Team 16: Automatic Pressure Sensor Testing Machine

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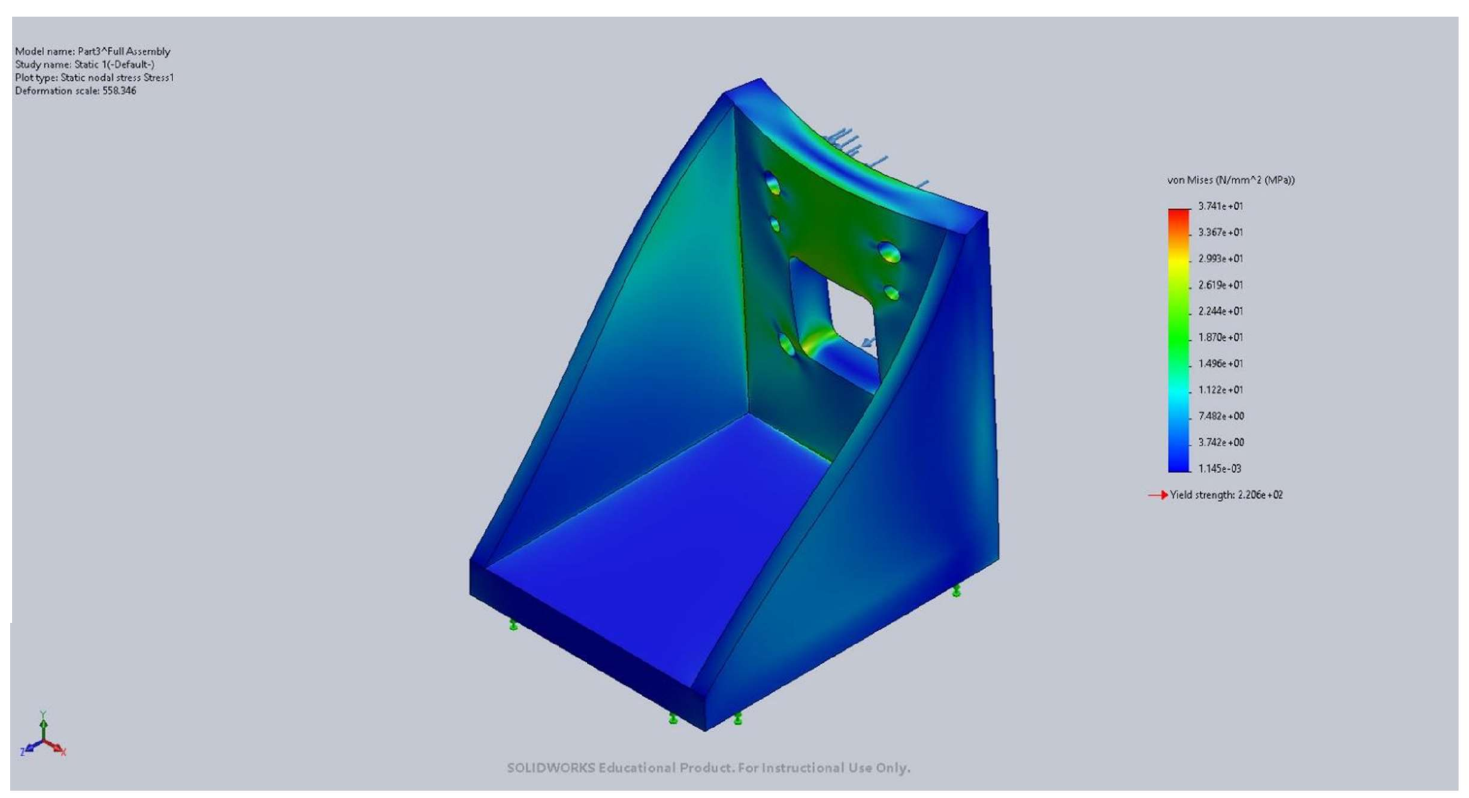
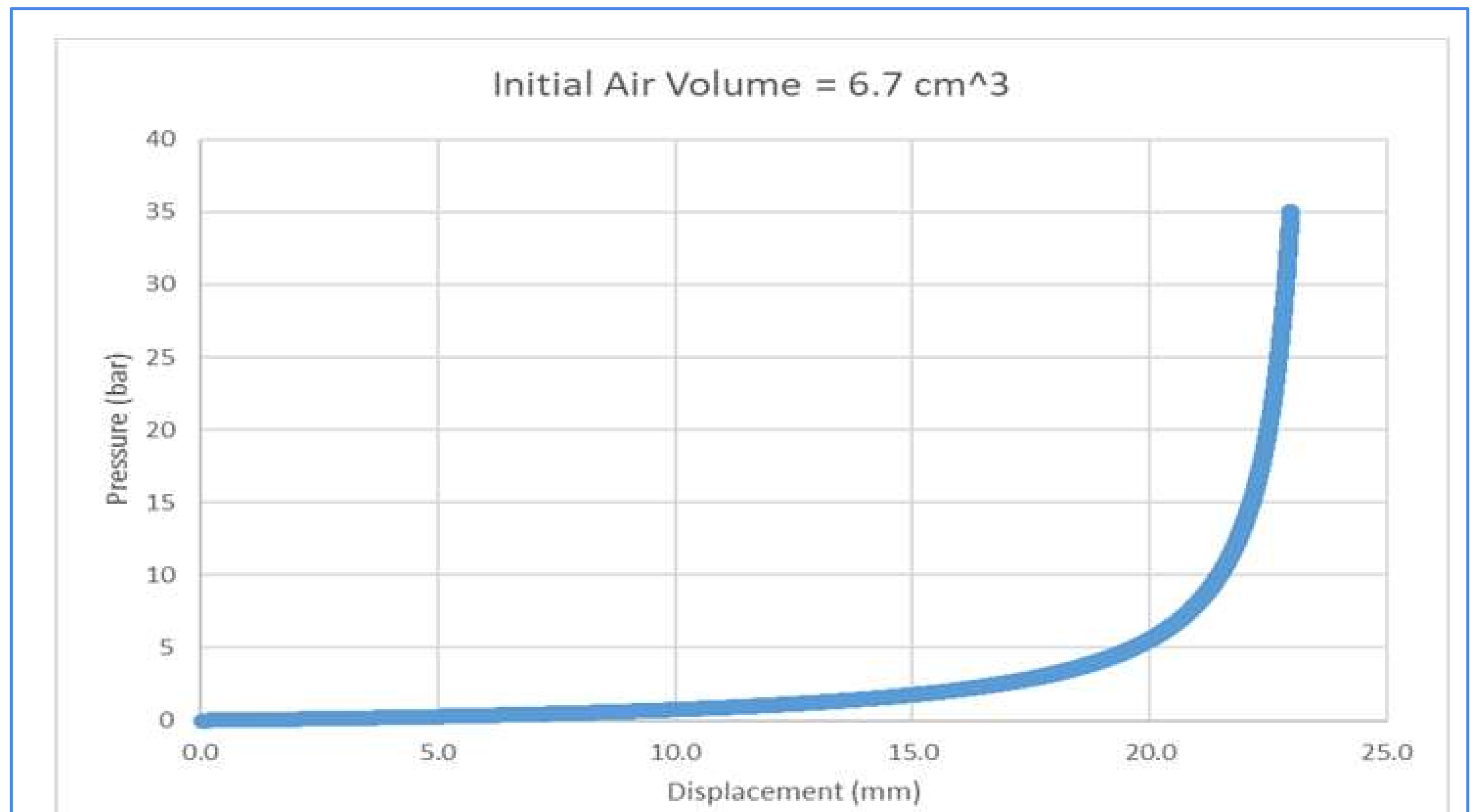
Design Choices

Given the high pressure in the hydraulic system (up to 70 bar or 1015 PSI) every bracket brace and plate was designed with stresses it will undergo in mind. Special considerations were given to the thickness and type of material selected for every component to design a safe and cost-effective solution. To ensure this simulations were performed to ensure that every component could handle said stresses. An example finite element analysis simulation is shown below.



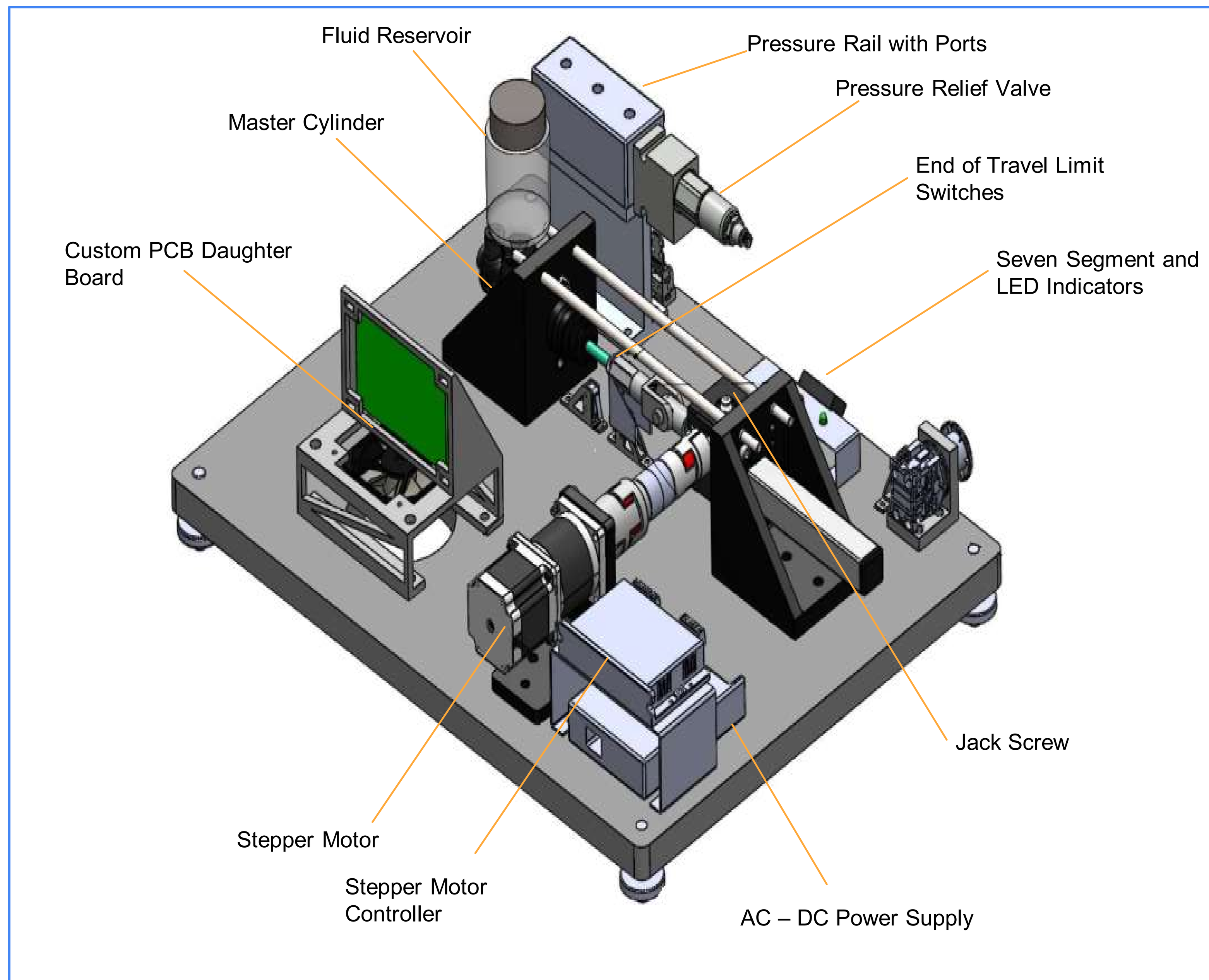
Pressure vs Displacement

Given the incompressible nature of mineral oil a small decrease in the volume of the fluid results in a relatively large increase in pressure. Below is the theoretical increase in pressure relative to the plunger insertion distance.



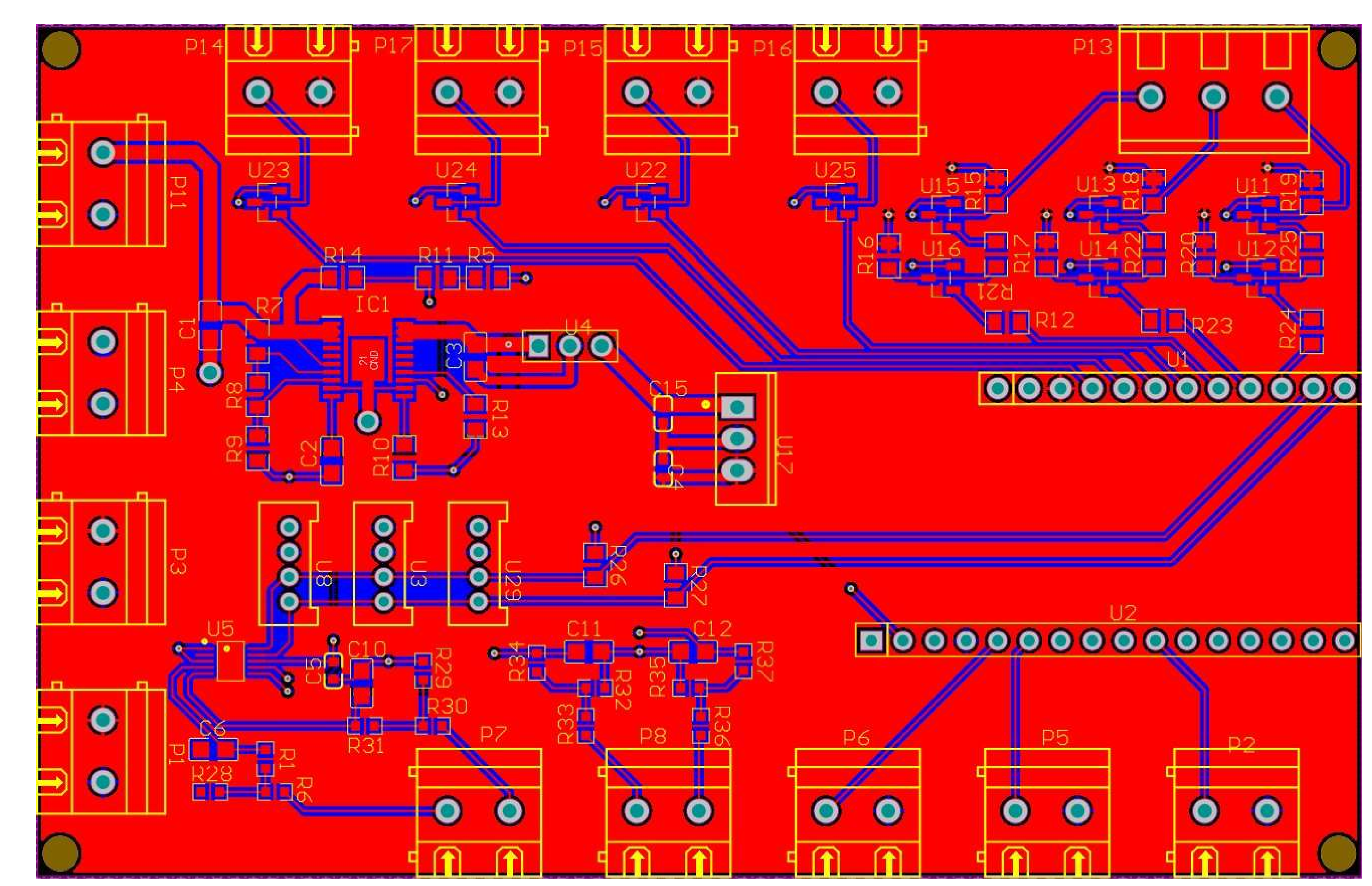
Machine Purpose

The purpose of our project is to design, build and test a machine to automatically test hydraulic pressure transducers. This machine will then generate a statistical analysis report on the test results. The system generates its pressure using a standard motorsport master cylinder. This master cylinder is linearly driven by a mini jack screw system. This mini jack screw is activated with a stepper motor. The pressurized hydraulic fluid is transferred through a steel braided line into a custom pressure rail that the transducers are placed in for testing. These pressure can reach up to 70 bar (1015 PSI). This pressure rail also includes a port for a pressure relief valve, bleed screw and mechanical pressure gauge, to increase the safety of the device's operator. The system is electrically powered with a 120 VAC wall outlet which is supplied to an AC to DC converter to achieve 24 VDC. This 24 VDC signal is connected to the stepper motor driver as well as a custom PCB daughter board connected to an off the shelf ESP dev board. On said daughter board the 24 VDC signal is converted to 5 V and 3.3 V signals to power the control circuit, driven by an ESP microcontroller. This system is also integrated with Racing Tech's web server management system.



Custom PCB

Due to the need for quick changing of sensors and a clean interface with an ESP microcontroller a PCB daughter board was designed. The PCB creates an electrical hub to allow all wire to be routed back to it, instead of a more distributed and messier look. Key components of said PCB are as follows. Two DC to DC converters to step down the 24 V signal to 5 V and 3.3 V control voltages used by the ESP and sensors, respectively. An on-board ADC to measure the voltage output of both the tested sensor and the sensor used as a reference. Level shifters to convert the ESP 3.3 V control signals to the 5 V control signals required by the stepper motor control module. Below is a trace level view of the PCB we designed.



Software

The ESP32 microcontroller is used to control the system. The ADS1115 is used to perform analog to digital conversion on the test and reference sensors. The ESP32 is connected to WiFi and it communicates to AWS via the AWS IoT Core. The GUI unlizes a custom API that interfaces with the ESP32 and the machine. AWS Lambda Functions are utilized to send test results to a database.