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Designing Covid Risk Monitor

Contributors:

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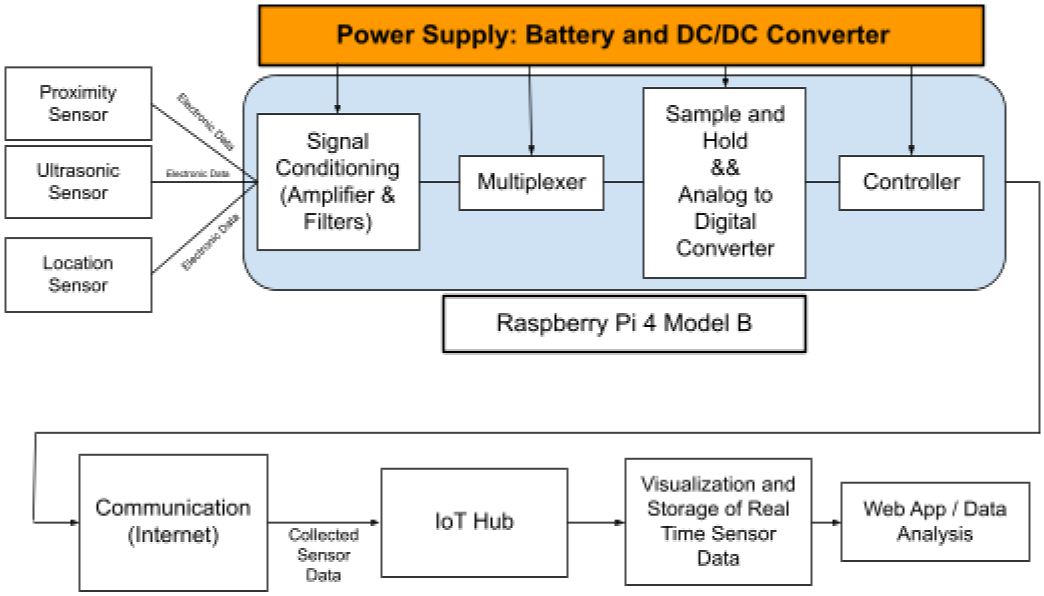


Figure 1- Block Diagram of the system

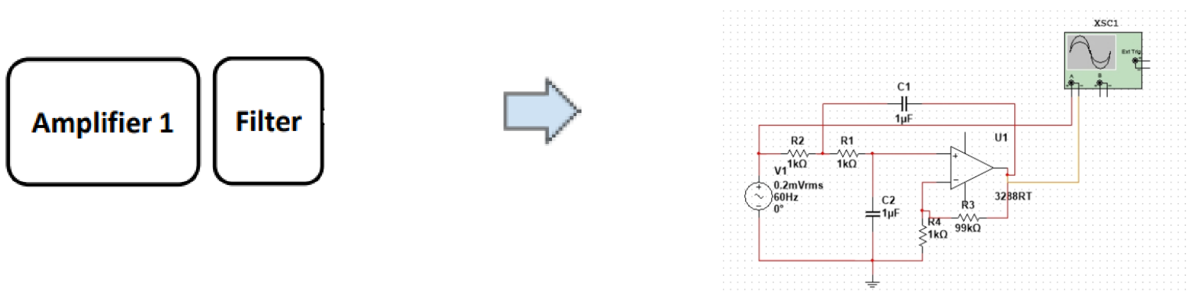
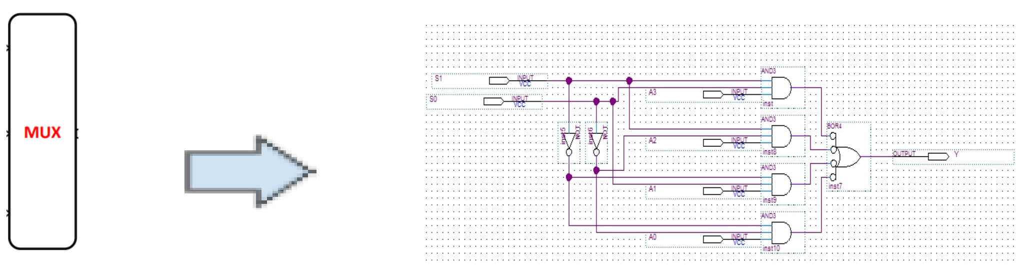
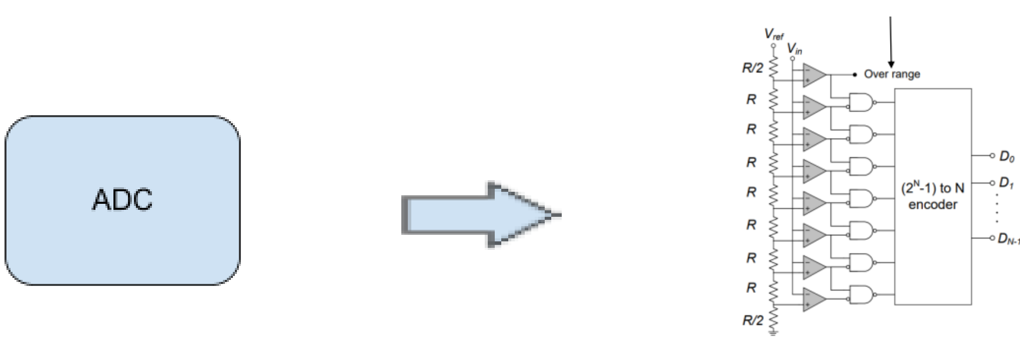


Figure 2 - Block diagram and design of signal conditioning circuit





System Under Consideration

The system under consideration is to design an IoT device that monitors a user's covid risk level based on their daily activities and interactions. This device will make it easier for users to abide by the Public Health covid-19 guidelines and prevent rapid growth of covid-19 cases. The device will detect other humans through their emitted energy (electromagnetic radiation) and keep track of their distance (at least two meters) with our user. This device will also keep track of the user's location,which will allow the user to see who they might have been in contact with. This way if one user tests positive, we can alert other users who were at the same location about a potential exposure to covid-19. Taking into account all the data gathered through the day, the user will be notified of their risk level or get an exposure warning.

Sensor Specification

Sensor 1 - Proximity Sensor

The proximity sensor will be used to detect the position of a person. If another person comes into range of the sensor, the user will be warned. The proximity sensor we chose to use is the LJC18A3-B-Z/BX sensor. This type of proximity sensor (capacitive) is useful for our needs because it can be used to detect the position of non-metallic material, such as the clothes humans wear. The specifications for this proximity sensor are listed below.

Table 1 - Kuuleyn LJC18A3-B-Z/BX sensor properties

Parameters	Specifications
Supply Voltage	10 V - 30 V
Current Output	200 mA
Response Frequency	100 Hz
Operating Temperature	-25 to +65 ℃
Detection range	1 mm to 10 mm
Dimensions	6.81 x 5.08 x 2.21 cm
Net weight	91 g

Sensor 2 - PIR (Passive infrared sensor)

The PIR sensor will be used to detect other humans through their emitted energy (electromagnetic radiation). The PIR sensor we chose to use is the ASIN B07NPKMH58. This sensor is very portable (small size) and provides low power consumption. The specifications for this sensor are listed below.

Table 2 - Geekstory HC-SR501 sensor properties

Parameters	Specifications
Supply Voltage	4.5 V - 20V
Current Output	50 uA

Operating Temperature	-15 to + 70 ℃
Measuring angle	< 100 degrees
Detection range	0 m to 7 m
Dimensions	12.2 x 8 x 3.4 cm
Net weight	60 g

Sensor 3 - Location Sensor (GPS)

The Location sensor will be used to keep track of the user's location. The Location sensor we chose to use is the Geekstory BN-220. The specifications for this sensor are listed below.

Table 3 - Geekstory BN-220 sensor properties

Parameters	**Specifications**
Supply Voltage	3V - 5.5 V (typically 5V)
Current Output	50 mA
Operating Temperature	-40 to + 85 ℃
Max Altitude	50,000 m
Max Velocity	515 m/s

Signal Conditioning Circuit

For our signal conditioning circuit, we designed an active filter to amplify and filter in the input signals from the sensors. The filter is a second order low pass filter cascaded with a non-inverting amplifier. To get a strong output signal we decided to design a filter with a gain of 100. For this filter the gain and cutoff frequency were calculated using the equations listed below.

$$A = \frac{R3}{R4} + 1 \quad (1)$$

$$F = \frac{1}{2\pi\sqrt{R1R2C1C2}} \quad (2)$$

Using a gain of 100, R3 and R4 were chosen to be 99 k**Ω** and 1k**Ω** and the cutoff frequency was calculated to be 160 Hz. For simplicity, the signal conditioning circuit was used for all the sensors since they yield relatively similar voltages in the output signal.

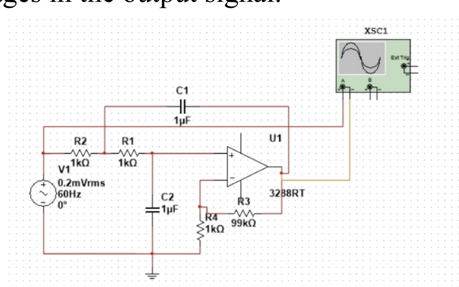


Figure 5 - Signal conditioning circuit in multisim

Multiplexer Design

A 4 to 1 multiplexer was designed using logic gates and boolean algebra. The multiplexer takes only 3 input signals due to the number of sensors, hence the last input represents a null state.

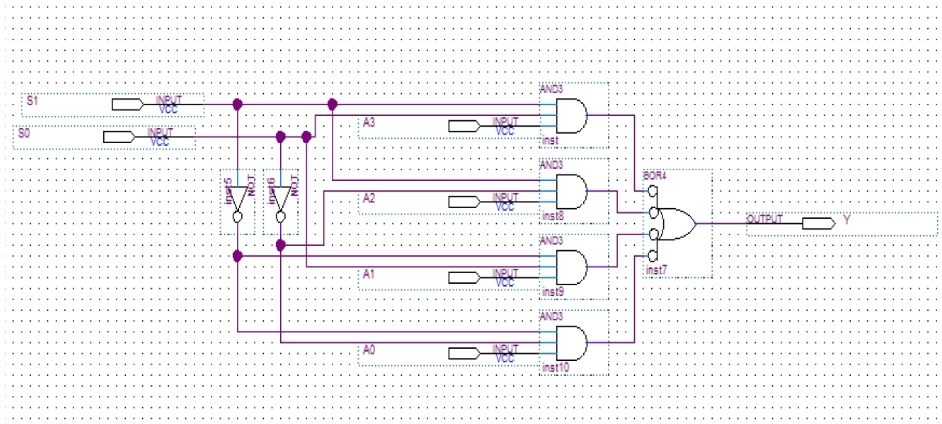


Figure 6 - Multiplexer circuit in multisim

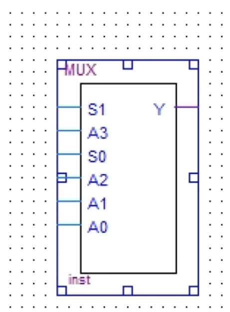


Figure 7 - Multiplexer block diagram

Table 4 - Truth table for the sensors

Sensor	Inputs		Outputs
-	S1	S1	Y
-	0	0	A0
Proximity	0	1	A1
Temperature	1	0	A2
GPS	1	1	A3

Sample and Hold

Sample and hold circuit is used to sample the signal for a short interval of time in this case 10µS and to hold on its last sampled value until the input signal is sampled again.

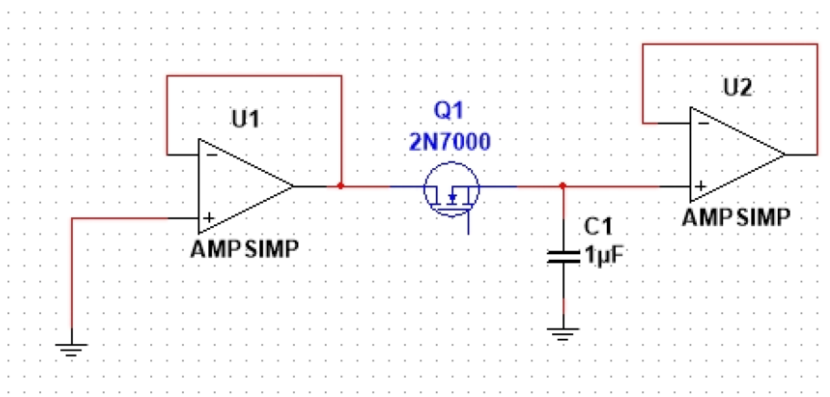


Figure 8 - Block Diagram of Sample and Hold Circuit

Analog to Digital Converter

For analog to digital converter a flash ADC was designed. The ADC is in the 12 bit configuration for better resolution.

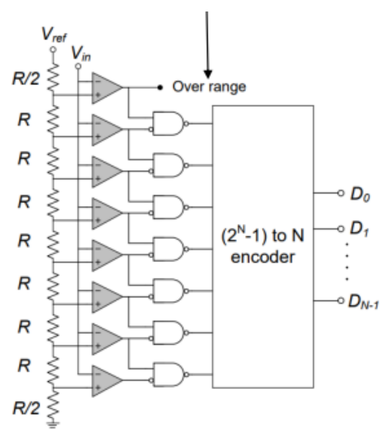


Figure 9 - Block Diagram of Sample and Hold Circuit

Through amplification and filtering of the signal from the sensors, the signal was linearly converted to a voltage signal of 0 to 1V, then digitized with a 12 bit ADC. Therefore the resolution is calculated as seen below:

$1/(2^{12}) = 0.000244V$ or about 0.244 mV per step