An Integrated G-Band 4-Channel Direct Detection Radiometer for the TROPICS Mission

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Abstract—The TROPICS (Time Resolved Observations of Precipitation structure and storm Intensity with a Constellation of Smallsats) mission, led by Dr. William Blackwell at MIT, is a constellation of CubeSats intended to dramatically increase the temporal resolution of several key measurements required to better determine the intensity and evolution of tropical storms. One of the instruments on this platform is a G-band radiometer with three channels near the 183 GHz water vapor absorption line to measure water vapor profiles and one channel at 206 GHz for cloud ice measurements. Because the CubeSat is already a small platform with limited volume and available power, and because the same CubeSat will also contain instruments for 118 GHz and 90 GHz measurements, the G-band radiometer must be contained in a very small form factor and consume a small amount of power.

We developed a prototype G-band radiometer to meet these stringent requirement including three stages of RF low-noise amplifiers, a noise diode for calibration, 2 GHz wide waveguide bandpass filters for each of the four channels, and diode detectors for each of the four channels, along with all the necessary regulation and video amplification. The prototype integrated radiometer fits in a single 1.49" x 2.26" x 0.50" split-block housing. The prototype was designed, assembled, and measured. Design and measurements will be presented in the final proceedings and presented at the Symposium. This includes measurements of filter passbands, receiver noise, NET (noise-equivalent temperature), and noise source injection. Noise temperature and noise source injection are also characterized as a function of ambient temperature from -40 C to +40 C. At room temperature, the measured noise temperature ranges from 900-1200K for the four channels. The noise source injects between 200-300K for each of the channels through a 9dB coupler in front of the LNAs. While the noise temperature and noise source measurements meet expectations, excess 1/f noise is limiting the achievable NET at the 10ms required integration time. Follow-on studies are proceeding to identify and mitigate the sources of excess 1/f noise, including bias voltage regulators, video amplifiers, detector diodes, and the HEMT LNAs. The results of this study will also be presented.