Stand-alone Solar Entertainment

Reinventing entertainment off the grid

The Team

Stand-alone Solar Entertainment System

Hugh Hackler

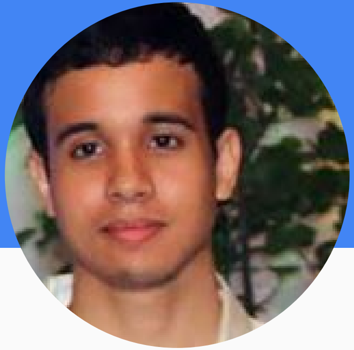
Electrical Engineering
Master Sound
Amplification Dude

Daniel Graves

Electrical Engineer

Devin Hobby

Electrical Engineering
Army Simulation Systems
Intern with MITRE Corp.

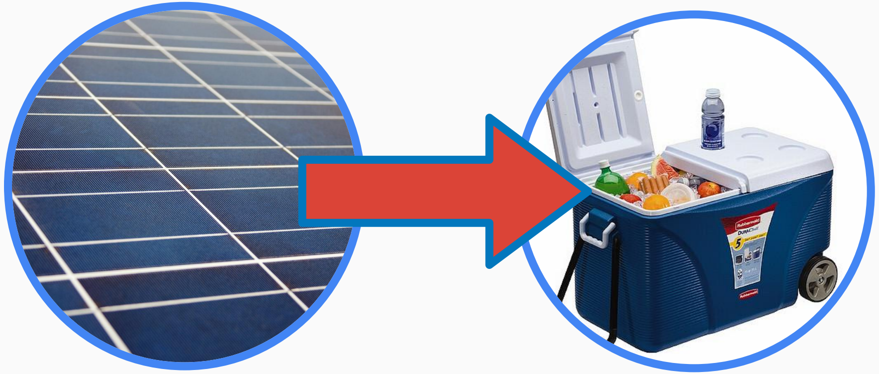


Mark Boutwell

Computer Engineering
Software Developer at IST

The Problem

Entertainment has become surprisingly mobile with recent technology, but power still remains an issue. Batteries are not able to last unless use is limited. The solar entertainment system provides a renewable energy source along with multiple functionalities in one system.



The solution

S.S. Entertainment

Now you can enjoy a refreshing drink, listen to music, enjoy ambient lighting, and power your devices; all with solar energy.

How it works

Phase 1

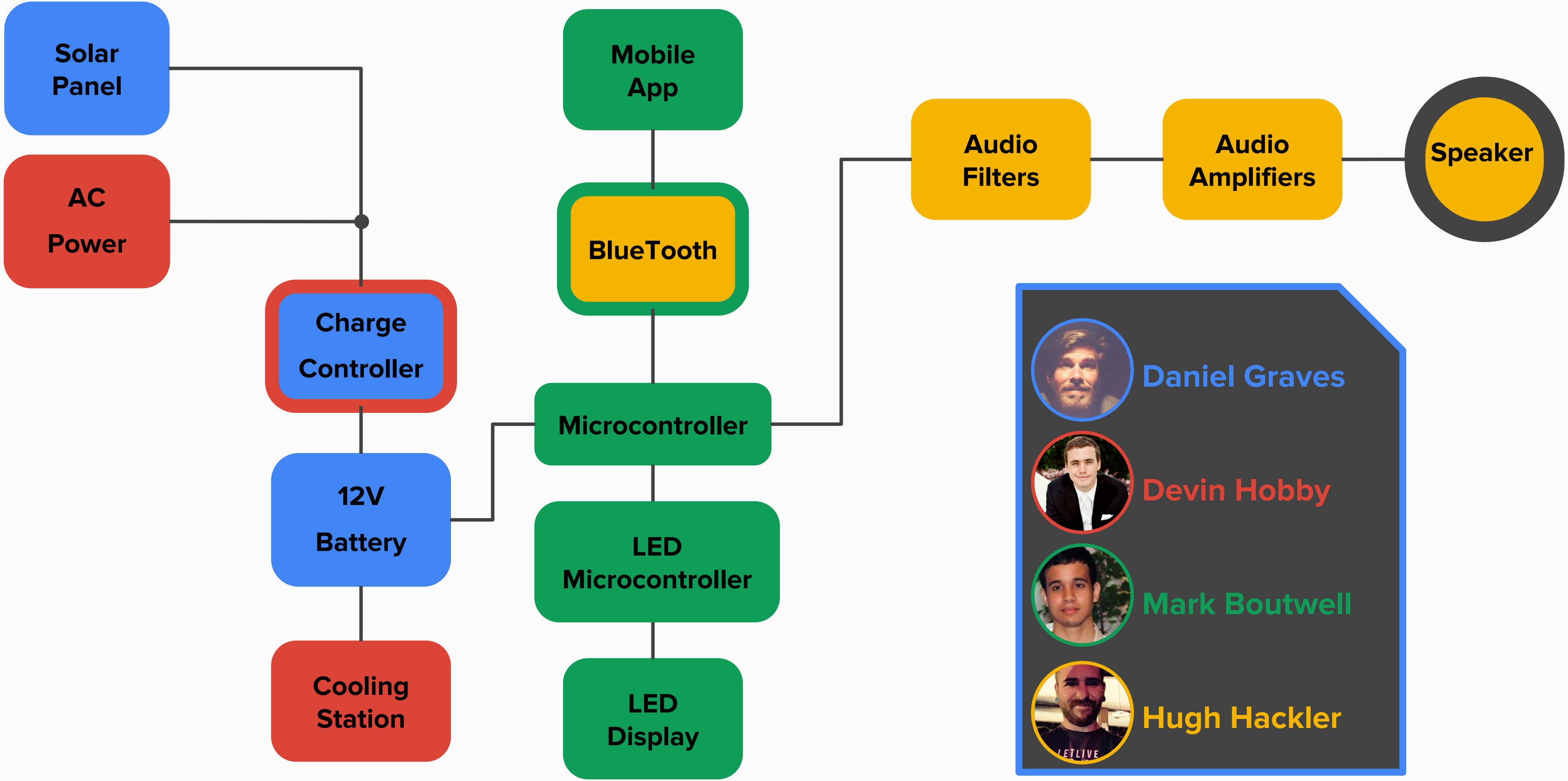
Collect power using a solar panel connected to the system

Phase 2

Use a charge controller to moderate charge from solar panel

Phase 3

Distribute power to the individual systems respectively



Team Member Workload Distribution Chart

Project Contribution Roles

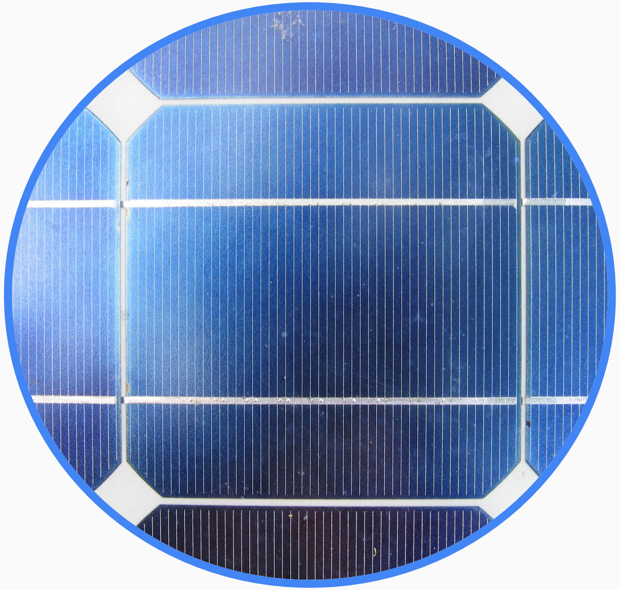
Member	Solar Panel	A/C Input	Charge Controller	Battery	Cooling Station	Micro controller	LED Display	BlueTooth	Mobile App	Audio Crossover	Audio Amplifier	Speakers
Daniel Graves	**P**	**S**	**P**	**P**								
Devin Hobby		**P**	**S**		**P**							
Mark Boutwell						**P**	**P**	**S**	**P**			
Hugh Hackler								**S**		**P**	**P**	**P**

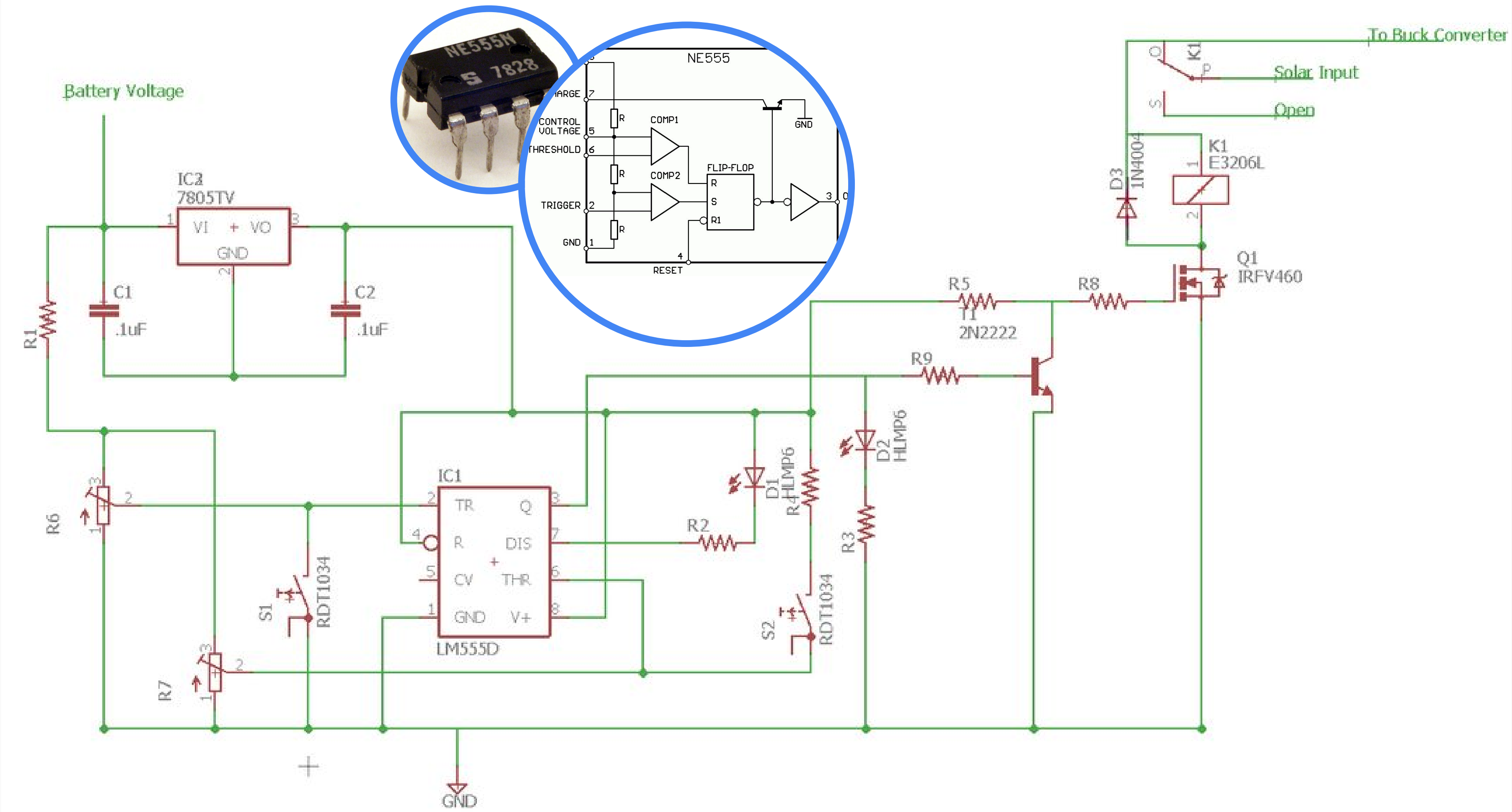
Designs:

And their capabilities

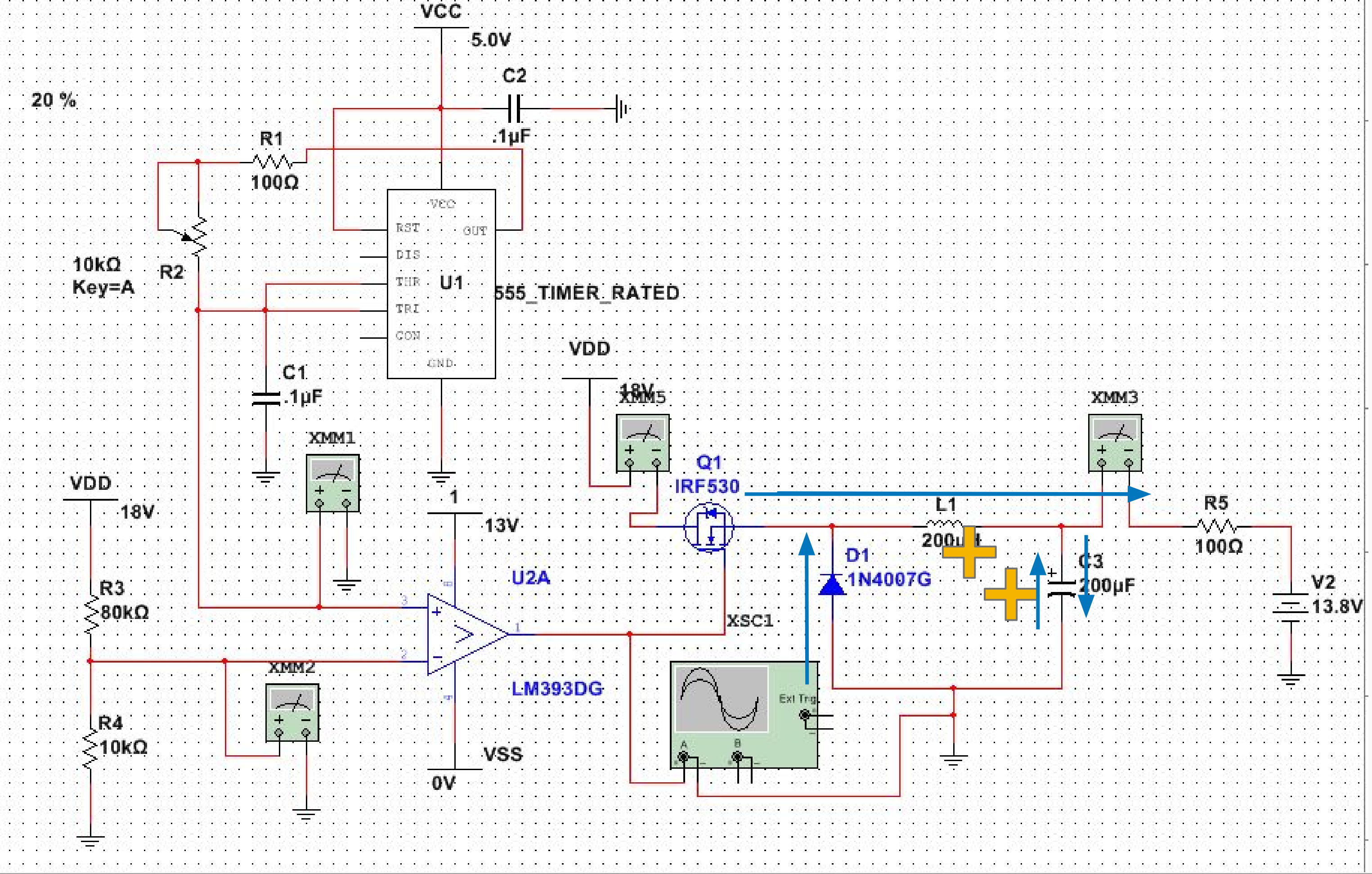
Charge Controller

- Using a comparator switching network we can control and protect from battery overcharge.
- A pulse width modulation signal is created contingent upon the voltage from the solar panel, which leads to the buck converter.
- The buck converter works using the PWM to mitigate the flow of power to the battery.





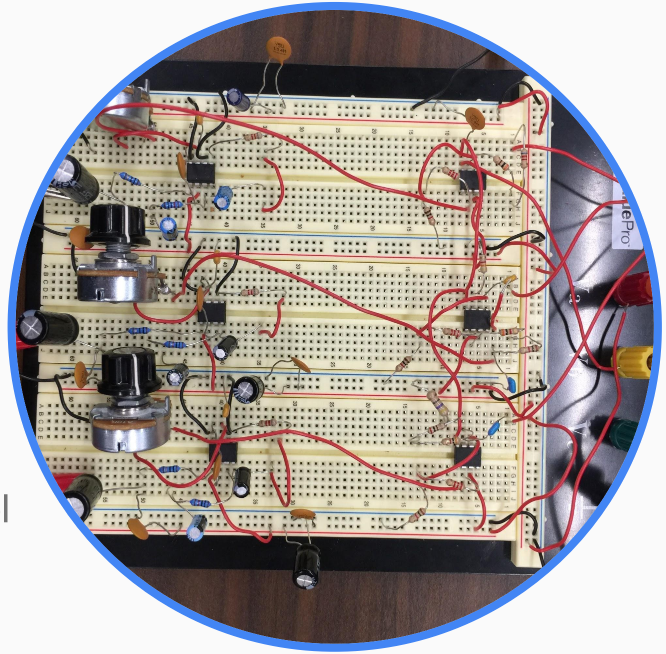
Switching Network Schematic



Buck Converter Schematic

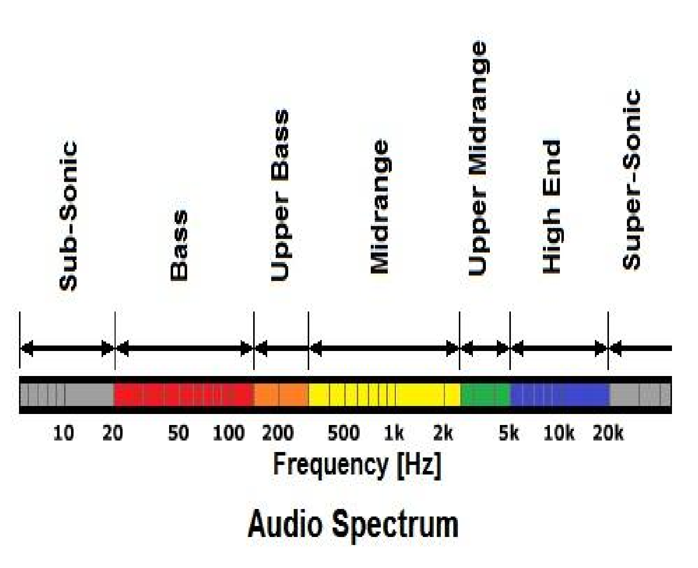
Audio Amplification System

- Three way crossover
  - Active filter network
  - Low-pass, band-pass, and high-pass filters provide frequency separation
  - Frequency response from 20 Hz - 20 kHz
  - LF351 Op-amp
- Class AB solid state amplifier
  - High fidelity and low power consumption
  - Fixed gain with variable volume control for each channel
  - LM386N-4 Op-amp



Frequency Separation

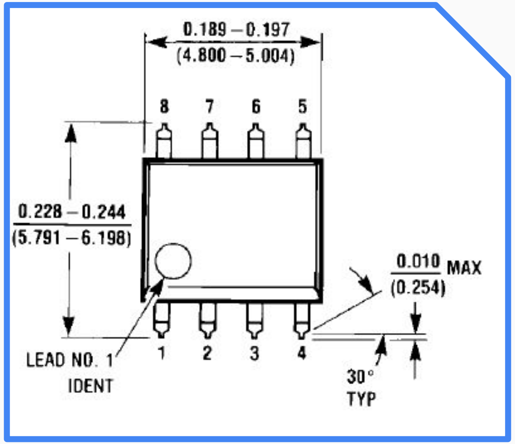
- Low-Pass Filter
  - Bass, and upper bass frequencies
  - Determines how fat or thin sound is
  - Fc = 200 Hz
- Band-Pass Filter
  - Includes upper bass and midrange
  - Low order harmonics; excess output can cause sound to be tinny and lead to ear fatigue
  - Fc1 = 250 Hz & Fc2 = 2 kHz
- High-Pass Filter
  - Upper midrange and high end frequencies
  - Timbre, clarity, definition and air of a sound
  - Fc = 4 kHz



Chip Selection

Filters

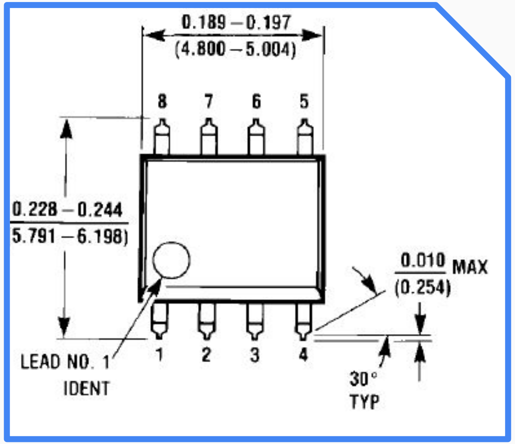
IC	LM741	LF351
Manufacturer	TI	TI
Slew rate	0.5 V/μs	13 V/μs
Input Impedance	0.3 MΩ	10 TΩ
Power Consumption	500 mW (max)	670 mW (max)
THD	< 0.06	< 0.02

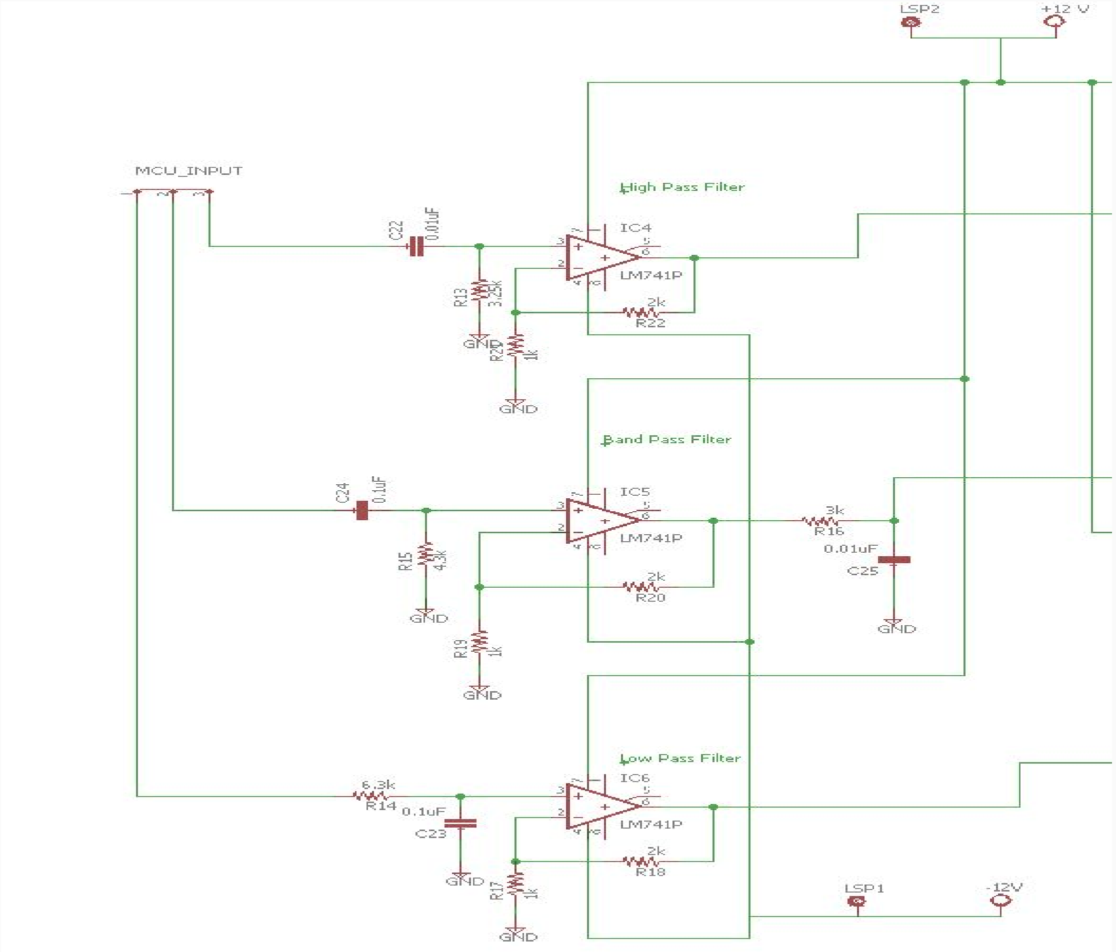


Chip Selection

Amplifier

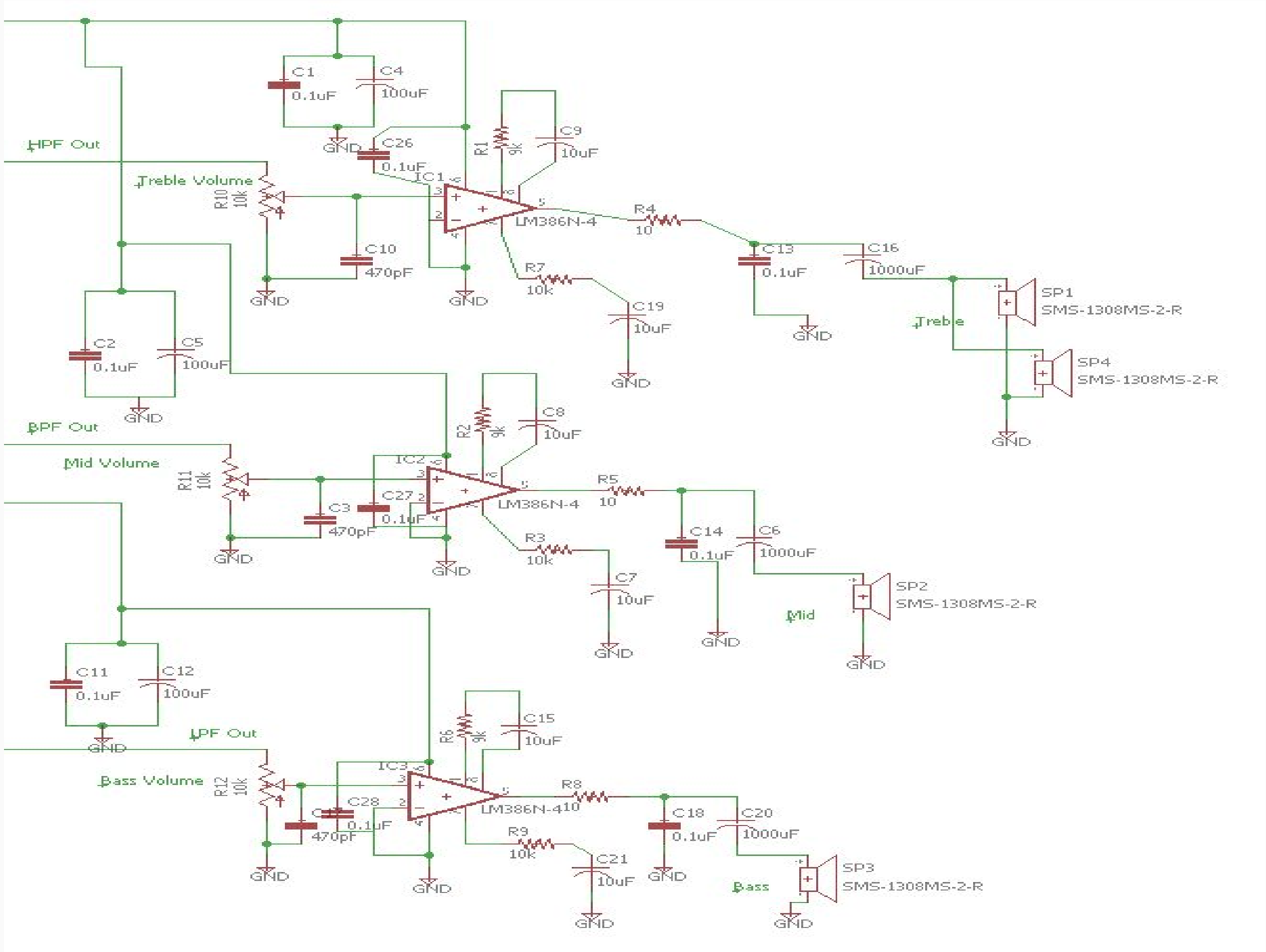
IC	LM386N-4
Manufacturer	TI
Gain	Pin 1-8 open: 20 (26 dB) 10µF cap_pin 1-8: 200 (46 dB)
Input Resistance	50 kΩ
Power Consumption	1.25 W (max)
THD	0.2 %





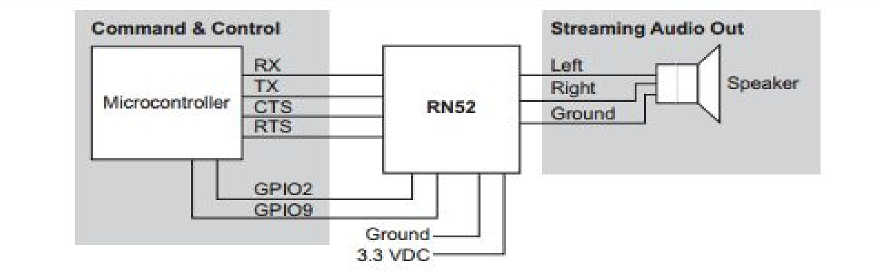
Audio Crossover Schematic

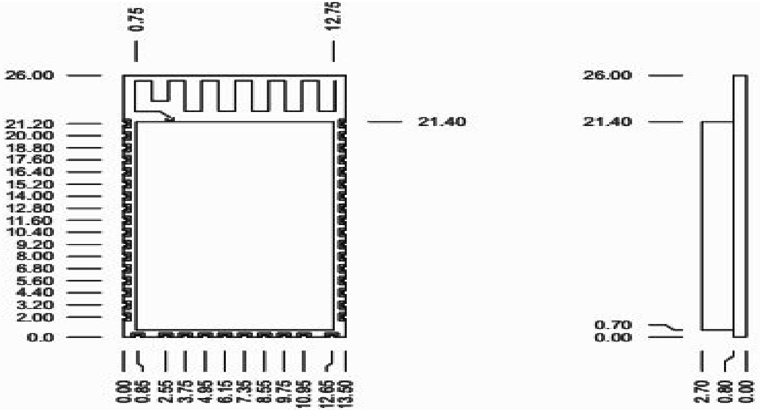
Audio Amplifier Schematic



Bluetooth Module

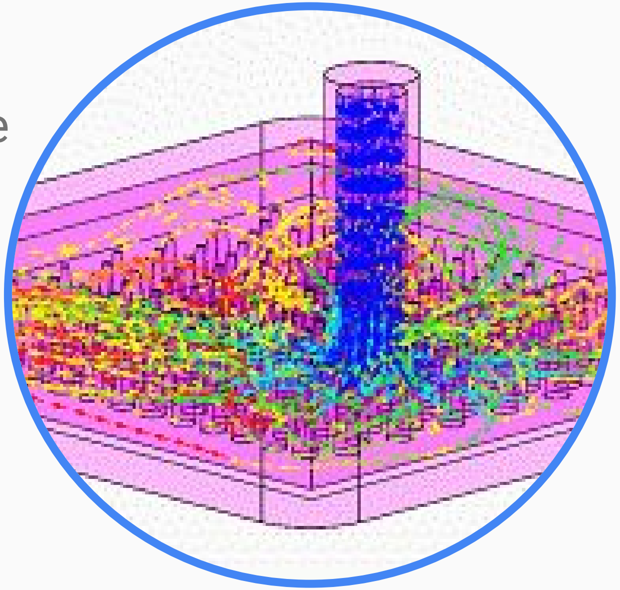
- RN-52 stereo audio module
  - Dual-channel, differential audio input and output for highest quality audio w/ onboard DSP
  - External audio CODECs supported via S/PDIF and UART interface
  - Bluetooth SIG certified
  - Bluetooth v3.0; backwards compatible w/ v2.1 + EDR, 1.2, and 1.1 devices
  - Class 2 Bluetooth device; range 10m (33 ft) in open air

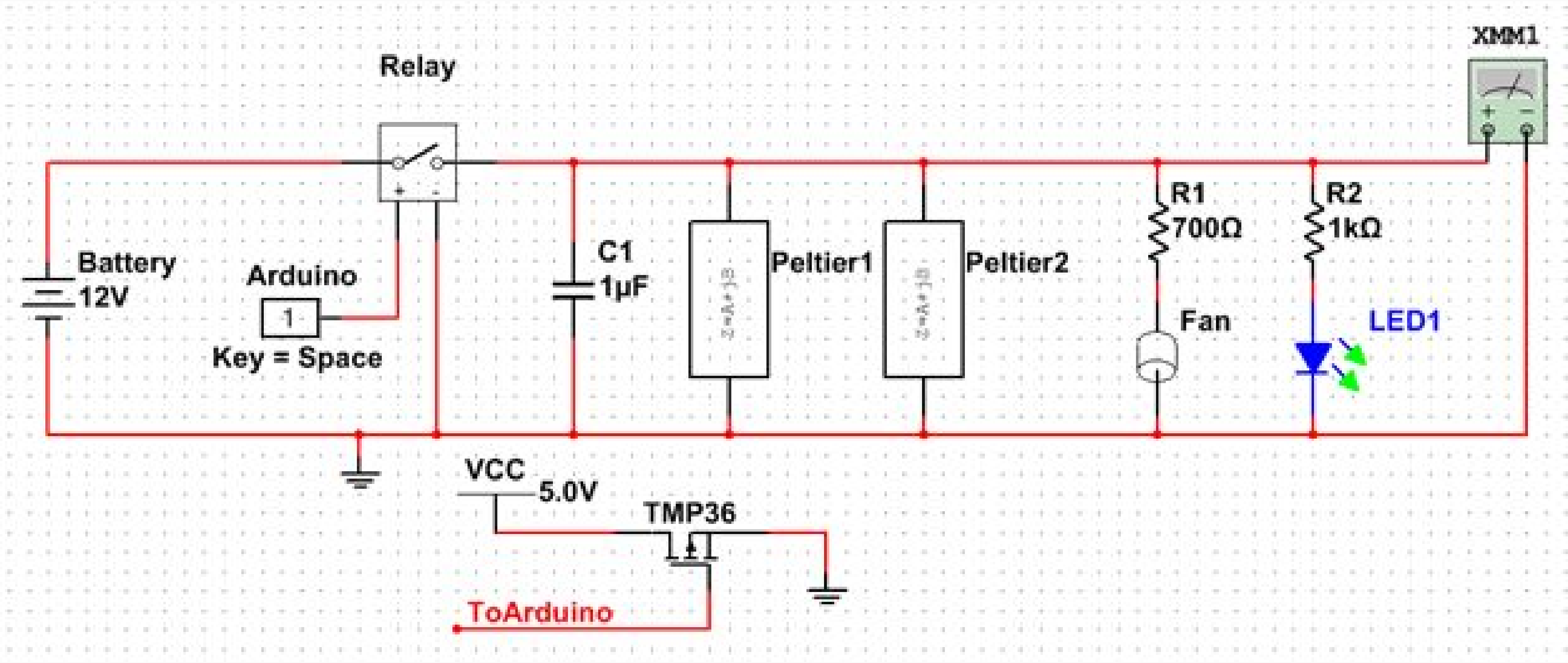




Cooling System

- Peltier plates are used due to their simple configuration and solid state design
- Although inefficient, the temperatures required are not low, and the benefits outweigh the costs
- Fans will cool the “hot” side of the plate, causing the cool side to drop ΔT degrees
- With contact to the drinks, the heat is pumped out leaving a cold beverage

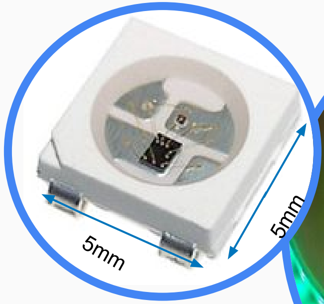


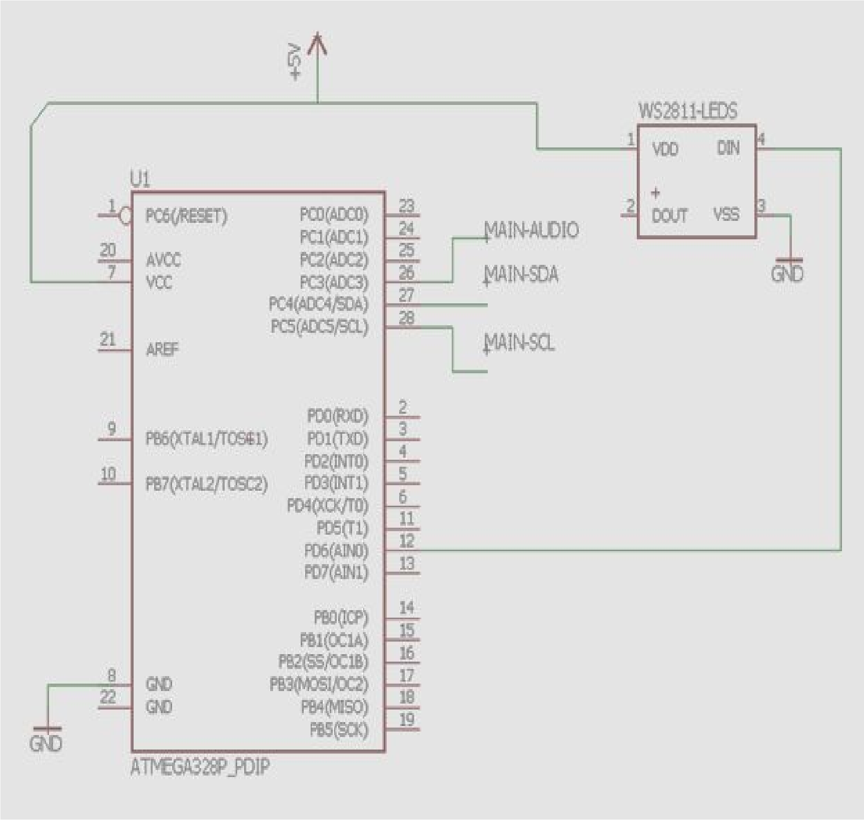


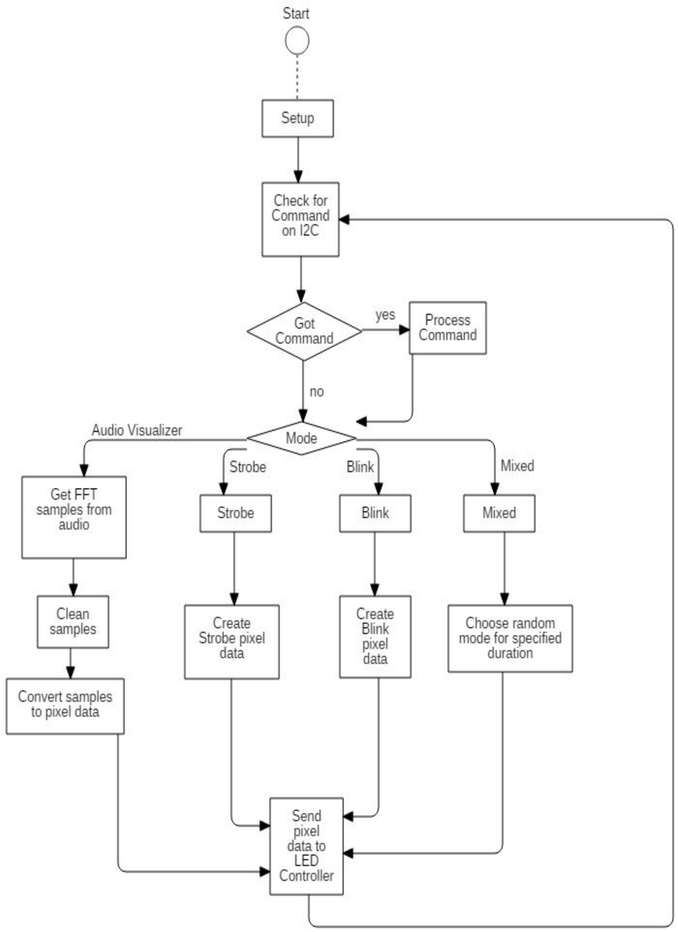
Cooling System Schematic

LED Display

- SMD5050 LEDs with WS2811 Controllers
- Atmega 328p microcontroller



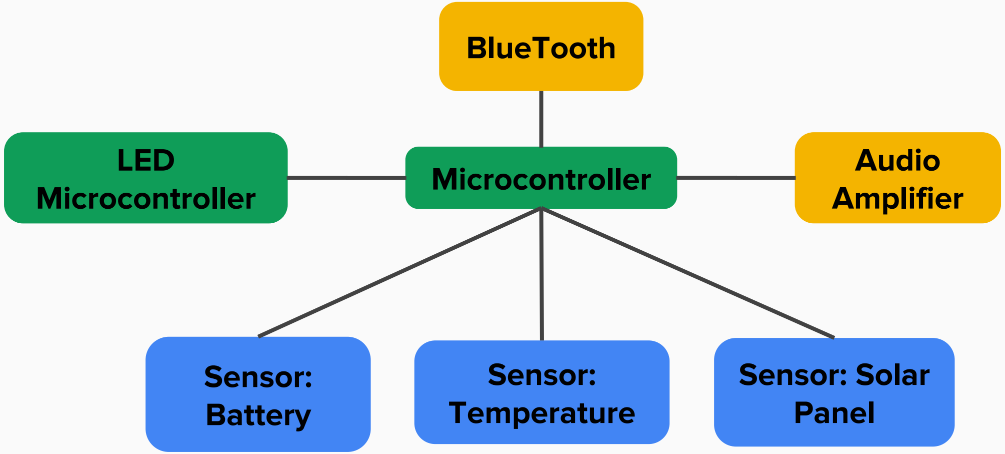


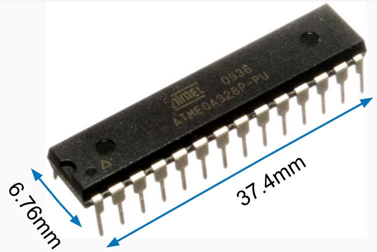


LED Controller Program

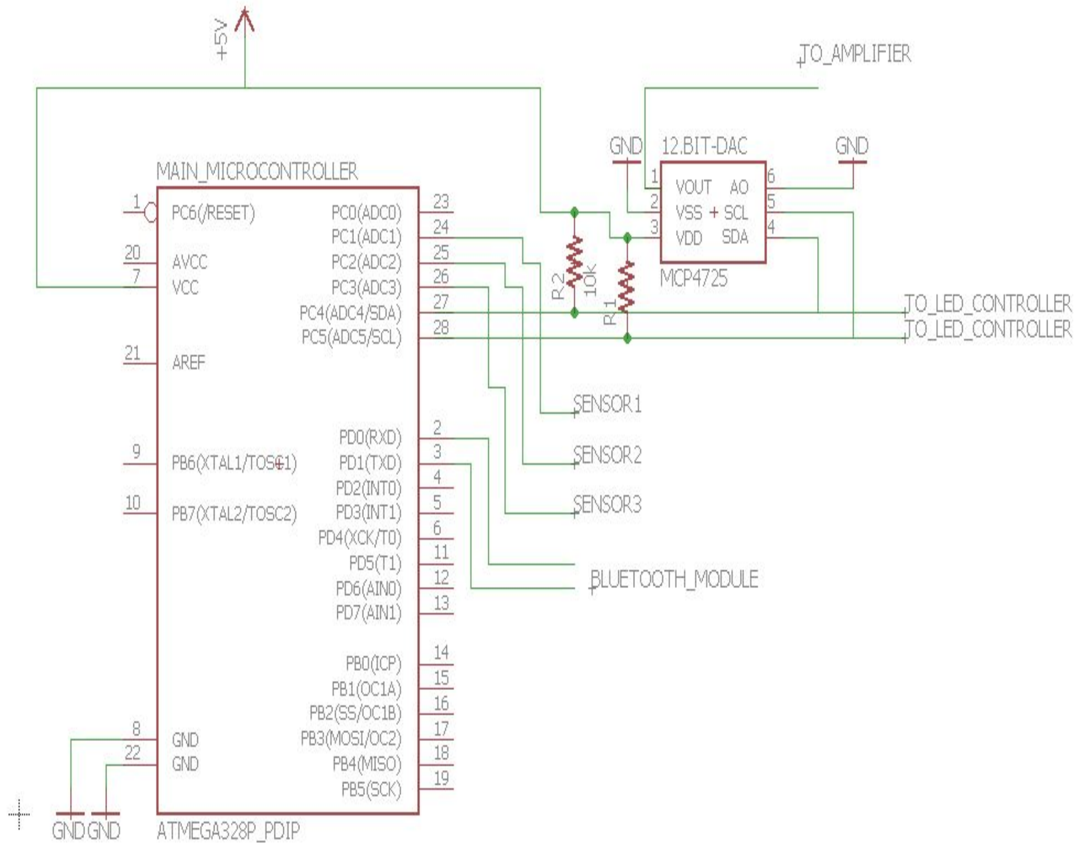
Main Microcontroller

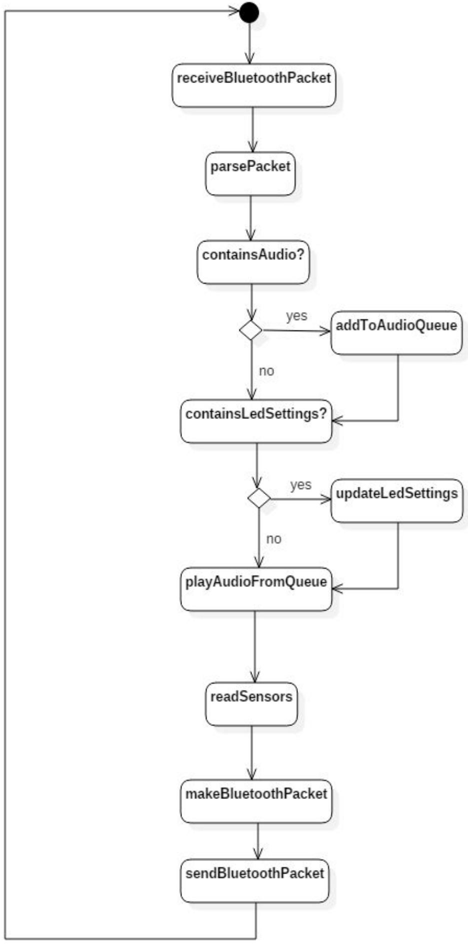
ATMega 328p





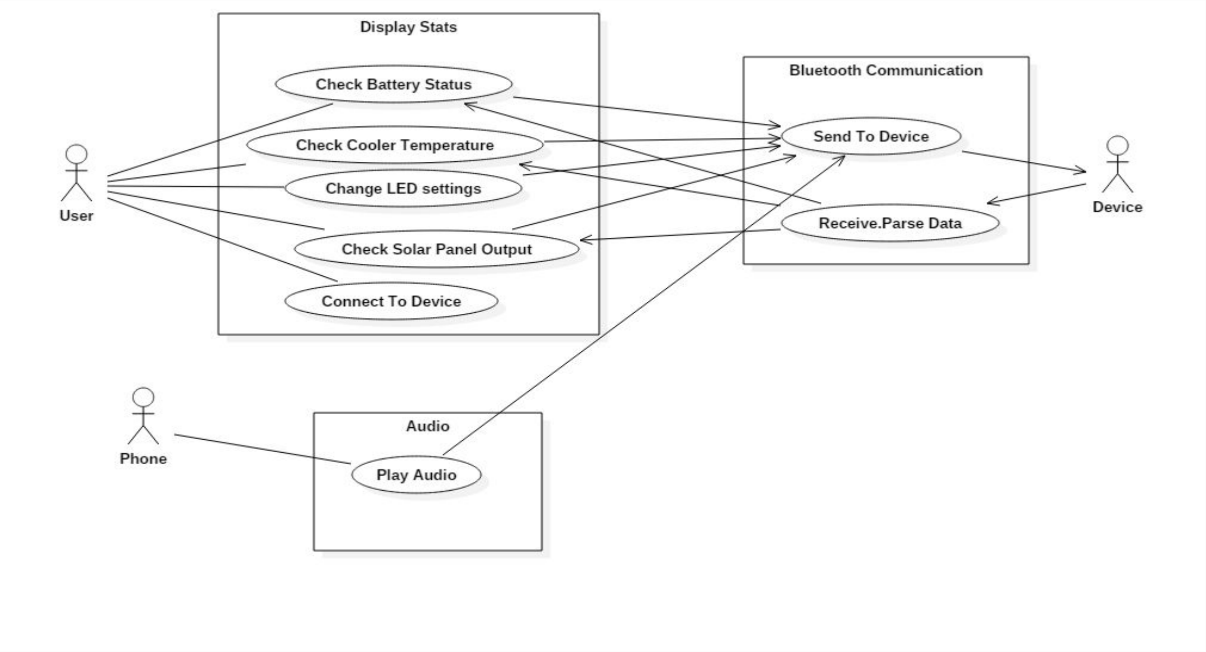
Flash (kBytes)”	**32 kBytes**
Pin Count:	28
Max. Operating Freq. (MHz):	20 MHz
CPU:	8-bit AVR
Max I/O Pins:	23
EEPROM	1KB
Internal SRAM	2K Bytes





Microcontroller Pin Layout and Program

Mobile Application



Milestones

Jun Jul Aug Sep Oct Nov

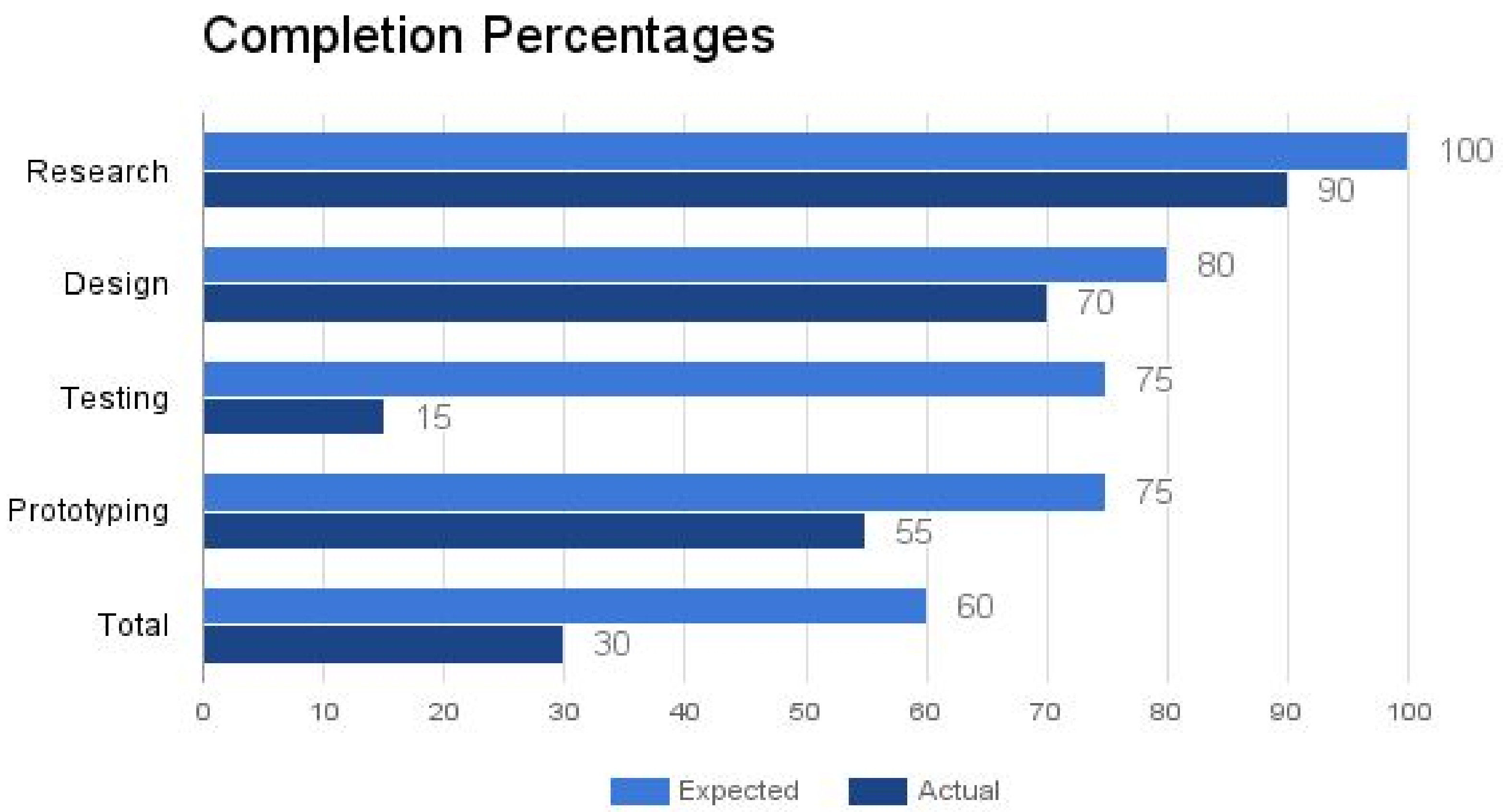
June 2016
Conceptualize and finish preliminary research

August 2016
Prototyping and final experimental test

September 2016
Finalize design and create and order PCB

October 2016
Assemble final product and begin testing. Make any necessary revisions

November 2016
Prepare product for presentation and write report


Completion Percentages
Research
Design
Testing
Prototyping
Total
100
90
80
70
75
15
75
55
60
30
0
10
20
30
40
50
60
70
80
90
100
Expected
Actual

Progress

Budget

The original projected cost derived for the entire project is in red. A majority of the components have changed so no individual estimated costs are displayed on this list. These new components proved to be cheaper and more effective at completing the necessary standards. The actual project total is highlighted in green, and is the total cost (as of today) spent by the team.

Item	Quantity	Estimated Cost	Actual Cost
IRF640 MOSFET	10		$17.99
555 Timer	3		$3.00
RS203 Bridge Rectifier	3		$5
Thermoelectric Plates	2		$20
Atmega328 processor	6		$25.98
MCP 4725 12 bit DAC	3		$4.80
16MHz Crystal Oscillator	10		$4.55
WS2812B LED Strip	1		$28.99
RN-52 - Bluetooth Audio Module	1		$29.60
Batteries	10		$54.99
Heat sinks	6		$24.00
LF351	10		$0
10k Pot	3		$4.65
Speakers	4		$60
LM386N-4	10		$8.73
Total	N/A	$1,410	$292.28

Prototyping

- Buy and modify cooler
- Mount PCB, speakers, LEDs, batteries, and cooling components.
- Verify connections to all parts and then connect the power
- Test all parts individually then collectively: Charge controller, cooling station, LED display, app controls, bluetooth music streaming, sound quality, and charging station