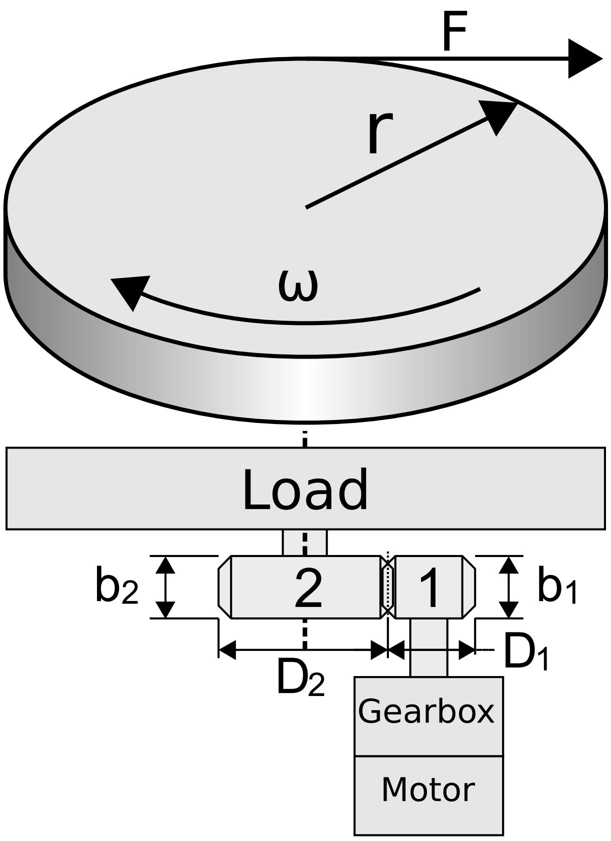
Generic Load



Geared Motor and Gear Train

This calculation module should be used when the basic parameters of the machine are already known. An intermediate reduction stage, composed of either two gear wheels or two pulleys and a timing belt are used to reduce the required gearbox size. The use of precision gears or timing belts also allow for increased system precision, and/or reduce gearbox costs. However, such devices are often noisy, can introduce additional backlash, and present wear issues. They are useful, however, when controlling very large loads, as the load's moment of inertia is divided by the square of the transmission ratio. This kind of arrangements are most often used for machines such as index tables, feeder machines, etc.

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

$$\eta=\eta_g\cdot\eta_m$$

Gear 1 Mass

$$m_1=\frac{\pi}{4}\cdot\frac{b_1}{1000}\cdot\left(\frac{D_1}{1000}\right)^2\cdot\rho\quad[kg]$$

Gear 2 Mass

$$m_2=\frac{1}{4}\cdot\rho\cdot\pi\cdot\frac{b_2}{1000}\cdot\left(\frac{D_2}{1000}\right)^2\quad[kg]$$

Gear 1 Inertia

$$J_{G1}=\frac{m_1\cdot\left(\frac{D_1}{1000}\right)^2}{8}\quad[kg\cdot m^2]$$

Constants

Pi	$\pi \simeq 3.141592654$
Acceleration of Gravity on Earth	$g = 9.80665 \ \frac{m}{s^2}$

Inputs

Rotating Mass Inertia	$J_L \ [kg \cdot m^2]$
Tangential Force	$F \ [N]$
Force at Radius	$r \ [mm]$
Rotational Speed	$\omega \ [rpm]$
Acceleration Time	$t_a \ [s]$
Gear Wheel Density	$\rho \ \left[\frac{kg}{m^3}\right]$
Gear 1 Pitch Diameter	$D_1 \ [mm]$
Gear 1 Tooth Width	$b_1 \ [mm]$
Gear 2 Pitch Diameter	$D_2 \ [mm]$
Gear 2 Tooth Width	$b_2 \ [mm]$
Service Factor	K_A
Machine Efficiency	η_m
Gearbox Efficiency	η_g
Gearbox Inertia	$J_R \ [kg \cdot cm^2]$
Motor Rated Speed	$n_1 \ [rpm]$
Motor Inertia	$J_M \ [kg \cdot cm^2]$

Gear 2 Inertia

$$J_{G2} = \frac{m_2 \cdot \left(\frac{D_2}{1000}\right)^2}{8} \quad [kg \cdot m^2]$$

Total Inertia as Seen by the Gearbox

$$J_T = \frac{J_L + J_2}{i_G^2} + J_1 \quad [kg \cdot m^2]$$

Load Inertia as Seen by the Motor

$$J_{T1} = \frac{10000 \cdot J_T}{i^2} \quad [kg \cdot cm^2]$$

Load to Motor Inertia Ratio

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

Rotational Acceleration

$$\alpha = \frac{\omega}{t_a} \quad \left[\frac{rad}{s^2}\right]$$

Rotational Speed

$$\omega = n_2 \cdot \frac{30}{\pi}$$

Acceleration Torque on Load

$$T_a = J_L \cdot \alpha \quad [N \cdot m]$$

Minimum Motor Power

$$P_1 = \frac{n_2 \cdot T_T}{9550 \cdot \eta} \quad [kW]$$

Total Required Ratio

$$i_T = \frac{n_1}{n_2}$$

Gear Wheels Ratio

$$i_G = \frac{D_2}{D_2}$$

Ideal Gearbox Ratio

$$i = \frac{i_T}{i_G}$$

Required Torque on Load

$$T_L = \frac{F \cdot r}{1000} \quad [N \cdot m]$$

Total Requited Torque on Load

$$T_T = T_a + T_L \quad [N \cdot m]$$

Required Gearbox Output Torque

$$T_2 = \frac{T_T}{i_g} \quad [N \cdot m]$$

Required Gearbox Output Torque, Adjusted for Service Factor

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