

# Ka-대역 위성 탑재체용 주파수 하향변환 장치 개발

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## Development of Downconverter Equipment for Ka-band Satellite Payload

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### Abstract

A Ka-band downconverter assembly, integrated microwave assembly was developed for Ka-band communications satellite payload in the frequency range of 29.6 ~ 30.0GHz for input and 3.2 ~3.6GHz for output. The assembly consists of a downconverter module, a local oscillator module and two OCXO modules. The output frequency of local oscillator module is 8.8GHz and it is multiplied by three in the downconverter module. The downconverter module and local oscillator module have primary chain and secondary chain internally for high reliability of space application. The downconverter module has been designed with Ka-band MMIC chip set fabricated for satellite transponder. The developed downconverter assembly has 22dB of gain, 27dBm of OIP3 and 96dBc/Hz of phase noise at 10kHz offset. The assembly is the size of 18cm x 14cm x 11cm and the mass of 1.6kg.

### I. Introduction

Communication satellite has a function of frequency translation from uplink signal to downlink signal. In the past, communication satellites were developed with the bend-pipe configuration, but the recent communication satellites are required to have on-board processing function on the payload to provide high quality services. Advance in technology and needs for broadband satellite services enable to develop Ka-band satellite payload and we will have a chance to use the commercial Ka-band satellite in the near future<sup>[1], [2]</sup>. The communications using Ka-band satellite have advantages such as in high speed communication, small size of user terminal, and reduction of antenna size.

We are developing Ka-band equipments and communications payload such as LNA module, downconverter assembly, upconverter assembly, channel amplifier module, and the Microwave Switch Matrix<sup>[3], [4]</sup>.

The Ka-band downconverter assembly includes a downconverter module for Ka-to-S band translation and a local oscillator module connected to two OCXO modules externally. The downconverter module is integrated by using MMIC amplifiers and frequency tripler MMIC for active components. Those MMIC chips had been fabricated in a space-qualified MMIC foundry. The local oscillator outputs the signal of 8.8GHz frequency and the frequency is multiplied by three to 26.4GHz through a frequency tripler in the downconverter module. The frequency multiplication technique is preferred for signal source of microwave and

millimeter wave range to hybrid MIC technology because difficulties of output power and good phase noise can be overcome by using the technique in the frequency range. Our local oscillator around 8.8GHz has been developed by using hybrid MIC technology.

We had designed the downconver module and local oscillator module with dual chain configuration in a housing body for compact assembly.

The developed assembly has the best performance in OIP3 and phase noise. This paper introduces those MMIC chips in the downconverter module and describes design and test results of the downconverter module and the local oscillator module.

### II. Downconverter Design

The Ka-band downconverter is required to have performances as summarized in Table I.

For the space applications, an equipment should be had backup equipments more than one to provide stable service in the situation of the equipment failure. However it is the additional charge to the payload in mass and volume. For compact downconverter assembly, we determined the dual configuration in a housing body for each module.

Figure 1 shows the block diagram of downconverter designed to be dual configuration. A chain in the diagram is composed of several MMICs and MIC filters and ThermoPads. Two Ka-band medium power amplifier MMICs are used in the RF front end and LO driving section.