8MM TOTAL POWER RADIOMETER WITH PERIODIC CALIBRATION

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Received June 8, 1994

ABSTRACT

The total power radiometer has simple structure and high theoretical sensitivity. But its actual sensitivity can not be so high as the application demands because of the effect of the gain fluctuation and other factors. This paper provides a 8mm total power radiometer system with periodic calibration which can be used on the ground and the aeroplane. It decreases the effect of the gain fluctuations effectively and increases the radiometer sensitivity. Experiments has also been made to analyse the effect of the calibration parameters upon the radiometer sensitivity. The results is given in the paper. Besides, the paper gives the way to do absolute calibration.

1. INTRODUCTION

Microwave radiometer is becoming more and more attractive in guidance and remote sensing because of its ability to all weather, day and night working, its simple structure, its being easy to conceal and many other advantages .

The earlier using total power radiometer has simple structure and high theoretical sensitivity. But its actual sensitivity can not meet the applied demand mainly because of the effect of the system gain fluctuation. Later developed Dicke and null-balancing radiometer decreases or eliminates this effect. Their ability to resisting interruption have been improved too. But their structures are more complex. And the theoretical sensitivity of the two radiometer is lower than that of the total power radiometer.

With the development of computer technique, the total power radiometer with periodic calibration has appeared in recent years. It uses computer to accomplish the function of some video circuit and completed periodic calibration . Except for persisting the original
simple structure of the total power radiometer, it decreases the effect of the gain fluctuation greatly and raises the system performance.

The periodic calibration plans are suggested generally for satellite radiometers. This 8mm total power radiometer system (with periodic calibration) can be used on imaging on the aeroplane and ground.

II. SYSTEM STRUCTURE AND PRINCIPLE

The structure of the radiometer system is shown in Fig.1.

![Fig.1. The system block diagram](image)

Antenna and receiver constitute the basic total power radiometer. Noisy source supplied by a constant current source, which can give high noise temperature and low noise temperature by the current source on and off respectively, is used as calibration load. Microwave switch decides whether receiver connects with antenna or calibration load. Two computer giving signals with TTL voltage control the switch. Receiver output analog signals are changed to digital signals by sampling and A/D converting. Then the digital signals are imported into computer to process.

The system running process is given below. First, computer giving switching driving signals makes microwave switch connecting to A port to calibration. Turn on constant current switch; the noisy source will give high noise temperature $T_1 = 800 \text{ K}$ and off the switch, it giving low noise temperature $T_2 = 300 \text{ K}$. On the basis of the receiver output at temperature $T_1$ and $T_2$, we can have the calibration equation. Then computer giving switch driving signal makes microwave switch connecting to B port to scene measuring. On the basis of the calibration equation, we can get the antenna temperature corresponding to the receiver output. Running following the steps describing above again and again will complete periodic calibration.

III. ANALYSIS OF THE SENSITIVITY

The original sensitivity formula of the total power radiometer, giving in formula (1), has met explained the effect of calibration noise upon the radiometer sensitivity and given the effect of the gain fluctuation in terms of calibration parameters.

$$
\Delta T_{\text{ant}} = T_{\text{sys}} \sqrt{\frac{1}{B \tau} + \left(\frac{\Delta T}{T}\right)^2}
$$

where $T_{\text{sys}}$ is the equivalent system input noise temperature, including the antenna output noise temperature based on scene radiation and the equivalent system internal input noise temperature. $B$ is the prefilter's bandwidth. In the following paragraphs we will give another