Skylight Glass

Group 13

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Goals/Objectives

Problems: Blind Automation

- Heating/Cooling is very expensive
- Sunlight (not) entering the house makes things worse.
- Traditional blinds don’t work with your AC system and still absorb heat
- Traditional blinds don’t compensate for the light lost when they’re shut
- Traditional lighting doesn’t replicate the sun’s color temperature
  - Very important for circadian rhythm

Specifications / Requirements

Component	Parameter	Design Specification
Smart Film	Light Blocked	70%
Bluetooth Module	Minimum Range	10 feet
LEDs	Full Duty Cycle Brightness	1000 Lumens
LEDs	Color Temperature	3000K-5000K
Temperature Sensor	Accuracy	1 degree
Light Sensor	Accuracy	10 Lumens
Time (software)	Accuracy	10 seconds

Features

Privacy

- Or none if you prefer
- Tint, when you want it

App control

- I/O
- Alarm Mode
- Seasonal Setting
- LED Control

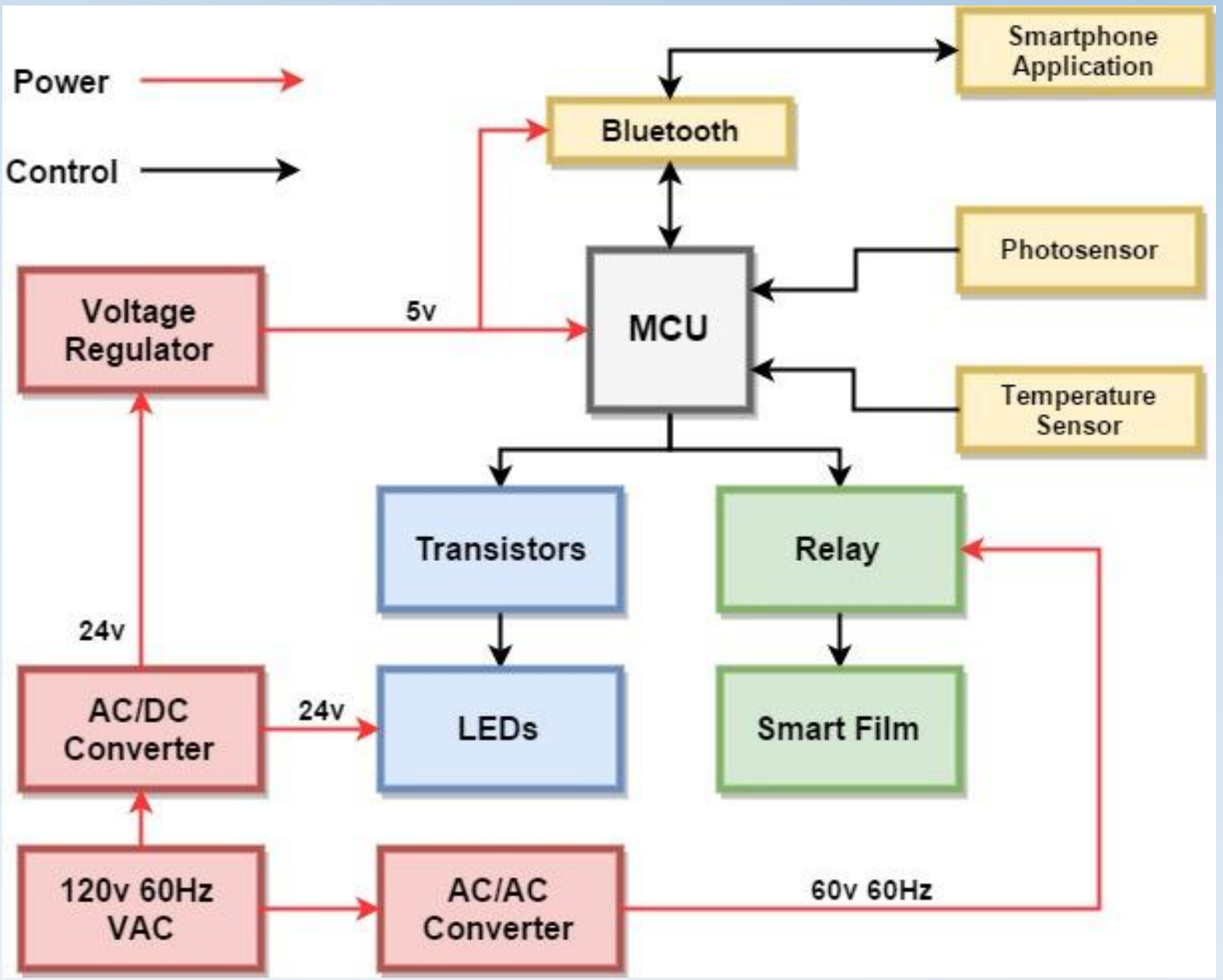
Savings

- Temperature control of household
- Less power used by A/C unit

Smart Control

- Temperature Sensor helps with auto tinting
- Tinting control without having to manually do it

Block Diagram



LED Subsystem

Power Subsystem

Smart Film Subsystem

Control/Feedback Subsystem

Work Distribution

Task	Primary	Secondary
LED Subsystem	Blake	Paul
Power Subsystem	Blake	Paul
Smart Film Subsystem	Paul	Blake
Feedback Subsystem	William	Ben
Control Subsystem	Ben	William
MCU programming	William	Ben
System Integration (PCB)	Paul	Blake

Design and Hardware Implementation

- Decentralized design approach
  We designed individual subsystems and then designed the architecture that integrated the subsystems into a coherent system.
  For implementation, the team then created a breadboard prototype for each subsystem and tested its functionality individually. After we tested each subsystem, we integrated the overall system as a breadboard prototype to verify complete system functionality. This was used as a basis for the PCB design.

Smart Film Subsystem

Smart Film Market Research

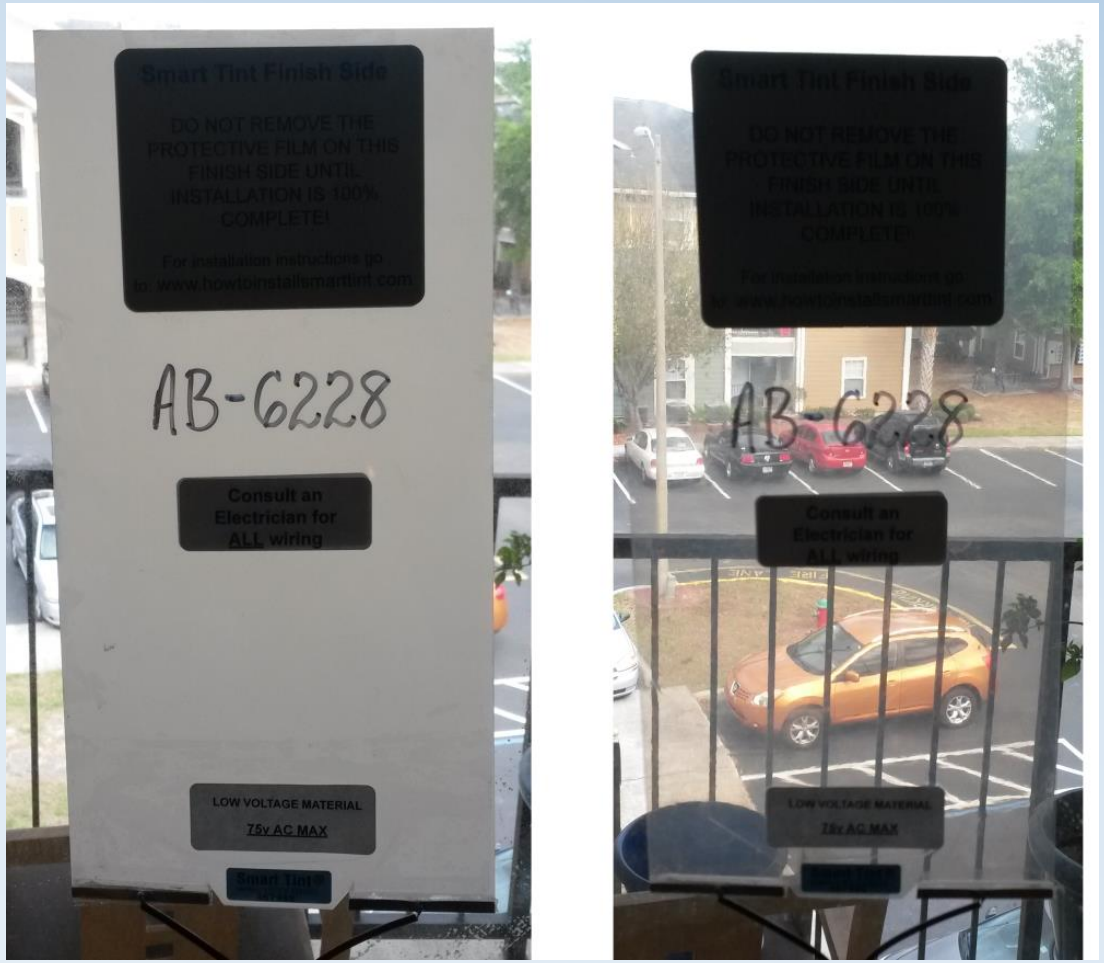
Requirement: Visible light transmission < 30% when opaque
Smart Film Technologies:

1. Electrochromic - slow transition time
2. **Polymer Disperse Liquid Crystal (PDLC)** - fast transition, industry standard
3. Suspended Particle Device (SPD) - few vendors sell film variant
4. Micro-blinds - patented and not on the market currently

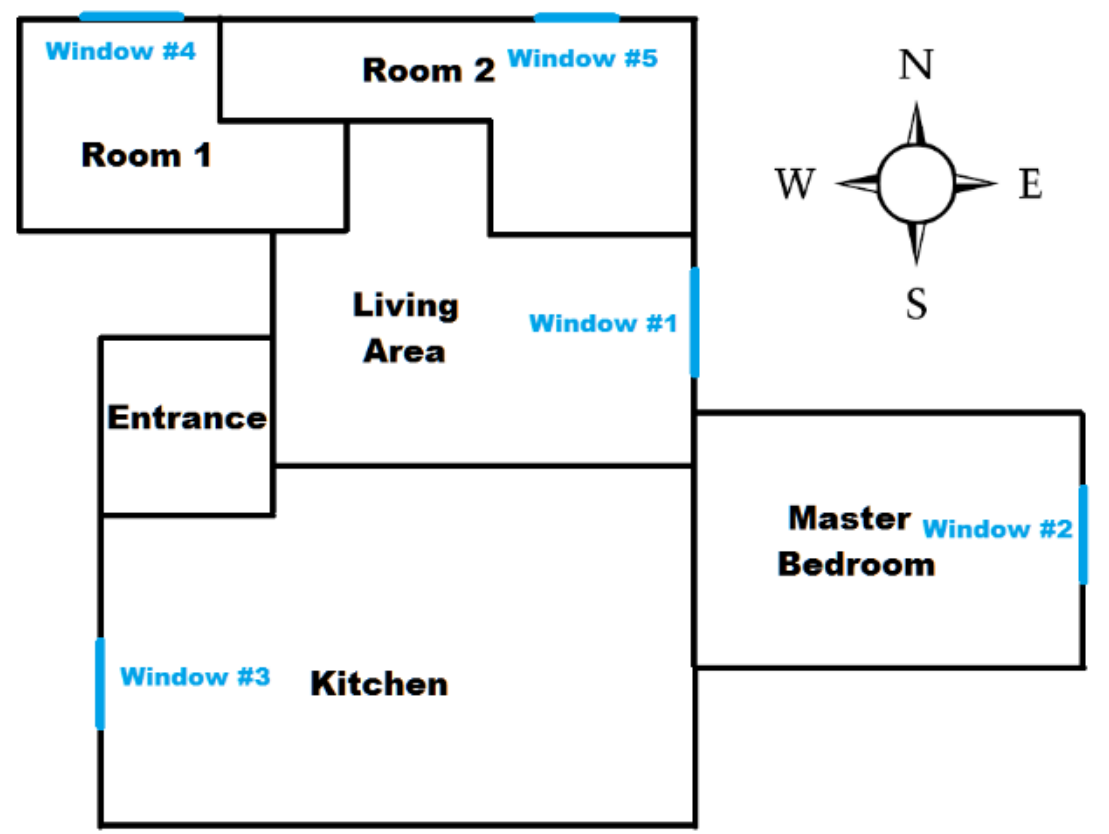
Smart Film Subsystem Components

Smart Film selected

Product Attributes	Smart Tint®
Light Transmittance (opaque state)	4% ± 2%
Switching Speed	50-100 ms
Operational Temperature Range	-10° to 60° C
Coefficient of Haze (transparent)	0.03 ± 0.01
UV Absorption Index (opaque)	99%
IR Absorption Index (opaque)	20% (regular) 90% (LV-NF)
Solar Heat Gain Coefficient	0.71
Energy Consumption (W/ft^2)	0.3-0.49



Example of Smart Film states



Morning:	7 AM - 11 AM
Midday:	11 AM - 2 PM
Afternoon:	2 PM - 6 PM
Evening:	6 PM - 11 PM
Night:	11PM - 7AM

Window	1	2	3	4	5
Room	Living Area	Master Bed	Kitchen	Room 1	Room 2
Morning	Off	Off	On	On	On
Midday	Off	Off	Off	Off	Off
Afternoon	On	On	Off	On	On
Evening	On	Off	On	Off	Off
Night	Off	Off	Off	Off	Off

LED Subsystem

LED Requirements

Requirements:

1) Illuminates a 10ft x 10ft room.
2) LED color temperature can vary between 3000K-5000K

LED Products:

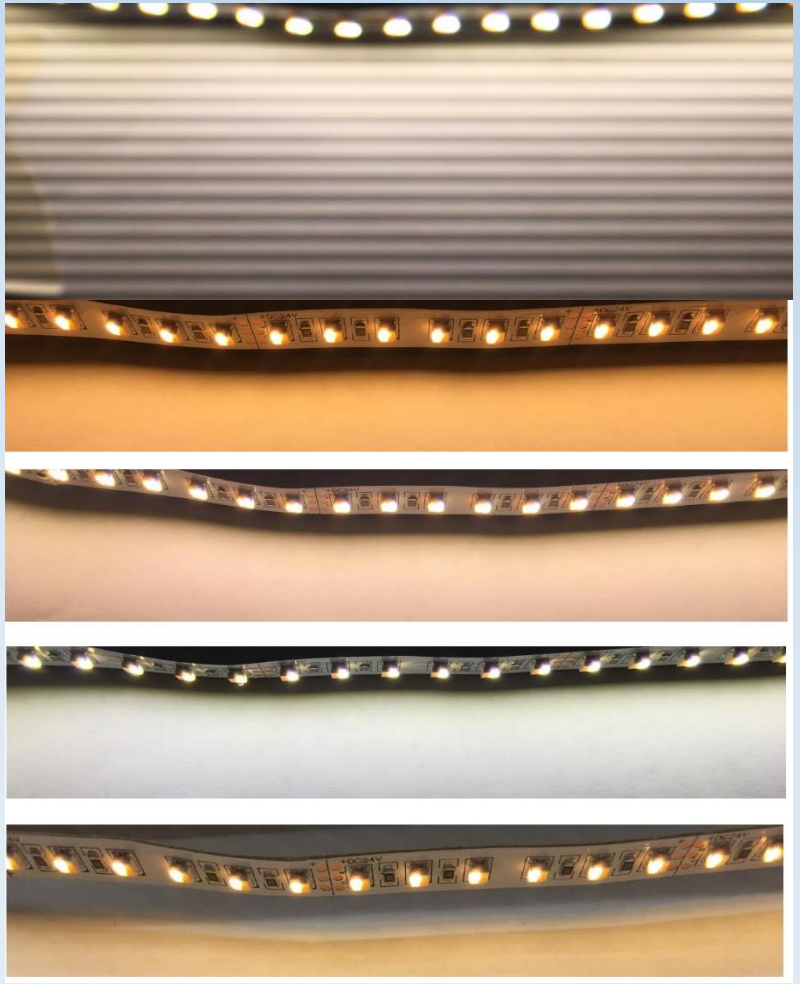
1. LED bulbs - meets the requirements but bulky and costly
2. **Surface Mounted Device** - LED strip, meets both requirements
3. Chips on Board - Maglite, will light the room but blind everyone

LED Color Temperature

3528 SMD LED strip (3.5 mm by 2.8 mm) demonstrating varying color temperature.

LED Challenges

- Too Bright
- Unequal Duty Cycle causes flickering
- Limited BJT current gain requires a base resistor that limited brightness
- Coupling capacitors needed to reduce MCU strain



Feedback System

Smart	• Incorporate System Automation
Energy	• Help Improve Efficiency
Sensors	• Light Intensity • Temperature

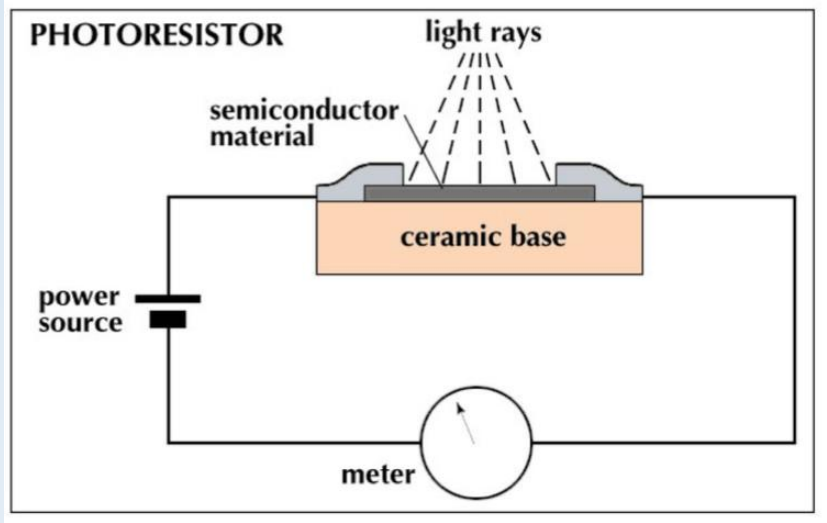
Light Sensor

Outdoor

- Determine outside light intensity

Indoors

- Control indoor light accordingly



Light Sensor

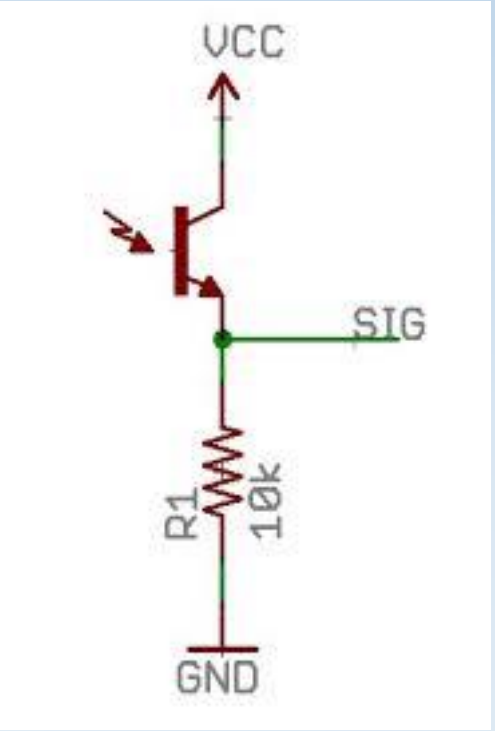
Resolution

- Can be varied by changing resistance

Easy of Use

- Output is easily accessible

Cost Effective



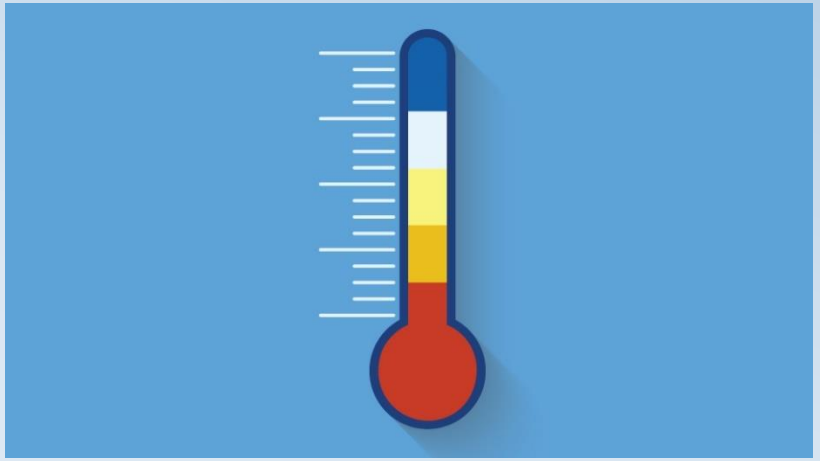
Temperature

Seasonal

- Adapt to conditions automatically

Efficiency

- Help improve energy consumption



Temperature

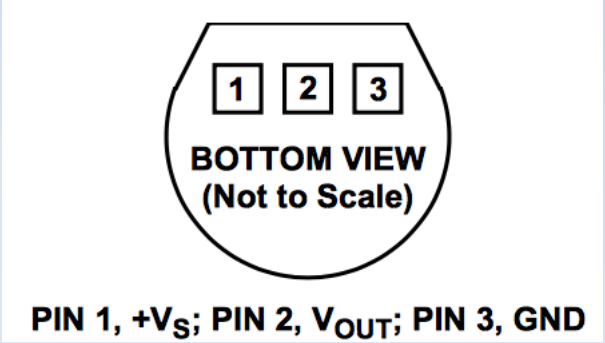
Accuracy

- Precise for our needs ± 1°C (+25°C)

Integration

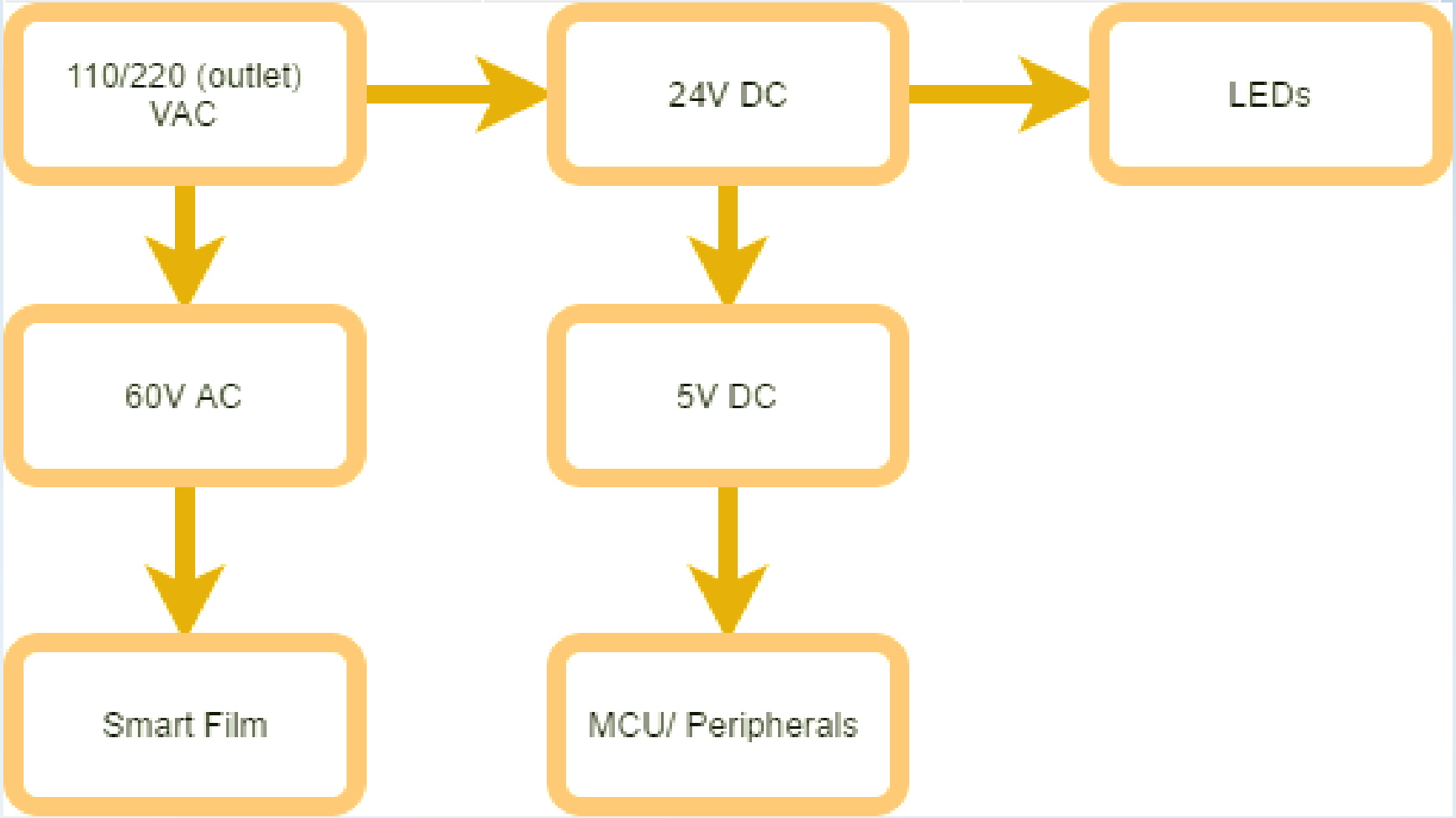
- 3 pins allows simple integration.

Cost Effective

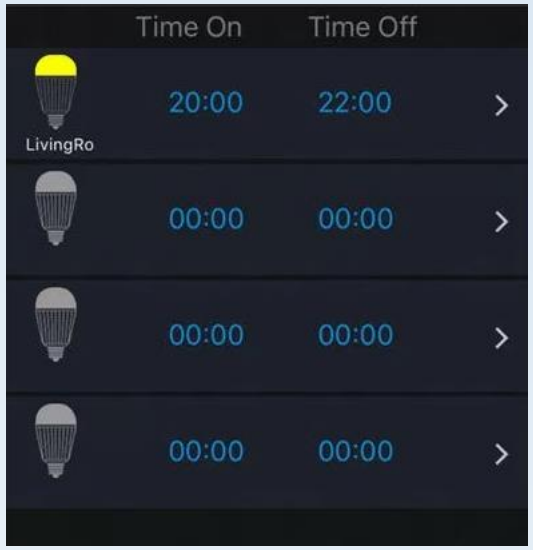


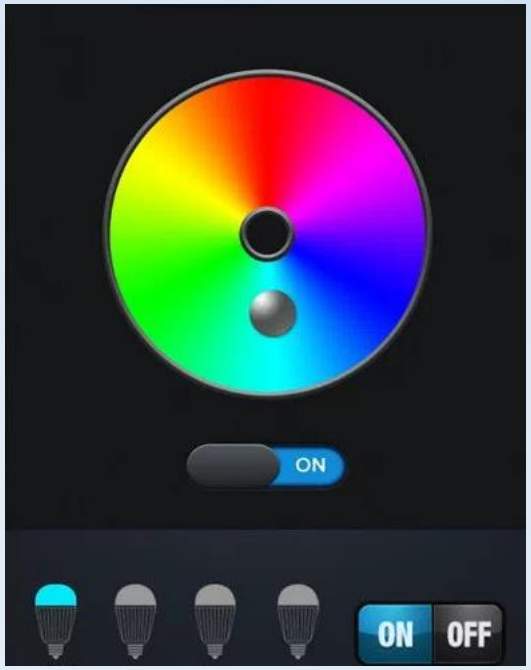
Power

System	Part	Requirement
Output	Smart Film	60v AC
Output	LEDs	24V DC
Main	MCU	5v

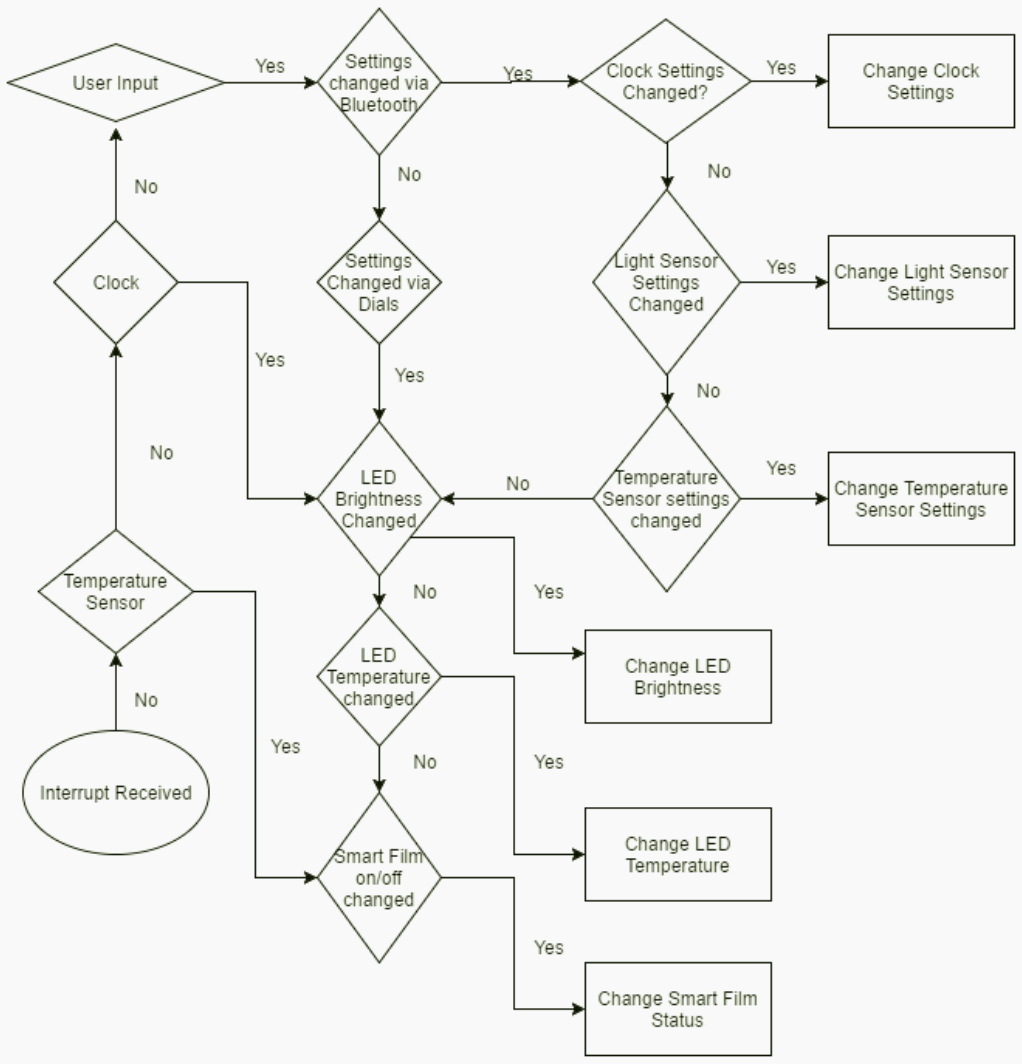


Application (Android Studio)





Software Logic



ATmega328P

Analog

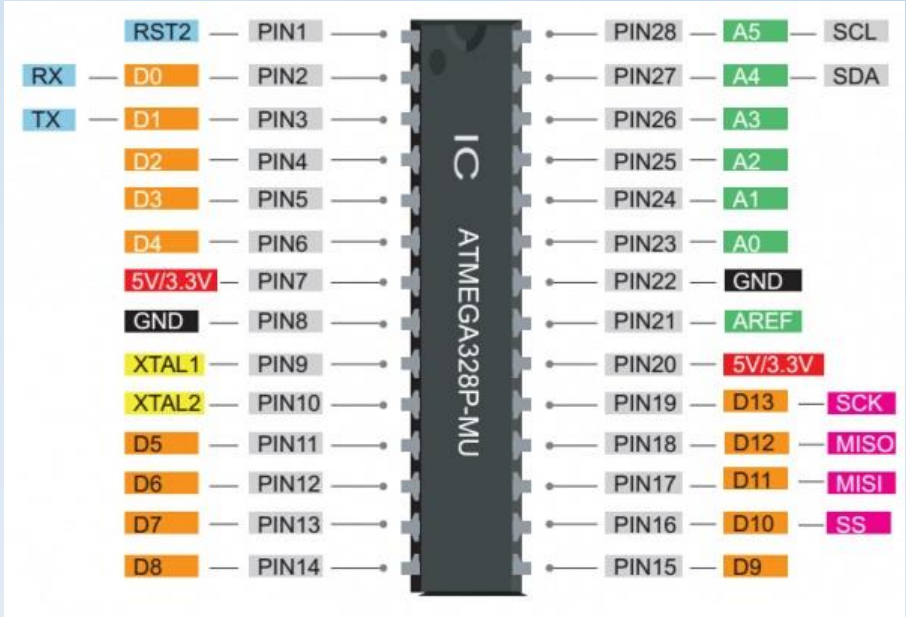
- Feedback System (6 A/D Pins)

Digital

- Controlling LEDs (6 PWM Pins)

Digital

- Communication (TX/RX)

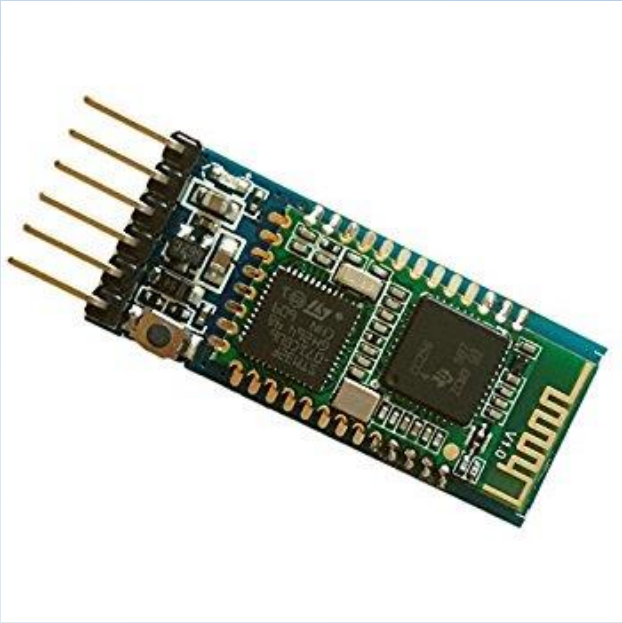


ATmega328P

Initial Testing

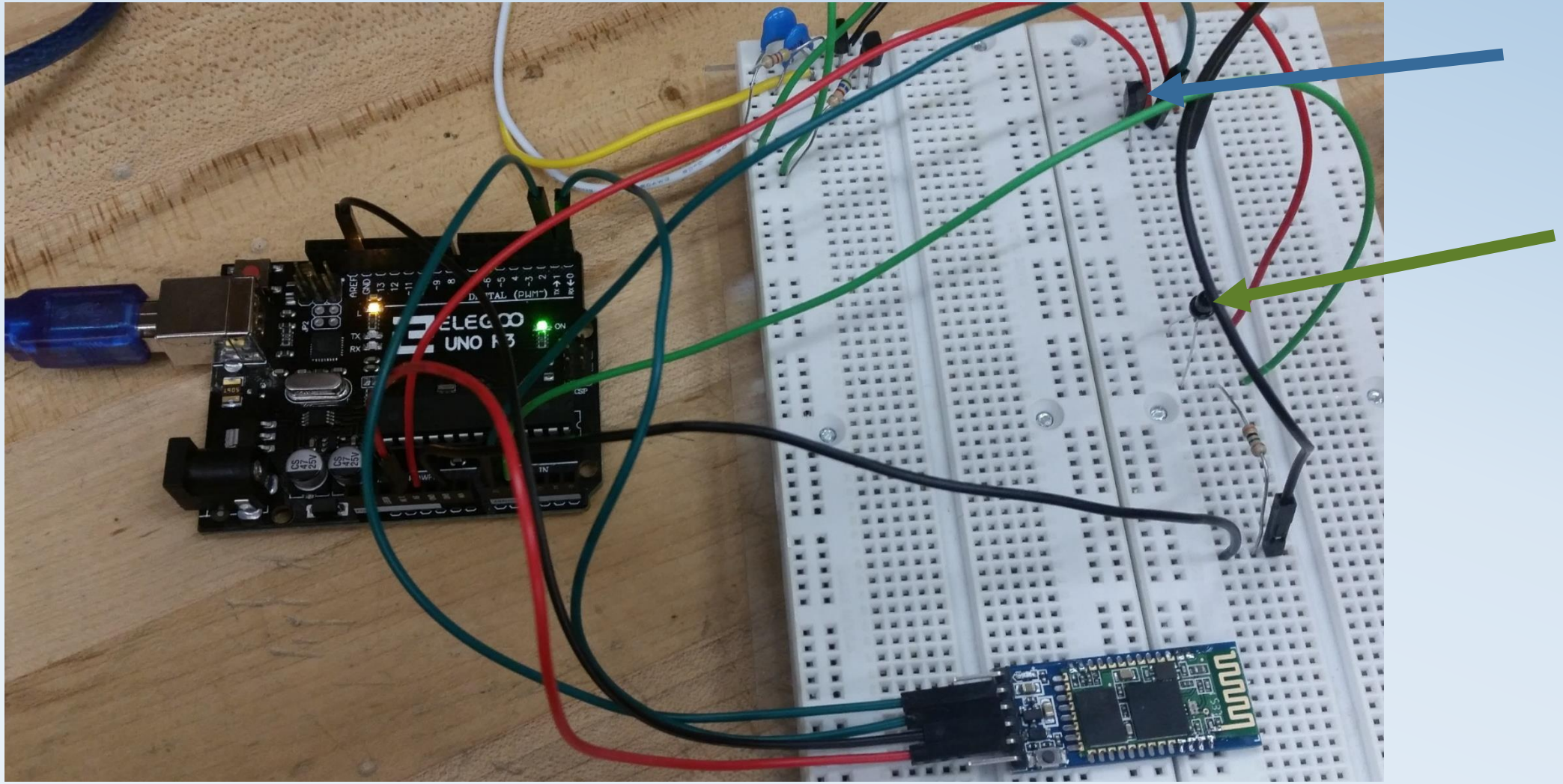
Bluetooth Communication

- Bluetooth module makes use of Serial Communication
- Communication happens via PCB
- Controls all major components
  - Major Features (I/O, LEDs, Alarm and Seasonal Modes, Manual/Auto)
  - Coincide with Application from Android Studio
- Range at 10 meters is fine for this project
- Will be embedded within the frame along with the rest of the components
- Difficulty with first Bluetooth module, possible shorted or burnt AGND
- For future applications a stronger Bluetooth module could be used for larger families moving from room to room.
- PCB design plan to implement HC-05
  - Through hole header for module
    - Cleaner
    - Ability to de-solder and toss burned out components

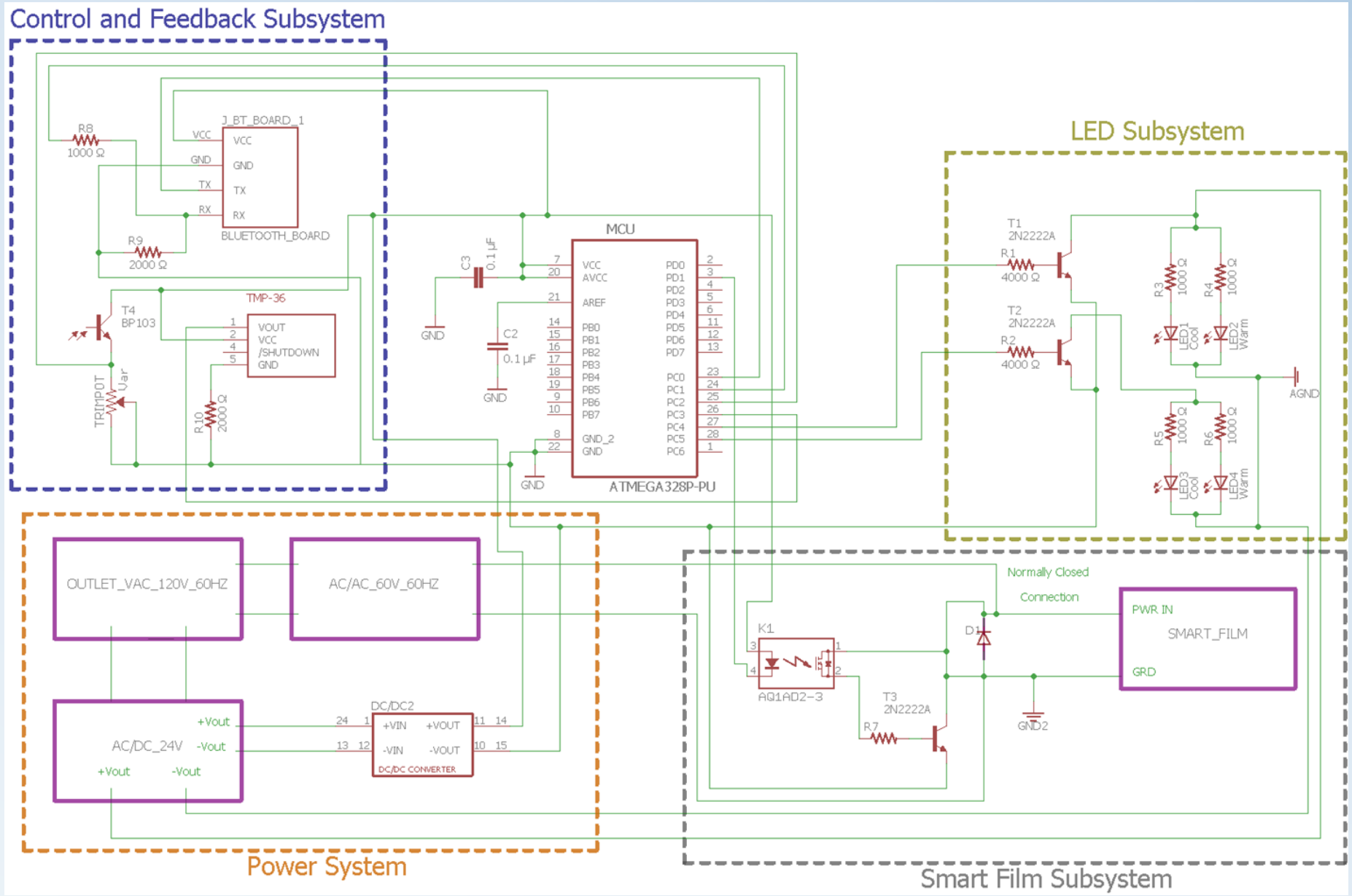


Description	Spec
Baud Rate	9600
Range	10 meters
Frequency	2.4GHz
Voltage	3.3V

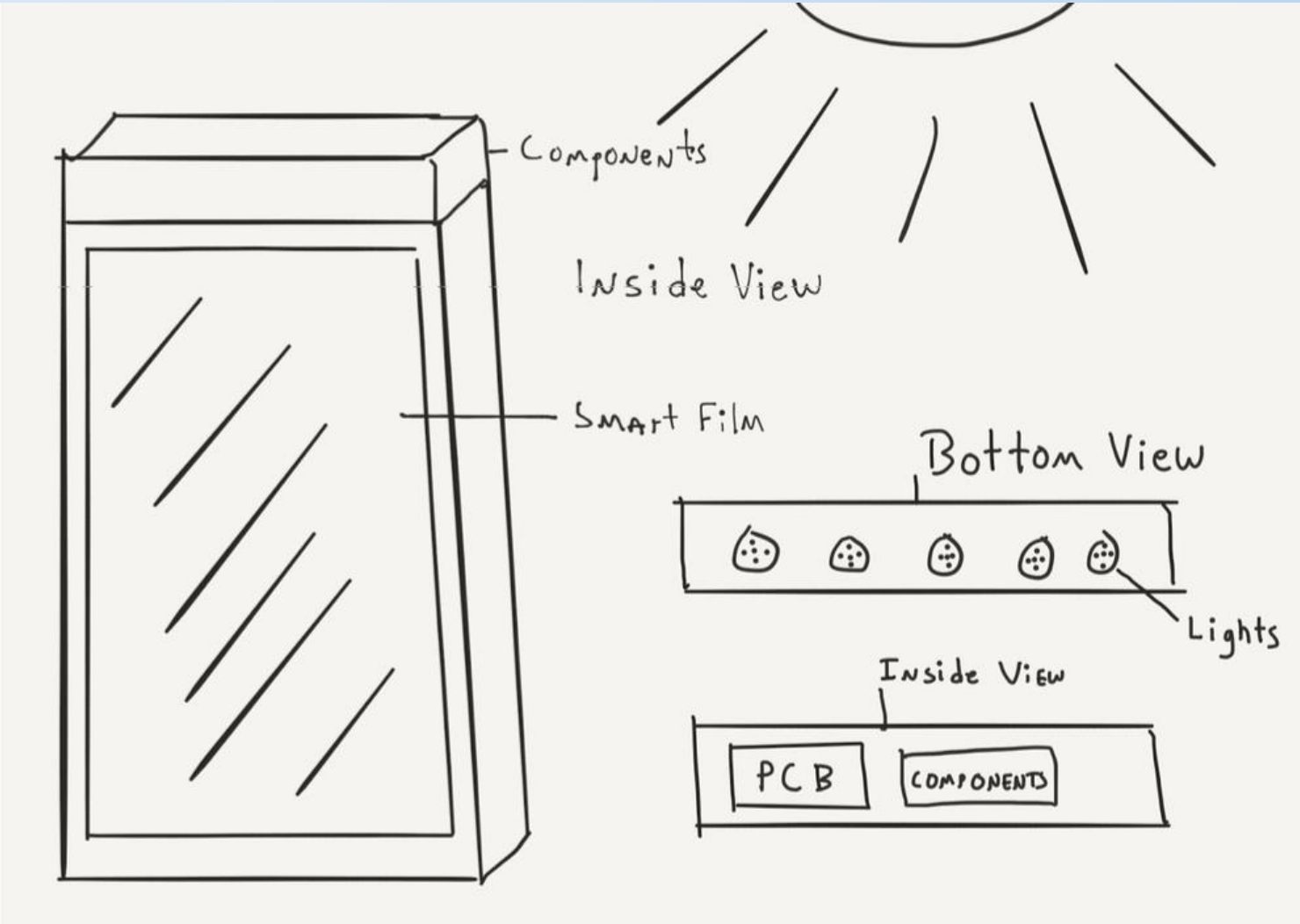
Bluetooth Integrated Prototype



Overall System Schematic



Prototype System

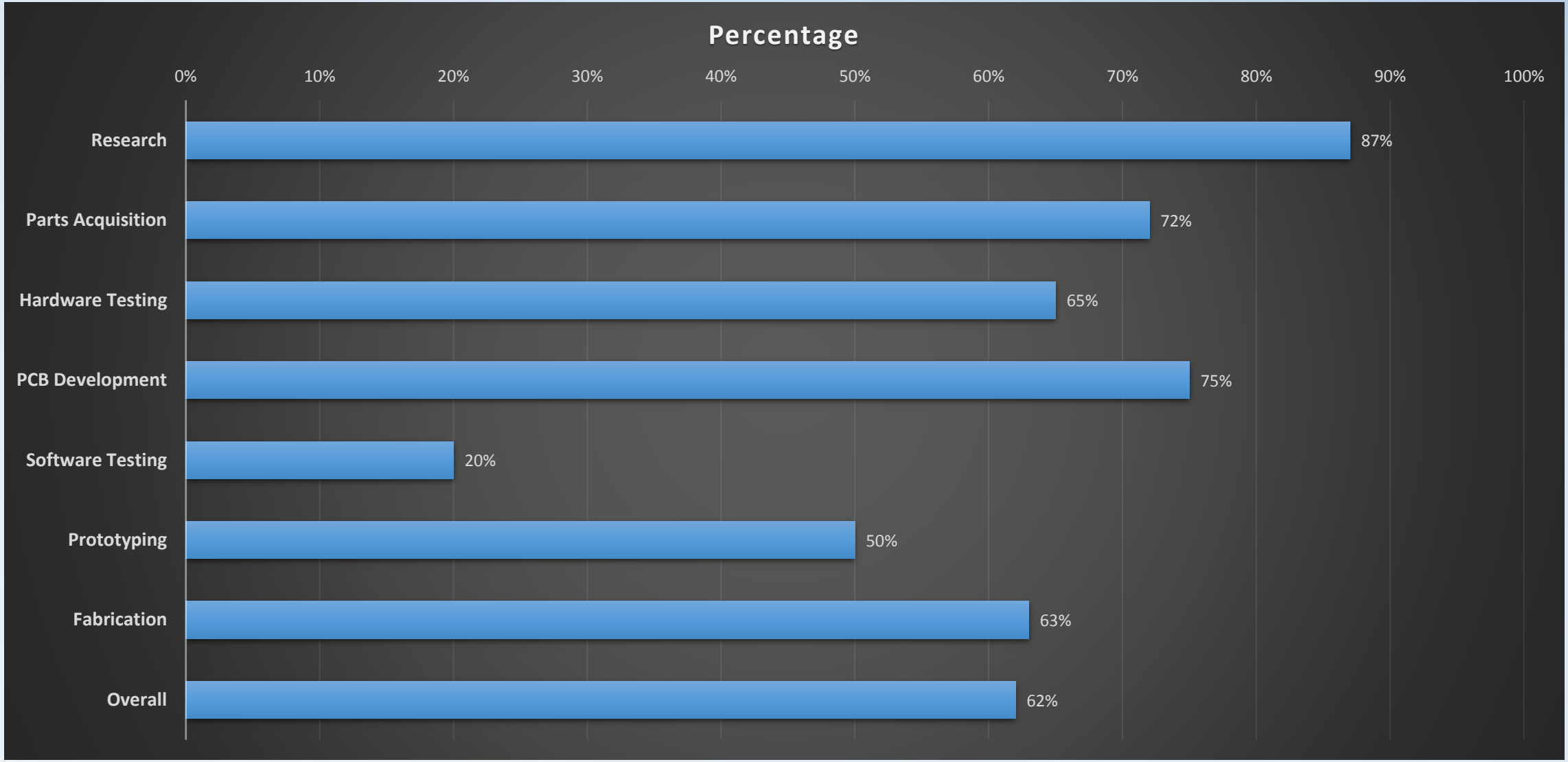


Administrative Content

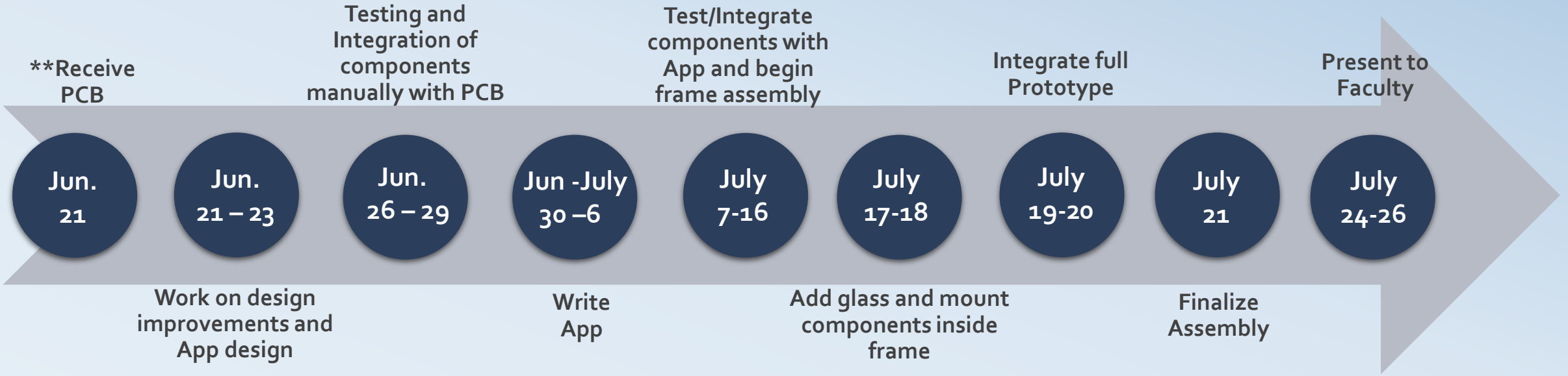
Budget

Item	Quantity	Price/Unit	Projected Cost	Actual Cost
Window Film	2	$145.07	$100.00	$145.07
Color Temp LED Strip	1	$24.95	$50.00	$24.95
Microcontroller Chip	3	$5.05	$1.00	$15.14
Voltage Regulators	5	$1.19	$1.50	$5.95
Relay for film control	2	$3.39	$30.00	$6.79
Power Supply (60 VAC)	1	$0.00	$0.00	$0.00
Power Supply (24VDC)	1	$19.95	$20.00	$19.95
Lux Sensor	3	$0.43	$6.00	$1.49
Bluetooth Module	1	$7.99	$10.00	$7.99
Polycarbonate Window	1	$0.00	$0.00	$0.00
Wood for Frame	1	$29.17	$35.00	$29.17
PCB Costs	3	$23.35	$150.00	$70.05
Temp Sensor	3	$1.48	$5.00	$4.44
Potentiometer	1	$3.25	$0.95	$6.50
Mosfets	10	$1.60	$10.00	$16.00
Total	36		$365.95	$353.49

Current Progress



Schedule Towards Completion



- **Ideal Schedule, approximate date for PCB shown
- Some padding added to dates for any extensive troubleshooting that may occur

Questions/Comments?