OVERVIEW
MOTOR SPECIFICATIONS
LINEAR SYSTEMS
CONNECTIVITY
PERIPHERALS
IP 65 MODELS & CONNECTIVITY
POWER SUPPLIES & SHUNTS
GEAR HEADS
SOFTWARE
APPENDIX

Calculating Power: the Real Story

Unit of electrical power where : Watts =(volts)(amps) or W=V*A Watts are a unit consisting of time since amps are a measure of electron flow per unit time.

For this reason, Torque cannot be directly equated with Watts or Horsepower without consideration of RPM where revolutions per minute contains time that would cancel out the time in watts to give you torque. This is why Horsepower is a useless unit of measure when sizing SmartMotor for motion control applications!

One horsepower equals 746 watts and has nothing to do with torque by itself!!!!!

Formula for Power to Torque:

$$\text{Power (HP)} = \text{Power (Watts)} \times 746$$

$$\text{Power (Watts)} = \frac{N\,(\text{RPM}) \times T\,(\text{ft-lbs})}{7.04}$$

$$\text{Power (HP)} = \frac{N\,(\text{RPM}) \times T\,(\text{ft-lbs})}{5252}$$

Torque required will be:

$$T\,(\text{ft-lbs}) = \frac{\text{Power (Watts)} \times 7.04}{N(\text{RPM})}$$

$$T\,(\text{ft-lbs}) = \frac{\text{Power (HP)} \times 5252}{N(\text{RPM})}$$

All references on the right side of this page are used in the formulas on page 205.

Symbol	Definition	SI	English
C_G	Circumference of Gear	m (or cm)	in (or ft)
$C_{P:1,2,3}$	Circumference of Pulleys, 1, 2, or 3	“	“
D_G	...(pitch dia.) of Gear	“	“
D_{PM}	...(pitch dia.) of Pulleys on Motor	“	“
$D_{P:1,2,3}$	...(pitch dia.) of Pulleys 1, 2, or 3	“	“
e	efficiency of mechanism or reducer	%	%
F	Forces due to	N	lb
F_{Fr}	...friction (Ffr = mWL cos g)	“	“
F_g	...gravity (Fg = WL sin g)	“	“
F_p	...Push or Pull forces	“	“
g	gravity accel constant	9.80 m/s²	386 in/s²
J	mass moment of inertia for	kg-m²	lb-in²
J_C	...Coupling	g-cm²	oz-in²
J_G	...Gear	etc.	or
J_L	...Load “ in-lb-s2		
$J_{L\rightarrow M}$	...Load reflected to Motor	“	or
J_M	...Motor	“	in-oz-s²
$J_{P:1,2,3}$	...Pulley or sprocket 1, 2, or 3	“	“
J_{Total}	...Total of all inertias	“	“
J_S	...lead Screw	“	“
N_r	Number ratio of reducer	none	none
P_G	Pitch of Gear, sprocket or pulley	teeth/m	teeth/inch
P_S	Pitch of lead Screw	revs/m	revs/inch
T	Torque...(for “required” Calculations)	Nm	in-lb
T_L	...at Load (not yet reflected to motor)	“	“
T_P .	...due to Preload on screw nut, etc.	“	“
V_L	linear Velocity of Load	m/s	in/s
ω_M	angular/rotational velocity of Motor	rad/s	rps or rpm
W_L	Weight of Load	kg	lb
W_B	Weight of Belt (or chain or cable)	“	“
W_T	Weight of Table (or rack & moving parts)	“	“
θ	rotation...	revs	revs
$\theta_{a,\,c,\,or\,d}$	rotation during accel, decel, etc.	“	“
θ_L	rotation of Load	“	“
θ_M	rotation of Motor	“	“
μ	coefficient of friction	none	none
γ	load angle from horizontal	degrees	degrees

Typical Friction Coefficients $(F_{fr} = \mu W_L \cos\gamma)$

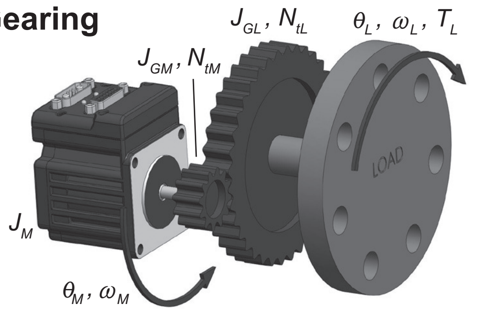
Materials	μ	Mechanism	μ
Steel on Steel	~0.58	Ball Bushings	<0.01
Stl. on Stl. (greased)	~0.15	Linear Bearings	<0.01
Aluminum on Steel	~0.45	Dove-Tail Slides	~0.2++
Copper on Steel	~0.30	Gibb Ways	~0.5++
Brass on Steel	~0.35		
Plastic on Steel	~0.15-0.25		

Animatics Corporation • All integrated motor products made by Animatics are covered by patent number 5,912,541
tel: 408.748.8721 • fax: 408.748.8725 • www.animatics.com

Application Sizing Equations

Motion Mechanism and Motion Equations | **Inertia, Torque Equations**

Gearing



$$N_r = \frac{N_{tL}}{N_{tM}}$$

$$\theta_M = N_r \times \theta_L$$

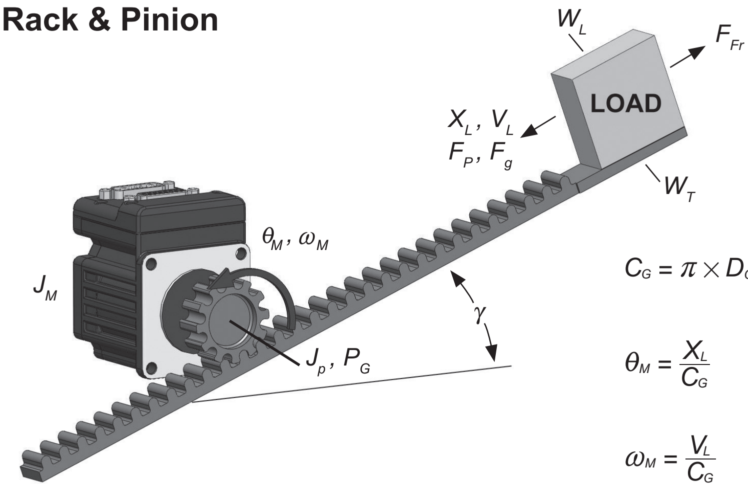
$$\omega = N_r \times \omega_L$$

$$J_{Total} + J_M + J_{GM} + J_{GL \to M} + J_{L \to M}$$

$$J_{GL \to M} = \left(\frac{1}{N_r}\right)^2 \times \frac{J_{GL}}{e} \qquad J_{L \to M} = \left(\frac{1}{N_r}\right)^2 \times \frac{J_L}{e}$$

$$T_{L \to M} = \frac{T_L}{N_r \times e}$$

Rack & Pinion



$$C_G = \pi \times D_G = \frac{N_t}{P_G}$$

$$\theta_M = \frac{X_L}{C_G}$$

$$\omega_M = \frac{V_L}{C_G}$$

$$J_{Total} = J_M + J_G + J_{L \to M}$$

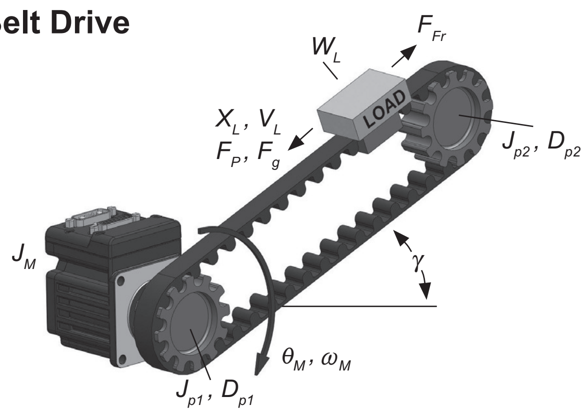
$$J_{L \to M} = \frac{(W_L = W_T)}{g \times e} \times \left(\frac{D_G}{2}\right)^2$$

$$F_g = (W_L + W_T) \times \sin\gamma$$

$$F_{fr} = \mu \times (W_L + W_T) \times \cos\gamma$$

$$T_{L \to M} = \left(\frac{F_P = F_g + F_{fr}}{e}\right) \times \left(\frac{D_G}{2}\right)$$

Belt Drive



$$C_{P1} = \pi \times D_{P1} = \frac{N_t}{P_G}$$

$$\theta_M = \frac{X_L}{C_{P1}}$$

$$\omega_M = \frac{V_L}{C_{P1}}$$

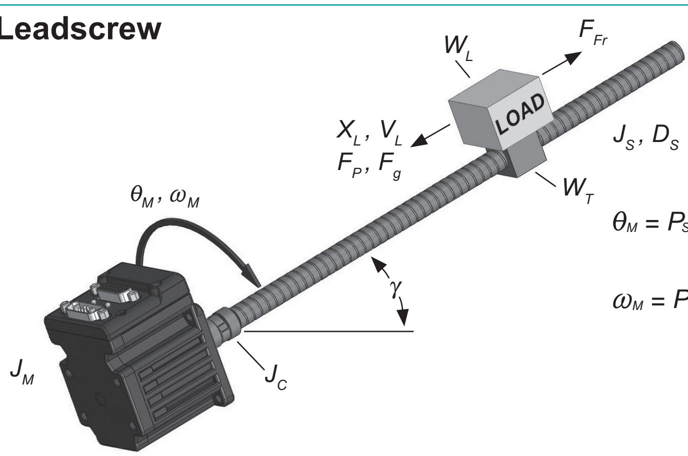
$$J_{Total} = J_M + J_{P1} + \left(\frac{D_{P1}}{D_{P2}}\right)^2 J_{P2} + J_{Load}$$

$$J_{L \to M} = \frac{(W_L + W_B)}{g \times e} \times \left(\frac{D_{P1}}{2}\right)^2$$

$$F_g = (W_L + W_B) \times \sin\gamma \quad F_{fr} = \mu \times (W_L + W_T) \times \cos\gamma$$

$$T_{L \to M} = \left(\frac{F_P + F_g + F_{fr}}{e}\right) + \left(\frac{D_{p1}}{2}\right)$$

Leadscrew



$$\theta_M = P_S \times X_L$$

$$\omega_M = P_S \times V_L$$

$$J_{Total} = J_M + J_C + J_S + J_{L \to M}$$

$$J_{L \to M} = \frac{(W_L + W_T)}{g \times e} \times \left(\frac{1}{2\pi \times P_S}\right)^2$$

$$F_g = (W_L + W_T) \times \sin\gamma \quad F_{fr} = \mu \times (W_L + W_T) \times \cos\gamma$$

$$T_{L \to M} = \left(\frac{F_P + F_g + F_{fr}}{2\pi \times P_S \times e}\right) + T_P$$