

Adaptive Baby Monitoring System

Mock Design Review

Team 56

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Block Diagram

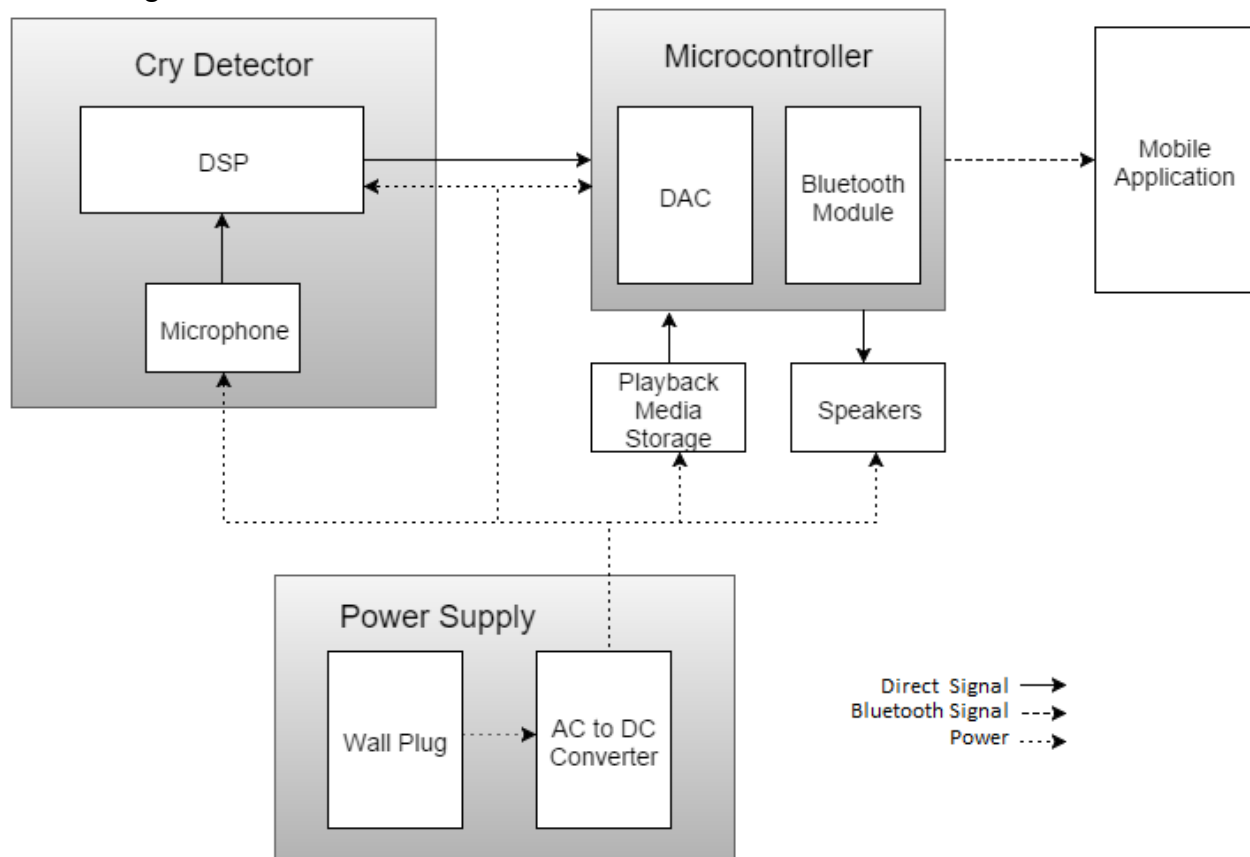


Figure 1: Block diagram for the overall system

Block Description

Power supply: The power supply is the main power source that powers the whole system. It will be plugged into a 120VAC/60Hz lab wall ac line, and produce a 12V DC voltage across its output port. The power supply can handle up to 2A current. The output can be connected to power routing system where the 12V supply can be down stepped to 5V and/or 3.3V to drive other components in the system.

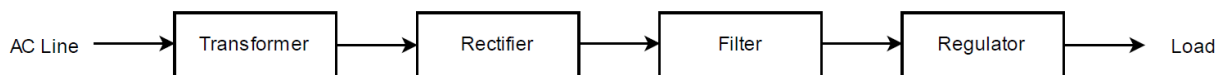


Figure 2: Block diagram for the power supply.

The 120VAC/60Hz AC voltage will be feed into wall plug transformer which convert it to 16.5VAC. The rectifier will force the voltage to be “one-sided” by using a bridge rectifier. The filter will greatly reduce the ripple by using a large capacitor. The regulator will further reduce the ripple and produce a stable 12V DC output.

Cry Detection Algorithm Flowchart

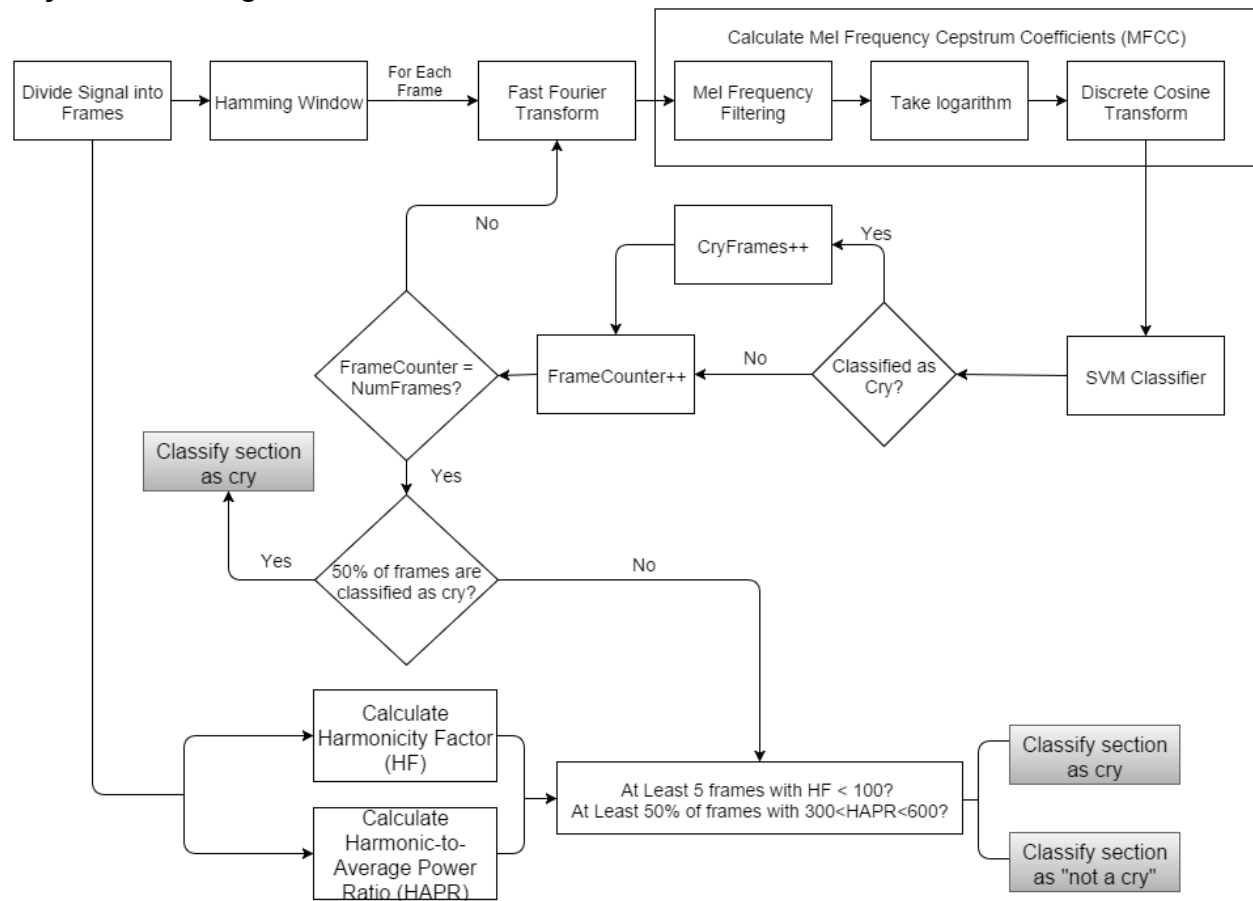


Figure 3: Algorithm Flowchart

Algorithm Description

Each “section” as shown in figure 3 will be one second segments of sound recorded from the microphone. Effectively, the algorithm runs once every second. Each section will then be divided into frames of about 20-40ms each, and the MFCC Coefficients will be computed[1]. The resulting feature vectors will go into an SVM classifier, which will classify each frame as cry or no cry. If over 50% of the frames are classified as “cry frames”, then we will classify the section as a cry, and our baby monitor will act accordingly[2]. Otherwise, if under 50% of the frames are classified as a cry, we will take into account some other features of the signal, namely the harmonic information of the signal like the Harmonicity Factor and Harmonic-to-Average Power Ratio. If these features satisfy the thresholds shown in the flowchart, then we will classify the section as a cry, and again, the baby monitor will act accordingly. Otherwise, the section will not be classified as a cry, and the baby monitor will not do anything.

Requirements and Verifications

The power supply needs to provide $12V \pm 0.25V$ with up to 2A current. For verification, it will be loaded with a 6 Ohm resistor with 30W power rating, which will theoretically draw 2A of current.

- Measure the output with multimeter to get DC voltage, which should be $12 \pm 0.25V$.
- Measure the output with an oscilloscope to analyze output ripple, it should be less than 0.25V.
- Repeat a. and b. with higher resistance to ensure the voltage is constant for all loads below 2A.

Design Process and Calculation

Regulator:

It need to output 12V and allow a maximum current of 2A. We pick LM1085-12 for our regulator. This is a LDO regulator with 12V output and 3A rating. From the datasheet, it requires a minimum input of 13.5V to ensure the output is 12V. The typical output is 12V, minimum is 11.88V and maximum is 12.12V, which satisfies this requirement[3].

Transformer:

The UB1640W provides 16.5VAC at 40VA power rating[4].

Rectifier:

A full-wave bridge rectifier with at least 2A rating is required. The 583BR31 has voltage range of 50-1000V, current of 3A, and 1V forward voltage[5].

Filter: Using a large capacitor for the filter, the minimum capacitance is given by the following calculation[6]. We need to pick a capacitor that has higher capacitance.

$$V_{ripple} = \frac{I}{2fC}$$

$$V_{rectifier,out} = V_{transformer,out} - V_{rectifier} = 16.5\sqrt{2} - 1 = 22.166V$$

$$V_{rectifier,min} = V_{rectifier,out} - V_{ripple} = 13.5V$$

$$V_{ripple} = V_{rectifier,out} - 13.5V = 8.666V$$

$$8.666V = \frac{2A}{2 * 60Hz * C}$$

$$C = 1923\mu F$$

A 2000uF capacitor was used for simulation, but a higher capacitance can be in the real design.

Schematic

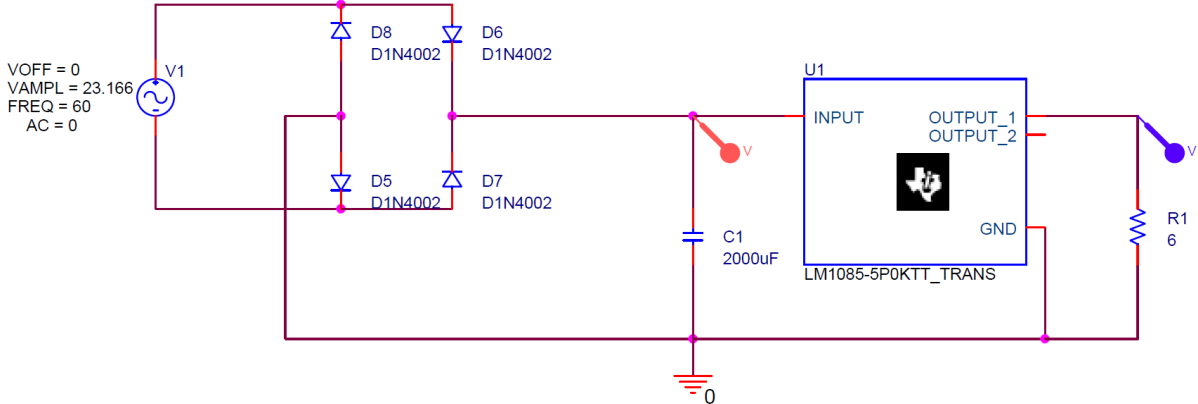


Figure 4: Schematic for the power supply.

Note that the PSPICE model for the transformer and the rectifier are not available. They are modeled with a VSIN source and a full-wave bridge rectifier implemented by diodes.

Simulation

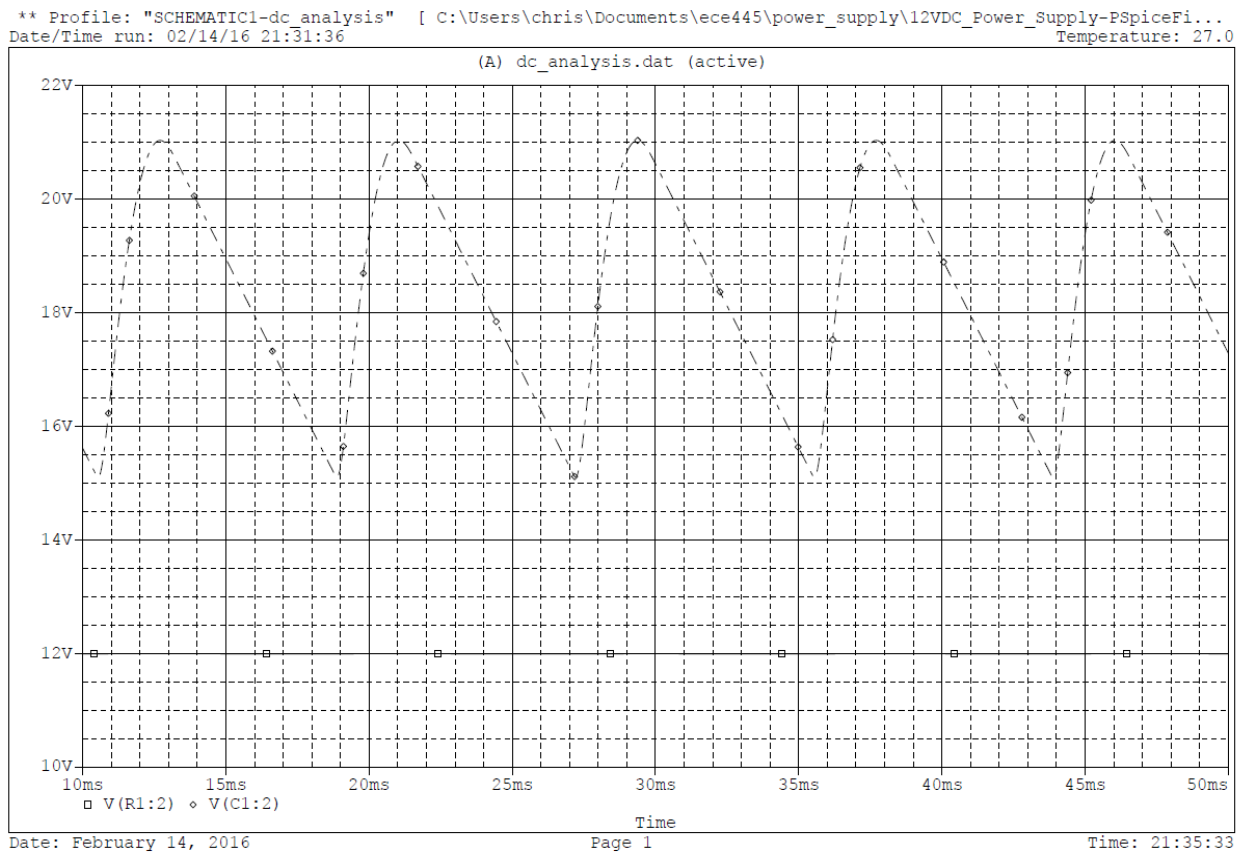


Figure 5: Transient simulation for the filter output and rectifier output voltage.

Using the built-in measurement calculation, the difference in the max and min value of output voltage is 6.5mV, which meets the requirement.

Safety Statement

1. The transformer directly plugs into the wall plug and should be handled with caution.
2. A 2A fuse may be added to ensure the safe operation of the power supply. The LM1085 IC already includes overpower protection mechanism.
3. Check the power rating of the load and estimate the current draw before connect to the power supply as it can provide a high current output.
4. Check the voltage/power rating of components used in the power supply before applying them.

References

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[3] Texas Instruments, "LM1085 3-A Low Dropout Positive Regulators", 2015. [Online]. Available: <http://www.ti.com/lit/ds/symlink/lm1085.pdf>. [Accessed: 17- Feb- 2016].

[4] UPG, "Transformer UB1640W". [Online]. Available: <http://upgi.com/Themes/leanandgreen/images/UPG/ProductDownloads/71782.pdf>. [Accessed: 17- Feb- 2016].

[5] Mouser, "SINGLE-PHASE SILICON BRIDGE RECTIFIER". [Online]. Available: <http://www.mouser.com/ds/2/345/br305-br310-27971.pdf>. [Accessed: 17- Feb- 2016].

[6] J. Millman and C. Halkias, *Integrated electronics: analog and digital circuits and systems*. New York: McGraw-Hill, 1972, pp. 112–114.