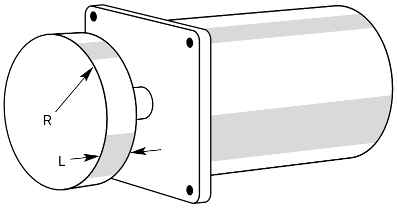
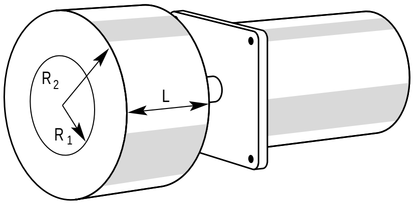
## Directly Driven Loads

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 = ______________ inches |
| R(1) – Inner radius | R(1) = ______________ inches |
| R(2) – Outer radius | R(2) = ______________ inches |
| L – Length | L = ______________ inches |
| W – Weight of disc | W = ______________ ounces |
| ρ – Density/Material | ρ = ______________ ounces/inch$^3$ |
| g – Gravity constant | g = ______________ 386 in/sec$^2$ |

### Solid Cylinder (oz-in$^2$)

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

Where weight and radius are known

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

Where ρ, the material density is known

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 (oz-in) = Ja

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

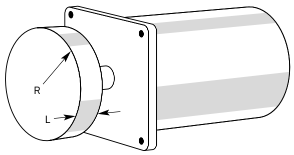
Where:

- $a$ = angular acceleration, radians/sec$^2$
- $\omega_2$ = final velocity, radians/sec
- $\omega_1$ = initial velocity, radians/sec
- $t$ = time for velocity change, seconds
- $J$ = inertia in units of oz-in$^2$

The angular acceleration equals the time rate of change of the angular velocity. For loads accelerated from zero, $\omega_1 = 0$ and $a = \frac{\omega}{t}$

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

$T_{Total}$ represents the torque the motor must deliver. The gravity constant (g) in the denominator represents acceleration due to gravity (386 in/sec$^2$) and converts inertia from units of oz-in$^2$ to oz-in-sec$^2$.




### Hollow Cylinder

$J_{Load} = \frac{W}{2} (R^2{}_1 + R^2{}_2)$

Where W, the weight, is known

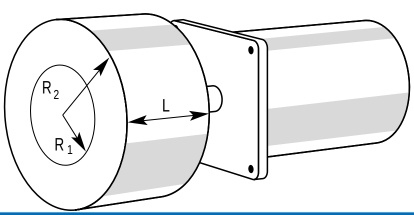
or

$J_{Load} = \frac{\pi L \rho}{2} (R^4{}_2 - R^4{}_1)$

Where ρ, the density, is known

$W = \pi L \rho (R^2{}_2 - R^2{}_1)$

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




### 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/in$^3$.

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

Assume the rotor inertia of the motor you will use is 37.8 oz-in$^2$.

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

$$= \frac{1}{386} \times (378 + 37.8) \times \frac{2.1}{0.25}$$

$$= 9.05 \text{ oz-in}$$