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A cryogenic front-end preamplifier operating at 120K for bolometric detector

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A tin cryogenic bolometer detector, TIN.TIN (The INdia based TIN detector), is being developed to study neutrinoless double beta decay in 124Sn [1]. The detector uses a NTD Ge sensor, cooled to 10 mK in a Cryogen Free Dilution Refrigerator [2]. The change in temperature of the absorber due to any incident photon/charged particle is detected by the sensor and the electrical signal is amplified using a low noise differential amplifier. In the present detection system, output signal of the sensor is transmitted using a long shielded twisted pair cables from the 10 mK stage to the amplification system at room temperature. The large time constant due to the sensor resistance (~500MΩ) and cable capacitance lead to deterioration of the electrical pulse. The long transmission cables are also prone to external EMI pickups. Generally, it is desirable to have a front-end amplification stage inside the cryostat to minimize the effect of long cables. In this paper, we present the design and test results of a cryogenic preamplifier operating at 120K. The preamplifier is implemented in source follower configuration using a low noise Si JFET (IF3601). The DC biasing lines of the amplifier are filtered using low pass RC circuits to eliminate supply noise. A NI based DAQ system is used to measure the voltage gain and input voltage noise density of the amplifier. The amplifier is characterized for different drain current and drain to source voltage of the FET. A gain ~ 0.95 with a 3-dB bandwidth over a wide range from DC to 10 MHz is achieved. The input voltage noise density ~ 3 nV/√Hz is obtained at room temperature which further reduces to 2.47 nV/√Hz at 120K. The flicker corner frequency is also observed to be below 60 Hz. The detailed test results of the amplifier for different bias conditions and its effect on the performance of amplifier will be presented.
[1] V. Nanal, EPJ Web of Conferences 66 (2014) 08005
[2] A. Garai et al. Journal of Low Temperature Physics 184 (2016) 609

Less than 5 years of experience since completion of Ph.D

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