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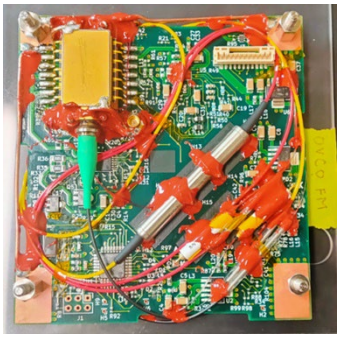
Mitsubishi Electric Achieves All Success Criteria for Orbital Demonstration of the Laser Source Module for Space Optical Communication

Use of off-the-shelf components and nanosatellite help realize lower costs and faster development



Laser source module implemented on nanosatellite

TOKYO, September 19, 2024 – Mitsubishi Electric Corporation (TOKYO: 6503) announced today that all success criteria,[1] including an additional success,[2] were achieved without performance degradation during a six-month on-orbit demonstration of its laser source module after extensive evaluation. Mitsubishi Electric conducted the test last year with a module it developed using low-cost commercial off-the-shelf (COTS) components. This is the first time in the world[3] that the performance degradation of optical components in a space environment has been evaluated.

To improve satellite communication, Mitsubishi Electric has been developing optical devices utilizing versatile, high-performance 1.5µm-wavelength lasers originally produced for land-based fiber-optic communication. After developing an optical receiver in May 2022, the company began developing a laser source module with COTS components for installation in a nanosatellite measuring only 10 x 10 x 34cm (WxDxH). The goals were to develop a laser source module capable of withstanding the extreme conditions of space, particularly radiation and thermal vacuum, and to demonstrate the module's viability in less time and at lower cost than conventional products.[4]

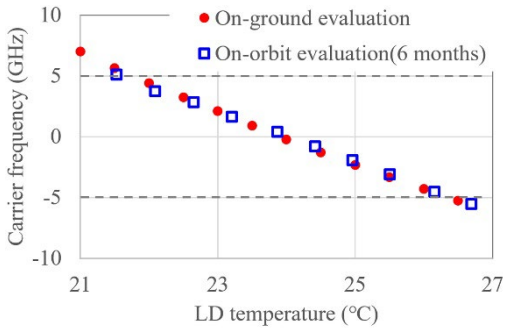
[1] Specific criteria and targets for evaluating the success of a project, mainly in the field of space science. See "Success criteria for on-orbit demonstration" on page 3/4.
[2] Results that meet or exceed targets for multiple levels of criteria based on degree of difficulty.
[3] According to Mitsubishi Electric's research as of September 19, 2024.
[4] Compared to previous demonstrations conducted in space by Mitsubishi Electric.

For the demonstration, the module was installed in the OPTIMAL-1[5] nanosatellite, which was developed through an industry-academia collaboration. The nanosatellite was launched early last year and an on-orbit demonstration of the module's laser optical frequency control, critical for space communication, was carried out over a six-month period beginning in January 2023. An extensive evaluation of the module's performance has now confirmed that the demonstration not only met all of its success criteria, but also exceeded initial expectations by additionally demonstrating that the module's optical performance was not degraded after six months of operation in space. The company will continue to pursue technological development aimed at the early realization of high-capacity space optical communication.

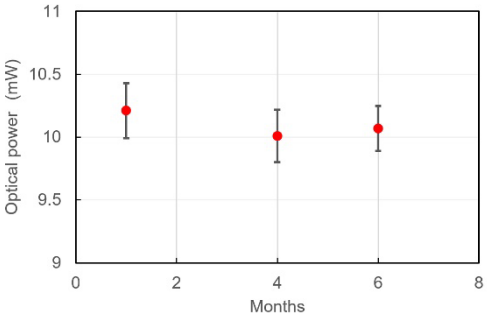
Features

1) *World's first on-orbit demonstration of laser source module performance evaluation achieves all success criteria*

- Optical communication between satellites requires compensation for frequency variations due to the Doppler effect caused by satellites moving at different speeds. Compensation is particularly important for relay communication between low-orbit and geostationary satellites, where the Doppler effect is most pronounced. The demonstration confirmed for the first time that a laser module made with COTS components can achieve compensation without degradation compared to ground-based evaluations.
- In addition to meeting all of its success criteria, the demonstration achieved an additional success by proving that the module's optical performance was not degraded by the effects of radiation and thermal vacuum in space even after six months in low orbit. This outcome reflects Mitsubishi Electric's expertise in selecting components and designing substrates capable of operating stably in space.



Comparison of on-ground and on-orbit demonstrations



Performance over 6 months
(●: actual values, I: measurement error)

[5] Led by ArkEdge Space Inc. and selected for the Ministry of Economy, Trade and Industry's Subsidy Program for Industrial Technology Practical Application Development (Space Industry Technology Information Infrastructure Development Research and Development Project), the project focused on the theme of "Demonstration of Ultra-Small Satellite Propulsion Systems, Communication Devices, and On-Orbit Advanced Information Processing Technologies using the TRICOM Satellite." The project involved collaboration with Pale Blue Inc., Seiren Co., Ltd., Fukui University, the University of Tokyo Graduate School of Engineering, and Mitsubishi Electric. The nanosatellite was released into space from the International Space Station (ISS) "Kibo" Japanese Experiment Module on January 6, 2023.

Success Criteria	Details
Minimum Success	Verification of satellite communication
Middle Success	Confirmation that laser works properly
Full Success	Optical frequency control using laser temperature adjustment
Extra Success	Operation in space for six months

Success criteria for on-orbit demonstration

2) Industry-academia collaboration develops nanosatellite for fast, low-cost on-orbit demonstration

- The on-orbit demonstration used a nanosatellite developed in collaboration with Fukui University, ArkEdge Space, and other organizations. Comprehensive development, from planning to the six-month on-orbit demonstration, was achieved in just three years, about one-third the time and at one-hundredth the cost of conventional demonstrations using large satellites.

Comments from Industrial and Academic Representatives

According to ArkEdge Space Inc.'s Chief Executive Officer Takayoshi Fukuyo: "Recently, there is an increasing demand to downlink large amounts of data at high speed from cameras mounted on satellites due to the advancement of space applications. Under such circumstances, it is a great achievement that the on-orbit demonstration of the laser source module for space optical communication has progressed successfully. This will contribute greatly to increasing the capacity, speed, and cost of satellite communication. In addition, this module was one of the missions mounted on a 3U size nanosatellite. Thus, it has confirmed the utility of the nanosatellite as an on-orbit demonstration platform for space components. I look forward to further expansion of the use of nanosatellites."

University of Fukui Special Appointment Associate Professor Yoshihide Aoyanagi said: "For the future prosperity of the space industry, it is necessary to actively incorporate technologies for high-performance terrestrial consumer components. To achieve this, it is crucial to accumulate operational experience in orbit. The success of the OPTIMAL-1 demonstration represents a significant milestone towards realizing optical communication capabilities in nanosatellites. I hope that this success will lead to further industrial application of nanosatellites."

Development Background

Satellite imagery is being used for a variety of applications, such as assessing situations at disaster sites, protecting forest resources, and more. Conventional satellite communications using radio waves have limitations in terms of communication capacity, time and distance when transmitting images to the ground and between satellites. Given that optical communication in space is capable of 10 times or greater capacity as well as much faster speeds and longer distances compared to radio-wave communication, the possibility of linking low-orbit satellites and ground stations via geostationary satellites is attracting great interest.

Future Development

Mitsubishi Electric will continue to develop technologies and devices for optical communication in space as well as propose technologies for large-scale space-development projects. In addition, the company will utilize space demonstration platforms such as nanosatellites for the practical use of optical components in space, aiming to accelerate the realization of high-capacity space-based optical communication.

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About Mitsubishi Electric Corporation

With more than 100 years of experience in providing reliable, high-quality products, Mitsubishi Electric Corporation (TOKYO: 6503) is a recognized world leader in the manufacture, marketing and sales of electrical and electronic equipment used in information processing and communications, space development and satellite communications, consumer electronics, industrial technology, energy, transportation and building equipment. Mitsubishi Electric enriches society with technology in the spirit of its "Changes for the Better." The company recorded a revenue of 5,257.9 billion yen (U.S.$ 34.8 billion*) in the fiscal year ended March 31, 2024. For more information, please visit www.MitsubishiElectric.com

*U.S. dollar amounts are translated from yen at the rate of ¥151=U.S.$1, the approximate rate on the Tokyo Foreign Exchange Market on March 31, 2024