325 GHz and 650 GHz Dual-polarisation receivers Concept

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***Abstract*— The integrated dual-polarisation receivers utilize a dual probe concept, efficiently integrating the antenna and MMIC package environment which allows for polarisation discrimination without the use of bulky and lossy external orthomode transducers. This concept increases the sensitivity of the instrument and reduces its size, enabling the development of future earth observation arrays. Omnisys Instruments AB (Sweden) and Chalmers University of Technology (Sweden) are working to demonstrate state-of-the-art dual polarisation capability with two integrated receiver modules at 325 GHz and 650 GHz.**

Keywords*— *Radiometer, receivers, Polarisations, remote sensing, Schottky diodes, Low noise amplifiers, Microwave,

I. Introduction

Integrated dual polarisation receiver demonstrators at 325 GHz and 650 GHz are an advantage for weather and climate applications such as, constellation of small weather satellites, cost efficient atmospheric science missions and future cubesat instruments, due to the strict volume accommodation and performance requirements. This article describes the architecture of two integrated Schottky – MMIC front-end receivers operating at 325 GHz and 650 GHz, respectively.

The schematic of the spaceflight intended dual-polarisation receivers is shown in Fig. 1. A synthetiser device with integrated voltage control oscillators (VCO) can deliver a tone from 40 MHz to 15 GHz. The selected VCO frequency is 10.156 GHz. A first stage of LO driver with active multiplier and power amplifier provides around 180 mW at a frequency of 81.25 GHz. A Schottky multiplier (x2) converts the 81.25 GHz frequency to 162.5 GHz with input and output powers of 125 mW and 50 mW, respectively. This multiplier provides the LO signal to the 325 GHz front-end. For the 650 GHz front-end, another Schottky multiplier (x2) is added to the LO multiplier stage to reach an output frequency of 325 GHz with 10 mW output power. Each front-end is integrated in one single block with similar architecture. One front-end is composed of a spline horn antenna, an integrated orthomode transducer (OMT), two sub-harmonic mixers (SHM), two IF low noise amplifier MMICs, and a LO splitter. The dual probe concept consists of the integration of an orthogonal probe layout with the two mixers on a single substrate. The design is a 3µm thick suspended GaAs membrane with 1µm thick gold strip. It is suspended in between the split blocks interconnected with on circuit integrated waveguide probe transitions and freestanding gold beam leads (used for mechanical support), RF/DC ground connections, and IF circuit interconnects. This configuration has previously been demonstrated at 424 GHz [1]. Anti-parallel Schottky diodes are provided by Chalmers University of Technology. They have been used as mixer diodes with state-of-the-art performances in several instruments in the past [2], and at frequencies up to 3.5 THz [3]. Low noise MMIC amplifier chips from Low Noise Factory AB (Sweden) are integrated with their matching networks inside the front-end block. A single chip has an RF bandwidth of 1-15 GHz and gain of 37 dB. Finally, spline horn has been designed for high cross-polarisation discrimination.

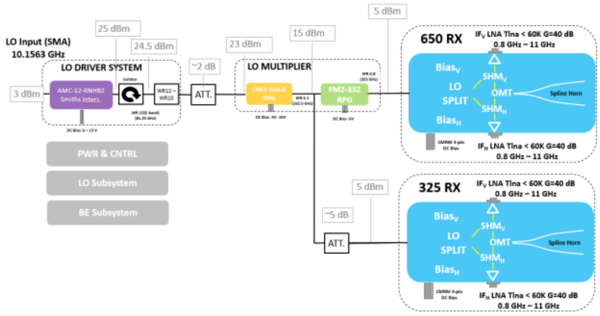

Fig. 1. Schematic of the dual-polarisation receivers at 325 GHz and 650 GHz

II. Results

Two dual-polarised receivers operating at 325 GHz and 650 GHz were modelled using Ansys HFSS and Advanced design System (ADS) and simulated with a non-linear analysis. The preliminary simulated performance of a single polarised sub-harmonic DSB mixer with an integrated OMT RF probe structure is shown in Table I. The OMTs for the 325 GHz and 650 GHz receivers have a simulated cross-polarisation discrimination better than -25 dB across the band and low transmission losses (around 0.2 dB). The mixer simulated conversion loss was simulated at around 9 dB with a 2 mW LO power at 325 GHz and 10 dB with 2.5 mW LO power at 650 GHz. Assuming a 180 K diode output noise, the receiver noise temperature with the integrated MMIC would range between 737 – 1024 K for the 325 GHz receiver and 982 – 1424 K, for 650 GHz receiver.

TABLE I. Simulation Results

Frequency (GHz)	*Mixer Conv. Loss (dB)*	*Trec.(K)*	*OMT X-pol. Discrimination (dB)*
314 – 336	8.67 – 9.14	737 - 1024	-26.3 ± 1.0
639 – 661	9.92 – 10.57	982 - 1424	-25.3 ± 0.2

References

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