A dual-polarization sideband separating Schottky based receiver for ALMA Band 2+3 Warm Cartridge Assembly

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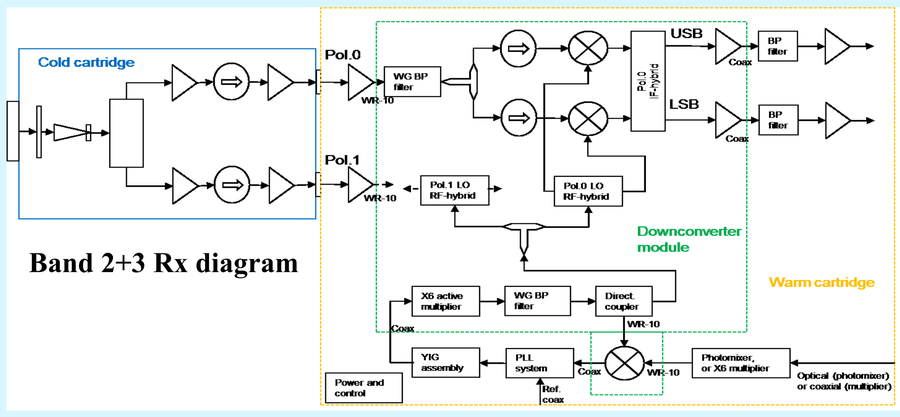
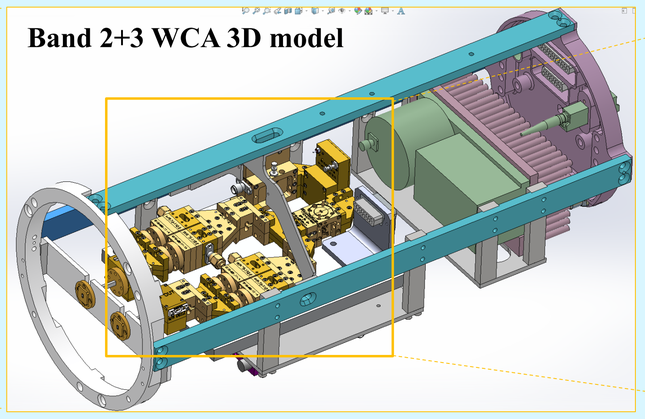
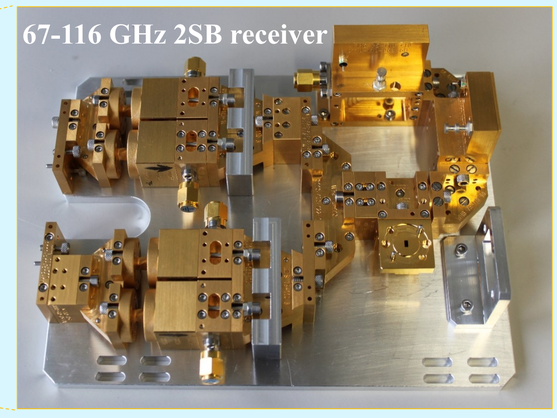
Design & Architecture

The ALMA Band 2+3 receiver is split into a cold cartridge and warm cartridge assemblies (WCA). High sensitivity and broad bandwidth is primarily achieved by an ultra-broadband and ultra-low noise cryogenic MMIC HEMT low noise amplifiers, allowing for the relaxation of the constraints in terms of noise temperature on the receiver chain inside the WCA. The Schottky based 2SB receiver presented here is located in the warm Cartridge Assembly. Each polarization channel of the side-band separating receiver consist of a broadband WR-10 waveguide Y-junction followed by two extended-W band ferrite isolators covering 67-116 GHz, two planar Schottky based fundamental balanced mixers operating in the range 67-116 GHz pumped by a common 75-110 GHz active sextupler and booster W-band amplifier source split and 90° phase shifted via a full-band 3dB waveguide hybrid coupler. IF signals are recombined with an hybrid coupler and amplified.



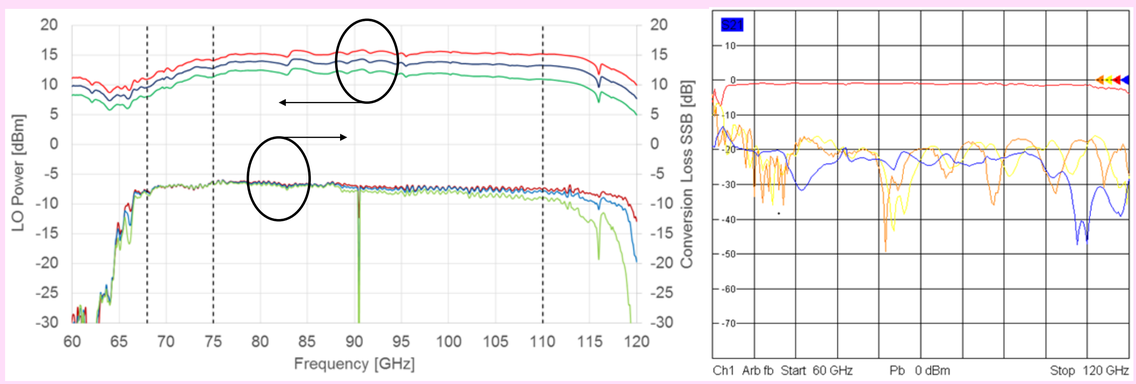
Band 2+3 Rx diagram



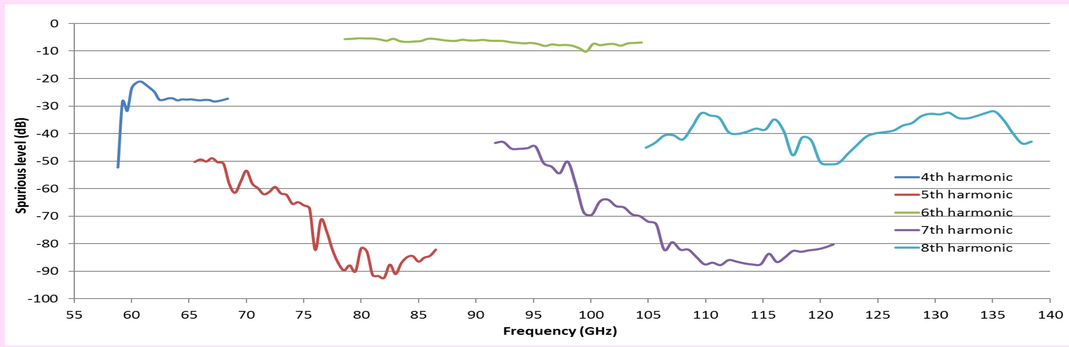


Component level characterization

A fundamental balanced mixer based on cross-bar topology has been designed to cover the extended WR10 waveguide band, from 67 GHz up to 116 GHz. In order to achieve such a broadband RF matching, the use of a ridged waveguide in the RF input waveguide to couple the RF signal to the diodes, as well as the natural mode decoupling of the RF and LO signal is necessary. Measured performance of the 67-116 GHz fundamental balanced mixer is shown below on the left hand side graph. The right hand side graph shows the measured S-parameters of the RPG 67-116 GHz isolator.

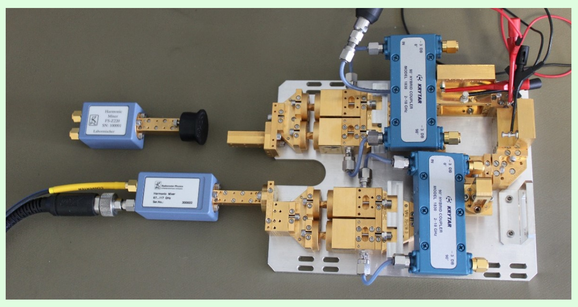


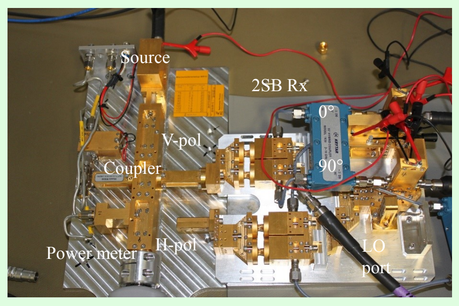
The W-band sextupler has been characterized for spurious emission (see graph below) before LO filter. The 5th and 7th harmonics of the fundamental signal appear inside the band and are not possible to filter out. The measured output power levels of the 5th and 7th harmonics is -40dBc and -30dBc respectively, in compliance with the ALMA requirements. A specially designed 79-104 GHz bandpass filter, with a rejection up to 200 GHz, allows to reject further the out-of-band 4th, 5th, 7th and 8th harmonics.



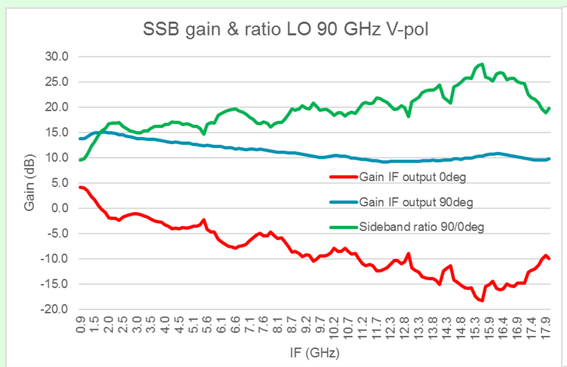
67-116 GHz 2SB receiver testing

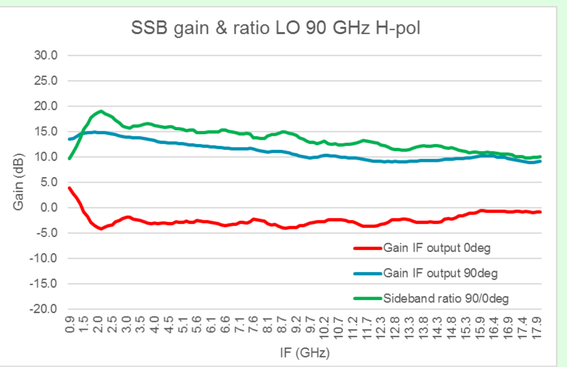
Extensive testing has been performed on the 2SB receiver chain shown in Fig.3 in order to verify the sensitivity of the receiver at room temperature. To do so, a traditional Y-factor measurement has been performed using an ambient and LN2 cooled calibration target. The fundamental LO signal is provided externally. Examples of the test setups (left for spurious measurement, right for gain and sideband ratio) are shown below.

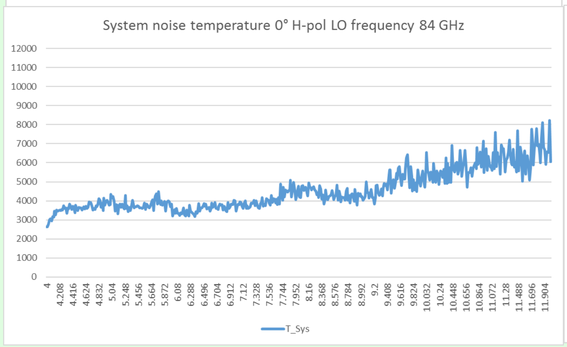


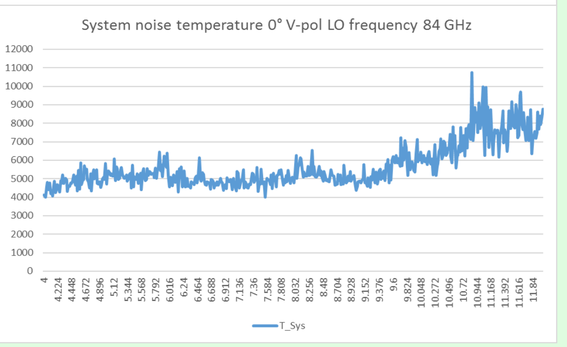


Example of test results showing the gain & USB ratio (top graphs), and receiver noise temperature (lower graphs) are presented below.









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