

Adaptive Baby Monitoring System

Design Review

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1.0 Introduction

1.1 Statement of Purpose

A baby's cry is an important signal that they are in need of care. For parents or caretakers with hearing disorders, it is sometimes hard for them to tell when a baby is crying. Our product will aid them and let them know when their baby is crying immediately so that they will know immediately and be able to provide assistance to the baby.

1.2 Objectives

1.2.1 Goals & Benefits:

ensure that parents with hearing disorders are always aware of whenever the baby is crying and in need of care promptly

optimize adaptability by providing immediate solution to alleviate stress from the baby

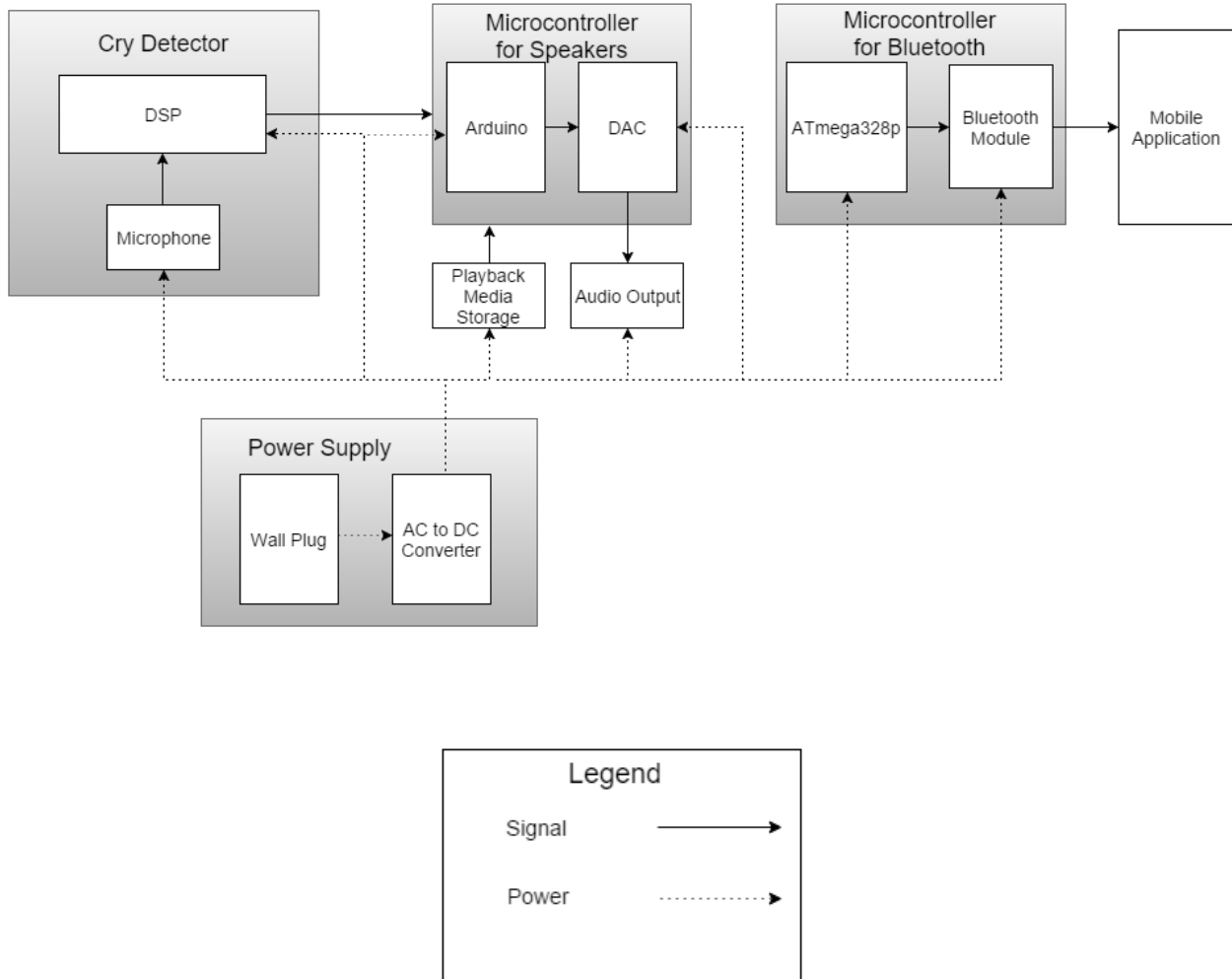
1.2.2 Functions & Features:

- cry detector which will be trained using machine learning to adapt to a baby's individual cry
- notify parents or caretakers whenever the baby starts to cry through mobile app
- upon detection of cry, playback device will play music
- playback device, which is powered through a wall plug, contains a power routing system that powers all the different components of the playback device

2.0 Design

2.1 Block Diagram

Figure 1: Block Diagram

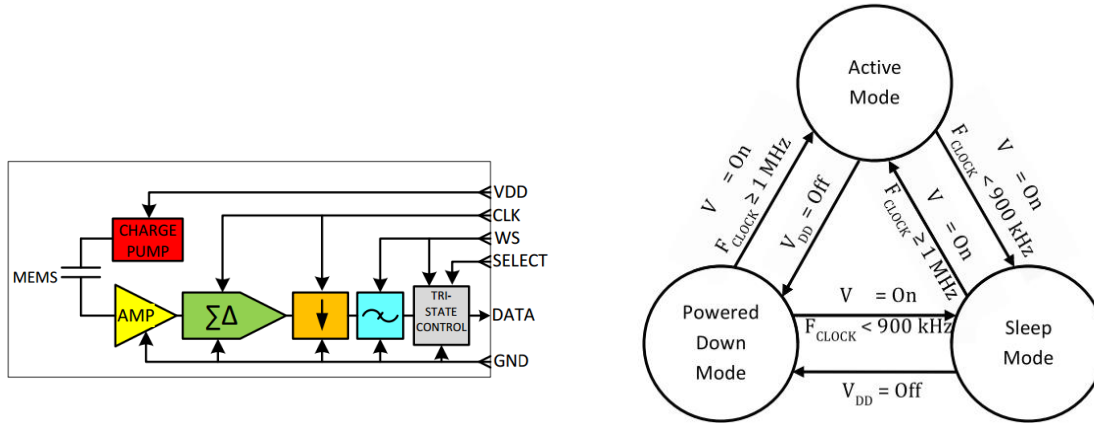


2.2 Block Descriptions

2.2.1 Cry Detector Module

Microphone:

Figure 2: Microphone Pins and State Machine [1]



The microphone will have a sampling rate of 32 kHz, which is well above the minimum sampling rate for the purposes of our project of 9 kHz. This will be powered with 1.8 V and driven by an external 2 MHz clock oscillator.

Figure 2 is a detailed block diagram of the microphone and the state machine for its operating modes. We always want it to be in Active Mode, where it continues to record sounds and output data. Hence, WS and SELECT are both set to high.

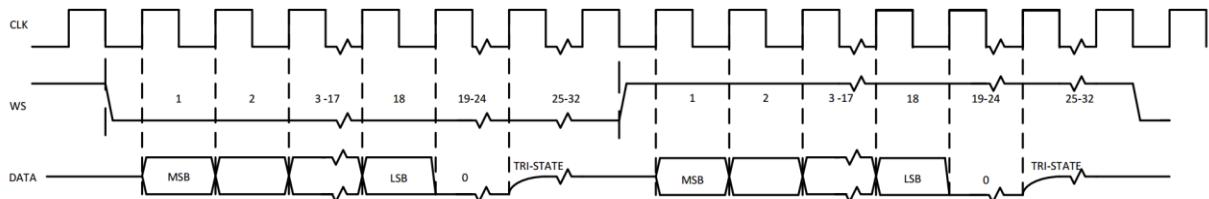
Table 1: Pins of Microphone [1]

Name	Pin #	I/O	Connection
VDD	1	Input	1.8V Power Supply
CLK	2	Input	2 MHz Clock Oscillator
WS	3	Input	1.8V Power Supply
SELECT	4	Input	1.8V Power Supply
GND	5	Input	0V
DATA	6	Output	Digital Signal Processor

Digital Signal Processor:

The DSP will receive input sound from the microphone through the I/O pin EMUD1. This will be a 24 bit word, which will be transmitted across 24 clock cycles as shown below. The format in which the data is received is shown in Figure 3.

Figure 3: Microphone to DSP Input Data Format [1]



The DSP will be programmed with a pattern recognition algorithm for cry detection. We will train a Support Vector Machine (SVM) classifier in MATLAB, obtain the SVM kernel function from the MATLAB struct, and then we will store that in the DSP. The DSP itself will obtain some frequency information from the sounds captured by the microphone, namely the MFCC coefficients, to use as feature vectors for the SVM classifier. This data is then fed into the SVM classifier, which gives a result of cry or no cry. Whenever a cry is detected, it will send a signal to the microcontroller.

Table 2: Pins for DSP [2]

Name	Pin #	I/O	Connection
Vdd	13	Input	5V Power Supply
Vss	8	Input	Ground
EMUD1	11	Input	Input from Microphone
EMUD2	14	Output	Output to microcontrollers for speakers and Bluetooth

2.2.2 Microcontroller for Speakers Module

This will be implemented by an Arduino built on top of an ATmega328p microcontroller. The microcontroller will receive input signal from the DSP, which will be high when a cry is detected and low otherwise. The microcontroller also interfaces with a SD card to play WAV files from it. Using libraries on the Arduino, the microcontroller will be programmed to output the driving signal and audio signal for the DAC in the correct format.

2.2.3 Audio Output Module

DAC

AD1856 DAC will be used in the circuit to perform the digital to analog conversion. The DAC will accept the clock, latch enable, and data input from the microcontroller. It will output an analog signal to the amplifier.

Amplifier

The amplifier acts as a amplification stage to connect the DAC and the speaker. Since the speaker is a heavy current load, the direct output from the DAC will fail to drive it. The amplifier will be using a fully discrete design to ensure the flexibility and power to drive a low impedance and high current load. The amplifier will buffer (when gain is set to 1) or increase the voltage and provide the current that will be able to drive the speaker. The amplifier have an adjustable voltage gain from 1 to at least 3. It will be done with a potentiometer.

Speaker

The speaker is a simple passive device that accepts audio signal and plays the WAV file from the SD card. It takes the output of the amplifier as an input.

2.2.4 Microcontroller for Bluetooth Module

We will have a second ATmega328p to interface between the DSP and the Bluetooth module. This microcontroller also receives an input from the DSP. It will be connected to a Bluetooth module and send a signal to it whenever a cry is detected. That way, the mobile application, which interfaces with the Bluetooth module, knows when a cry is detected based on the input from the DSP, and it will send a notification accordingly.

2.2.5 Power supply Module

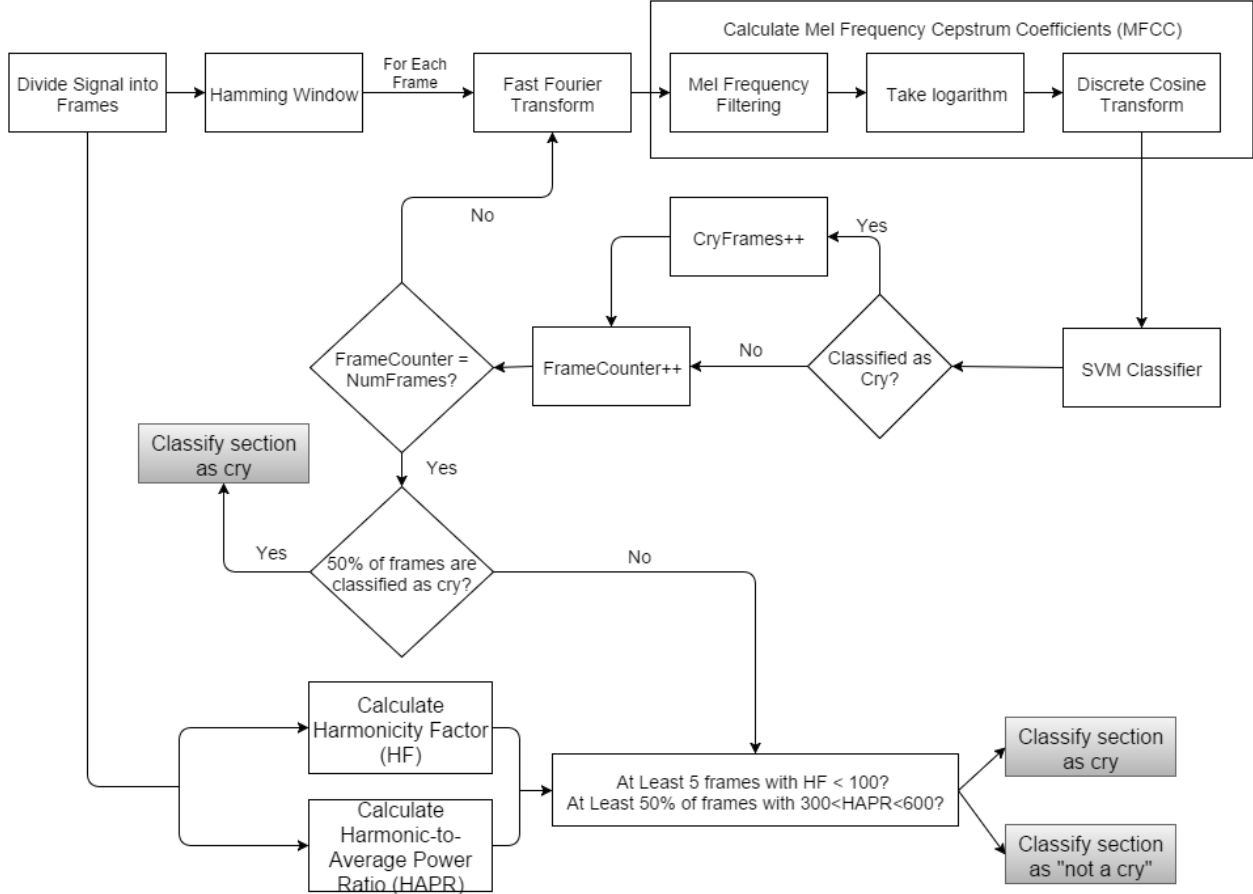
The power supply will convert 120 VAC to +12V, +5V, +1.8V and -12V DC. It is used to power up the entire system. +12V rail will be used for the amplifier and DAC, -12V rail for the amplifier, +5V rail for all other IC chips and +1.8V rail for microphone.

A transformer will be used to bring 120VAC down to approximately 24VAC. A bridged rectifier will be built from diodes to rectify the AC voltage. A capacitor will be used as a filter to reduce the ripple. Four LDO regulator ICs together with resistive network will be used to regulate the filter output and produce the four DC rails.

2.3 Schematics and Flowcharts

2.3.1 Cry Detection Algorithm

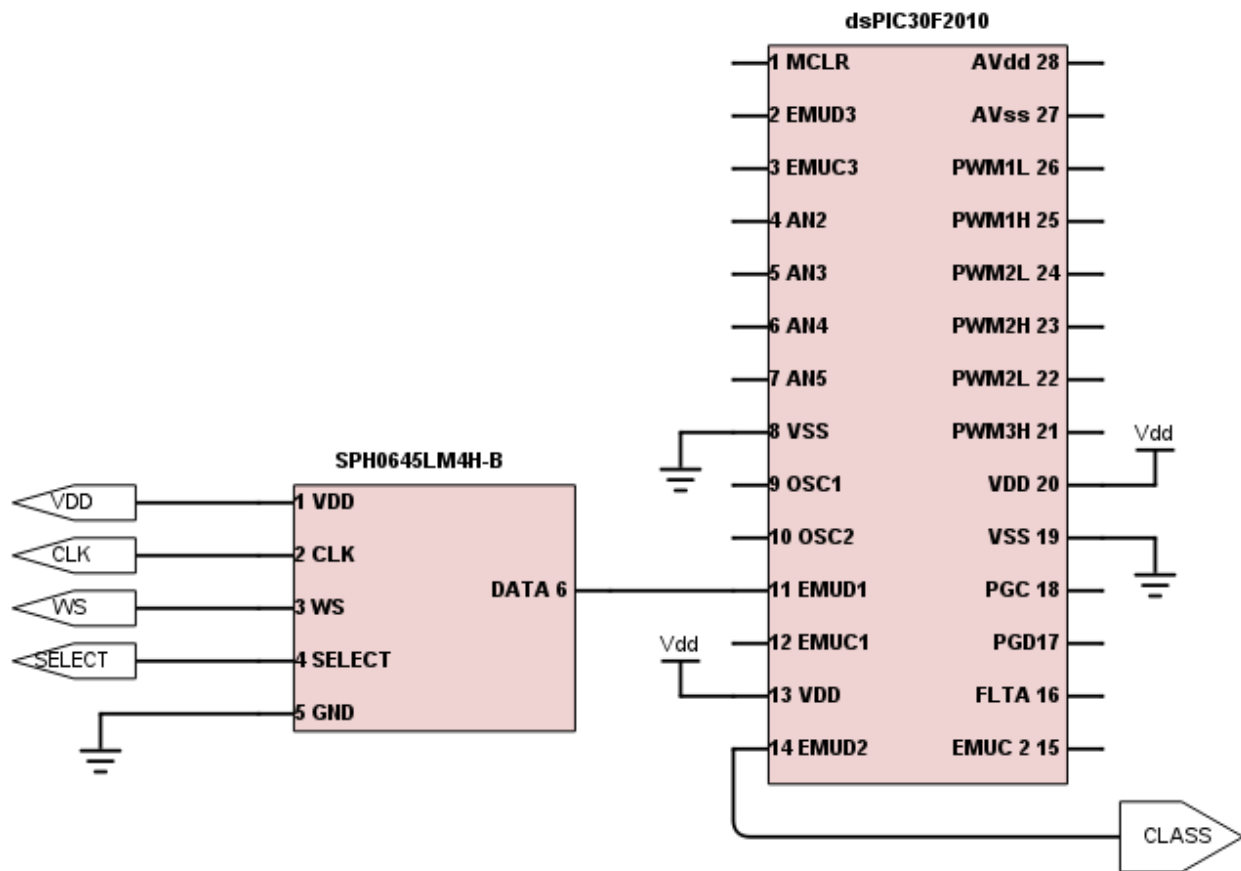
Figure 4: Cry Detection Algorithm Flowchart



Each “section” as shown in Figure 4 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 [3]. 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 [4]. 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.

2.3.2 Microphone and Digital Signal Processor:

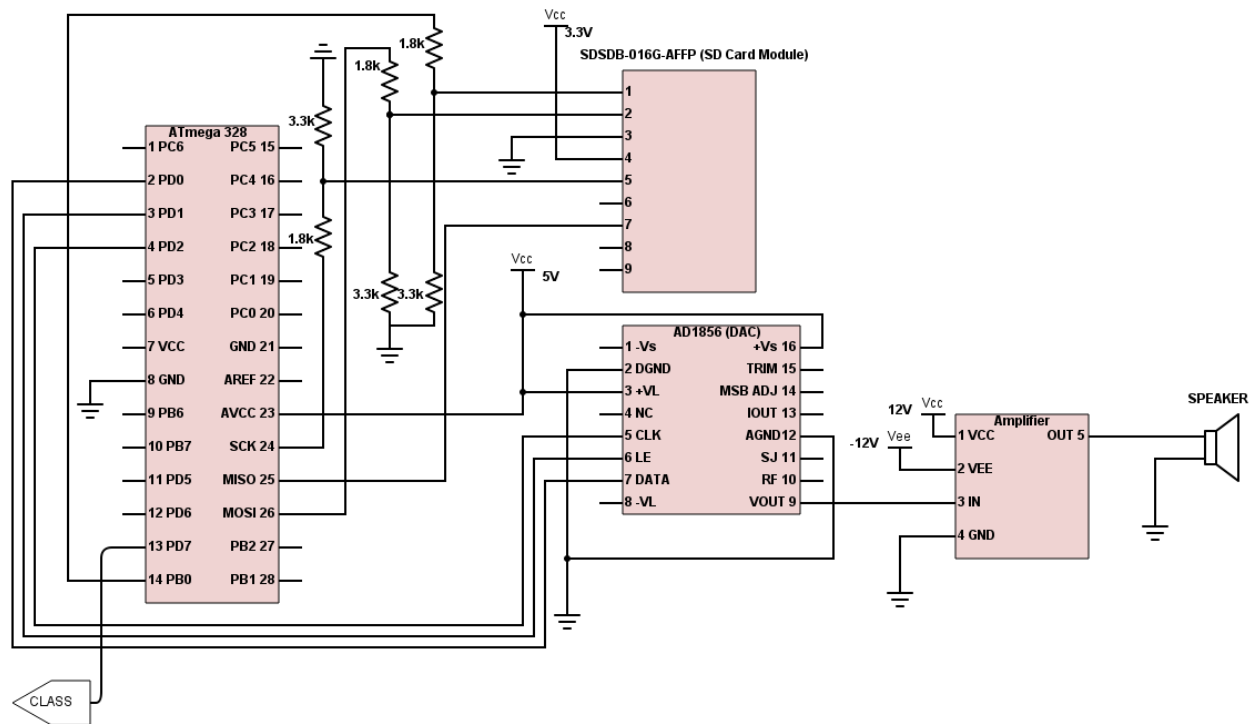
Figure 5: Schematic for Microphone and Digital Signal Processor



The input pins for the SPH0645LM4H-B microphone are all described in section 2.2.1. The output of the microphone goes into EMUD1, an I/O pin, of the dsPIC 30F2010 DSP [1][2]. After the classification is done within the DSP, it outputs “CLASS”, a 1-bit signal, on I/O pin EMUD2. When “CLASS” is high, then a cry has been detected. Otherwise, no cry has been detected.

2.3.3 Microcontroller for Speakers

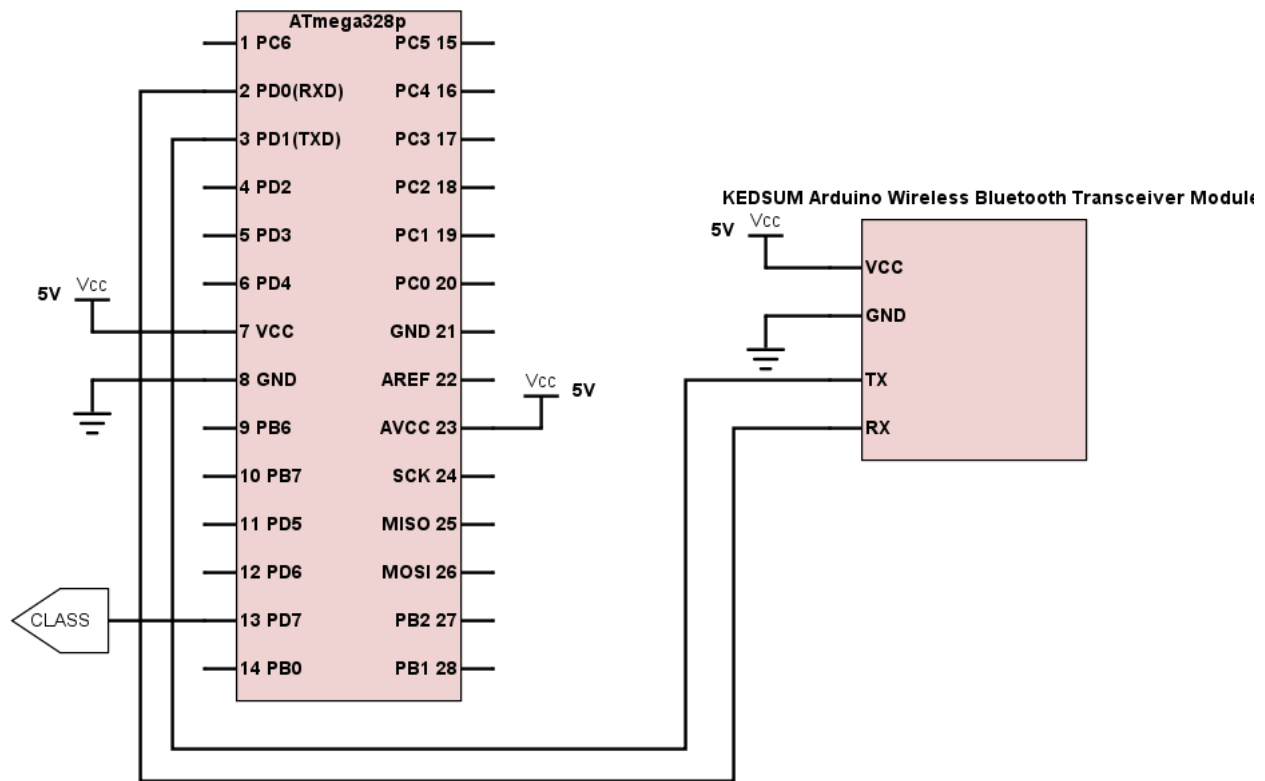
Figure 6: Schematic for microcontroller, SD Card Module, DAC, and audio output



The microcontroller for speaker module, as shown in Figure 6, is used to allow the DSP to interface with the analog audio output [5]. Once ATmega328 microcontroller receives a high signal at pin 13, flagging that a cry is detected, it will read the data from the SD card. The resistive network between the microcontroller and the SD card is used to bring 5V to 3.3V. The resistive network between the microcontroller and the SD card is used to bring 5V to 3.3V [6]. The microcontroller then extracts a WAV file from the SD card using the Arduino software interface and sends it to the DAC to the DATA pin, which contains the data for the WAV file in digital form. The microcontroller will output a clock, latch enable and data signal to the AD1856 DAC [7]. The DAC will then produce a 3V output into the amplifier which drives the speaker, which plays a WAV file off of the SD card.

2.3.4 Microcontroller for Bluetooth

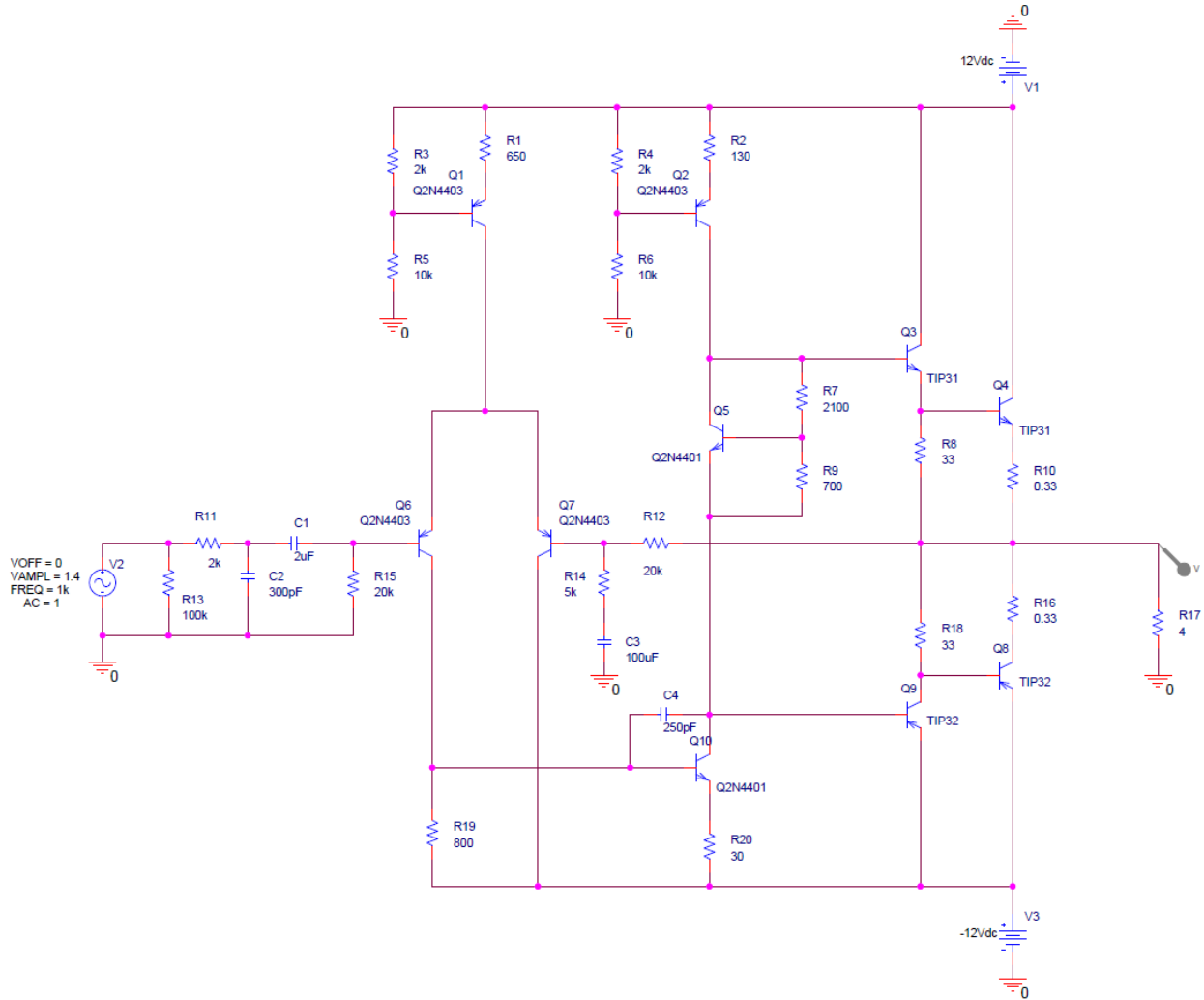
Figure 7: Schematic for microcontroller and Bluetooth Module



The microcontroller for the Bluetooth module, as shown in Figure 7, is used to allow the DSP to interface with the Bluetooth module. Hence, we will have a second ATmega328p for this purpose. The ATmega328p takes in “CLASS”, the output of the DSP. Whenever, a cry is detected and class becomes high, it sends a signal to the Bluetooth module through the RXD/RX and TXD/TX pins on the ATmega328p and Bluetooth module respectively [5][8]. This allows the mobile application to extract information from the Bluetooth module and send a notification accordingly. The specifics of the signals sent between the ATmega328p, Bluetooth module, and mobile app will be implemented through the Bluetooth software interface and Android Development IDE.

2.3.5 Audio Output

Figure 8: Schematic for the Amplifier



Amplifier:

The amplifier shown in Figure 8 is adapted from a basic three stage audio power amplifier [9]. It is implemented in the following stages.

Input network

R_{13} connects the output of the DAC to ground to avoid floating at DC. R_{11} and C_2 forms a low pass filter to filter out some radio frequency signal.

$$f_{-3dB} = \frac{1}{2\pi RC} = 265kHz$$

R_{15} is picked to be the same value as $-R_{12}$ in the feedback network to balance out the differential.

Input stage

Q_1 , R_1 , R_3 and R_5 forms a 2mA current source. R_3 and R_5 is picked so that the base of Q_1 is set to a known value. Then assume that V_{be} is 0.7V, we can pick R_1 to get the desired current. The output resistance is relatively high so we don't need to worry too much about the load.

$$V_b = \frac{R_5}{R_3 + R_5} * V_{cc} = \frac{10k}{2k + 10k} * 12 = 10V$$
$$V_e = 10 + 0.7 = 10.7V$$
$$R_1 = \frac{V_{cc} - V_e}{I} = \frac{12 - 10.7}{2mA} = 650\Omega$$

The 2mA current will be used to biasing the input differential pair which acts as first stage gain and also the comparator for the negative feedback network.

Voltage amplification stage

R_4 , R_6 , R_2 and Q_2 are used to form another current source. This time 10mA is needed for the voltage amplification stage.

$$R_2 = \frac{V_{cc} - V_e}{I} = \frac{12 - 10.7}{10mA} = 130\Omega$$

Q_{10} is used in the voltage amplification stage configured as a common emitter amplifier with emitter degeneration.

R_{19} is used to bias the base of Q_{10} . Assume that Q_{10} has V_{be} of 0.7V and also an emitter voltage at 0.3V+V_{ee} resulting from the biasing current and the emitter resistance. Also the current across R_{19} is approximately 1mA from the differential pair. We can calculate the value needed for R_{19} .

$$R_{19} = \frac{V_e + V_{be}}{I_{19}} = \frac{0.3 + 0.7}{1mA} = 1k\Omega$$

R_{20} is the degeneration resistor to boost the bandwidth and linearity for the amplifier. C_4 is the miller effect capacitance added to stabilize the amplifier.

Output stage

The output stage is formed by using a push-pull network to form a class AB emitter follower. Q_3 and Q_4 form a Darlington pair that is capable of very high current gain. TIP31 which is a power BJT is used here to make sure it can handle large current. Q_8 and Q_9 form the complementary part of the network. The output stage is biased using a V_{be} multiplier consists of Q_5 , R_7 and R_9 . We need at least $4 * V_{be}$ between the base of Q_3 and Q_9 to ensure the output stage is active.

$$4 * V_{be} = \frac{R_7 + R_9}{R_9} * V_{be}$$
$$\frac{R_7}{R_9} = 3$$

So 2100 Ohm and 700 Ohm are picked here.

Feedback network

The previous stages provides a very large open loop gain of at least several thousand. We don't need that much gain since the input is a typical 1Vrms signal from the DAC. We want the output voltage in the range of +10V to -10V, leaving some headroom to the current source and transistors. The actual gain needed depends on the input signal. R_{12} and R_{14} forms the feedback network. It is basically a voltage divider that feed a portion of the output to the differential stage. The gain is:

$$G_v = \frac{R_{12} + R_{14}}{R_{14}} = 1 + \frac{R_{12}}{R_{14}}$$

The values of R_{12} and R_{14} -in the schematic will thus produce a gain of 5.

Load

The load will be an 8 Ohm speaker. The actual load will be reactive and have different impedance at different frequency. Here a 4 Ohm resistor is used to model a heavy current load case.

2.3.6 Power Supply

Figure 9: Schematic for the power supply with +12V, +5V and +1.8V rails.

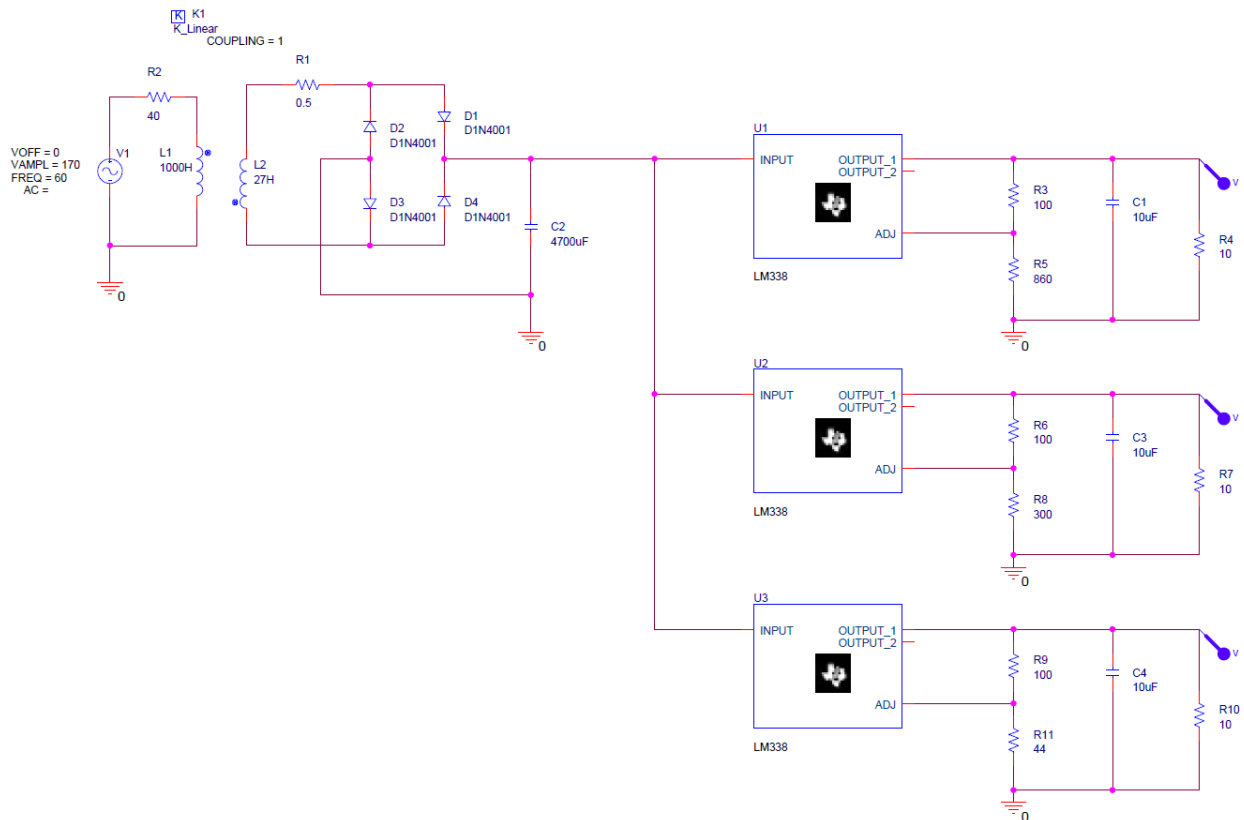
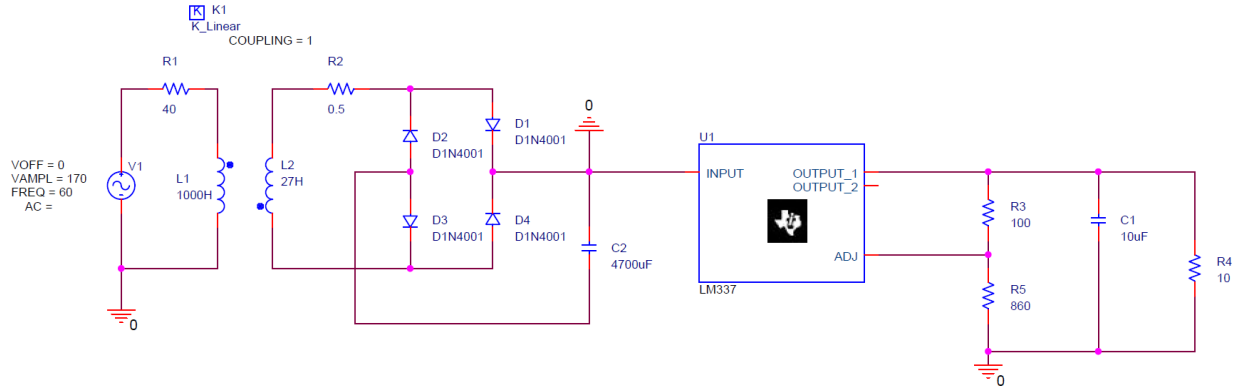


Figure 10: Schematic for the power supply with -12V rail.



The power supply will create four voltage rails. It is shown in Figure 9 and 10 for positive rails and negative rail.

Filter Capacitor

Assume maximum current load of 2A.

$$V_{ripple} = \frac{I}{2fC} = \frac{2A}{2 * 60Hz * C}$$

$$V_{rectifier,out} = V_{transformer,out} - V_D = 18\sqrt{2} - 1 = 24.4V$$

The actual voltage may be lower due to the charging current is greater than 2A and there will be voltage drop across parasitic resistance of the transformer. We calculated the rectifier output to be about 20V.

Then assume the highest output rail of 12V and highest dropout voltage of 3V, which results in the input of the regulator to be 15V.

$$V_{filter,min} = V_{rectifier,out} - V_{ripple} = 15V$$

$$V_{ripple} < 5V$$

$$C > 3333\mu F$$

To compensate for other voltage drop and stability, we picked a higher capacitor at 4700uF.

Output adjustment resistors

According to the datasheet of regulator [10].

$$V_{out} = 1.25(1 + \frac{R_2}{R_1})$$

So in order to achieve 12V, 5V and 1.8V output, set R1 to 100 ohm and calculate for R2.

$$R_2 = 100(\frac{V_{out}}{1.25} - 1)$$

$$R_{2,12V} = 100(\frac{12}{1.25} - 1) = 860\Omega$$

$$R_{2,5V} = 100(\frac{5}{1.25} - 1) = 300\Omega$$

$$R_{2,1.8V} = 100(\frac{1.8}{1.25} - 1) = 44\Omega$$

2.4 Simulations

Figure 10: MFCC of a 30 Second Track in Training Data

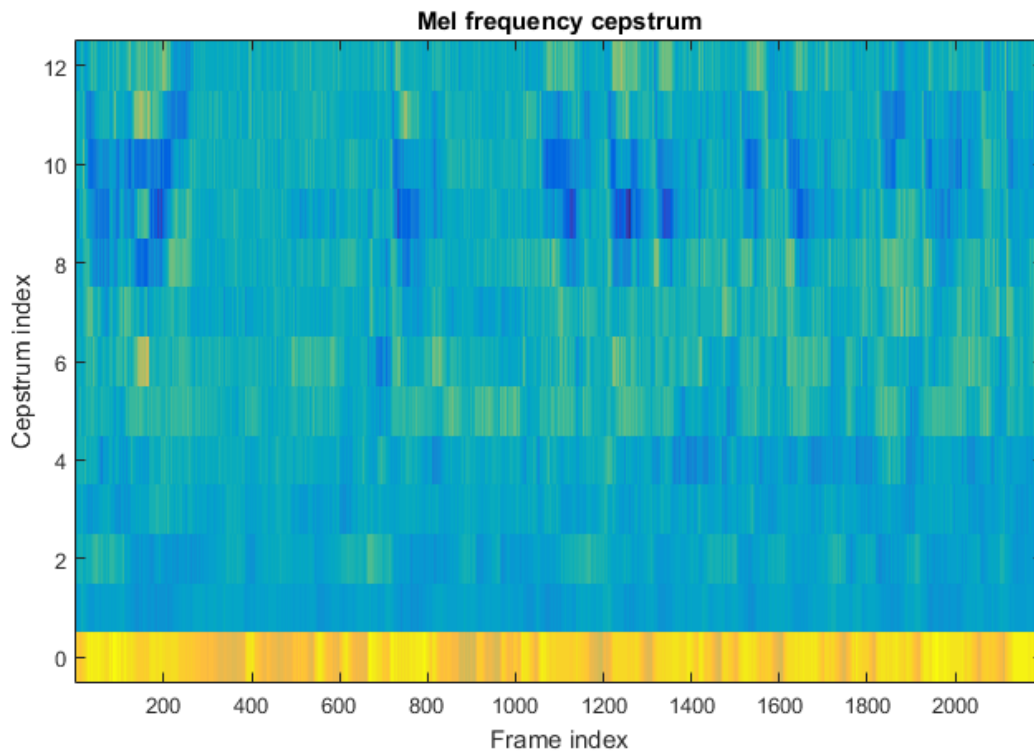


Figure 10 shows the resulting MFCC coefficients of a 30 second track of crying sounds in the training set. Each frame in the track will have a 1x13 feature vector, which represents the short-term power spectrum. After applying MFCC on all the tracks in the training set, the resulting feature vectors will then be used in the SVM classification algorithm.

Figure 11: Visual of SVM Classification Results

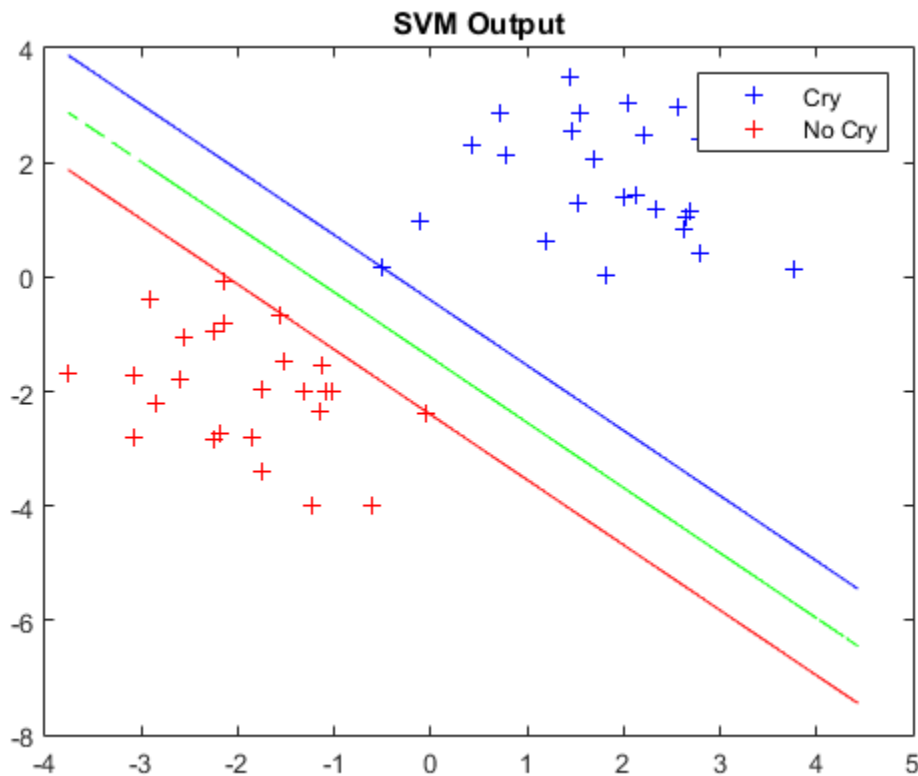


Figure 11 is a visual of what the classification result should look like. Shown above in Figure 2 is a linear SVM boundary, with the green line being the separating hyperplane and the blue and red lines being the margins. The data points that lie on the margins are called support vectors. In our case, our SVM will use a non-linear radial basis function kernel, but a linear SVM is shown for illustrative purposes.

After applying MFCC on a test track, it will then be classified as "Cry" or "No Cry" according to the separating hyperplane.

Figure 12: Transient simulation of the regulator output voltage

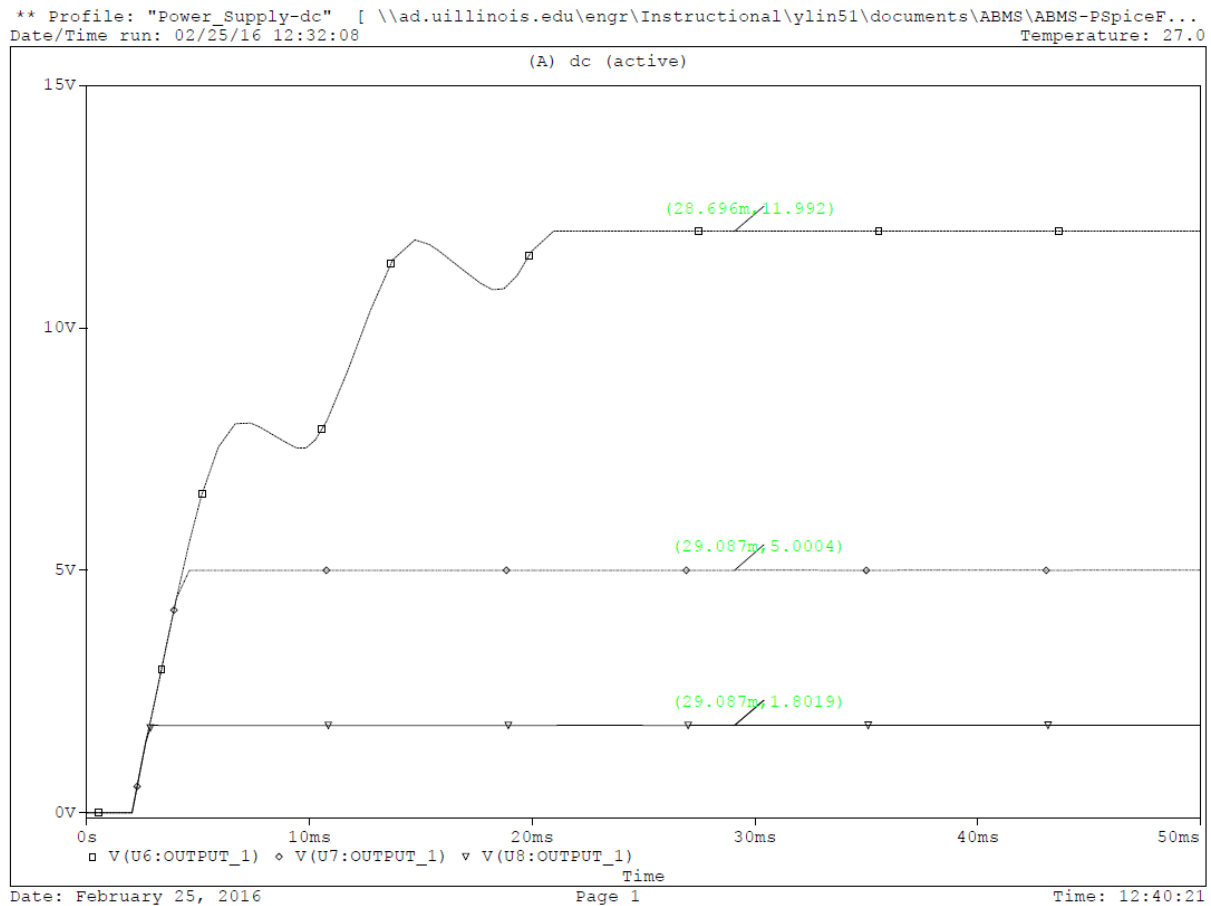


Figure 12 shows the output voltage measured at the regulator output with some very current heavy load (10 ohm resistors). This is a transient simulation from zero time. We can see that the 12V rail takes the longest time of approximately 20ms to reach a stable status. All the output voltages are within the requirement range and stays quite stable.

Figure 13: Transient simulation of the amplifier output

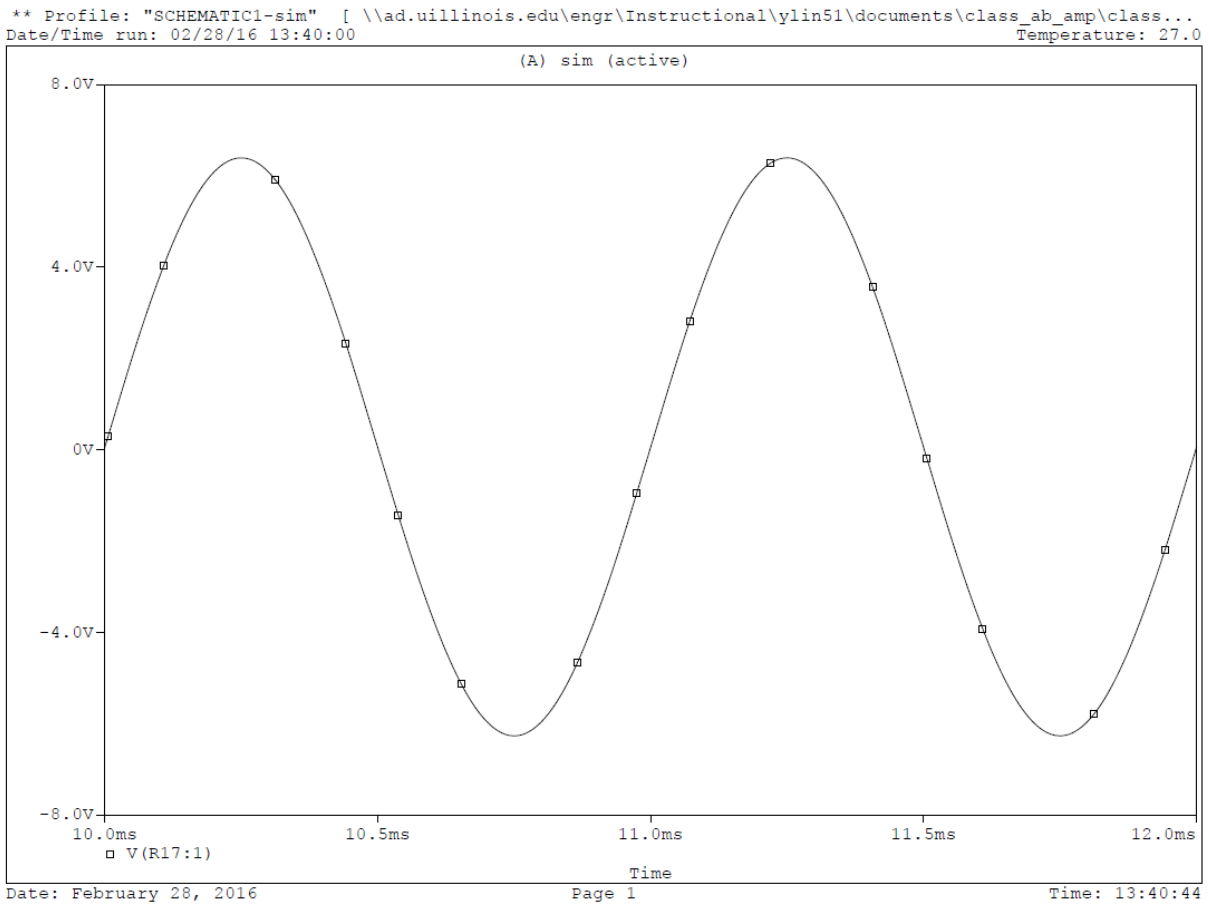


Figure 13 shows the transient output waveform of the amplifier with sine wave input of 1.4V amplitude at 1kHz. The feedback network is adjusted to 4:1 ratio for a gain of 5. The load is modeled as a 4 Ohm resistor. The actual gain is slightly less at around 4.5. Here we can see the waveform is very well reproduced with gained amplitude. No significant distortion can be observed. A total harmonic distortion over 10 harmonics gives THD=0.078% at 1kHz, or equivalently -62dB.

Figure 14: Frequency response of the amplifier output

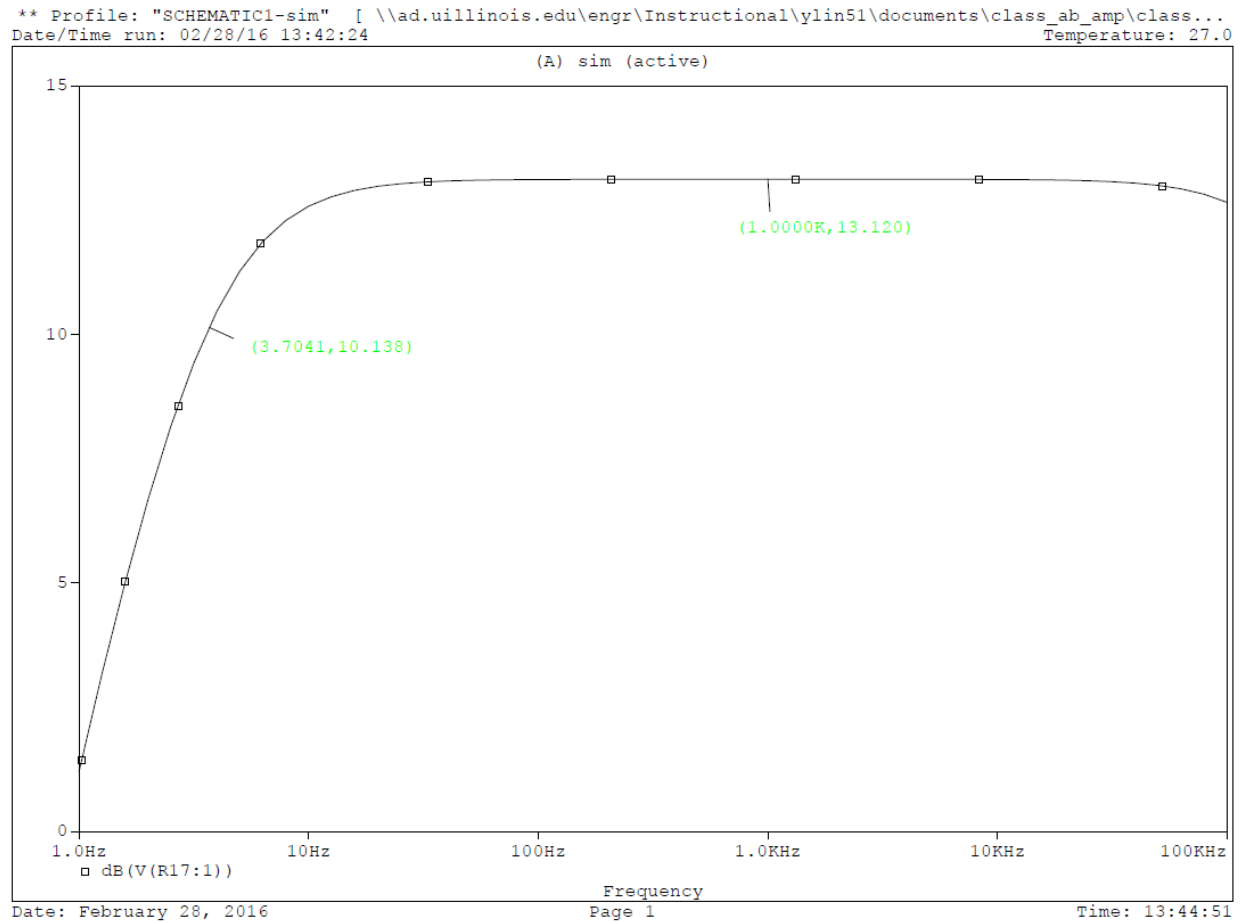


Figure 14 shows the AC response under the same condition as the transient simulation. We can see that the gain at 1kHz is 13.120 and the 3-dB roll-off point is at 10Hz. This means that the 3-dB bandwidth covers all audible frequencies from 20Hz to 20kHz.

3.0 Requirements and Verification

3.1 Requirements

Block	Requirement	Verification	Points
Module 1: Microphone	Microphone must sample recorded sound with a sample rate of at least 9 kHz	This can be tested by putting an oscilloscope on the output of the microphone and viewing the waveform of the audio signal. The Fast Fourier Transform will be used to determine the sampling rate.	3
Module 1: Cry Detector	SVM classifier must successfully classify testing tracks at at least 90% accuracy.	Across 50 or more tracks of human vocalizations with class labels “cry” and “no cry”, at least 90% of them must be classified correctly by the algorithm. Also, we will perform 10-fold cross validation on the training set. The resulting accuracy must also be at least 90%.	10
Module 1: Digital Signal Processor	DSP receives a 24-bit signal from the microphone	Use an oscilloscope to capture the waveform of the output of the microphone across 24 clock cycles. This is the data outputted by the microphone. From the DSP, output the same signal onto one of the I/O pins. Use an oscilloscope to capture the waveform of the value of that pin across 24 clock cycles. Compare the 2 waveforms above. The 24-bit number represented by these waveforms must be the same.	3
Module 1: Digital Signal Processor	(a) Upon detection of a cry, EMUD2 (the pin that goes to the output “CLASS”) must be high.	Play a crying sound near the microphone. Open up the ICD2 debugger and look at a list of all the pins with	5

	(b) If a human sound that is not a cry is played, EMUD2 (the pin that goes to the output "CLASS") must remain low.	their values. (a) If that sound is labeled as a cry, then check if the EMUD2 pin is high for at least one clock cycle. (b) Otherwise, if the sound is not labeled as a cry, EMUD2 should remain low. If EMUD2 is high in this case, then we have a false positive.	
Module 2: Microcontroller for speakers	Once the microcontroller receives a high signal from the EMUD2 pin of the DSP, music must start playing within 30 seconds.	The music playback will be verified by the correct track being played from the SD card.	9
Module 2: DAC	(a) Master Clock must have a frequency of 12.288 MHz +/- 50 ppm. (b) Frequency response of test file must have a 3dB bandwidth from 20Hz-20kHz.	(a) Connect oscilloscope to Master Clock and measure frequency. (b) Connect oscilloscope to output and obtain frequency response.	5
Module 3: Amplifier and Speaker	(a) The amplifier must be able to achieve 2.83V/V (9dB) gain with 1Vrms, 1kHz input and 8 ohm load. (b) The amplifier must have a 3-dB bandwidth for at least 200Hz to 20kHz.	(a) Generate an 1Vrms sine wave input from function generator, load with 8 ohm resistor and measure the voltage across it using an oscilloscope, it should be at least 2.83Vrms. (b) Generate an AC sweep from the function generator and measure and plot the frequency response, the gain should not roll-off more than 3 dB at 200Hz and 20kHz.	7
Module 4: Android Application	The user must receive a notification on the mobile application within 30 seconds of a	Play a crying sound near the microphone. Set a timer to 30 seconds. Before	3

	detected cry.	the timer reaches 0, the user should have received a notification saying that the baby is crying.	
Module 5: Power Supply	The power supply needs to have $\pm 12V$, $+5V$ and $+1.8V$ output rails. The $\pm 12V$ rails need to provide up to $0.8A$ current each. The $+5V$ rail need to provide $50mA$ and the $+1.8V$ rail need to provide $5mA$. The tolerance for voltage should be within $\pm 5\%$.	Measure the open circuit and maximum load (maximum current) voltage with multimeter for each rail, they should be within the desired range. Resistors can be applied at the output to simulate maximum current draw.	5

3.2 Tolerance Analysis

To ensure that the sound quality represents the digital file as closely as possible, we need to consider the path for a digital music file to reach the final audio output through speaker. There are mainly three stages: digital transfer, digital to analog conversion and analog amplification.

The digital transfer stage consists of the microcontroller reading from the SD card, and output digital sequence to the DAC. The data is binary, so as long as the program works as desired, it will not cause any information loss or distortion.

The power supply switching is somewhat slow, but the DAC needs high speed operation, so any small changes in the voltage will not be immediately compensated from the voltage source. Therefore, near the pins of V_S and V_L we need to place two AC decoupling capacitors in a shunt connection to ground. The value should be around 100nF, as the ripple will not be very big since the voltage is already regulated. Higher value can be used for more stability.

The amplifier is an analog amplification device so its performance will have the greatest impact on the fidelity of input signal. It is important to keep the circuit biased as desired so all transistors will operate in the linear portion. The current source is used to bias the amplification stages, and their precision needs to be taken into account first. Consider an extreme case:

$$\begin{aligned}R_3 &= 2k * 90\% = 1.8k\Omega \\R_5 &= 10k * 110\% = 11k\Omega \\R_1 &= 650 * 110\% = 715\Omega \\V_B &= \frac{11k}{11k + 1.8k} * V_{cc} = 10.31V \\V_E &= 10.31 + 0.7 = 11.01V \\I &= \frac{V_{cc} - V_E}{R_1} = \frac{12 - 11.01}{715} = 1.38mA\end{aligned}$$

The result is only 69% of the desired value of 2mA. This will underdrive the amplifier and produce less open loop gain. Also, the drop in current will result in drop of voltage for biasing Q_{10} . In the worst case, it may turn off Q_{10} so the amplifier will produce a lot of distortion and will not achieve the theoretical gain. We want to be careful for the choice of the resistor that biases the current source. One way is to pick resistors that has lower error tolerance. 1% will be the best choice in this case. The other way around this is to slightly overbias the current source so it will make some more current. One disadvantage of the latter choice is that it results in more power consumption. Same analysis also applies to the second current source that drives the voltage amplification stage.

We also need to consider the biasing network for the output stage. In our design case, it is the V_{be} -multiplier consists of Q_5 , R_7 and R_9 . The ratio of R_7 and R_9 determines the voltage ratio. We want it to be 3 to achieve best quality and power balance. In practice, increasing this ratio will produce better quality but dissipate more power. Decreasing this ratio will result in more distortion. We don't want to overbias the output stage too much since it will increase the power dissipation significantly. From this balance, we find that 3:1 is a good ratio.

4.1 Cost and Schedule

4.1.1 Labor

Name	Hourly Rate	Total Hours Invested	Total = Hourly Rate x 2.5 x Total Hours Invested
Michael Qiu	\$30	240	\$18,000
Luis Ramirez	\$30	240	\$18,000
Yueyang Lin	\$30	240	\$18,000
Total Labor Cost			\$54,000

4.1.2 Parts

Description	Source	Part	Quantity	Cost/Unit	Total Cost
Microcontroller	Mouser	ATmega328p	2	\$3.37	\$6.74
Digital Signal Processor	Mouser	Microchip dsPIC30F2010	1	\$4.22	\$4.22
Full-range speaker	Parts Express	Dayton Audio CE32A-8	2	\$3.65	\$7.30
Bluetooth Module	Amazon	KEDSUM Arduino Wireless Bluetooth Transceiver Module	1	\$9.99	\$9.99
SD Cards	Amazon	SDSDB-016G-AFFP	1	\$5.99	\$11.98
Microphone	Digikey	I2S SPH0645LM4H-B	1	\$3.06	\$3.06
LDO Regulator	Mouser	LM338T/NOPB	3	\$1.90	\$5.70
Negative LDO Regulator	Mouser	LM337T/NOPB	1	\$1.59	\$1.59
AC/AC Adapter	Allied Electronics	Hammond Manufacturing BPE2G	1	\$21.25	\$21.25
DAC	Mouser	AD1856	1	\$22.89	\$22.89
Passive devices	ECE parts shop	/	/	/	/
Total					\$94.72

4.1.2 Grand Total

Section	Total
Labor	\$54,000
Parts	\$94.72
Grand Total	\$54,094.72

4.2 Schedule

Week	Task	Responsibility
February 8	Finalize proposal	Michael Qiu
	Prepare mock design review	Luis Ramirez
	Begin design review prep	Yueyang Lin
February 15	Construct flow chart of cry detection algorithm	Michael Qiu
	Come up with detailed schematic of intermodule interfacing	Luis Ramirez
	Research on power supply and routing system and develop the fundamental schematic	Yueyang Lin
February 22	Finalize Design Review	Michael Qiu
	Order parts	Luis Ramirez
	Finalize circuit schematics	Yueyang Lin
February 29	Prototype cry detection algorithm on MATLAB	Michael Qiu
	Prototype audio playback device on microcontroller and map out connections	Luis Ramirez
	Prepare for design review and prototype and debug the amplifier	Yueyang Lin
March 7	Implement cry detection algorithm on MATLAB	Michael Qiu

	Implement connections between storage devices, DSP and microcontroller	Luis Ramirez
	Prototype and debug the power supply Finalize amplifier and power supply design	Yueyang Lin
March 14	Export SVM kernel onto DSP and begin testing	Michael Qiu
	Solder any necessary connections between storage devices, DSP and microcontroller	Luis Ramirez
	Revise the power routing system to meet all the final requirements including interconnection network between components Finalize the first PCB design	Yueyang Lin
March 21	Spring Break	
March 28	Test cry detection algorithm and evaluate accuracy	Michael Qiu
	Begin work on Android IDE and have skeleton of mobile application	Luis Ramirez
	Finalize the revision of all circuitry level design and the final PCB design	Yueyang Lin
April 4	Ensure that cry detector works through the microphone and DSP	Michael Qiu
	Ensure that user receives notification on mobile application upon detection of a cry	Luis Ramirez
	Make the PCB and solder all parts and debugging	Yueyang Lin
April 11	Test system and make sure that all components work together as intended	Michael Qiu
	Solder components and package them	Luis Ramirez
	Prepare for mock demo	Yueyang Lin
April 18	Start planning for presentation	Michael Qiu
	Start planning for demonstration	Luis Ramirez

	Continue testing and debugging Prepare for final paper	Yueyang Lin
April 25	Finalize presentation	Michael Qiu
	Finalize demonstration	Luis Ramirez
	Prepare for final paper	Yueyang Lin
May 2	Finalize presentation	Michael Qiu
	Finalize final paper and lab checkout	Luis Ramirez
	Finalize final paper	Yueyang Lin

5.0 Integrity

5.1 Ethics

In accordance with the IEEE Code of Ethics:

“To accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment[11]”.

The design included some parts that operate with high voltage, which can potentially hurt people who touch the circuit while it is connected to wall plug. To ensure that no one will be harmed by the device, everyone operating with the device should follow the safety guidelines. The power supply should be enclosed with an insulating case to avoid been touched when exposed to consumers.

“To avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist [11]”.

The device will collect voice signals nearby to perform the cry classification function. The data will be used locally and will not be distributed to any external network. The classification algorithm is based on real-time signals, meaning that no data of the collected voice will be left in storage after the classification is done. This ensures that the device will not harm the user's privacy.

5.2 Safety

1. The output of the transformer will output a 18VAC voltage and feed into the AC-DC power supply. 18VAC has a peak voltage of approximately 25V relative to ground, it can go higher with no load condition. This is some significant amount of voltage and may cause severe current across human body if touched. So when dealing with the power supply module, one should never try to touch the components when the circuit is operating. Always unplug the wall plug first before taking any operation on the circuit. This rule should be apply to everyone that is working or nearby the power supply circuit and throughout all phases of the project including implementation on breadboard and PCB.
2. The voltage to across most of the components are large. So double check the voltage, current and/or power ratings of the components used in the circuit to prevent any breakthrough. In case that a lower rating components is used in the circuit and start burning, unplug the wall plug first before taking any other measure.
3. The speaker may produce high volume. Don't try to get very close to the speaker to try to hear the sound if the volume is low. The speaker should produce audible sound if the operation of the circuit is correct. So always listen at a normal distance.

6.0 References

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