Excellent Technology for Evolving Industries

Harmonic Drive LLC engineers and manufactures precision servo actuators, gearheads and gear component sets. We work closely with companies of all sizes to understand their application requirements and provide a standard or custom-engineered solution to enable the success of their design project. Our mission is to provide motion control solutions that give our customers a competitive advantage.

With over 50 years of experience, our expert engineering and production teams develop enabling technologies and products to meet the needs of an evolving motion-control market. We are very proud of our outstanding company history.

Our high-precision, zero-backlash Harmonic Drive® actuators and gears have, and continue to play critical roles in robotics, spaceflight applications, semiconductor manufacturing equipment, factory automation equipment, medical diagnostics, and surgical robotics.

C. Walt Musser
Patented Strain Wave Gearing in 1955
Harmonic Drive® High-Precision Strain Wave Gearing

Features
• Zero backlash
• High positioning accuracy
• High repeatability
• Compactness
• Light weight
• High reduction ratio
• High torque capacity
• High efficiency
• Quiet operation

Structure
Utilizing a unique operating principle, the gear consists of only 3 basic parts (Wave Generator, Flexspline, and Circular Spline). It provides excellent features not found in other speed reducers.

Structure of Harmonic Drive® component product
- Wave Generator
  The Wave Generator is a thin raked ball bearing fitted onto an elliptical hub. This serves as a high efficiency torque converter and is generally mounted onto the input or motor shaft.
- Flexspline
  The Flexspline is a non-rigid, thin cylindrical cup with external teeth on the open end of the cup. The Flexspline fits over the Wave Generator and takes on its elliptical shape. The Flexspline is generally used as the output of the gear.
- Circular Spline
  The Circular Spline is a rigid ring with internal teeth. It engages the teeth of the Flexspline across the major axis of the Wave Generator ellipse. The Circular Spline has two more teeth than the Flexspline and is generally mounted onto a housing.

Operating Principle
- The Flexspline is slightly smaller in diameter than the Circular Spline and usually has two fewer teeth than the Circular Spline. The elliptical shape of the Wave Generator causes the teeth of the Flexspline to engage the Circular Spline at two opposite regions across the major axis of the ellipse.
- As the Wave Generator rotates the teeth of the Flexspline engage with the Circular Spline at the major axis. For every 180 degree clockwise movement of the Wave Generator the Flexspline rotates counter-clockwise by one tooth in relation to the Circular Spline.
- Each complete clockwise rotation of the Wave Generator results in the Flexspline moving counter-clockwise by two teeth from its original position relative to the Circular Spline.

Tooth engagement
The strain wave gear has a unique tooth engagement which results in a zero-backlash gear mesh that provides high positional accuracy and high torque with a compact form factor.
The Harmonic Drive® strain wave gear utilizes a unique gear tooth profile for optimized tooth engagement. Unlike an involute tooth profile, which is used in conventional gears, this optimized tooth profile (“S tooth”) enables about 30% of the total number of teeth to be engaged at the same time. This technological innovation results in high torque, high torsional stiffness, long life and smooth rotation.
The “S” tooth profile eliminates stress concentration by widening the tooth root and providing a large tooth root radius. This figure shows the progression of the Flexspline tooth engagement as it meshes with the teeth of the fixed Circular Spline.
Rotary Actuators

AC Servomotors
- Miniature Flat Hollow Shaft | FHA-Crmini
- Flat Hollow Shaft | FHA-C
- Flat Hollow Shaft | FHA-C PR
- Flat Hollow Shaft | FHA-C H
- Hollow Shaft | SHA-CG
- Flat Hollow Shaft | SHA-SG
- Ultra-flat | FLA
- Ultra Compact Cylinder | RSF Supermini
- Compact Cylinder | RSF mini
- Compact Cylinder | RSF
- Compact Cylinder | RKF

DC Servomotors
- Compact Cylinder | RH mini

Direct Drive Motor
- Ultra Precision Direct Drive Motor | KDU

Hollow Shaft Motor
- Ultra Precision Hollow Shaft | HMA

Linear Actuators

AC Servomotor
- High-Force Positioning | LBC

DC Servomotors
- Low-Force Positioning | LA
- Medium-Force Positioning | LAH-46
- High-Force Positioning | LAH-80

Stepping Motors

Other Actuators
- Optical Galvano Scanners
- Micro Encoder

Sensors

Super-Compact Encoders

Servo Drivers

DC Digital Servo Drive
- Multiple Operating Modes | DCJ Series
- Multiple Operating Modes | DDP Series
- Multiple Operating Modes | DEP Series

AC Digital Servo Drive
- Multiple Communication Modes | RTL Series
- Multiple Operating Modes | REL Series

For AC Servomotors
- Position and Speed Control | HA-680 Series
- Field Boss | HA-800 Series
- Field Boss | HA-800CL Series
- Field Boss | HA-680ML Series

For Direct Drive Motor
- Position Control Only | HA-770 Series

The combinations with actuator and driver may not comply with foreign safety standards. Please contact our sales office.

<table>
<thead>
<tr>
<th>Peak Torque (Nm)</th>
<th>Maximum Speed (rpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8–28</td>
<td>60–200</td>
</tr>
<tr>
<td>39–820</td>
<td>22–96</td>
</tr>
<tr>
<td>39–820</td>
<td>22–96</td>
</tr>
<tr>
<td>23–3419</td>
<td>25–120</td>
</tr>
<tr>
<td>73–3419</td>
<td>17–118</td>
</tr>
<tr>
<td>1.8 ~ 34</td>
<td>50–500</td>
</tr>
<tr>
<td>0.13–1.4</td>
<td>100–333</td>
</tr>
<tr>
<td>1.8–28</td>
<td>60–200</td>
</tr>
<tr>
<td>34–330</td>
<td>45–90</td>
</tr>
<tr>
<td>39–820</td>
<td>22–96</td>
</tr>
<tr>
<td>7.0–15.0</td>
<td>160–180</td>
</tr>
<tr>
<td>0.39–20</td>
<td>50–180</td>
</tr>
<tr>
<td>1.8–33</td>
<td>3000–6000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum Driving Force (N)</th>
<th>Maximum Speed (mm/s)</th>
<th>Stroke (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6000–1200</td>
<td>10–20</td>
<td>50</td>
</tr>
<tr>
<td>49</td>
<td>0.9</td>
<td>10–30</td>
</tr>
<tr>
<td>392</td>
<td>3.7</td>
<td>10–30</td>
</tr>
<tr>
<td>3000</td>
<td>3000</td>
<td>0.9–10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moment of Inertia (g·cm²)</th>
<th>Torque Constant (N·m/A(rms))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.9–8.5</td>
<td>0.0082–0.05</td>
</tr>
</tbody>
</table>
Custom actuators also available. Contact us to find out more about our engineering design services.
### Harmonic Drive® Precision Product

#### Component Gear Sets
Consisting of three basic components: flex spline, circular spline and wave generator, component gear sets offer ultimate design flexibility and can be tightly integrated in equipment sub-structures.

#### Gear Unit
Housed component gearing combined with precision cross roller output bearing & flange. Very compact, robust and easy to use gearhead solution.

#### Simplicity Gear Unit
Non-housed component gearing combined with a precision cross roller output bearing. Similar to Gear Units (above), without the housing and output flange, for tighter integration into the customer's housing or machine structure.

#### Planetary Gearing
The use of planetary gearing yields more compact, lightweight, lightweight and high-torque gearsets.

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### Quick Connect®

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Harmonic Drive LLC

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Harmonic Drive LLC
Hollow Shaft Brushless Actuators

FHA-C Mini Series

These servo actuators utilize Harmonic Drive® precision gears combined with a performance matched brushless servomotor and incremental encoder. The cube shaped form factor is very compact and features a through hole in the center of the shaft. This hollow shaft may be used to pass cables, tubing or a laser beam through the axis of rotation.

The FHA-mini series is designed to operate with a wide range of third-party drivers, as well as Harmonic Drive LLC’s DDP Series, DCJ Series, and DEP Series.

• Large center through hole
• Compact design
• Body width from 50 mm to 75 mm
• Body length from 48.5 mm to 66 mm

• FHA-C mini Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>FHA-8C</th>
<th>FHA-11C</th>
<th>FHA-14C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td>30</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Maximum Torque</td>
<td>N*m</td>
<td>1.8</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>in-lb</td>
<td>15.9</td>
<td>29.2</td>
</tr>
<tr>
<td>Maximum Positioning Speed</td>
<td>rpm</td>
<td>200</td>
<td>120</td>
</tr>
<tr>
<td>Torque Constant 100V, 200V</td>
<td>N*m/A</td>
<td>3.9</td>
<td>6.7</td>
</tr>
<tr>
<td></td>
<td>in-lb/A</td>
<td>34.5</td>
<td>59.3</td>
</tr>
<tr>
<td>Torque Constant 24V</td>
<td>N*m/A</td>
<td>0.8</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>in-lb/A</td>
<td>7.1</td>
<td>11.5</td>
</tr>
<tr>
<td>Maximum Current</td>
<td>A</td>
<td>0.61</td>
<td>0.64</td>
</tr>
<tr>
<td>DC 100V, 200V</td>
<td>3.0</td>
<td>3.3</td>
<td>2.4</td>
</tr>
<tr>
<td>Moment of Inertia (GD²/4) (J)</td>
<td>kg*m²</td>
<td>0.0026</td>
<td>0.0074</td>
</tr>
<tr>
<td></td>
<td>kgf*cm²</td>
<td>0.027</td>
<td>0.075</td>
</tr>
<tr>
<td>One-Way Positioning Accuracy</td>
<td>arc/sec</td>
<td>150</td>
<td>120</td>
</tr>
<tr>
<td>Allowable Moment Load</td>
<td>N-m</td>
<td>15</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>in-lb</td>
<td>133</td>
<td>354</td>
</tr>
<tr>
<td>Moment Stiffness</td>
<td>N-m/rad</td>
<td>2x10⁴</td>
<td>4x10⁴</td>
</tr>
<tr>
<td></td>
<td>in-lb/rad</td>
<td>18x10⁴</td>
<td>35x10⁴</td>
</tr>
<tr>
<td>Quad Encoder Resolution (At x 4)*3</td>
<td>Pulses/Revolution</td>
<td>240,000</td>
<td>400,000</td>
</tr>
<tr>
<td>Power Supply</td>
<td>V</td>
<td>DC 24, AC 100, AC 200</td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td>kg</td>
<td>0.40</td>
<td>0.62</td>
</tr>
<tr>
<td>Protection</td>
<td>Totally closed, self-cooling (Equivalent to IP44)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Conditions</td>
<td>Operating Temperature: 0 to 40°C • Storage Temperature: -20 to 60°C. Operating and storage humidity: 20 to 80% RH (No condensation permitted). Vibration resistance: 25g (frequency: 10 to 400Hz) • Shock resistance: 300g. Indoor installation: No dust, no metal powder, no corrosive gas, no inflammable gas, no oil mist, no other foreign matter and no direct sunshine. Altitude 1000m or less. Insulation resistance: 100Mohms. Insulation class: Class B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recommended Driver</td>
<td>DC24V</td>
<td>DCJ-055-09/DDP-090-09/DEP-090-09</td>
<td>DCJ-055-18/DDP-090-18/DEP-090-18</td>
</tr>
<tr>
<td></td>
<td>AC100/200</td>
<td>DDP-090-36/DEP-090-36</td>
<td></td>
</tr>
</tbody>
</table>

1 The figures in the table are those at the output shaft.
2 The figures are typical values.
3 The quad encoder resolution is obtained by the formula (motor encoder resolution) x4 x (reduction ratio).

Unit: mm

<table>
<thead>
<tr>
<th>Model</th>
<th>A</th>
<th>B</th>
<th>øC</th>
<th>øD</th>
</tr>
</thead>
<tbody>
<tr>
<td>FHA-8C</td>
<td>50</td>
<td>48.5</td>
<td>33.5</td>
<td>6.2</td>
</tr>
<tr>
<td>FHA-11C</td>
<td>60</td>
<td>56</td>
<td>41</td>
<td>8</td>
</tr>
<tr>
<td>FHA-14C</td>
<td>75</td>
<td>66</td>
<td>52.5</td>
<td>13.5</td>
</tr>
</tbody>
</table>
Hollow Shaft Brushless Actuators
FHA-C Series

These servo actuators utilize Harmonic Drive® precision gears combined with a performance matched brushless servo motor and incremental encoder. The FHA has a low profile form factor and features a hollow shaft through the center of the output. This hollow shaft feature may be used to pass cables, tubing or a laser beam through the axis of rotation.

The FHA series is designed to operate with a wide range of third-party drivers, as well as Harmonic Drive LLC’s DDP Series, DEP Series, and RTL Series.

- High torque
- Large center through hole
- Compact cylindrical design

### FHA-C Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>FHA-17C</th>
<th>FHA-25C</th>
<th>FHA-32C</th>
<th>FHA-40C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td></td>
<td>50</td>
<td>100</td>
<td>160</td>
<td>50</td>
</tr>
<tr>
<td>Maximum Torque</td>
<td>N-m</td>
<td>39</td>
<td>57</td>
<td>64</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>in-lb</td>
<td>345</td>
<td>504</td>
<td>566</td>
<td>1328</td>
</tr>
<tr>
<td>Maximum Rotational Speed</td>
<td>rpm</td>
<td>96</td>
<td>48</td>
<td>27</td>
<td>90</td>
</tr>
<tr>
<td>Torque Constant</td>
<td>Nm/Aex</td>
<td>21</td>
<td>42</td>
<td>67</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>in-lb/Aex</td>
<td>186</td>
<td>372</td>
<td>593</td>
<td>195</td>
</tr>
<tr>
<td>Moment of Inertia (kgm²/j)</td>
<td></td>
<td>0.17</td>
<td>0.67</td>
<td>1.7</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>kgfcm²</td>
<td>1.7</td>
<td>6.9</td>
<td>17</td>
<td>8.3</td>
</tr>
<tr>
<td>One-Way Positioning Accuracy</td>
<td>arcs/sec</td>
<td>60</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Allowable Moment Load</td>
<td>Nm</td>
<td>188</td>
<td>370</td>
<td>530</td>
<td>690</td>
</tr>
<tr>
<td></td>
<td>in-lb</td>
<td>1664</td>
<td>3275</td>
<td>4691</td>
<td>6107</td>
</tr>
<tr>
<td>Moment Stiffness</td>
<td>Nm/rad</td>
<td>220x10³</td>
<td>490x10³</td>
<td>790x10³</td>
<td>1400x10³</td>
</tr>
<tr>
<td></td>
<td>in-lb/rad</td>
<td>1947x10³</td>
<td>4337x10³</td>
<td>6992x10³</td>
<td>12390x10³</td>
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<tr>
<td>Quad Encoder Resolution</td>
<td></td>
<td>500,000</td>
<td>1,000,000</td>
<td>1,600,000</td>
<td>500,000</td>
</tr>
<tr>
<td>Rotary Resolution (At x 4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Supply</td>
<td>V</td>
<td>DC 24V, AC 100, AC 200</td>
<td>AC 100, AC 200</td>
<td>AC 100, AC 200</td>
<td>AC 100, AC 200</td>
</tr>
<tr>
<td>Weight</td>
<td>kg</td>
<td>2.5</td>
<td>4.0</td>
<td>6.5</td>
<td>12</td>
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<td>Protection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Conditions</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Operating temperature</td>
<td>°C</td>
<td>0 to 40°C</td>
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<td></td>
</tr>
<tr>
<td>Storage temperature</td>
<td>°C</td>
<td>-20 to 60°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating humidity</td>
<td>%</td>
<td>20 to 80%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>Ω</td>
<td>100M</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dielectric strength</td>
<td>V</td>
<td>1500V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration resistance</td>
<td>mm/s²</td>
<td>24.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shock resistance</td>
<td>mm/s²</td>
<td>294</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 The figures in the table are those at the output shaft.
2 The figures are typical values.
3 The quad encoder resolution is obtained by the formula (motor encoder resolution) x 4 x (reduction ratio).

### Size Symbol

<table>
<thead>
<tr>
<th>Size Symbol</th>
<th>FHA-17C</th>
<th>FHA-25C</th>
<th>FHA-32C</th>
<th>FHA-40C</th>
</tr>
</thead>
<tbody>
<tr>
<td>øA</td>
<td>128</td>
<td>155</td>
<td>175</td>
<td>230</td>
</tr>
<tr>
<td>øB</td>
<td>70</td>
<td>85</td>
<td>105</td>
<td>130</td>
</tr>
<tr>
<td>øC</td>
<td>18</td>
<td>32</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>D</td>
<td>21</td>
<td>25</td>
<td>22</td>
<td>30</td>
</tr>
<tr>
<td>E</td>
<td>78</td>
<td>90.5</td>
<td>111.5</td>
<td>127</td>
</tr>
</tbody>
</table>

Unit: mm

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Harmonic Drive LLC
Hollow Shaft Brushless Actuators

FHA-C PR Series

FHA-C-PR features improved one way and bi-directional positioning repeatability and is ideal for high-precision rotary positioning. These servo actuators utilize Harmonic Drive® precision gears combined with a performance matched brushless servo motor and incremental encoder. The FHA has a low profile form factor and features a hollow shaft through the center of the output. This hollow shaft feature may be used to pass cables, tubing or a laser beam through the axis of rotation.

The FHA series is designed to operate with a wide range of third-party drivers, as well as Harmonic Drive LLC’s DDP Series, DEP Series, and RTL Series.

- High torque
- Large center through hole
- Compact cylindrical design

• Dimensions

<table>
<thead>
<tr>
<th>Actuator Model</th>
<th>FHA-17C-PR</th>
<th>FHA-25C-PR</th>
<th>FHA-32C-PR</th>
<th>FHA-40C-PR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimension L₁</td>
<td>35</td>
<td>44.3</td>
<td>46</td>
<td>58.5</td>
</tr>
<tr>
<td>Dimension L₂</td>
<td>29.5</td>
<td>39.3</td>
<td>41</td>
<td>51.5</td>
</tr>
</tbody>
</table>

• Mechanical Accuracy

The FHA-C-PR mechanical accuracies of the output shaft and mounting flange are shown below: (Unit: mm)

<table>
<thead>
<tr>
<th>Feature</th>
<th>FHA-17C-PR</th>
<th>FHA-25C-PR</th>
<th>FHA-32C-PR</th>
<th>FHA-40C-PR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Output shaft surface runout</td>
<td>0.010</td>
<td>0.012</td>
<td>0.012</td>
<td>0.014</td>
</tr>
<tr>
<td>2. Output shaft axial runout</td>
<td>0.010</td>
<td>0.012</td>
<td>0.012</td>
<td>0.014</td>
</tr>
<tr>
<td>3. Parallelism between output shaft and mounted surface</td>
<td>0.040</td>
<td>0.050</td>
<td>0.050</td>
<td>0.060</td>
</tr>
<tr>
<td>4. Concentricity of output flange to mounting pilot</td>
<td>0.040</td>
<td>0.050</td>
<td>0.050</td>
<td>0.060</td>
</tr>
</tbody>
</table>

Note: For information on the measurement method, refer to the “FHA-C Series Technical Manual.”
Note: Values are based on the Total Indicator Reading (T.I.R.).
### FHA-C PR Series

"200V" and "100V" in the table are referred to as the 200V specification (standard) and the 100V specification (option), respectively.

<table>
<thead>
<tr>
<th>Item</th>
<th>FHA-17C-PR</th>
<th>FHA-25C-PR</th>
<th>FHA-32C-PR</th>
<th>FHA-40C-PR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td>50</td>
<td>100</td>
<td>160</td>
<td>50</td>
</tr>
<tr>
<td>Maximum torque</td>
<td>39</td>
<td>57</td>
<td>64</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>281</td>
<td>398</td>
<td>453</td>
<td>500</td>
</tr>
<tr>
<td>Maximum speed</td>
<td>96</td>
<td>48</td>
<td>30</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>40</td>
<td>25</td>
<td>70</td>
</tr>
<tr>
<td>Torque constant</td>
<td>200V</td>
<td>100V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200V N•m/A&lt;sub&gt;max&lt;/sub&gt;</td>
<td>21</td>
<td>42</td>
<td>22</td>
<td>150</td>
</tr>
<tr>
<td>100V N•m/A&lt;sub&gt;max&lt;/sub&gt;</td>
<td>11</td>
<td>21</td>
<td>11</td>
<td>90</td>
</tr>
<tr>
<td>Maximum current&lt;sup&gt;2&lt;/sup&gt;</td>
<td>200V</td>
<td>100V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200V A&lt;sub&gt;max&lt;/sub&gt;</td>
<td>2.1</td>
<td>1.6</td>
<td>1.1</td>
<td>7.3</td>
</tr>
<tr>
<td>100V A&lt;sub&gt;max&lt;/sub&gt;</td>
<td>4.2</td>
<td>3.2</td>
<td>2.2</td>
<td>15</td>
</tr>
<tr>
<td>EMF voltage constant&lt;sup&gt;3&lt;/sup&gt;</td>
<td>200V V/(rpm)</td>
<td>2.3</td>
<td>4.7</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>2.8</td>
<td>4.0</td>
<td>4.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Phase resistance</td>
<td>200V Ω (20°C)</td>
<td>7.9</td>
<td>2.6</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>100V Ω (20°C)</td>
<td>2.0</td>
<td>0.65</td>
<td>0.25</td>
</tr>
<tr>
<td>Phase inductance</td>
<td>200V nH</td>
<td>6.0</td>
<td>2.6</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>100V nH</td>
<td>1.5</td>
<td>0.65</td>
<td>0.33</td>
</tr>
<tr>
<td>Moment of inertia&lt;sup&gt;4&lt;/sup&gt;</td>
<td>200V (kg•m)&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.21</td>
<td>0.83</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9.2</td>
<td>2.1</td>
<td>8.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5.5</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>100V (kg•m)&lt;sup&gt;2&lt;/sup&gt;</td>
<td>2.1</td>
<td>8.5</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>94</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>56</td>
</tr>
<tr>
<td>Allowable radial load</td>
<td>kN</td>
<td>2.9</td>
<td>4.9</td>
<td>9.5</td>
</tr>
<tr>
<td></td>
<td>kgf</td>
<td>300</td>
<td>500</td>
<td>970</td>
</tr>
<tr>
<td>Allowable axial load</td>
<td>kN</td>
<td>9.8</td>
<td>14.7</td>
<td>24.5</td>
</tr>
<tr>
<td></td>
<td>kgf</td>
<td>1000</td>
<td>1500</td>
<td>2500</td>
</tr>
<tr>
<td>Max. moment load</td>
<td>N•m</td>
<td>188</td>
<td>370</td>
<td>530</td>
</tr>
<tr>
<td></td>
<td>kgf•m</td>
<td>19</td>
<td>38</td>
<td>54</td>
</tr>
<tr>
<td>Moment stiffness</td>
<td>N•m/rad</td>
<td>220×10&lt;sup&gt;3&lt;/sup&gt;</td>
<td>490×10&lt;sup&gt;3&lt;/sup&gt;</td>
<td>790×10&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>kgf•m/arc-min</td>
<td>6.5</td>
<td>15</td>
<td>23</td>
</tr>
<tr>
<td>One-way positioning accuracy</td>
<td>arc-sec</td>
<td>60</td>
<td>40</td>
<td>40</td>
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<tr>
<td></td>
<td>±5</td>
<td>±5</td>
<td>±4</td>
<td>±4</td>
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<tr>
<td>One-way repeatability</td>
<td>arc-sec</td>
<td>75</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Bi-directional repeatability</td>
<td>arc-sec</td>
<td>75</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>20</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Motor encoder</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2500 counts / revolution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quad encoder resolutions&lt;sup&gt;3&lt;/sup&gt;</td>
<td>Pulse/rev</td>
<td>500,000</td>
<td>1,000,000</td>
<td>1,600,000</td>
</tr>
<tr>
<td>Mass</td>
<td>kg</td>
<td>2.8</td>
<td>4.7</td>
<td>7.1</td>
</tr>
<tr>
<td>Enclosure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temperature: 0 to 40°C/storage temperature: -20 to 80°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating humidity / storage humidity: 20 to 80%/RH (no condensation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vibration resistance: 24.5 m/s&lt;sup&gt;2&lt;/sup&gt; (frequency: 10 to 400Hz) / shock resistance: 294 m/s&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do not expose to dust, metal powder, corrosive gas, flammable gas, or oil mist.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use indoors, and do not expose to direct sunlight.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Altitude: 1000 m or lower above sea level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor insulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation resistance: 100MΩ or higher (500 VDC), Withstanding voltage: AC1500V/1min, Insulation class: Type F</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mounting direction</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All position</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combination servo driver</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>200V</td>
<td>HA-800*-3C-200</td>
<td>HA-800*-3C-200</td>
<td>HA-800*-6C-200</td>
<td>HA-800*-6C-200</td>
</tr>
<tr>
<td>100V</td>
<td>HA-800*-3C-100</td>
<td>HA-800*-6C-100</td>
<td>HA-800*-6C-100</td>
<td>-</td>
</tr>
</tbody>
</table>

1 The values in the table above are referred to as typical values for the output shaft.
2 The value when used with the HA-800 driver.
3 Quadrature resolutions are obtained by (motor encoder resolution x 4) x (reduction ratio)

*www.HarmonicDrive.net • 800-921-3332*
Hollow Shaft Brushless Actuators
FHA-C H Series

New! FHA-C Series servo actuators are now available with IP65 protection. Four sizes are available: 17, 25, 32 and 40. The IP65 rated FHA-C actuator is ideal for harsh environments. With IP65 and 480V, the FHA actuator is well suited for machine tool, packaging, and washdown applications.

- High torque
- Large center through hole
- Compact cylindrical design
- IP65 Rating
- 480VAC*
- EnDat® & HIPERFACE® Encoder Protocols
- DESINA style flex rated cables

* Contact us for additional voltage options.

Hollow Shaft Brushless Actuators
FHA-C H Series

Feature FHA-17C-H FHA-25C-H FHA-32C-H FHA-40C-H
1. Axial run-out of output flange 0.010 0.012 0.012 0.014
2. Radial run-out of output flange 0.010 0.012 0.012 0.014
3. Parallelism of output flange and mounting flange 0.040 0.050 0.050 0.060
4. Concentricity of output flange to mounting pilot 0.040 0.050 0.050 0.060

Dimensions

<table>
<thead>
<tr>
<th>Size Symbol</th>
<th>FHA-17C-H</th>
<th>FHA-25C-H</th>
<th>FHA-32C-H</th>
<th>FHA-40C-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>øA</td>
<td>18</td>
<td>32</td>
<td>35</td>
<td>45</td>
</tr>
<tr>
<td>øB H7</td>
<td>25</td>
<td>42</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>øC</td>
<td>70</td>
<td>85</td>
<td>105</td>
<td>130</td>
</tr>
<tr>
<td>øD</td>
<td>105</td>
<td>125</td>
<td>140</td>
<td>185</td>
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<tr>
<td>øE</td>
<td>128</td>
<td>155</td>
<td>175</td>
<td>230</td>
</tr>
<tr>
<td>F</td>
<td>12</td>
<td>15</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>G</td>
<td>105.5/121*</td>
<td>106.5/132.5*</td>
<td>129/155*</td>
<td>143.8/164.8*</td>
</tr>
</tbody>
</table>

* with brake

Mechanical Accuracy

Units: mm (inches)
## FHA-C H Series

### Hollow Shaft Brushless Actuators

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>FHA-17C-H (Bus voltage 680VDC)</th>
<th>FHA-25C-H (Bus voltage 680VDC)</th>
<th>FHA-32C-H (Bus voltage 680VDC)</th>
<th>FHA-40C-H (Bus voltage 680VDC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td></td>
<td>50</td>
<td>100</td>
<td>160</td>
<td>50</td>
</tr>
<tr>
<td>Maximum Torque N•m</td>
<td>TM</td>
<td>39</td>
<td>57</td>
<td>64</td>
<td>151</td>
</tr>
<tr>
<td>Maximum Current A•rms</td>
<td>IM</td>
<td>1.4</td>
<td>1.1</td>
<td>0.8</td>
<td>3.9</td>
</tr>
<tr>
<td>Continuous Torque N•m</td>
<td>TC</td>
<td>15</td>
<td>23</td>
<td>23.2</td>
<td>40</td>
</tr>
<tr>
<td>Continuous Current A•rms</td>
<td>IC</td>
<td>0.65</td>
<td>0.55</td>
<td>0.45</td>
<td>1.3</td>
</tr>
<tr>
<td>Maximum Speed rpm</td>
<td>NM</td>
<td>96</td>
<td>48</td>
<td>30</td>
<td>90</td>
</tr>
<tr>
<td>Torque Constant N•m/A•rms</td>
<td>KT</td>
<td>37</td>
<td>75</td>
<td>120</td>
<td>42</td>
</tr>
</tbody>
</table>

### Motor EMF Constant 

<table>
<thead>
<tr>
<th>(Line-Line)</th>
<th>$V_{ref}(kpm)$</th>
<th>$V_{ref}(rad/s)$</th>
<th>0.48</th>
<th>0.55</th>
<th>0.64</th>
<th>0.77</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase Resistance (20'C, Line-Line)</td>
<td>R</td>
<td>64</td>
<td>22.4</td>
<td>7.8</td>
<td>5.6</td>
<td></td>
</tr>
<tr>
<td>Phase Inductance (Line-Line)</td>
<td>mH</td>
<td>42</td>
<td>20</td>
<td>9.8</td>
<td>11.2</td>
<td></td>
</tr>
<tr>
<td>Number of Pole Pairs p</td>
<td>P</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Allowable Axial Load kN</td>
<td>LA</td>
<td>9.8</td>
<td>14.7</td>
<td>24.5</td>
<td>39.2</td>
<td></td>
</tr>
<tr>
<td>Allowable Radial Load kN</td>
<td>LR</td>
<td>2.9</td>
<td>4.9</td>
<td>9.5</td>
<td>14.7</td>
<td></td>
</tr>
<tr>
<td>Allowable Moment Load Nm</td>
<td>LM</td>
<td>188</td>
<td>370</td>
<td>530</td>
<td>690</td>
<td></td>
</tr>
<tr>
<td>Moment Stiffness N•m/rad</td>
<td></td>
<td>220 x 10^3</td>
<td>490 x 10^3</td>
<td>790 x 10^3</td>
<td>1400 x 10^3</td>
<td></td>
</tr>
<tr>
<td>One-Way Positional Accuracy arc-sec</td>
<td>60</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

### Feedback Type

<table>
<thead>
<tr>
<th>Feedback Type</th>
<th>Single-turn absolute (EnDat and HIPERFACE)</th>
<th>Multi-turn absolute (EnDat)</th>
<th>Single-turn absolute (EnDat and HIPERFACE)</th>
<th>Multi-turn absolute (EnDat)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass M kg</td>
<td>3.3</td>
<td>4.6</td>
<td>6.8</td>
<td>10.8</td>
</tr>
<tr>
<td>Mass (with brake) M kg</td>
<td>3.7</td>
<td>5.4</td>
<td>7.7</td>
<td>12.8</td>
</tr>
<tr>
<td>Motor Inertia (without brake) kg-m²</td>
<td>1.37</td>
<td>3.95</td>
<td>7.63</td>
<td>19.3</td>
</tr>
<tr>
<td>Motor Inertia (with brake) kg-m²</td>
<td>1.44</td>
<td>3.65</td>
<td>7.33</td>
<td>19.3</td>
</tr>
</tbody>
</table>

The table shows typical values. *1 Refer to manual for details. *2 Inertia shown in this table is at input side. To convert to output side, multiply the inertia by (ratio)^3.
 SHA-CG Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>SHA20A</th>
<th>SHA25A (Motor voltage 100V)</th>
<th>SHA25A (Motor voltage 200V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>SHA20A</td>
<td>SHA25A (Motor voltage 100V)</td>
<td>SHA25A (Motor voltage 200V)</td>
</tr>
<tr>
<td>Ratio</td>
<td>50 80 100 120 160</td>
<td>50 80 100 120 160</td>
<td>50 80 100 120 160</td>
</tr>
</tbody>
</table>
| Maximum Torque 
N-m                                             | 73 96 107 113 120 | 127 178 204 217 229 | 127 178 204 217 229 |
| Maximum Torque 
in-lb                                          | 642 850 947 100 1062 | 1124 1575 1805 1920 2027 | 1124 1575 1805 1920 2027 |
| Maximum Rotational Speed  
 rpm                                           | 120 75 60 50 37.5 | 96 60 48 40 30 | 112 70 56 46.7 35 |
| Torque Constant  
N-m/A•sec                                           | 16 26 33 39 53 | 10.9 17.7 22 27 35 | 19 31 38 46 61 |
| Maximum Current  
A•amp                                                   | 6.1 5 4.6 4.1 3.4 | 15.1 13.2 12.2 11 9 | 8.7 7.6 7 6.3 5.2 |
| Moment of Inertia  
kg-m²/A•amp (without brake)  
J                                                        | 0.21 0.3 0.82 1.2 2.1 | 0.5 1.3 2 2.9 5.1 | 0.5 1.3 2 2.9 5.1 |
| Moment of Inertia  
kg-m²/A•amp (with brake)  
J                                                       | 2.1 5.4 8 12 22 | 5.1 13 20 29 52 | 5.1 13 20 29 52 |
| One-Way Positioning Accuracy  
arc•sec                                                  | 60 50 50 50 50 | 50 40 40 40 40 | 50 40 40 40 40 |
| Allowable Moment Load  
N-m                                                   | 187          | 258                         |
| Allowable Moment Load  
in-lb                                             | 1655         | 2283                        |
| Moment Stiffness  
N-m/rad                                               | 25.2×10⁴     | 39.2×10⁴                   |
| Output Resolution  
Pulses/Revolution                                      | 5,553,600 10,485,760 15,107,200 15,728,640 20,971,320 | 5,553,600 10,485,760 15,107,200 15,728,640 20,971,320 |
| Power Supply  
V                                                  | 200V         | 100V                        |
| Mass (without brake)  
kg                                                   | 2.6          | 3.95                        |
| Mass (with brake)  
kg                                                   | 2.7          | 4.1                         |
| Protection Structure                                                       | Enclosed, self-cooled (IP54) |
| Environmental Conditions                                        | Operating temperature: 0 to 40°C • Storage temperature: -20 to +60°C • Operating and storage humidity: 20 to 80% RH (No condensation permitted). • Vibration resistance: 25m/s² (frequency: 10 to 400Hz) • Shock resistance: 300/m/s². Indoor installation: No dust, no metal powder, no corrosive gas, no inflammable gas, no oil mist, no other foreign matter and no direct sunshine. Altitude 1000m or less. Insulation resistance: 100MW or higher (DC 500V). Dielectric strength: AC 1500V/1min. Insulation class: Class E |
| Recommended Driver                                                      | REL-230-18, HA-800-3D/E-200 |
| Recommended Driver                                                      | REL-230-18, REL-230-36, HA-800-6D/E-100*1 |
| Recommended Driver                                                      | REL-230-18, REL-230-36, HA-800-3D/E-200 |
| Encoder Type                                                             | Magnetic absolute encoder |

The table shows typical output values of actuators.

*1 Typical specifications when combined with our drivers.
### SHA-CG Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>SHA32A</th>
<th>SHA40A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SHA-CG Series Ratings</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ratio</strong></td>
<td>50 80 100 120 160</td>
<td>50 80 100 120 160</td>
</tr>
<tr>
<td><strong>Maximum Rotational Speed</strong></td>
<td>rpm</td>
<td>rpm</td>
</tr>
<tr>
<td>Maximum Torque^1</td>
<td>N·m</td>
<td>N·m</td>
</tr>
<tr>
<td></td>
<td>in-lb</td>
<td>in-lb</td>
</tr>
<tr>
<td><strong>Torque Constant</strong></td>
<td>N·m/A_in</td>
<td>N·m/A_in</td>
</tr>
<tr>
<td></td>
<td>in-lb/A_in</td>
<td>in-lb/A_in</td>
</tr>
<tr>
<td><strong>Maximum Current^1</strong></td>
<td>A_ext</td>
<td>A_ext</td>
</tr>
<tr>
<td><strong>Moment of Inertia</strong> GD/4</td>
<td>kg·m²/arms</td>
<td>kg·m²/arms</td>
</tr>
<tr>
<td>(without brake) J</td>
<td>kgf·cm²/arms</td>
<td>kgf·cm²/arms</td>
</tr>
<tr>
<td><strong>Moment of Inertia</strong> GD/4</td>
<td>kg·m²/arms</td>
<td>kg·m²/arms</td>
</tr>
<tr>
<td>(with brake) J</td>
<td>kgf·cm²/arms</td>
<td>kgf·cm²/arms</td>
</tr>
<tr>
<td><strong>One-Way Positioning</strong></td>
<td>arc·sec</td>
<td>arc·sec</td>
</tr>
<tr>
<td><strong>Allowable Moment Load</strong></td>
<td>N·m</td>
<td>N·m</td>
</tr>
<tr>
<td></td>
<td>in-lb</td>
<td>in-lb</td>
</tr>
<tr>
<td><strong>Moment Stiffness</strong></td>
<td>N·m/rad</td>
<td>N·m/rad</td>
</tr>
<tr>
<td></td>
<td>in-lb/rad</td>
<td>in-lb/rad</td>
</tr>
<tr>
<td><strong>Output Resolution</strong></td>
<td>6,553,600, 10,485,760, 13,107,200, 15,728,640, 20,971,520</td>
<td>6,553,600, 10,485,760, 13,107,200, 15,728,640, 20,971,520</td>
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<td><strong>Power Supply</strong></td>
<td>V</td>
<td>V</td>
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<tr>
<td></td>
<td>200V</td>
<td>200V</td>
</tr>
<tr>
<td><strong>Mass (without brake)</strong></td>
<td>kg</td>
<td>kg</td>
</tr>
<tr>
<td></td>
<td>7.7</td>
<td>13</td>
</tr>
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<td><strong>Mass (with brake)</strong></td>
<td>kg</td>
<td>kg</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>13.8</td>
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<tr>
<td><strong>Protection Structure</strong></td>
<td>Enclosed, self-cooled (IP54)</td>
<td>Enclosed, self-cooled (IP54)</td>
</tr>
<tr>
<td><strong>Environmental Conditions</strong></td>
<td>Operating temperature: 0 to 40°C • Storage temperature: -20 to +60°C • Operating and storage humidity: 20 to 80% RH (No condensation permitted). • Vibration resistance: 25m/s² (frequency: 10 to 400Hz) • Shock resistance: 300m/s². • Indoor installation: No dust, no metal powder, no corrosive gas, no inflammable gas, no oil mist, no other foreign matter and no direct sunshine. · Altitude 1000m or less. · Insulation resistance: 100MΩ or higher (DC 500V). · Dielectric strength: AC 1500V/1min. · Insulation class: Class E. REL-230-18, REL-230-36, HA-800-6D/E-200 REL-230-36, REL-230-40, HA-800-24D/E-200</td>
<td></td>
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<tr>
<td><strong>Encoder Type</strong></td>
<td>Magnetic absolute encoder</td>
<td>Magnetic absolute encoder</td>
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### Size Symbol

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<tr>
<th>Size Symbol</th>
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<th>SHA25A</th>
<th>SHA32A</th>
<th>SHA40A</th>
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<tr>
<td>øA</td>
<td>117</td>
<td>144</td>
<td>175</td>
<td>225</td>
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<td>øB</td>
<td>69</td>
<td>84</td>
<td>110</td>
<td>132</td>
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<td>øC</td>
<td>17</td>
<td>27</td>
<td>35</td>
<td>45</td>
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<tr>
<td>D</td>
<td>26</td>
<td>28.5</td>
<td>34</td>
<td>40</td>
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<td>E</td>
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<td>127.5</td>
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### Mechanical Accuracy of the Output Shaft and Mounting Flange

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<th>SHA32A</th>
<th>SHA40A</th>
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<tbody>
<tr>
<td>1. Output shaft surface runout</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>2-1. Output shaft axial runout (Outside diameter)</td>
<td>10</td>
<td>10</td>
<td>10</td>
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<tr>
<td>2-2. Output shaft axial runout (Inside diameter)</td>
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<td>15</td>
<td>15</td>
<td>15</td>
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<tr>
<td>3. Parallelism between the output shaft and actuator mounting surface</td>
<td>30</td>
<td>30</td>
<td>35</td>
<td>35</td>
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<td>4. Parallelism between the output shaft and actuator mounting surface</td>
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<td>45</td>
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<tr>
<td>5. Concentricity between the output shaft and actuator mounting diameter</td>
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<td>50</td>
<td>55</td>
<td>60</td>
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<td>6. Concentricity between the output shaft and actuator mounting diameter</td>
<td>60</td>
<td>60</td>
<td>65</td>
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Note: All values are T.I.R. (Total Indicator Reading).
SHA Series Ratings

<table>
<thead>
<tr>
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<th>SHA25A</th>
<th>SHA32A</th>
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<tbody>
<tr>
<td><strong>Ratio</strong></td>
<td>51</td>
<td>81</td>
<td>101</td>
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<tr>
<td><strong>Maximum Torque</strong></td>
<td>N·m</td>
<td>73</td>
<td>96</td>
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<tr>
<td><strong>in-lb</strong></td>
<td>646</td>
<td>850</td>
<td>947</td>
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<tr>
<td><strong>Maximum Rotational Speed</strong></td>
<td>rpm</td>
<td>117.6</td>
<td>74.1</td>
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<td><strong>Torque Constant</strong></td>
<td>N·m/A_{es}</td>
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<td><strong>in-lb/A_{es}</strong></td>
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<td>239</td>
<td>292</td>
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<td><strong>Maximum Current</strong></td>
<td>A_{es}</td>
<td>6.0</td>
<td>4.9</td>
</tr>
<tr>
<td><strong>Moment of Inertia GD^4/4 (without brake)</strong></td>
<td>J</td>
<td>0.23</td>
<td>0.58</td>
</tr>
<tr>
<td><strong>kg·m^2</strong></td>
<td>0.24</td>
<td>6.0</td>
<td>9.3</td>
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<tr>
<td><strong>kg·m^2/s^2</strong></td>
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<td>0.56</td>
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<td><strong>Moments of Inertia GD^2/4 (with brake)</strong></td>
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<td><strong>kg·m^2</strong></td>
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<td><strong>kg·m^2/s^2</strong></td>
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<td>6.7</td>
<td>17</td>
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<td><strong>One-Way Positioning Accuracy</strong></td>
<td>arc·sec</td>
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<td><strong>Allowable Moment Load</strong></td>
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<td>410</td>
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<td><strong>in-lb</strong></td>
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<td>3629</td>
<td>2283</td>
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<tr>
<td><strong>Moment Stiffness</strong></td>
<td>N·m/rad</td>
<td>25.2 x 10^4</td>
<td>57.4 x 10^4</td>
</tr>
<tr>
<td><strong>in-lb/rad</strong></td>
<td>223 x 10^4</td>
<td>393 x 10^4</td>
<td>346.9 x 10^4</td>
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<tr>
<td><strong>Output Resolution</strong></td>
<td>Pulse/Revolution</td>
<td>6,884,672</td>
<td>10,616,832</td>
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<td><strong>Power Supply</strong></td>
<td>V</td>
<td>AC 200</td>
<td>AC 200</td>
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<td><strong>Mass (with brake)</strong></td>
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<td>5.1</td>
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<td><strong>Environmental Conditions</strong></td>
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<tr>
<td>Operating temperature: 0 to 40°C</td>
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<tr>
<td>Storage temperature: -20 to +60°C</td>
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<tr>
<td>Vibration resistance: 25mm/s² (frequency: 10 to 1000Hz)</td>
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<td>Shock resistance: 300m/s²</td>
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<td>Indoor installation: No dust, no metal powder, no corrosive gas, no inflammable gas, no oil mist, no other foreign matter and no direct sunshine</td>
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<td>Altitude 1000m or less. Insulation resistance: 100MΩ or higher (DC 500V). Dielectric strength: AC 1500V/min. Insulation class: Class E</td>
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</table>

1 The table shows typical output values of actuators.
2 When combined with HA-800 driver.
4 Please refer to the manual for rating details.
### Rotary Servo Actuator SHA Series

**SHA-SG Series**

#### SHA Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
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<td>114</td>
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<td>284</td>
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<td>65</td>
</tr>
</tbody>
</table>

### Units: mm

1. The table shows typical output values of actuators.
2. When combined with HA-800 driver.
3. Encoder Type: Magnetic absolute encoder. Single-turn: 2\(^{17}\) (313,072). Multi-turn: 2\(^{18}\) (65,536) (Battery back-up).
4. Please refer to the manual for detail of ratings.
**FLA Series Ratings**

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>FLA-11A-08HP</th>
<th>FLA-14A-08HP</th>
<th>FLA-17A-09HP</th>
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<tr>
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<td>Maximum Torque N•m</td>
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<td>1.8</td>
<td>3.7</td>
<td>7.3</td>
</tr>
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<td>1.2</td>
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<td>500</td>
<td>500</td>
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<td>100</td>
<td>100</td>
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<td>13.6</td>
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<tr>
<td>Allowable Continuous Current (24VDC) A_{ves}</td>
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<td>6.0</td>
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<tr>
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<td>1.6</td>
<td>3.0</td>
<td>5.3</td>
</tr>
<tr>
<td>Moment of Inertia (GD²/4) kgm²</td>
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<td>0.00013</td>
<td>0.00039</td>
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<td>Allowable Moment Load v</td>
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<td>1.6</td>
<td>2.0</td>
</tr>
<tr>
<td>Moment Stiffness N•m/rad</td>
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<td>2.0 x 10³</td>
<td>3.3 x 10³</td>
<td>4.4 x 10³</td>
</tr>
<tr>
<td>Motor Position Sensor</td>
<td>Hall sensor</td>
<td>Base</td>
<td>Base</td>
<td>Base</td>
</tr>
<tr>
<td>Positioning Resolution per Motor Rotation pls/rev</td>
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<td>30</td>
<td>30</td>
</tr>
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<td>Output Shaft Resolution pls/rev</td>
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<td>240</td>
<td>240</td>
<td>270</td>
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<tr>
<td>Weight g</td>
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<td>390</td>
<td>620</td>
<td>870</td>
</tr>
<tr>
<td>Enclosure</td>
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<td>Fully enclosed self-cooling (IP40)</td>
<td>Fully enclosed self-cooling (IP40)</td>
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<table>
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<td>Allowable Continuous Speed rpm</td>
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<td>2.0 x 10³</td>
<td>3.3 x 10³</td>
<td>4.4 x 10³</td>
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<tr>
<td>Motor Position Sensor</td>
<td>Hall sensor</td>
<td>Base</td>
<td>Base</td>
<td>Base</td>
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<tr>
<td>Positioning Resolution per Motor Rotation pls/rev</td>
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<td>Output Shaft Resolution pls/rev</td>
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<td>720</td>
<td>940</td>
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<td>Fully enclosed self-cooling (IP40)</td>
<td>Fully enclosed self-cooling (IP40)</td>
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## MAGNETIC POLE SENSOR LEAD WIRE

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<td>Hall Sensor Output (U-Phase)</td>
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<tr>
<td>GREEN</td>
<td>HV</td>
<td>Hall Sensor Output (V-Phase)</td>
</tr>
<tr>
<td>BLUE</td>
<td>HW</td>
<td>Hall Sensor Output (W-Phase)</td>
</tr>
<tr>
<td>RED</td>
<td>+5V</td>
<td>Power Input +5 V</td>
</tr>
<tr>
<td>BLACK</td>
<td>0V</td>
<td>Power Input 0 V (GND)</td>
</tr>
<tr>
<td>YELLOW</td>
<td>TH</td>
<td>Thermistor Output</td>
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## MOTOR LEAD WIRE

<table>
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<th>SIGNAL</th>
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<td>Motor U-Phase</td>
</tr>
<tr>
<td>WHITE</td>
<td>Motor V-Phase</td>
</tr>
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<td>BLACK</td>
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### FLA-HP Dimensions

<table>
<thead>
<tr>
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<th>FLA-11</th>
<th>FLA-14</th>
<th>FLA-17</th>
<th>FLA-20</th>
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<tr>
<td>øA</td>
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<td>85</td>
<td>92</td>
<td>100</td>
</tr>
<tr>
<td>øB</td>
<td>58</td>
<td>72</td>
<td>79</td>
<td>87</td>
</tr>
<tr>
<td>øC</td>
<td>43</td>
<td>54</td>
<td>60</td>
<td>64</td>
</tr>
<tr>
<td>D</td>
<td>13</td>
<td>13</td>
<td>14</td>
<td>14.5</td>
</tr>
<tr>
<td>E</td>
<td>39.8</td>
<td>43.3</td>
<td>48.7</td>
<td>47.8</td>
</tr>
</tbody>
</table>

### FLA-FB Dimensions

<table>
<thead>
<tr>
<th>Size Symbol</th>
<th>FLA-11</th>
<th>FLA-14</th>
<th>FLA-17</th>
<th>FLA-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>øA</td>
<td>71</td>
<td>85</td>
<td>92</td>
<td>100</td>
</tr>
<tr>
<td>øB</td>
<td>58</td>
<td>72</td>
<td>79</td>
<td>87</td>
</tr>
<tr>
<td>øC</td>
<td>43</td>
<td>54</td>
<td>60</td>
<td>64</td>
</tr>
<tr>
<td>D</td>
<td>13.5</td>
<td>15</td>
<td>17.1</td>
<td>18.1</td>
</tr>
<tr>
<td>E</td>
<td>40.3</td>
<td>45.3</td>
<td>51.8</td>
<td>51.4</td>
</tr>
</tbody>
</table>
Brushless Actuators

RSF Supermini Series

These extremely small servo actuators utilize zero backlash Harmonic Drive® precision gears, a brushless servo motor and an incremental encoder to deliver precision motion control. The RSF Supermini series is designed to operate with a wide range of third party drivers as well as Harmonic Drive LLC's DCJ Series, DDP Series, DEP Series, and HA680 drivers. The units are small enough to fit inside the finger of a robotic hand.

- Compact, lightweight
- High output torque
- High positional accuracy
- RSF-5B is available with an optional brake

•RSF Supermini Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>RSF-3C</th>
<th>RSF-5B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>Power Supply Voltage (driver)</td>
<td>V DC24±10%</td>
<td>DC24±10%</td>
</tr>
<tr>
<td>Maximum Continuous Current</td>
<td>A_{max}</td>
<td>0.65</td>
</tr>
<tr>
<td>Rated Torque</td>
<td>N_{m}</td>
<td>0.03</td>
</tr>
<tr>
<td>(during operation at allowable)</td>
<td>in-lb</td>
<td>0.27</td>
</tr>
<tr>
<td>Maximum Rotational Speed (output shaft)</td>
<td>rpm</td>
<td>150</td>
</tr>
<tr>
<td>Continuous Stall Torque</td>
<td>N_{m}</td>
<td>0.04</td>
</tr>
<tr>
<td>Maximum Instantaneous Current</td>
<td>A_{max}</td>
<td>0.13</td>
</tr>
<tr>
<td>Maximum Torque</td>
<td>N_{m}</td>
<td>1.15</td>
</tr>
<tr>
<td>Maximum Speed</td>
<td>rpm</td>
<td>333</td>
</tr>
<tr>
<td>Torque Constant</td>
<td>N_{m}/A_{W}</td>
<td>0.11</td>
</tr>
<tr>
<td>EMF Constant</td>
<td>V/(rpm)</td>
<td>0.015</td>
</tr>
<tr>
<td>Phase Resistance (at 20˚C)</td>
<td>Ω</td>
<td>1.34</td>
</tr>
<tr>
<td>Phase Inductance</td>
<td>mH</td>
<td>0.18</td>
</tr>
<tr>
<td>Moment of Inertia ¹</td>
<td>J</td>
<td>1.07x10^{-4}</td>
</tr>
<tr>
<td>Encoder Pulses (motor shaft)</td>
<td>Pulse</td>
<td>200</td>
</tr>
<tr>
<td>Encoder Resolutions ²</td>
<td></td>
<td>24,000</td>
</tr>
<tr>
<td>Motor Shaft Brake</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input Power Voltage</td>
<td>V</td>
<td>-</td>
</tr>
<tr>
<td>Retention Torque</td>
<td>N_{m}</td>
<td>-</td>
</tr>
<tr>
<td>Retention Torque</td>
<td>in-lb</td>
<td>-</td>
</tr>
<tr>
<td>Mass ³</td>
<td>g</td>
<td>31.0(except clamp filter)</td>
</tr>
<tr>
<td>Mass ³</td>
<td>g</td>
<td>-</td>
</tr>
<tr>
<td>Recommended Driver</td>
<td></td>
<td>DC24V</td>
</tr>
<tr>
<td>Mass ³</td>
<td>g</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1 The table shows typical output values of actuators.
2 The values in the table above are obtained when it is combined with the driver (HA-680-4B-24).
3 All values are typical.
4 The moment of inertia is the total value of the motor shaft and the gear's moment of inertia values converted to the output side. The values in parentheses are for equipment with a brake.
5 The quad encoder resolution is (motor shaft encoder resolution when multiplied by 4 x gear ratio).
6 The weight of clamp filter is 6g each.
Brushless Actuators

RSF-Mini Series

These brushless servo actuators utilize zero backlash Harmonic Drive® precision gears for precise motion control. The RSF Mini Series is designed to operate with a wide range of third party drivers as well as Harmonic Drive LLC’s DCJ Series, DDP Series, DEP Series, and HA680 drivers.

- Exceptional positional accuracy
- Compact design

• RSF Mini Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>RSF-8B</th>
<th>RSF-11B</th>
<th>RSF-14B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Voltage V</td>
<td>DC24</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum Torque N•m</td>
<td>1.8</td>
<td>3.3</td>
<td>4.8</td>
<td>4.5</td>
</tr>
<tr>
<td>Maximum Speed rpm</td>
<td>200</td>
<td>120</td>
<td>60</td>
<td>200</td>
</tr>
<tr>
<td>Maximum Current A&lt;sub&gt;max&lt;/sub&gt;</td>
<td>3.6</td>
<td>3.9</td>
<td>2.9</td>
<td>14.4</td>
</tr>
<tr>
<td>Allowable Continuous Torque N•m</td>
<td>0.78</td>
<td>1.4</td>
<td>2.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Allowable Continuous Torque N•m/A&lt;sub&gt;max&lt;/sub&gt;</td>
<td>6.9</td>
<td>12.4</td>
<td>17.7</td>
<td>9.7</td>
</tr>
<tr>
<td>Allowable Continuous Speed rpm</td>
<td>100</td>
<td>60</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>Torque Constant N•m/A&lt;sub&gt;max&lt;/sub&gt;</td>
<td>0.62</td>
<td>1.1</td>
<td>2.1</td>
<td>0.4</td>
</tr>
<tr>
<td>EMF Constant V(rpm)</td>
<td>0.07</td>
<td>0.11</td>
<td>0.22</td>
<td>0.04</td>
</tr>
<tr>
<td>Phase Resistance Ω (25°C)</td>
<td>0.93</td>
<td>0.19</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td>Phase Inductance mH</td>
<td>0.45</td>
<td>0.1</td>
<td>0.19</td>
<td></td>
</tr>
<tr>
<td>Moment of Inertia GD&lt;sup&gt;2&lt;/sup&gt;/4</td>
<td>0.06</td>
<td>0.16</td>
<td>0.65</td>
<td>0.18</td>
</tr>
<tr>
<td>J x10&lt;sup&gt;2&lt;/sup&gt; kg•cm&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.6</td>
<td>1.7</td>
<td>6.6</td>
<td>1.8</td>
</tr>
<tr>
<td>Allowable Radial Load</td>
<td>196</td>
<td>245</td>
<td></td>
<td>392</td>
</tr>
<tr>
<td>lbf</td>
<td>44</td>
<td>55</td>
<td></td>
<td>88</td>
</tr>
<tr>
<td>Allowable Axial Load</td>
<td>98</td>
<td>196</td>
<td></td>
<td>392</td>
</tr>
<tr>
<td>lbf</td>
<td>22</td>
<td>44</td>
<td></td>
<td>88</td>
</tr>
<tr>
<td>One-Way Positioning Accuracy</td>
<td>180</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Quad Encoder Resolutions p/rev</td>
<td>120000</td>
<td>200000</td>
<td>400000</td>
<td>120000</td>
</tr>
<tr>
<td>Mass kg</td>
<td>0.3</td>
<td>0.5</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Insulation Class</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation Resistance</td>
<td>100M Ω (DC500V) or more</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Withstanding Voltage</td>
<td>AC500V/1 min</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. The table shows output values of the actuator.
2. All specifications are applicable for actuators mounted on an aluminum heat sink of size: 150 x 150 x 6(mm).
3. Values for saturated actuator temperature. Other values are for actuator temperature of 20°C.
4. Values are during operation at allowable continuous rotation speed.
5. All values are typical.
6. Quad encoder resolution is (motor shaft encoder resolution) x 4 x (gear ratio).
7. The specifications above are based on using HA-680 driver.

<table>
<thead>
<tr>
<th>Model</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>φ Et7</th>
<th>φ F</th>
<th>G</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSF-8B</td>
<td>124.3</td>
<td>21.8</td>
<td>76.5</td>
<td>26</td>
<td>21</td>
<td>34.5</td>
<td>7.5</td>
</tr>
<tr>
<td>RSF-11B</td>
<td>141.7</td>
<td>25</td>
<td>90.7</td>
<td>26</td>
<td>24</td>
<td>32.5</td>
<td>9.5</td>
</tr>
<tr>
<td>RSF-14B</td>
<td>168.5</td>
<td>28</td>
<td>114.5</td>
<td>26</td>
<td>30</td>
<td>32.5</td>
<td>11.5</td>
</tr>
</tbody>
</table>
The RSF series is compact and includes high torque AC servo actuators with high rotational accuracy, a shaft output combining Harmonic Drive® strain wave gearing for precision control and an AC servomotor. The RSF Series is designed to operate with a wide range of third party drivers as well as Harmonic Drive LLC’s RTL Series, and REL Series.

- Compact and lightweight
- High power
- High positioning and high rotational accuracies

### RSF Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>RSF-17</th>
<th>RSF-20A</th>
<th>RSF-25A</th>
<th>RSF-32A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td></td>
<td>50</td>
<td>100</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Rated Output</td>
<td>W</td>
<td>62</td>
<td>62</td>
<td>120</td>
<td>111</td>
</tr>
<tr>
<td>Power Supply Voltage (driver)</td>
<td>V</td>
<td>AC200V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated Torque</td>
<td>N•m</td>
<td>9.8</td>
<td>20</td>
<td>19</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>in-lb</td>
<td>87</td>
<td>177</td>
<td>168</td>
<td>310</td>
</tr>
<tr>
<td>Rated Rotational Speed</td>
<td>rpm</td>
<td>60</td>
<td>30</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>Continuous Stall Torque</td>
<td>N•m</td>
<td>9.8</td>
<td>20</td>
<td>19</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>in-lb</td>
<td>87</td>
<td>177</td>
<td>168</td>
<td>310</td>
</tr>
<tr>
<td>Max. Momentary Torque</td>
<td>in-lb</td>
<td>301</td>
<td>478</td>
<td>496</td>
<td>726</td>
</tr>
<tr>
<td>Max. Rotational Speed</td>
<td>rpm</td>
<td>90</td>
<td>45</td>
<td>90</td>
<td>45</td>
</tr>
<tr>
<td>Moment of Inertia*4</td>
<td>(GD^2/4) kg•m^2</td>
<td>0.047</td>
<td>0.19</td>
<td>0.088</td>
<td>0.39</td>
</tr>
<tr>
<td></td>
<td>(J) kgfcm^2</td>
<td>0.48</td>
<td>1.9</td>
<td>1.0</td>
<td>4.0</td>
</tr>
<tr>
<td>One-Way Positioning Accuracy</td>
<td>arc/sec</td>
<td>120</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Allowable Radial Load</td>
<td>N</td>
<td>780</td>
<td>1400</td>
<td>2900</td>
<td>4400</td>
</tr>
<tr>
<td></td>
<td>Lbf</td>
<td>175</td>
<td>315</td>
<td>652</td>
<td>989</td>
</tr>
<tr>
<td>Allowable Axial Load</td>
<td>N</td>
<td>780</td>
<td>1370</td>
<td>2900</td>
<td>4400</td>
</tr>
<tr>
<td></td>
<td>Lbf</td>
<td>175</td>
<td>308</td>
<td>652</td>
<td>989</td>
</tr>
<tr>
<td>Quad Encoder Resolution*5</td>
<td>Pulse/Revolution</td>
<td>400,000</td>
<td>800,000</td>
<td>400,000</td>
<td>800,000</td>
</tr>
<tr>
<td>Mass</td>
<td>kg</td>
<td>2.1</td>
<td>2.9</td>
<td>4.7</td>
<td>8.7</td>
</tr>
</tbody>
</table>

**Notes:**
1. The values in the table are those at the output shaft.
2. The actuator specification is the value when mounted on the following aluminum radiation plate:
   - RSF-17, RSF-20: 250 x 250 x 12mm
   - RSF-25, RSF-32: 300 x 300 x 15mm
3. The values are those on temperature rise saturation. The other values are those at 20°C.
4. The moment of inertia is the sum of the inertia of the motor and Harmonic Drive® gear reflected at the output shaft.
5. Quad Encoder resolution is calculated using (Motor shaft encoder resolution) x 4 x (Reduction ratio).

### Model Dimensions

<table>
<thead>
<tr>
<th>Model</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Dz1</th>
<th>ø Eh7</th>
<th>F</th>
<th>G</th>
<th>Mass(kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSF-17A</td>
<td>210</td>
<td>40</td>
<td>88</td>
<td>82</td>
<td>20</td>
<td>60</td>
<td>76</td>
<td>2.1</td>
</tr>
<tr>
<td>RSF-20A</td>
<td>242</td>
<td>48</td>
<td>98</td>
<td>96</td>
<td>85</td>
<td>60</td>
<td>93</td>
<td>2.9</td>
</tr>
<tr>
<td>RSF-25A</td>
<td>286.7</td>
<td>60</td>
<td>104.7</td>
<td>124</td>
<td>110</td>
<td>60</td>
<td>116</td>
<td>4.7</td>
</tr>
<tr>
<td>RSF-32A</td>
<td>331</td>
<td>80</td>
<td>123</td>
<td>128</td>
<td>130</td>
<td>80</td>
<td>137</td>
<td>8.7</td>
</tr>
</tbody>
</table>

Unit: mm
### Brushless Actuators

**RKF Series**

The RKF series is compact and includes high torque AC servo actuators with high rotational accuracy, a flange output combining Harmonic Drive® strain wave gearing for precision control and an AC servo motor. The RKF Series is designed to operate with a wide range of third party drivers as well as Harmonic Drive LLC’s RTL Series, and REL Series.

- Compact and lightweight
- High power
- High positioning and high rotational accuracies

---

#### •RKF Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>RKF-20A</th>
<th>RKF-25A</th>
<th>RKF-32A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td></td>
<td>50</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Rated Output</td>
<td>W</td>
<td>120</td>
<td>111</td>
<td>180</td>
</tr>
<tr>
<td>Power Supply Voltage (driver)</td>
<td>V</td>
<td></td>
<td></td>
<td>AC200</td>
</tr>
<tr>
<td>Rated Torque</td>
<td>N•m</td>
<td>19</td>
<td>35</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>in-lb</td>
<td>168</td>
<td>310</td>
<td>257</td>
</tr>
<tr>
<td>Rated Rotational Speed</td>
<td>rpm</td>
<td>60</td>
<td>30</td>
<td>60</td>
</tr>
<tr>
<td>Continuous Stall Torque</td>
<td>N•m</td>
<td>19</td>
<td>35</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>in-lb</td>
<td>168</td>
<td>310</td>
<td>257</td>
</tr>
<tr>
<td>Max. Momentary Torque</td>
<td>N•m</td>
<td>56</td>
<td>82</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>in-lb</td>
<td>496</td>
<td>726</td>
<td>867</td>
</tr>
<tr>
<td>Max. Rotational Speed</td>
<td>rpm</td>
<td>90</td>
<td>45</td>
<td>90</td>
</tr>
<tr>
<td>Moment of Inertia*&lt;sup&gt;4&lt;/sup&gt;</td>
<td>(GD²/4) kg•m²</td>
<td>0.098</td>
<td>0.39</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>(J) kgf(cm)²</td>
<td>1.0</td>
<td>4.0</td>
<td>2.0</td>
</tr>
<tr>
<td>One-Way Positioning Accuracy</td>
<td>arc/sec</td>
<td>90</td>
<td>90</td>
<td>90</td>
</tr>
<tr>
<td>Allowable Radial Load</td>
<td>N</td>
<td>2000</td>
<td>2500</td>
<td>3900</td>
</tr>
<tr>
<td></td>
<td>Lbf</td>
<td>450</td>
<td>562</td>
<td>877</td>
</tr>
<tr>
<td>Allowable Axial Load</td>
<td>N</td>
<td>880</td>
<td>1100</td>
<td>1600</td>
</tr>
<tr>
<td></td>
<td>Lbf</td>
<td>198</td>
<td>247</td>
<td>360</td>
</tr>
<tr>
<td>Quad Encoder Resolution*&lt;sup&gt;5&lt;/sup&gt;</td>
<td>Pulses/Revolution</td>
<td>400,000</td>
<td>800,000</td>
<td>400,000</td>
</tr>
<tr>
<td>Mass</td>
<td>kg</td>
<td>2.9</td>
<td>5.0</td>
<td>9.5</td>
</tr>
<tr>
<td>Recommended Driver</td>
<td></td>
<td>AC200</td>
<td></td>
<td>RTL-230-18, REL-230-18</td>
</tr>
</tbody>
</table>

Notes:
1. The aforementioned values are those at the output shaft including the Harmonic Drive® gear efficiency.
2. The actuator specifications are based on operating when mounted on an aluminum heat sink of the following sizes or its equivalent:
   - RKF-20: 250 x 250 x 12mm
   - RKF-25, RKF-32: 300 x 300 x 15mm
3. The values are those on temperature rise saturation. The other values are those at 20°C.
4. The moment of inertia is the total of the inertia moments of the motor shaft and Harmonic Drive® gear converted into the output shaft side.
5. Quad Encoder resolution is calculated using \((\text{Motor shaft encoder resolution}) \times 4 \times \left(\frac{\text{Reduction ratio}}{100}\right)\).
This RH Mini Series is a DC servo actuator incorporating Harmonic Drive® precision gears, a high performance brush DC servomotor and an incremental encoder.

- High torque
- Precise positional accuracy
- Compact design

### RH Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>RH-5A</th>
<th>RH-8D</th>
<th>RH-11D</th>
<th>RH-14D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8802</td>
<td>5502</td>
<td>4402</td>
<td>6006</td>
<td>3006</td>
</tr>
<tr>
<td>Rated Output W</td>
<td>1.5</td>
<td>1.7</td>
<td>1.4</td>
<td>8.6</td>
<td>6.2</td>
</tr>
<tr>
<td>Rated Voltage V</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Maximum Momentary Torque N•m</td>
<td>0.39</td>
<td>0.59</td>
<td>0.69</td>
<td>2.7</td>
<td>3.5</td>
</tr>
<tr>
<td>Maximum Continuous Stall Torque in-lb</td>
<td>3.45</td>
<td>5.22</td>
<td>6.11</td>
<td>23.9</td>
<td>31.0</td>
</tr>
<tr>
<td>Rated Torque N•m</td>
<td>0.16</td>
<td>0.29</td>
<td>0.29</td>
<td>1.4</td>
<td>2</td>
</tr>
<tr>
<td>Maximum Positioning Speed rpm</td>
<td>180</td>
<td>110</td>
<td>90</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Rated Positioning Speed rpm</td>
<td>88</td>
<td>55</td>
<td>44</td>
<td>60</td>
<td>30</td>
</tr>
<tr>
<td>Maximum Momentary Current A_{rms}</td>
<td>0.83</td>
<td>0.78</td>
<td>0.77</td>
<td>1.6</td>
<td>1.1</td>
</tr>
<tr>
<td>Rated Current A_{rms}</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>1.0</td>
<td>0.8</td>
</tr>
<tr>
<td>Torque Constant N•m/A_{rms}</td>
<td>0.69</td>
<td>1.11</td>
<td>1.38</td>
<td>2.1</td>
<td>4.2</td>
</tr>
<tr>
<td>in-lb/A_{rms}</td>
<td>6.1</td>
<td>9.8</td>
<td>12.2</td>
<td>18.6</td>
<td>37.2</td>
</tr>
<tr>
<td>Moment of Inertia kg•m²</td>
<td>6.3x10^{-6}</td>
<td>16x10^{-6}</td>
<td>25x10^{-6}</td>
<td>37x10^{-6}</td>
<td>150x10^{-6}</td>
</tr>
<tr>
<td>kgf•cm•s²</td>
<td>0.007</td>
<td>0.016</td>
<td>0.026</td>
<td>0.04</td>
<td>0.15</td>
</tr>
<tr>
<td>One-Way Positioning Accuracy arc/sec</td>
<td>290</td>
<td>290</td>
<td>290</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Allowable Axial Load N</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>98</td>
<td>98</td>
</tr>
<tr>
<td>Allowable Axial Load lbf</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Reduction Ratio</td>
<td>50</td>
<td>80</td>
<td>100</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Mass kg</td>
<td>0.09</td>
<td>0.09</td>
<td>0.09</td>
<td>0.3</td>
<td>0.3</td>
</tr>
</tbody>
</table>

**Environmental Conditions**

- Time constant: Continuous
- Protection: Totally closed, self-cooling
- Ambient temperature: 0 to 40°C
- Ambient humidity: 35 to 80% RH (no condensation permitted)

**Recommended Driver**

| DC 20V | DCJ-055-09, DDP-090-09, DEP-090-09 | – | – | – | DCJ-055-09, DDP-090-09, DEP-090-09 |

**Unit:** mm

<table>
<thead>
<tr>
<th>Model</th>
<th>øA</th>
<th>øB</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH-5A</td>
<td>20</td>
<td>5</td>
<td>11</td>
<td>78</td>
</tr>
<tr>
<td>RH-8D</td>
<td>33</td>
<td>8</td>
<td>21.8</td>
<td>107.2</td>
</tr>
<tr>
<td>RH-11D</td>
<td>40</td>
<td>10</td>
<td>25</td>
<td>125.5</td>
</tr>
<tr>
<td>RH-14D</td>
<td>50</td>
<td>12</td>
<td>28</td>
<td>148</td>
</tr>
</tbody>
</table>

Harmonic Drive LLC

www.HarmonicDrive.net • 800-921-3332
Direct Drive Motor

KDU Series

The KDU Series are Direct Drive Motors which achieve 10 arc-sec positioning accuracy as well as ±0.5 arc-sec repeatability with a resolution of 0.16 arc-sec. Also, the KDU has a large Hollow Shaft design which allows cables, shafts or lasers to pass through the axis of rotation.

- Exceptional positional accuracy
- Exceptional repeatability
- Ultra high resolution

**KDU Series Ratings**

<table>
<thead>
<tr>
<th>Item</th>
<th>KDU-13SB</th>
<th>KDU-13WB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Torque*2 Nm</td>
<td>7.0Nm (62.0 In.lb)</td>
<td>15.0Nm (132.8 In.lb)</td>
</tr>
<tr>
<td>Max. Rotational Speed  rpm</td>
<td>127</td>
<td>127</td>
</tr>
<tr>
<td>Torque Constant Nm/Arms</td>
<td>3.1 (26.9 In.lb/A(rms))</td>
<td>6.5 (56.4 In.lb/A(rms))</td>
</tr>
<tr>
<td>Input Power Supply Voltage V</td>
<td>AC 100/AC200</td>
<td></td>
</tr>
<tr>
<td>Moment of Inertia kg.m²</td>
<td>0.0047</td>
<td>0.0065</td>
</tr>
<tr>
<td>Moment Stiffness Nm/rad</td>
<td>2.4 x 10⁶</td>
<td></td>
</tr>
<tr>
<td>Motor Position Sensor pulse/rev</td>
<td>Incremental encoder</td>
<td>Square wave : phase A and B: 11,840,000</td>
</tr>
<tr>
<td>Repeatability³ arc sec</td>
<td>± 0.5</td>
<td></td>
</tr>
<tr>
<td>Absolute Positioning Accuracy⁴ arc sec</td>
<td>10 (Angular position corrected)</td>
<td></td>
</tr>
<tr>
<td>Mass kg</td>
<td>4.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Mounting Direction</td>
<td>Output shaft to face upward</td>
<td></td>
</tr>
<tr>
<td>Combined Driver</td>
<td>HA-770-2</td>
<td></td>
</tr>
<tr>
<td>Induced Voltage Constant V (rpm)</td>
<td>0.033</td>
<td>0.68</td>
</tr>
<tr>
<td>Line Resistance W (20°C)</td>
<td>9.1</td>
<td>14.0</td>
</tr>
<tr>
<td>Line Inductance mH</td>
<td>19</td>
<td>35</td>
</tr>
<tr>
<td>Motor Insulation</td>
<td>Insulation Resistance: 100 M W more (DC500V)</td>
<td></td>
</tr>
<tr>
<td>Protective Structure⁵</td>
<td>Total-enclosed self-enclosed type (IP 40 or equivalent)</td>
<td></td>
</tr>
</tbody>
</table>

1 The table above shows output values of output shaft.
2 The values in the table above are obtained when connected to HA-770 servo driver.
3 The values listed are measured in an environment of 23 ±0.3°C in temperature, 50% RH in humidity and with output shaft facing upward in mounting direction. Please contact Harmonic Drive LLC, to inquire about use with different environmental conditions.
4 Value after angular position of the HA-770 servo driver is corrected.
5 All parts, except the rotary sliding parts (oil seal), of the actuators are protected against solid bodies of superior dimensions to 1mm, and against the water sprays.

**Direct Drive Motor HA-770 Series**

<table>
<thead>
<tr>
<th>Model</th>
<th>HA-770-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Current</td>
<td>1.8A</td>
</tr>
<tr>
<td>Maximum Current</td>
<td>10A</td>
</tr>
<tr>
<td>Power Source Voltage</td>
<td>AC100V<del>115V(Single-phase) + 10%</del>−15% 50/60Hz, AC200V<del>230V (Single-phase) + 10%</del>−15% 50/60Hz</td>
</tr>
<tr>
<td>Position Command Pulse</td>
<td>Line driver system: Maximum response frequency, Two-pulse system, One-pulse system: 1MHz, Two-phase pulse system: 200kHz</td>
</tr>
<tr>
<td>Control System</td>
<td>Sine wave PWM system, switching frequency: 25kHz</td>
</tr>
<tr>
<td>Control Mode</td>
<td>Position control</td>
</tr>
<tr>
<td>Weight</td>
<td>0.8kg</td>
</tr>
</tbody>
</table>

**Motor Length**

<table>
<thead>
<tr>
<th>Item</th>
<th>KDU-13SB</th>
<th>KDU-13WB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor Length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>80</td>
<td>94</td>
</tr>
</tbody>
</table>
Harmonic Drive LLC offers HMA hollow shaft motors. Hollow shaft design allows cables, shafts or lasers to pass through the axis of rotation.

- Large Hollow Shaft
- 17-bit Absolute Encoder
- Available in 5 frame sizes

### HMA Motor Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>HMAC08</th>
<th>HMAB09</th>
<th>HMAB12</th>
<th>HMAB15</th>
<th>HMAA21A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined driver</td>
<td>HA-800-3D-200</td>
<td>HA-800-3D-200</td>
<td>HA-800-6D-E-100</td>
<td>HA-800-6D-E-200</td>
<td>HA-800-24D-E-200</td>
</tr>
<tr>
<td>Input power supply voltage V</td>
<td>200</td>
<td>200</td>
<td>100</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Rated output W</td>
<td>163</td>
<td>251</td>
<td>406</td>
<td>754</td>
<td>1320</td>
</tr>
<tr>
<td>Instantaneous maximum torque Nm</td>
<td>1.8</td>
<td>3.0</td>
<td>6.6</td>
<td>13</td>
<td>33</td>
</tr>
<tr>
<td>Rated torque Nm</td>
<td>0.52</td>
<td>0.80</td>
<td>1.55</td>
<td>3.60</td>
<td>12.6</td>
</tr>
<tr>
<td>Maximum speed rpm</td>
<td>6,000</td>
<td>5,600</td>
<td>4,800</td>
<td>4,800</td>
<td>4,000</td>
</tr>
<tr>
<td>Rated speed rpm</td>
<td>3,000</td>
<td>3,000</td>
<td>2,500</td>
<td>2,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Instantaneous maximum current A</td>
<td>6.5</td>
<td>8.9</td>
<td>15.4</td>
<td>18</td>
<td>29</td>
</tr>
<tr>
<td>Rated current A</td>
<td>2.1</td>
<td>2.5</td>
<td>4.3</td>
<td>4.2</td>
<td>7.8</td>
</tr>
<tr>
<td>Torque constant Nm/m/A_max</td>
<td>0.35</td>
<td>0.41</td>
<td>0.24</td>
<td>0.44</td>
<td>0.54</td>
</tr>
<tr>
<td>EMF constant V/rpm</td>
<td>0.037</td>
<td>0.043</td>
<td>0.025</td>
<td>0.046</td>
<td>0.057</td>
</tr>
<tr>
<td>Phase resistance (20°C)</td>
<td>1.43</td>
<td>1.2</td>
<td>0.4</td>
<td>0.33</td>
<td>0.19</td>
</tr>
<tr>
<td>Phase inductance mH</td>
<td>2.5</td>
<td>3.0</td>
<td>1.0</td>
<td>1.4</td>
<td>1.2</td>
</tr>
<tr>
<td>Moment of Inertia J x10^-3 kg-m^2</td>
<td>0.734 (0.828)</td>
<td>1.78 (2.16)</td>
<td>6.45 (6.83)</td>
<td>15.8 (19.8)</td>
<td>125 (141)</td>
</tr>
<tr>
<td>Allowable radial load (static)</td>
<td>800</td>
<td>800</td>
<td>1200</td>
<td>2400</td>
<td>4500</td>
</tr>
<tr>
<td>Allowable axial load (static)</td>
<td>81.6</td>
<td>81.6</td>
<td>122</td>
<td>245</td>
<td>459</td>
</tr>
<tr>
<td>Rated radial load (At the rated speed)</td>
<td>100</td>
<td>105</td>
<td>130</td>
<td>180</td>
<td>880</td>
</tr>
<tr>
<td>Rated axial load (At the rated speed)</td>
<td>175</td>
<td>185</td>
<td>233</td>
<td>530</td>
<td>1040</td>
</tr>
<tr>
<td>Encoder type Absolute encoder</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encoder resolution capability</td>
<td>Single turn motor revolution</td>
<td>2^17(131,072)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Encoder resolution capability</td>
<td>Multi-turn revolution counter</td>
<td>2^16(65,536)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>1.4 (1.5)</td>
<td>2.0 (2.1)</td>
<td>3.4 (3.8)</td>
<td>5.5 (6.2)</td>
<td>17.5 (19.7)</td>
</tr>
</tbody>
</table>

The values in the table above show typical values.

*1: When tested with HA-800.

*2: This is the value for saturated temperature when installed on the next aluminum heatsink of the following size:

- HMAC08: 320 x 320 x 16 [mm], HMAB09: 350 x 350 x 18 [mm], HMAB12: 400 x 400 x 20 [mm], HMAB15: 500 x 500 x 25 [mm], HMAA21A: 650 x 650 x 30 [mm]

*3: This is the value of the phase EMF constant multiplied by 3.

*4: The range of the multi revolution counter is from -32,768 to 32,767.
Precision Linear Actuators

LBC Series

The precision lead screw provides positioning accuracy in the micron range with sub-micron repeatability. The actuator is capable of thrust forces up to 12,000 N. This product is useful for precise positioning of heavy loads or applications where high force is required such as molding equipment or precision presses.
- 12,000 N Force
- 0.32 µm positioning resolution
- Brushless servomotor with incremental encoder
- Integral Limit Switches

LBC Series Ratings

<table>
<thead>
<tr>
<th>Model</th>
<th>Drive</th>
<th>Stroke (mm)</th>
<th>Maximum Driving Force (N)</th>
<th>Resolution (µm)</th>
<th>Maximum Speed (mm/s)</th>
<th>Repeatability</th>
<th>Outside Dimensions (mm)</th>
<th>Total length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LBC-25A-5D6K</td>
<td>Brushless Motor</td>
<td>50</td>
<td>6000</td>
<td>0.32</td>
<td>20</td>
<td>±5µm or less/50mm stroke</td>
<td>φ136</td>
<td>353</td>
</tr>
<tr>
<td>LBC-25A-5D12K</td>
<td>Brushless Motor</td>
<td>50</td>
<td>12000</td>
<td>0.16</td>
<td>10</td>
<td></td>
<td>φ136</td>
<td>353</td>
</tr>
</tbody>
</table>

Harmonic Drive LLC
www.HarmonicDrive.net • 800-921-3332
A precision ball screw provides positioning accuracy better than 2 microns and repeatability of 0.1 microns. This product is well suited for measuring instruments, test and inspection systems, optical equipment, semiconductor and LCD manufacturing equipment.

- 49 N Force
- 2 micron positioning accuracy
- Brush DC motor with incremental encoder

### LA Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>Drive</th>
<th>Stroke (mm)</th>
<th>Maximum Driving Force (N)</th>
<th>Resolution (µm)</th>
<th>Maximum Speed (mm/s)</th>
<th>One-way Positioning Accuracy</th>
<th>Repeatability</th>
<th>Outside Dimensions (mm)</th>
<th>Total length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LA-30B-10-F</td>
<td>DC motor</td>
<td>10</td>
<td>49</td>
<td>0.0174</td>
<td>0.9</td>
<td>2µm or less/40µm stroke</td>
<td>±0.1µm or less/1mm stroke</td>
<td>28</td>
<td>143</td>
</tr>
<tr>
<td></td>
<td>LA-32-30-F</td>
<td>DC motor</td>
<td>30</td>
<td>49</td>
<td>0.0174</td>
<td>0.9</td>
<td></td>
<td></td>
<td>36</td>
<td>164</td>
</tr>
</tbody>
</table>

Unit: mm

<table>
<thead>
<tr>
<th>Size</th>
<th>LA-30B-10F</th>
<th>LA-32-30-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>28</td>
<td>36</td>
</tr>
<tr>
<td>B(Stroke)</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>C</td>
<td>10</td>
<td>13.3</td>
</tr>
<tr>
<td>D</td>
<td>133</td>
<td>150.8</td>
</tr>
</tbody>
</table>
**LAH Series Ratings**

<table>
<thead>
<tr>
<th>Model</th>
<th>Item</th>
<th>Drive</th>
<th>Stroke (mm)</th>
<th>Maximum Driving Force (N)</th>
<th>Resolution (µm)</th>
<th>Maximum Speed (mm/s)</th>
<th>One-way Positioning Accuracy</th>
<th>Repeatability</th>
<th>Outside Dimensions (mm)</th>
<th>Total length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAH-46-1002-F</td>
<td>DC motor</td>
<td>10</td>
<td>392</td>
<td></td>
<td>0.069</td>
<td>3.7</td>
<td>±0.5µm or less/0.02mm stroke</td>
<td>47</td>
<td>185</td>
<td></td>
</tr>
<tr>
<td>LAH-46-3002-F</td>
<td>DC motor</td>
<td>30</td>
<td>392</td>
<td></td>
<td>0.069</td>
<td>3.7</td>
<td>±1µm or less/1mm stroke</td>
<td>47</td>
<td>204</td>
<td></td>
</tr>
<tr>
<td>LAH-80-5020-F-PA</td>
<td>Stepper motor</td>
<td>50</td>
<td>3000</td>
<td></td>
<td>2</td>
<td>10</td>
<td>±1µm or less/2mm stroke</td>
<td>85</td>
<td>320</td>
<td></td>
</tr>
</tbody>
</table>

Unit: mm

**A precision ball screw provides positioning accuracy better than 4 microns and repeatability of 1 micron. This product is well suited for measuring instruments, test and inspection systems, optical equipment, semiconductor and LCD manufacturing equipment.**

- 392 to 3000 N Force
- 4 micron positioning accuracy
Galvano Optical Scanners

LSA Series

Galvanometric Laser Scanning Actuator. LSA laser scanning actuators are Galvanometric scanners capable of scanning at high speed with high precision. A newly developed optical sensor and our unique moving magnet motors are used in the LSA Series laser scanning actuators

- High response frequency
- High accuracy / repeatability
- Continuous scanning or discrete pointing

• LSA Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>LSA-10A-30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Angular Runout Degrees</td>
<td>±15</td>
<td></td>
</tr>
<tr>
<td>Rotor Moment of Inertia g cm²</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>Torque Constant N m/v/A ms</td>
<td>0.008</td>
<td></td>
</tr>
<tr>
<td>Coil Resistance Ω</td>
<td>0.28</td>
<td></td>
</tr>
<tr>
<td>Coil Inductance mH</td>
<td>0.098</td>
<td></td>
</tr>
<tr>
<td>Sensor Linearity (At full scale) %</td>
<td>±0.06</td>
<td></td>
</tr>
<tr>
<td>Sensor Angle Sensitivity V/˚</td>
<td>0.275</td>
<td></td>
</tr>
<tr>
<td>Offset Drift μrad/˚C</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Scale Drift %/˚C</td>
<td>0.005</td>
<td></td>
</tr>
<tr>
<td>Repeatability (Excluding offset/scale drift) mrad</td>
<td>±5</td>
<td></td>
</tr>
<tr>
<td>1°step Response Load Condition: (2g cm²) ms</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Sensor Power Supply V</td>
<td>5±5%-15±5%</td>
<td></td>
</tr>
<tr>
<td>Sensor Power Consumption 5V±5% mA</td>
<td>90(Max)</td>
<td></td>
</tr>
<tr>
<td>-15V±5% mA</td>
<td>120(Max)</td>
<td></td>
</tr>
<tr>
<td>Weight g</td>
<td>180</td>
<td></td>
</tr>
</tbody>
</table>

1 All angles are mechanical angles.
## Micro Encoder Series

Available in two sizes, the micro encoders are ultra-miniature, high resolution incremental encoders.

The ultra-micro model
- Dimensions ø7.5 x 10.5mm, Incremental encoder 360 line count
- Output phases: A, B, Z
- Square wave open collector output

The micro model
- Dimensions ø13 x 20mm, Incremental encoder 1000 line count
- Output phases: A, B, Z
- Square wave open collector output
- Hollow shaft is also available

### Micro Encoder Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>MES-6-PC</th>
<th>ME-9-PC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td></td>
<td>DC5V±10%</td>
<td>DC5V±10%</td>
</tr>
<tr>
<td>Current Consumption</td>
<td></td>
<td>30mA or less (under no load)</td>
<td>40mA or less (under no load)</td>
</tr>
<tr>
<td>Detection System</td>
<td></td>
<td>Incremental</td>
<td>Incremental</td>
</tr>
<tr>
<td>Number of Output Pulses (Standard)</td>
<td></td>
<td>100 200 300 360</td>
<td>100 200 300 360 500 1000</td>
</tr>
<tr>
<td>Output Phases</td>
<td></td>
<td>A, B and Z phases</td>
<td>A, B and Z phases</td>
</tr>
<tr>
<td>Output Mode</td>
<td></td>
<td>Square wave, open collector output</td>
<td>Square wave, open collector output</td>
</tr>
<tr>
<td>Maximum Response Frequency</td>
<td></td>
<td>100kHz</td>
<td>100kHz</td>
</tr>
<tr>
<td>Output Phase Difference</td>
<td></td>
<td>Difference between A and B Phases 90°±45° (T/4±T/8), Z Phase TaT/2 (See output waveform diagram.)</td>
<td>Difference between A and B Phases 90°±45° (T/4±T/8), Z Phase TaT/2 (See output waveform diagram.)</td>
</tr>
<tr>
<td>Permissible Maximum Positioning Speed (Mechanical)</td>
<td></td>
<td>6000rpm</td>
<td>6000rpm</td>
</tr>
<tr>
<td>Operating Temperature and Humidity</td>
<td></td>
<td>0°C~60°C RH 35%~90% No condensation permitted</td>
<td>0°C~60°C RH 35%~90% No condensation permitted</td>
</tr>
<tr>
<td>Storage Ambient Temperature</td>
<td></td>
<td>-20°C~80°C</td>
<td>-20°C~80°C</td>
</tr>
<tr>
<td>Weight</td>
<td></td>
<td>5g</td>
<td>10g</td>
</tr>
</tbody>
</table>

### Model Ordering Code

ME-X-X-XXXPX

1. Shaft shape: S, H**
2. Size: 6, 9
3. Output pulses: 100, 200, 300, 360, 500**, 1000**
4. Output circuit: C = Open collector output
   None = Voltage output ***

** Hollow shaft feature and line counts of 500 and 1000 are only available in size 9
*** Voltage output is only available in size 9.

### 06 SERIES

- **Output Waveform**
- **Dimensions**

### 09 SERIES

- **Output Waveform**
- **Dimensions**

* Z is Low-active
* Z is High-active

---

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## Servo Driver Specifications

### DC Digital Servo Drive DCJ Series

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Vdc (Apk)</th>
<th>Ic (Apk)</th>
<th>Ip (Apk)</th>
<th>Control Modes</th>
<th>Control Interface</th>
<th>Encoder</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCJ-055-09</td>
<td>20-55</td>
<td>3</td>
<td>9</td>
<td>Indexer, Point-to-Point, Camming, Gearing</td>
<td>CANopen/DeviceNet ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>DCJ-055-18</td>
<td>20-55</td>
<td>6</td>
<td>18</td>
<td>Indexer, Point-to-Point, Camming, Gearing</td>
<td>CANopen/DeviceNet ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>DCJ-090-09</td>
<td>20-90</td>
<td>3</td>
<td>9</td>
<td>Position, Velocity, Torque (PVT)</td>
<td>CANopen/DeviceNet ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>DCJ-090-12</td>
<td>20-91</td>
<td>6</td>
<td>12</td>
<td>Position, Velocity, Torque (PVT)</td>
<td>CANopen/DeviceNet ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
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</tbody>
</table>

### DC Digital Servo Drive DDP Series

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Vdc (Apk)</th>
<th>Ic (Apk)</th>
<th>Ip (Apk)</th>
<th>Control Modes</th>
<th>Control Interface</th>
<th>Encoder</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDP-090-09</td>
<td>90</td>
<td>3</td>
<td>9</td>
<td>Indexer, Point-to-Point, Camming, Gearing</td>
<td>CANopen/DeviceNet ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>DDP-090-15</td>
<td>90</td>
<td>6</td>
<td>18</td>
<td>Indexer, Point-to-Point, Camming, Gearing</td>
<td>CANopen/DeviceNet ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>DDP-090-36</td>
<td>90</td>
<td>12</td>
<td>36</td>
<td>Position, Velocity, Torque (PVT)</td>
<td>CANopen/DeviceNet ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>DDP-055-18</td>
<td>55</td>
<td>6</td>
<td>18</td>
<td>Position, Velocity, Torque (PVT)</td>
<td>CANopen/DeviceNet ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>DDP-180-09</td>
<td>180</td>
<td>3</td>
<td>9</td>
<td>Position, Velocity, Torque (PVT)</td>
<td>CANopen/DeviceNet ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>DDP-180-18</td>
<td>180</td>
<td>6</td>
<td>18</td>
<td>Position, Velocity, Torque (PVT)</td>
<td>CANopen/DeviceNet ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
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</table>

### DC Digital Servo Drive DEP Series

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Vdc (Apk)</th>
<th>Ic (Apk)</th>
<th>Ip (Apk)</th>
<th>Control Modes</th>
<th>Control Interface</th>
<th>Encoder</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEP-090-09</td>
<td>90</td>
<td>3</td>
<td>9</td>
<td>Indexer, Point-to-Point, Camming, Gearing</td>
<td>CANopen over EtherCAT (CoE) ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>DEP-090-18</td>
<td>90</td>
<td>6</td>
<td>18</td>
<td>Indexer, Point-to-Point, Camming, Gearing</td>
<td>CANopen over EtherCAT (CoE) ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>DEP-090-36</td>
<td>90</td>
<td>12</td>
<td>36</td>
<td>Position, Velocity, Torque (PVT)</td>
<td>CANopen over EtherCAT (CoE) ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>DEP-055-18</td>
<td>55</td>
<td>6</td>
<td>18</td>
<td>Position, Velocity, Torque (PVT)</td>
<td>CANopen over EtherCAT (CoE) ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
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</tr>
<tr>
<td>DEP-180-09</td>
<td>180</td>
<td>3</td>
<td>9</td>
<td>Position, Velocity, Torque (PVT)</td>
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<tr>
<td>DEP-180-18</td>
<td>180</td>
<td>6</td>
<td>18</td>
<td>Position, Velocity, Torque (PVT)</td>
<td>CANopen over EtherCAT (CoE) ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
</tbody>
</table>

### AC Digital Servo Drive RTL Series

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Vac (Apk)</th>
<th>Ic (Apk)</th>
<th>Ip (Apk)</th>
<th>Control Modes</th>
<th>Control Interface</th>
<th>Encoder</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTL-230-18</td>
<td>100-240</td>
<td>6</td>
<td>18</td>
<td>Indexer, Point-to-Point, Camming, Gearing</td>
<td>CANopen/DeviceNet ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>RTL-230-36</td>
<td>100-240</td>
<td>12</td>
<td>36</td>
<td>Indexer, Point-to-Point, Camming, Gearing</td>
<td>CANopen/DeviceNet ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>RTL-230-40</td>
<td>100-240</td>
<td>20</td>
<td>40</td>
<td>Indexer, Point-to-Point, Camming, Gearing</td>
<td>CANopen/DeviceNet ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
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### AC Digital Servo Drive REL Series

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Vac (Apk)</th>
<th>Ic (Apk)</th>
<th>Ip (Apk)</th>
<th>Control Modes</th>
<th>Control Interface</th>
<th>Encoder</th>
</tr>
</thead>
<tbody>
<tr>
<td>REL-230-18</td>
<td>100-240</td>
<td>6</td>
<td>18</td>
<td>Indexer, Point-to-Point, Camming, Gearing</td>
<td>CANopen over EtherCAT (CoE) ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>REL-230-36</td>
<td>100-240</td>
<td>12</td>
<td>36</td>
<td>Indexer, Point-to-Point, Camming, Gearing</td>
<td>CANopen over EtherCAT (CoE) ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
<tr>
<td>REL-230-36</td>
<td>100-240</td>
<td>12</td>
<td>36</td>
<td>Indexer, Point-to-Point, Camming, Gearing</td>
<td>CANopen over EtherCAT (CoE) ASCII and discrete I/O, Stepper commands ±10V position/velocity/torque command PWM velocity/torque command Master encoder (Gearing/Camming)</td>
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<tr>
<td>REL-230-36</td>
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<td>Indexer, Point-to-Point, Camming, Gearing</td>
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<td>14 Wire Standard Incremental Encoder Type</td>
</tr>
</tbody>
</table>

Harmonic Drive® Servo Drivers

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### DC Digital Servo Drive DCJ Series

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Vdc</th>
<th>Ic (Apeak)</th>
<th>Ip (Apeak)</th>
<th>Supply Voltage</th>
<th>Combination Actuator</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCJ-055-09</td>
<td>20-55</td>
<td>3</td>
<td>9</td>
<td>DC24V</td>
<td>FHA-8C-30 / 50 / 100-US200-E, RSF-8B-30 / 50 / 100-F100-24B, RSF-5A-30 / 50 / 100-US500, RSF-3B-30 / 50 / 100-US300</td>
</tr>
<tr>
<td>DCJ-055-18</td>
<td>20-55</td>
<td>6</td>
<td>18</td>
<td>DC24V</td>
<td>FHA-11C-30 / 50 / 100-US200-E</td>
</tr>
<tr>
<td>DCJ-090-03</td>
<td>20-90</td>
<td>1</td>
<td>3</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>DCJ-090-09</td>
<td>20-90</td>
<td>3</td>
<td>9</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>DCJ-090-12</td>
<td>20-90</td>
<td>6</td>
<td>12</td>
<td>–</td>
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### DC Digital Servo Drive DDP Series

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Vdc</th>
<th>Ic (Apeak)</th>
<th>Ip (Apeak)</th>
<th>Supply Voltage</th>
<th>Combination Actuator</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDP-090-09</td>
<td>90</td>
<td>3</td>
<td>9</td>
<td>DC24V</td>
<td>FHA-8C-30 / 50 / 100-US200-E, RSF-8B-30 / 50 / 100-F100-24B, RSF-5A-30 / 50 / 100-US500, RSF-3B-30 / 50 / 100-US300</td>
</tr>
<tr>
<td>DDP-090-18</td>
<td>90</td>
<td>6</td>
<td>18</td>
<td>DC24V</td>
<td>FHA-11C-30 / 50 / 100-US200-E</td>
</tr>
<tr>
<td>DDP-090-36</td>
<td>90</td>
<td>12</td>
<td>36</td>
<td>DC24V</td>
<td>FHA-14C-30 / 50 / 100-US200-E, FHA-17C-50 / 100 / 160-US250-E-SP, RSF-14B-30 / 50 / 100-F100-24B, RSF-11B-30 / 50 / 100-F100-24B</td>
</tr>
<tr>
<td>DDP-055-18</td>
<td>55</td>
<td>6</td>
<td>18</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>DDP-180-09</td>
<td>180</td>
<td>3</td>
<td>9</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>DDP-180-18</td>
<td>180</td>
<td>6</td>
<td>18</td>
<td>–</td>
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</tbody>
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### DC Digital Servo Drive DEP Series

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Vdc</th>
<th>Ic (Apeak)</th>
<th>Ip (Apeak)</th>
<th>Supply Voltage</th>
<th>Combination Actuator</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEP-090-09</td>
<td>90</td>
<td>3</td>
<td>9</td>
<td>DC24V</td>
<td>FHA-8C-30 / 50 / 100-US200 / 120176b / E200, RSF-8B-30 / 50 / 100-F100-24B, RSF-5A-30 / 50 / 100-US500, RSF-3B-30 / 50 / 100-US300</td>
</tr>
<tr>
<td>DEP-090-18</td>
<td>90</td>
<td>6</td>
<td>18</td>
<td>DC24V</td>
<td>FHA-11C-30 / 50 / 100-US200 / 120176b / E200</td>
</tr>
</tbody>
</table>

### AC Digital Servo Drive RTL Series

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Vac</th>
<th>Ic (Apeak)</th>
<th>Ip (Apeak)</th>
<th>Supply Voltage</th>
<th>Combination Actuator</th>
</tr>
</thead>
<tbody>
<tr>
<td>RTL-230-40</td>
<td>100-240</td>
<td>20</td>
<td>40</td>
<td>AC200V</td>
<td>FHA-40C-US250 / 120176b / E200</td>
</tr>
</tbody>
</table>

### AC Digital Servo Drive REL Series

<table>
<thead>
<tr>
<th>MODEL</th>
<th>Vac</th>
<th>Ic (Apeak)</th>
<th>Ip (Apeak)</th>
<th>Supply Voltage</th>
<th>Combination Actuator</th>
</tr>
</thead>
<tbody>
<tr>
<td>REL-230-40</td>
<td>100-240</td>
<td>20</td>
<td>40</td>
<td>AC200V</td>
<td>FHA-40C-US250 / 120176b / E200</td>
</tr>
</tbody>
</table>

### Recommended Driver

**Combinations with Servo Drive and Actuator**

**Harmonic Drive® Servo Drivers**
Servo Drivers

**Servo Driver Specifications**

### AC Servo Digital Drivers HA-800 Series

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>HA-800C-1</th>
<th>HA-800C-3</th>
<th>HA-800C-6</th>
<th>HA-800C-24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Current*</td>
<td></td>
<td>1.5A</td>
<td>3.0A</td>
<td>6.0A</td>
<td>24.0A</td>
</tr>
<tr>
<td>Maximum Current*</td>
<td></td>
<td>4.0A</td>
<td>9.5A</td>
<td>19.0A</td>
<td>55.0A</td>
</tr>
<tr>
<td>Power Supply</td>
<td>Main Circuit</td>
<td>AC100<del>115V (Single phase) or AC200</del>230V (Single phase/3 phases) +10~15%</td>
<td>AC200<del>230V (3 phases) +10</del>15%</td>
<td>AC200<del>230V (Single phase) +10</del>15%</td>
<td>AC200<del>230V (3 phases) +10</del>15%</td>
</tr>
<tr>
<td></td>
<td>Control Circuit</td>
<td>AC100<del>115V (Single phase) or AC200</del>230V (Single phase) +10~15%</td>
<td>AC200<del>230V (3 phases) +10</del>15%</td>
<td>AC200<del>230V (Single phase) +10</del>15%</td>
<td>AC200<del>230V (3 phases) +10</del>15%</td>
</tr>
<tr>
<td>Power Supply Frequency</td>
<td></td>
<td>50/60Hz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Conditions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Mode</td>
<td></td>
<td>Position control, speed control, torque control (available to change from I/O)</td>
<td>Position control, speed control, torque control (available to change from I/O)</td>
<td>Position control, speed control, torque control (available to change from I/O)</td>
<td>Position control, speed control, torque control (available to change from I/O)</td>
</tr>
<tr>
<td>Position Command Pulse</td>
<td></td>
<td>Line driver type: maximum response frequency. 2-pulse system, 1-pulse system: 2-phase pulse system: 200kHz</td>
<td>Open collector type: maximum response frequency 200kHz</td>
<td>Open collector type: maximum response frequency 200kHz</td>
<td>Open collector type: maximum response frequency 200kHz</td>
</tr>
<tr>
<td>Monitor Terminal</td>
<td></td>
<td>3ch motor rpm, current command, general-purpose output (parameter selection)</td>
<td>3ch motor rpm, current command, general-purpose output (parameter selection)</td>
<td>3ch motor rpm, current command, general-purpose output (parameter selection)</td>
<td>3ch motor rpm, current command, general-purpose output (parameter selection)</td>
</tr>
<tr>
<td>Regenerative Processing</td>
<td>External regenerative resistance Mounting terminal attached</td>
<td>Regenerative resistance installed Mounting terminal for the external regenerative resistance attached</td>
<td>External regenerative resistance Mounting terminal attached</td>
<td>Regenerative resistance installed Mounting terminal for the external regenerative resistance attached</td>
<td>External regenerative resistance Mounting terminal attached</td>
</tr>
<tr>
<td>Regenerative Resistance Absorption Power</td>
<td>–</td>
<td>3W Max</td>
<td>8W Max</td>
<td>90W Max</td>
<td>–</td>
</tr>
<tr>
<td>Surge Current Suppress Function</td>
<td></td>
<td>Built-in (CPU control by the main circuit voltage monitoring)</td>
<td>Built-in (CPU control by the main circuit voltage monitoring)</td>
<td>Built-in (CPU control by the main circuit voltage monitoring)</td>
<td>Built-in (CPU control by the main circuit voltage monitoring)</td>
</tr>
<tr>
<td>Weight</td>
<td></td>
<td>1kg</td>
<td>1.2kg</td>
<td>5.8kg</td>
<td></td>
</tr>
</tbody>
</table>

* The values shown represent the driver rated and maximum currents. Currents are adjusted to match the actuator current ratings before shipment.

### HA-800B (MECHATROLINK Compatible) Communication Specification

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECHATROLINK Version</td>
<td>MECHATROLINK-II</td>
</tr>
<tr>
<td>Transmission Speed</td>
<td>10Mbps</td>
</tr>
<tr>
<td>Maximum Transmission</td>
<td>50m</td>
</tr>
<tr>
<td>Distance Between Channels</td>
<td>0.5m</td>
</tr>
<tr>
<td>Transmission Medium</td>
<td>Shielded twist pair cable (Two-core)</td>
</tr>
<tr>
<td>Number of Connected</td>
<td>Max: 30 slave stations</td>
</tr>
<tr>
<td>Station</td>
<td>Max: 30 slave stations</td>
</tr>
<tr>
<td>Topology</td>
<td>Bus</td>
</tr>
<tr>
<td>Communication Cycle</td>
<td>1, 1.5, 2, 3, 4, 5ms</td>
</tr>
<tr>
<td>Communication Method</td>
<td>Master-slave full synchronization</td>
</tr>
<tr>
<td>Encoding</td>
<td>Manchester encoding</td>
</tr>
<tr>
<td>Data Length</td>
<td>17 bytes/32 bytes, selectable</td>
</tr>
<tr>
<td>Number of Connectable Units</td>
<td>Max: 30 units</td>
</tr>
</tbody>
</table>

### HA-800C (CC-LINK Compatible) Communication Specification

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC-LINK Version</td>
<td>Ver.1.10</td>
</tr>
<tr>
<td>Station Type</td>
<td>Remote device station</td>
</tr>
<tr>
<td>Communication Speed</td>
<td>10Mbps/5Mbps/2.5Mbps/625Kbps/156Kbps</td>
</tr>
<tr>
<td>Communication Method</td>
<td>Broadcast polling method</td>
</tr>
<tr>
<td>Synchronization Method</td>
<td>Frame synchronization method</td>
</tr>
<tr>
<td>Encoding Method</td>
<td>NRZI</td>
</tr>
<tr>
<td>Transmission Path Format</td>
<td>Bus format (EIA RS-485 compliant)</td>
</tr>
<tr>
<td>Error Control Method</td>
<td>CRC (X16+X12+X5+1)</td>
</tr>
<tr>
<td>Connection Cable</td>
<td>CC-Link, Ver.1.10 compatible cable (Shielded twist pair cable (Three core))</td>
</tr>
<tr>
<td>Transmission Format</td>
<td>HDLC compliant</td>
</tr>
<tr>
<td>Remote Channel</td>
<td>1-64</td>
</tr>
<tr>
<td>Number of Occupied</td>
<td>1, 2 station</td>
</tr>
<tr>
<td>Stations</td>
<td></td>
</tr>
</tbody>
</table>

1. A repeater is required when communicating with 17 or more drives or if the total distance is 30m or longer when communicating with 16 or more drives. The maximum allowable number of units connected depends on the communication cycle setting and the number of allowable retries. For details, please see MECHATROLINK Association web site (http://www.mechatrolink.org).
2. Use MP2300 (Yaskawa Electric) controller.
3. Be sure to use the dedicated cable. Do not use commercially available USB cable.
4. When CC-Link Ver 1.00 compatible cable coexists: The total cable extension and the inter-office cable length will be the specification of Ver 1.00.
## Servo Driver Specifications

### AC Servo Digital Drivers (DC24V) HA-680 Series

<table>
<thead>
<tr>
<th>Item</th>
<th>Model</th>
<th>HA-680-4-24</th>
<th>HA-680-6-24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Current*</td>
<td></td>
<td>1.8A</td>
<td>3.9A</td>
</tr>
<tr>
<td>Maximum Current*</td>
<td></td>
<td>3.4A</td>
<td>8.4A</td>
</tr>
<tr>
<td>Power Supply</td>
<td>Main Circuit</td>
<td>DC24V20-28V</td>
<td>DC24V20-28V</td>
</tr>
<tr>
<td></td>
<td>Control Circuit</td>
<td>DC24V20-28V</td>
<td>DC24V20-28V</td>
</tr>
<tr>
<td>Control System</td>
<td>Sine wave PWM control, switching frequency: 12.5kHz</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Mode</td>
<td>Position control, speed control, torque control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight</td>
<td></td>
<td>230g</td>
<td></td>
</tr>
</tbody>
</table>

* The values shown represent the driver rated and maximum currents. Currents are adjusted to match the actuator current ratings before shipment.

### HA-680ML (MECHATROLINK Compatible) Communication Specification

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>MECHATROLINK Version</td>
<td>MECHATROLINK-II</td>
</tr>
<tr>
<td>Transmission Speed</td>
<td>10Mbps</td>
</tr>
<tr>
<td>Maximum Transmission Distance</td>
<td>50m</td>
</tr>
<tr>
<td>Minimum Distance Between Channels</td>
<td>0.5m</td>
</tr>
<tr>
<td>Transmission Medium</td>
<td>Shielded twist pair cable (Two-core)</td>
</tr>
<tr>
<td>Number of Connected Station</td>
<td>Max 30 Slave stations</td>
</tr>
<tr>
<td>Topology</td>
<td>Bus</td>
</tr>
<tr>
<td>Communication Cycle</td>
<td>1, 2, 3, 4, 5ms</td>
</tr>
<tr>
<td>Communication Method</td>
<td>Master-slave full synchronization</td>
</tr>
<tr>
<td>Encoding</td>
<td>Manchester encoding</td>
</tr>
<tr>
<td>Data Length</td>
<td>17 bytes/32 bytes, selectable</td>
</tr>
<tr>
<td>Number of Connectable Units</td>
<td>Max 30 units</td>
</tr>
</tbody>
</table>

### HA-680CL (CC-LINK Compatible) Communication Specification

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>CC-LINK Version</td>
<td>Ver1.10</td>
</tr>
<tr>
<td>Station Type</td>
<td>Remote device station</td>
</tr>
<tr>
<td>Communication Speed</td>
<td>10M/5M/2.5M/625K/156Kbps</td>
</tr>
<tr>
<td>Communication Method</td>
<td>Broadcast polling method</td>
</tr>
<tr>
<td>Synchronization Method</td>
<td>Frame synchronization method</td>
</tr>
<tr>
<td>Encoding Method</td>
<td>NRZI</td>
</tr>
<tr>
<td>Transmission Path Format</td>
<td>Bus format (EA RS-485 compliant)</td>
</tr>
<tr>
<td>Error Control Method</td>
<td>CRC (x^16 + x^12 + x^5 + 1)</td>
</tr>
<tr>
<td>Connection Cable</td>
<td>CC-Link, Ver.1.10 compatible cable (Shielded twist pair cable (Three-core))</td>
</tr>
<tr>
<td>Transmission Format</td>
<td>HDLC compliant</td>
</tr>
<tr>
<td>Remote Control</td>
<td>1~64</td>
</tr>
<tr>
<td>Number of Occupied Stations</td>
<td>1 station</td>
</tr>
<tr>
<td>Number of Connectable Units</td>
<td>Maximum 42 units with remote device station only, can be shared with other devices.</td>
</tr>
</tbody>
</table>

* A repeater is required when communication with 17 units or more is performed or the total extended distance is 30m or longer when communication with 16 units or more is performed. The maximum number of connectable units restricted through setting communication cycle and the number of retry. For details, please see MECHATROLINK Association web site (http://www.mechatrolink.org).
The Harmonic Drive® CSF gears can be directly integrated into your machinery/equipment. Available in a variety of sizes and ratios, you can select the unit that is most suitable for your needs.

- Zero backlash
- Compact design
- High torque capacity
- High torsional stiffness
- High positioning accuracy
- Housed configuration is available (see p. 42)

### CSF Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Ratio</th>
<th>8</th>
<th>11</th>
<th>14</th>
<th>17</th>
<th>20</th>
<th>25</th>
<th>32</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>100%</td>
<td>176</td>
<td>1558</td>
<td>500</td>
<td>4425</td>
<td>950</td>
<td>8408</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>100%</td>
<td>158</td>
<td>1398</td>
<td>375</td>
<td>3208</td>
<td>750</td>
<td>6528</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>100%</td>
<td>131</td>
<td>1121</td>
<td>280</td>
<td>2425</td>
<td>570</td>
<td>4876</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>100%</td>
<td>158</td>
<td>1398</td>
<td>375</td>
<td>3208</td>
<td>750</td>
<td>6528</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>100%</td>
<td>131</td>
<td>1121</td>
<td>280</td>
<td>2425</td>
<td>570</td>
<td>4876</td>
<td></td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>100%</td>
<td>158</td>
<td>1398</td>
<td>375</td>
<td>3208</td>
<td>750</td>
<td>6528</td>
<td></td>
<td></td>
</tr>
<tr>
<td>65</td>
<td>100%</td>
<td>131</td>
<td>1121</td>
<td>280</td>
<td>2425</td>
<td>570</td>
<td>4876</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Dimensions

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Size</th>
<th>Unit: mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>øA</td>
<td>8</td>
<td>10 11 14 17 20 25 32 40</td>
</tr>
<tr>
<td>B</td>
<td>22.1</td>
<td>25.8 28.5 32.5 33.5 37 44 53</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Size</th>
<th>Unit: mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>øA</td>
<td>45</td>
<td>155 170 195 215 265 300 330 100</td>
</tr>
<tr>
<td>B</td>
<td>58.5</td>
<td>64 75.5 83 101 112.5 125</td>
</tr>
</tbody>
</table>
Cup Type - High Torque

CSG Series

CSG is available in 10 sizes with gear reduction ratios from 50:1 to 160:1. CSG high torque series was based on our CSF standard torque series with the goal of upgrading load capacity, strength & reliability and extending service life.

- Zero backlash
- Compact and simple design
- High torque capacity
- High torsional stiffness
- High positioning accuracy
- Housed unit type is available (see p. 44)
- 30% higher torque than a CSF unit

---

**Dimensions**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>14</th>
<th>17</th>
<th>20</th>
<th>25</th>
<th>32</th>
<th>40</th>
<th>45</th>
<th>50</th>
<th>58</th>
<th>65</th>
</tr>
</thead>
<tbody>
<tr>
<td>ø A</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>85</td>
<td>110</td>
<td>135</td>
<td>155</td>
<td>170</td>
<td>195</td>
<td>215</td>
</tr>
<tr>
<td>B</td>
<td>28.5</td>
<td>32.5</td>
<td>33.5</td>
<td>37</td>
<td>44</td>
<td>53</td>
<td>58.5</td>
<td>64</td>
<td>75.5</td>
<td>83</td>
</tr>
</tbody>
</table>

---

**CSG Series Ratings**

<table>
<thead>
<tr>
<th>Item</th>
<th>Ratio</th>
<th>Rated Torque at 2000rpm</th>
<th>Limit for Repeated Peak Torque</th>
<th>Limit for Momentary Peak Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Nm</td>
<td>In-lb</td>
<td>Nm</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>50</td>
<td>7.0</td>
<td>62</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80</td>
<td>10</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
<td>10</td>
<td>89</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>50</td>
<td>21</td>
<td>186</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80</td>
<td>29</td>
<td>257</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
<td>31</td>
<td>274 70</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>50</td>
<td>33</td>
<td>292</td>
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<tr>
<td></td>
<td></td>
<td>80</td>
<td>44</td>
<td>389</td>
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<td></td>
<td></td>
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<td>52</td>
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<td>25</td>
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<td></td>
<td></td>
<td>80</td>
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<td></td>
<td></td>
<td>100</td>
<td>52</td>
<td>460</td>
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<td>32</td>
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<td>50</td>
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<td></td>
<td>80</td>
<td>153</td>
<td>1354</td>
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<tr>
<td></td>
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<td>100</td>
<td>178</td>
<td>1575</td>
</tr>
<tr>
<td></td>
<td></td>
<td>120</td>
<td>178</td>
<td>1575</td>
</tr>
</tbody>
</table>

---

**Performance comparison of CSF and CSG Series Harmonic Drive® gearing**

<table>
<thead>
<tr>
<th>Item</th>
<th>Ratio</th>
<th>Rated Torque at 2000rpm</th>
<th>Limit for Repeated Peak Torque</th>
<th>Limit for Momentary Peak Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Nm</td>
<td>In-lb</td>
<td>Nm</td>
</tr>
<tr>
<td>40</td>
<td></td>
<td>50</td>
<td>178</td>
<td>1575</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80</td>
<td>268</td>
<td>2372</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
<td>345</td>
<td>3053</td>
</tr>
<tr>
<td>45</td>
<td></td>
<td>50</td>
<td>229</td>
<td>2027</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80</td>
<td>407</td>
<td>3602</td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>50</td>
<td>484</td>
<td>4283</td>
</tr>
<tr>
<td>58</td>
<td></td>
<td>50</td>
<td>969</td>
<td>8576</td>
</tr>
<tr>
<td>65</td>
<td></td>
<td>50</td>
<td>1236</td>
<td>10939</td>
</tr>
</tbody>
</table>

---

Harmonic Drive® Component Set

Harmonic Drive LLC

www.HarmonicDrive.net • 800-921-3332
The ultra-flat CSD precision gears are available in seven sizes, opening up new applications for motion control speed reducers.

- Zero backlash
- Extremely high positioning accuracy
- Excellent Repeatability
- Superior axial compactness
- Hollow through bore, also available with extra large through bore

### CSD Series Ratings

<table>
<thead>
<tr>
<th>Size</th>
<th>Ratio</th>
<th>Rated Torque at 2000 rpm</th>
<th>Limit for Repeated Peak Torque</th>
<th>Limit for Momentary Peak Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Nm</td>
<td>Nm</td>
<td>Nm</td>
</tr>
<tr>
<td>14</td>
<td>50</td>
<td>3.7</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>5.4</td>
<td>16</td>
<td>31</td>
</tr>
<tr>
<td>17</td>
<td>50</td>
<td>11</td>
<td>23</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>16</td>
<td>37</td>
<td>55</td>
</tr>
<tr>
<td>20</td>
<td>50</td>
<td>17</td>
<td>39</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>28</td>
<td>57</td>
<td>76 (65)</td>
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<tr>
<td>25</td>
<td>50</td>
<td>27</td>
<td>69</td>
<td>127</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>47</td>
<td>117</td>
<td>152 (135)</td>
</tr>
<tr>
<td>32</td>
<td>50</td>
<td>53</td>
<td>151</td>
<td>286</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>96</td>
<td>233</td>
<td>359 (331)</td>
</tr>
<tr>
<td>40</td>
<td>50</td>
<td>96</td>
<td>281</td>
<td>480</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>185</td>
<td>398</td>
<td>694 (580)</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
<td>172</td>
<td>500</td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>329</td>
<td>686</td>
<td>1440 (1315)</td>
</tr>
</tbody>
</table>

Note: Values in (parenthesis) are for Big Bore (BB) version

### Dimensions

<table>
<thead>
<tr>
<th>Size Symbol</th>
<th>14</th>
<th>17</th>
<th>20</th>
<th>25</th>
<th>32</th>
<th>40</th>
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Pancake gears consist of four main parts: Wave Generator, Flexspline, Dynamic Spline, and Circular Spline. Extremely flat, these pancake gears offer the design engineer high ratios in extremely compact configurations.

- Flat profile
- Easily adapted to customer supplied assembly
- FB uses single wave generator bearing
- FR is heavy duty version of the FB
- FR uses double wave generator bearing

### FB, FR Series Ratings

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**Unit: mm**

www.HarmonicDrive.net • 800-921-3332
Harmonic Drive® Component Set SHF Series

SHF is a silk hat, component set gear available with a large hollow through bore. It provides exceptional positioning accuracy in a compact design.

- Zero backlash
- Hollow bore units available
- Compact and simple design
- High torque capacity
- High positioning accuracy
- High torsional stiffness
- Housed version of this component set is available (see p. 50)

**SHF Series Ratings**

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Unit: mm

L₁₀ Life: 7,000h
Silk Hat - High Torque

SHG Series

SHG is a high torque, silk hat, component set gear available with a large hollow through bore. It provides exceptional positioning accuracy in a compact design.

- Zero backlash
- Hollow bore units available
- Excellent positioning accuracy
- Compact and simple design
- High torque capacity
- High torsional stiffness
- 30% higher torque rating than SHF series

**Performance comparison of SHF and SHG Series Harmonic Drive® gearing**

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Unit: mm

www.HarmonicDrive.net • 800-921-3332
CSF-2UH is a housed component gear set combined with a precision cross roller output bearing & flange. It is a very compact, robust and easy to use gearhead solution.

- Zero backlash
- Compact and simple design
- High torque capacity
- High torsional stiffness
- High positioning accuracy

### CSF Series Ratings

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### Cross Roller Bearing Specification

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* “Basic dynamic rated load” is a constant stationary radial load that achieves a basic dynamic rated life of the bearing of one million revolutions.

* “Basic static rated load” is a static load that achieves a contact stress of a constant level (408kN/mm²) at the center of a contact zone between the rolling element receiving a maximum load and track.

* The moment stiffnesses are mean values.

### Dimensions

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### Lightweight Gear Unit

**CSF-2UH-LW Series**

LW indicates lightweight, the CSF-2UH is a housed component gear set combined with a precision cross roller output bearing & flange.

- Zero Backlash
- 30% average lower weight than Standard Series
- High Torque to Weight ratio
- Accuracy <1 arc-min
- High torsional stiffness
- High efficiency
- Robust cross roller output bearing
- Output flange for direct mounting of load

**CSF-LW Series Ratings**

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**Cross Roller Bearing Specification**

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**LW** indicates lightweight, the CSF-2UH is a housed component gear set combined with a precision cross roller output bearing & flange.
CSG-2UH is a high torque housed component gear set combined with a precision cross roller output bearing & flange. It is a very compact, robust and easy to use gearhead solution.

- Zero backlash
- High torque capacity
- High torsional stiffness
- Compact and simple design
- High positioning accuracy
- 30% higher torque than a CSF unit

### CSG Series Ratings

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**Cross Roller Bearing Specification**

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- "Basic dynamic rated load" is a constant stationary radial load that achieves a basic dynamic rated life of the bearing of one million revolutions.
- "Basic static rated load" is a static load that achieves a contact stress of a constant level (408kN/mm²) at the center of a contact zone between the rolling element receiving a maximum load and track.

### Dimensions

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Unit: mm
High Torque, Lightweight Gear Unit

CSG-2UH-LW Series

LW indicates lightweight. CSG-2UH is a high torque housed component gear set combined with a precision cross roller output bearing & flange. It is a very compact, robust and easy to use gearhead solution.

- Zero Backlash
- 30% average lower weight than Standard Series
- High Torque to Weight ratio
- Accuracy <1 arc-min
- High torsional stiffness
- High efficiency
- Robust cross roller output bearing
- Output flange for direct mounting of load

CSG-2UH-LW Series Ratings

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<th>Item</th>
<th>Ratio</th>
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Cross Roller Bearing Specification

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CSG-2UK is a high torque fully sealed, high accuracy gear reducer ideally suited for machine tool applications.

- Zero backlash
- Compatible with Fanuc motors
- High torque capacity
- High torsional stiffness
- High positioning accuracy

**CSG Series Ratings**

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**Cross Roller Bearing Specification**

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<th>Moment Stiffness Km</th>
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High Torque Gear Unit
CSG Series

• Overview Drawing

* This is a fully enclosed unit with oil seals at the input and output shafts.

• Typical Assembly

Harmonic Drive LLC
www.HarmonicDrive.net • 800-921-3332
Ultra-Flat Gear Unit
CSD-2UH Series

Available in 7 sizes with ratios 50:1 to 160:1, CSD-2UH is an ultra-thin and compact housed gear component unit.

- Zero Backlash
- Lightweight
- Ultra-flat
- Compact and simple design

•CSD-2UH Series Ratings

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•Cross Roller Bearing Specification

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Ultra-Flat, Hollow Shaft Gear Unit

CSD-2UF Series

Available in 6 sizes with ratios 50:1 to 160:1, CSD-2UF is an ultra-thin and compact housed gear component unit with a hollow through bore.

- Zero Backlash
- Hollow shaft
- High load capacity
- Lightweight
- Ultra-flat
- Compact and simple design

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CSF Mini and Supermini Series

**Rated Torque at 2000 rpm**

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**Moment Stiffness Km**

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The CSF-2UP gear units have an ultra-flat configuration with high-moment stiffness. The new models are lightweight and extremely flat. Thanks to a cross roller bearing used at the output flange, the CSF-2UP gearheads offer high-moment stiffness.

- Zero backlash
- High positioning accuracy
- Compact and lightweight
- High torque capacity
- High radial, axial, and moment load capacity
- Cross roller bearing
- Ratios: 30:1 to 100:1

---

### CSF Mini Series Ratings

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<th>Limit for Momentary Peak Torque</th>
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### Cross Roller Bearing Specification

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Harmonic Drive® Housed Unit  Miniature Gear Units

www.HarmonicDrive.net • 800-921-3332
Incorporating a Harmonic Drive® gear component into an integral housing, the SHF-2UH is a compact hollow shaft gearhead with zero backlash.

- Zero backlash
- Large hollow thru bore
- High positioning accuracy
- Compact and simple design
- High torque capacity
- High torsional stiffness
- Shaft input units available (SHF-2UJ)

Harmonic Drive LLC
52
www.HarmonicDrive.net • 800-921-3332

Harmonic Drive® Housed Unit
SHF Series
Lightweight gear unit with hollow shaft or solid input shaft

**SHF-2UH-LW Series**

LW indicates lightweight. Incorporating a Harmonic Drive® gear component into an integral housing, the SHF-2UH-LW is a lightweight, compact hollow shaft gearhead with zero backlash.

- Zero backlash
- 20% lighter than standard unit
- Large hollow through bore
- High positioning accuracy
- High torque capacity
- High torsional stiffness

**Cross Roller Bearing Specification**

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The SHG-2UH series with a hollow shaft is a high torque, compact, precision gearhead with zero backlash and exceptional accuracy and repeatability.

- Zero backlash
- Large hollow through bore
- High positioning accuracy
- High torque capacity
- High torsional stiffness
- Shaft input units available (SHG-2UJ)
- 30% increased torque compared to SHF Units

**SHG Series Ratings**

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**Cross Roller Bearing Specification**

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**Dimensions**

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*Basic dynamic rated load* is a constant stationary radial load that achieves a basic dynamic rated life of the bearing of one million revolutions. *Basic static rated load* is a static load that achieves a contact stress of a constant level (408kN/mm²) at the center of a contact zone between the rolling element receiving a maximum load and track.
Incorporating a Harmonic Drive® gear component into an integral housing, the SHF-2UH-LW is a lightweight compact hollow shaft gearhead with zero backlash.

- Zero backlash
- 20% lighter than standard unit
- Large hollow through bore
- High positioning accuracy
- High torque capacity
- High torsional stiffness
- 30% increased torque compared to SHF Units

![Lightweight, high torque gear unit with hollow shaft](image)

### SHG-2UH-LW Series

#### Item| Size| Symbol|øA| B
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### SHG-LW Series Ratings

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### Cross Roller Bearing Specification

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### Dimensions

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Unit: mm

1. *Basic dynamic rated load* is a constant stationary radial load that achieves a basic dynamic rated life of the bearing of one million revolutions.
2. *Basic static rated load* is a static load that achieves a contact stress of a constant level (408N/mm²) at the center of a contact zone between the rolling element receiving a maximum load and track.

*SHG-2UH-LW Series*
Lightweight, Hollow Shaft

SHD-2UH-LW Series

LW indicates lightweight. Axially compact, these gear units feature a large hollow input shaft and a robust cross roller bearing so loads can be mounted directly to the unit without the need for additional support bearings.

- Zero Backlash
- Ultra-flat design
- Large Hollow Input Shaft
- Accuracy <1 arc-min (most sizes)
- Rigid cross roller output bearing
- Lightweight

**1:** "Basic dynamic rated load" is a constant stationary radial load that achieves a basic dynamic rated life of one million revolutions.

**2:** "Basic static rated load" is a static load that achieves a contact stress of a constant level (408kN/mm²) at the center of a contact zone between the rolling element receiving a maximum load and track.

**Dimensions**

Size | Symbol | 14 | 17 | 20 | 25 | 32 | 40
--- | --- | --- | --- | --- | --- | --- | ---
øA | 74 | 84 | 95 | 115 | 147 | 175
B | 45.5 | 48 | 42 | 46.5 | 55 | 65

**SHD-2UH-LW Series Ratings**

**Cross Roller Bearing Specification**

**Dimensions**

Size | Symbol | 14 | 17 | 20 | 25 | 32 | 40
--- | --- | --- | --- | --- | --- | --- | ---
øA | 74 | 84 | 95 | 115 | 147 | 175
B | 45.5 | 48 | 42 | 46.5 | 55 | 65

**Harmonic Drive® Housed Unit          SHD Series**
Hollow Shaft, Simplicity Unit

SHD-2SH Series

Axially compact, these gear units feature a large hollow input shaft and a robust cross roller bearing so loads can be mounted directly to the unit without the need for additional support bearings.

- Zero backlash
- Extremely flat profile
- Hollow through bore
- High positioning accuracy
- High stiffness cross roller bearing output
- High radial, axial, and moment load capacity

L10 Life: 7,000 h

•SHD Series Ratings

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<th>Limit for Average Torque</th>
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•Cross Roller Bearing Specification

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<th>Moment Stiffness Km</th>
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<td>Basic Static Rated Load Co</td>
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* "Basic dynamic rated load" is a constant stationary radial load that achieves a basic dynamic rated life of the bearing of one million revolutions.

* "Basic static rated load" is a static load that achieves a contact stress of a constant level (4kN/mm²) at the center of a contact zone between the rolling element receiving a maximum load and track.

•Dimensions

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Simplicity Gear Units are Non-housed component gears combined with a precision cross roller output bearing. Simplicity Gear Units do not include the housing and output flange, which allows for even tighter integration into the customer’s housing or machine structure.

- Zero backlash
- High positioning accuracy
- Compact and simple design
- High torque capacity
- High torsional stiffness

**SHF Series Ratings**

<table>
<thead>
<tr>
<th>Item</th>
<th>Ratio</th>
<th>Size</th>
<th>Rated Torque at 2000rpm (Nm)</th>
<th>Limit for Repeated Peak Torque (Nm)</th>
<th>Limit for Momentary Peak Torque (Nm)</th>
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*SHG only

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Harmonic Drive® Simplicity Gear Unit

**Item**

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*Basic dynamic rated load* is a constant stationary radial load that achieves a basic dynamic rated life of the bearing of one million revolutions. *Basic static rated load* is a static load that achieves a contact stress of a constant level (408kN/mm²) at the center of a contact zone between the rolling element receiving a maximum load and track.
High Torque versions of our Simplicity Gear Units. Simplicity Gear Units do not include the housing and output flange, which allows for even tighter integration into the customer's housing or machine structure.

- Zero backlash
- High positioning accuracy
- High torque capacity
- High torsional stiffness
- 30% increased torque compared to SHF Units

### •SHG Series Ratings

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<tr>
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### •Cross Roller Bearing Specification

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**High Torque Simplicity Gear Unit**

**SHG-2SH/2SO Series**

High Torque Simplicity Gear Units feature enhanced performance compared to SHF Series.

- Zero backlash
- High positioning accuracy
- High torque capacity
- High torsional stiffness
- 30% increased torque compared to SHF Units

### SHG Series Ratings

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**Harmonic Drive LLC**

www.HarmonicDrive.net • 800-921-3332
Phasing Differential
FD Series Component

The FD series is an extremely compact differential unit that allows you to fine-tune the phase and timing during operation.
- Pancake
- Ultra compact differential unit
- Backlash is very small and unit requires no assembly adjustment

### FD Series Ratings

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The FD series is an extremely compact differential unit that allows you to fine-tune the phase and timing during operation. The unit type is provided with the housing so additional gears or pulleys required for the machine can be directly mounted onto it.

- Pancake
- Ultra compact differential unit
- Backlash is very small and unit requires no assembly adjustment

### FD Series Ratings

<table>
<thead>
<tr>
<th>Size</th>
<th>Rotation Speed rpm</th>
<th>Nm</th>
<th>In-lb</th>
<th>Nm</th>
<th>In-lb</th>
<th>Nm</th>
<th>In-lb</th>
<th>Nm</th>
<th>In-lb</th>
<th>Nm</th>
<th>In-lb</th>
<th>Nm</th>
<th>In-lb</th>
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<td>266</td>
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</tr>
<tr>
<td></td>
<td>1450 rpm</td>
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### Dimensions

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Unit: mm

www.HarmonicDrive.net • 800-921-3332
The FBB was developed as a versatile simple differential drive transmission for direct phasing of rotating elements while they are in motion. Offsetting internal gear ratios deliver a through ratio of 1:1 and trim adjustments can be applied through one or both of two wave generators.

- 1:1 phasing differential between input and output
- High ratio trim adjustment
- Compact, low backlash design for end roll mounting

### FBB Series Ratings

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<thead>
<tr>
<th>Size</th>
<th>Ratio</th>
<th>Maximum Input Speed rpm</th>
<th>Rated Torque @1750 rpm</th>
<th>Maximum Output Torque</th>
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<th>Input Inertia</th>
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### Dimensions

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<th>25</th>
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<th>50</th>
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<td>70</td>
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<td>134</td>
<td>170</td>
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<td>42</td>
<td>56.5</td>
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HDI Infinit-Indexer® Phase Adjuster

Infinit-Indexer® phase adjusters are available from immediate stock in the standard bore sizes shown with keyways, set screws, and tapped holes for face mounting of either hub. It is possible for the user to modify these configurations by disassembling the unit. The hub material is low carbon steel with suitable sizes shown in notes to the dimensional drawings. Additional sizes and configurations are available by special order.

- Fine tune rotational position of shafts and machine parts
- Phase cams
- Adjust roll registration
- Take up backlash in spur and worm gears
- Synchronize indexing devices

•3 Models, 6 Bore Sizes Available From Stock

<table>
<thead>
<tr>
<th>HDI Size</th>
<th>Bore Size</th>
<th>O.D.</th>
<th>Length</th>
<th>Torque Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>-10</td>
<td>1/2&quot;, 5/8&quot;</td>
<td>25/8&quot; (60.33mm)</td>
<td>1½&quot; (42.9mm)</td>
<td>1000 lb-in (113 Nm)</td>
</tr>
<tr>
<td>-25</td>
<td>3/4&quot;, 1&quot;</td>
<td>3&quot; (76.2mm)</td>
<td>2½&quot; (76.2mm)</td>
<td>2500 lb-in (283 Nm)</td>
</tr>
<tr>
<td>-50</td>
<td>1⅛&quot;</td>
<td>3⅛&quot; (95.3mm)</td>
<td>2¾&quot; (95.3mm)</td>
<td>5000 lb-in (565 Nm)</td>
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</tbody>
</table>

To operate, hand rotate the adjusting ring in either direction to produce a 100:1 reduction between the ring and the output. Adjust the friction adjustment/locking screw to desired resistance. For some applications, one adjustment will be sufficient for both shaft turning and phase adjusting modes. For more severe loading, such as hard stops or high peak torque situations, the friction adjustment/locking screw may be used to lock the adjusting ring in place to maintain phase.

Flexible Couplings

<table>
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<th>HDI Size</th>
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IN-LINE SHAFT

IN-LINE SHAFT

CONCENTRIC SHAFT

•Dimensions

<table>
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<th>10</th>
<th>25</th>
<th>25</th>
<th>50</th>
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<td>2.38</td>
<td>3.00</td>
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<td>3.75</td>
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<td>1.69</td>
<td>1.69</td>
<td>2.19</td>
<td>2.19</td>
<td>2.37</td>
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<tr>
<td>øC</td>
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<td>0.625</td>
<td>0.750</td>
<td>1.000</td>
<td>1.250</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>1.38</td>
<td>1.38</td>
<td>1.38</td>
<td>1.75</td>
<td>1.75</td>
<td>2.17</td>
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</table>
Quick Connect® Gearhead for Servomotors

CSF-GH Series

CSF-GH Quick Connect® gearheads with zero-backlash Harmonic Drive® gearing are available with high reduction ratios, 50:1 to 160:1. CSF-GH utilizes our proprietary S tooth profile and provides high precision positioning (repeatability ±4 to ±10 arc-sec).

- Zero Backlash
- Available in 5 Sizes
- Peak torque 18Nm ~ 2630Nm
- Ratios, 50:1 to 160:1
- Accuracy <1 arc-min
- High Efficiency
- High load capacity output bearing
- Motor size range 30W to 5,000W

L10 Life: 7,000h

•CSF-GH Series Ratings

<table>
<thead>
<tr>
<th>Size</th>
<th>Ratio</th>
<th>Rated Torque at 2000rpm</th>
<th>Limit for Repeated Peak Torque</th>
<th>Limit for Momentary Peak Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Nm</td>
<td>In-lb</td>
<td>Nm</td>
</tr>
<tr>
<td>14</td>
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<td>5.4</td>
<td>48</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>100</td>
<td>7.8</td>
<td>69</td>
<td>23</td>
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<td>25</td>
<td>221</td>
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<tr>
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<td>176</td>
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•Cross Roller Bearing Specification

<table>
<thead>
<tr>
<th>Size</th>
<th>Item</th>
<th>Basic Rated Load</th>
<th>Allowable Moment Load Mc</th>
<th>Moment Stiffness Km</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>lb</td>
<td>Nm</td>
<td>lb</td>
</tr>
<tr>
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</tr>
<tr>
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<td>18344</td>
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</table>

* "Basic dynamic rated load" is a constant stationary radial load that achieves a basic dynamic rated life of the bearing of one million revolutions.

* "Basic static rated load" is a static load that achieves a contact stress of a constant level (4kN/mm²) at the center of a contact zone between the rolling element receiving a maximum load and track.

•Dimensions

<table>
<thead>
<tr>
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<th>Symbol</th>
<th>Unit: mm</th>
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</tr>
<tr>
<td></td>
<td>D</td>
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<td>eE</td>
<td>16 25 40 50 70</td>
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</table>

The length and shape of the motor adapter flange will depend upon the specific motor that is selected for use with the gearhead. Please contact Harmonic Drive LLC for a detailed drawing.
Quick Connect® Gearhead for Servomotors

CSG-GH Series

CSG-GH high-torque Quick Connect® gearheads with zero backlash Harmonic Drive® gearing are available with high reduction ratios, 50:1 to 160:1.
- Zero Backlash
- Available in 5 Sizes
- Peak torque 23Nm ~ 3419Nm
- Ratios, 50:1 to 160:1
- Repeatability as low as 4 arc-seconds
- Accuracy <1 arc-min
- High Efficiency
- High load capacity output bearing
- Motor size range 30W to 5,000W
- 30% higher rated torque, repeated peak torque & maximum momentary torque than CSF series products of the same size

L_{10} Life: 10,000h

- **CSG-GH Series Ratings**

<table>
<thead>
<tr>
<th>Size</th>
<th>Ratio</th>
<th>Rated Torque at 2000rpm</th>
<th>Limit for Repeated Peak Torque</th>
<th>Limit for Momentary Peak Torque</th>
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- **Cross Roller Bearing Specification**

<table>
<thead>
<tr>
<th>Size</th>
<th>Item</th>
<th>Basic Rated Load</th>
<th>Allowable Moment Load Mc</th>
<th>Moment Stiffness Km</th>
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<td>Basic Dynamic Rated Load C</td>
<td>Basic Static Rated Load Co</td>
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* "Basic dynamic rated load" is a constant stationary radial load that achieves a basic dynamic rated life of the bearing of one million revolutions.
* "Basic static rated load" is a static load that achieves a contact stress of a constant level (4kN/mm²) at the center of a contact zone between the rolling element receiving a maximum load and track.

- **Dimensions**

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* The length and shape of the motor adapter flange will depend upon the specific motor that is selected for use with the gearhead. Please contact Harmonic Drive LLC for a detailed drawing.
Quick Connect® gearhead for high performance servo motors. Reduction ratios 3:1 to 50:1. Available with flange output, straight shaft (without key), straight shaft (with key) and center tapped hole.

- Low backlash: Less than 3 arc-min (less than 1 arc-min optional)
- Ratios, 3:1 to 50:1
- Quick Connect® coupling
- Peak torque 5Nm ~ 3200Nm
- High moment capacity cross roller output bearing
- High efficiency
- Sealed structure
- Motor size range 10W to 15,000W

### HPG Series Ratings

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### Cross Roller Bearing Specification

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* The length and shape of the motor adapter flange will depend upon the specific motor that is selected for use with the gearhead. Please contact Harmonic Drive LLC for a detailed drawing.

--- Size 65—Shaft is available as special request, ---
Quick Connect® gearhead for high performance servo motors. Reduction ratios 3:1 to 10:1. Available with flange output, straight shaft (without key), straight shaft (with key) and center tapped hole.

- Helical Gearing
- Available in four Frame Sizes
- Peak Torque: 5Nm to 400Nm
- Ratios: 3, 4, 5, 6, 7, 8, 9 and 10:1
- High Efficiency
- Backlash <3 arc-min (<1arc-min available as an option)
- Repeatability ±20 arc-sec
- High load capacity Cross Roller output bearing
- Quick Connect® coupling for easy mounting of any motor

**HPG Helical Series Ratings**

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**Cross Roller Bearing Specification**

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*The length and shape of the motor adapter flange will depend upon the specific motor that is selected for use with the gearhead. Please contact Harmonic Drive LLC for a detailed drawing.*
Harmonic Planetary® Gearhead
Quick Connect® Coupling
HPGP Series

High torque Quick Connect® gearhead for high performance servo motors. Reduction ratios 3:1 to 50:1. Available with flange output, Straight shaft (without key), Straight shaft (with key) and center tapped hole.
• Peak torque 12Nm – 3940Nm
• High precision
• Backlash <1 arc-min is available (size #14-65) (Standard backlash specification is < 3 arc-min)
• Cross roller bearing for high load capacity and moment stiffness
• Quick Connect® coupling
• Ratios, Single Stage: 4:1 to 5:1, Two Stage: 11:1 to 45:1
• Motor size range 10W to 15,000W

-•HPGP Series Ratings

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-•Cross Roller Bearing Specification

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-•Dimensions

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</table>

* The length and shape of the motor adapter flange will depend upon the specific motor that is selected for use with the gearhead. Please contact Harmonic Drive LLC for a detailed drawing.

--- Size 65—Shaft is available as special request. ---
Right angle, high precision, Harmonic Planetary® gearhead with low backlash.

- High precision Planetary gearhead
- Low backlash: Less than 3 arc-min (less than 1 arc-min optional)
- Quick Connect® coupling
- High torque capacity
- High moment capacity cross roller output bearing
- Right angle configuration allows for use in limited space

**HPG RA Series Ratings**

<table>
<thead>
<tr>
<th>Size</th>
<th>Model</th>
<th>Ratio</th>
<th>Rated Torque</th>
<th>Limit for Average Load Torque*1</th>
<th>Limit for Repeated Peak Torque*2</th>
<th>Limit for Momentary Peak Torque*3</th>
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*1: Average load torque calculated based on the application motion profile must not exceed values shown in the table.

*2: The limit for torque during start and stop cycles. Always operate below this value.

*3: The limit for torque during emergency stops or from external shock loads.

**Cross Roller Bearing Specification**

<table>
<thead>
<tr>
<th>Item</th>
<th>Basic Rated Load</th>
<th>Allowable Moment Load MC</th>
<th>Moment Stiffness Km</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic Dynamic Rated Load C</td>
<td>Basic Static Rated Load Co</td>
<td>Nm</td>
</tr>
<tr>
<td>Size</td>
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<td>lb</td>
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**Dimensions**

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<th>C</th>
<th>D</th>
<th>E*</th>
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<td>168/200</td>
<td>209/234/254</td>
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<td>168/200</td>
<td>291/316/336</td>
<td>130/180/220</td>
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</tbody>
</table>

* Left side description: The limited length of the Motor shaft is 81mm. Right side description: The limited length of the Motor shaft is 116mm.

Note: Dimensions F & G depend on the chosen Motor flange square size. Contact Harmonic Drive LLC for special flange motor combination.
HPN value series planetary gearheads feature a robust design utilizing helical gears for quiet performance and long life. These gearheads are available with short lead times and are designed to couple to any servo motor with our Quick Connect® coupling.

- Peak torque 9Nm to 752Nm
- Compact design
- High precision
- Backlash <5 arc-min (One-stage), <7 arc-min (Two-stage)
- Quick Connect® coupling
- Reduction ratios between 3:1 and 50:1
- Helical gears for quiet performance
- Motor size range 30W to 7500W
- Quick delivery

### HPN Series Ratings

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<th>Repeated Peak Torque Nm</th>
<th>Momentary Peak Torque Nm</th>
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### Dimensions

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Dimensions depend upon the motor selected. Dimensions shown in the table are a typical range for reference only. Contact HDLLC for detailed dimensions of the gear used for your motor.
Hollow Shaft Planetary Gear

**HPF Series**

Hollow shaft planetary gear with output flange. The flange is integrated with a robust cross-roller bearing which can support high axial, radial and moment loads without the need for additional support bearings.

- Hollow Shaft Structure
- Coaxial input and output shafts
- Cross Roller Output Bearing
- Backlash < 3 arc-min
- The precision HPF planetary gear is also available in our SHA Series Hollow Shaft Brushless Actuators as a standard product

### HPF Series Ratings

<table>
<thead>
<tr>
<th>Item</th>
<th>Ratio</th>
<th>Rated Torque</th>
<th>Limit for Repeated Peak Torque</th>
<th>Limit for Momentary Torque</th>
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<td>In-lb</td>
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### Cross Roller Bearing Specification

<table>
<thead>
<tr>
<th>Item</th>
<th>Basic Rated Load</th>
<th>Allowable Moment Load Mc</th>
<th>Moment Stiffness Km</th>
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<td>Size</td>
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<td>32</td>
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<td>5058</td>
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</tbody>
</table>

**1:** “Basic dynamic rated load” is a constant stationary radial load that achieves a basic dynamic rated life of the bearing of one million revolutions.

**2:** “Basic static rated load” is a static load that achieves a contact stress of a constant level (408kN/mm²) at the center of a contact zone between the rolling element receiving a maximum load and track.

Unit: mm

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Size</th>
<th>A</th>
<th>B</th>
<th>C</th>
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### Applications

#### Robots
- Industrial robots
- Robot peripheral equipment

<table>
<thead>
<tr>
<th>Primary axis</th>
<th>FHA-Mini</th>
<th>FHA-C</th>
<th>CSD</th>
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<tbody>
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<td>RSF</td>
<td>SHG</td>
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<td>Linear axis</td>
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<td>Indexing table</td>
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<tr>
<td>Peripheral equipment</td>
<td>HPG</td>
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</tbody>
</table>

#### Humanoid Robots
- Joint articulation
- Robotic hand
- Vision sensor positioning
- Torque sensing

| FHA-Mini | CSG |
| FHA-C | CSD |
| RSF | CSF |
| RSF-Mini | SHG |
| Micro Encoder | SHF |
| | SHD |
| | HPG |

#### Metal Machine Tools
- Machining centers
- Turning centers
- Work transfer systems
- CNC Grinders
- EDM systems

| FHA-C | CSG |
| RSF | CSF |
| RSF-Supermini | SHG |
| RSF-Mini | SHF |
| FHA-Mini | SHD |
| C Axis | HPG |

#### Metal Working Machines
- Bending machines
- Rolling machines
- Presses
- Work transfer systems

| FHA-C | CSG |
| RSF | CSF |
| LSA | SHG |
| SHF | HPG |

#### Printing, Bookbinding and Paper Processing Machines
- Printing presses
- Folding machines
- Paper changing machines
- Paper positioning machines
- Paper machines

| FHA-C | CSG |
| RSF | CSF |
| CSG | SHG |
| CYF | SHF |
| FB | HPG |
## Applications

### Wood, Light Metal and Plastic Machine Tools

<table>
<thead>
<tr>
<th>Woodworking machines</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-axis machining centers</td>
</tr>
<tr>
<td>3-axis gantry mills</td>
</tr>
<tr>
<td>Work transfer systems</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Milling head drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool magazine drive</td>
</tr>
<tr>
<td>Work positioning machines</td>
</tr>
<tr>
<td>Rotary table drive</td>
</tr>
<tr>
<td>Tool positioning machine drive</td>
</tr>
<tr>
<td>Direct transmission shaft drive</td>
</tr>
<tr>
<td>Shaft drive</td>
</tr>
</tbody>
</table>

| FHA-Cmini |
| FHA-C |
| RSF |
| RSF-Supermini |
| LAH |
| CSG |
| CSF |
| SHG |
| SHF |
| HPG |

### Energy

<table>
<thead>
<tr>
<th>Oil exploration robot</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind power equipment</td>
</tr>
<tr>
<td>Electric power equipment</td>
</tr>
<tr>
<td>Photovoltaics</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Directional drilling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Propeller pitch control</td>
</tr>
<tr>
<td>Solar panel positioning</td>
</tr>
</tbody>
</table>

| FHA-C |
| CSF |
| FR |

### Paper-making Machines

<table>
<thead>
<tr>
<th>Paper-making machines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrugated fiberboard box making and printing machines</td>
</tr>
</tbody>
</table>

| Coating-process roller positioning drive |
| Head box slice lip positioning |
| Cutter knife positioning |
| Cutter knife traveling drive |

| RSF |
| FHA-C |
| RH |
| CSF |
| SHF |
| HPG |

### Crating and Packaging Machines

<table>
<thead>
<tr>
<th>Sealing machines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Label printing machines</td>
</tr>
<tr>
<td>Label attaching machines</td>
</tr>
<tr>
<td>Robots</td>
</tr>
<tr>
<td>Work transfer systems</td>
</tr>
</tbody>
</table>

| Shaft synchronizing drive |
| Roll synchronizing drive |
| Joint drive |
| Trolley drive |

| FHA-C |
| RSF |
| RH |
| CSF |
| SHF |
| FB |
| FR |
| FD |
| HPG |

### Flat Panel Display Manufacturing Systems

| Array process equipment |
| Cell process equipment |
| Assembly process equipment |
| Work transfer systems |

| Transfer systems |
| Positioning |
| Indexing tables |
| Direct transmission tables |
| Work reversing machines |
| Tension controllers |
| Hatch opening/closing drive |
| Joint drive |
| Trolley drive |

| FHA-Gmini |
| FHA-C |
| RSF |
| RSF-Supermini |
| KDU |
| RH |
| LA |
| HPG |
| SHD |
| SHF |
## Communication Equipment

- Antennas
- Microphones
- Cameras
- Wavelength duplexers
- Radars

### Pan & Tilt drives
- FHA-C mini
- FHA-C
- RSF
- RSF-Supermini
- LAH
- CSG
- CSF
- SHF
- HPG

## Printed Circuit Board Manufacturing Machines

- Electronic component insertion machines
- Solder paste dispensing machines
- Board inspection systems
- Transfer systems

### Drilling head drive
- FHA-C mini
- FHA-C
- RSF
- RSF-Supermini
- LAH
- CSG
- CSF
- SHF
- HPG

### Tool changer drive
- Work positioning machines
- Rotary table drive
- Tool positioning machine drive
- Shaft drive

## Space

- Communication
- Antennas
- Solar Array Drives
- Robotic joints
- Robotic arms

### Pan & Tilt drive
- Joint drive
- Wheel drive

## Aircraft

- Flight simulators
- Cargo handling and transfer systems
- Reconnaissance cameras
- Valves

### Valve actuator
- Trolley drive
- Cargo wheel power drive unit
- Fly-by-Wire Components

## Glass and Ceramic Manufacturing Systems

- Ceramic forming machines
- Glass polishing machines
- Sheet glass cutting machines

### Valve opening and closing
- Valve positioning
- Traveling trolley drive
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