

DESIGN, SIMULATION AND OPTIMIZATION OF GROUND BASED MICROWAVE SPECTROMETER FOR ATMOSPHERIC PROFILE SOUNDING

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I. Introduction

Temperature and humidity profiles are two of the most important parameters for meteorological forecast and atmospheric science. Compared with radiosonde and GPS balloon sounder, ground based microwave/millimeter wave radiometer has the advantages of small size, low operation and allocation cost and higher spatial and temporal resolutions. Compared with space-borne microwave radiometers, ground based microwave radiometers can provide higher vertical resolution for the lower atmosphere, especially bottom of troposphere and boundary layers, and can provide instant data for local areas, which is very important for short-term and local meteorological forecast.

In this paper, simulator of a microwave spectrometer is presented. With this simulator, two type of system configurations, the microwave RF filter bank system and system with tunable receiver frequency are compared. Simulations for different number of channels/frequencies are presented to optimize the retrieval precisions.

II. System descriptions

The ground based microwave spectrometer for atmospheric profile sounding is a total-power microwave radiometer with a scanning mechanism with can rotate continuously in the vertical plane. The system is with a multi-point calibration unit, including a microwave absorber with precise temperature measurement.

The system includes a receiver with noise injection circuit, a scanning servo, a command and processing unit and a blackbody calibrator.

For agile application purpose, two sounders will be integrated into a system, which includes a humidity profile sounder (20~30GHz) and a temperature profile sounder (50~60GHz).

Fig.1 shows the system diagram of one sounder. Table-I lists the main system specifications.

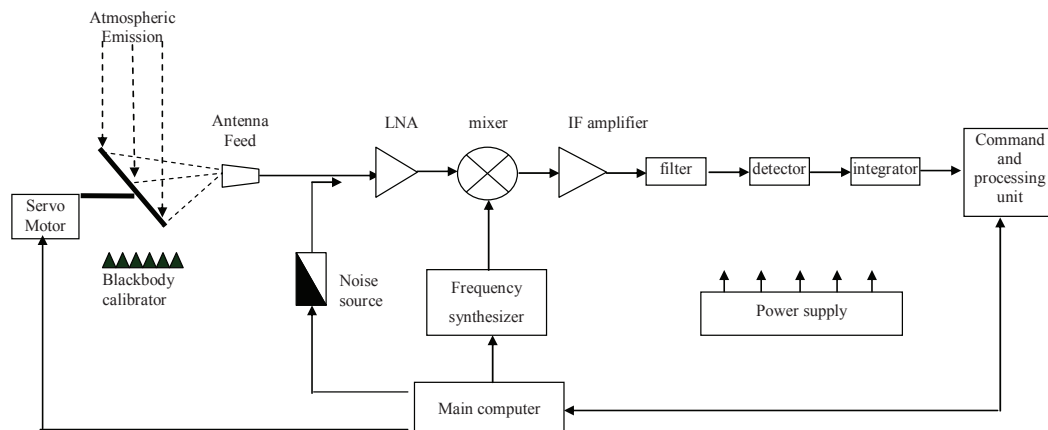


Fig.1 System diagram

Table-I system specifications

Parameters	Values
System stability	0.5~1 K
Brightness temperature range	0-400 K
Calibration	Internal and outer blackbody calibrator
Internal calibrator	Noise source
Gain correction	automatic
Integration time	≥ 1 s (for each channel)
Sampling interval	> 1 s (tunable)
Data interface	RS-232, 115 kbps
Data rate	< 20 kbps, RS-232
Inversion algorithm	ANN, LMS, Statistical regression
Angular resolution	Better than 5 degree
Sidelobe level	< -30 dBc
Operation temperature range	-30° C to 45° C
Power consumption	Average: < 150 W Peak: < 400 W
Power voltage	200-230 VAC, 50 Hz

III. System simulation and optimization

Simulations with system parameters will be optimized for the atmospheric profiling retrieval precisions. Statistical regression algorithm and artificial neural network (ANN) algorithm will be employed as the inversion method. Simulations will be done for the following parameters.

- Effect of number of channels/frequencies;
- Effect of beam width and sidelobe level;
- Effect of brightness temperature precisions;
- Effect of calibration errors;
- Effect of frequency configurations.

Based on the simulation and optimization, details of the system design will be presented.

IV. Summary

In this paper, design, simulation and optimization of a ground based microwave/millimeter wave spectrometer will be presented. Optimization of the system parameters will be done for optimized system performances.