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Integrated Dual-polarisation receivers for microwave remote sensing applications

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Summary

Omnisys Instruments AB (Sweden) and Chalmers University of Technology (Sweden) demonstrate start-of-the-art dual polarisation receivers operating at 325 GHz and 650 GHz from a European Space Agency (ESA) funding. This concept has a great technological advantage for meteorological and scientific applications such as, the constellation of small weather satellites, cost-efficient atmospheric science missions and future cubesat radiometric instruments. The integrated dual-polarisation receiver comprises two orthogonal RF probes incorporated in a MMIC package environment with state-of-the-art Schottky diodes. This permits to measure both H and V polarisation using a compact and efficient orthomode transducer, therefore reducing the receiver noise.

1.Integrated Dual-polarisation Receivers

The integrated dual polarization concept relies upon the integration the antenna in a MMIC package environment to reduce the loss in high frequency front-end microwave receivers. Indeed, this concept permits to remove wired polarisation grid or orthomode transducer, lossy element within the RF path. By doing so, the radiometric sensitivity is improved and the size of the front-end is reduced. This would allow, for example, the incorporation of more microwave channels observing both polarisations in future microwave sounder missions. This article focuses on the development of the 325 GHz and 650 GHz channels, which are important to better resolve ice-clouds which are thought to be critical in atmospheric cooling processes and the generation of precipitation. This configuration has previously been demonstrated at 424 GHz [1].

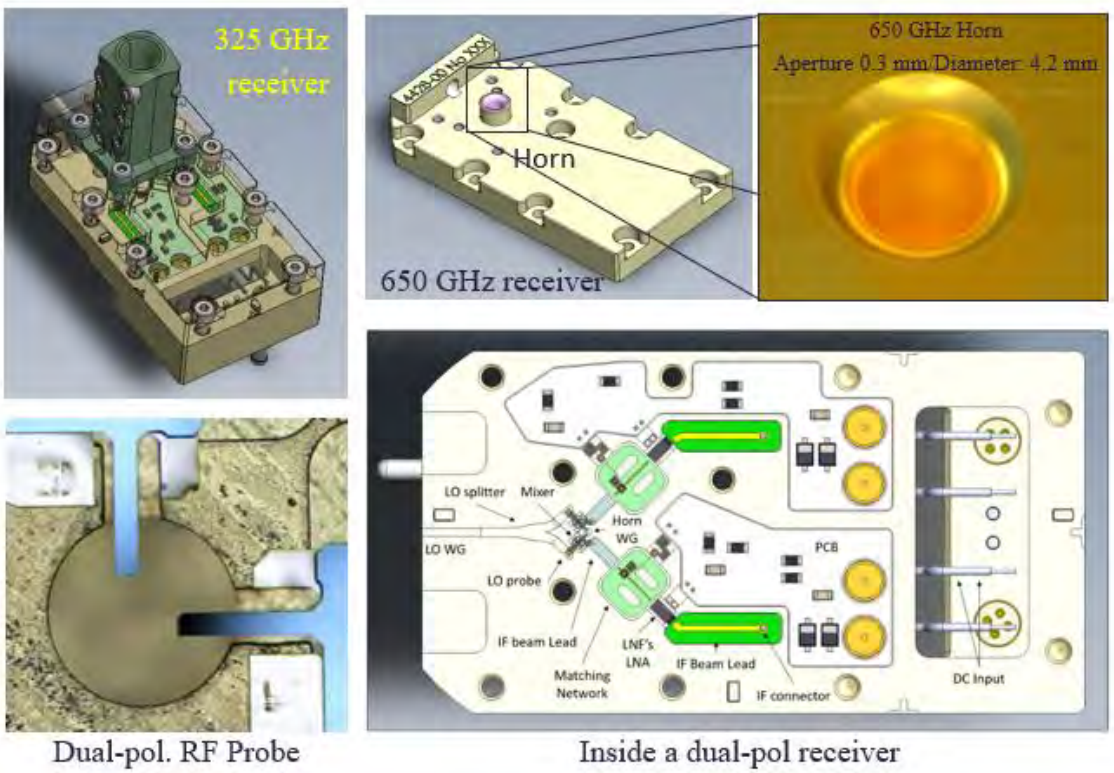

Figure 1 325 GHz and 650 GHz dual-polarsiation front-end receivers

Figure 1 shows the design of various parts of the dual-polarisation receiver (Othrogonal RF probes, 650 GHz integrated spline horn antenna, internal components). Each receiver is integrated into one single split block with similar architecture. It comprises a spline horn antenna, an integrated orthomode transducer (OMT), two subharmonic mixers (SHM), two IF low noise amplifier MMICs, and a LO splitter. The dual-probe concept integrates an orthogonal probe layout with the two mixers on a single substrate. The design is a 3μm thick suspended GaAs membrane with a 1 μm thick gold strip. It is suspended 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. Chalmers University of Technology provides anti-parallel Schottky diodes and MMIC chip. They have been used as mixer diodes with state-of-the-art performances in many instruments [2]. Low noise MMIC amplifier chips from Low Noise Factory AB (Sweden) are integrated with matching networks inside the front-end block. Biasing boards are integrated into the receiver block for the low noise amplifier.

2. Radiometric Results

Two dual-polarised receivers operating at 325 GHz and 650 GHz, were assembled, and tested. Preliminary results show a system noise temperature between 800 K and 1500 K for an intermediate frequency (IF) between 1 – 15 GHz with a local oscillator at 325 GHz. For the 650 GHz receiver, it is between 1500 K – 2500 K over the 1 – 15 GHz IF bandwidth. The cross-polarisation of the 325 GHz receiver is better than 15 dB and the Allan variance stability time above 10 seconds. The final tests of the 650 GHz receiver are currently on-going and will be presented at the conference.

References

[1]. P. Sobis, et al., “Membrane Integrated Asymmetric Dual E-plane Probe Ortho Mode Transducer at 424 GHz”, *29th IEEE International Symposium on Space Terahertz Technology*, 2018.

[2]. M. Anderberg et al., “A 183-GHz Schottky Diode Receiver with 4 dB Noise Figure,” Feb. 2019, pp. 172–175, doi: 10.1109/mwsym.2019.8701051.