

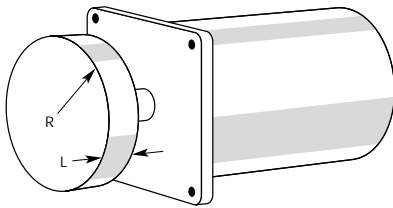
Directly Driven Loads

There are many applications where the motion being controlled is rotary and the low-speed smoothness and high resolution of a Compumotor system can be used to eliminate gear trains or other mechanical linkages. In direct drive applications, a motor is typically connected to the load through a

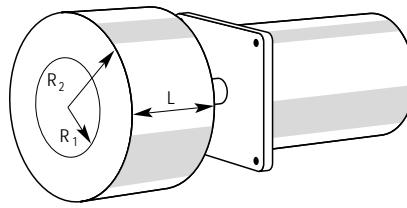
flexible or compliant coupling. This coupling provides a small amount of damping and helps correct for any mechanical misalignment.

Direct drive is attractive when mechanical simplicity is desirable and the load being driven is of moderate inertia.

Direct Drive Formulas



R – Radius
 R(1) – Inner radius
 R(2) – Outer radius
 L – Length
 W – Weight of disc
 ρ – Density/Material
 g – Gravity constant



R = _____ inches
 R(1) = _____ inches
 R(2) = _____ inches
 L = _____ inches
 W = _____ ounces
 ρ = _____ ounces/inch³
 g = _____ 386 in/sec²

Solid Cylinder (oz-in²)

$$\text{Inertia: } J_{\text{Load}} = \frac{WR^2}{2}$$

Where weight and radius are known

$$\text{Inertia (oz-in}^2\text{) } J_{\text{Load}} = \frac{\pi L \rho R^4}{2}$$

Where ρ, the material density is known

$$\text{Weight } W = \pi L \rho R^2$$

Inertia may be calculated knowing either the weight and radius of the solid cylinder (W and R) or its density, radius and length (ρ, R and L.)

The torque required to accelerate any load is:

$$T \text{ (oz-in)} = Ja$$

$$a = \frac{\omega_2 - \omega_1}{t} = 2\pi \text{ (accel.) for Accel. in rps}^2$$

Where:

a = angular acceleration, radians/sec²

ω₂ = final velocity, radians/sec

ω₁ = initial velocity, radians/sec

t = time for velocity change, seconds

J = inertia in units of oz-in²

The angular acceleration equals the time rate of change of the angular velocity. For loads accelerated from zero, ω₁ = 0 and a = $\frac{\omega}{t}$

$$T_{\text{Total}} = \frac{1}{g} (J_{\text{Load}} + J_{\text{Motor}}) \frac{\omega}{t}$$

T_{Total} represents the torque the motor must deliver.

The gravity constant (g)

in the denominator

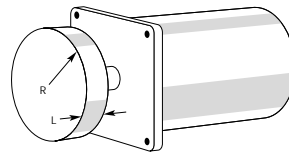
represents acceleration

due to gravity (386 in/

sec²) and converts

inertia from units of oz-

in² to oz-in-sec².



Hollow Cylinder

$$J_{\text{Load}} = \frac{W}{2} (R_1^2 + R_2^2)$$

Where W, the weight, is known

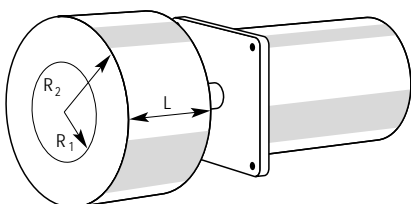
or

$$J_{\text{Load}} = \frac{\pi L \rho}{2} (R_2^4 - R_1^4)$$

Where ρ, the density, is known

$$W = \pi L \rho (R_2^2 - R_1^2)$$

$$T = \frac{1}{g} (J_{\text{Load}} + J_{\text{Motor}}) \frac{\omega}{t}$$



Problem

Calculate the motor torque required to accelerate a solid cylinder of aluminum 5" in radius and 0.25" thick from rest to 2.1 radians/sec (0.33 revs/sec) in 0.25 seconds. First, calculate J_{Load} using the density for aluminum of 1.54 oz/in³.

$$J_{\text{Load}} = \frac{\pi L \rho R^4}{2} = \frac{\pi \times 0.25 \times 1.54 \times 5^4}{2} = 378 \text{ oz-in}^2$$

Assume the rotor inertia of the motor you will use is 37.8 oz-in².

$$\begin{aligned} T_{\text{Total}} &= \frac{1}{g} (J_{\text{Load}} + J_{\text{Motor}}) \times \frac{\omega}{t} \\ &= \frac{1}{386} \times (378 + 37.8) \times \frac{2.1}{0.25} \\ &= 9.05 \text{ oz-in} \end{aligned}$$