# Electronics/Computers

## Miniature Low-Noise G-Band I-Q Receiver

### This receiver can be used in humidity sounders for weather forecasting, in broadband communications, and in security imagers.

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Weather forecasting, hurricane tracking, and atmospheric science applications depend on humidity sounding of atmosphere. Current instruments provide these measurements from ground-based, airborne, and low Earth orbit (LEO) satellites by measuring radiometric temperature on the flanks of the 183-GHz water vapor line. Miniature, low-noise receivers have been designed that will enable these measurements from a geostationary, thinned array sounder, which is based on hundreds of low-noise receivers that convert the 180-GHz signal directly to baseband in-phase and in-quadrature signals for digitization and correlation. The developed receivers provide a noise temperature of 450 K from 165 to 183 GHz (NF = 4.1 dB), and have a mass of 3 g while consuming 24 mW of power. These are the most sensitive broadband I-Q receivers at this frequency range that operate at room temperature, and are significantly lower in mass and power consumption than previously reported receivers.

The receiver development was based on the latest high-performance monolithic millimeter-wave integrated circuit (MMIC) process. The technology used for the MMICs was 35-nm-gate-length InP HEMT (high electron mobility transistor). It has demonstrated very high transconductance of over 2,000 mS / mm, and sharp turn-on characteristics, which are beneficial for low-noise amplifiers (high transconductance at low drain current). The noise temperature of the receiver is dictated by the first low-noise amplifiers (LNAs) that were slightly modified from the previously reported LNA MMICs. They had three amplifier stages in common source configuration, and passive circuitry was designed with microstrip transmission lines on the 2-mil-thick InP material.

The MMIC LNA has been designed and processed in 35-nm InP technology where the MMIC is 900 × 600 $\mu m^2$. It is a three-stage design, where each transistor has two gate fingers, for a total of 30 µm gate periphery per device. These LNAs were screened for assembly in the receiver modules by on-wafer measurements.

The LNAs provided the low noise and sufficient gain for the receiver modules, so that an MMIC second harmonic I-Q mixer could be implemented as a resistive balanced mixer. The mixer MMIC was designed in the same 34-nm technology as the LNAs. The quadrature downconversion was implemented with a 90° hybrid coupler (Lange coupler) on the RF side of the mixer. This coupler improved the return loss of the mixer, and achieved broadband 90° phase difference between the two balanced resistive unit mixers. The HEMTs of the mixers had dual gates for balanced LO feed, and they operated biased to below channel pinch-off to maximize the second harmonic content in the channel conduction cycle. The RF signals were directed to the unbiased drains of the mixer HEMTs, and the IF channels were filtered from the drain contacts. A compact and highly efficient power divider and balun were developed for the LO side.

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## Methods of Using a Magnetic Field Response Sensor Within Closed, Electrically Conductive Containers

### The sensor can be used in containers such as metal fuel tanks.

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tMagnetic field response sensors are a class of sensors that are powered via oscillating magnetic fields, and when electrically active, respond with their own magnetic fields with attributes dependent upon the magnitude of the physical quantity being measured. A magnetic field response recorder powers and interrogates the magnetic sensors [see "Magnetic-Field-Response Measurement-Acquisition System," *NASA Tech Briefs* Vol. 30, No, 6 (June 2006, page 28)].

Electrically conductive containers have low transmissivity for radio frequency (RF) energy and thus present problems for magnetic field response sensors. It is necessary in some applications to have a magnetic field response sensor's capacitor placed in these containers. Proximity to conductive surfaces alters the inductance and capacitance of the sensors. As the sensor gets closer to a conductive surface, the electric field and magnetic field energy of the sensor is reduced due to eddy currents being induced in the conductive surface. Therefore, the capacitors and inductors cannot be affixed to a conductive surface or embedded in a conductive material. It is necessary to have a fixed separation away from the conductive material. The minimum distance for separation is determined by the desired sensor response signal to noise ratio.

Although the inductance is less than what it would be if it were not in prox-