Design of Large-Band Room-Temperature On-Chip Diplexed Schottky Receivers for Planetary Science

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Abstract— Planetary Water, chemistry and energy/heat are the three key aspects to consider when it comes to address habitability in planetary bodies such as Europa and Enceladus. Most of these lines, salts (**NaCl, KCl, MgCl, NaOH, KOH, MgO**), carbon molecules (**CO, CN, HCN, H_2C, CH_3CN, CH_3OH**), water (**H_20, $H_2{}^{18}O$, $H_2{}^{17}O$, HDO**), and sulfur molecules (**H_2S, SO_2**), span across a large frequency band: 216-580 GHz, which imposes a large required RF bandwidth for a receiver. Such a receiver needs to be room-tcapable of high-resolution (<100 kHz) molecular spectroscopy to measure line shapes and Doppler shifts of molecular emissions from gases in environments as harsh as the Jupiter system. This can be accomplished using Schottky diode heterodyne receivers, which offer high resolution based on their temporal stability and dynamic range. The GaAs diodes are inherently radiation immune. Fly-bys mission require fast integration times, which also implies high-receiver sensitivities. By using a single large-band receiver with no need to continuously switch the LO, data can be retrieved faster. To be able to detect simultaneously most of the key molecules without switching the LO, a 3-50 GHz IF is required. In addition, the use of a single-receiver avoids the need of polarizing grids to separate the telescope beam into multiple receivers, which reduces RF losses and increases the sensitivity.

In this work we will present the progress towards developing a large-band receiver in the 216-581 GHz featuring Schottky mixers based on a novel frequency mixer design topology, on-chip frequency diplexer-mixer that will be able to extend the bandwidth of current submillimeter-wave receivers from the current 15% (state-of-the-art) up to around 90%. The mixers will be pumped by frequency multiplied local oscillator sources based on the same on-chip duplexing concept. This novel concept is an evolution of the JPL's on-chip power-combined frequency multiplier concept [1] and it consists of a single-substrate multiplier or mixer chip with half of the diodes tuned to the lower half of the target frequency band, and the other half tuned to the upper half of the band. All diodes couple the multiplied signal to the same output waveguide using two on-chip E-probes, each one tuned to one half of the total band.