J Series Servo Motor Life

Overview
Applied Motion Products’ J series servo motors are brushless motors with excellent bearings. As such, they can have an extremely high life expectancy. The major factors that determine the life of these motors include: bearing life, insulation system temperature, shaft strength, and environmental conditions. The goal of this paper is to help you understand these factors, and avoid motor life problems. And to offer solutions if a standard motor does not meet your needs.

Most life factors are rated in hours. It’s important to note that hours here are defined as the number of hours when the motor is running at its operating temperature. As a guide, life of 20,000 hours running is suitable for many applications. This typically represents 10+ years of field use (8 hours / day, 5 days / week, and 50 weeks / year). With good system design, the life of your J Series motor can be much longer once the actual working cycle, shaft loads, and motor temperatures are fully accounted for.

Radial Loads
The key load to take in to account when calculating bearing life is the radial load, including the distance from the mounting surface to the load. As an example, a common cause for shaft and bearing failures are high radial loads that are created when a pulley is attached under high tension to the motor shaft at a large distance from the motor mounting face. To avoid this condition, mount pulleys and gears as close to the face of the motor as possible, and avoid over tightening belts – this can dramatically reduce the radial load, and increases the life of the bearings. The table and diagram below show the direction of radial loading, and the radial load ratings for the different J Series frame sizes to ensure infinite bearing life. Detailed bearing life curves can be found at the end of this document.

<table>
<thead>
<tr>
<th>Frame size</th>
<th>Radial Force Location From Motor Mounting</th>
<th>Max. Radial Force</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>Inch</td>
</tr>
<tr>
<td>40 mm</td>
<td>25</td>
<td>0.98</td>
</tr>
<tr>
<td>60 mm</td>
<td>30</td>
<td>1.18</td>
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<tr>
<td>80 mm</td>
<td>40</td>
<td>1.57</td>
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*Standard J series motor shafts: Maximum rated radial load for infinite bearing life*

When a motor shaft is subjected to large radial loads it can break after many hours of use. This is due to the radial load causing the shaft material to fatigue as it rotates. Shaft life is a function of the magnitude and location of the radial load, as well as the shaft material and shaft size. As the radial load is moved further from the motor mounting face the maximum radial force the shaft can withstand drops. We have designed our standard J Series motors to have large diameter shafts, which provide high stiffness. As a result, the shafts in J Series motors are rarely a limiting factor in motor life.
Other Factors
Motor life depends on a number of factors besides radial loads including axial loads, motor speed, temperature, and bearing ratings. Because the front bearing is positioned closest to the motor shaft, it usually carries a higher radial load and has the shortest life.

Another limiting factor for bearing life can be the bearing grease life. Applied Motion Products uses special high grade bearing grease. Normally motors operate for years without the grease being an issue. Typical grease life is 40,000 hours of operation.

J series motors use standard Class B insulation, rated for 130°C. By industry definition, insulation life is rated for 20,000 hours, at rated temperature. For every 10°C temperature reduction, insulation life approximately doubles. If the motor internal temperature is actually running at 120°C insulation life is 40,000 hours; at 110°C the life is 80,000 hours, etc. Because it’s rare for Applied Motion Products motors to be operated so that internal motor temperatures are continuously above 90°C, insulation life is usually not a limiting factor.

Insulation and bearing temperature can be confirmed in the application by measuring the surface temperature of the motor, after running the machine under worse case conditions for several hours. The maximum internal temperature is about 15°C hotter than the surface temperature of Applied Motion Products J series motors. Thus, maximum temperature equals the measured motor body temperature, plus 15°C, plus the difference between the maximum rated machine ambient temperature and the test ambient temperature.

Other application specific conditions that can lead to early motor failure include:

- The presence of water, humidity, or dust can cause corrosion and binding inside motors. *All J series motors have sealed IP 65 construction and encapsulated windings to resist the presence of water and dust. However, the standard shaft opening and connectors are not sealed. To provide more protection, shaft seals and sealed connectors are available from Applied Motion Products.*
- High shock and vibration can cause a variety of failures. *All J series motors have large bearings, sealed IP 65 construction and encapsulated windings to resist shock and vibration.*
- High shaft loads or longer life may be required. *All J series motors have large shafts and bearings to accommodate high shaft loads. Applied Motion Products can supply motors with over size bearings and shafts to meet your needs.*
- Excessive temperatures may be present, and shorten the life of the insulation or bearing grease. *Low temperature rise solutions are available from Applied Motion Products.*
More Information

The bearing life curves at the end of this document show bearing life at various speeds and radial loads. These curves were calculated with the radial load applied at the end of the shaft. Each page has six graphs for one motor size and length. There are multiple graphs for different axial loads, and separate graphs for English and metric units.

Technical specs and drawings are always available on our website, www.applied-motion.com. For engineering assistance with your application, please contact Applied Motion Products’ Application Engineering group at (800)-525-1609, or by emailing support@applied-motion.com. We can help with an analysis of your application, and make recommendations for your specific needs.
40mm J Series Servo Motor – Bearing Life

Front Bearing L10 Life

J Series Servo: 40 mm, 100 Watt
Axial Load: 5 lbs
Radial Load at: End of Shaft (0.086 lbs from mounting)
- Bearing Life at 1,000 rpm
- Bearing Life at 2,500 rpm
- Bearing Life at 4,000 rpm
- Shaft Radial Load Limit = 28 lbs at End of Shaft

Front Bearing L10 Life

J Series Servo: 40 mm, 100 Watt
Axial Load: 11 lbs
Radial Load at: End of Shaft (0.86 lbs from mounting)
- Bearing Life at 1,000 rpm
- Bearing Life at 2,500 rpm
- Bearing Life at 4,000 rpm
- Shaft Radial Load Limit = 28 lbs at End of Shaft

Front Bearing L10 Life

J Series Servo: 40 mm, 100 Watt
Axial Load: 27 N
Radial Load at: End of Shaft (25 mm from mounting)
- Bearing Life at 1,000 rpm
- Bearing Life at 2,500 rpm
- Bearing Life at 4,000 rpm
- Shaft Radial Load Limit = 125 N at End of Shaft

Front Bearing L10 Life

J Series Servo: 40 mm, 100 Watt
Axial Load: 49 N
Radial Load at: End of Shaft (25 mm from mounting)
- Bearing Life at 1,000 rpm
- Bearing Life at 2,500 rpm
- Bearing Life at 4,000 rpm
- Shaft Radial Load Limit = 125 N at End of Shaft

Front Bearing L10 Life

J Series Servo: 40 mm, 100 Watt
Axial Load: 98 N
Radial Load at: End of Shaft (25 mm from mounting)
- Bearing Life at 1,000 rpm
- Bearing Life at 2,500 rpm
- Bearing Life at 4,000 rpm
- Shaft Radial Load Limit = 125 N at End of Shaft
60mm J Series Servo Motor – Bearing Life

Front Bearing L10 Life

J Series Servo: 60 mm, 200 Watt
Axial Load: 6 lbs
Radial Load at: End of Shaft (1.58 in. from mounting)
- Bearing Life at 1,500 rpm
- Bearing Life at 2,000 rpm
- Bearing Life at 4,000 rpm
- Shaft Radial Load Limit = 160.8 lb at End of Shaft

Front Bearing L10 Life

J Series Servo: 60 mm, 200 Watt
Axial Load: 22 lbs
Radial Load at: End of Shaft (1.58 in. from mounting)
- Bearing Life at 1,500 rpm
- Bearing Life at 2,000 rpm
- Bearing Life at 4,000 rpm
- Shaft Radial Load Limit = 100.8 lb at End of Shaft

Front Bearing L10 Life

J Series Servo: 60 mm, 200 Watt
Axial Load: 6 lbs
Radial Load at: End of Shaft (38 mm from mounting)
- Bearing Life at 1,500 rpm
- Bearing Life at 2,000 rpm
- Bearing Life at 4,000 rpm
- Shaft Radial Load Limit = 450 N at End of Shaft

Front Bearing L10 Life

J Series Servo: 60 mm, 200 Watt
Axial Load: 45 lbs
Radial Load at: End of Shaft (38 mm from mounting)
- Bearing Life at 1,500 rpm
- Bearing Life at 2,000 rpm
- Bearing Life at 4,000 rpm
- Shaft Radial Load Limit = 450 N at End of Shaft
60mm J Series Servo Motor – Bearing Life

- **J Series Servo: 60 mm, 400 Watt**
  - **Axial Load:** 6 lbs
  - **Radial Load at End of Shaft (1.18 in. from mounting):**
    - Bearing Life at 1,500 rpm
    - Bearing Life at 2,500 rpm
    - Shaft Radial Load Limit: 100.8 lb at End of Shaft

- **J Series Servo: 60 mm, 400 Watt**
  - **Axial Load:** 27 N
  - **Radial Load at End of Shaft (30 mm from mounting):**
    - Bearing Life at 1,500 rpm
    - Bearing Life at 2,500 rpm
    - Shaft Radial Load Limit: 450 N at End of Shaft

- **J Series Servo: 60 mm, 400 Watt**
  - **Axial Load:** 48 N
  - **Radial Load at End of Shaft (30 mm from mounting):**
    - Bearing Life at 1,500 rpm
    - Bearing Life at 2,500 rpm
    - Shaft Radial Load Limit: 450 N at End of Shaft
80mm J Series Servo Motor – Bearing Life

Front Bearing L10 Life
J Series Servo: 80 mm, 750 Watt
Axial Load: 11 lb
Radial Load at: End of Shaft (1.17 in. from mounting)
- Bearing Life at 1,500 rpm
- Bearing Life at 2,500 rpm
- Bearing Life at 4,000 rpm
- Shaft Radial Load Limit = 391.6 lb at End of Shaft

Front Bearing L10 Life
J Series Servo: 80 mm, 750 Watt
Axial Load: 46 lb
Radial Load at: End of Shaft (40 mm from mounting)
- Bearing Life at 1,500 rpm
- Bearing Life at 2,500 rpm
- Bearing Life at 4,000 rpm
- Shaft Radial Load Limit = 989 lb at End of Shaft

Front Bearing L10 Life
J Series Servo: 80 mm, 750 Watt
Axial Load: 36 lb
Radial Load at: End of Shaft (1.17 in. from mounting)
- Bearing Life at 1,500 rpm
- Bearing Life at 2,500 rpm
- Bearing Life at 4,000 rpm
- Shaft Radial Load Limit = 391.6 lb at End of Shaft

Front Bearing L10 Life
J Series Servo: 80 mm, 750 Watt
Axial Load: 60 lb
Radial Load at: End of Shaft (40 mm from mounting)
- Bearing Life at 1,500 rpm
- Bearing Life at 2,500 rpm
- Bearing Life at 4,000 rpm
- Shaft Radial Load Limit = 989 lb at End of Shaft
80mm J Series Servo Motor – Bearing Life