ECE 445

Spring 2017

Mock Design Review Document

Turning Tracker for Pressure Ulcers

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1 Block Diagram

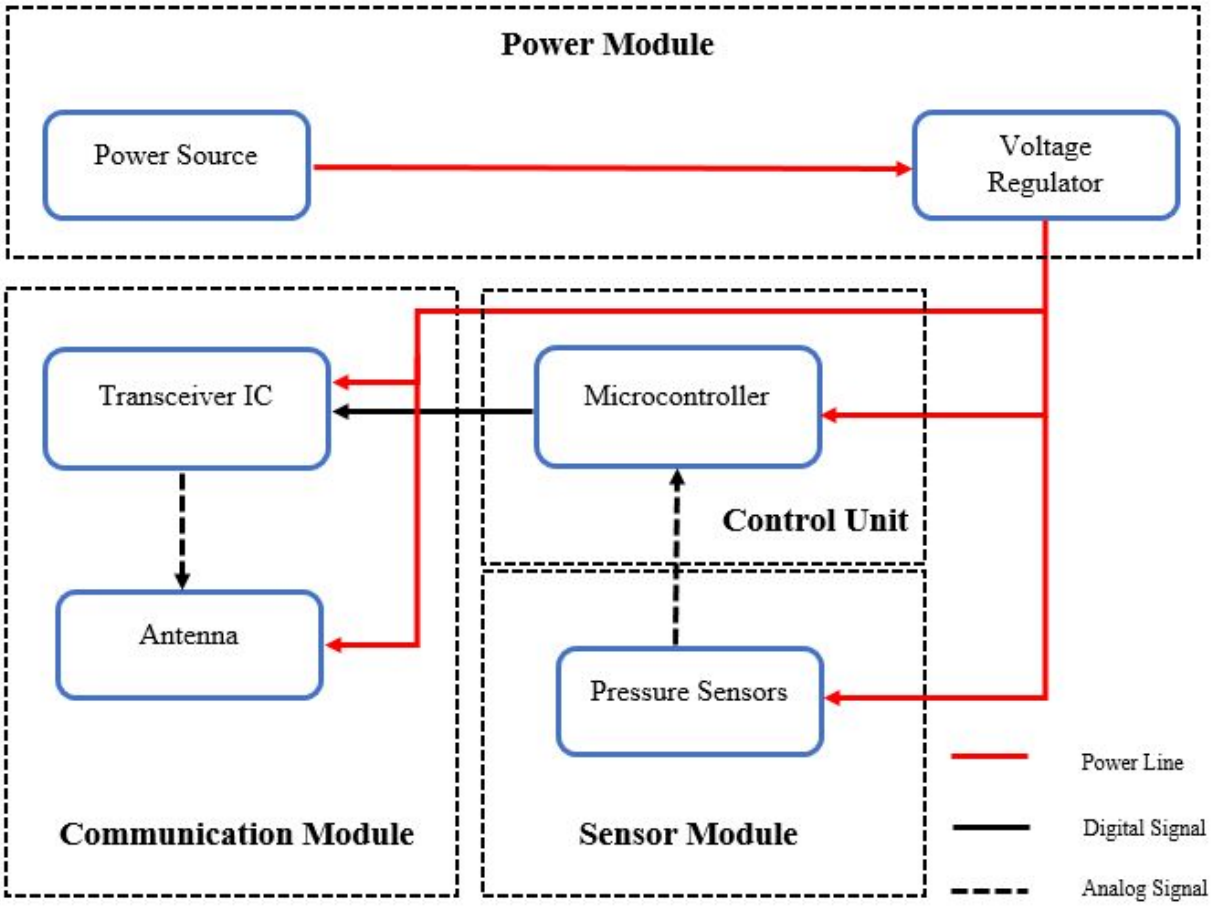

Figure 1. Block Diagram

2 Circuit Schematic (Sensor Module)

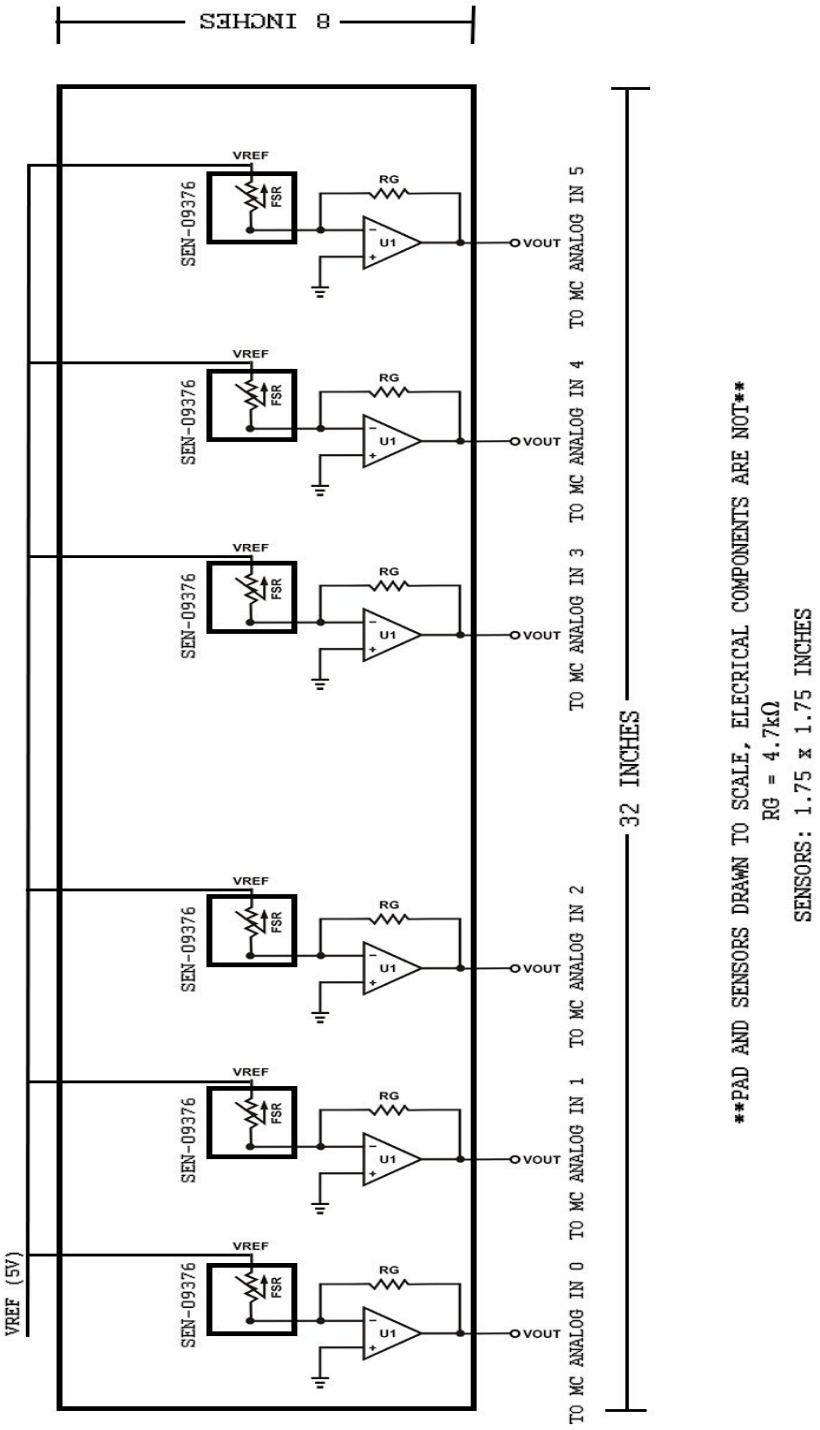

Figure 2. Pad and Sensor Schematic

3 Calculation

The calculations that are being shown were used to estimate how many sensors we would need for our pad. We were not able to obtain the sensors we are intending to use to take realistic data, so instead we used a bathroom scale to take very rough measurements of how your weight changes when you are standing up and laying down (as you would be if you were laying on our pad) on a hardwood floor versus when you are on a firmer bed.

Condition	Measured Weight (lbs)
Standing on hardwood	169.6
Standing on firm bed	15.2
Laying on hardwood	69.2
Laying on firm bed	10.01

We then took these measurements and compared how the weight changed from measuring on the hardwood versus a firm bed for each position.

Standing:

$$\frac{15.2\ lb}{169.6 lb} = 8.96\%$$

Laying:

$$\frac{10.0\ lb}{69.2 lb} = 14.45\%$$

Comparing these two percentages we can see the bathroom scale was not very accurate when taking measurements on a softer surface, but it is accurate enough to estimate the amount of need sensors.

We then compared the measured standing weight on a hard floor versus the laying weight on a firm bed. This percentage can be used for estimating the average weight that is distributed near a person's hip.

Standing on hardwood vs. Laying on a firm bed:

$$\frac{10.0\ lb}{169.2 lb} = 5.896\%$$

Then we took the average weight of a person 80.7 kg [1]

Average weight distributed near hips = $80.7kg \times 5.896\% = 4.76kg$

We intend to use Force Sensitive Resistor SEN-09376 which can measure 0-1000 kg. So we use 6 sensor, each sensor will see on average:

$$\frac{4.76kg}{6} = 793.33g/sensor$$

4 Plot

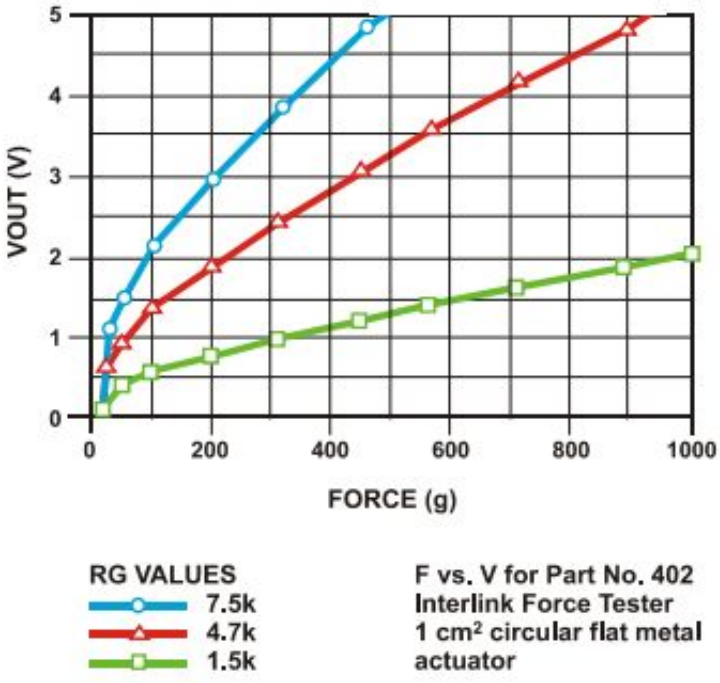

Figure 3. Voltage vs. Force for Different Resistor Values[2]

We used this plot to decide what value for RG we will be using which is shown in our circuit schematic. We choose 4.7k because this value has the most linear plot which will allow the sensor to most accurately see changes in force.

5 Block Description (Sensor Module)

Please reference the schematic for our pressure module for this description.

Our sensor module will be housed in a 8 X 32” pad made of nylon or synthetic fiber for its durable, waterproof properties. The pad will be designed to sit under the buttox area of the patient and will monitor major shifts in weight distribution. We have one row of six sensors, three sensors on one side and three on the other. This is a design choice due to the three main positions for patients: lying mostly on the right side, lying evenly distributed between the two sides, and lying on the left side. We chose the the dimensions 8 X 32” because 8” in the approximate height of the buttox and 32” is the width of the most thin hospital beds[3], with 2” cut off from each side.

The sensors we are using are Sparkfun SEN-09376. As described above, we will be using 4.7k resistors due to the sensor’s apparent linearity at higher forces.

6 Requirement and Verification (Power Module)

Requirement:

The power module must be able to supply at least 5 volts to meet the needed reference voltage for all of the sensors as well as provide enough power for the control unit and the communication unit.

Verification:

In order to verify that the power module is supplying at least 5 volts to the rest of the system, we will use a multimeter to read the voltage that is outputted from the voltage regulator.

7 Ethics and Safety

Our group realizes the utmost importance of safety when it comes to medical devices. We have considered many aspects of how and when an issue can occur that could cause injuries or even lives to elders.

As we come to create our product, we need to be within 98% confidence that our product *reliably* senses a flip and *reliably* communicates with the nurse. We will strive to make the most reliable, well-made device we possibly can, and will be honest with those in the unlikely case of failure.

We will make sure that our power source is safe and reliable. We ensure the device poses no electrical risk to the patient but all the while, ensure the power will not go unknowing out on a patient. This is why we will include an emergency buzzer on our device.

We will design our device to ensure that no nurse can “cheat” a flip.

We will ensure that the communication between the device and nurse is consistent through all who are tracking the device. We have implemented our buzzer for this purpose.

We will make sure all who use this device on patients is qualified to flip patients and will design the device as such.

8 References

[1] "The Weight of Nations: An Estimation of Adult Human Biomass." *BMC Public Health*. BioMed Central, 18 June 2012. Web. 21 Feb. 2017.

[2] "Force Sensitive Resistor - Square." *SEN-09376 - SparkFun Electronics*. N.p., n.d. Web. 21 Feb. 2017.

[3] "Guidance for Industry and FDA Staff." *Handbook of Adhesives and Surface Preparation*(2011): 395-405. Web.