Development of MMIC Receivers for Observation in the 3-mm Band at CARMA

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CARMA, the Combined Array for Research in Millimeter-wave Astronomy, provides observational facilities in the 1-cm, 3-mm, and 1-mm bands. The current receivers in the 3-mm band are single polarization, double sideband SIS mixers with cooled MMIC IF amplifiers that deliver 8 GHz of instantaneous bandwidth. We are in the process of developing a new generation of receiver based on 3-mm MMIC amplifiers followed by image separating mixers, which will be capable of delivering 17 GHz of bandwidth in each sideband for two polarizations, or 68 GHz total instantaneous bandwidth per antenna. We will present results of the continuing development.

The amplifiers are integrated blocks incorporating three MMICs, waveguide input and output probes, and gain slope equalizers, as well as an integrated bias protection circuit. Measurements of the first demonstration blocks show an amplifier noise temperature between 25 and 45 K across the 75-116 GHz band, with 45-55 dB gain.

Custom designs for waveguide components including a quadrature hybrid splitter and an in-phase splitter required for sideband separation will be described, along with VNA measurements of the *s*-parameters. We will discuss machining methods and tolerances for these components. Measurements of phase and amplitude matching of commercial broadband solid-state mixers will be shown. Experimental characterization of complete sideband separating mixers using the components will be compared with the performance expected from the component designs, as well as the system requirements.

A complete prototype receiver with dual-circular polarization MMIC receivers and sideband separating mixer has been assembled and tested in the lab. Measured noise for the receiver, including the OMT and polarizer varies between ~45 and ~70 K. On-the-sky tests on CARMA are being carried out, and for line observations the improvement in sensitivity relative to the DSB SIS receivers is ~60% is. With dual polarization this will yield a total sensitivity increase of ~2.3.