Smart Security Hub
Group 22
Mock Design Review

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September 21, 2016
# Table of Contents

1. Block Diagram
2. Circuit Schematic for Microphone Array
3. Calculations
   3.1 Power Consumption of the ATmega328P Microprocessor
4. Plots
   4.1 Frequency vs Sensitivity for the AOM-4546P-R Microphone
5. Block Description for Sound Detector
6. Requirements and Verification of Sound Detector
7. Safety Statement
8. Citations
1. Block Diagram
2. Circuit Schematic for Microphone Array
3. Calculations

3.1 Power Consumption of the ATmega328P Microprocessor

From the datasheet, we know the maximum voltage and current consumption with the clock frequency set at the default 16MHz.

\[
\begin{align*}
F &= 16\text{MHz} \\
V &= 5\text{V} \\
I &= 16\text{mA} = 16 \times 10^{-3}\text{ A} \\
P &= I \times V = 0.08\text{W}
\end{align*}
\]

Thus, the calculated power consumption of the microprocessor is 0.08W.
4. Plots

4.1 Frequency vs Sensitivity for the AOM-4546P-R Microphone
5. Block Description for Sound Detector

The sound detector will record sounds in real time in the form of analog signals from separate microphones. The signal is fed through a circuit of resistors, capacitors, and non-inverting amplifiers. The analog signal is then converted to a digital signal and transferred to the microprocessor. The 10 uF capacitor connecting the two gain pins of the amplifier chip controls the gain of the signal. This value capacitor will render the amplifier to supply a gain of 200. To decrease the gain, a resistor can be placed in series with this capacitor. To obtain a gain of 50, a 1.2k ohm resistor can be used. The capacitor connecting the microphone to the amplifier is used for blocking the direct current from entering the amplifier. Only the alternating current is needed, so this capacitor allows the alternating current through while not letting the direct current from the power supply through. The input to the sound detector is a voltage that comes from the microprocessor. The output to the sound detector is the signal which is sent to the microprocessor.
6. Requirements and Verification of Sound Detector

<table>
<thead>
<tr>
<th>Hardware/Requirements</th>
<th>Verification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Microphone Output</strong></td>
<td>1) Verification for microphone output:</td>
</tr>
<tr>
<td>1) The microphone located at least 10ft away should not output more than 20 mV an environment with an average of 35 ± 5 dBa of noise.</td>
<td>a) Hook the mic up to an oscilloscope</td>
</tr>
<tr>
<td><strong>Amplifier Gain</strong></td>
<td>2) Amplifier should be able to supply a gain of 200 with 90 ± 5 % accuracy. (small amount of signal distortion)</td>
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<td>b) Probe the terminals of the microphone</td>
</tr>
<tr>
<td><strong>Microphone Input</strong></td>
<td>3) The DC current coming into the microphone should not exceed 0.45 ± 0.05 mA.</td>
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<td>c) Simulate conversation or other normal noise</td>
</tr>
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<td>4) The input voltage for the amplifier should not be more than 0.35 ± 0.05 V.</td>
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<td>4) The input voltage for the amplifier should not be more than 0.35 ± 0.05 V.</td>
<td>d) Observe the peak-to-peak Voltage. Check that it stays under the desired level.</td>
</tr>
</tbody>
</table>

1) Verification for microphone output:
   - a) Hook the microphone up to an oscilloscope
   - b) Probe the terminals of the microphone
   - c) Simulate conversation or other normal noise
   - d) Observe the peak-to-peak Voltage. Check that it stays under the desired level.

2) Verification for amplifier gain
   - a) Connect input to a function generator and output to an oscilloscope
   - b) Generate a sine wave and take note of its frequency, amplitude, and any other characteristics
   - c) Check that the amplitude is correctly multiplied and that the characteristics of the output wave are consistent with that of the input (ripples, frequency, etc.)
   - d) If the amplitude is not in the desired range, vary the value of resistor 2 a little bit.

3) Verification for microphone input
   - a) Connect ammeter to the input of the microphone.
   - b) Verify that the current coming from the power sources and resistor generate a current that is no higher than 0.05 mA.

4) Verification for amplifier input
   - a) Connect a voltmeter to the input of the amplifier, after the potentiometer.
   - b) Measure the voltage to be sure it doesn’t exceed the maximum input voltage rating.
7. Safety Statement

Facts on noise levels:
1. Decibels measure sound pressure and are logarithmic. That means that only a 3db increase almost doubles sound pressure, a 6db increase quadruples sound pressure, etc.
2. Gradual hearing loss may occur after prolonged exposure to 90 decibels or above.
3. Exposure to 100 decibels for more than 15 minutes can cause hearing loss.
4. Exposure to 110 decibels for more than a minute can cause permanent hearing loss.
5. At 140 dBA noise causes immediate injury to almost any unprotected ear.
6. There is also the more extreme ‘acoustic trauma’, which is an immediate loss of hearing after a sudden, exceptionally loud noise such as an explosion.

If we are to test using real sounds instead of simulating the signal, then earplugs or muffs should be worn. Properly fitted earplugs or muffs reduce noise 15 to 30 dB. The better earplugs & muffs are approximately equal in sound reductions, although earplugs are better for low frequency noise and earmuffs for high frequency noise.

Regarding Electrical concerns:
1. The power will be supplied by an AC power adapter which takes in 120V.
2. The cord should be handled with care. Avoid letting it get caught in places where the insulating coating could be torn, which could deliver a shock.
8. Citations

[1] Various noise level of firearms
http://m14forum.com/hearing/78442-various-noise-levels-firearms.html

https://www.youtube.com/watch?v=jSeD5F8vuFw

[3] AOM-4546P-R Datasheet


[5] ATmega328P Power Consumption
https://www.avrprogrammers.com/howto/atmega328-power