

Test Capabilities Applied to Space Rate Sensors for Tactical and Space Inertial Reference Navigation and Small Satellite Applications

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Introduction

- Inertial Reference Units (IRUs) are key components for angular rate sensing for guidance, navigation, and control in tactical, space, small satellite (small sat), and cube satellite (cube sat) applications
- Test methods are described that were selected to demonstrate capability of a three-axis HG4934SRS Space Rate Sensor (SRS) [1-2]
- As a test example, the HG4934SRS achieves the performance summarized in Table 1 using tactical and space rated parts
- To support expected life estimation, risk assessment, confidence analysis, mission class categorization, development, and qualification for component, module, and system applications, testing that such IRUs must pass use available test capabilities
- Such test capabilities include environmental, electro-magnetic, and radiation environments testing
- Environmental (ENV) testing and test capabilities performed at or by Honeywell in Minneapolis, MN, include vibration, shock, sine vibration, half-sine shock, acoustic, temperature, temperature shock, and temperature/humidity testing, performed, e.g., per MIL-STD-810 [5]
- Electro-magnetic interference (EMI) testing and test capabilities performed at or by Honeywell in Minneapolis, MN, include conducted susceptibility (CS), conducted emissions (CE), radiated susceptibility (RS), and radiated emissions (RE) testing performed, e.g., per MIL-STD-461
- Radiation testing includes total ionizing dose (TID) and single-event effects (SEE) testing performed, e.g., per MIL-STD-883, MIL-STD-750, MIL-HDBK-814, ESCC 22900, and ESCC 25100
- Radiation test capabilities, such as for TID and SEE testing, were applied by Honeywell, Clearwater, FL, and feature a full suite of in-house radiation test sources, analysis tools, and resources; and were performed in coordination with Honeywell, Minneapolis, MN, and other sites

Summary Performance Specifications



Fig. 1. HG4934SRS 3-Axis Rate Sensor.

Table 1. HG4934SRS Summary Performance Specifications

Parameter	Unit	Capability
Sample Rate	Hz	600 Hz
Dynamic Range	deg/s	+/- 200 deg/s
Max Gyro Bias (including repeatability)	deg/hr, 3σ	<225
Scale Factor	ppm, 3σ	<3000
Bias In-Run Stability (Over Temperature, >0.75 °C/min)	deg/hr, 3σ	<3.0
Angular Random Walk (ARW)	deg/rt-hr, 3σ	<0.2
Peak System Power - nominal	Watts	<5.5 W peak, <3 W nominal
Mass	g	<145 g
Envelope, H x D	cm	3.6 by 6.5
Configuration	-	single string 3-axis
Mission Life	Years	>6.5
Storage	Years	>10
Parts Level	-	Tactical and Space Rated
Operating Temp Range	°C	-41 to +71°C
Power Bus	V	5 V +/-10%
Interface	-	Async UART (SDLIC Option)

KEY POINTS:

- Small, low cost space rate sensor based on proven tactical grade IMUs delivered for Military applications
 - Over 500,000 IMU systems delivered
- Space Rated Rate Sensor
 - RadHard controller and electronics
 - Mix of industrial and space qualified parts
- Manufactured and tested at Honeywell - Minneapolis, MN
 - High rate production facility
 - Experience in high volume production for space
 - 50,000 IMUs per year
- 6.5-Year LEO missions
- Planned Qualification Mid 2019

Test Standards and Discussion

Table 2. Summary of ENV Test Parameters

ENV test parameters (Reference MIL-STD-810)
Vibration and Shock
Sine Vibration
Half-Sine Shock
Acoustics
Temperature
Temperature Shock
Temperature/Altitude
Rapid Decompression
Temperature/Humidity
Angular Vibration
Angular Acceleration
Acceleration

Table 3. Summary of EMI Test Parameters

EMI test parameters (Reference MIL-STD-461)
Conducted Emissions (CE)
Conducted Susceptibility (CS)
Radiated Emissions (RE)
Radiated Susceptibility (RS)

Radiation testing (Reference MIL-STD-750, MIL-STD-883, MIL-HDBK-814, ESCC 22900, and ESCC 25100)

Total Ionizing Dose (TID)
Single Event Effects (SEE)

Table 4. Summary of Radiation Test Standards

- For EMI testing, passing results were obtained for conducted susceptibility (CS), conducted emissions (CE), radiated susceptibility (RS), and radiated emissions (RE) tests. Tests were performed, e.g., per MIL-STD-461, and typically included CS101, CS115, CS116, RS103, CE102, and RE102 testing
- Radiation test capabilities [3-4], such as for TID and SEE, were applied by Honeywell-Clearwater, which features a full suite of in-house radiation test sources, analysis tools, and resources, in coordination with Honeywell-Minneapolis and related sites
- Passing results were obtained for conditions of interest, such as for natural radiation, e.g., LEO, with TID >18 krad(Si) and an SEE MTTF > 2,000 years. SEU and SET effects were analyzed. Latch-up and functional interrupts are managed via fault detection and correction (FDC) and power management

Conclusions

- Test methods and environments are described that were selected to demonstrate performance and capabilities of a three-axis HG4934SRS IRU SRS
- IRUs are key components for angular rate sensing for guidance, navigation, and control in tactical, space, small satellite (small sat), and cube satellite (cube sat) applications
- Demonstrating performance and capabilities accounting for ENV, EMI, and radiation effects in devices such as the HG4934SRS is important for supporting applications
- Passing results were obtained for the HG4934SRS based on ENV, EMI, and radiation testing

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References

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