

Prelaunch Performance of the 118 GHz PolarCube 3U CubeSat Temperature Sounding Radiometer

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The low cost PolarCube 3U CubeSat supports a 118.75 GHz imaging spectrometer for temperature profiling of the troposphere and surface temperature. It is a demonstrator for a constellation of LEO passive microwave imaging and sounding satellites at V- and G-band using 3U/6U CubeSats. Such a satellite constellation for weather forecasting will provide data at high spatial and temporal resolution to observe rapidly evolving mesoscale weather.

The satellite payload is an eight channel, double sideband passive microwave temperature sounder with cross-track scanning and will provide ~17 km surface resolution from a ~450 km orbit. The radiometer implements a two-point calibration using an internal PIN switch and view of cold space. The estimated radiometer sensitivity, ΔT_{rms} varies from 0.3 to 2 K across the eight channels. The 50 MHz to 7 GHz 8-channel filter bank (designed with surface mount capacitors and inductors) fits on a 9x5 cm² RO4350B PCB and includes 2-stage amplification and detector circuitry. The scanning reflector with an 8 cm² main aperture uses a 3D printed corrugated feed that includes a WR8 to WC8 waveguide transition with a ~17° bend.

Although the instrument is based on a well established design, the challenges lie in developing a sensitive spectrometer that fits within a 1.5U volume, has high (>90%) and extremely well determined ($\pm 0.1\%$ or better) main beam efficiency, is low cost, consumes less than ~4 W of power, and satisfies the CubeSat weight and envelope constraints. Initial performance results from the instrument using the 3D printed feed and IF/VA board obtained from airborne measurements over Antarctica on the NASA DC-8 in November 2016 indicate a well-functioning radiometer and scanning antenna subsystem. PolarCube is scheduled for launch under the NASA ELaNA program in April 2018. The end-to-end characterization of the payload with the satellite bus, performance results from vibration and thermal-vacuum tests and roof-top measurements will be presented.