

ALMA Band 5 cartridge performance.

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Abstract

Work presented here concerns the design and performance of the ALMA Band 5 cold cartridge, one of the 10 frequency channels of ALMA project, a radio interferometer under construction at Atacama Desert in Chile.

The Band 5 cartridge is a dual polarization receiver with the polarization separation performed by orthomode transducer (OMT) [1]. For each polarization, Band 5 receiver employs sideband rejection (2SB) scheme based on quadrature layout, with SIS mixers covering 163-211 GHz with 4-8 GHz IF. The LO injection circuitry is integrated with mixer chip and is implemented on the same substrate, resulting in a compact 2SB assembly.

Amongst the other ALMA bands, the ALMA Band 5 being the lowest frequency band that uses all cold optics, has the largest mirror. Consequently, ALMA Band 5 mirror along with its support structure leaves very little room for placing OMT, mixers and IF subsystems. The constraints put by the size of cold optics and limited cartridge space, required of us to revise the original 2SB design and adopt a design where all the components like OMT, mixer, IF hybrid, isolators and IF amplifier are directly connected to each other without using any co-ax cables in-between. The IF subsystem uses the space between 4 K and 15 K stage of the cartridge and is thermally connected to 4 K stage. Avoiding co-ax cabling required use of custom designed IF hybrid, furthermore, due to limited cooling capacity at 4 K stage, resistive bias circuitry for the mixers is moved to 15 K stage and the IF hybrid along with an integrated bias-T is implemented using superconducting micro-strip lines.

The E-probes for both LO and RF waveguide-to-microstrip transitions are placed perpendicular to the wave direction (back-piece configuration). The RF choke at the end of the probes provides a virtual ground for the RF/LO signal, and the choke is DC grounded to the chassis. The on-chip LO injection is done using a microstrip line directional coupler with slot-line branches in the ground plane. The isolated port of the LO coupler is terminated by floating wideband elliptical termination. The mixer employs two SIS junctions with junction area of $3 \mu m^2$ each, in twin junction configuration, followed by a quarter wave transformer to couple it to the signal probe. A quarter-wave high impedance line on an extra layer of SiO_2 is used to extract the IF by separating from RF [2].

At the conference, we plan to present details of the cartridge design and results of the experimental characterization of the ALMA Band 5 cold cartridge.

REFERENCES

- [1] The actual Band 5 OMT uses slightly modified design suggested by Dr. S. Asayama for Band 5 and based on the ALMA Band 4 cartridge OMT.
- [2] Bhushan Billade, "Design of Dual Polarization Sideband Separation Mixer for ALMA Band 5", Thesis for the degree of licentiate of engineering, ISBN/ISSN:1652-9103, Gothenburg 2009.