Upgraded Local Oscillator System for the ALMA Band 5 Receiver

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***Abstract*— The ALMA Band 5 receiver has recently completed a trial phase of development and pre-production. The work has been led by the University of Chalmers' Group for Advanced Receiver Development, Sweden, and in partnership with the United Kingdom's Rutherford Appleton Laboratory (RAL), the latter developing the receiver local oscillator (LO) chain. During 2011 the first Band 5 receiver was successfully deployed at the ALMA Observatory site, and more receivers will follow in 2012.**

The RAL Band 5 LO system operates over the frequency range of 171-203 GHz with a levelled dual minimum power output of 0.5 mW. The LO is used to pump two independent SIS sideband separating mixers that are part of a dual polarisation receiver system encompassing the input signal range of 163-211 GHz, and with a 4 to 8 GHz instantaneous frequency bandwidth. The LO uses a tunable YIG oscillator as the fundamental source and which is harmonically multiplied to the required frequency range by a combination of commercially available and bespoke components; the latter have been developed by the Rutherford Appleton Laboratory and include a Ka band photomixer, required for frequency stabilization, and a high efficiency millimetre wave doubler. Six LO units have been constructed and delivered to date.

During the LO development phase, initial receiver trials revealed a high level of amplitude modulation (AM) noise associated with the LO which affected receiver noise performance and which was partially, though not wholly, cured by attention to inter-component matching and adjustment of millimetre wave power level settings. With the objective of totally eradicating the LO noise, RAL has subsequently performed a redesign of key sections of the LO millimetre wave circuitry that have been determined to be the source of the noise. Specifically, the millimetre doubler has been upgraded to provide high frequency up-conversion efficiency with low input power, and uses RAL fabricated varactor diodes in a more optimum configuration. The, refined design will enable the operation of the doubler in a saturated mode which, in turn, will limit the undesirable LO AM noise component.

An additional benefit of the upgraded doubler is a reduction in component count associated with the millimetre wave circuitry located within the receiver vacuum space, and which is therefore less accessible. Combining the doubler with a commercially available high-power tripler allows the removal of a W-band power amplifier, these having proved difficult to source with consistent specification performance. Moreover, reducing the number of active components located in the receiver cryostat enhances the production efficiency and lowers the unit cost; both key factors that will influence the anticipated move towards full production of the ALMA Band 5 receivers.

In addition to presenting the Band 5 LO upgraded doubler design, we will also describe an improvement to the LO phase lock circuit. This uses a novel integrated W-photomixer and subharmonic mixer and will enhance compatibility of the LO chain with the ALMA frequency reference system. A schematic of the upgraded LO chain is shown in Figure 1.

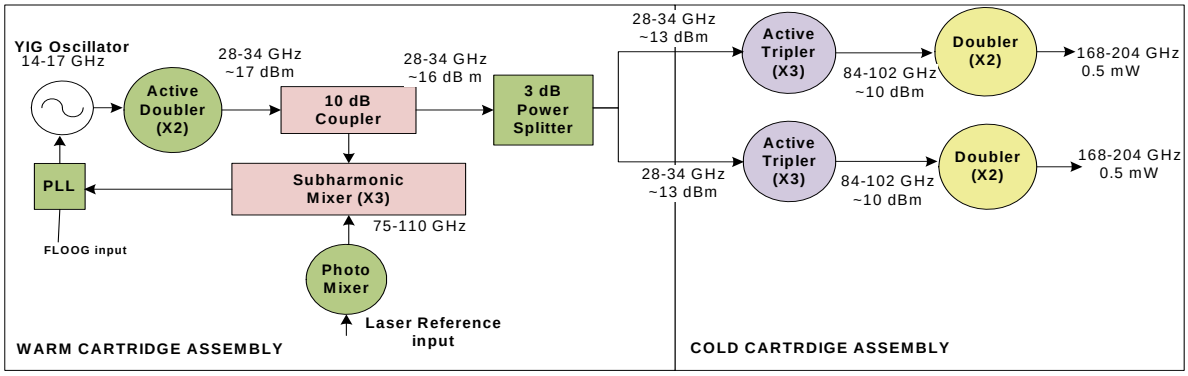

Figure 1: Schematic representation of the upgraded RAL Band 5 LO assembly