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PROTOTYPE DESIGN AND VALIDATION OF SPACE-GRADE WDM-BASED HPA/LNA MODULES FOR SMALL SATELLITE PLATFORMS

Abstract

High data-rate transmission has been highly required as an extended business market of earth observation by utilizing low earth orbit (LEO) satellite. Recently, laser satellite communication has gathered much attention to achieve high data rate of satellite communication system. Some organizations have currently been conducting and planning on-orbit demonstrations of inter-satellite optical links between LEO satellite and geostationary earth orbit (GEO) satellite. Furthermore, laser satellite communication can be contributed into satellite constellation, which is implemented by a large number of small LEO satellites.

Under these scenarios, National Institute of Information and Communications Technology (NICT) has been developing a miniaturized laser communication terminal (LCT) onboard small LEO satellite. The LCT not only satisfies size, weight and power (SWaP) requirements but also provides 10 Gbit/s optical signal at a single wavelength. In this work, a miniaturized 2W booster amplifier module has been developed and it will be integrated into the miniaturized LCT.

In the future aspect, it is anticipated that a large transmission capacity will be demanded for LEO satellite constellation. Therefore, wavelength division multiplexing (WDM) scheme is expected as a key technology to expand the transmission capacity of laser satellite communication. Some European organizations and companies are planning to demonstrate WDM optical feeder link utilizing GEO satellite in 2023. However, very little research works have been reported for WDM-based optical amplifier module onboard small LEO satellite.

In view of this, we have started research work for space-grade WDM-based high power booster amplifier (HPA) and low-noise pre-amplifier (LNA) modules for small satellite platforms. Our proposed HPA/LNA modules are electrically and mechanically designed to meet the technical requirements including reliability, tolerance for harsh space environment, SWaP requirements, doppler frequency shift, gain flatness and optical nonlinearity occurred inside the HPA module. These modules are applicable for WDM optical signals with a maximum of four wavelengths in inter-satellite optical links and satellite-to-ground optical links. The HPA module is also capable to deliver output power of more than 2 W. Moreover, the size of each module is expected to be less than 0.5U.

In this paper, we will report prototype design and validation of our proposed HPA/LNA modules. This paper will describe the specifications, block diagrams and exterior design. In addition, we will also show the verification results of component technology of these modules.