

Developing Low-cost Microwave Radiometer Felix Ogordi, Matias Calderon Mentors: Hu (Tiger) Yang

Objectives

- Create a low-cost microwave radiometer operating at Ka band (18~22GHz) for student's education and training
- Be able to collect and process the data and save it to the flash drive through SPI communication
- Using the level-1 instrument to collect atmosphere observations at designated locations
- The collected data will be used as training datasets for ML-based retrieval algorithm

Results

- Completed the development of an operational instrument product during the 2023 summer field campaign
- Successful completion of test and evaluation for key function modules of the Ka-band radiometer
- Evaluation results show that the instrument performance meet the expectations

Figure(s)



Instrument setup for testing



Instrument packaging



Back end circuit diagram



Fundamentals of the Instrument/Hardware and Software

Hardware

- Feed Horn Antenna: Collects the incoming signal
- Switch: Dicke/High Power Mode switch
- Low Noise Block Down-Converter: Attenuates the incoming signal
- Power Detector: detects switch on/off mode of square wave power signal
- Digital Synchronous Demodulator: converts analog signal to digital data counts
- Thermistor: used to monitor the temperature of the radiometer's LNB down converter
- Fan: To control the temperature of the radiometer
- LCD screen: Utilized to display the counts from the signal and temperature of internal components, can be used to monitor stability of incoming signal





Design of the Radiometer



GUI used for data collection



Software

- Created code on Arduino that printed out the signal's counts received from the feed horn and the temperature of the instrument onto the LCD screen
- Wrote code to save the data being collected to an SD card and code for when the radiometer's temperature rose, the fan level would increase
- Utilized and updated our Graphical user interface (GUI) for the collection of data during our field campaign

Arduino code snippet



Field Campaign Data Collection and Future Work



Future Work

- Lower frequency channels with different polarization for surface observation
- Compress device packaging using printed circuit boards
- Support for autonomous data collection
- Use device to demonstrate the benefits of the ground based measurements for the calibration and validation of satellite products.



possible PCB model

Data Collection

- Our team ran tests at 11 am and 12 pm and took in the frequency signals at 5 degree intervals starting with the instrument facing directly upward
- At each angle rotation we collected the environment's temperature, pressure, altitude, and humidity
- The frequency signal and time was collected and stored on the GUI's file
- We found that counts from demodulator increased as the elevation angle increased







Interns collecting data