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Improving the Reliability of the Hall A GEM Gas Monitoring System

I am working on making the GEM gas monitoring system more reliable. Currently, two Raspberry Pis are used to monitor BigBite gas flow and pressure, Fig. 1. After the improvements, a single Raspberry Pi will be used to read out all gas flow and pressure sensors from the detector. Using a single Raspberry Pi will reduce the number of system components that could malfunction, Fig. 2. Additionally, the current setup needs to run different programs on each Raspberry Pi to monitor the system. The improvements reduce the software to a single flow monitoring program, which calls a subroutine to monitor additional pressure signals.

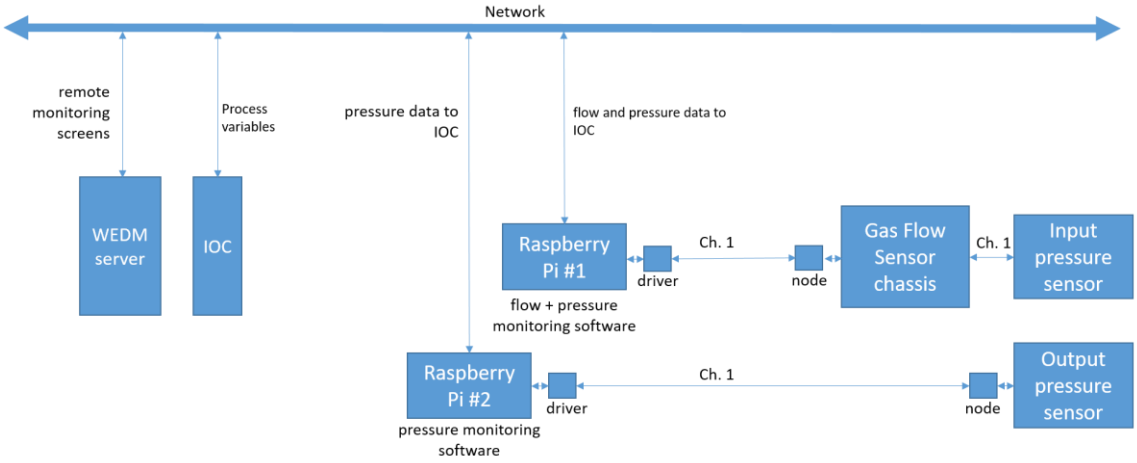

FIG. 1. The current BigBite I^2C data flow diagram needs two Raspberry Pi single-board computers to read all channels

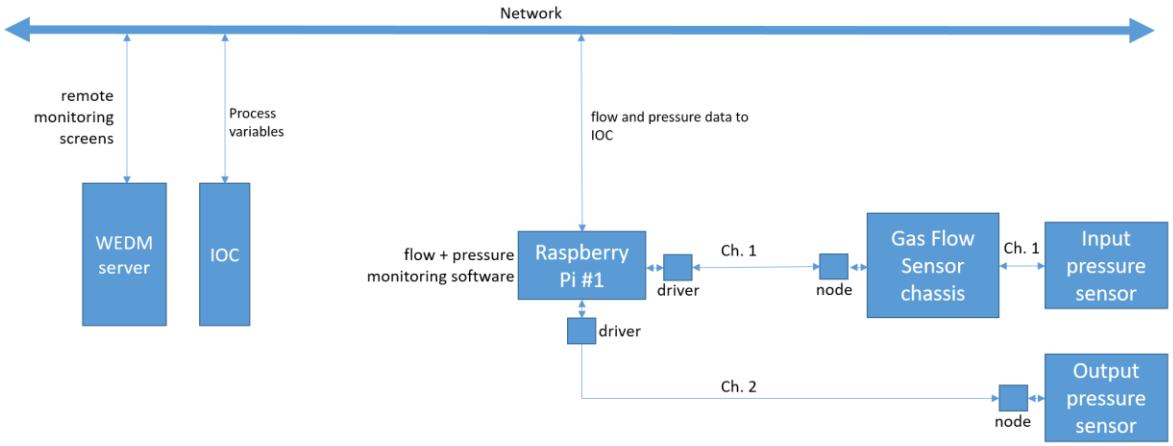

FIG. 2. The improved system requires a single Raspberry Pi to read out all sensors

The Raspberry Pi comes with one dedicated I^2C channel (Ch. 1). The monitored sensors need to be individually addressed by the Python software. A multiplexer is used to individually address each channel.

During prototype testing in the TEDF, the system read all flow channels with I^2C (Ch 1). To read the input and output pressure signals, additional I^2C channels (Ch 2 and Ch 3) were assigned by converting input/output ports in the firmware of the Raspberry Pi.

After installation in Hall A, channels 2 and 3 stopped functioning, while channel 1 continued to work as expected. The difference between the TEDF setup and the hall setup is the cable length. In the hall, each channel has ~200' cables and they use Hall A-developed drivers and nodes for I^2C signals. Since the issues are only with channels 2 and 3, a second Raspberry Pi was installed. All flow sensors and input

pressure are monitored by Raspberry Pi #1 on channel 1. The output pressure was moved to channel 1 of the second Raspberry Pi. Raspberry Pi #2 runs a program that only monitors and updates the output pressure in a continuous loop, Fig. 1.

I am duplicating the Hall A setup using longer cables and the same driver/nodes setup used in the hall to resolve the connectivity and pull-up resistor issues. I have modified the Python software to monitor flow and pressure signals with multiple I^2C channels with a single Raspberry Pi. The software reads the available flow sensors on the multiplexer and updates the associated process variables. Next, the program closes the multiplexer and reads and updates the input pressure on channel 1. Then the software reads the output pressure from I^2C channel 2 and updates those process variables.

Next month I plan to modify the software to use one I^2C channel per GEM system. A multiplexer will be used to switch between pressure sensors.

[1] B. Eng et al., *Development of Readout Electronics for Gas Flow Sensors for the Hall A GEM Detectors*, DSG Note 2020-20," 19 August 2019.
[2] B. Eng and M. McMullen, *Hall A Super Big Bite and Big Bite GEM Detector Flow Sensors' Readout Electronics*, DSG Talk 2020-19" 25 June 2020.