Donkey Kong Music Box

Developer Guide

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The DK Crew

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System Overview

The Donkey Kong Music Box features a battery-powered music box with a custom 3D printed figurine. The box is intended to be a portable music player with a charming and interesting design. It is capable of playing two pre-programmed songs, encoded in the .wav file format, out of two speakers built into the enclosure. During music playback, the Donkey Kong figurine will spin. The user also has the ability to control the color and intensity of the party lights inside the barrel of the enclosure.

Electrical Specifications

Electrical Part	Max Supply Voltage(V)	Minimum Supply Voltage(V)	Inom(mA)	Ipeak(mA)	Operating Temperature(°C)
Buttons (specifications are for one button)	5	0	0~500	1000	20
2N700 MOSFET	60 (Drain to Source) 20 (Gate to Source)	0	80	400	-55~150
GM3 Motor	9	0	80	400	20
Speakers	5	0	40	500	20
RGB LEDs (specifications are for one LED)	5	0	0~20	30	-25~85
Knobs (specifications are for one knob)	200	0	0~20	30	-25~200
Arduino UNO	20	6	1000	1500	-40~85

microSD Card Adapter	5	3.3	20	40	-25~85
Power Switch	125	0	0~1000	10000	-20~85
PCB	9	8.5	400~1000	1500	-20~85

Table 1: Electrical Specifications

User Guide

When first setting up your Donkey Kong Music Box, follow these steps to power the box and test the lights:

1. Flip the power switch on the box to the "OFF" state. OFF is when the "O" part of the switch is depressed.
2. Ensure that there are two 9V batteries in the battery packs. The battery packs are mounted on the side walls of the box and are removable for battery replacement.
3. Switch both battery packs to the on state. This switch is located on the back of the battery pack and is labeled to indicate which position is on and which position is off..
4. Replace the battery packs. The box is now powered.
5. Flip the power switch to the "ON" state. ON is when the "|" part of the switch is depressed.
6. If the box is properly powered, the LEDs inside the barrel should turn on. The knobs on the front of the box control the color of the LEDs. They are color coded to Red, Blue, and Green. Turn the knobs to change the color and the intensity of the LEDs.

To play a pre-programmed song, follow these steps:

1. Ensure that the box is powered on.
2. The white and blue buttons on the box correspond to the first and second pre-programmed songs, respectively. *NOTE: song one and song two are initially set to play the DK Rap and Gangplank Galleon. If the user wishes to change which songs are played, please see the instructions for changing the pre-programmed songs provided on the next page.*
3. Press the desired button and enjoy the sight and sound of your music box.
4. OPTIONAL: if you wish to stop playing a song before it has ended, press the red button.

To record and play your own audio, follow these steps:

1. Ensure that the box is powered on.
2. Press the yellow button and play your audio into the microphone. The microphone will record up to 20 seconds of audio.
3. Once 20 seconds have elapsed, press the green button to play your recorded audio.
4. OPTIONAL: if you wish to stop playing your recorded audio, press the red button.

To change the pre-programmed songs, follow these steps:

1. Ensure the box is powered off by flipping the power switch to the "OFF" state.
2. Carefully unscrew and remove the bottom cover of the box. Do not disconnect any electronics or parts attached to the cover.
3. Locate the microSD card adapter. It is a blue chip on the inside wall of the box.
4. Remove the microSD card from the adapter. Do not remove the adapter itself.
5. Connect the microSD card to your computer.
6. Locate your two .wav files you want to load onto the card. Rename the first song into the following: "song1.wav", omitting the quotation marks. Rename the second song into the following: "song2.wav" omitting the quotation marks. Place both songs into the microSD card. *NOTE: you may wish to save the pre-existing song1.wav and song2.wav files on the microSD card to your computer if you want to keep the original DK Rap and Gangplank Galleon songs.*
7. Remove the microSD card from your computer and replace it in the microSD card adapter inside the music box.
8. Replace the bottom cover of the box.

You should now be able to play your own songs on the music box by following the steps for playing a pre-programmed song.

Design Artifact Figures

Figure 1: Black Box Block Diagram

This diagram depicts the basic inputs and outputs to the music box. The user has the ability to provide input to the box by adjusting knobs and pressing buttons on the left. The box will respond by outputting changes in the lights, by recording music, or by playing some music to the user.

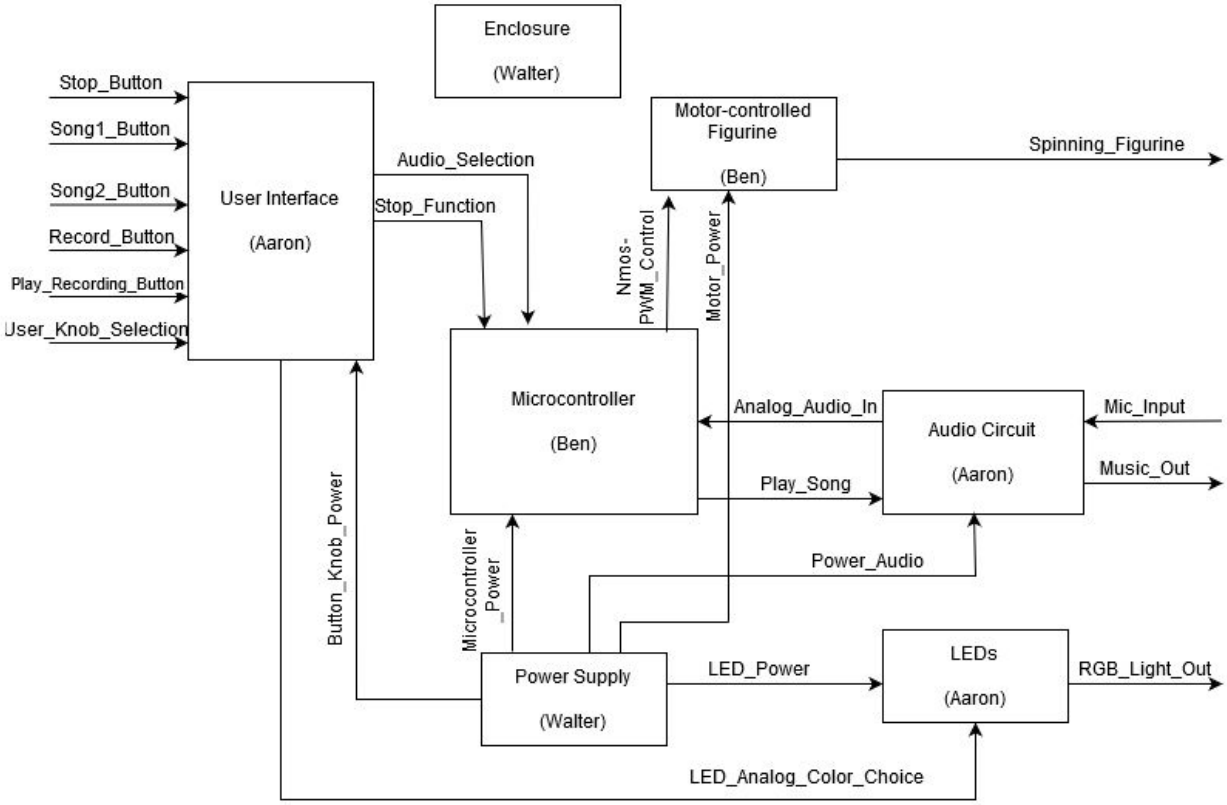

Figure 2: Top-Level Block Diagram

The top-level diagram depicts the interfaces between the individual blocks of the music box. The user interacts with the User Interface block, which then sends signals that cascade through the other blocks to create the outputs of the box. Note that the Power Supply block provides electrical power to all blocks in the system and the Microcontroller block acts as the brain of the system, providing controls and commands to the other blocks.

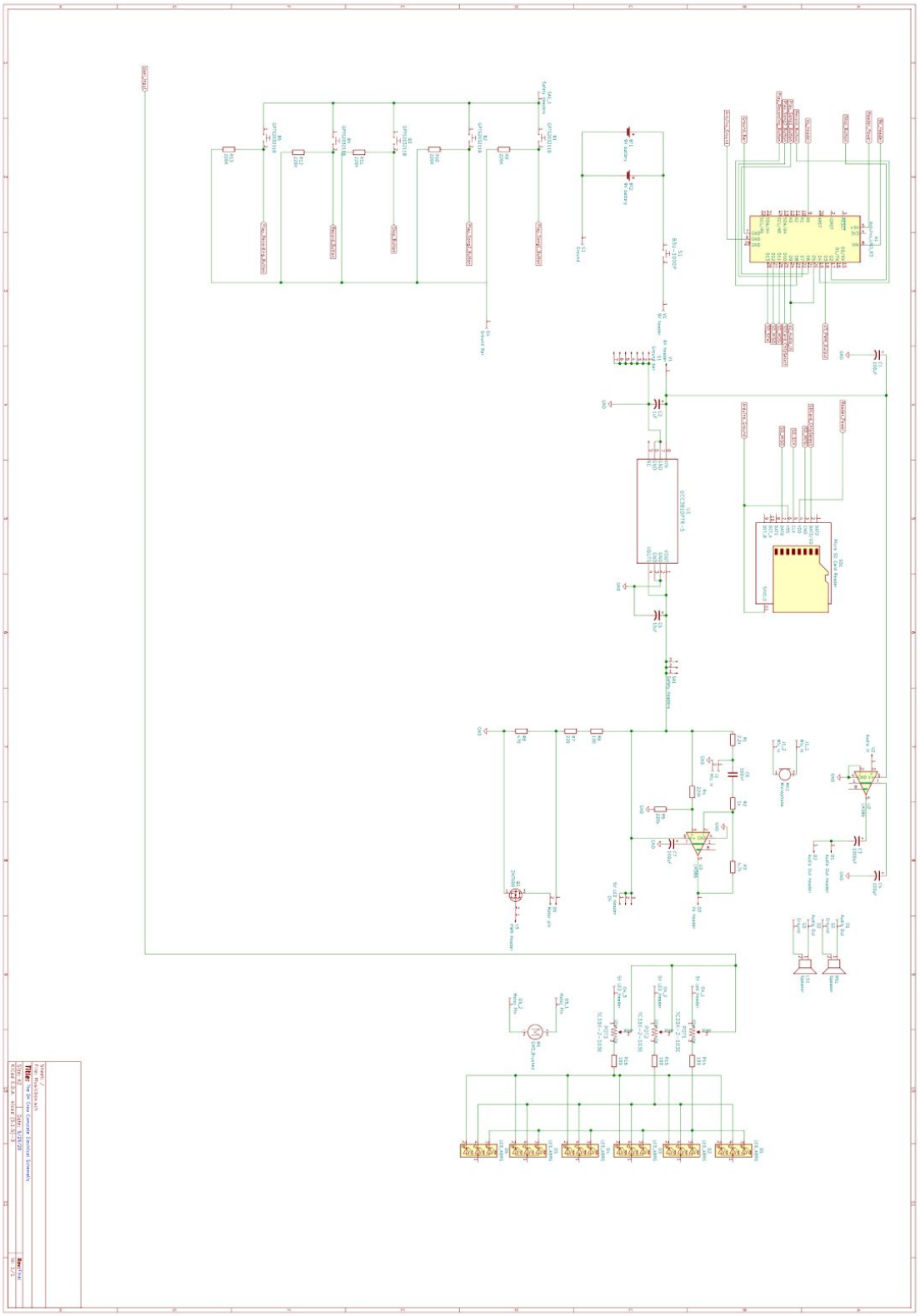

Figure 3: Complete Electrical Schematic

Figure 3 depicts the electrical connections for all components in the music box, the image is rotated to provide maximum clarity. When viewed with the orientation of the title block in the bottom right corner: the microcontroller is positioned in the top left. Directly beneath the microcontroller is the battery pack circuit and directly below that are the buttons. The microSD card adapter is directly to the right of the microcontroller and above the LDO. The LDO circuit is in the middle of the schematic. To the right of the power supply are the audio amplifier circuits and motor control circuit. The top circuit is the amplifier for the speakers, the circuit below that is the amplifier for the microphone, and on the bottom is the circuit for the motor. Finally the rightmost circuit in the schematic is the LED circuit. The connections between isolated circuits are implemented by wires fitted with the appropriate header pins and a custom PCB. All parts are then stored inside the enclosure of the music box for a pleasing presentation.

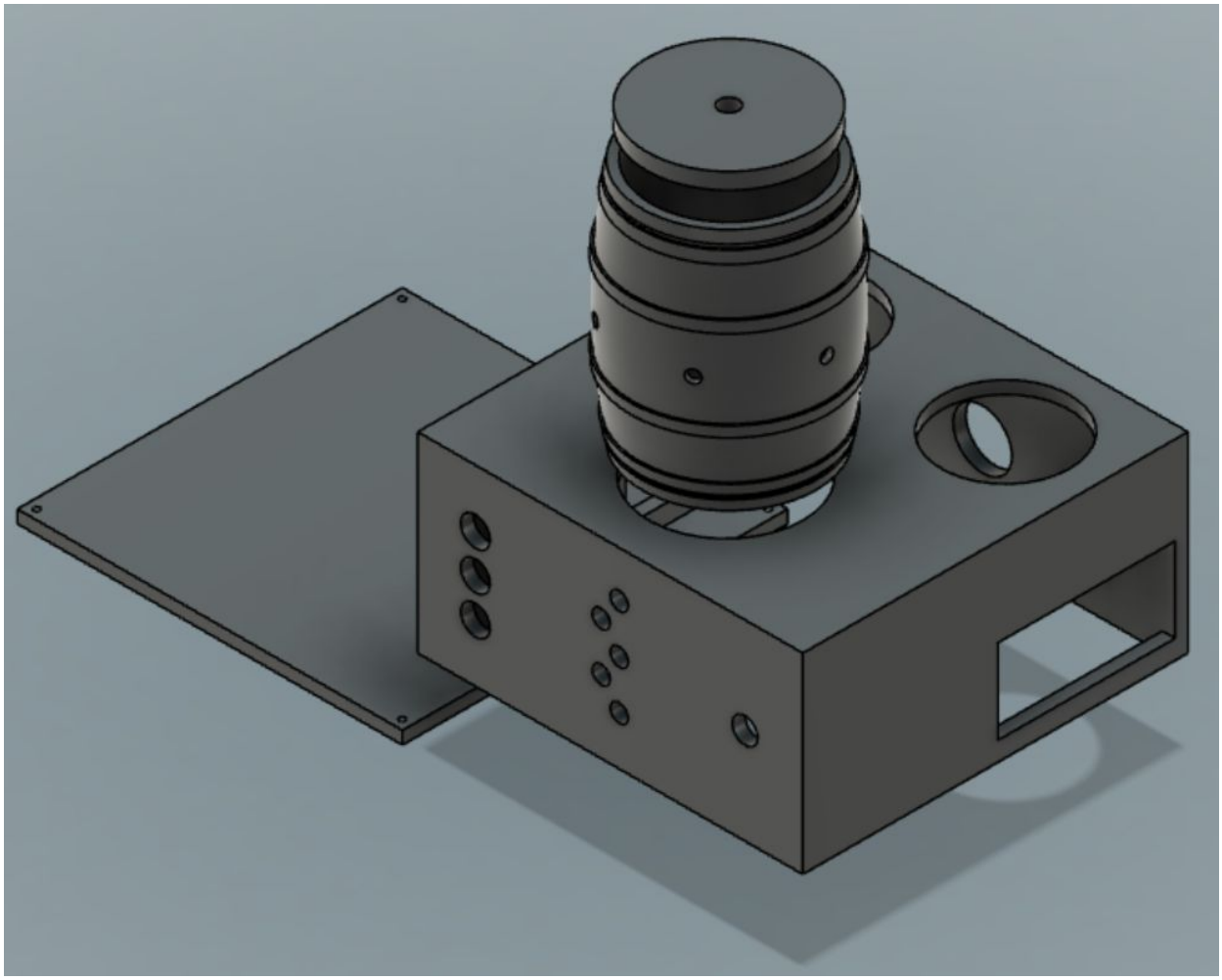

Figure 4: Enclosure 3D Model

Figure 5 shows the Fusion360 3D model of the physical structure of the box. Note that the modular nature of the box allows for parts to be replaced and for easy access to the inside of the box while maintaining an aesthetic that remains true to the Donkey Kong theme. The small

hole in the center of the circle atop the barrel allows for a drive shaft to spin the wheel without the need for the motor to be placed directly inside the barrel. The holes in the back are designed to house the speakers for a sleek look. Holes in the walls of the music box are designed to hold the specific interface components bought by the DK Crew. Finally, the LEDs are concentrated inside the barrel. The barrel itself has holes around the center that are covered with diffusion film, which results in a smooth, pleasant lighting atmosphere.

Figure 5: Custom Donkey Kong Figurine Model

Figure 6 displays the custom 3D model of Donkey Kong that the team created using Fusion360. The figurine is easily attached to the circular base seen in Figure 5 which allows it to

be spun by the motor. The model remains true to the style and shape of Donkey Kong while retaining its own charm.

PCB Information

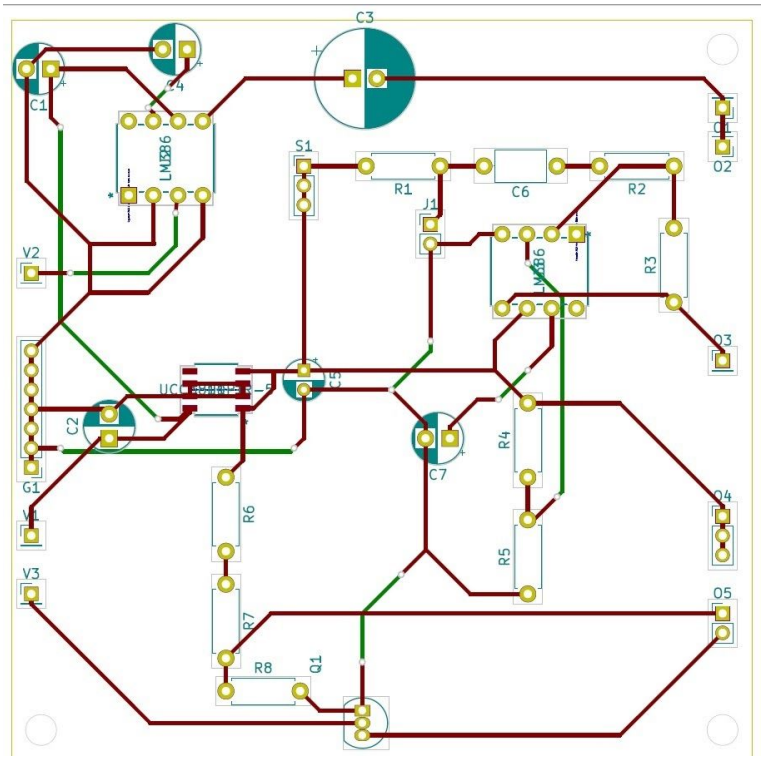

Figure 6: Custom Designed PCB Layout

Figure 6 shows the custom PCB the DK Crew designed to implement the requirements for the music box. This PCB is a 76.1 by 76.1 mm two layer board fabricated through the company OSH Park. The PCB contains the LDO regulator circuit, amplifier circuits for the microphone and the speakers, the motor-control circuit, and has multiple header pins for accessing the 5V LDO output for use by other circuits in the music box.

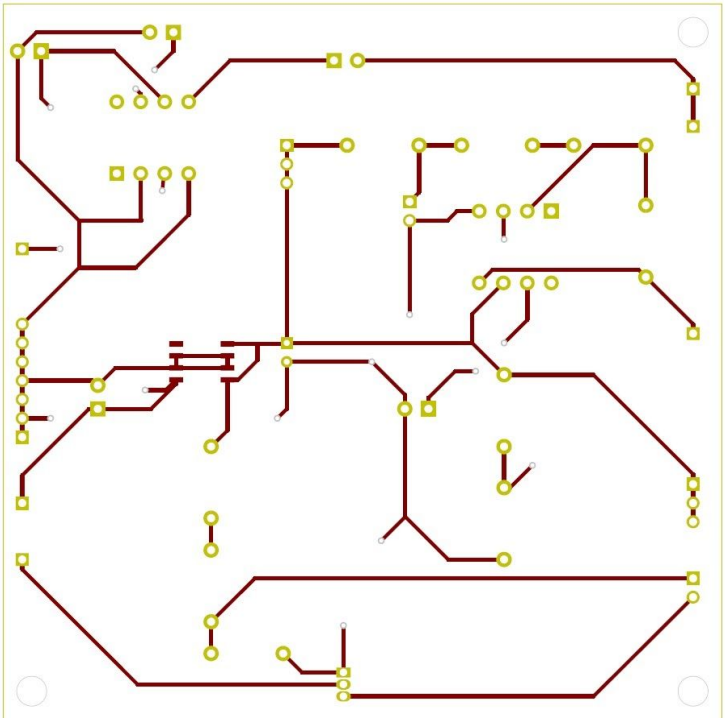

Figure 7: Top Layer of Custom Designed PCB Layout

Figure 7 exclusively shows the trace layout of the top layer of the PCB along with vias used on the board.

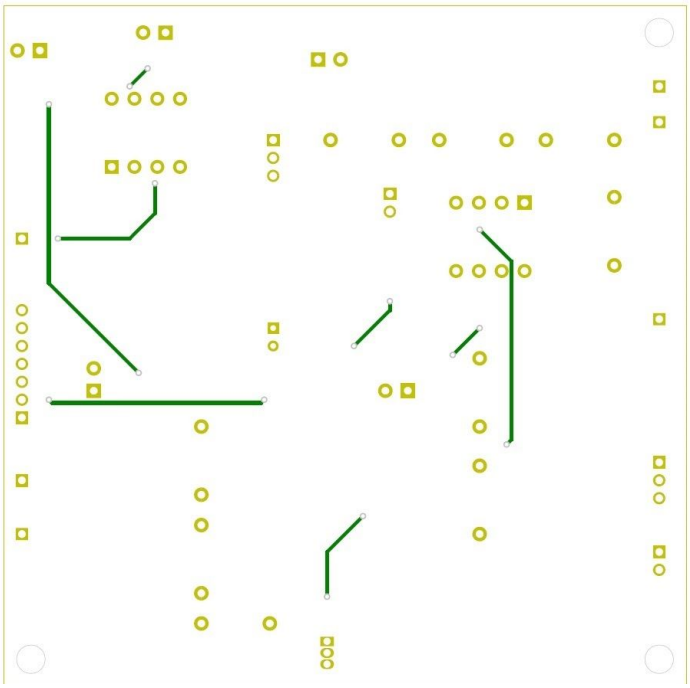

Figure 8: Bottom Layer of Custom Designed PCB

Figure 8 exclusively shows the trace layout of the bottom layer of the PCB.

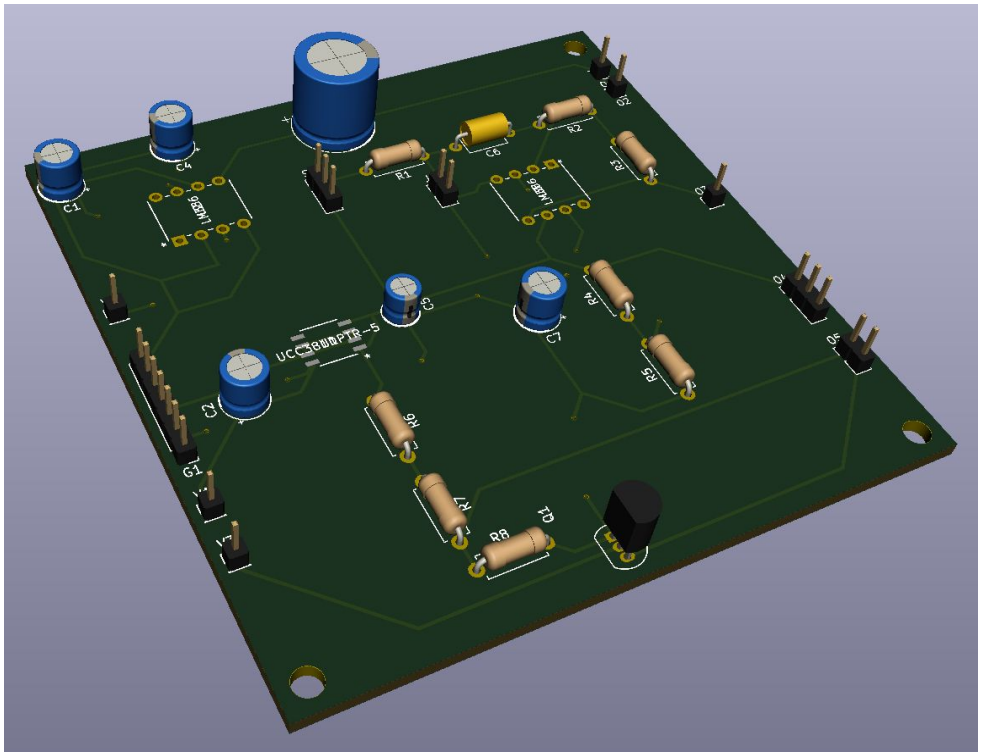

Figure 9: Custom Designed PCB 3D Model

Figure 9 shows the computer model of the custom designed PCB inside the music box. This model was generated through KiCad. Since the specific LDO and op-amps used in the PCB did not have 3D models within KiCad they are omitted from the model.

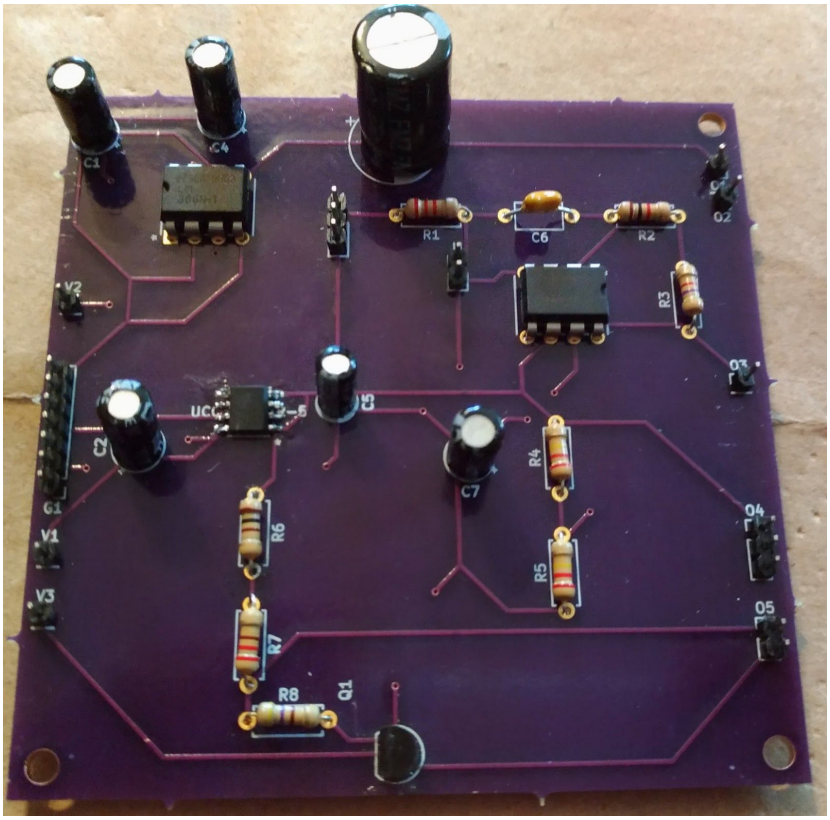

Figure 10: Assembled Custom Designed PCB

Figure 10 shows the physically implemented PCB. The PCB was constructed in the 9th week of the Spring 2020 term at Oregon State University.

Part Information

Component	Description	Manufacturer	Reference	Value	Quantity	Cost per Unit (USD)
nmos MOSFET	2N700 N-Channel T092	Fairchild Semicor	Q1	N/A	1	$0.36
GM3 Plastic Geared Motor	DC Brushed Motor	Solarbotics	M1	N/A	1	$5.95
Mic	Electret Microphone	N/A	J1	15 mV	1	$1.50
Resistor	Carbon Film Resistor	Austor	R1	2.2kΩ	1	$0.01
Resistor	Carbon Film Resistor	Austor	R2	1kΩ	1	$0.01
Resistor	Carbon Film Resistor	Austor	R3	4.7kΩ	1	$0.01
Resistor	Carbon Film Resistor	Austor	R4,R5,R9-R13	220kΩ	2	$0.01
Resistor	Resistor	Austor	R6, R14-R16	100Ω	3	$0.05
Capacitor	Electrolytic Capacitor	Swpeet	C1,C4,C7	100uF	3	$0.04
Capacitor	Electrolytic Capacitor	Swpeet	C3	1mF	1	$0.04
Capacitor	Polarized capacitor	Swpeet	C2	1uF	1	$0.05
Capacitor	Polarized capacitor	Swpeet	C5	10uF	1	$0.24
Capacitor	Ceramic Capacitor	AVX	C6	100nF	1	$0.16
LDO	UCC381DPTR-5	Texas Instrumen	U1	N/A	1	$5.14
Op-Amp	LM386 Low Voltage Audio Power Amplifier	Texas Instrumen	U2, U3	N/A	2	$0.09
Speakers	Full Range 3w Speaker	Gikfun	RS1, LS1	4Ω	2	$5.00
Triple Color common cathode LED	RGB LED	Edgelec	D1-D6	N/A	6	$0.08
16mm Rotary Potentiometer	Potentiometer	KLS Electronic	POT1-POT3	0-5kΩ	3	$0.50
Arduino UNO r3	Microcontroller from Arduino: UNO type, r3 revision	Arduino	A1	N/A	1	$23.00
MicroSD Card Adapter	MicroSD Card Reader and Adapter	HiLetgo	SD1	N/A	1	$0.72
Power Switch	Round Rocker Power Switch	ZF Electronics	S1	125V 10A	1	$1.20
Battery Case	9V battery holder	Eagle Plastic Dev	BT1, BT2	9V	2	$1.71
Push Buttons	Momentary Mini Push Buttons	Cylewet	B1-B5	250V 1A	5	$0.49

Table 2: Part Information

This table lists the parts used in the construction of the DK Music Box in addition to other information about each part. Each part correlates to a reference designator in the electrical schematic. Cost per Unit was recorded at the time of purchase.