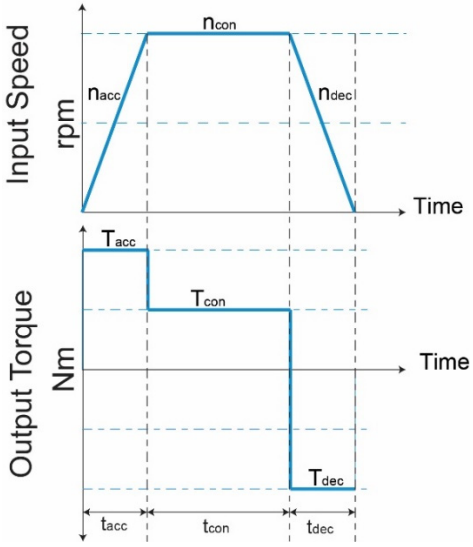
Selection Guide

Lifetime Series Harmonic Gearheads

Step 1: Determine Your Application Motion Profile and Loading

Proper sizing and selection of the Conic servo gearheads includes review of the harmonic gear service life and confirmation that output bearing load ratings are not exceeded. The harmonic gear life is based upon input motor speed and output torque requirements. The output bearing load check requires review of the axial and radial loads applied to the output shaft and average output speed.



n_{acc} = average input speed during accel (rpm)
n_{con} = input speed during operation (rpm)
n_{dec} = average input speed during decel (rpm)
T_{acc} = acceleration torque (Nm)
T_{con} = constant torque (Nm)
T_{dec} = deceleration torque (Nm)
t_{acc} = acceleration time (sec)
t_{con} = constant run time (sec)
t_{dec} = deceleration time (sec)
F_r = radial load applied at output shaft (N)
F_a = axial load applied at output shaft (N)
L_{hr} = required gearhead service life (hrs)

Step 2: Calculate Average Output Torque and Input Speed

Calculate the average output torque T_{avg}, and average input speed $n_{i(avg)}$, based upon your motion profile.

$$T_{avg} = \sqrt[3]{\frac{n_{acc} * t_{acc} * |T_{acc}^3| + n_{con} * t_{con} * |T_{con}^3| + n_{dec} * t_{dec} * |T_{dec}^3|}{n_{acc} * t_{acc} + n_{con} * t_{con} + n_{dec} * t_{dec}}}$$

$$n_{i(avg)} = \frac{n_{acc} * t_{acc} + n_{con} * t_{con} + n_{dec} * t_{dec}}{t_{acc} + t_{con} + t_{dec}}$$

Step 3: Select Gearhead Size and Ratio

Compare your calculated average output torque (T_{avg}) against the nominal output torque rating in the gearhead specification tables. Conic Systems recommends selecting a gearhead with a nominal output torque higher than the application's average torque for the greatest service life. The nominal rated torque can be exceeded by up to 50%, but service life will be reduced. Ensure the maximum output torque and maximum input speeds are not exceeded, or immediate damage may occur. If the desired service life exceeds 25,000 hours, calculate the anticipated service life based upon the method provided in Step 4.

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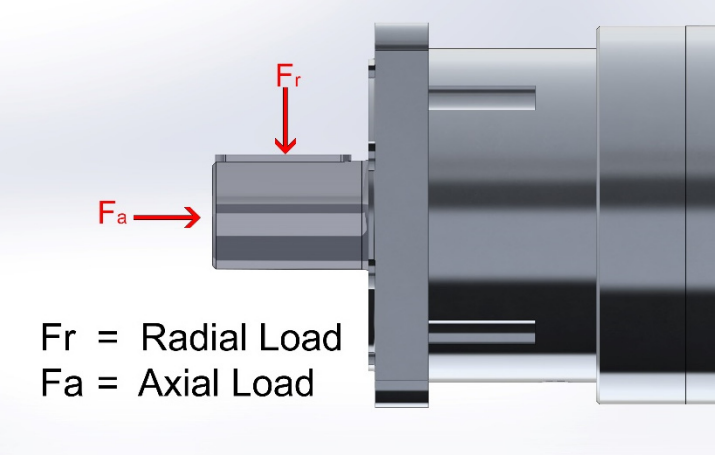
Step 4: Calculate Service Life

Conic Systems harmonic gearing servo gearheads are rated for 25,000 hours of operation at nominal output torque and nominal input speed. Based upon your calculated average torque and average input speed, the estimated service life can be calculated using the equation below. If the calculated Service Life (Lhr) is lower than is desired, a larger size should be selected. If the Lhr is higher than required, a smaller size may meet your requirements. Contact Conic Systems engineering department for further information and assistance if required.

$$L_{hr} = 25000 * \left(\frac{T_{nom}}{T_{avg}}\right)^3 * \frac{n_{nom}}{n_{i(avg)}}$$

T_{nom}	= Nominal Output Torque
T_{avg}	= Average Output Torque
n_{nom}	= Nominal Input Speed
$n_{i(avg)}$	= Average Input Speed

Step 5: Determine Average Radial and Axial Loads



Radial and axial load maximums are listed under specifications by frame size. Radial load maximums are calculated with the load applied at key center. The average radial and axial forces can be calculated using the equations provided below. If the forces calculated exceed maximums for the gearhead, select a larger size or contact Conic Systems for further assistance.

Fr_{avg} = average radial force applied at the midpoint of the shaft

Fa_{avg} = average axial force applied along the center of the shaft

$$Fr_{avg} = \sqrt[3]{\frac{n_{acc} * t_{acc} * |Fr_{acc}|^3 + n_{con} * t_{con} * |Fr_{con}|^3 + n_{dec} * t_{dec} * |Fr_{dec}|^3}{n_{acc} * t_{acc} + n_{con} * t_{con} + n_{dec} * t_{dec}}}$$

$$Fa_{avg} = \sqrt[3]{\frac{n_{acc} * t_{acc} * |Fa_{acc}|^3 + n_{con} * t_{con} * |Fa_{con}|^3 + n_{dec} * t_{dec} * |Fa_{dec}|^3}{n_{acc} * t_{acc} + n_{con} * t_{con} + n_{dec} * t_{dec}}}$$

Selection Example

Step 1:

Assume a selection for a 100:1 ratio gearhead with a timing belt drive on the output shaft.	
Operation Cycle:	
Starting (acceleration):	T_{acc} = 75 Nm, t_{acc} = 0.4 sec, n_{acc} = 1100 rpm, Fr = 5580 N, Fa = 0 N
Steady State (constant):	T_{con} = 60 Nm, t_{con} = 8.0 sec, n_{con} = 2200 rpm, Fr = 4462 N, Fa = 0 N
Stopping (deceleration):	T_{dec} = 75 Nm, t_{dec} = 0.4 sec, n_{dec} = 1100 rpm, Fr = 5580 N, Fa = 0 N

Step 2:

Calculate the average output torque and average input rotational speed.

$$T_{avg} = \sqrt[3]{\frac{1100\ rpm * 0.4\ sec * |75Nm|^3 + 2200\ rpm * 8\ sec * |60Nm|^3 + 1100\ rpm * 0.4\ sec * |75Nm|^3}{1100rpm * 0.4sec + 2200rpm * 8sec + 1100rpm * 0.4sec}}$$

$$T_{avg} = 60.89\ Nm$$

$$n_{i(avg)} = \frac{1100\ rpm * 0.4\ sec + 2200\ rpm * 8\ sec + 1100\ rpm * 0.4\ sec}{0.4\ sec + 8\ sec + 0.4\ sec}$$

$$n_{i(avg)} = 2100\ rpm$$

Step 3:

A preliminary selection is made based on a calculated T_{avg} of 60.89 Nm and an $n_{i(avg)}$ of 2100 rpm. A comparison of gearhead sizes at ratio 100:1 indicates the LT4 would best meet operational needs. A life calculation should then be made to verify the gearhead suitability to application.

Step 4:

$$L_{hrs} = 25000 * \left(\frac{120\ Nm}{60.89\ Nm}\right)^3 * \frac{3000\ rpm}{2100\ rpm} = 273{,}368$$

After establishing that the service life estimate meets your needs, ensure the average radial and axial forces do not exceed maximums for the unit. As there are no axial forces on the output shaft in this example, only a calculation for average radial force is necessary.

Step 5:

$$Fr_{avg} = \sqrt[3]{\frac{1100\ rpm * 0.4\ sec * |5580\ N|^3 + 2200\ rpm * 8\ sec * |4462\ N|^3 + 1100\ rpm * 0.4\ sec * |5580\ N|^3}{1100\ rpm * 0.4\ sec + 2200\ rpm * 8\ sec + 1100\ rpm * 0.4\ sec}}$$

The calculated Fr_{avg} is 4528 N < 6012 N therefore the LT4 is a correct selection.

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