A 1080-1280 GHz Sub-Harmonic biasable Schottky Front-end Design for Planetary Science and Remote Sensing

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The design and optimization of a sub-harmonic biasable frequency mixer at 1.2 THz based in the Schottky diode technology is presented in this work. The design is dedicated to the Sub-millimeter Wave Instrument (SWI) which will take part of the payload in the JUpiter ICy moon Explorer (JUICE) mission of the European Space Agency (ESA). The procedure previously followed by LERMA in the design of a front-end receiver at 600 GHz that performs an average of 1284 K DSB noise temperature, presented in [1], is applied on the design of this receiver at 1.2 THz. The methodology used in the design and optimization is based on a non-linear harmonic balance simulator (Agilent ADS) coupled with a 3D-Electro-magnetic simulator (Ansoft HFSS). Both the Monolithic Microwave Integrated Circuits (MMIC) of the local oscillator (LO) chain and the mixing stage are manufactured using the E-beam photolithography LERMA-LPN process [2], especially important for the fabrication of the smallest features in the chip, such as the Schottky anodes and air-bridges. The local oscillator chain consist of an already tested power combiner frequency doubler at 270-320 GHz, which performs up to 27% of conversion efficiency using the on board power supply configuration, and a second single chip frequency doubler at 540-640 GHz which has been designed to perform up to 17% of conversion efficiency to deliver at least 1 mW of local oscillator input power. Due to the low LO power delivered on the mixer, a bias configuration has been included in the design in order to increase the tune-ability of the receiver along the frequency band. Several technical improvements in the manufacture process of these MMIC devices have allow us the design of more sophisticated structures, such as the DC path and the edging of the GaAs-membrane to reduce transmission losses. In addition, some of the possible options related to the Schottky diode structure have been studied by considering a 2-dimensional physical simulator base on the *ensemble* Monte Carlo method for semiconductor devices [3].

Preliminary discrete Schottky components fabricated for the 1.2 THz frequency mixer, have given us a set of measurements of the I-V characteristics to be introduced in the ADS Schottky diode model. The parameters used in the Schottky diode model consist of a $C_{j0} < 1$ fF junction capacity, a $I_s = 3.65\cdot10^{-13}$ A saturation current, a $\eta>1.4$ ideality factor and a $R_s>60\ \Omega$ series resistance. The ADS test-bench includes the losses introduced by the RF antenna, the real LO and RF path dimensions and the noise figure of the low noise amplifier (LNA), in order to reproduce as well as possible the real conditions of the receiver. A DSB noise temperature under 5000 K is expected at room temperature in the entire frequency band according to our ADS-HFSS simulations. The experimental verification of this performances waits for the finalization of the current manufacture process at LPN.

References

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