Comparing Pressure Sensors for Ambient Pressure Measurement

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The Hall B Gas System currently using a MKS Baratron capacitance manometer to measure the ambient pressure inside the end station. It was requested to expand the number of sensors to record pressure at additional locations. While the MKS sensor offers accurate pressure measurements they are expensive and generally not in-stock. As a possible alternative a Dwyer 628 pressure transmitter with a psia (absolute pressure [rather than the traditional gauge pressure]) was selected for evaluation. Also tested was a Bosch BMP390 absolute barometric pressure sensor. The Dwyer uses a more traditional NPT fitting as the sensor mount along with a 2-wire 4-20mA output as the interface. The Bosch is a 10-pin LGA (land grid array) package with a metal lid with an I2C digital interface.

The Dwyer sensor would simply connect to an available current input channel to one of the cRIO modules, and as such interfacing with it is trivial for the existing system. Since the Bosch has a digital interface and there isn't any native I2C inputs available another interface is needed. An ESP32-S3 microcontroller similar to the ones used for the CLEO field mapping units was used, which then can transmit the pressure readings either directly to the network using the built-in WiFi or via a serial port on the microcontroller, the latter was chosen for all data presented.

The Dwyer sensor was setup to acquire data every 50 ms and then averaged every 20 samples, to get a data rate of 1 Hz. The Bosh has built-in options to reduce the noise and increase the accuracy. The oversampling was set to 16x and the IIR (infinite impulse response) filter was set to 4 (options range from 0 to 7 with a lower number indicating a faster response). These settings were selected to match the datasheets suggested values for ultra high resolution. Figure 1 shows data for slightly over 4.5 days showing changes in ambient pressure as both sensor remain fixed and figure 2 shows a period of 10 minutes where the ambient pressure was relatively stable.

- **Compared Dwyer and Bosch pressure sensor**
  - **Dwyer analog voltage output**
  - **Bosch digital I2C output**
- **Bosch is less noisy and offers additional temperature measurement**

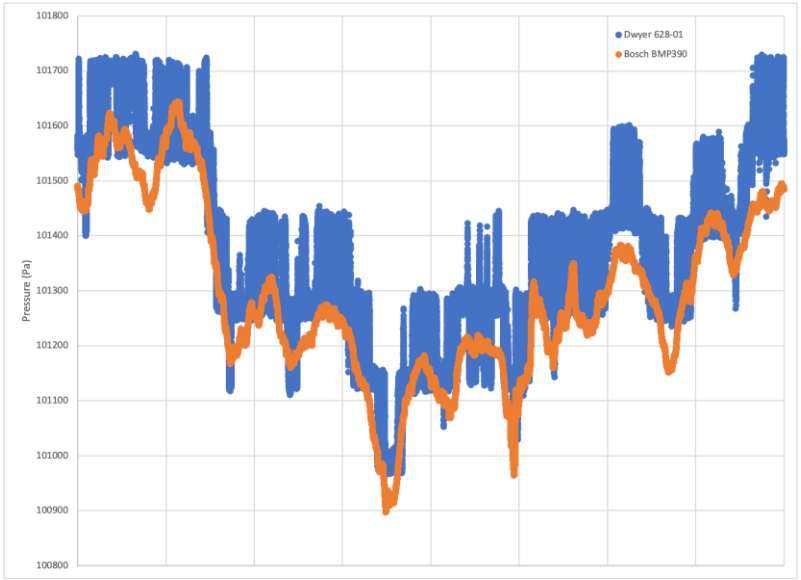

Fig. 1. ~4.5 days of ambient pressure

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Since what the sensors are measuring is not a fixed value and is constantly changing it has difficult to quantitatively assess how much better one sensor is than the other, but from the figure 2 plots of 10 minutes worth of data the Dwyer has a standard deviation of 5.89 Pa compared to 1.27 Pa with the Bosch. Qualitatively, the Bosch has significantly less noise in the pressure measurements. While not part of the consideration for sensor evaluation the Bosch also has a built-in temperature readout available.

Without native inputs to the cRIO the Bosch will require an external component to read the sensor data in. While the WiFi is fine for short term testing, the final and permanent solution will need to either use wired ethernet or directly interface with the cRIO. Evaluation is ongoing to find either a suitable microcontroller or find a better way to interface with the cRIO instead of a serial port.

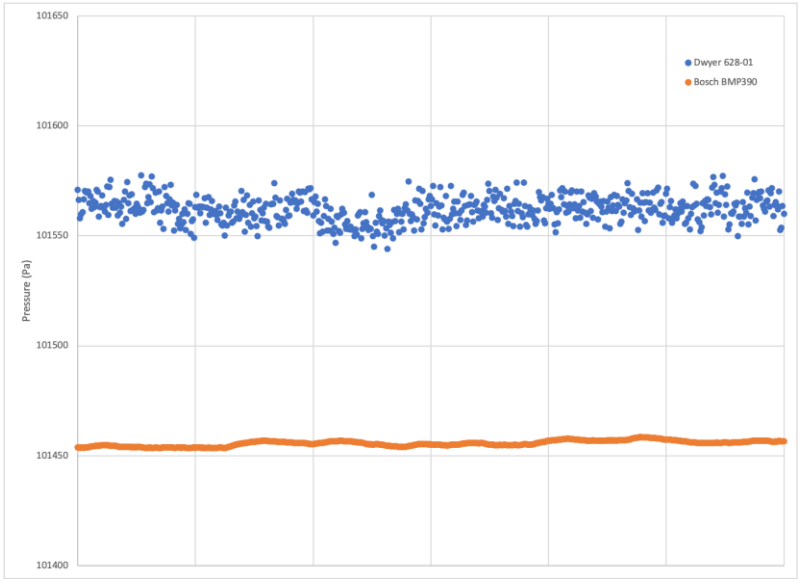

Fig. 2. 10 minutes of ambient pressure