Control of a Vacuum System with Data Logging Feature

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Project Introduction and Motivation

Introduction to Project

Project Aims:

- Control a basic vacuum system
- Create a data system which would display the data in real time
- Be able to store the data for historical use

Vacuum systems uses:

- High vacuum systems are used for manufacturing light bulbs, aluminising mirrors, coating glass, decorative metallurgy and ion implantation
- Very high vacuum systems are used for thin-film application, mass spectroscopy, crystal growth, electron microscopy and electron lithography [1]

Determining Vacuum System Pressure

The vacuum system in this project uses a Pirani gauge and Convectron gauge to measure the pressure within the system. Pirani and Convectron gauges measure the rate of heat transfer through a gas to determine the pressure within the system. The more heat that the filament of each of these gauges loses to the surrounding environment, the higher the pressure. Below is a schematic of each of these gauges:

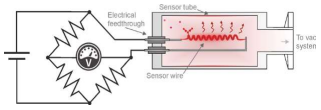

Fig. 1: Schematic of Edwards Pirani Gauge

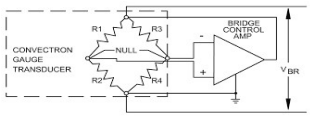

Fig. 3: Schematic of Granville Phillips Convectron Gauge

Fig. 2: Edwards Pirani Gauge

Fig. 4: Granville Phillips Convectron Gauge

Producible Goals of the Project

- Show a strong knowledge and understanding on how vacuum systems operate, operating principles of various pressure gauges, and methods for controlling vacuum systems
- Create a program which would allow for user control of a basic vacuum system
- Create a graphical display to show relevant pressure data in real time
- Create a method for logging data which would allow the user to access historical data in the future

Experimental Setup

Physical Setup

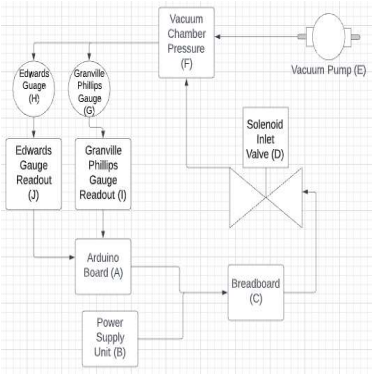

Fig. 5: Vacuum System Setup Schematic

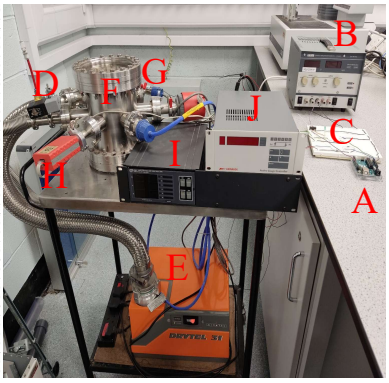

Fig. 6: Vacuum System Setup

Pressure Signal Extraction, Graphical Display and Data Logging Feature

The following are the components which make up the data side of the project:

- Arduino code to extract voltage signals from the pressure gauges
- Arduino code to convert the voltage signals to pressure signals
- Visual Basic GUI and code to display real time data
- Visual Basic code to save the pressure signals recorded

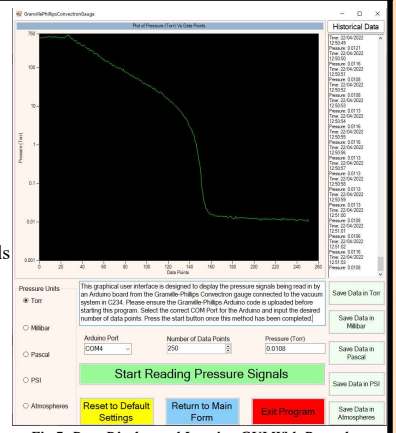

Fig 7: Data Display and Logging GUI With Pumpdown

Results and Analysis

Results and Conclusions

Key Results:

- Created calibration graphs to convert voltage signals into pressure signals for each pressure gauge
- Used relationship between voltage signals and pressure signals to write Arduino code which maintains the system at setpoint pressure
- Able to maintain the pressure of the system at the desired pressure input by the user
- Plot of pressure real-time shown in Visual Basic UI *(Fig 5)*
- Pressure data can be saved to CSV file using Visual Basic user interface for historical reference

Conclusions:

- Control of pressure works better at higher pressures *(Fig. 9)*
- At setpoints below 1 Torr, errors of greater than 100% are shown
- At setpoints between 1 Torr and 10 Torr, errors of up to 100% are shown
- At setpoints above 10 Torr, errors of up to 20% are shown
- System can be maintained at setpoint pressure for limited pressure range

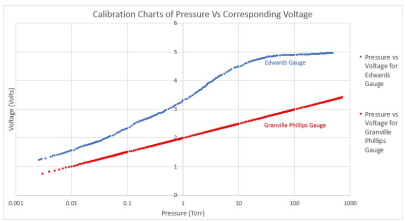

Fig. 8: Calibration Charts for Pressure Gauges

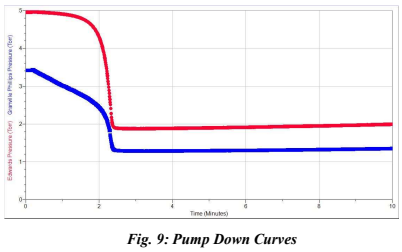

Fig. 9: Pump Down Curves

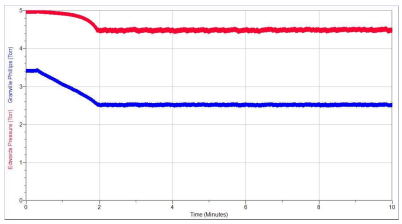

Fig. 10: Pump Down Curves with Setpoint of 10 Torr

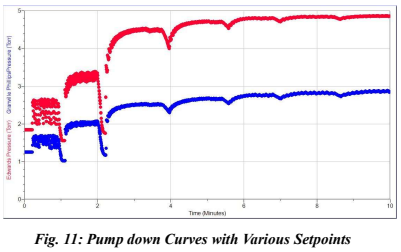

Fig. 11: Pump down Curves with Various Setpoints

References

1. D. Yu.Tsipenyuk, Eolss.net, 2009. [Online]. Available: https://www.eolss.net/sample-chapters/c05/E6-08-04-04.pdf. [Accessed 18 January 2022].