Digitally tunable 150 GHz Local Oscillator chain for the Submillimeter Wave Instrument onboard the ESA JUICE mission

B. Thomas[1], M. Philipp[1], K. Lichius[1], M. Trasatti[1], A. Maestrini[2], E.P. Miettinen[3] and P. Hartogh[3]

The Submillimeter Wave Instrument (SWI) is one of the 10 scientific instruments selected as payload onboard the JUpiter ICy moons Explorer (JUICE) satellite [1], the first large-class mission in ESA's Cosmic Vision 2015-2025 programme. SWI will perform atmospheric remote sensing of Jupiter's middle atmosphere and the exosphere of the Galilean moons [2].

SWI features two heterodyne channels centered around 600 GHz and 1200 GHz frequencies, relying on passively cooled Schottky diodes receivers [3]. Part of the Local Oscillator operates nevertheless at close to ambient temperature.

RPG is developing the 150 GHz Local Oscillator chains for both 600 GHz and 1200 GHz channels. It uses a combination of discrete Schottky Varactor diodes (from Teratech Ltd.) and amplifier MMICs (from ADI/Hittite). Although the LO chain for the 600 GHz channel is relatively straightforward with a cascaded E-band tripler, E-band Medium Power Amplifier and 150 GHz doubler chain, the 1200 GHz LO chain relies on power-combining techniques already described in [4]. A view of this power-combined LO chain is shown in Fig.1.

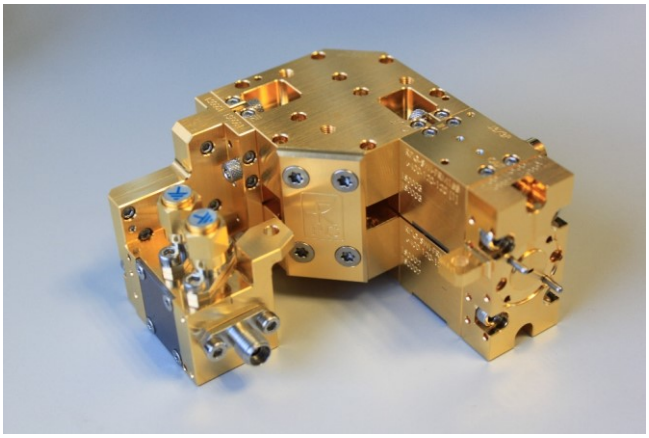

Fig. 1. View of the 150 GHz power-combined LO chain for the 1200 GHz EM channel. Outer dimensions are 70x74x38.5 mm[3]

This chain operates between 136 GHz and 158 GHz and includes internal voltage regulation and digital control of the output power. The main challenge in developing the EM LO chain was to integrate a DC circuit controllable electronically with 12 bits of TTL lines in order to tune the amount of LO power from +13dBm to +19dBm. Each amplifier and doubler module includes an independent fixed DC bias voltage, and 3 bits of control. The tripler operates in self-biasing mode.

The components and LO chains have been designed for broad bandwidth, wide power tuning capability, low DC power consumption and maximum integration of the control electronics, featuring radiation hard parts and additional spot shielding to increase resilience against the harsh Jupiter radiation environment.

Extensive test results of the EM LO chains for both 600 and 1200 GHz channels will be presented, as well as the FM development status and qualification approach.

REFERENCES

[1] ESA JUICE web portal. Website: http://sci.esa.int/juice/

[2] P. Hartogh el al, "The Submillimeter Wave Instrument on JUICE", proceedings of the 29th Internal Symposium on Space Terahertz Technology – ISSTT, Pasadena, CA, USA, March 26-28, 2018.

[3] A. Maestrini el al, "The 1200GHz receiver front-end of the Submillimeter Wave Instrument of ESA Jupiter Icy moons Explorer", proceedings of the 8th ESA Workshop on millimeter-wave technology and applications – ESA-ESTEC, Noordwijk, The Netherlands, December 10-12, 2018.

[4] B. Thomas et al, "Compact power-combined LO sources for SWI onboard JUICE", proceedings of the 36th ESA Antenna Workshop on Antennas and RF Systems for Space Science, ESTEC, Noordwijk, the Netherlands, Oct. 6-9, 2015.

[1] Radiometer Physics GmbH, 53340, Meckenheim, Germany

[2] Observatoire de Paris, LERMA, 75014, Paris, France.

[3] Max Planck Institute for Solar System Research, 37077, Göttingen, Germany.

NOTES: