A New UHF High Dynamic Range Receiver for the Arecibo Observatory

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The Arecibo Observatory's radio telescope studies the upper regions of the atmosphere using its 430 MHz receiver system. The current receiver has limited dynamic range and can saturate when detecting high power signals. The receiver is also plagued with a lengthy recovery time when overpowered by the nearby radar transmitter pulse. In this paper, a new design of a low noise amplifier (LNA) is presented, which will extend the receiver's sensitivity and exhibit a faster recovery time to the radar's transmitter leakage pulse. In addition, a compact high temperature superconducting (HTS) bandpass filter is introduced to the receiver chain to replace the receiver's current cavity resonator filter. The design of the planar filter improves the rejection of undesired signals into the 430 MHz receiver chain.

Prototypes of both the low noise amplifier and bandpass filter have been designed, fabricated, and tested with successful results. Arranged in a balanced configuration, the LNA employs GaAs high electron mobility transistor (HEMT) packaged-integrated circuits selected for their low noise characteristics. The amplifier prototypes were tested at room temperature and in a cryogenic environment. Final verification of the amplifier design involves precision cryogenic noise temperature measurement techniques commonly adopted in the field of radio astronomy instrumentation. Such methods eliminate many errors present in the standard cryogenic measurements. In addition, the bandpass filter design utilizes distributed microstrip elements fabricated from an Yttrium Barium Copper Oxide (YBCO) thin film superconductor on a Magnesium Oxide (MgO) substrate. The new filter prototype uses interdigital hairpin resonators to improve spurious suppression and size reduction. We will present a full description of the design process, validation, measurements, and deployment results of the new receiver system.