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# Design of Data Acquisition Circuit and Data Acquisition Program for EIC DIRC's Quartz Bar Quality Assurance Tests

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This note presents the design of a data acquisition (DAQ) circuit for quality assurance (QA) tests of the EIC-DIRC quartz bars.

The designed DAQ circuit, Fig. 1, and associated DAQ code will be used in QA tests to confirm that quartz bars meet the 99%-transmissivity specification.

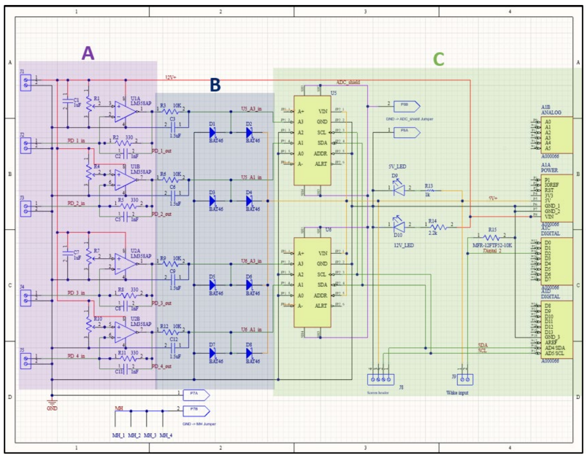


FIG. 1. Schematic of the DAQ circuit board.

Figure 1 shows the DAQ circuit developed with segments that perform specific functions, labeled A, B, and C. With this circuit, up to four Thorlabs SM1PD2A photodiodes' current $I_{in}$ can be converted by the circuit's transimpedance amplifiers, section A, to output voltages $V_{out}$ given by

$$V_{out} = V_{+} + I_{in} \times Rf$$

where $V_{out} \in$ [0 V, 5 V] for $I_{in} \in$ [0 mA, 15 mA (the maximum expected current when the test station's 325/425-nm-dual-wavelength HeCd laser is pointed directly at a photodiode)], bias voltage $V_{+} \approx 0.05$ V, and (to tune $V_{out}$ to be ≤5 V) the variable feedback resistor $R_f \approx 330$ Ω.

At the output of each operational amplifier, section B, are low-pass filters comprised of a 10-kΩ resistor and a 1.5-µF capacitor. These filters help reduce the effects of ± 10%, 30-kHz minimum noise in the laser's power output to below 180 µV, the resolution of the ADS1115 ADC [1].

To provide over- and under-voltage protection for the ADC inputs, in section B there are two Schottky diodes, connected in series, for each ADC input. The anode of the first in the series is connected to ground, the signal to the ADC connected between the diodes, and the cathode of the second diode connected to +5 V. Input protection to the ADC is provided by clamping the output voltage of the low pass amplifier to be approximately 0 V–5 V.

Connections for processing and viewing data with two ADS1115 ADC, one Arduino Uno R3 board, and an LCD screen is shown in section C. Inter-Integrated Circuit ($I^2C$) protocol is used to communicate with the ADC boards, each of which has the ability to measure four single-ended or two differential ADC inputs, and each of which has a configurable sensor address, allowing up to four ADC boards to be used on one $I^2C$ bus. The two ADC boards configured with $I^2C$ addresses of 0x48 and 0x49 and set up as differential ADC inputs provide readout for a total of four ADC channels.

The created acquisition program, EIC DIRC Quartz Bar QA DAQ

- Enables Arduino Uno R3 to communicate with the ADCs via the $I^2C$ protocol
- Converts raw ADC counts to voltage and communicates result using a serial connection to a computer and to a local LCD screen
- Handles user inputs, errors, and LCD screen sleep function with a state machine
- Uses the serial connection to the Arduino Uno R3 to communicate acquisition and system parameters, such as acquisition rate, channel name assignment, adjustable screen timeout duration, and logic, to automatically turn off the local LCD screen after a pre-set timeout period
- Re-wakes screen to display data, accomplished by pressing a button that provides input to Arduino Uno R3 labeled "wake input"—bottom right most connection in section C. Turning off the LCD screen after a timeout period prolongs its lifetime by preventing screen burn and eliminates background light.

To conclude, the designed DAQ circuit for reading the current response of up to four photodiodes, and the associated EIC DIRC Quartz Bar QA DAQ program for the quartz bar QA tests, have been tested. Currently a four-layer printed circuit board of the circuit is being manufactured.

[1] T. Lemon, et al., *Design and Simulation of the Photodiode Readout Circuit for the Quartz Bar Acceptance Tests for the Electron-Ion Collider's Detection of Internally Reflected Cherenkov Light Detector*, DSG Note 2023-14, 2023.