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PID Controller Test for the Hall B Drift Chamber Gas System

Tyler Lemon, Mary Ann Antonioli, Sahin Arslan, Peter Bonneau, Brian Eng, Amanda Hoebel, George Jacobs, Mindy Leffel, Marc McMullen, Anatoly Sitnikov, and Amrit Yegneswaran
Physics Division, Thomas Jefferson National Accelerator Facility, Newport News, VA 23606
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This note presents the test results of the prototype proportional-integral-derivative (PID) controller developed for the drift chambers.

PID controller VI was developed in LabVIEW and deployed to a National Instruments' CompactRIO system. The *VI* keeps the pressure differential, ΔP, between the inside of the drift chambers (DCs) and the outside (ambient pressure) at 0.075 ±0.05 inH_2O, preventing rupture of the large surface area windows of the DCs or damage to the guard wires that are in close proximity to the windows.

PID controller VI was tested by controlling the pressure of the two 240 gal buffer tanks, one for DC R1/R2 and one for DC R3. Figure 1 shows the steady state condition of the measured pressure in one of the buffer tanks.

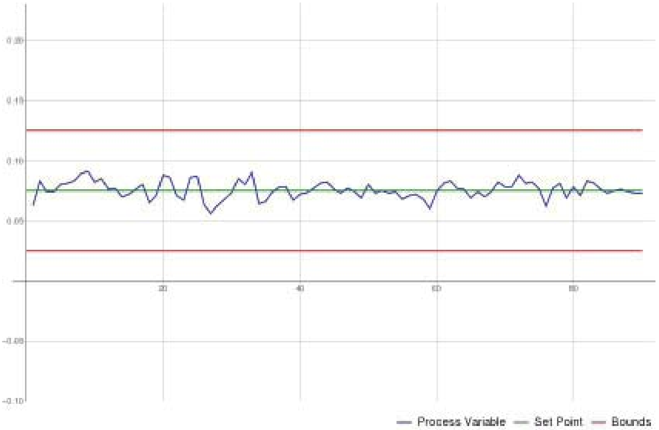
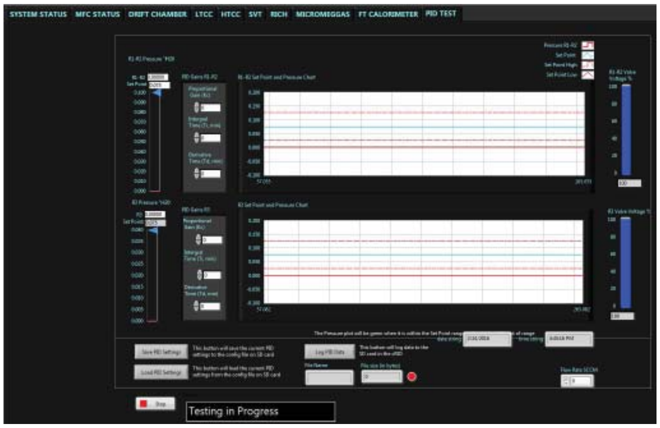


FIG. 1. Buffer tank pressure over a period of 90 s. Values used are: P = 3.5, I = 0.3 s, and D = 0.001 s. Pressure is kept close to the set point of 0.075 inH_2O (green line); bounds, ±0.05 inH_2O, are shown as red lines.

In addition to regulating the pressure, *PID controller VI* plots pressure vs. time on the touchscreen in a separate graph for each tank, Fig. 2.

The setpoint is the solid, light blue line and the bounds are the dotted red lines. For the plot, green color is used if the pressure of the tanks is within bounds, otherwise red.

After finding the PID parameters that regulate the steady state pressure of the tanks, transients were introduced in the tank DC R1/R2 to see how well the PID controller corrected the transients.



Testing in Progress

FIG. 2. A screenshot of the *PID controller VI* on the touchscreen front panel, which is directly connected to the CompactRIO system. The graph for the R1/R2 tank is above the graph for the R3 tank. As there is no flow into the tanks, pressure is 0 inH_2O. Because the pressure is out of bounds, it is plotted in red. PID parameters for each tank can be changed using the controls to the left of the graphs.

Flow to the tank was changed from 30 slm to 20 slm to cause a pressure drop (a negative transient). *PID controller VI* corrected the negative transient in ~60 s, Fig. 3.

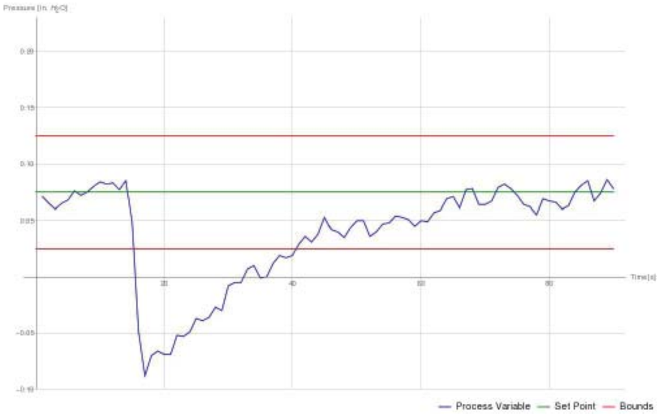


FIG. 3. A plot of the pressure over 90 s for a negative transient. *PID controller VI* adjusts valves to bring the pressure back to the set point, using the parameters P = 3.5, I = 0.3 s, and D = 0.001 s.

A positive transient generated by changing flow rate from 20 slm to 30 slm was corrected in ~70 s, Fig. 4.

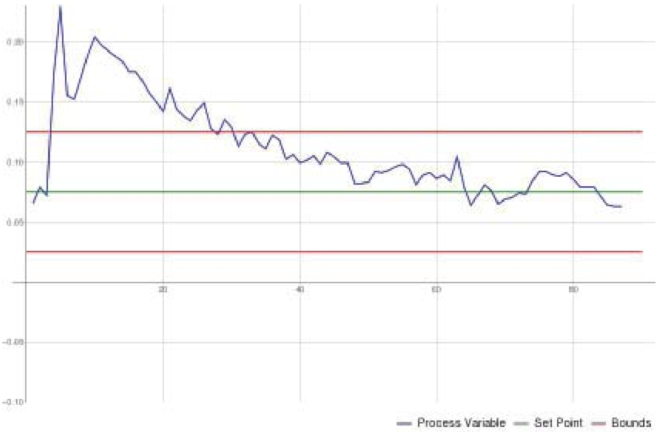


FIG. 4 A plot of the pressure over 90 seconds for a positive transient. *PID controller VI* adjusts valves to bring the pressure back to the set point, using the parameters of P = 3.9, I = 0.3 s, and D = 0.001 s.

From the plots of the positive and negative transients, a proportional gain of 3.5 would be better than a proportional gain of 3.9, as the controller is 10 s faster correcting the transient.

In summary, *PID controller VI* works as expected; it corrects both positive and negative transients and it can hold the tanks' pressure in a steady state.