

Pneumatic Demonstrator Applications Using Electronic Digital Control

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Customer Background

Proportion-Air, Inc. is a reputable manufacturer of electronic air pressure regulators and air flow control valves. The company was established in 1985 by its corporate president, Daniel E. Cook, he is the creator of a groundbreaking invention - the electronic air pressure regulator. This device is engineered to accept a wide range of electronic analog and digital signals, providing extreme accuracy in controlling pneumatic pressures, while mitigating the impact of vibration, mounting position, and environmental factors

Problem Statement / Scope of Work

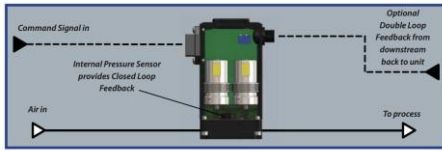
Our team aims to bridge the existing instructional tools and pneumatics technology. Our proposed instructional system helps students understand industry-standard pneumatic systems and Proportion-Air components. We have added modules to an existing device for Proportion-Air's engineer and sales training. With our system we can control power output, rotary pneumatic actuator speed, and vacuum systems to demonstrate system power control, cutting speed, and suction cups.

Requirements

Proportion-Air tasked us with two major project requirements:

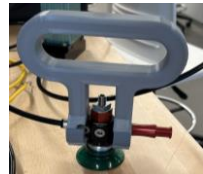
- Control pneumatic power
- Demonstrate this concept and monitor it

This evolved into us using an angle grinder and vacuum lifter to demonstrate this, and a PLC and HMI to monitor it in real time .



Experimentation and Concepts

In order to house the electrical and mechanical components of the project, two custom pieces were designed to ergonomically hold the pieces. This was outside the original scope of work, but we knew it was necessary to show off the Proportion-Air Equipment



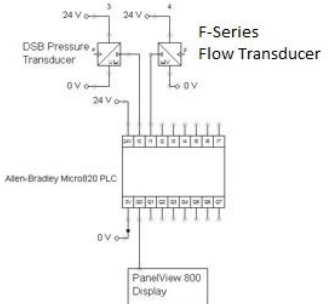
New panel display



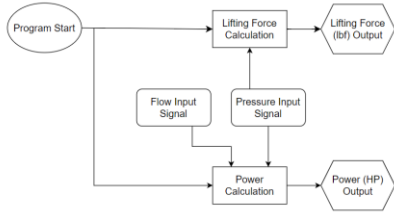
PLC controller

Additionally, an Allen Bradley PLC is used to monitor the pneumatic devices. The code for this was written custom by our electrical lead and underwent many iterations

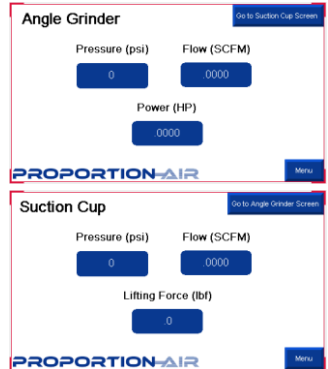
Final Design



Electrical System Design



Programming Concept



HMI Displays

FMEA

Key Process Step	Potential Failure Mode	FMEA - Failure Modes and Effects Analysis		Current Controls	Action Taken
		Potential Failure Effects	Potential Causes O/C		
Pneumatic System					
Delivery of air to electro-pneumatic systems and necessary devices	Arriages and fittings	Reduced flow or failure to deliver air to components	Airline detaches from fitting	Visual inspection of fittings and airlines	Testing and inspection to make sure all airlines are secure
Angle Grinder					
Demonstration of power control	Angle grinder disk	Increased safety risk or possible injury	Improperly secured angle grinder disk	Visual inspection of surrounding area, and personal protective equipment	Manual inspection of angle grinder disk, safety check of surrounding area, and personal protective equipment
Demonstration of power control	Angle grinder	The angle grinder will not function, meaning we cannot demonstrate the capabilities of the system	Reduced or insufficient flow from air supply	Use air supplies that can provide at least 90 psig of air to the system for proper function of the angle grinder	Continue to use air supplies with sufficient flow to demonstrate our system.
Electrical System					
Data being shared with the user from electro-pneumatic sensors	Internal wiring	Inaccurate information or no information is given to user	Sensor's wiring is connected incorrectly	Manual and visual inspection of electrical connections	Sufficient testing and confirmed visual and manual inspection of wires and sensors.
Display Case Info					
Securing all internal components	Fasteners	Loose or detached components could be damaged	Vibration and handling could cause fasteners to come loose	Securing all fasteners and components	Torquing all fasteners before moving the case and inspecting the inlet for loose components

Testing

Electrical System Testing			
Step	Test	Details	Outcome
1	Sensor Inputs	The PLC reads the inputs from the flow and pressure sensor	All of the sensors are reading to the PLC
2	HMI Data Display	HMI shows both the data from the sensors and the figures that are calculated	HMI displays all data values
3	HMI Screens	HMI can switch between the different screens for the Angle Grinder and the Suction Cup	HMI successfully switches between the two screens
Mechanical System Testing			
4	Angle Grinder Speed Control	The speed of the angle grinder is controlled by the potentiometer connected to the EPR	The potentiometer successfully varies the speed of the angle grinder
5	Suction Cup Force Control	The lifting force of the suction cup is controlled by the potentiometer connected to the EPR	The potentiometer successfully varies the lifting force of the suction cup