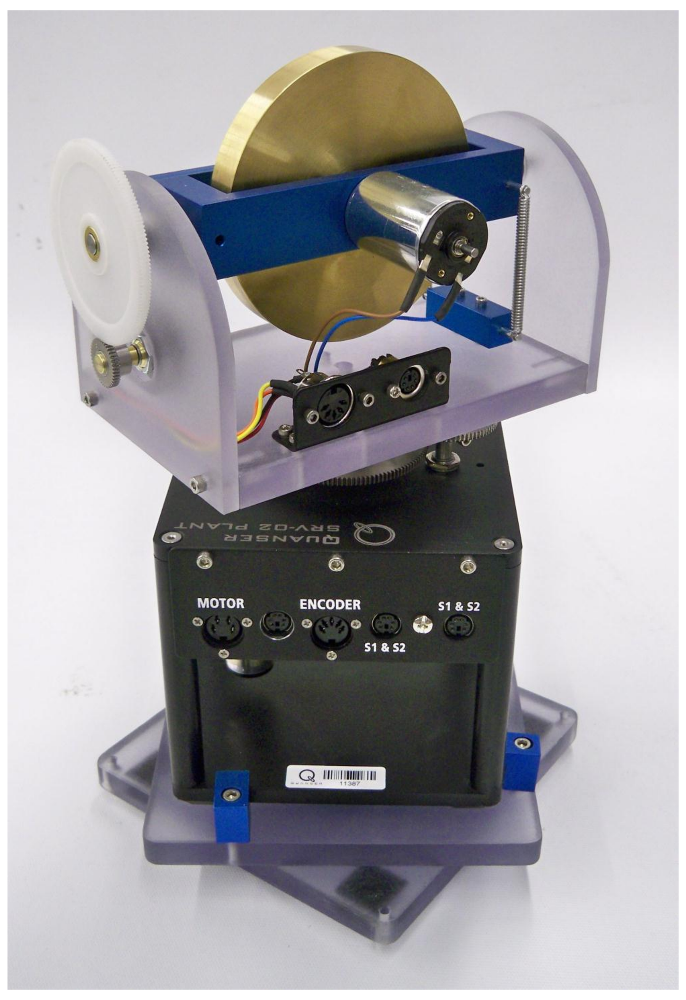
Gyroscope



The objective of this lab is to develop a controller that maintains the direction of the gyroscope while the top base plate is rotated relative to the bottom base plate. This means when a disturbance is applied to the bottom plate, the SRV02 plant will apply just the right amount of counter-torque to maintain the direction of the gyroscope.

The gyroscope plant consists of a rotating disc mounted in between a blue frame. The disc is rotated at constant angular velocity by a DC motor. The blue frame can then rotate within an external frame and is geared to an encoder to measure rotation of that frame. The blue frame also has springs attached to apply tension. The entire system is then mounted onto the output shaft of a SRV02 plant. The SRV02 plant is then mounted onto a rotating plate with simple clamps. The rotating plate at the bottom allows the user to simulate external disturbances.

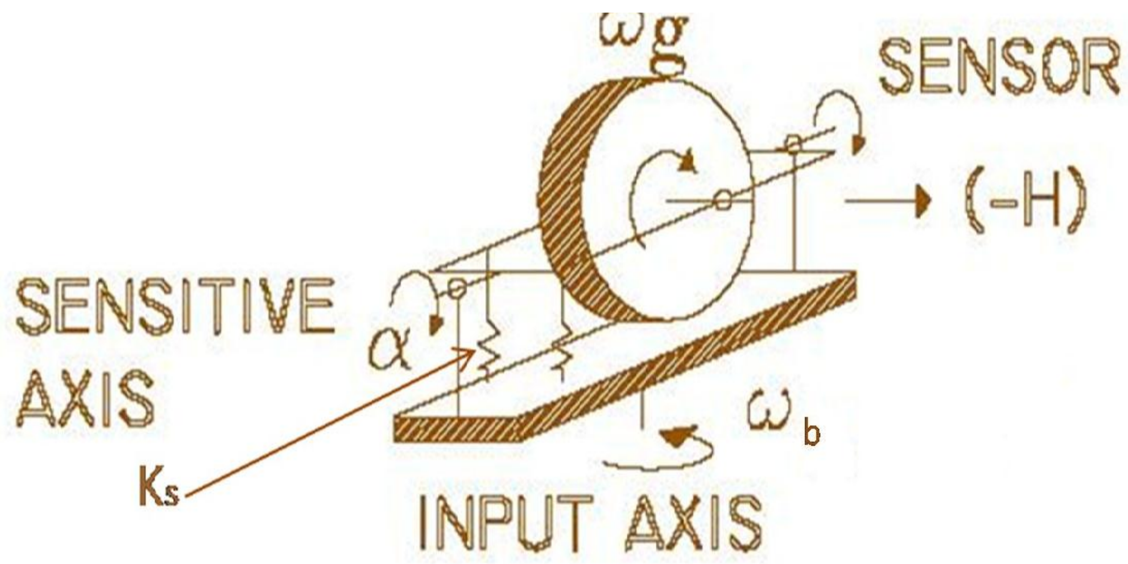
Equations of motion

$$\tau_g = \omega_b H \qquad H = J_f \omega_g \qquad \tau_s = K_s \alpha = \tau_g \qquad \alpha = \omega_b \frac{H}{K} \qquad \xi = \int \omega_b dt \qquad V = I_m R_m + K_t \omega_g \qquad \xi = \gamma + \theta$$

$$d\frac{\xi}{dt} = d\frac{\gamma}{dt} + d\frac{\theta}{dt} \qquad V_m = I_m R_m + K_m K_g \omega_g \qquad \tau = I_m K_t K_g = J_t d^2 \frac{\theta}{dt^2} \qquad \theta = \frac{V_m}{\left(s^2 R_m \frac{J_t}{(K_t K_g)} - K_t K_g s\right)}$$

$$\beta(s) = 4G_g s\gamma + 4G_g \frac{sV_m}{\left(s^2 R_m \frac{J_t}{(K_t K_g)} - K_t K_g s\right)}$$

$$\frac{\epsilon}{\gamma} = \frac{\left(4G_g R_m J_t s^2 - 4G_g K_t^2 K_g^2 s\right)}{\left(R_m J_t s^2 - \left(K_t^2 K_g^2 + 4G_g K_t K_g K_d\right)s - 4G_g K_t K_g K_p\right)}$$



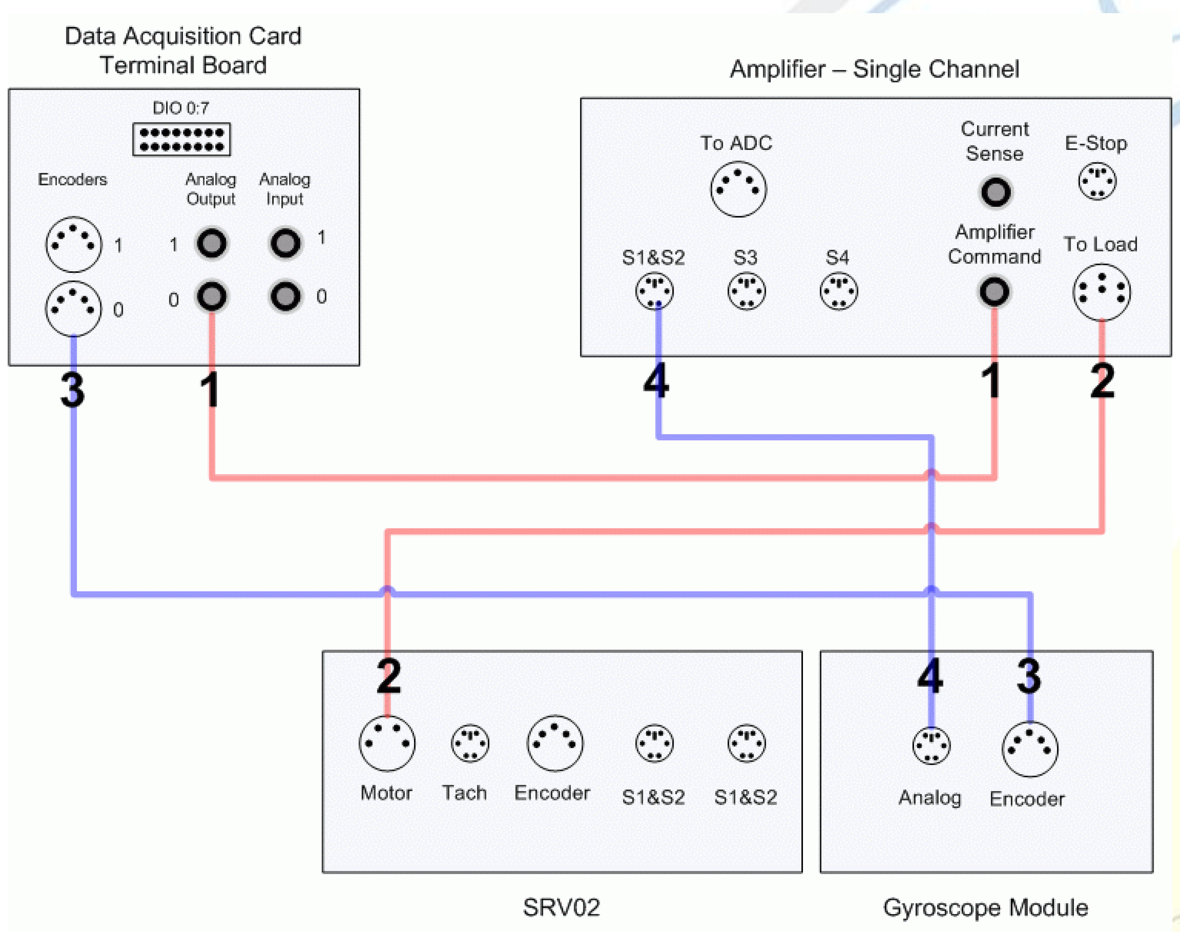
Specifications

Damping ratio: $\zeta = 0.707$

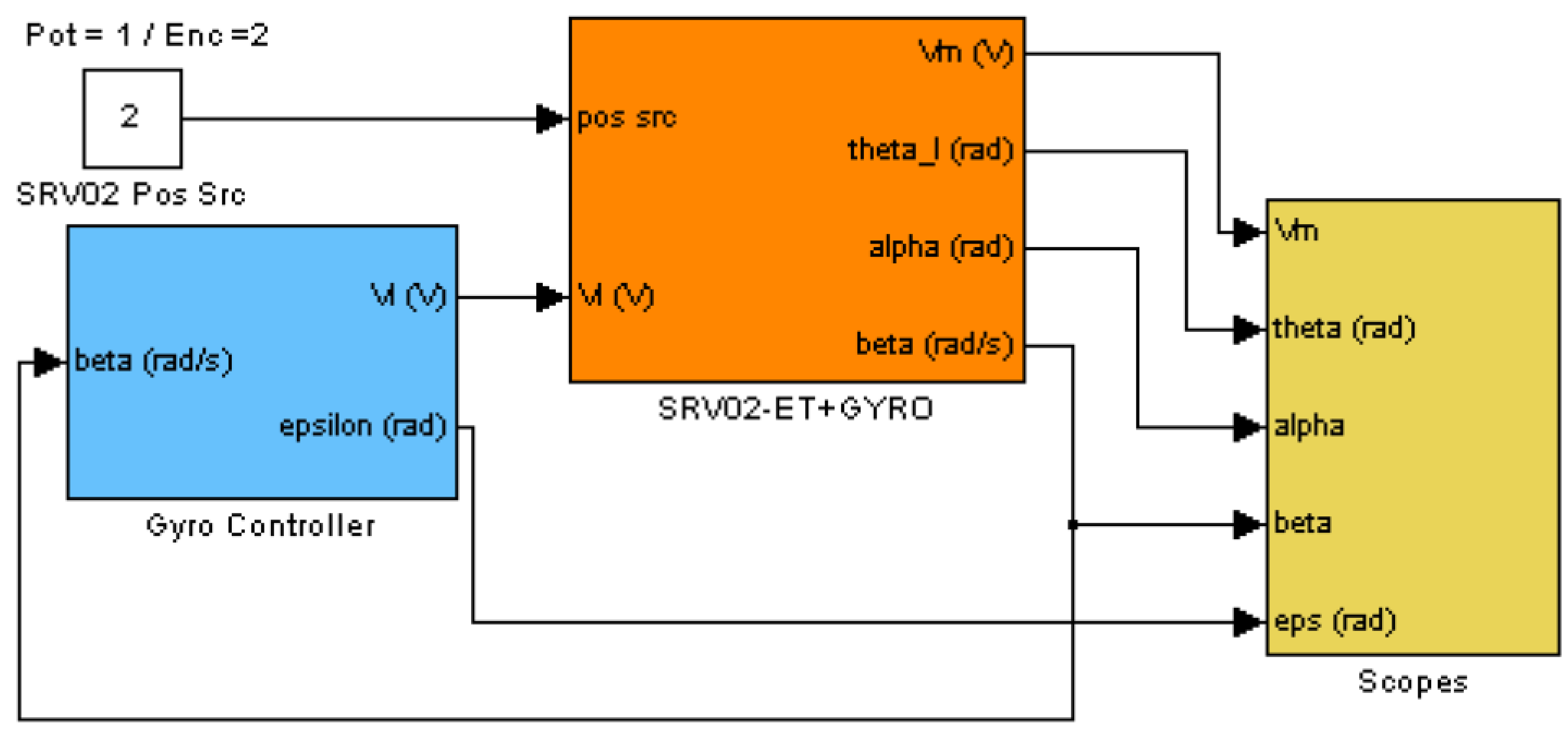
Natural frequency: $\omega_n = 10\ rad/s$

$$K_p = -19.84 V/rad, \qquad K_d = -2.20 V/rad/s$$

Wiring diagram



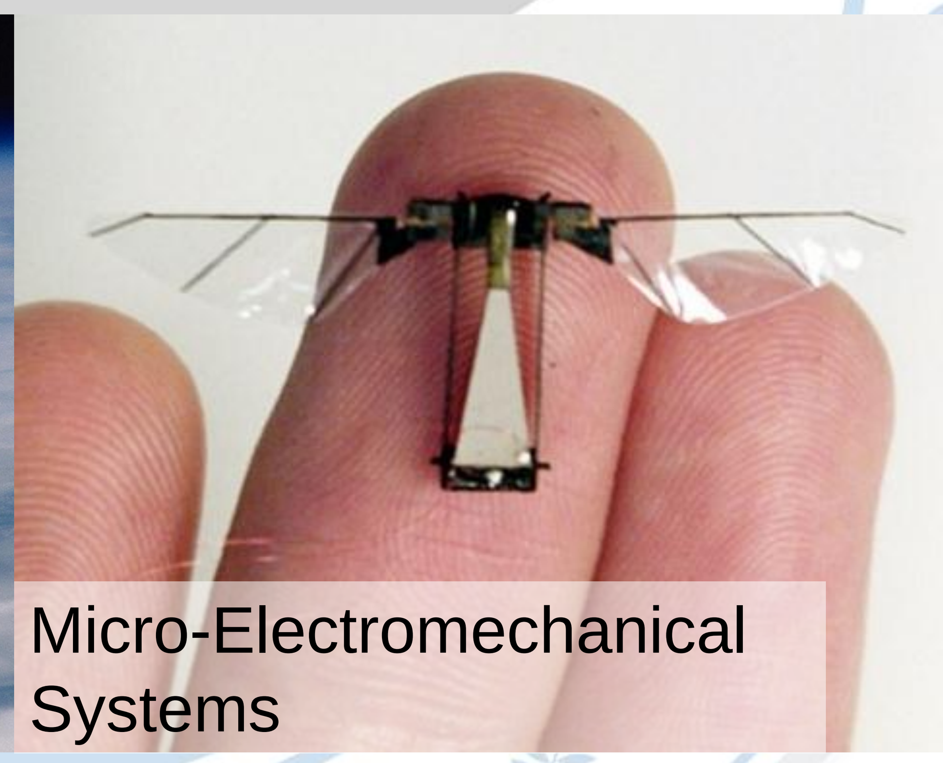
Simulink block diagram



Applications

F-22
Raptor

Hubble
Space Telescope



Micro-Electromechanical
Systems

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