



A front-end electronics for MKID-array readout towards observation of CMB polarization

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Primordial gravitational waves generated by inflation have produced odd-parity patterns, B-modes, in the cosmic microwave background (CMB) polarization. The GroundBIRD experiment aims to detect the B-mode signal at large angular scale from the ground[1]. GroundBIRD employs microwave kinetic inductance detector (MKID) arrays. We report a development of its readout system.

The readout system consists of analog parts and digital parts. Analog parts are mainly composed of analog-to-digital converter (ADC), digital-to-analog converter (DAC) and oscillator. We used commercial products for both components before[2]. However, the product of analog parts has some problems: 1) limitation of frequency range, 2) overkill functions, i.e., Field-programmable gate array (FPGA) firmware becomes to be complex, 3) electric power consumption is high; therefore, the readout system is not stable during the long term operation. This is a fatal problem as the application of the CMB observation. Therefore, we developed a new analog circuit to solve these problems.

We made the prototype of the new electronics board RHEA optimized for GroundBIRD. Two outputs/inputs of DAC/ADC operated with 200 MHz clock allow us to measure both phase and amplitude responses of MKID with continuous high rate sampling (1 kSPS with no dead-time for GroundBIRD). Its effective bandwidth is 200 MHz which fulfills GroundBIRD's requirements (>100 multiplexing). We improved both the clock

distribution and the power supply circuit, so that power consumption of analog parts is roughly half as compared with before. These improvements results in the long term stability of the system as well as easiness of coding of FPGA firmware.

Another important feature is that this board is completely separated from the digital part. Each user can choose their favorite FPGA; all functions can be controlled via the FMC LPC connector. We can switch digital control part using cutting edge FPGA at any time during our development. In particular, Xilinx UltraScale+ FPGA[3] will be released in the fourth calendar quarter of 2015. We can quickly switch it.

We will present concepts and performance of this analog board toward an application for CMB experiment, GroundBIRD.

References

- [1] S. Oguri et al. "GroundBIRD experiment - detecting CMB polarization power in a large angular scale from the ground." LTD-15 Proceedings, 2014.
- [2] Y. Kibe et al. "Low noise readout system for MKIDs with frequency-domain multiplexing technique towards application of CMB observation." LTD-15 Proceedings, 2014.
- [3] <http://www.xilinx.com/>

