Low Mass, Low Power Millimeter-wave Receiver for Space Applications

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Abstract

We describe a low cost, low mass, low power millimeter-wave receiver build for use in space in the Microwave Instrument for the Rosetta Orbitor (MIRO). The mixer based receiver is used in a double sideband (DSB) mode as a low noise radiometer front-end.

Conclusion

Low mass and power are primary enabling characteristics for unmanned planetary exploration. Low cost and quick turn around proposal to implementation has become the standard mode of operation in the field. Limitations on the solar energy available at the outer planets constrains power consumption and available launch capacity to the outer planets limits mass. The MIRO instrument has worked closely with Aerojet to minimize mass, power and cost as much as possible but still maintain the reliability necessary for space applications.

The millimeter-wave receiver frontend (mmRFE) consists of a corrugated horn, sub-harmonically pumped waveguide mixer, Gunn oscillator at 94.1 GHz and low noise amplifier (LNA) mounted on an optically aligned mounting plate. The RF input is centered at 188.2 GHz and the down converted IF band is 1.0 to 1.5 GHz.

The entire IF band is detected in the backend electronics and used as a low noise radiometer "continuum" channel. The receiver is used to probe surface and sub-surface temperatures of a comet. In combination with a 560 GHz continuum channel in the MIRO instrument, which penetrates less deeply into the cometary surface, temperature gradients and energy balance of the comet can be characterized.

The double sideband (DSB) noise performance of the receiver developed, which is less than 800 K over the IF band and operating temperature, meets the 2000 K DSB noise temperature specification required by the science handedly.