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Gravity Probe B Relativity Mission

Period of the Body-Fixed Calibration Signal

S0718, Rev. -

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ITAR Control Req'd? ☐ Yes ☒ No 10/16/02

Purpose:

This document verifies the Gravity Probe B System Design and Performance (T003) Requirement 3.5.3.2, on the period of the low frequency calibration signal:

3.5.3 Low Frequency Calibration Signal

3.5.3.2 Period – "The period of the body-fixed calibration signal shall be between 45 minutes and 20 seconds."

This requirement is verified based another requirement in SQUID Readout Electronics (SRE) Specification (LMMS/P480136D) given below:

> 3.2.3.1.2.5 Calibration Signal Current
>
> The calibration signal current shall have a range from 0 to 250 nA ±2 % peak to peak when operating both high and low frequencies with 4 amplitude settings at frequencies 220 Hz or 110 Hz and 1/124 Hz or 1/62 Hz. There shall be approximately an 8:1 ratio between the high frequency and the low frequency maximum amplitudes.

This requirement is supported from the test data included in the SRE Acceptance Data Package. This data is documented in (McGinnis 2002).

Background:

The calibration signal is injected into the input circuit of the SQUID readout system. This calibration signal is sinusoidally modulated at both a high frequency close to the gyroscope spin speed (~150 Hz) and a low frequency in the neighborhood of the satellite roll frequency. The purpose of this calibration signal is to check on the stability of the scale factor and phase shift of the SQUID readout system. A schematic diagram of the calibration signal and SQUID readout system is shown below.

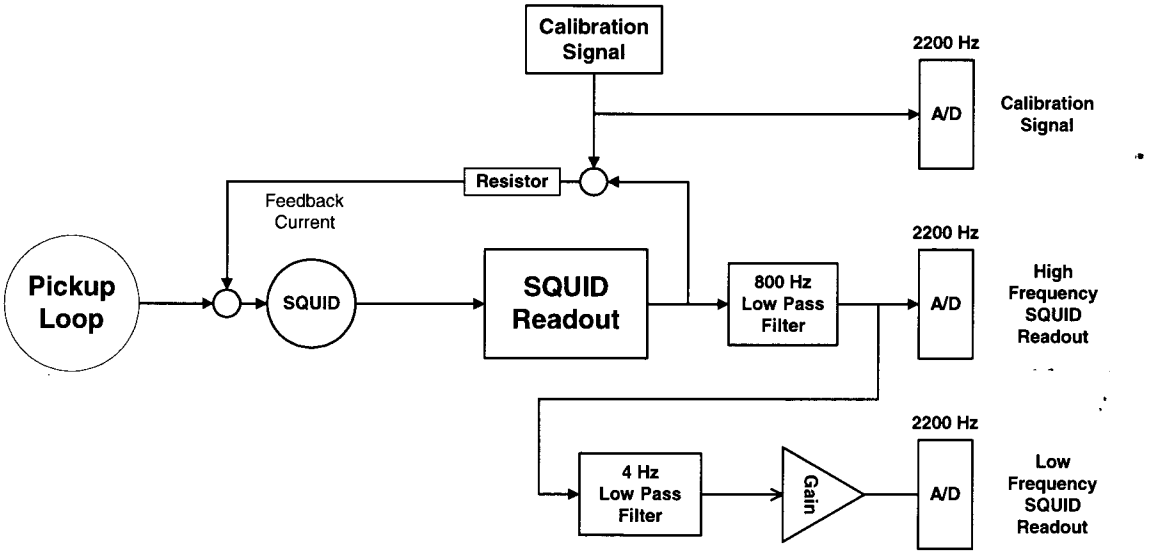

Fig. 1. Calibration Signal and SQUID Readout System.

Analysis:

The frequencies of 1/124 Hz and 1/62 Hz for the low frequency calibration signal current, specified in requirement 3.2.3.1.2.5, have periods of 124 and 62 seconds. Since these periods fall well within the range of 45 minutes to 20 seconds, given by T003 requirement 3.5.3.2, this requirement is verified based on analysis and supporting data in the SRE specification.

This System Design and Performance (T003) Requirement predates the design of the SQUID Readout Electronics. The design insures that there will be no drift in the frequency of the sampled calibration signal because the D/A converter used to generate the calibration signal and the A/D converter used to measure it are driven from the same clock. For additional details of the Gravity Probe B timing system, see (Li 2000).

Conclusion:

The frequency of the low frequency calibration signal is well within the range given by T003 Requirement 3.5.3.2.

References:

Li, J. (2000). Gravity Probe B Timing System. Stanford University, GP-B, S0307.

McGinnis, T. (2002). SRE Board Level Test Analyses. Lockheed-Martin, EM PLE 311, 29 April 2002.