Pre-prototype ALMA Band 2+3 Down-Converter & Local Oscillator System

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Abstract— A merger of the individual ALMA front-end receiver Bands 2 and 3 into a single receiver system (Band 2+3) has the advantage of allowing simultaneous observations of spectral lines across a wide frequency range and thereby enhancing ALMA science. It also provides operational advantage by increasing access to the ALMA front-end cryostat system and thus allowing the possibility of expansion of the array front-end capability in the future.

The wide operational bandwidth of a Band2+3 system requires demonstration, however, and key technologies need to be proven. In support of this, the UK Science and Technology Facilities Council (STFC) has funded the development of a pre-prototype down-converter chain suitable for use with Band 2+3 front-end LNAs and in support of the European Southern Observatory (ESO) objective of exploring the feasibility of developing a combined Band 2+3 receiver front-end.

The ALMA Band 2+3 system is designed to operate over an input signal frequency range of 67-116GHz. The receiver system uses a cryogenic low noise amplifier (LNA) at its input, the output of which must be frequency translated (down converted) to the ALMA intermediate frequency (IF) range of 4-12GHz. The down-converter comprises a subharmonic sideband separating mixer (one for each polarisation), local oscillator (LO) and IF amplifier chain. The LO must be frequency tunable and provide sufficient output power to pump the mixer. The LO chain includes a voltage controlled oscillator (VCO) which is amplified and harmonically up converted and encompasses the frequency range 39-52.5GHz, with typical +8dBm output power. A digital interface connected to a control computer via a standard universal serial bus (USB) is used to set the VCO, and hence LO output frequency.

The sideband separating subharmonic mixer uses RAL fabricated Schottky barrier diodes. Signal input and LO division is accomplished within single mixer block housing. Design simulations indicate the expected mixer noise and conversion loss performance to be approximately 1000K (SSB) and -8dB respectively for a typical LO power level of +8dBm. The mixer block and internal circuitry have been manufactured at RAL. Details of the measurement results including mixer noise temperature and conversion loss will be presented.