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Gravity Probe B Gyroscope Electrostatic Suspension System (GSS)[1] WILLIAM BENCZE, DAVID HIPKINS, TOM HOLMES, SAPS BUCHMAN, Stanford University, ROBERT BRUMLEY, Boeing Company — Presented here is a hybrid digital/analog electrostatic suspension control system for the Gravity Probe B Relativity Mission's science gyroscopes. The chief challenge for this system is to operate over 8 orders of force magnitude while minimizing classical torques on the gyroscope. A novel, adaptive LQE digital control algorithm was developed to meet the high dynamic range requirements for rotor suspension, while minimizing suspension-induced torques. A set of three backup, all-analog proportional-derivative (PD) controllers were provided to maintain rotor centering in the event of computer faults during all phases of the mission. The capacitive position sensing system measured rotor position to a noise floor of 0.15 nm/$\sqrt{\text{Hz}}$ in the science band (5 - 30 mHz). In addition, this system also applied controlled torques to perform a post spin-up alignment of the gyroscope spin axes to within 10 arc-sec of a desired orientation, and measured the rotor charge to the 2 pC (2 mV) level. The GSS contributed to drag-free operation of the space vehicle by using one of the gyroscopes as an isolated, inertial proof mass and was able to resolve accelerations to the 10^{-12}g level. On-orbit performance of this system will be discussed in detail.

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