

Wideband Receiver Prototype For ngVLA: Development Report

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A wideband, 1.2 to 4.2 GHz, receiver front-end has been designed, built and tested as a demonstration system for the future ngVLA. The front-end is a single pixel cryogenic receiver which covers the ngVLA baseline Band 1, frequency range using a Quad Ridge Flared Horn (QRFH) feed and SiGe bipolar transistors low noise amplifiers. A compact vacuum vessel was designed and fabricated to host the feed and the cooled electronics. The vacuum chamber has a large 39.4 cm diameter vacuum window and is outfitted with a single cryogenic cooler. The feed is cooled to <100K using the 1st stage and the LNAs to <20K using the 2nd stage of a commercially available, compact and low power Gifford McMahon cryogenic cooler. Results of the thermal, mechanical and RF design will be presented. The simulated RF performance of the QRFH feed inside the cryogenic package will be shown including aperture efficiency and spillover noise with an offset-Gregorian SKA-type optics system as well as measured feed reflection coefficient. The performance will be presented including: noise temperature of low noise amplifiers, power dissipation of cryogenic electronics and calibration schemes. The heat load data will be shown based on actual measured temperature data on the prototype system. The noise temperature of the packaged receiver will be measured “off antenna” using the Y-factor method and the noise contributions of each component of the system will be determined. We believe this system provides an early ngVLA demonstration of capability leading to $T_{\text{sys}} < 20\text{K}$, frequency range of 3.5:1, low cost manufacture, and low power consumption for low operating cost.