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Gravity Probe B Relativity Mission

E28 Scope Reduction

(in conjunction with E28 TRR-S0734, PCB 577, and PCB 584)

S0751, Rev. -

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ITAR Control Req'd? ☐ Yes ☒ No

Purpose:

This document provides rational for changes to the Stanford E28 test content.

Summary of Changes

The following E28 tests were modified per PCB 577.

1. Incorporate E28 test SQUID EMC (IT01 3B test 13.5) into vehicle-based software sim.
2. Incorporate E28 test SRE safemode (IT01-3B 15.34) into vehicle-based software sim.
3. Reduce scope of E28 test PID Algorithm Check (IT01-3B 15.11) to include only window PID checkout
4. Reduce scope of E28 test SRE: Linearity...(IT01-3B 15.16) to allow running in 1day
5. Delete E28 test TRE charge control (IT01-3B test 15.1.2).
6. Delete E28 test ECU Monitor test (IT01-3B 15.33)1.

The following E28 tests were modified per PCB 584.

7. Eliminate IT01-3B E28 test 15.12: Final Flux Flush.
8. Reduce duration of IT01-3B E28 test 15.13: Low Temperature Bakeout.

Risk Mitigations/Rationale for Scope Changes:

Number 1 above: (Incorporate E28 test SQUID EMC (IT01 3B test 13.5) into software sim). No reduction in scope. Test can be run in simulation to retire EMC risk.

Number 2 above: Incorporate E28 test SRE safemode (IT01-3B 15.34) into software sim. No reduction in scope. Test can be run in simulation to retire remaining safemode issue (activation of B side following failure of A side SRE).

Number 3 above: Reduce scope of E28 test PID Algorithm Check (IT01-3B 15.11) to include only window PID checkout. PID checkout portion of test covered by low temperature bakeout and flux flush tests. Window heating portion of test retained.

Number 4 above: Reduce scope of E28 test SRE: Linearity...(IT01-3B 15.16) to allow running in 1day. Linearity testing of SRE performed by LM off of the vehicle is in-work and is more cost effective and more technically effective than performing linearity test on vehicle. In practice there was no reduction in scope in the as-run procedure.

Number 5 above: Delete E28 test TRE charge control (IT01-3B test 15.1.2). Not required. Charge control algorithm retires risk of interactions between the TRE and the charge control system.

Number 6 above: Delete E28 test ECU Monitor test (IT01-3B 15.33). Test remained in test plan as place holder for anomalous ECU heating. Risk of ECU issue retired prior to E28 with the completion of the ECU thermal anomaly investigation (DR 442).

Number 7 above: Flux Flush test is not required. Flux changes each time the SV is moved. The E28 Flux Flush test would not eliminate the requirement for an on-orbit flux flush.

The expectation is that the E28 Flux Flush will have no impact on post-launch flux state of science gyroscopes. On-orbit operational risks are retired by other E-28 tests and a newly planned flux flush simulation.

The hardware to perform a flux flush is fully exercised in other existing E28 tests. The valves and plumbing lines used in E28 15.10 GMA flow test to show that we still have the ability to spin up the gyros (note that flux flushing is not done through a gyro spin up line...it has its own line) are the same ones used to flow gas for flux flushing. The combination of the pre-thermal-vac flux flush, the GMA flow test, the vatterfly test, and the low temperature bake out fully operate the hardware and software needed for the on-orbit flux flush.

A flux flush mini-SIM using the ITF has been added to the simulation schedule, with date(s) and time(s) per PCB 585. The plan will be to execute the relevant flight sequences using approved SPC templates and procedures, in an operational environment from the MOC using the ITF simulators. The relevant Stanford and Lockheed operations and REE personnel will participate in the mini-sim, which will ensure that the team is ready to perform the actual flux flush operations on orbit.

Number 8 above: Low temperature bakeout test modified for ground use. Modified low temperature bakeout provides lower probe pressure (for ground hold) than on-orbit bakeout. This lower pressure is achieved in approximately half the time of the on-orbit bakeout. The modified test also reduces the risk of excessive heat rate into the main tank post-main tank fill at VAFB.