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JAPAN'S FIRST FLIGHT DEMONSTRATION OF NAVIGATION SENSOR INTEGRATED WITH
AFTS USING SOUNDING ROCKET.**Abstract**

This paper introduces the flight demonstration results of a newly developed rocket navigation sensor equipped with the AFTS (Autonomous Flight Termination System) for unmanned range safety operations. This marks first flight demonstration of AFTS equipped navigation sensor in Japan. So far, we have developed tracking sensor RINA (Radio and Inertial Navigation sensor) for launch vehicle. RINA has been equipped with a total of 21 launch vehicles such as H-IIA, H-IIB, H3 and Epsilon in Japan. It can replace conventional radar tracking system and leads to reduction of tracking station maintenance costs. To replace radar tracking system with on-rocket type navigation sensor, it requires highly accurate sensors, which increases costs. RINA achieved cost reduction through hybrid navigation using low-cost IMU (Inertial Measurement Unit) and GNSS (Global Navigation Satellite System). Based on the development of RINA, we have released NANA (New Advanced Navigation sensor), which achieved downsizing and cost reduction by adopting COTS components, for commercial small rockets. It's first flight is scheduled in 2024. The next generation navigation sensor (NANA-Ka) introduced in this report has following four main improvements with the aim of further downsizing and multifunctionality. First, this sensor adopts the latest SoC (System on Chip) for improved performance and size reduction through chip integration.

Second, by using our in-house MEMS-IMU (Micro Electro Mechanical Systems IMU), we achieved internalization and downsizing of major component of navigation sensor. Third, we have newly incorporated signal processing to handle the high dynamics such as high-rate spins. This enables continuous satellite positioning without interruption, even during spin and attitude instability. Finally, we integrated the AFTS software developed by JAXA (Japan Aerospace Exploration Agency). AFTS is a system that autonomously determines the continuation or termination of flight based on observed information such as position and velocity. It can reduce human-operated tasks on the ground, human errors, and leads to cost reduction. Because of these improvements, NANA-Ka is expected to make mounting easier, and can achieve flight safety operations with a single component. To test this component, we got the opportunity to conduct flight demonstration on JAXA's Sounding rocket S520-33 on December 2nd 2023. The flight demonstration was a success, confirming that all functions were operating normally. We will explain the details in this paper.