Evaluation of an ADC Module to be Used with the Raspberry Pi Single Board Computer for the Hall A GEM Detectors

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This note describes the evaluation of an ADC module, which will be used in conjunction with the Raspberry Pi single board computer to read the Hall A GEM detectors' pressure sensors.

The Raspberry Pi single board computer is used in instrumentation setups that need to run Linux. Because the Raspberry Pi's input-output channels are digital, an interface board is necessary for sensors that require as inputs and generate as outputs analog signals.

To measure the accuracy of the selected ADC board [1], a DAC board [2] was procured as well; both were from VP Process, Inc. The ADC board is configurable via solder jumpers to accept inputs of 4–20 mA, 0–5 VDC, 0–10 VDC, or 10-K thermistor output signals. The DAC has separate 4–20 mA outputs wired in parallel with 0–10 VDC outputs. Both boards communicate via serial peripheral interface and use an on-board regulator; they require power from the 3.3-V line of the Raspberry Pi.

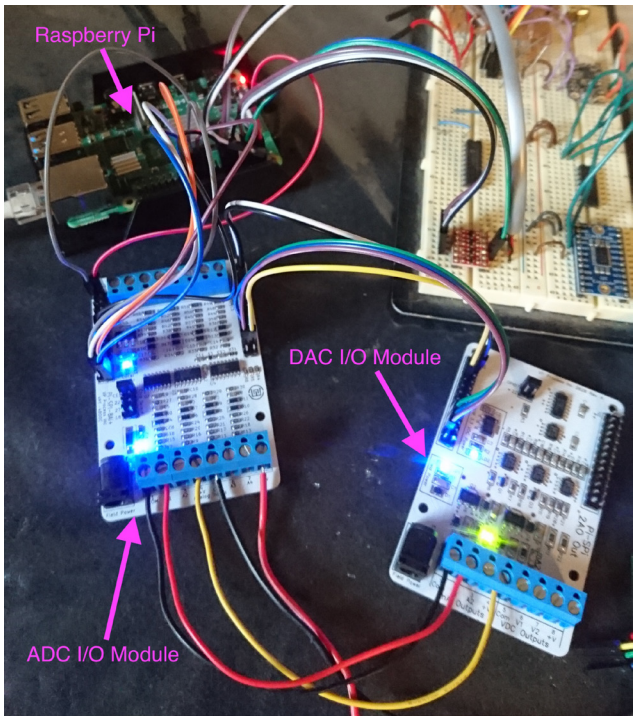

FIG. 1. Test setup for the initial testing.

Figure 1 shows the setup for the initial testing with the DAC board's output directly connected to the ADC board's input; the Raspberry Pi is used for control and readout. In the mA configuration, the difference between the DAC setpoints and the ADC readback values was on the average ~10%.

To ascertain which board, ADC or DAC, was the major contributor to the error, the DAC board's output was connected to an HP 3458A DMM and the ADC board's input was connected to a Krohn-Hite 523 Calibrator and measurements were made over a range of setpoints.

Figure 2 shows a plot of delta, difference, between the setpoint and the measured value as a function of the setpoint for the DAC. Figure 3 shows a similar plot for the ADC.

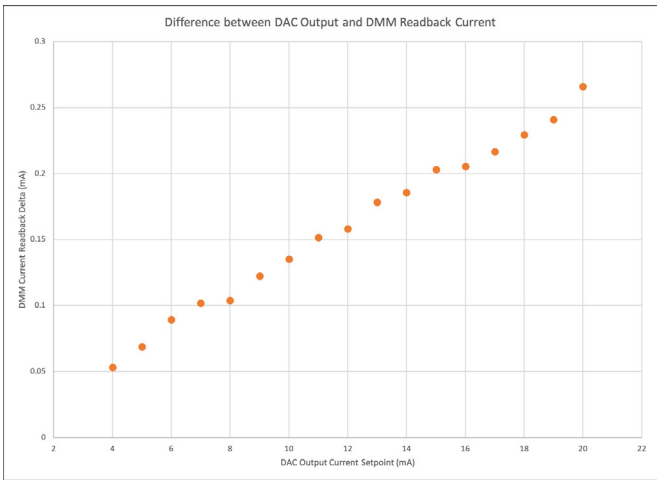

FIG. 2. DAC output current setpoint vs DMM current readback delta.

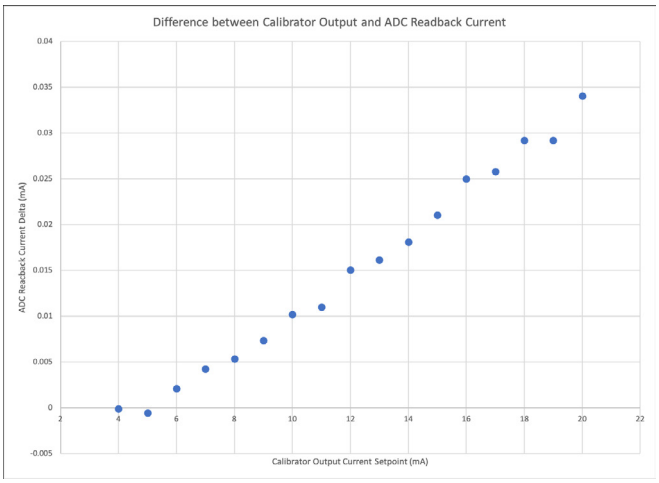

FIG. 3. Calibrator readback current vs ADC readback current delta.

The 10% difference measured in the first test between the DAC output and the ADC is roughly the average difference measured between the DAC and the DMM. The difference between the calibrator and the ADC is < 0.2%, Fig. 3. Hence, the error measured in the initial test is attributed to the DAC output.

To conclude, the ADC accuracy is acceptable to read the GEM detectors' Dywer differential pressure sensors, which have a sensor accuracy of ± 2% (electrical) and a mechanical accuracy of ±4% (for the gauge indicator).

[1] Widgetlords Electronics, *Pi-SPi-8AI-16B Raspberry Pi 8 Channel Analog Input 16 Bit (4–20 mA) Interface*, Retrieved from https://widgetlords.com/products/pi-spi-8ai-16b-raspberry-pi-analog-input-16-bit-4-20-ma-interface.

[2] Widgetlords Electronics, *Pi-SPi-2A0 Raspberry Pi Analog Output (mA + VDC) Interface*, Retrieved from https://widgetlords.com/collections/pi-spi-series-1/products/pi-spi-2a0-raspberry-pi-analog-output-ma-vdc-interface.