DESIGN AND CHARACTERIZATION OF 225–370 GHZ DSB AND 250–360 GHZ SSB FULL HEIGHT WAVEGUIDE SIS MIXERS

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We report on the design and characterization of two full height waveguide SIS mixers for astronomical applications: a DSB fixed tuned mixer covering 225–370 GHz, and an SSB tunable mixer covering 250–360 GHz.

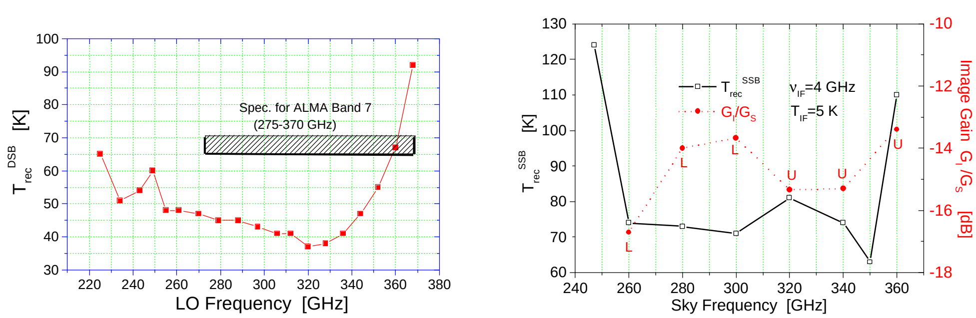
The DSB and SSB mixers are based on identical wideband single-ended probe transitions from the full height waveguide to suspended microstrip, with the substrate perpendicular to the waveguide axis. The DSB mixer is intended as a baseline design for ALMA band 7, and the SSB mixer is intended for the new receivers of IRAM's Plateau de Bure interferometer. Both mixers use similar chips comprising — besides the usual RF choke — a parallel inductor tuning structure, and a quarter-wave impedance transformer in capacitively loaded coplanar waveguide.

The DSB mixer has a fixed backshort cavity approximately $\lambda/4$ behind the substrate, while the SSB mixer has a moving non-contacting backshort in a circular waveguide (0.88mm diameter), with a transition to the rectangular waveguide (0.76×0.38mm).

For the SSB mixer, image rejection is achieved by adjusting the backshort to a position such that, simultaneously, an optimum match is achieved at the signal frequency, while a reactive termination is presented to the junction at the image frequency. With the currently adopted IF frequency (4GHz), these conditions can be realized with the backshort located approximately 6mm away from the probe.

Maybe the most significant design issue in the present work was to achieve SSB operation over a wide tuning range, while ensuring stable operation in all cases. A stability criterion has been derived and applied in the design; the results confirm the correctness of this approach.

The DSB mixer achieves a noise temperature lower than 50K over a bandwidth larger than 100GHz, with a minimum value of 37K. The SSB mixer achieves a (quasi-SSB, image gain less than –13dB) noise temperature of the order of 80K over most of the band with a minimum of 63K at 350GHz.



Results achieved with the two mixers. Left: DSB mixer, DSB noise temperature. Right: SSB mixer, receiver noise temperature from hot-cold load measurement, not corrected by (1+g_i), and image gain ratio, measured using a MPI interferometer. The receiver noise temperatures are not corrected for optics or LO injection losses.