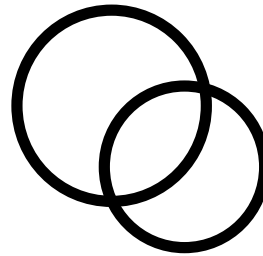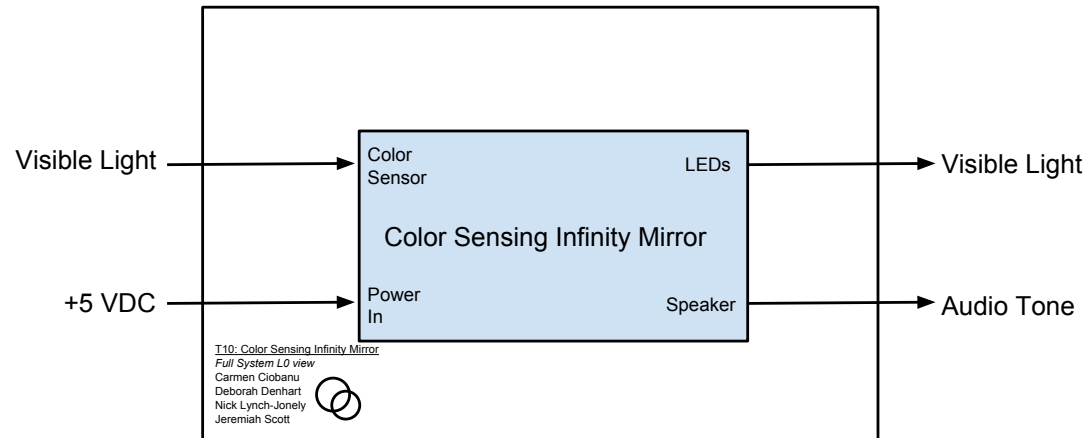<u>T10: Color Sensing Infinity Mirror</u>
System Level Design: Functional Decomposition and UML Behavior Modeling

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┌─────────────────────────────────────────────────────────────┐
│                                                              │
│                    ┌──────────────────────────┐              │
│   Visible Light ──→│ Color              LEDs  │──→ Visible Light
│                    │ Sensor                   │              │
│                    │                          │              │
│                    │ Color Sensing Infinity   │              │
│                    │          Mirror          │              │
│                    │                          │              │
│   +5 VDC  ────────→│ Power           Speaker  │──→ Audio Tone │
│                    │ In                       │              │
│                    └──────────────────────────┘              │
│   T10: Color Sensing Infinity Mirror                         │
│   Full System L0 view                                        │
│   Carmen Ciobanu                                             │
│   Deborah Denhart                                            │
│   Nick Lynch-Jonely                                          │
│   Jeremiah Scott                                             │
└─────────────────────────────────────────────────────────────┘
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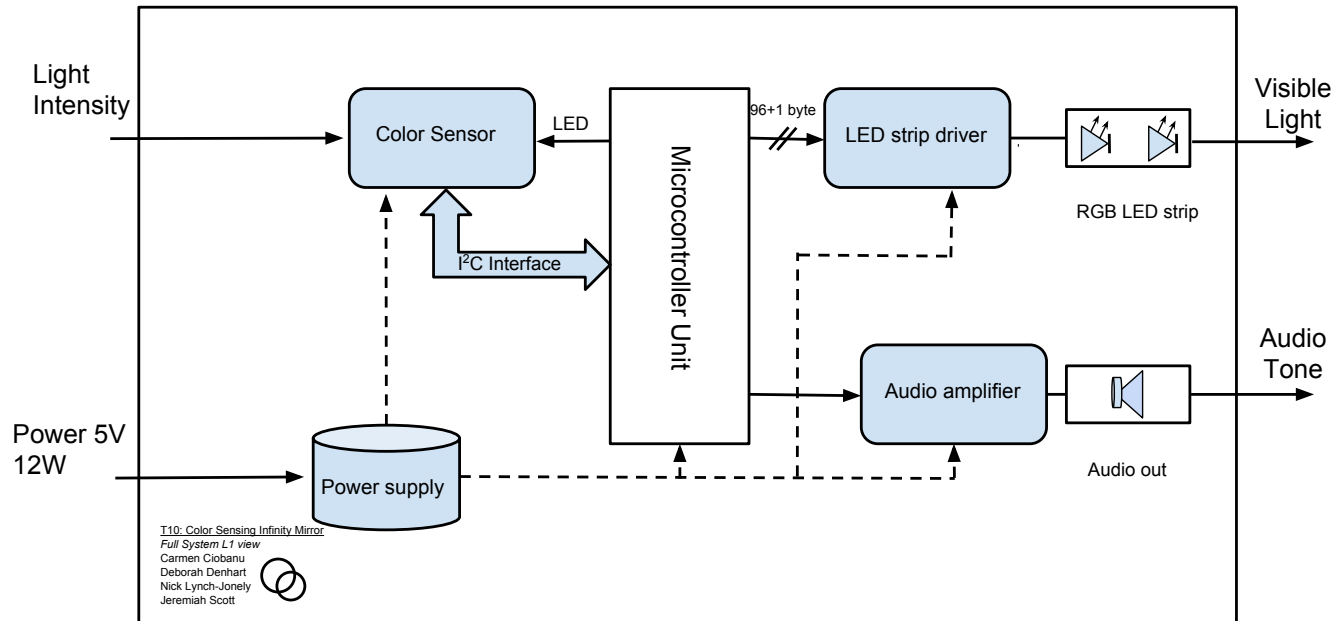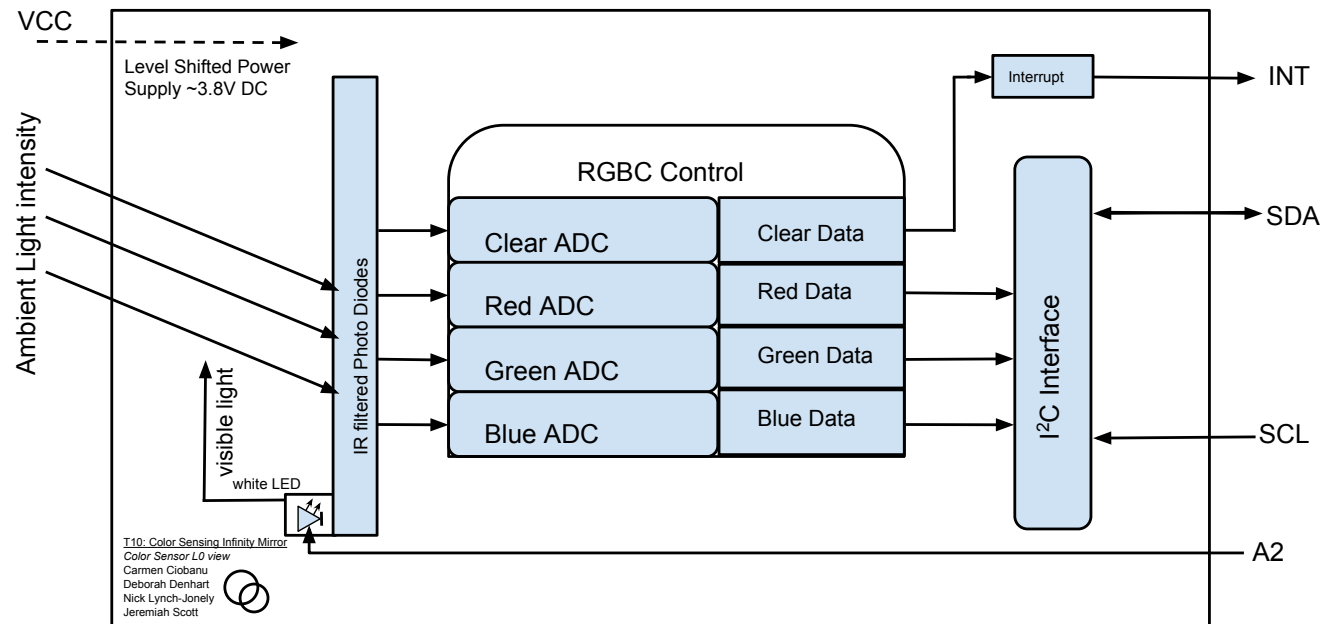
Module:	T10: Color Sensing Infinity Mirror *(Level-0 system view)*
Inputs:	Visible light of wavelength 300 to 1100nm, +5 VDC power supply.
Outputs:	Corresponding RGB light and audio tone sequence.
Functionality:	System outputs RGB light and audio tone sequence corresponding to visible light input.

Light
Intensity

Color Sensor

LED

Microcontroller Unit

96+1 byte

LED strip driver

Visible
Light

RGB LED strip

I²C Interface

Power 5V
12W

Power supply

Audio amplifier

Audio out

Audio
Tone

T10: Color Sensing Infinity Mirror
Full System L1 view
Carmen Ciobanu
Deborah Denhart
Nick Lynch-Jonely
Jeremiah Scott

T10: Color Sensing Infinity Mirror *(Level-1 system view)*	
Brief Description	System responds to color of ambient light input by generating a corresponding color LED output and selects a single audio tone from a bank of six corresponding audio sequences that are assigned a range of color.
Inputs	Light intensity reading: λ = 300 - 1100nm Power: 5VDC 12W
Outputs	LED emission: RGB color corresponding to light intensity input Audio output: Tone sequence corresponding to light intensity input

VCC

Level Shifted Power Supply ~3.8V DC

Ambient Light intensity

visible light

white LED

IR filtered Photo Diodes

RGBC Control

Clear ADC | Clear Data
Red ADC | Red Data
Green ADC | Green Data
Blue ADC | Blue Data

Interrupt

I²C Interface

INT

SDA

SCL

A2

T10: Color Sensing Infinity Mirror
Color Sensor L0 view
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Deborah Denhart
Nick Lynch-Jonely
Jeremiah Scott

Module:	T10: Color Sensor *(Level-0 module view)*
Inputs:	Analog signal corresponding to detected light wavelengths of 300-1100nm, line A2 connected to white LED to assist with capturing light wavelength data. -0.5 to +3.8 VDC power supply.
Outputs:	Analog-to-digital conversion of IR filtered photodiode signal is transferred to double buffered data registers and sent to a two wire I²C serial bus directly connected to microcontroller unit, ~400kHz transmission rate.
Functionality:	16-bit digital signal containing 4-bit representations of RGB levels plus a 4-bit clear register sent to an I²C interface

x16 LED Current Driver
x32 RGB LED

VCC

data

clock

LED Current Driver 1

r data
g data
b data
→ RGB LED

r data
g data
b data
→ RGB LED

data

clock

LED Current Driver 2

r data
g data
b data

r data
g data
b data

data

clock

... x14

T10: Color Sensing Infinity Mirror
RGB-LED strip L0 view
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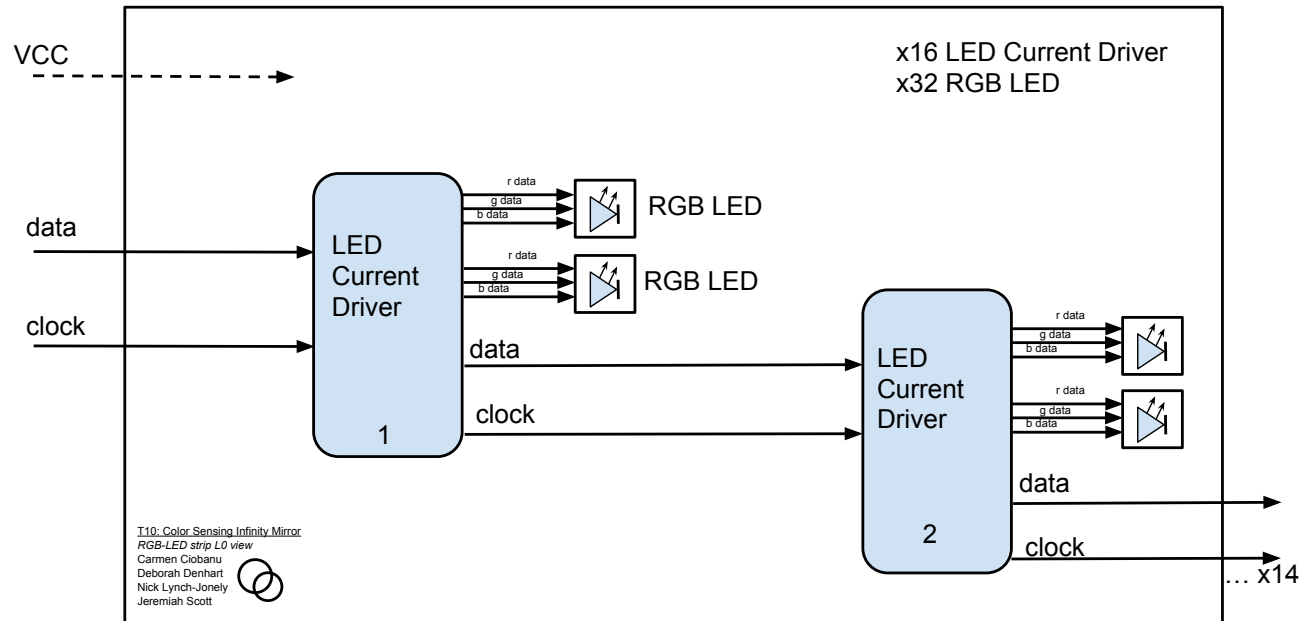
Module:	T10: RGB LED Strip *(Level-0 module view)*
Inputs:	+5 VDC power supply (Vcc), 96+1 byte serial data, clock
Outputs:	x6 1-byte PWM channels driving x2 RGB LEDs in light range from 475 to 630nm wavelength, serial data, 1Hz clock signal
Functionality:	Drives RGB LED color from +/- 0.4V PWM signal input. Each driver chip is responsible for 2 LEDs. 96+1 bytes of information are sent to the first driver chip, 6 bytes are used for that chip and 90+1 bytes are passed on. Process continues for remaining driver chips.

VCC ->

Input
Signal ──────────────────────────────>

```
        Audio Amplifier          Audio out
                              ────────────────>  [speaker]
```

T10: Color Sensing Infinity Mirror
Audio Amplifier L-0 view
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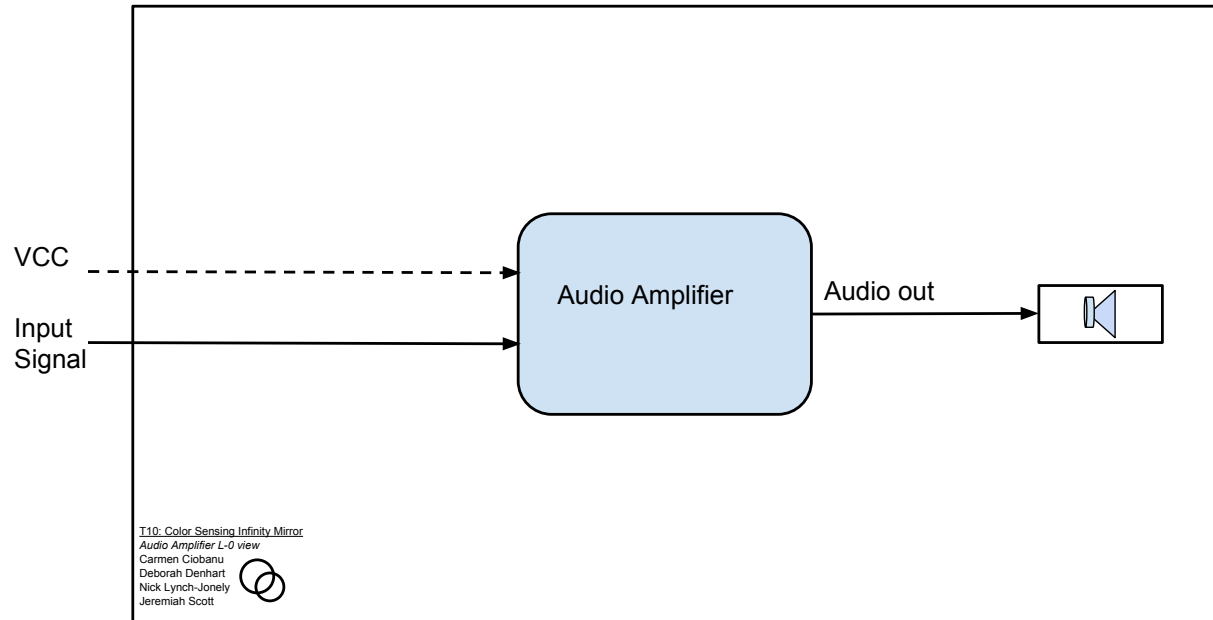
Module:	T10: Audio Amplifier *(Level-0 module view)*
Inputs:	+/- 0.5V PWM signal, +5 VDC power supply (Vcc)
Outputs:	One of 6 possible audio tones corresponding to the color of the ambient light detected by the system.
Functionality:	Amplify digitally-generated sinusoid signal from microcontroller into audio tone. Amplification is static and no volume control is available.

Microcontroller

LED Driver 1

LED Driver 2

LED Driver 16

A2.1: Reset Byte Counter

A3.1: Reset Byte Counter

A17.1: Reset Byte Counter

A1.1: Send reset byte and clock

A2.2: Send reset byte and clock

A3.2 Send reset byte and clock

A16.2 Send reset byte and clock

. . . (LED drivers 3 - 15)

B1.1: Send data bytes 1 to 96 + 1 latch byte and clock

B2.1: Set PWM 1 output — LED 1 Green

B2.2: Increment Byte Counter

B2.3: Set PWM 2 output — LED 1 Red

B2.4: Increment Byte Counter

B2.5: Set PWM 3 output — LED 1 Blue

B2.6: Increment Byte Counter

B2.7: Set PWM 4 output — LED 2 Green

B2.8: Increment Byte Counter

B2.9: Set PWM 5 output — LED 2 Red

B2.10: Increment Byte Counter

B2.11: Set PWM 6 output — LED 2 Blue

B2.12: Increment Byte Counter

B2.13: Send data bytes 7 to 96 + 1 latch byte and clock

B3.1: Set PWM 1 output — LED 3 Green

B3.2: Increment Byte Counter

B3.3: Set PWM 2 output — LED 3 Red

B3.4: Increment Byte Counter

B3.5: Set PWM 3 output — LED 3 Blue

B.3.6: Increment Byte Counter

B3.7: Set PWM 4 output — LED 4 Green

B3.8: Increment Byte Counter

B3.9: Set PWM 5 output — LED 4 Red

B3.10: Increment Byte Counter

B3.11: Set PWM 6 output — LED 4 Blue

B3.12: Increment Byte Counter

Send data bytes 13 to 96 + 1 latch byte and clock

. . .

Send data bytes 91 to 96 + 1 latch byte and clock

B17.1: Set PWM 1 output — LED 31 Green

B17.2: Increment Byte Counter

B17.3: Set PWM 2 output — LED 31 Red

B17.4: Increment Byte Counter

B17.5: Set PWM 3 output — LED 31 Blue

B17.6: Increment Byte Counter

B17.7: Set PWM 4 output — LED 32 Green

B17.8: Increment Byte Counter

B17.9: Set PWM 5 output — LED 32 Red

B17.10: Increment Byte Counter

B17.11: Set PWM 6 output — LED 32 Blue

B17.12: Increment Byte Counter

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Power system on → Initialize Atmega 328p for interrupt, LED and I2C → Connect to color sensor → Initialize color sensor → Enable sensor interrupt

Atmega 328p waits for interrupt

Color sensor Sleeps

Color sensor detects the light threshold has been exceeded

PON bit is not set

Clear interrupt → I2C starts and the Color Sensor Idles → Check PON bit in the Enable register

PON bit is set

Turn on LED | AEN bit in the Enable register is set | The RGB ADC initializes | The RGB ADC takes a reading

Atmega 328p delays for 205 ms | Color sensor waits for 2.4 ms warm up delay | Color sensor waits for 2.4 ms warm up delay | Wait for 200 ms

Read RGB Registers | Calculate color temperature | Calculate lux | Turn off LED | Send to LED output function

Atmega 328p wait for Interrupt | Color sensor sleeps

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T10 Color Sensor
UML Activity View
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