Terahertz Heterodyne Receiver Frontend Based on SiGe BiCMOS Technology for Space Applications

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***Abstract*— We present a heterodyne receiver based on SiGe BiCMOS technology covering frequencies from 225 GHz to 255 GHz. We have performed emission and absorption spectroscopy of gaseous acetonitrile and have characterized the receiver. The double sideband noise temperature increases from 9 000 to 20 000 K in the frequency band of the receiver.**

Keywords—millimeter-waves, heterodyne receiver, gas spectroscopy, SiGe technology

I. Introduction

The terahertz (THz) spectral range is of great interest in astronomy and in atmospheric research because they cover rotational transitions of many relevant molecules. For instance, carbon monoxide (230.5 GHz) or ozone (235.7 GHz) provide strong transitions in this frequency range. Instruments working at millimeter-wave (mmW)/THz frequencies have been employed successfully to study the Earth's atmosphere, planetary atmospheres, comets and other astronomical objects [1-5].

For missions on small satellites such as CubeSats, compact systems without the need for cryogenic cooling are desired. Silicon-based technology is well suited as it fulfils these requirements and furthermore offers high integration capabilities and relatively low costs. Earlier, we have demonstrated sensitive active gas spectroscopy using a tunable transmitter and receiver based on SiGe BiCMOS technology [6].

In this work, we demonstrate passive absorption and emission spectroscopy around 240 GHz with a SiGe-based receiver frontend and characterize it with respect to space applications.

II. Results

The receiver frontend is implemented in IHP's 0.13 µm SiGe BiCMOS technology [7]. It is mounted on a compact baseband board which provides the supply voltages and the PLL for the local oscillator (LO). The LO covers frequencies between 225 GHz and 255 GHz. We demonstrate passive absorption and emission spectroscopy with a digital fast Fourier transform backend spectrometer and characterize important characteristics of the receiver, e.g. Allan time and noise temperature. Fig. 1 shows emission spectra of acetonitrile measured at different pressures. The noise temperature of the receiver was measured by the Y-factor method and was determined to 9 000 K – 20 000 K depending on the LO frequency [8].

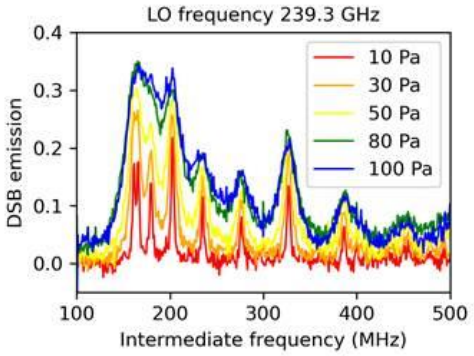

Fig. 1. Emission spectrum of Acetonitrile measured at different total pressures (10 Pa – 100 Pa) with an LO frequency of 239.3 GHz.

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