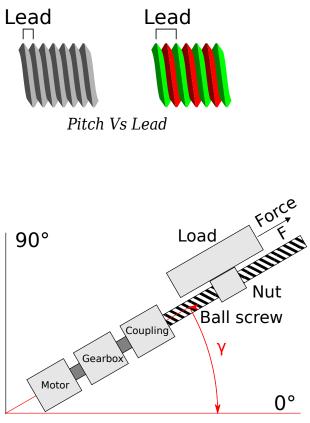


## **Ball Screw**



Ball Screw Positioner

The screw mechanism converts rotational motion into linear motion. Ball screws use circulating ball bearings to minimize friction and obtain high performance, high thrust and high precision. They are used in machinery such as injection molding machines, dosing and filling machines, simulators and test benches, machine tools, small and medium servo-presses, X-Y tables, tool bit positioning, pick & place machines, engraving machines, motorized microscope devices, etc. They are however not recommended for high cycle rates with high turning speeds, due to their high noise generation in these conditions. Do not confuse with conventional trapezoidal thread screws, such as those with acme threads, that offer much lower efficiency and performance.

## Disclaimer

This tool has been created to assist engineers with the sizing of the different parts of the system. Calculations might not cover all corner cases. and results should always be checked by a qualified engineer. Under no circumstances shall we beheld responsible to any damages to persons or property due to correct or incorrect use of this tool, or to errors in it.

System Efficiency  $\eta_t = \eta_{bs} \cdot \eta_r$ 

Weight Force

$$F_{w} = m \cdot g \cdot \sin\left(\frac{\gamma \cdot \pi}{180}\right) [N]$$

**Friction Force** 

$$F_f = m \cdot g \cdot \mu \cdot \cos\left(\frac{\gamma \cdot \pi}{180}\right) [N]$$

**Acceleration Force** 

$$F_a = \frac{m \cdot v}{t_a} [N$$



С	onstants
Pi	$\pi \simeq 3.141592654$
Acceleration of Gravity on Earth	$g = 9.80665 \frac{m}{s^2}$
Density of Steel	$\rho_{steel} = 7850 \left[ \frac{kg}{m^3} \right]$
Inputs	
System Inclination	$\gamma \ [degrees]$
Ball Screw Lead	$p\left[\frac{mm}{rev}\right]$
Ball Screw Length	$L \ [mm]$
Ball Screw Diameter	<b>D</b> [ <i>mm</i> ]
Ball Screw Efficiency	$\eta_{bs}$
Friction Coefficient	μ
Service Factor	$K_A$
Traveling Mass	<i>m</i> [ <i>kg</i> ]
Linear Speed	$v \left[\frac{m}{s}\right]$
Acceleration Time	$t_a [s]$
Machining Force	$F_m [N]$
Max. Motor Speed During Cycle	$n_1 [rpm]$
Gearbox Efficiency	$\eta_r$
Gearbox Inertia	$J_{R} \left[ kg \cdot cm^{2} \right]$
Motor Inertia	$J_{M}$ [kg·cm <sup>2</sup> ]

## Total Force

$$F_T = F_w + F_f + F_a + F_m [N]$$

**Traveling Mass Inertia** 

$$J_L = 10000 \cdot m \cdot \left(\frac{p}{2000 \cdot \pi}\right)^2 \left[kg \cdot cm^2\right]$$

**Ball Screw Inertia** 

$$J_{bs} = 5 \cdot \rho_{steel} \cdot \pi \cdot L \cdot \left(\frac{D}{2000}\right)^4 \left[kg \cdot cm^2\right]$$

**Total Inertia** 

$$J_T = J_L + J_{bs} \left[ kg \cdot cm^2 \right]$$

Total Inertia as seen by the motor

$$J_{T1} = \frac{J_T}{i^2} \left[ kg \cdot cm^2 \right]$$

Load to Motor Inertia Ratio

$$\Lambda = \frac{J_{T1}}{J_M + J_r}$$

**Screw Rotational Acceleration** 

$$\alpha_{bs} = \frac{\omega_{bs}}{t_a} \left[ \frac{rad}{s^2} \right]$$

Screw Rotational Speed

$$\omega_{bs} = \frac{2000 \cdot \pi \cdot v}{p} \left[ \frac{rad}{s} \right]$$

**Screw Rotational Speed** 

$$n_{bs} = \omega_{bs} \cdot \frac{30}{\pi} [rpm]$$

**Ideal Gearbox Ratio** 

$$i = \frac{n_1}{n_{bs}}$$



## **Required Gearbox Output Torque**

$$T_2 = \frac{p \cdot F_T}{2000 \cdot \pi \cdot \eta_{bs}} [N \cdot m]$$

Required Gearbox Output Torque, Adjusted for Service Factor

$$T_{2KA} = K_A \cdot T_2 \ [N \cdot m]$$

**Motor Power** 

$$P_1 = \frac{T_2 \cdot n_{bs}}{9550 \cdot \eta_r} [kW]$$

Axis Automation, SLU Avda de la Plata, 23-1 E-46013 Valencia - Spain Tel. +34-963 950 442 e-mail: info@servotak.com www.servotak.com