S6-3 Development of a LD pumped Nd:YAG Oscillator for Space-borne LaserAltimeter

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1. Introduction

For global observation of the Moon, a lunar orbit satellite (SELENE) is scheduled to be launched by an H-IIA rocket in August, 2003.

The SELENE comprises an orbiter (a mission module and a propulsion module) and a relay satellite. When the SELENE enters into a lunar orbit, the relay satellite will be separated from the orbiter. The orbiter will make observations of the Moon for one year and, then, separate the propulsion module from the mission module for Moon landing. The mission module is planned to have about 10 observation instruments on board.

The laser altimeter (LALT), one of the observation instruments, shoots pulse laser beams from the lunar orbit to measure the distance to the lunar surface and will be in service for about one year. The acquired data will be used for analyzing the surface structure of the Moon, rectifying the topographic map of the Moon, and others.

We developed a prototype model of a laser oscillator to be used as the light source of the LALT in 1997, and conducted evaluation tests on the laser oscillator in 1998. This paper describes the test results.

2. Overview of LALT

Table-1 lists performance specifications of the LALT.

Table-1 LALT Performance Specifications

Wave length	1,064 nm
Raging distance	50 to 150 km
Pulse repetition rate	2 Hz
Laser output	> 100 mJ/pulse
Pulse width	Less than 15 nsec
Receiver diameter	ϕ 100 mm
Observation direction	directly below or 40 degrees aside
Receiver field of view	1 mrad
Transmitting beam divergence	0.3 mrad
Ranging accuracy	±5 m
Weight Laser receiver/transmitter Controller	 13 kg 4 kg

3. Structure of Oscillator

Figure 3-1 shows a block diagram of the laser oscillator.

1) Laser crystal

Nd:YAG is employed. With consideration on radiation resistance, the Cr^{4+} ion doped Nd:YAG crystal is used for the flight model.

2) Pumping source

The laser diode pumping system is employed due to its small power requirement, small-size light-weight feature, and long life cycle. To pump uniformly, it is designed with eight laser diodes to pump to eight lateral directions from the laser medium. For the flight model, each diode and Nd:YAG are equipped in pair to implement redundancy.

3) Q switch

The EO Q switch composed of $LiNbO_3$ and the 1/4 wavelength plate is employed. $LiNbO_3$ is used as a Q switch element because it needs lower 1/4 wavelength voltage and produces less optical loss.

4) Polarizer (POL)

To cover the difference of atmospheric and vacuum characteristics, a polarizer with a flat glass plate stuck that uses the Brewstar angle is employed instead of a polarizer with dielectric multilayer coating.

5) Resonator (EP-DP-FM)

The resonator contains for a end prism(EP) and a trapezoidal prism(DP) that are widely used due to durability to vibration, shock, and changes in temperature. These prisms are combined so that the ridgelines from both prisms perpendicularly intersect with each other. Resonator can be aligned by a shifter(SHT) and a wedge prism (WP).

6) Other optical components

With consideration on radiation resistance, non-browning glass is used. Coating is also tested on radiation resistance, and successful coating will be applied.

7) Heat dissipation system

The LALT employs an independent heat control system to lead generated heat to the radiator by means of thermal conductivity and dissipate the heat from the radiator surface to the outer space.

The laser diodes and laser medium, which are heat sources of the laser oscillator, are mounted to the homothermal base with the aluminum heat sink and designed to cool down by means of thermal conductivity provided by contact.

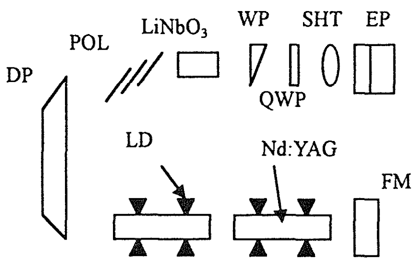

Figure 3-1 Block Diagram of Laser Oscillator

4. Evaluation Test

1) Performance evaluation under the ordinary temperature and the atmospheric pressure

Figure 4-1 shows input and output characteristics under the ordinary temperature and the atmospheric pressure. With the input energy of 710 mJ, the output energy of 115 mJ and the pulse width of 14.5 nsec are obtained The slope efficiency is 29.6%.

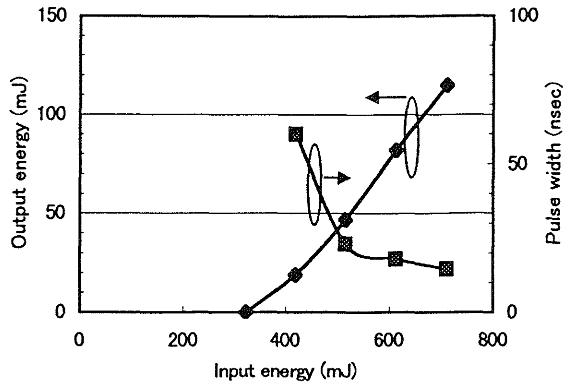

Figure 4-1 Input and Output Characteristics under Ordinary Temperature and Atmospheric Pressure

2) Performance evaluation with the environmental tests

Table-2 lists environmental tests performed.
The output fluctuation of the laser oscillator was 7% or less in every environmental test. The shock test and the EMC test will be conducted in the future to prove environmental durability as satellite equipment.

Table-2 List of Environmental Tests

Test	Condition
Temperature test	
Low temperature	-25°C
High temperature	+55°C
Vacuum test	
Degree of vacuum	5×10^{-6} Torr
Vibration test	
Sine wave vibration	5 to 15 Hz, 10 G
	15 to 100 Hz, 20 G
Random vibration	17.5 Grms, 80 sec

5. Conclusion

The laser oscillator, a light source of the LALT to be mounted in the SELENE, was developed and evaluated for its performance with environmental tests. With the input energy of 710 mJ under the ordinary temperature and the atmospheric pressure, the output energy of 115 mJ and the pulse width of 14.5 nsec were obtained The slope efficiency was 29.6%. The temperature, vacuum, and vibration tests were conducted and the output fluctuation of the laser oscillator was found 7% or less in every test.