

## Opto-electrical Data Transfer from Room Temperature to 4K for Superconducting Quantum Computing

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**Abstract**—The superconducting quantum computing (QC) system using 3-4K cryogenic interfacing electronics require high speed data link between the room temperature (RT) and the 3-4K environment. In this work, an opto-electrical data link is proposed for data transfer from RT directly to 4K temperature plate in the dilution refrigerator (DR). The modulated optical signal from RT is sent to a cryogenic opto-electrical receiver working under 3-4K through a fiber. The receiver is composed of a photodetector (PD), a transimpedance amplifier (TIA) and a clock-data-recovery (CDR) circuit. To validate this method, a prototype cryogenic opto-electrical receiver has been built with a PIN PD followed by a monolithic 10Gbps TIA by Siboard®. The output electrical signal is then fed into a CPLD (Complex Programming Logic Device) -based CDR circuit. To verify the function of the cryogenic receiver, its output is used to manipulate a cryogenic qubit controller ASIC (Application Specific Integrated Circuit). The cryogenic receiver has been tested on the 4K plate in a DR. In this work we have demonstrated a link speed of 12.5Mbps for the proof of concept. Actually this method can provide link speed up to several Gbps or even more, if the CPLD is replaced by a CDR ASIC. The proposed opto-electrical link can provide high-speed optical data transfer from RT to 4K, while avoiding the heat-conduction effect associated with the coaxial cables.

**Keywords (Index Terms)**—Cryogenic CMOS, superconducting quantum computing, opto-electrical, optical data link