CMB-S4

READOUT-DAQ & CONTROL INTERFACE CONTROL DOCUMENT

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Document release signatures

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REVISION HISTORY

Version Letter	Revision Date	Author: Notes
v1	6/29/20	Initial draft
v2	11/03/21	Adding detail
v3	7/17/23	Define scope boundaries, add technical detail

REFERENCED & APPLICABLE DOCUMENTS

The requirements in the following documents apply, but this document supersedes if there is a conflict.

Reference used within this doc	Version	Title & Description	Notes, relevant part of document

TABLE OF CONTENTS

1. Purpose and Scope

This document defines and describes the interface between the readout electronics and the DAQ (Data Acquisition). The readout electronics consists of cryo electronics (mK), cold electronics (4K) and warm electronics (300K) sub-systems. The warm electronics consists of a set of FPGA boards interconnected as a group with a single timing and networking link to readout software hosted on a standard server. This group of boards consists of the row and column boards required to address and readout the cold electronics associated with each flange.

A local Ethernet network and its associated commercial switch provides the interconnect between the flange groups and the readout server which hosts the readout software as well as the interface between the readout and DAQ software layers. A fiber connects the readout server with the DAQ server. The servers are commercial computers.

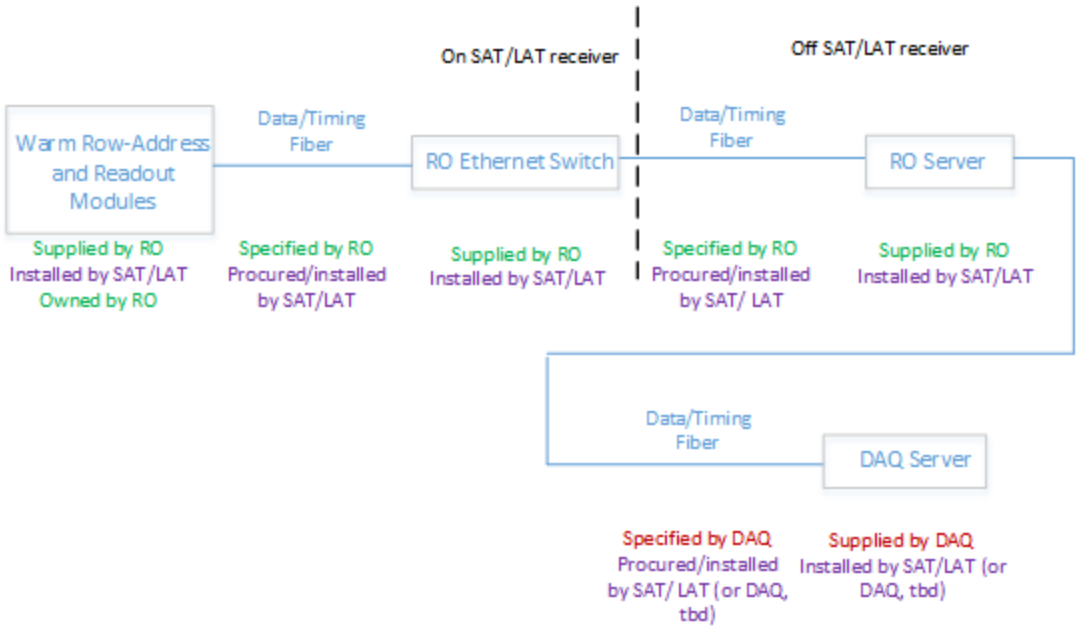

Figure 1: Component Block Diagram

The physical interface is the Ethernet cable at the end plugging into the readout network Ethernet switch, with the cable owned by the DAQ system. The protocol used to deliver timing to the readout system is under the control of the DAQ. The local protocols which exist between the readout server(s) and the readout modules are under the control of the readout system. The data and control interface between the readout and DAQ system exists as a software construct.

The component owners are:

- Readout
  - Readout modules
  - Fiber from Readout modules to on-receiver RO Ethernet switch
  - On-receiver Ethernet switch that collects data from multiple readout modules
  - Fiber from the RO switch to the off-receiver RO server.

- Control software that communicates with the readout modules (interfaces directly to OCS through an API)
- Housekeeping monitoring software to communicate with the readout modules
- Protocol which communicates between the readout software and the readout FPGAs.

- DAQ
  - Fiber from the RO to the DAQ server
  - DAQ Server
  - Timing protocol (either discrete or Ethernet based)
  - Control & monitoring framework for the observatory. Readout control software must integrate into this.
  - Support for implementing DAQ at test stands.
  - High-speed detector data collection software (not related to OCS)
  - DHCP server to assign dynamic addresses to the readout module FPGAs.

2. Abbreviations and Definitions

2.1 Abbreviations

- SQUID: Superconducting Quantum Interference Device
- TDM: Time-Division Multiplexing
- DAQ; Data Acquisition
- RO: Readout
- FPGA: Field Programmable Gate Array
- OCS: Observatory Control System
- API: Application Programming Interface

2.2 Definitions

3. Mechanical/Structural Interfaces

3.1 Hardware Interface

RO-DAQ-0010 Data Communication

The data link shall be 10 Gbit Ethernet, connecting a readout owned switch to a DAQ owned central switch.

RO-DAQ-0020 Data Connection Cable

The data cable shall contain no fewer than two single mode fiber pairs with LC connectors for each SAT/LAT. One pair is designated the primary data connection, and the other is redundant. Additional fiber pairs may be included in the data cable. They shall also be terminated in LC connectors.

RO-DAQ-0030 Timing

DAQ shall provide observatory timing functions over the primary data connection timing functions using PTP (IEEE 1588) synchronous Ethernet (tbd).

4. Software Interfaces

4.1 DAQ and Control

RO-DAQ-0040 Application Programming Interface
DAQ shall provide an API in the form of a Python package containing well documented functions and run on the readout server.

RO-DAQ-0050 Opaque Configuration Support
DAQ shall provide capability to pass opaque configuration and state data to and from the readout software running on the Readout Server.

RO-DAQ-0060 User Configuration Interface
DAQ shall provide the ability for a user to get and set configuration and state values in the Readout.

RO-DAQ-0070 Publish Interface
DAQ shall provide an interface which will allow the Readout software to publish quantities upon change or schedule to the DAQ. The DAQ will then log and/or threshold and alert as necessary.

RO-DAQ-0080 Control Interface
DAQ shall provide an interface to control the run state of the readout system. It will provide control over readout system calibration and tuning. It will provide the ability to pass parameters required. It will monitor the state of the readout system as it changes state.

RO-DAQ-0090 Bulk Data Interface
DAQ shall provide an interface to which the readout system will write its high-rate data. This may include time-aligned configuration and status data.

5. Additional Interfaces

RO-DAQ-0100 POR Reset
Readout shall implement a Power-On-Reset.

RO-DAQ-0110 External Reset
Readout shall implement an external Reset signal.

RO-DAQ-0120 Housekeeping
Readout shall provide housekeeping information to DAQ (details tbd)

RO-DAQ-0130 MAC Addressing
Readout shall provide MAC addressing information to DAQ. This will take the form of a list of relevant MAC addresses and what host they correspond to, as well as any desired hostnames if applicable.

RO-DAQ-0140 IP Addressing
DAQ shall provide IP addresses , DNS servers and routes to readout using DHCP.

4. Electromagnetic Interfaces

N/A

5. THERMAL INTERFACES

N/A