Gas Pressure Meter

Engineering World Health

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Abstract

Engineering World Health (EWH), an organization that provides medical equipment to underserved areas of the world, is in need of an external device to measure pressure of gasses provided by anesthesia machines, ventilators, and other similar medical equipment. The most important limitation of this design is cost. Once background research was completed and a design matrix was constructed, a strain gage design was selected. This led to the construction of calibration curves and selection of suitable op amps and resistors. With appropriate amplifications, the pressure is able to be read by a voltmeter. In the future, the project will consist of writing a proposal for EWH, improving the pricing and size of the device and finally its mass production.

Background

Engineering World Health (EWH) is an organization of engineers, scientists, doctors, students, etc. who are interested in making a difference in disadvantaged areas of the world. It supplies appropriate medical technology to third world countries and other underserved areas in order to provide adequate medical care for the people living in these regions. (http://ewh.org).

Purpose/Motivation

The purpose of this design is to provide an inexpensive instrument that is able to measure useful ranges and types of pressures in a hospital setting, in order to improve medical care in underserved and underdeveloped areas of the world.

Current Technology

Different instruments are used to measure pressure in many settings:

- Monometer
- Bourdon Gage
- Strain Gage (digital)

Problem Statement

Our task is to develop an external gas pressure meter to be used in third world countries and to be distributed by Engineering World Health. The pressure meter will be used to measure the pressure of oxygen, medical air, and carbon dioxide and must be compatible with several different machines, including ventilators and anesthesia machines. The pressure leaving the machines will be measured and displayed in a digital readout.

Specifications

The device must:

- Measure pressure to within at least 10% of its true value, while 1% is optimal
- Have a continuous, digital readout
- Have dimensions of 4” x 4” x 1” for a device with only one segment, or 1” x 4” x 1” for a device with several segments
- Read pressures between -35 mm of Hg and +75 mm of Hg
- Compensate for different connections (e.g. hose barb, locking ring, quick release)
- Be reusable and autoclave compatible
- Cost less than two dollars individually in quantities of 500, including packaging, but not including the cost of manufac turing
- Not block the airways of the patient in the case of a malfunc tion

Designs Considered

- Propeller design - the propeller spins as air flows past it. The speed of the spinning creates a voltage that can be calibrated to coincide with a particular pressure. This idea was eliminated due to its dependence on flow and the risk of the propeller dislodging or sticking, potentially blocking air flow.

- Piezoelectric material - as the pressure changes, it causes the material to emit a voltage which is used in a simi lar way as the propeller idea. However, these materials can only detect change in pressures, not constant. Also, the cost of material makes it impossible to stay un der the specified cost.

Final Design: Strain Gage

This design consists of a Wheatstone bridge which uses known resistances of three resistors to find an unknown, fourth resistance. Connecting this system to a strain gage allows the pressure to be recognized and, through several circuit manipulations, displayed.

Pros

- Inexpensive
- Accurate to within cli ent’s specifications
- Measures static pressure
- Battery powered
- Parts are commercially available

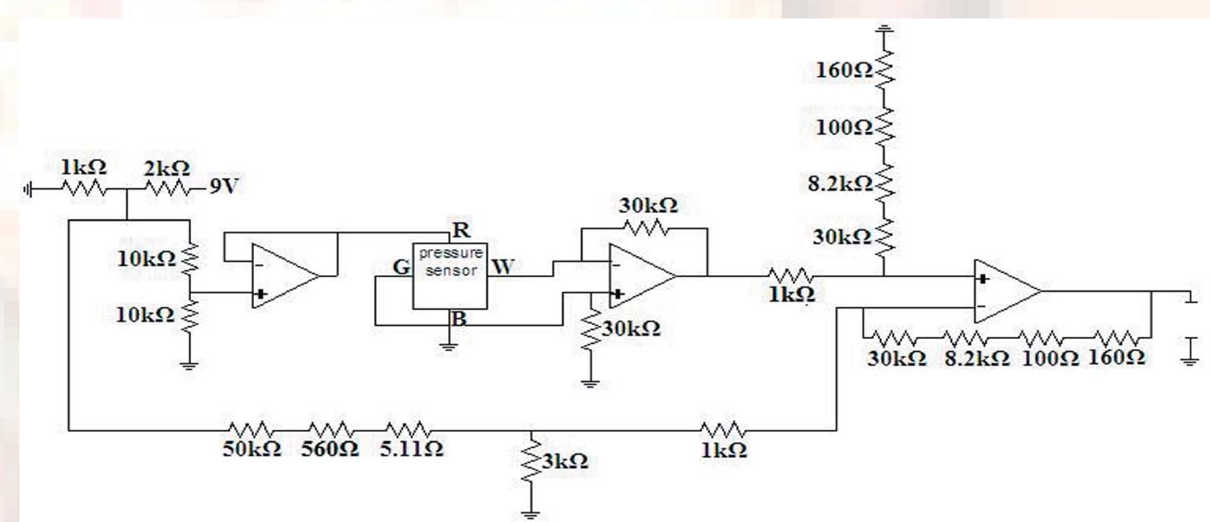
Cons

- Requires calibration
- Numerous circuit com ponents increases risk of malfunction

Cost Analysis

Part	Cost ($)
Resistors	2
Op-Amps	0.6
Battery	0.5
Strain Gage	35
Display	5
Total	42.35

Figures



Testing

We first created several calibration curves for our device using equipment from Professor Chesler’s lab. We varied the resistors following the pressure sensor to see what would best amplify the signal. Our final decision was the 30kΩ resistor and we found the equation for this curve ($y = 0.0026x + 0.1682$) which related the input pressure (x) with the output voltage (y). The exact accuracy value that we got from the calculations of our curve was between 99.98672 and 99.08497%. Next, we adjusted this equation to find out how much amplification of the output we would need in order to present the pressure using a voltmeter. For this, we also needed to take into account the offset voltage (0.1682). We found that the signal needed to be amplified 38.46 times and the offset voltage needed to be amplified 16.88 times the input voltage. We added a differential amplifier to remove the offset and output the pressure value. One adjustment this design requires is multiplying the output by 10 since the real amplification would have required a much greater voltage source which we would not be able to implement into our design. At this point the design’s accuracy is ???%. Part of our work for next semester will be devoted to improving this number.

Future Work

Next semester we will focus on first writing a proposal and submitting it to EWH. In terms of the design, we will focus on reducing cost, size, and efficacy. By the end of next semester we should have a printed circuit board (PCB) of our prototype. The final semester will be focused on getting the product ready for mass production and distribution to a 3rd world country.

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