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Development of Wide-band Microwave Radiometer for Ground Observation

Tadashi Takano*(1), Noriyuki Kawaguchi(2), and Takashi Maeda(3)
(1) Nihon University, Funabashi, JAPAN
(2) National Astronomical Observatory of Japan, Mitaka, JAPAN
(3) Japan Aerospace Exploration Agency, Tsukuba, JAPAN

1 Introduction

Microwave radiometer (MR) for the ground observation is necessary for validation of geophysical values retrieved by a satellite-borne MR. The characteristics of brightness temperatures emitted from various objects were usually obtained by an MR several decades ago. However, as conditions considered for the specific object are increasing, we often noticed that the brightness temperature data corresponding to these conditions were not completely measured in the ground observation. Additionally, brightness temperatures emitted from the object must be measured more precisely and acculately using a new MR taking in the recent progress of microwave components. Therefore, we planned to develop a new MR for the ground observation, and investigated its design. In this paper, we present the basic plan and preliminary investigation results.

2 Problems in a traditional microwave radiometer for the ground observation

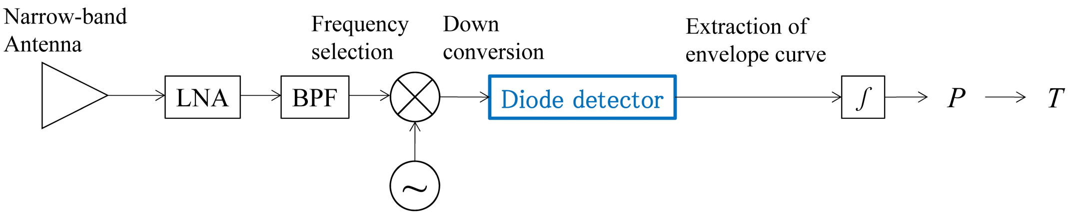

Figure 1: Simple block diagram of a traditional MR for the ground observation

Figure 1 depicts the block diagram of a traditional MR for the ground observation. It mainly consists of a narrow-band microwave antenna, a low noise amplifier (LNA), and a diode detector. In this figure, "$\int$" is an integrator, P is a microwave power, and T is a brightness temperature.

Generally, T values as a fundamental data for the retrieval of a geophysical value should be measured at multi frequencies. Accordingly, several MRs were required depending on the target geophysical value. It was difficult to make observation conditions (i.e., the antenna beam's center and width, azimuth and incident angle) of each MR completely identical, which became a potential error cause for the retrieval of the target geophysical value.

Additionally, it is well known that a diode detector has nonlinearity on the detection sensitivity. The amplitude of a microwave signal measured actually is not constant. Therefore, finally obtained T has a bias as long as nonlinearity for such a signal is precisely corrected. Thus, there were some problems in T values measured by a traditional MR.

3 Concept of a new microwave radiometer for the ground observation

In order to solve the problem in a traditional MR, we preliminarily investigated the design of a new MR. Figure 2 depicts the block diagram of a new MR.

The new MR has a wide-band microwave antenna. The wide-band microwave antenna such as a quad-ridge feed horn is already put to practical use, and it enables us to measure microwave signals from C- to Ka-band. Because a wide-band microwave signal is measured by the single antenna, a microwave signal at every frequency band is continuously measured in the same observation conditions.

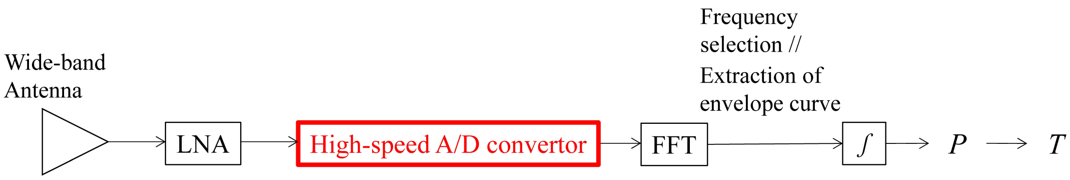

Figure 2: Simple block diagram of a new MR for the ground observation

Next, the new MR has a high-speed A/D converter. The sampling speed of the A/D converter is 24 Gsps. When a wide-band analog signal is converted to a digital signal by the A/D converter, nonlinear distortion is possibly reduced. If the digital signal is processed by fast fourier transform (FFT), we can extract a time-series data of the amplitude at any frequency and frequency bandwidth. Consequently, the new MR enables measurements not only like a traditional MR but also like a digital oscilloscope.

Additionally, we try to make the noise temperature of an LNA stabilized by electronic cooling. It will realize more precise and accurate measurement with a high-speed A/D converter.