Stroke Ball Spline

LS

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CAT-57155
Unprecedented smoothness and compactness for Saving energy and Compact designing

**IKO Stroke Ball Spline LS**

This is our new output for the manufacturing process of semiconductor and liquid crystal display requires high speed and high acceleration. As a regular leader of this industrial field..........

**Unprecedented smoothness**

Precise ball retainer is incorporated and non-circulation structure provide superior low friction even in the vertical operation.

**Compact design with high rigidity**

Large diameter steel balls are arranged in two rows and in four point contact with the raceways, achieving compact design with high rigidity under any direction of load and moment.

**Superior positioning accuracy**

By applying suitable preload, clearance in the rotational direction is eliminated. So high positioning accuracy in the rotational direction has been obtained.

**Stroke Ball Spline LS (Limited Stroke length)**

- Available shaft diameter: 4mm to 6mm
- Allowable stroke length
- Travel length of cage x 2 = Effective stroke

**Linear Ball Spline G LSAG (Unlimited Stroke length)**

- Available shaft diameter: 2mm to 50mm
Features of Stroke Ball Spline LS

Identification numbers of Stroke Ball Spline LS series consist of a model code, a size, a part code, a preload symbol, a classification symbol, and supplemental codes.

Example of identification number

<table>
<thead>
<tr>
<th>LS</th>
<th>T</th>
<th>5</th>
<th>C1</th>
<th>R150</th>
<th>T1</th>
<th>P</th>
<th>/S</th>
</tr>
</thead>
</table>

- **Series**: Stroke Ball Spline LS
- **Type of spline shaft**: Solid shaft: No symbol, Hollow shaft: T
- **Size**: 4, 5, 6
- **Number of external cylinders**: C1
- **Length of spline shaft**: R
- **Preload amount**: Light preload: T1
- **Accuracy class**: Precision class: P
- **Optional specification**: Spline shaft made of stainless steel / S

Additional machinings and special designs are available. Please consult us.

Examples:

- With female thread
- Stepped shaft with male thread
- External cylinder with holder

Application

- Offering to the nozzle of pick and place unit in semiconductor manufacturing process
- Suitable to high tact operation in vertical axis

75% better in base value
60% better in variation

Test result of frictional resistance

<table>
<thead>
<tr>
<th>Test condition</th>
<th>LS4</th>
<th>LSAG4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preload</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>2 mm/s</td>
<td></td>
</tr>
<tr>
<td>Travel distance</td>
<td>10 mm</td>
<td></td>
</tr>
<tr>
<td>Lubrication</td>
<td>Pre-oiled grease</td>
<td></td>
</tr>
</tbody>
</table>

Special designs welcomed

The material of solid spline shaft of Stroke Ball Spline LS to be changed to stainless steel. The load rating will be obtained by multiplying that of high carbon steel by a factor of 0.8.
The accuracy of Stroke Ball Spline LS is shown in Table 1 and the accuracy of spline shaft is shown in Table 2 and 3.

### Table 1 Accuracy of each part of Stroke Ball Spline LS

<table>
<thead>
<tr>
<th>Measuring item</th>
<th>Illustration of measuring method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall length of spline shaft</td>
<td>While supporting the spline shaft at its supporting parts, place dial gage probes to the outer peripheral faces of two parts mounting part, and measure the runout from the splines end face and measure runout from one rotation of the spline shaft.</td>
</tr>
</tbody>
</table>

### Table 2 Test of grooves with respect to effective length of the spline shaft

<table>
<thead>
<tr>
<th>Accuracy class</th>
<th>Precision (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall length of spline shaft</td>
<td>Precision (P)</td>
</tr>
<tr>
<td>Over</td>
<td>Incl.</td>
</tr>
<tr>
<td>200</td>
<td>26</td>
</tr>
<tr>
<td>300</td>
<td>57</td>
</tr>
</tbody>
</table>

### Table 4 Measuring method of accuracy

<table>
<thead>
<tr>
<th>Measuring item</th>
<th>Measuring method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radial runout of peripheral of parts mounting part relative to axial line of supporting part of alpine shaft (See Table 1, (5))</td>
<td>While supporting the spline shaft at its supporting parts, place dial gage probes to the outer peripheral faces of the parts mounting part, and measure the runout from one rotation of the spline shaft.</td>
</tr>
<tr>
<td>Perpendicularity of spline end face relative to axial line of supporting part of alpine shaft (See Table 2, (6))</td>
<td>While supporting the spline shaft at its supporting parts, place a dial gage probe to the surface of the external cylinder, and measure runout from one rotation of the spline shaft.</td>
</tr>
<tr>
<td>Tolerance of grooves with respect to effective length of the spline part (See Table 2)</td>
<td>Fix and support the spline shaft. Then apply a uniform load to the external cylinder (for measurement purpose), before placing a dial gage probe to the side face of the sump key attached to the external cylinder. Measure runout when the external cylinder and the gage probe have traveled together 100mm on any effective part of the spline shaft. However, the gage probe should be applied as near as possible to the outer peripheral of the external cylinder.</td>
</tr>
<tr>
<td>Total radial runout of axial line of spline shaft (See Table 3)</td>
<td>While supporting the spline shaft at its supporting parts or at both center holes, place a dial gage probe to the outer peripheral faces of the external cylinder (for measurement purpose), and measure runout at several positions in the axial direction while turning the spline shaft one rotation. Use the maximum value.</td>
</tr>
</tbody>
</table>

Accurate measurement is shown in Table 3 Total radial runout of axial line of spline shaft.

### Table 3 Total radial runout of axial line of spline shaft

<table>
<thead>
<tr>
<th>Unit: μm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall length of spline shaft</td>
</tr>
<tr>
<td>mm</td>
</tr>
<tr>
<td>200</td>
</tr>
<tr>
<td>300</td>
</tr>
</tbody>
</table>

### Table 5 Load ratings corrected for the load direction

<table>
<thead>
<tr>
<th>Load direction</th>
<th>Load rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upward and forward</td>
<td>4-6 C</td>
</tr>
<tr>
<td>Lateral</td>
<td>1.47C</td>
</tr>
</tbody>
</table>

**Accuracy**

The basic dynamic load rating is defined as a constant load that gives a prescribed constant contact stress at the center of the contact area under rolling elements and raceways receiving the maximum load. Generally, the basic static load rating is used in combination with the static safety factor.

### Load Rating and Life

#### Basic dynamic load rating $C$

The basic dynamic load rating is defined as a constant load that gives a prescribed constant contact stress at the center of the contact area under rolling elements and raceways receiving the maximum load. Generally, the basic static load rating is used in combination with the static safety factor.

#### Allowable load $F$

The allowable load is a load under which the sum of elastic deformations of the rolling element and the raceways in the contact area subjected to the maximum contact stress is small enough to guarantee accuracy and smooth rolling movement. Therefore, where very smooth and highly accurate linear motion is required, make sure to use Stroke Ball Spline LS well within the allowable load values.

#### Dynamic rated torque $T$

The dynamic rated torque is defined as a rotational torque (See Fig.2) constant both in magnitude and direction under which 80% of a group of the same Stroke Ball Spline LS can travel $50 \times 10^3$m without suffering from material damage due to rolling contact fatigue when they are individually operated.

#### Static rated torque and Static rated moment $T_0$, $T_x$, $T_y$

The static rated torque and static rated moment are defined as a static torque or static moment which gives a prescribed constant contact stress at the center of the contact area between the steel ball and raceway receiving the maximum load when a torque or moment (See Fig.2) is loaded. They are the allowable limit torque or moment that permits normal rolling movement. Generally, they are used in combination with the static safety factor.

### Load direction and Load rating

Since the load ratings of Stroke Ball Spline LS given in the dimension table are for upward/downward load, they must be corrected for the load direction for lateral load. The corrected basic dynamic load ratings and basic static load ratings are shown in Table 5.
Load Rating and Life

**Life**
The rating life of Stroke Ball Spline LS is obtained from the following formula.

\[
L = \left( \frac{C_L^P}{T} \right)^{M} \\
L = \left( \frac{C_L^P}{T} \right)^{M} 
\]

where,
- \( L \) : Rating life, 10^6h
- \( C \) : Basic dynamic load rating, N
- \( T \) : Dynamic rated torque, N \cdot m
- \( P \) : Theoretically calculated radial load, N
- \( M \) : Theoretically calculated torque, N \cdot m

If the stroke length and the number of strokes per minute are given, the life in hours can be obtained from the following formula.

\[
L = \left( \frac{10^6}{S \cdot P} \right)^{M} \\
L = \left( \frac{10^6}{S \cdot P} \right)^{M} 
\]

where,
- \( L \) : Rating life in hours
- \( S \) : Stroke length, mm
- \( n \) : Number of strokes per minute, cpm

**Static safety factor**
When excessive large or heavy loads are applied on Stroke Ball Spline LS, local permanent deformation will be made on balls or raceways, resulting in deterioration in running performance. In general, the allowable loads depend on the operating conditions and the requirements in the application, and the margin of safety is determined considering the above factors. The static safety factor, \( f_s \), can be obtained from the following formula. General values of this factor are shown in Table 6.

\[
f_s = \frac{C_b}{P_b} \]

where,
- \( f_s \) : Static safety factor
- \( C_b \) : Basic static load rating, N
- \( P_b \) : Static radial load (maximum load), N
- \( T_r \) : Static rated torque, N \cdot m
- \( M_r \) : Static torque (maximum torque), N \cdot m

**Load factor**
Due to vibration and/or shocks during machine operation, the actual load on each rolling guide becomes greater in many cases than the theoretically calculated load. The applied load is generally calculated by multiplying the theoretically calculated load by the load factor shown in Table 7.

\[
\text{Operating conditions} \quad f_s \\
\text{Normal operation} \quad 1.2 \sim 1.5 \\
\text{Operation with vibration and/or shocks} \quad 1.5 \sim 3 \\
\]

**Spline Shaft**
Moment of inertia of sectional area and section modulus of the spline shaft are shown in Table 8.

**Lubrication and Dust Protection**
In Stroke Linear Ball Spline LS, grease is not pre-packed. In Cleaning of rust preventive oil and Initial lubrication with grease or oil is necessary by users before the operation. Quality lithium-soap base grease is recommended. Stroke Linear ball Spline LS does not have oil hole and grease nipple. Apply grease on the raceway part of spline shaft in case of relubrication.

**Precautions for use**
1. **Fit of external cylinder**
   Generally, transition fit (JT) is applied between the external cylinder and the housing bore. When high accuracy and high rigidity are not required, clearance fit (H7) may also be applicable.
2. **Stopper mechanism**
   Stroke Linear Ball Spline LS does not have mechanical stopper. Prepare mechanical stopper if over stroking is concerned.
3. **Standard mounting example**
   Fig.3 shows standard mounting methods of external cylinder.
4. **Additional machining of spline shaft**
   The high carbon steel spline shaft is hardened by induction hardening. When additional machining on the shaft end is needed, make sure that the maximum diameter of the shaft end machining part does not exceed the dimension shown in the dimension tables. Spline shafts with special end shapes can be prepared upon request. Consult for further information.
5. **Operating temperature**
   The maximum ambient temperature is 120°C. In case of continuously operation, ambient temperature should not exceed 100°C.
6. **Precaution for mounting**
   Mounting the external cylinder
   When press-fitting the external cylinder to the housing, assemble them correctly by using a pressing equipment and a suitable jig fixture, etc. (See Fig.5)
Stroke Ball Spline LS

**LS · LST**

<table>
<thead>
<tr>
<th>Model number</th>
<th>Mass (Ref.) g</th>
<th>Dimension and tolerance of external cylinder mm</th>
<th>Dimension and tolerance of spline shaft mm</th>
<th>Model number</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS 4</td>
<td>5.65</td>
<td>9.6</td>
<td>6.6</td>
<td>LS 4</td>
</tr>
<tr>
<td>LST 4</td>
<td>8.6</td>
<td>10.0</td>
<td>7.0</td>
<td>LST 4</td>
</tr>
<tr>
<td>LS 5</td>
<td>8.90</td>
<td>14.9</td>
<td>10.0</td>
<td>LS 5</td>
</tr>
<tr>
<td>LST 5</td>
<td>12.4</td>
<td>14.9</td>
<td>10.0</td>
<td>LST 5</td>
</tr>
<tr>
<td>LS 6</td>
<td>10.90</td>
<td>19.0</td>
<td>16.5</td>
<td>LS 6</td>
</tr>
<tr>
<td>LST 6</td>
<td>16.5</td>
<td>19.0</td>
<td>16.5</td>
<td>LST 6</td>
</tr>
</tbody>
</table>

**Effective stroke length**

<table>
<thead>
<tr>
<th>Model number</th>
<th>Maximum stroke length</th>
<th>Mounting dimension</th>
<th>Basic dynamic load rating</th>
<th>Basic static load</th>
<th>Allowable load</th>
<th>Dynamic torque rating</th>
<th>Static torque</th>
<th>Static moment rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS 4</td>
<td>10</td>
<td>13.2</td>
<td>5</td>
<td>285</td>
<td>380</td>
<td>127</td>
<td>0.66</td>
<td>0.87</td>
</tr>
<tr>
<td>LST 4</td>
<td>12</td>
<td>14.7</td>
<td>7</td>
<td>616</td>
<td>748</td>
<td>249</td>
<td>1.8</td>
<td>2.2</td>
</tr>
<tr>
<td>LS 5</td>
<td>10</td>
<td>13.6</td>
<td>8</td>
<td>673</td>
<td>855</td>
<td>285</td>
<td>2.4</td>
<td>3.0</td>
</tr>
<tr>
<td>LST 5</td>
<td>12</td>
<td>15.0</td>
<td>8</td>
<td>673</td>
<td>855</td>
<td>285</td>
<td>2.4</td>
<td>3.0</td>
</tr>
</tbody>
</table>

**Note:**
- **(1)**: Lengths indicated are standard lengths. Spline shafts in different lengths are also available. Simply indicate the necessary length of spline shaft (mm) in the identification number.
- **(2)**: The directions of dynamic load rating (C), basic static load rating (C₀), dynamic torque rating (T), and static torque/moment rating (T₀, Tₓ and Tᵧ) are shown in the sketches below.

**Remark:** Grease is not pre-packed. Initial lubrication with grease or oil is necessary before the operation.

---

**Example of identification number of assembled set**

<table>
<thead>
<tr>
<th>Model number</th>
<th>Model code</th>
<th>Size</th>
<th>Part code</th>
<th>Pellet symbol</th>
<th>Interchangeable code</th>
<th>Supplemental code</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS 4</td>
<td>LS</td>
<td>T</td>
<td>5</td>
<td>C1</td>
<td>R150</td>
<td>P</td>
</tr>
</tbody>
</table>

**Explanation:**
- **Model code**: LS, LST
- **Size**: T, 5
- **Part code**: C1, R150
- **Pellet symbol**: P
- **Interchangeable code**: LS, LST
- **Supplemental code**: Optional specification, L₂, T₁, Y₁, etc.
C-Lube Linear Ball Spline MAG has launched.

The final answer to your lube requirement.