img src="image" alt="INFORMATION" /></td>
<td>This is not a safety symbol. This symbol indicates important information.</td>
</tr>
<tr>
<td><img src="image" alt="Warning" /></td>
<td>Warning of a general hazard. The type of hazard is determined by the specific warning text.</td>
</tr>
<tr>
<td><img src="image" alt="Warning" /></td>
<td>Warning of dangerous electrical voltage and its effects.</td>
</tr>
<tr>
<td><img src="image" alt="Beware" /></td>
<td>Beware of hot surfaces.</td>
</tr>
<tr>
<td><img src="image" alt="Beware" /></td>
<td>Beware of suspended loads.</td>
</tr>
<tr>
<td><img src="image" alt="Precautions" /></td>
<td>Precautions when handling electrostatic sensitive components.</td>
</tr>
</tbody>
</table>

### 1.2 Disclaimer and Copyright

The contents, images and graphics contained in this document are protected by copyright. In addition to the copyright, logos, fonts, company and product names can also be protected by brand law or trademark law. The use of text, extracts or graphics requires the permission of the publisher or rights holder.

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. Specialy designed models may differ in technical detail. If in doubt, we strongly recommend that you contact the manufacturer, giving the type designation and serial number for clarification.

2.1 Hazards

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

The surface temperature of gears, motors and actuators can exceed 55 degrees Celsius. The hot surfaces should not be touched.

Cables must not come into direct contact with hot surfaces.
**DANGER**

Electric, magnetic and electromagnetic fields are dangerous, in particular for persons with pacemakers, implants or similar. 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.

**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.

**ADVICE**

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 protection, 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 protection 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. A copy of the EC conformity declaration is supplied in the appendix.

In accordance with the Machinery Directive, Harmonic Drive® Servo Actuators and Servo 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 article 2 and article 3 Harmonic Drive® Servo Actuators and Motors are not classified as equipment, finished apparatus or fixed installation.

Harmonic Drive® Servo Actuators and Motors are classified as components which are not intended to be installed by the end-user in a finished apparatus. Harmonic Drive® Servo Actuators and Motors therefore are not within the scope of the EMCDirective.

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 manufacturer 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 manufacturer to ensure that the installation is undertaken correctly.
High speed and low cogging torque

The CHM Servo Motor is characterised by distributed winding, high resolution measuring systems and a hollow shaft. Available in five sizes, the motors offer maximum torques from 2.8 to 37 Nm at speeds of up to 6,500 rpm.

To adapt to specific applications, the CHM Series offer numerous possible combinations covering the selection of various options.

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. Accurate positioning ensures stable machine characteristics, short cycle times and minimum space requirements. With high protection ratings and corrosion resistance, the series is perfectly suited for use in harsh and demanding environmental conditions.
# 3.2 Ordering Code

Table 9.1

<table>
<thead>
<tr>
<th>Series</th>
<th>Size</th>
<th>Motor winding</th>
<th>Connector configuration</th>
<th>Motor feedback</th>
<th>Degree of protection</th>
<th>Brake</th>
<th>Special design</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM</td>
<td>0083A</td>
<td>AM</td>
<td>H</td>
<td>CDO</td>
<td>54</td>
<td>B</td>
<td>According to customer requirements</td>
</tr>
<tr>
<td></td>
<td>0200A</td>
<td>AR</td>
<td>H</td>
<td></td>
<td>54</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0390A</td>
<td>AU</td>
<td>H</td>
<td></td>
<td>65</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0800A</td>
<td>AX</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1100A</td>
<td>AX</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9.2

<table>
<thead>
<tr>
<th>Size</th>
<th>Ordering Code</th>
<th>Motor winding</th>
<th>Maximum DC bus voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0083A</td>
<td>AM</td>
<td>AM</td>
<td>680 VDC</td>
</tr>
<tr>
<td>0200A</td>
<td>AR</td>
<td>AR</td>
<td></td>
</tr>
<tr>
<td>0390A</td>
<td>AU</td>
<td>AU</td>
<td></td>
</tr>
<tr>
<td>0800A</td>
<td>AX</td>
<td>AX</td>
<td></td>
</tr>
<tr>
<td>1100A</td>
<td>AX</td>
<td>AX</td>
<td></td>
</tr>
</tbody>
</table>

Table 9.3

<table>
<thead>
<tr>
<th>Connector configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordering Code</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>H</td>
</tr>
</tbody>
</table>

Table 9.4

<table>
<thead>
<tr>
<th>Motor feedback</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordering Code</td>
</tr>
<tr>
<td>CDO</td>
</tr>
</tbody>
</table>

Table 9.5

<table>
<thead>
<tr>
<th>Degree of protection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ordering Code</td>
</tr>
<tr>
<td>54</td>
</tr>
<tr>
<td>65</td>
</tr>
</tbody>
</table>

Explanation of the technical data can be found in the Glossary.
Table 10.1

<table>
<thead>
<tr>
<th>Size</th>
<th>0083A</th>
<th>0200A</th>
<th>0390A</th>
<th>0800A</th>
<th>1100A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor winding</td>
<td>●</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>AM</td>
<td>●</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>AR</td>
<td>-</td>
<td>●</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>AU</td>
<td>-</td>
<td>-</td>
<td>●</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>AX</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Connector configuration</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>H</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Motor feedback</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>CDD</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Degree of protection</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>54</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>65</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Brake</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>B</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

● available  ○ on request  - not available
## 3.3 Technical Data

### 3.3.1 General Technical Data

<table>
<thead>
<tr>
<th>Table 11.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Insulation class (EN 60034-1)</strong></td>
</tr>
<tr>
<td><strong>Insulation resistance (500VDC)</strong></td>
</tr>
<tr>
<td><strong>Insulation voltage (10s)</strong></td>
</tr>
<tr>
<td><strong>Degree of protection (EN 60034-5)</strong></td>
</tr>
<tr>
<td><strong>Ambient operating temperature</strong></td>
</tr>
<tr>
<td><strong>Ambient storage temperature</strong></td>
</tr>
<tr>
<td><strong>Altitude (a. s. l.)</strong></td>
</tr>
<tr>
<td><strong>Relative humidity (without condensation)</strong></td>
</tr>
<tr>
<td><strong>Vibration resistance (DIN IEC 68 Part 2-6, 10 ... 500 Hz)</strong></td>
</tr>
<tr>
<td><strong>Shock resistance (DIN IEC 68 Part 2-27, 18 ms)</strong></td>
</tr>
<tr>
<td><strong>Temperature sensor</strong></td>
</tr>
<tr>
<td><strong>Shaft tolerances</strong></td>
</tr>
</tbody>
</table>

The continuous operating characteristics specified in the following refer to a temperature rise of the motor winding of 100 K at an ambient temperature of 40 degrees Celsius. The continuous operating characteristic curve applies to actuators mounted on an aluminium plate with the following dimensions.

<table>
<thead>
<tr>
<th>Table 11.2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Series</strong></td>
</tr>
<tr>
<td>CHM</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
### 3.3.2 Motor Data

<table>
<thead>
<tr>
<th>Symbol [Unit]</th>
<th>CHM-0083A</th>
<th>CHM-0200A</th>
<th>CHM-0390A</th>
<th>CHM-0800A</th>
<th>CHM-1100A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of protection</td>
<td>IP54</td>
<td>IP65</td>
<td>IP54</td>
<td>IP65</td>
<td>IP54</td>
</tr>
<tr>
<td>Maximum output torque</td>
<td>$T_{\text{max}}$ [Nm]</td>
<td>2.9</td>
<td>2.8</td>
<td>6.4</td>
<td>6.4</td>
</tr>
<tr>
<td>Maximum output speed</td>
<td>$n_{\text{max}}$ [rpm]</td>
<td>6500</td>
<td>5600</td>
<td>4000</td>
<td>4000</td>
</tr>
<tr>
<td>Continuous stall torque</td>
<td>$T_s$ [Nm]</td>
<td>0.76</td>
<td>0.70</td>
<td>1.8</td>
<td>1.7</td>
</tr>
<tr>
<td>Rated torque</td>
<td>$T_r$ [Nm]</td>
<td>0.6</td>
<td>0.4</td>
<td>1.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Rated speed</td>
<td>$n_r$ [rpm]</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
</tr>
<tr>
<td>Rated power</td>
<td>$P_r$ [W]</td>
<td>190</td>
<td>120</td>
<td>450</td>
<td>350</td>
</tr>
<tr>
<td>Maximum output torque</td>
<td>$T_{\text{max}}$ [Nm]</td>
<td>2.9</td>
<td>2.8</td>
<td>6.4</td>
<td>6.4</td>
</tr>
<tr>
<td>Maximum output speed</td>
<td>$n_{\text{max}}$ [rpm]</td>
<td>6500</td>
<td>5600</td>
<td>4000</td>
<td>4000</td>
</tr>
<tr>
<td>Continuous stall torque</td>
<td>$T_s$ [Nm]</td>
<td>0.76</td>
<td>0.70</td>
<td>1.8</td>
<td>1.7</td>
</tr>
<tr>
<td>Rated torque</td>
<td>$T_r$ [Nm]</td>
<td>0.6</td>
<td>0.4</td>
<td>1.4</td>
<td>1.1</td>
</tr>
<tr>
<td>Rated speed</td>
<td>$n_r$ [rpm]</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
<td>3000</td>
</tr>
<tr>
<td>Rated power</td>
<td>$P_r$ [W]</td>
<td>190</td>
<td>120</td>
<td>450</td>
<td>350</td>
</tr>
</tbody>
</table>

### Moment of Inertia

<table>
<thead>
<tr>
<th>Symbol [Unit]</th>
<th>CHM-0083A</th>
<th>CHM-0200A</th>
<th>CHM-0390A</th>
<th>CHM-0800A</th>
<th>CHM-1100A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moment of inertia without brake</td>
<td>$J$ [x10^-4kgm²]</td>
<td>0.94</td>
<td>3.2</td>
<td>8</td>
<td>13.9</td>
</tr>
<tr>
<td>Moment of inertia with brake</td>
<td>$J$ [x10^-4kgm²]</td>
<td>1.2</td>
<td>4.1</td>
<td>9.9</td>
<td>16.6</td>
</tr>
</tbody>
</table>

### Technical Data Brake

<table>
<thead>
<tr>
<th>Symbol [Unit]</th>
<th>CHM-0083A</th>
<th>CHM-0200A</th>
<th>CHM-0390A</th>
<th>CHM-0800A</th>
<th>CHM-1100A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brake voltage</td>
<td>$U_{\text{br}}$ [$V_{\text{rms}}$]</td>
<td>24 ±10%</td>
<td>24 ±10%</td>
<td>24 ±10%</td>
<td>24 ±10%</td>
</tr>
<tr>
<td>Brake holding torque (at output)</td>
<td>$T_{\text{br}}$ [Nm]</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Brake current to open</td>
<td>$I_{\text{br}}$ [A]</td>
<td>0.6</td>
<td>0.9</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>Brake current to hold (10 V)</td>
<td>$I_{\text{br}}$ [A]</td>
<td>0.3</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Number of brake cycles at n = 0 rpm</td>
<td></td>
<td>10000000</td>
<td>10000000</td>
<td>10000000</td>
<td>10000000</td>
</tr>
<tr>
<td>Emergency brake cycles</td>
<td></td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Opening time</td>
<td>$t_o$ [ms]</td>
<td>110</td>
<td>110</td>
<td>110</td>
<td>110</td>
</tr>
<tr>
<td>Closing time</td>
<td>$t_c$ [ms]</td>
<td>70</td>
<td>70</td>
<td>70</td>
<td>70</td>
</tr>
</tbody>
</table>
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 13.1 CHM-0083A

Illustration 13.2 CHM-0200A

Illustration 13.3 CHM-0390A

Illustration 13.4 CHM-0800A

Illustration 13.5 CHM-1100A

Legend

Intermittent duty
Continuous duty IP54 $U_{p1} = 430$ VAC
Continuous duty IP65 $U_{p1} = 220$ VAC
### 3.3.3 Dimensions

Detailed 2D drawings and 3D models can be found at the following Quicklink:

**QUICKLINK** [www.harmonicdrive.de/CAD1080](http://www.harmonicdrive.de/CAD1080)

#### Table 14.3

<table>
<thead>
<tr>
<th>Symbol [Unit]</th>
<th>CHM-0083A [mm]</th>
<th>CHM-0200A [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor feedback system</td>
<td>CDO</td>
<td>CDO</td>
</tr>
<tr>
<td>Length (without brake)</td>
<td>L [mm]</td>
<td>83.3</td>
</tr>
<tr>
<td></td>
<td>L1 [mm]</td>
<td>103.3</td>
</tr>
<tr>
<td>Length (with brake)</td>
<td>103.3</td>
<td>120</td>
</tr>
</tbody>
</table>

#### Table 14.6

<table>
<thead>
<tr>
<th>Symbol [Unit]</th>
<th>CHM-0390A [mm]</th>
<th>CHM-0800A [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor feedback system</td>
<td>CDO</td>
<td>CDO</td>
</tr>
<tr>
<td>Length (without brake)</td>
<td>L [mm]</td>
<td>97.5</td>
</tr>
<tr>
<td></td>
<td>L1 [mm]</td>
<td>116.5</td>
</tr>
<tr>
<td>Length (with brake)</td>
<td>116.5</td>
<td>132.5</td>
</tr>
</tbody>
</table>
Table 15.2

<table>
<thead>
<tr>
<th>Symbol [Unit]</th>
<th>CHM-1100A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor feedback system</td>
<td>CDO</td>
</tr>
<tr>
<td>Length (without brake) L [mm]</td>
<td>123.2</td>
</tr>
<tr>
<td>Length (with brake) L1 [mm]</td>
<td>144.2</td>
</tr>
</tbody>
</table>
3.3.4 Output Bearing

The AC Servo Motors CHM incorporate a high stiffness output bearing to support output loads. This bearing can withstand high axial and radial forces as well as high tilting moments.

Technical Data

Table 16.1

<table>
<thead>
<tr>
<th>Symbol [Unit]</th>
<th>CHM-0083A</th>
<th>CHM-0200A</th>
<th>CHM-0390A</th>
<th>CHM-0800A</th>
<th>CHM-1100A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing type 1)</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>R</td>
</tr>
<tr>
<td>Offset bearing to shaft end</td>
<td>R [mm]</td>
<td>31</td>
<td>30</td>
<td>34</td>
<td>50</td>
</tr>
<tr>
<td>Offset bearing to shaft end</td>
<td>R [mm]</td>
<td>15</td>
<td>17</td>
<td>18</td>
<td>19</td>
</tr>
<tr>
<td>Dynamic tilting moment</td>
<td>M_{dyn(max)} [Nm]</td>
<td>6.7</td>
<td>9.4</td>
<td>12</td>
<td>23</td>
</tr>
<tr>
<td>Dynamic axial load 2)</td>
<td>F_{A,dyn(max)} [N]</td>
<td>180</td>
<td>210</td>
<td>220</td>
<td>280</td>
</tr>
<tr>
<td>Dynamic radial load 2)</td>
<td>F_{R,dyn(max)} [N]</td>
<td>220</td>
<td>310</td>
<td>350</td>
<td>450</td>
</tr>
</tbody>
</table>

1) R = Ball bearing
2) 10000h bei 3000 rpm

Tolerances according to DIN 42955 N

Table 16.2

<table>
<thead>
<tr>
<th>Symbol [Unit]</th>
<th>CHM-0083A</th>
<th>CHM-0200A</th>
<th>CHM-0390A</th>
<th>CHM-0800A</th>
<th>CHM-1100A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radial eccentricity</td>
<td>[mm]</td>
<td>0.050</td>
<td>0.050</td>
<td>0.060</td>
<td>0.060</td>
</tr>
<tr>
<td>Concentricity</td>
<td>[mm]</td>
<td>0.080</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
</tr>
<tr>
<td>Axial eccentricity</td>
<td>[mm]</td>
<td>0.080</td>
<td>0.100</td>
<td>0.100</td>
<td>0.100</td>
</tr>
</tbody>
</table>
3.3.5 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 rotation set for a starting position) of the motor.

This measurement is effected via a rotary 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.
Incremental motor feedback with SIN / COS signals
reference and commutation signals

Table 18.1

<table>
<thead>
<tr>
<th>Ordering Code</th>
<th>Symbol [Unit]</th>
<th>CDO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer’s designation</td>
<td></td>
<td>CCK</td>
</tr>
<tr>
<td>Power supply $^0$</td>
<td>$U_b$ [VDC]</td>
<td>5 ± 10%</td>
</tr>
<tr>
<td>Current consumption $^5$</td>
<td>$I$ [mA]</td>
<td>150</td>
</tr>
<tr>
<td>Incremental signals</td>
<td>$u_\text{pp} [V_{ss}]$</td>
<td>1 ±20% / -25%</td>
</tr>
<tr>
<td>Signal form</td>
<td></td>
<td>sinusoidal</td>
</tr>
<tr>
<td>Number of pulses</td>
<td>$n_\text{A / B}$</td>
<td>1024</td>
</tr>
<tr>
<td>Commutation signals</td>
<td>$u_\text{pp} [V_{ss}]$</td>
<td>1</td>
</tr>
<tr>
<td>Signal form</td>
<td></td>
<td>sinusoidal</td>
</tr>
<tr>
<td>Number of pulses</td>
<td>$n_\text{C / D}$</td>
<td>1</td>
</tr>
<tr>
<td>Reference signal</td>
<td>$n_3 [R]$</td>
<td>1</td>
</tr>
<tr>
<td>Accuracy $^5$</td>
<td>$[\text{arcsec}]$</td>
<td>±12</td>
</tr>
<tr>
<td>Incremental resolution $^5$</td>
<td>$\text{inc } [\text{arcsec}]$</td>
<td>262144</td>
</tr>
<tr>
<td></td>
<td>$[\text{arcsec}]$</td>
<td>4.9</td>
</tr>
</tbody>
</table>

$^0$ Source: Manufacturer
$^5$ For interpolation with 8 bit

Signal wave form

Illustration 18.2

Valid for direction of rotation
- CW at the motor shaft (when viewed from the front face of the motor)
3.3.6 Temperature Sensors

For motor protection at speeds greater than zero, temperature sensors are integrated in the motor windings. For applications with high load where the speed is zero, additional protection (e.g., I²t monitoring) is recommended. When using the KTY 84-130, the values given in the table can be parametrized in the servo controller or an external evaluation unit.

<table>
<thead>
<tr>
<th>Sensor type</th>
<th>Parameter</th>
<th>( T_{\text{nat}} ) [°C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTC</td>
<td>Rated operating temperature</td>
<td>145</td>
</tr>
</tbody>
</table>

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

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

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 protect the actuator grease from temperature overload.

Temperature sensors used in the CHM Actuator Series meet the requirements for safe separation according to EN50178.
3.3.7 Electrical Connections

CHM-xxxx-H-CDO

Table 20.1

<table>
<thead>
<tr>
<th>Connector pin</th>
<th>Motor connector</th>
<th>Cable plug</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor connector</td>
<td>6 / M23 x 1</td>
<td>6 / M23 x 1 / Part no. 301193</td>
</tr>
<tr>
<td>External diameter</td>
<td>ca. 26 mm</td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>ca. 60 mm</td>
<td></td>
</tr>
</tbody>
</table>

Illustration 20.2

Table 20.3

<table>
<thead>
<tr>
<th>Connector pin</th>
<th>Motor phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>U</td>
</tr>
<tr>
<td>2</td>
<td>V</td>
</tr>
<tr>
<td>3</td>
<td>PE</td>
</tr>
<tr>
<td>4</td>
<td>BR+</td>
</tr>
<tr>
<td>5</td>
<td>BR-</td>
</tr>
<tr>
<td>6</td>
<td>W</td>
</tr>
</tbody>
</table>

Illustration 20.5

Table 20.4

<table>
<thead>
<tr>
<th>Connector pin</th>
<th>Encoder connector</th>
<th>Cable plug</th>
</tr>
</thead>
<tbody>
<tr>
<td>Encoder connector</td>
<td>17 / M23 x 1</td>
<td>17 / M23 x 1 / Part no. 270199</td>
</tr>
<tr>
<td>External diameter</td>
<td>ca. 26 mm</td>
<td></td>
</tr>
<tr>
<td>Length</td>
<td>ca. 60 mm</td>
<td></td>
</tr>
</tbody>
</table>

Table 20.6

<table>
<thead>
<tr>
<th>Connector pin</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7 (15)</th>
<th>8</th>
<th>9</th>
<th>10 (16)</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15 (7)</th>
<th>16 (10)</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDO</td>
<td>A+</td>
<td>A-</td>
<td>R+</td>
<td>D-</td>
<td>C+</td>
<td>C-</td>
<td>GND</td>
<td>Temp+</td>
<td>Temp-</td>
<td>KTY</td>
<td>Up</td>
<td>B+</td>
<td>B-</td>
<td>R-</td>
<td>D+</td>
<td>GND</td>
<td>Up</td>
</tr>
</tbody>
</table>

Illustration 20.6
## Connecting cables SINAMICS S120 with SMC Modul

Table 21.1

<table>
<thead>
<tr>
<th>Power Connection</th>
<th>Part no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM without brake</td>
<td>6FX8002-SCG01-1xx0</td>
</tr>
<tr>
<td>CHM with brake</td>
<td>6FX8002-SDG01-1xx0</td>
</tr>
<tr>
<td>Motor feedback</td>
<td></td>
</tr>
<tr>
<td>H-CDO</td>
<td>6FX8002-2CA31-1xx0</td>
</tr>
</tbody>
</table>

## Connecting cables with flying leads

Table 21.2

<table>
<thead>
<tr>
<th>Version</th>
<th>Part no.</th>
<th>Length [m]</th>
</tr>
</thead>
<tbody>
<tr>
<td>H-CDO</td>
<td>308853</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>308854</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>308855</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>308856</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>308857</td>
<td>25</td>
</tr>
</tbody>
</table>
4. Actuator Selection Procedure

4.1. Selection Procedure and Calculation Example

**ADVICE**

We will be pleased to make a gear calculation and selection on your behalf. Please contact our application engineers.

Flowchart for actuator selection

Equation 22.1

\[ T_1 = T_s - \frac{2\pi}{60} \left( J_m + J_j \right) \cdot n_j \cdot \frac{t_1}{t_s} \]

Equation 22.2

\[ T_2 = T_1 \]
\[ T_3 = T_1 - (T_1 - T_2) \]
\[ T_{rms} = \sqrt{\frac{T_1^2 \cdot t_1 + T_2^2 \cdot t_2 + T_3^2 \cdot t_3}{t_1 + t_2 + t_3}} \]

Equation 22.3

\[ n_{av} = \frac{|n_j| \cdot t_1 + |n_j| \cdot t_2 + |n_j| \cdot t_3}{2 \cdot t_1 + t_2 + t_3 + t_p} \]

Equation 22.4

\[ ED = \frac{t_1 + t_2 + t_3}{t_1 + t_2 + t_3 + t_p} \cdot 100\% \]
Pre selection conditions

Table 23.1

<table>
<thead>
<tr>
<th>Load</th>
<th>Confirmation</th>
<th>Catalogue value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load max. rotation speed ($n_2$)</td>
<td>$\leq n_{\text{max}}$</td>
<td>Max. output speed</td>
<td>[rpm]</td>
</tr>
<tr>
<td>Load moment of inertia ($J_L$)</td>
<td>$\leq 3J_{\text{Out}}$</td>
<td>Moment of inertia</td>
<td>[kgm$^2$]</td>
</tr>
</tbody>
</table>

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

Linear horizontal motion

Illustration 23.2

![Linear horizontal motion](image)

Equation 23.3

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

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

Rotary motion

Illustration 23.4

Equation 23.5

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

$$T_s = \mu \cdot m \cdot g \cdot r [\text{Nm}]$$

$g = 9.81 [\text{m/s}^2]$
Example of actuator selection

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

Table 24.1

<table>
<thead>
<tr>
<th>Load condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load rotation speed</td>
<td>( n_2 = 40 ) [rpm]</td>
</tr>
<tr>
<td>Load torque (e.g., friction)</td>
<td>( T_L = 5 ) [Nm]</td>
</tr>
<tr>
<td>Load inertia</td>
<td>( J_L = 1.3 ) [kgm²]</td>
</tr>
</tbody>
</table>

**Speed pattern**
- Acceleration; Deceleration: \( t_1 = t_2 = 0.1 \) [s]
- Operate with rated speed: \( t_2 = 0.1 \) [s]
- Stand still: \( t_p = 1 \) [s]
- Total cycle time: \( t_O = 1.3 \) [s]

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

Illustration 24.2

Actuator data FHA-25C-50-L

Table 24.3

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. Torque</td>
<td>( T_{max} = 151 ) [Nm]</td>
</tr>
<tr>
<td>Max. output speed</td>
<td>( n_{max} = 90 ) [rpm]</td>
</tr>
<tr>
<td>Moment of inertia</td>
<td>( J_{out} = 0.86 ) [kgm²]</td>
</tr>
</tbody>
</table>
Actuator selection

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

\[
\begin{align*}
n_l &= 40 \text{ rpm} < n_{max} = 90 \text{ rpm} \\
J_l &= 1.3 \text{ kgm}^2 < 3J_{max} = 2.58 \text{ kgm}^2
\end{align*}
\]

Calculate required acceleration torque \((T_1)\)

\[
T_1 = 5 + \frac{2\pi}{60} \left( \frac{1.3 + 0.86}{0.1} \right) \cdot 40 = 95 \text{ Nm}
\]

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

\[T_1 = 95 \text{ Nm} < T_{max} = 151 \text{ Nm}\]

Yes

Calculate effective torque \((T_{rms})\)

\[
T_{rms} = \sqrt{\frac{95^2 \cdot 0.1 + 5^2 \cdot 0.1 + (-85)^2 \cdot 0.1}{1.3}} = 35 \text{ Nm}
\]

Check according to the performance characteristics \(T_{rms}\) and \(n_{av}\) are inside the continuous duty zone

Calculation of the duty factor

\[
ED = \frac{0.1 + 0.1 + 0.1}{1.3} \cdot 100\% = 23\%
\]

Calculation of the average speed

\[
n_{av} = \frac{40 \cdot 0.1 + 40 \cdot 0.1 + 40 \cdot 0.1}{1.3}
\]

\[n_{av} = 6 \text{ rpm}\]

Confirm final selection

Illustration 25.1

FHA-25C-50L

\[
T_{rms} = 35 \text{ Nm} \quad n_{av} = 6 \text{ rpm}
\]

Calculation of the average speed

\[
n_{av} = \frac{40 \cdot 0.1 + 40 \cdot 0.1 + 40 \cdot 0.1}{1.3}
\]

\[n_{av} = 6 \text{ rpm}\]

Calculation of the duty factor

\[
ED = \frac{0.1 + 0.1 + 0.1}{1.3} \cdot 100\% = 23\%
\]

Tentative selection requirements from catalogue value (see rating table)

\[
\begin{align*}
n_l &= 40 \text{ rpm} < n_{max} = 90 \text{ rpm} \\
J_l &= 1.3 \text{ kgm}^2 < 3J_{max} = 2.58 \text{ kgm}^2
\end{align*}
\]

Continuous duty

Intermittent duty

Calculation of the average speed

\[
n_{av} = \frac{40 \cdot 0.1 + 40 \cdot 0.1 + 40 \cdot 0.1}{1.3}
\]

\[n_{av} = 6 \text{ rpm}\]

Calculation of the duty factor

\[
ED = \frac{0.1 + 0.1 + 0.1}{1.3} \cdot 100\% = 23\%
\]

Check according to the performance characteristics \(T_{rms}\) and \(n_{av}\) are inside the continuous duty zone

Calculation of the effective torque \((T_{rms})\)

\[
T_{rms} = \sqrt{\frac{95^2 \cdot 0.1 + 5^2 \cdot 0.1 + (-85)^2 \cdot 0.1}{1.3}} = 35 \text{ Nm}
\]

Confirm final selection

Calculation of the average speed

\[
n_{av} = \frac{40 \cdot 0.1 + 40 \cdot 0.1 + 40 \cdot 0.1}{1.3}
\]

\[n_{av} = 6 \text{ rpm}\]
5. Installation and Operation

5.1 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.

5.2 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.

5.3 Mechanical Installation

The data necessary for mounting the actuator and for connecting to the load are given in table 45.1.

<table>
<thead>
<tr>
<th></th>
<th>Symbol [Unit]</th>
<th>CHM-0083</th>
<th>CHM-0200</th>
<th>CHM-0390</th>
<th>CHM-0800</th>
<th>CHM-1100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load assembly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of screws</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Screw size</td>
<td>M3</td>
<td>M3</td>
<td>M4</td>
<td>M4</td>
<td>M4</td>
<td>M4</td>
</tr>
<tr>
<td>Screw quality</td>
<td>12.9</td>
<td>12.9</td>
<td>12.9</td>
<td>12.9</td>
<td>12.9</td>
<td>12.9</td>
</tr>
<tr>
<td>Pitch circle diameter</td>
<td>[mm]</td>
<td>27</td>
<td>40</td>
<td>48</td>
<td>53</td>
<td>53</td>
</tr>
<tr>
<td>Screw tightening torque</td>
<td>[Nm]</td>
<td>2.3</td>
<td>2.3</td>
<td>5.1</td>
<td>5.1</td>
<td>5.1</td>
</tr>
<tr>
<td>Housing assembly</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of holes</td>
<td>4 x Ø 7</td>
<td>4 x Ø 11</td>
<td>4 x Ø 13.5</td>
<td>4 x Ø 13.5</td>
<td>4 x Ø 13.5</td>
<td></td>
</tr>
<tr>
<td>Screw size</td>
<td>M6</td>
<td>M10</td>
<td>M12</td>
<td>M12</td>
<td>M12</td>
<td>M12</td>
</tr>
<tr>
<td>Screw quality</td>
<td>8.8</td>
<td>8.8</td>
<td>8.8</td>
<td>8.8</td>
<td>8.8</td>
<td>8.8</td>
</tr>
<tr>
<td>Pitch circle diameter</td>
<td>[mm]</td>
<td>130</td>
<td>165</td>
<td>215</td>
<td>215</td>
<td>215</td>
</tr>
<tr>
<td>Screw tightening torque</td>
<td>[Nm]</td>
<td>48</td>
<td>84.0</td>
<td>84</td>
<td>84</td>
<td>84</td>
</tr>
</tbody>
</table>

The data in the table are valid for completely cleaned and degreased surfaces (friction coefficient $\mu = 0.15$).
5.4 Electrical Installation

All work should be carried out with power off.

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 auxiliary 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.

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.

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

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 $n_{\text{max}}$ 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.

5.6 Overload Protection

Temperature sensors are integrated into the servo actuators and motors to protect them from.

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 only with an input speed $> 0$. For special applications (e.g., 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.
5.7 Protection against Corrosion and Penetration of Liquids and Debris

Table 29.1

<table>
<thead>
<tr>
<th></th>
<th>CHM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrosion protection</td>
<td>IEC 68 2-11</td>
</tr>
<tr>
<td>Salt spray test</td>
<td>Test time 16 h</td>
</tr>
</tbody>
</table>

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.

5.8 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.
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

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.

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!

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 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 occurs. 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 (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.

6. 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.
7. Glossary

7.1 Technical Data

AC Voltage constant $k_{EM}$ [Vrms / 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 $\tau_e [s]$
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 $\phi$ 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 $U_{DC\text{ (max)}}$ [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 $d_{H\text{ (max)}}$ [mm]
For gears with a hollow shaft, this value is the maximum possible diameter of the axial hollow shaft.

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

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

Maximum motor speed $n_{\text{max}}$ [rpm]
The maximum allowable motor speed.

Maximum output speed $n_{\text{max}}$ [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 $T_{\text{max}}$ [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 $P_{\text{max}}$ [W]
Maximum power output.

Mechanical time constant $\tau_{m}$ [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 $J$ [kgm²]
Mass moment of inertia at motor side.

Moment of inertia $J_{in}$ [kgm²]
Mass moment of inertia of the gearing with respect to the input.

Moment of inertia $J_{out}$ [kgm²]
Mass moment of inertia with respect to the output.
Motor terminal voltage (Fundamental wave only) $U_M$ [V<sub>rms</sub>]
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 [mm]**
Distance between output bearing and contact point of the load.

**Pitch circle diameter $d_p$ [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.

<table>
<thead>
<tr>
<th>Product series</th>
<th>$n_n$ [rpm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>CobaltLine®, HFUC, HFUS, CSF, CSG, CSD, SHG, SHD</td>
<td>2000</td>
</tr>
<tr>
<td>PMG size 5</td>
<td>4500</td>
</tr>
<tr>
<td>PMG size 8 to 14</td>
<td>3500</td>
</tr>
<tr>
<td>HPG, HPGP, HPN</td>
<td>3000</td>
</tr>
</tbody>
</table>

**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.

Repeatability $= \pm \frac{x}{2} = \pm \frac{x}{2}$

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 be not be exceeded.

Resistance (L-L, 20° C) $R_{L-L}$ [$\Omega$]
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.

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) $k_{\text{out}}$ [Nm/A$_{\text{rms}}$]
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.

**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.

**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.
7.2 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.

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

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