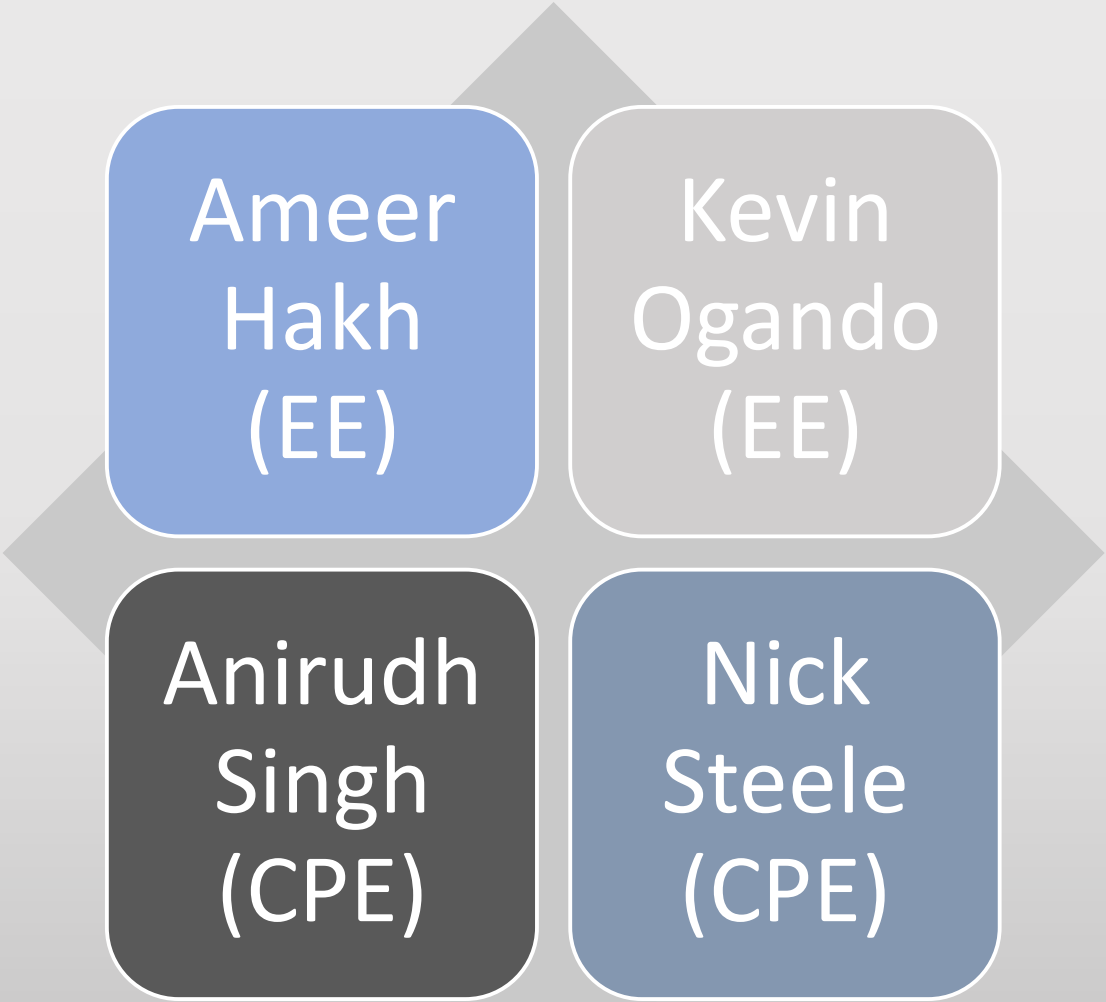
Smartphone Powered Laptop

Group 15



Motivation

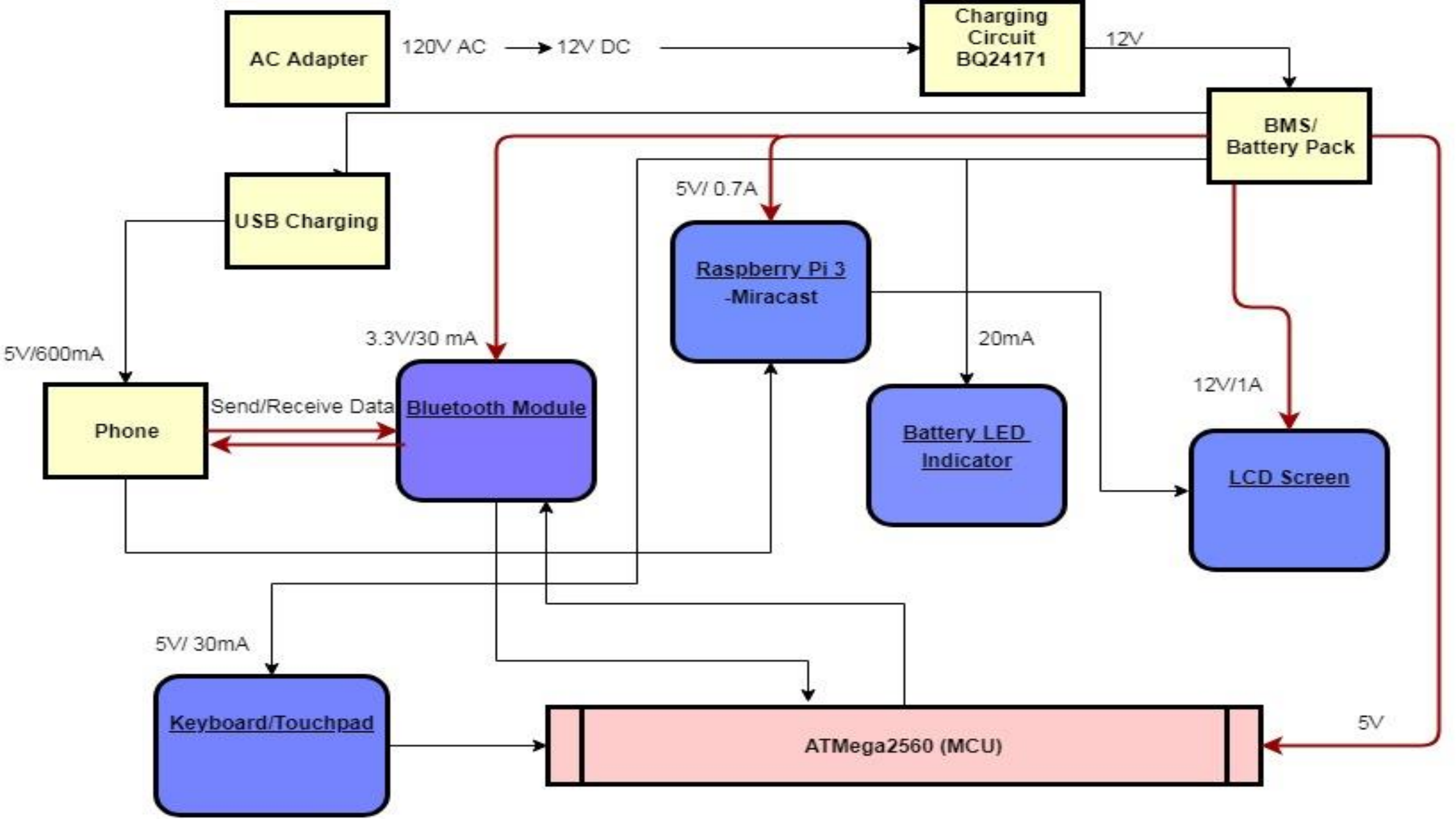
- Today's smartphones and laptops can cost anywhere from $800 - $1200 individually. But they are not interchangeable, you need both for separate tasks. Phone calls, texts, homework, projects.
- Creating a laptop that utilizes the components from the inside of a smart phone would save consumers hundreds of dollars.
- Potential breakthrough for schools in low-income areas.

Goals and Objectives

- Create an affordable laptop shell (~$100 -$200)
- Successfully implement full wireless data connection (Wi-fi, Bluetooth)
- Allow users to implement with any android device

Specifications

- Wi-Fi Direct (Peer to peer communication)
- Bluetooth 2.0
- Asus G50 Laptop Keyboard
- Asus G50 synaptic Touchpad
- 17" LCD screen 1024x768
- 11.1V Battery


AC Adapter
120V AC
12V DC
Charging Circuit BQ24171
12V
BMS/ Battery Pack
USB Charging
5V/ 0.7A
Raspberry Pi 3 -Miracast
3.3V/30 mA
5V/600mA
Phone
Send/Receive Data
Bluetooth Module
20mA
Battery LED Indicator
12V/1A
LCD Screen
5V/ 30mA
Keyboard/Touchpad
ATMega2560 (MCU)
5V

Wi-Fi Technology

- The Wi-Fi technology will help implement the screen cast from android phone to laptop LCD.
- Three technologies researched; Miracast, DLNA and MHL.
- Choice: Miracast

Miracast	DLNA	MHL
Implements Peer to peer communication	Uses a client server model	Wired HDMI to USB C cable
Supports Android devices and not apple devices	Works best with Sony devices	
Allows streaming of 1080p videos	Does not allow streaming only allows file transfer.	

Wi-Fi Technology Implementation

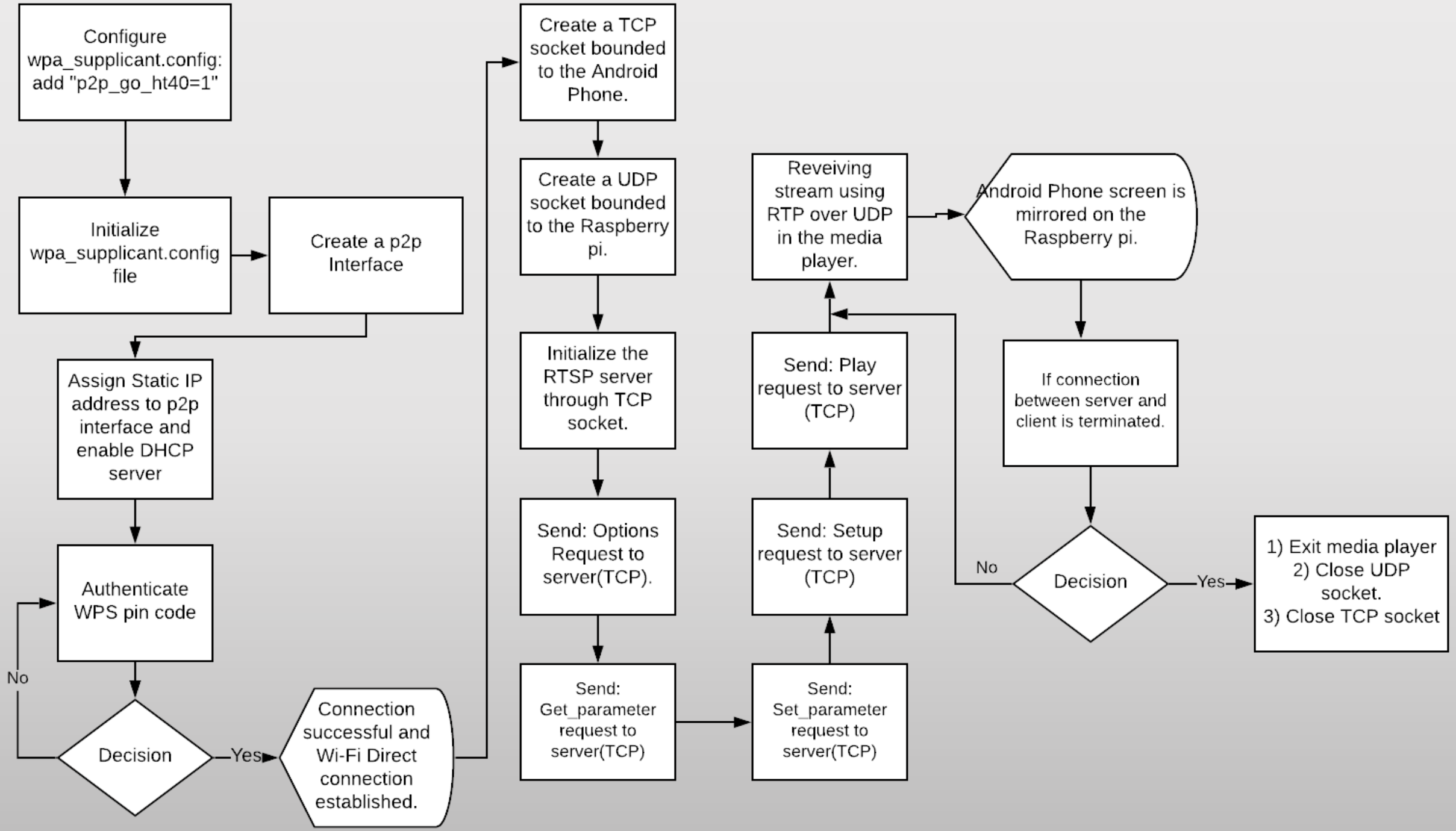
- First step is to establish a Wi-Fi Direct connection between the Android phone and the Raspberry pi.
- Next step is to utilize sockets for RTSP (Real Time Streaming Protocol).
- Once sockets are communicating with the server (Android Phone) and client (Raspberry Pi).
- The next step is to initialize the media player to which the the Android screen will be mirrored to.

Wi-Fi Technology: Wi-Fi Direct Connection

- Wi-Fi Direct uses Wi-Fi protected setup for authentication that consists of two modes Push Button Control (PBC) and Pin Code. The Pin Code method was utilized.
- Modify wpa_supplicant.config by adding “p2p_g0_ht40=1”.
- The created p2p interface is assigned a static IP address along with enabling the DHCP server.
- Try connection from Android to Raspberry pi using pin code provided.

Wi-Fi Technology: Screen Mirror

- The Unicast delivery method is utilized to stream data packets from Android to Raspberry pi.
- This method utilizes RTSP over TCP for server initialization and RTP over UDP to transport the data to the pi.


Configure wpa_supplicant.config: add "p2p_go_ht40=1"
Initialize wpa_supplicant.config file
Create a p2p Interface
Assign Static IP address to p2p interface and enable DHCP server
Authenticate WPS pin code
Decision
No
Yes
Connection successful and Wi-Fi Direct connection established.
Create a TCP socket bounded to the Android Phone.
Create a UDP socket bounded to the Raspberry pi.
Initialize the RTSP server through TCP socket.
Send: Options Request to server(TCP).
Send: Get_parameter request to server(TCP)
Send: Set_parameter request to server(TCP)
Send: Setup request to server (TCP)
Send: Play request to server (TCP)
Reveiving stream using RTP over UDP in the media player.
Android Phone screen is mirrored on the Raspberry pi.
If connection between server and client is terminated.
Decision
No
Yes
1) Exit media player
2) Close UDP socket.
3) Close TCP socket

Hardware Components

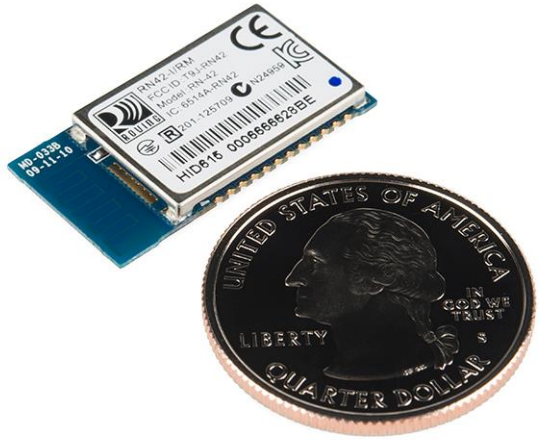
Microcontrollers

Choice: ATMEGA 2560 and BCM2387

	ATMEGA 328	ATMEGA 2560	BCM2837
Cost	$2.15	$2.69	$30.75
Number of I/O pins	23 Pins	54 Pins	40 Pins
Manufacture	Adafruit	Adafruit	Raspberry Pi Foundation
Operating Volatage	5V	5V	2.5V-5.5V
Flash Memory	32 KB	256 KB	SD card storage

Bluetooth

Module/ Company	**RN42 HID/** Microchip Technology	**MDBT40** / Raytac
Bluetooth	BT 2.0	BT 4.2 LE
Range	20 m	50 m
Current Consumption	30 mA	15 mA
Flashed Firmware	Yes	No
Size (mm)	13.44 x 20 x 2	18 x 10 x 3.2
Price	$15.48	$7.95

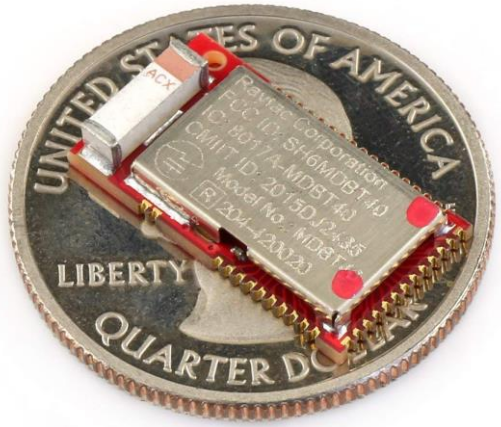


Requirements

- Bluetooth 2.0
- HID Firmware
- Backwards Compatible
- HID Documentation

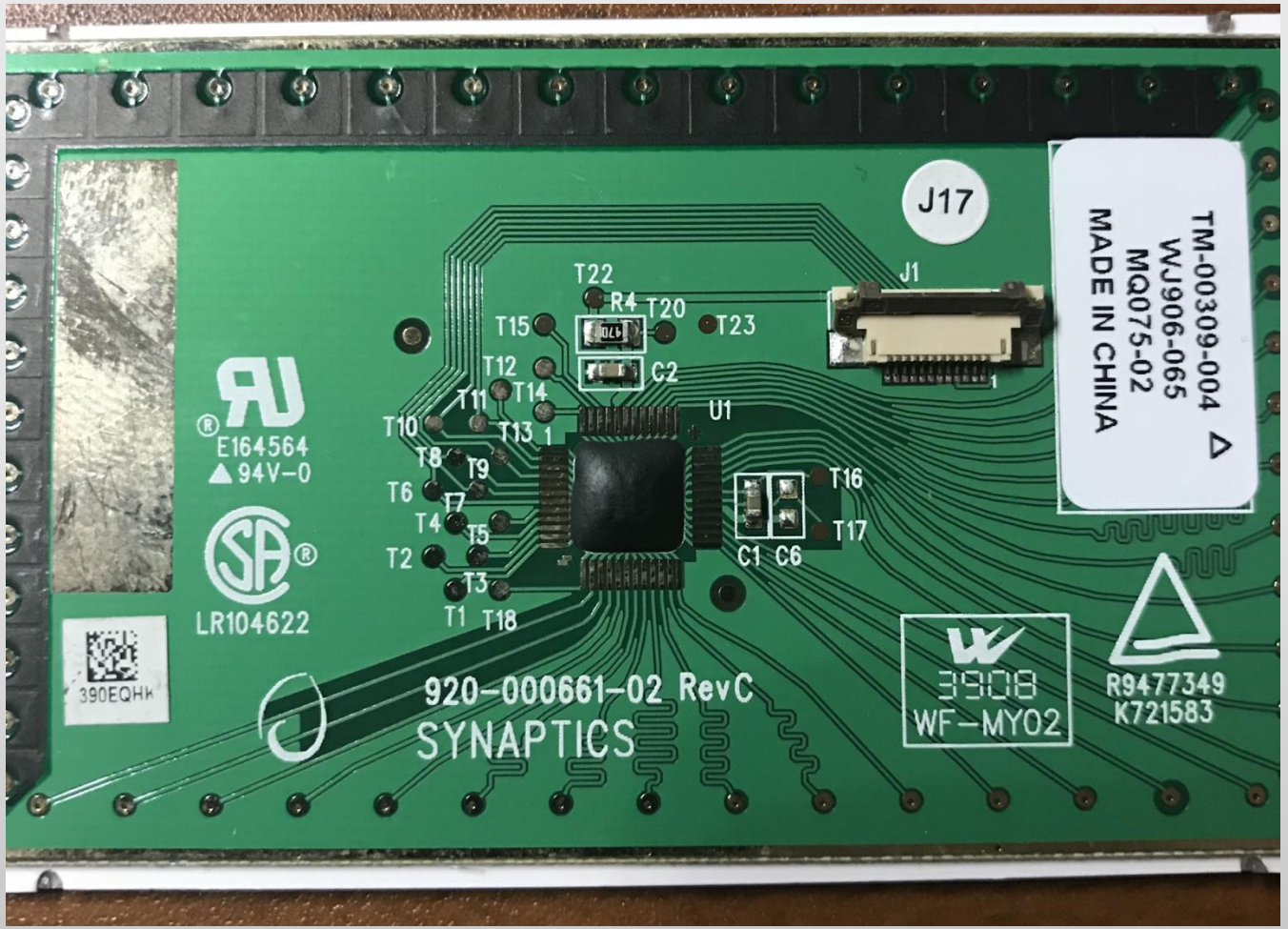
Hardware Configuration

i. Auto discovery
ii. 9600 Baud Rate
iii. Factory Reset
vi. BT Master



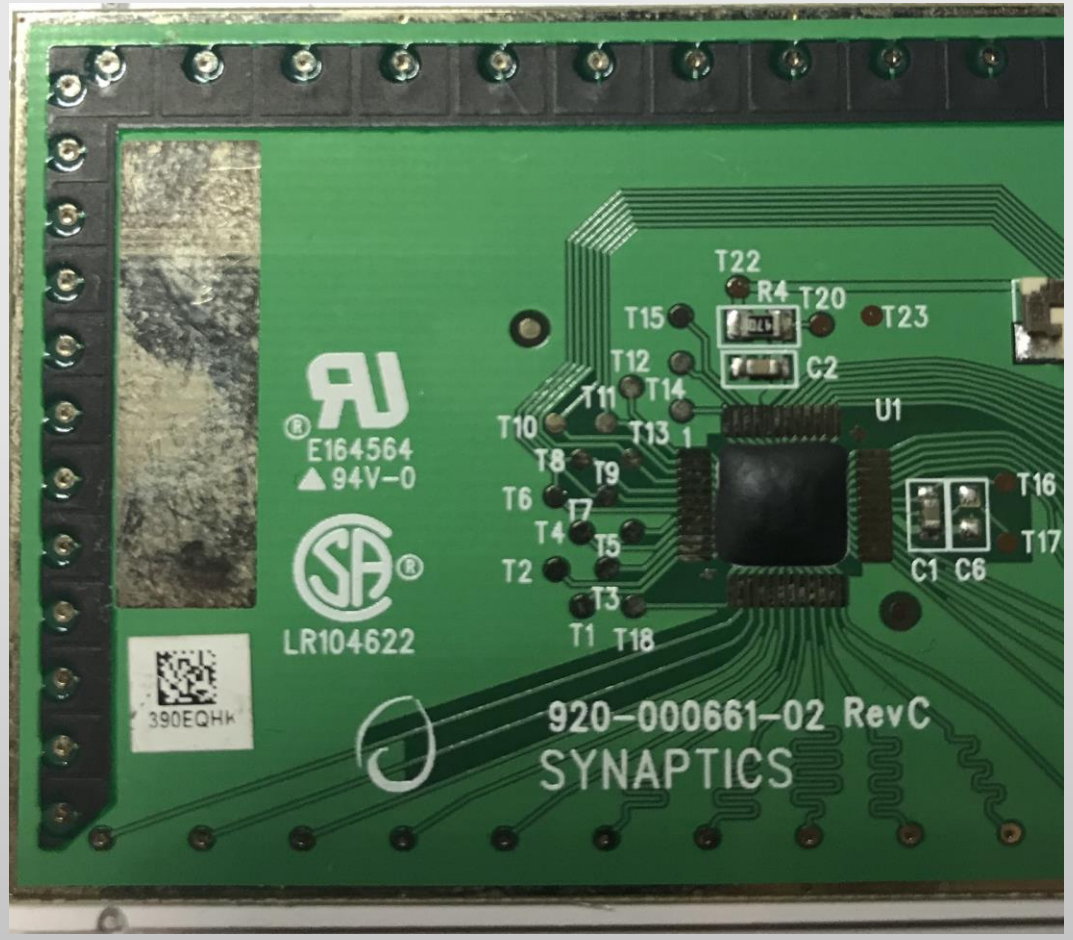
Touchpad

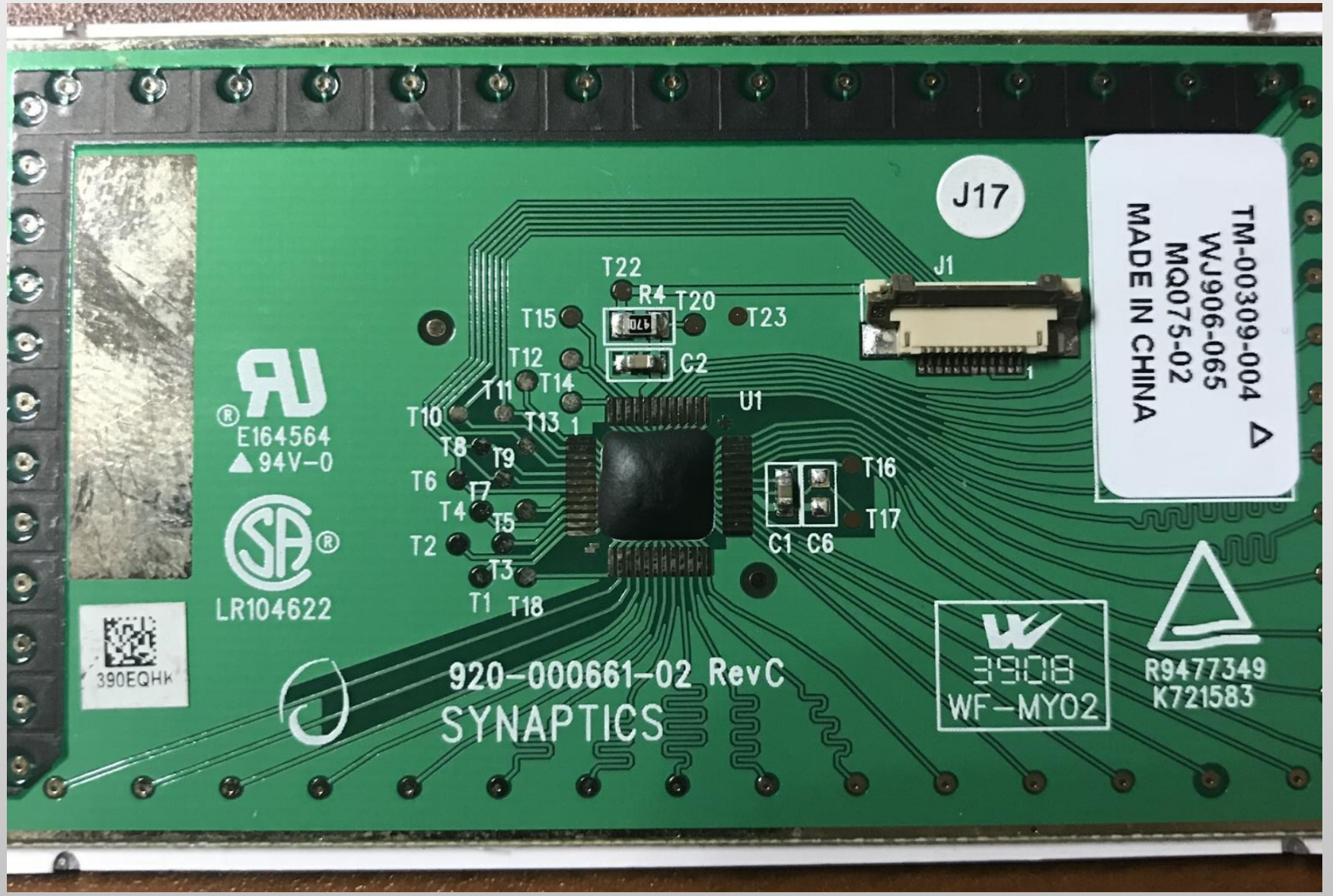
	TM-00309-004
OEM	Yes
Manufacturer	Synaptics
Price	Free
Size	88mm x 86mm x 14mm
Communication	PS/2



PS/2 Touchpad Electrical Interface

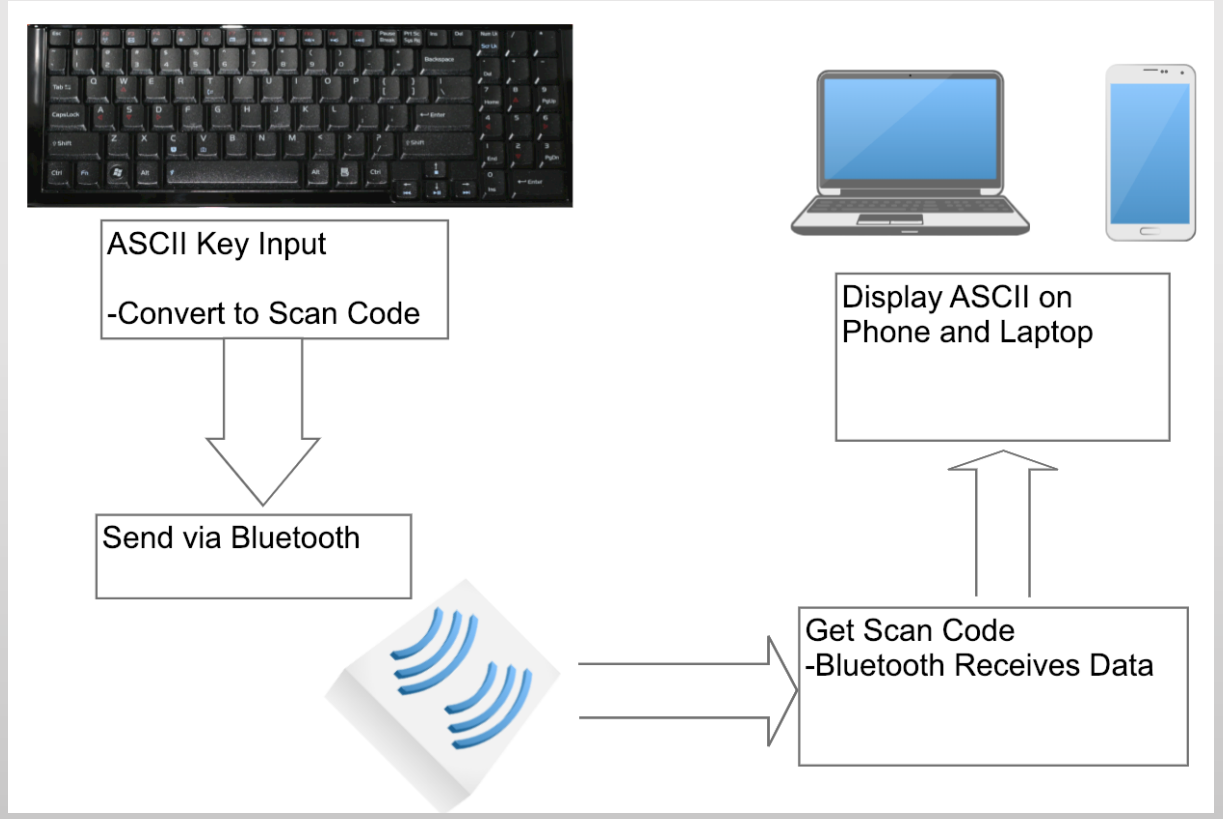
	Pad
5V Supply	T22
GND	Copper Pad
Data	T11
Clock	T10




J17
J1
T22
R4
T20
T23
T15
T12
T14
T11
T10
T13
T8
T9
T6
T7
T4
T5
T2
T3
T1
T18
C2
U1
C1
C6
T16
T17
E164564
94V-0
LR104622
390EQHK
920-000661-02 RevC
SYNAPTICS
TM-00309-004
WJ906-065
MQ075-02
MADE IN CHINA
3908
WF-MY02
R9477349
K721583

Keyboard HID Interface

- Bluetooth v2.0
- Used for wireless connection to keyboard
- Bluetooth v4.0+ is backwards compatible

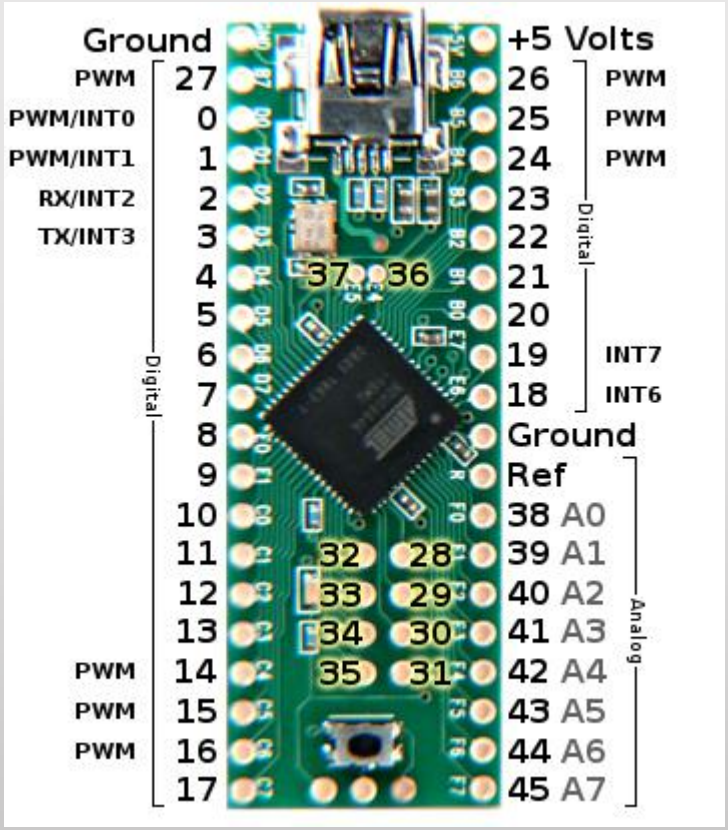


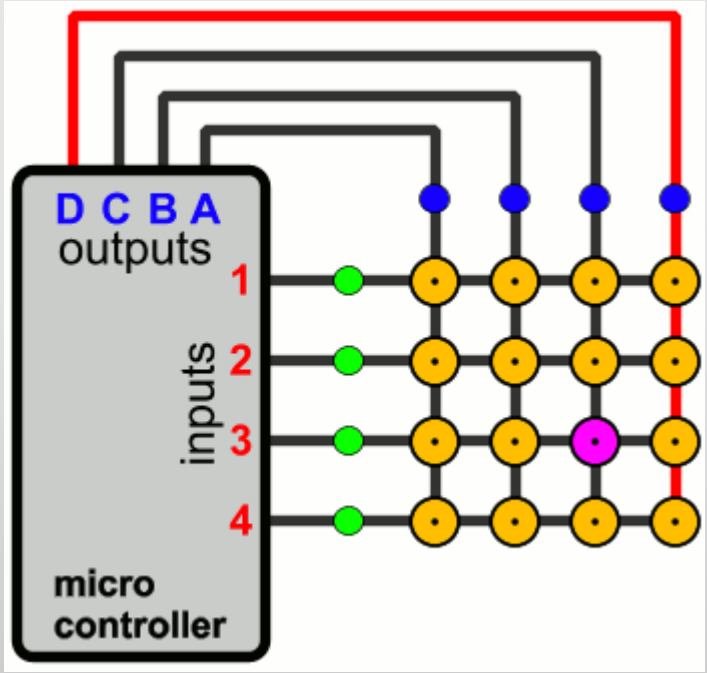
Keyboard

Part #04GNED1KUK10

Keyboard Analysis

- Originally tried using multimeter to individually test individual ribbon connectors
- Used teensyduino as an automated continuity tester to build keyboard matrix





Keyboard Implementation

Output/Input (16X8)	13	12	10	9	7	6	4	3
24	n	n	F8 (o)	n	Pad 4	Pad 5	Pad 6	Arror right
23	Apostrophe (')	n	n	Equal	Backspace	]	n	Enter (e)
22	**Cntr-R (c)**	n	n	n	n	n	n	**Cntrl-L (c)**
21	Comma (,)	F6 (r)	F7 (&)	F5 (%)	8	I	K	Insert (i)
20	n	F9 (( )	Pad 8	n	n	Menu	Arrow-Left	n
19	V	T	G	5	4	R	F	B
18	Period (.)	F11	Forwardslash \	F10 ( ))	9	O	L	Arrow-Down
17	C	F4 ($)	F3 (#)	Caps-Lock (k)	3	E	D	Space (s)
16	n	Tab (t)	Fn	`	1	Q	A	Pad 0
15	X	F1 (!)	F2 (@)	Esc (d)	2	W	S	Z
14	Backslash /	F12 (_)	Minues (-)	0	P	[	;	Arrow-Up
11	n	**GUI (w)**	Pg-Up/Pad 9	Home/Pad 7	Pad *	Pad /	Num-Lock (j)	n
8	**Alt-R (a)**	n	n	n	n	n	n	**Alt-L (a)**
5	**Shift-R (u)**	n	n	n	n	n	n	**Shift-L (u)**
2	Pad Enter (e)	Pad 2	Pad +	Pg-Dn/Pad 3	Delete/Pad (h	End/Pad 1	n	Pad -
1	M	Y	H	6	7	U	J	N

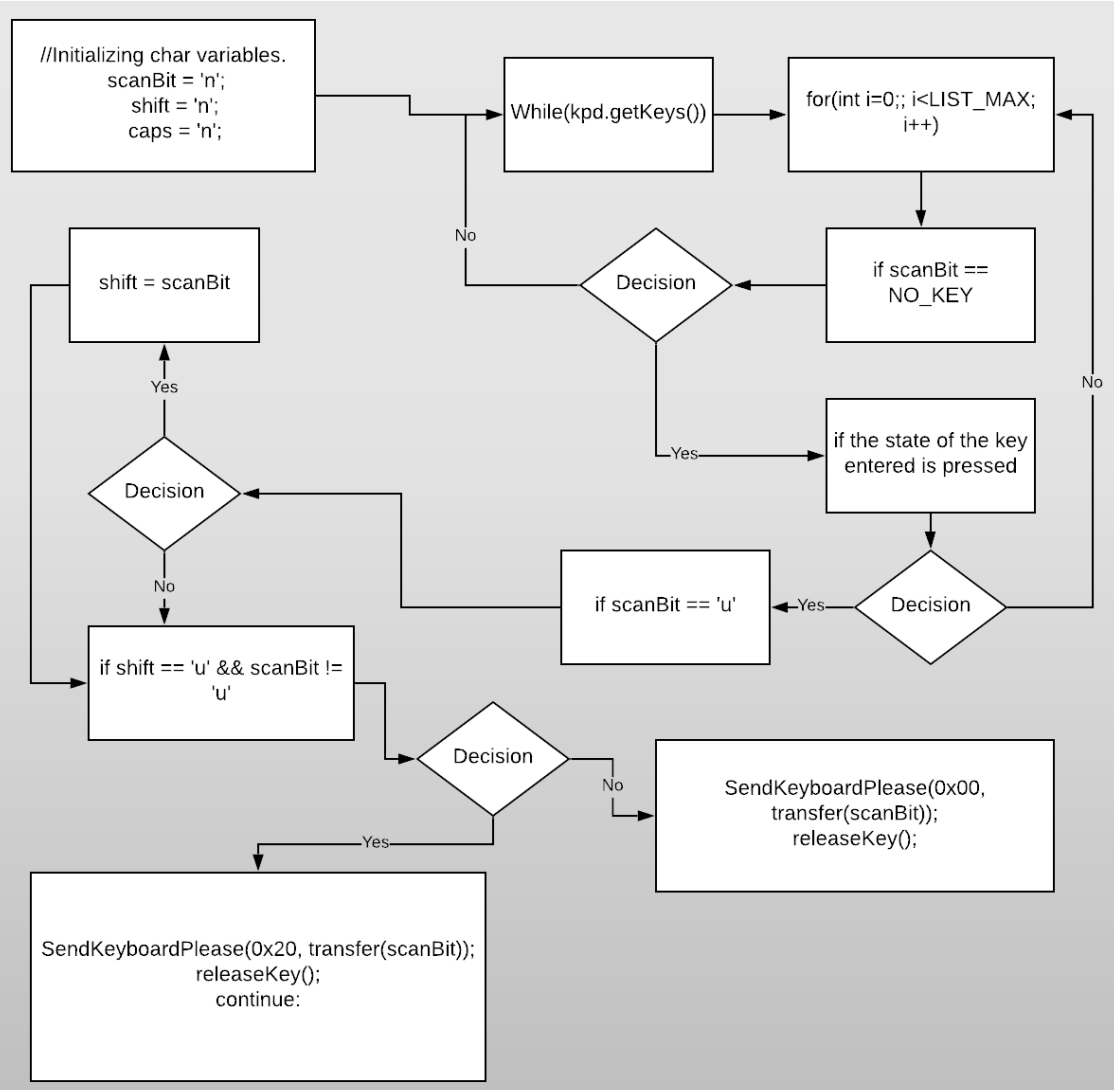
```
const byte ROWS = 8; // Four rows
const byte COLS = 16; // Three columns
// Define the Keymap
char keys[ROWS][COLS] = {
  {'M','e','u','a','n','/','X','n','C','.','V','n',',','c','`','n'},
  {'Y','2','n','n','w','_','!','t','$','f','T','(','r','n','n','n'},
  {'H','+','n','n','9','-','@','y','#','g','G','8','&','n','n','o'},
  {'6','3','n','n','7','0','d','?','k',')','5','n','%','n','=','n'},
  {'7','.','n','n','*','P','2','1','3','9','4','n','8','n','|','4'},
  {'U','1','n','n','/','[','W','Q','E','O','R','m','I','n',']','5'},
  {'J','n','n','n','j',';','S','A','D','L','F','<','K','n','n','6'},
  {'N','-','u','a','n','^','Z','0','s','v','B','n','i','c','e','>'}
};
```

- Attempted to use keyboard.h library, but only works on devices that use the ATmega32u4 processor
- Investigated hoodloader alternative
- Utilized keypad.h to build matrix and send characters to serial monitor

Keyboard Design with Bluetooth

- Wrote conversion function to convert character output to hex code to output via serial port for Bluetooth
- Use serial.write to produce RN42 HID raw report for bluetooth output

0xFE	Length	Modifier	Scan Code 1	Scan Code 2	Scan Code 3	Scan Code 4	Scan Code 5	Scan Code 6



Battery Selection

Laptop Battery	Specifications	Price
Dell 9-Cell Lithium Ion battery pack	11.1V 7800mAh/87Wh	$69.90 - Laptopbatteryexpress
DENAQ 6-Cell New Laptop Battery for HP	11.1V 4400mAh/49Wh	$53.73 - Newegg
Replacement Notebook Battery for Asus G50V	11.1V 4400mAh/49Wh	$19.99 - BattDepot

Requirements:

- 11.1V power supply
- Compatible fit with Asus G50V

Reasons for Selection:

- Price is much cheaper for our type of application
- Compatible Asus G50V laptop shell
- Cheap batteries from BattDepot

Battery Management System (BMS)

Name of BMS	Battery Voltage	Current Rating	Price
3S Balance 18560 Li Ion Battery Protection Board	11.1V to 12.6V	25A	$3.99 - Amazon
2S 18560 Charger BMS Protection Board	7.4V to 8.4V	8A	$2.12 - Amazon
3S Lithium Battery BMS Protection Board	12.6V	20A	$2.10 - Banggood

Requirements:

- 3-Series cells
- Balanced cell charging
- Short circuit protection

Reason for Selection:

- Our battery is 3S2P, so the BMS must be 3S.
- Battery voltage is set to 11.1V
- BMS charges/discharges the battery properly
- Designed charging circuit and purchased BMS

AC Adapter Selection

AC Adapter Name	Specifications	Price
BINZET Power Supply AC Adapter	Input: 120V AC Output: 12V/10A 120W	$19.99 - Amazon
TDK DTM65PW280D	Input: 230V AC Output: 28V/2.32A ~65W	$73.54 - Mouser
XINKAITE Wall Power Supply Adapter	Input: 120V AC Output: 12V/2A 24W	$8.98 - Amazon

Requirements:

- 12V input voltage
- Rated for 4A

Reasons for selection:

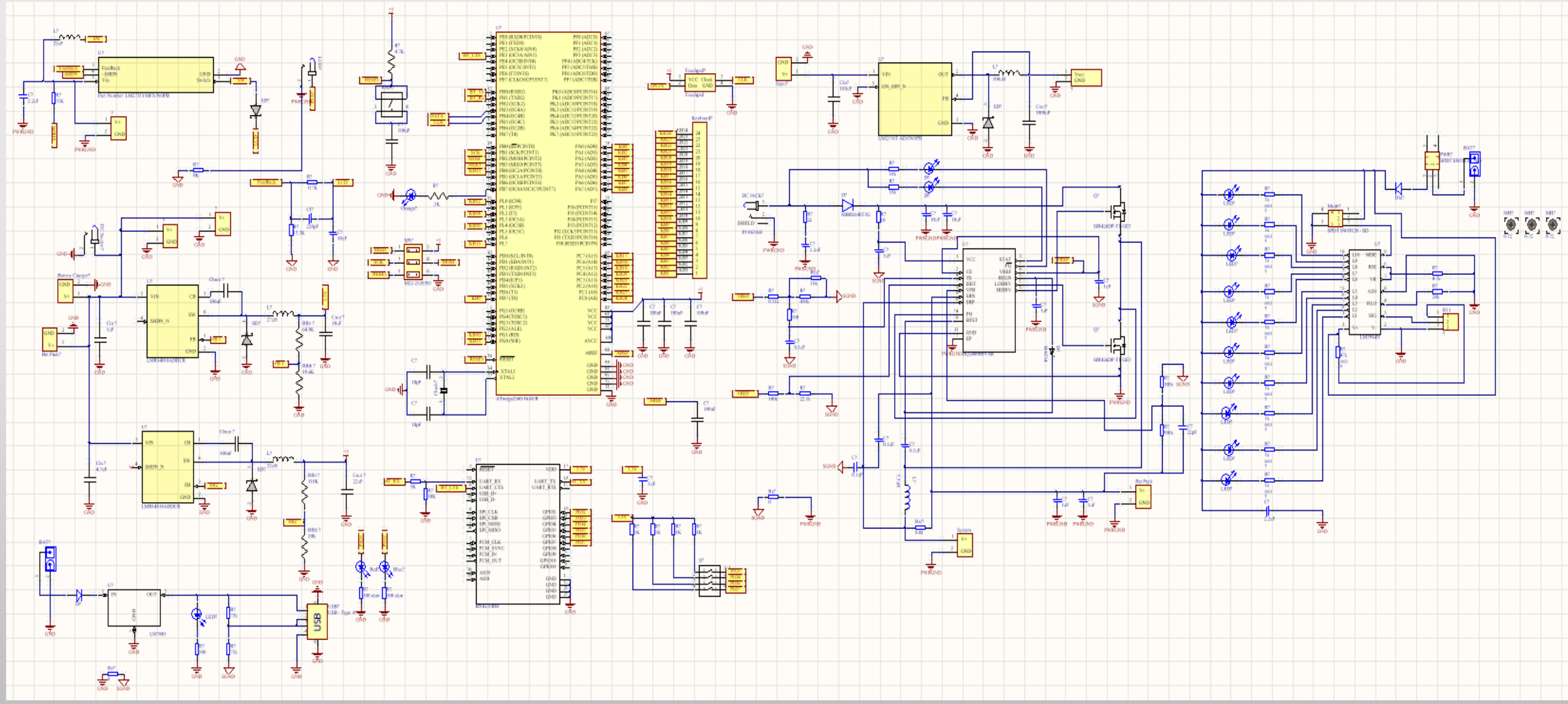
- Price is cheaper than other competitors
- Output voltage/current is within charging IC input threshold

Switching Regulators

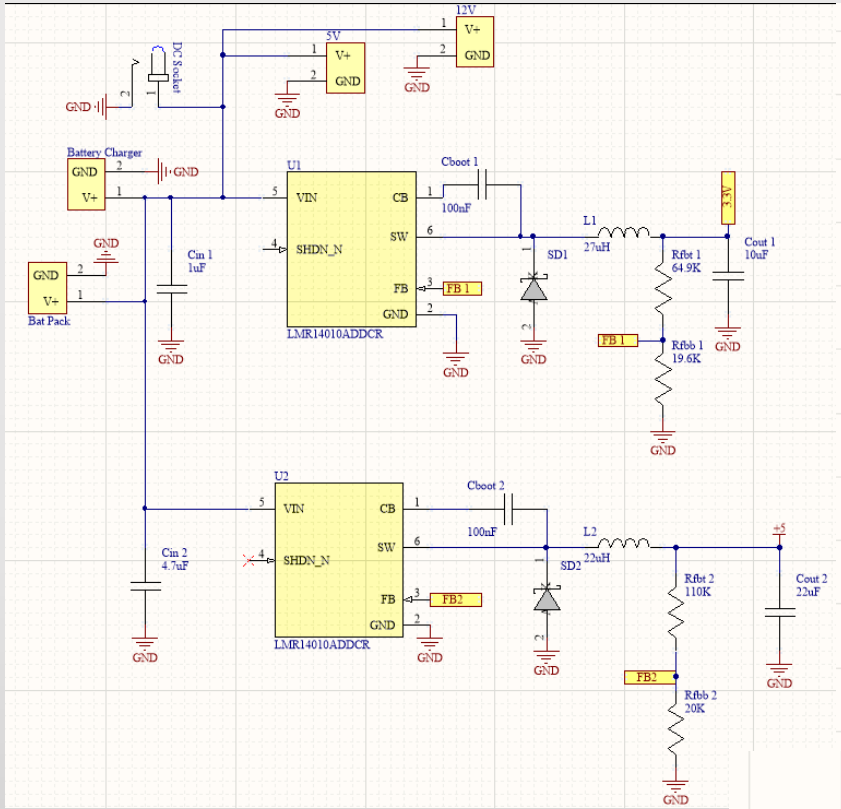
Requirements	LCD	Raspberry Pi 3 Model B	Bluetooth	Microcontroller
Voltage	12V	5V	3.3V	5V
Current Rating	1A	2.5A	30mA	250mA

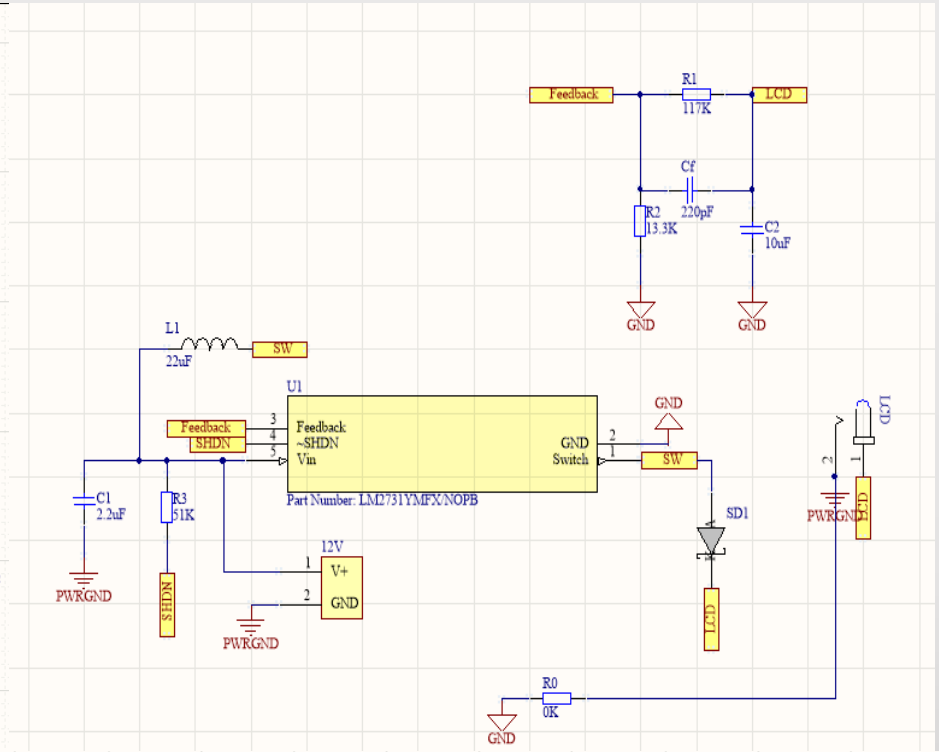
	LM2731	LM2576T-5.0	LMR14010A	TPS54302
Type	Step-Up	Buck	Buck	Buck
Input Voltage	2.7 - 14V	4 - 40V	4 - 40 V	4.5 - 28V
Output Desired	12V (ADJ)	5V	3.3V and 5V	5V (ADJ)
Max Current	1.8A	3A	1A	3A
Components	9	6	7	12
Price (Arrow)	$1.94	$2.03	$2.76	$2.17

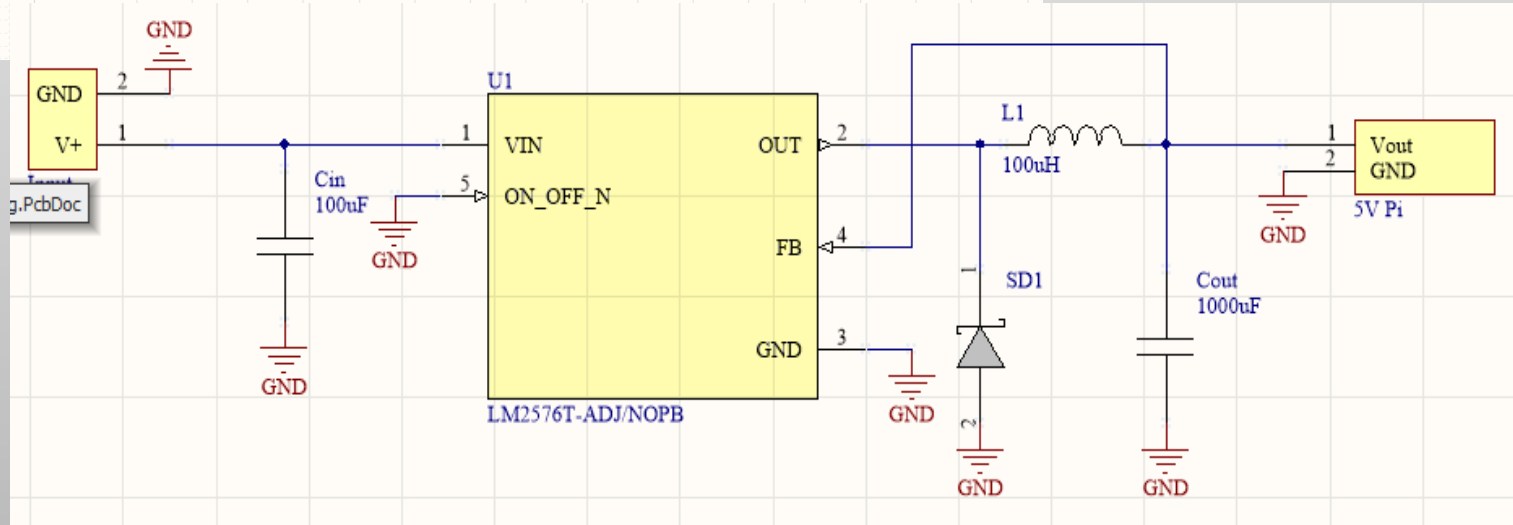
Overall Schematic



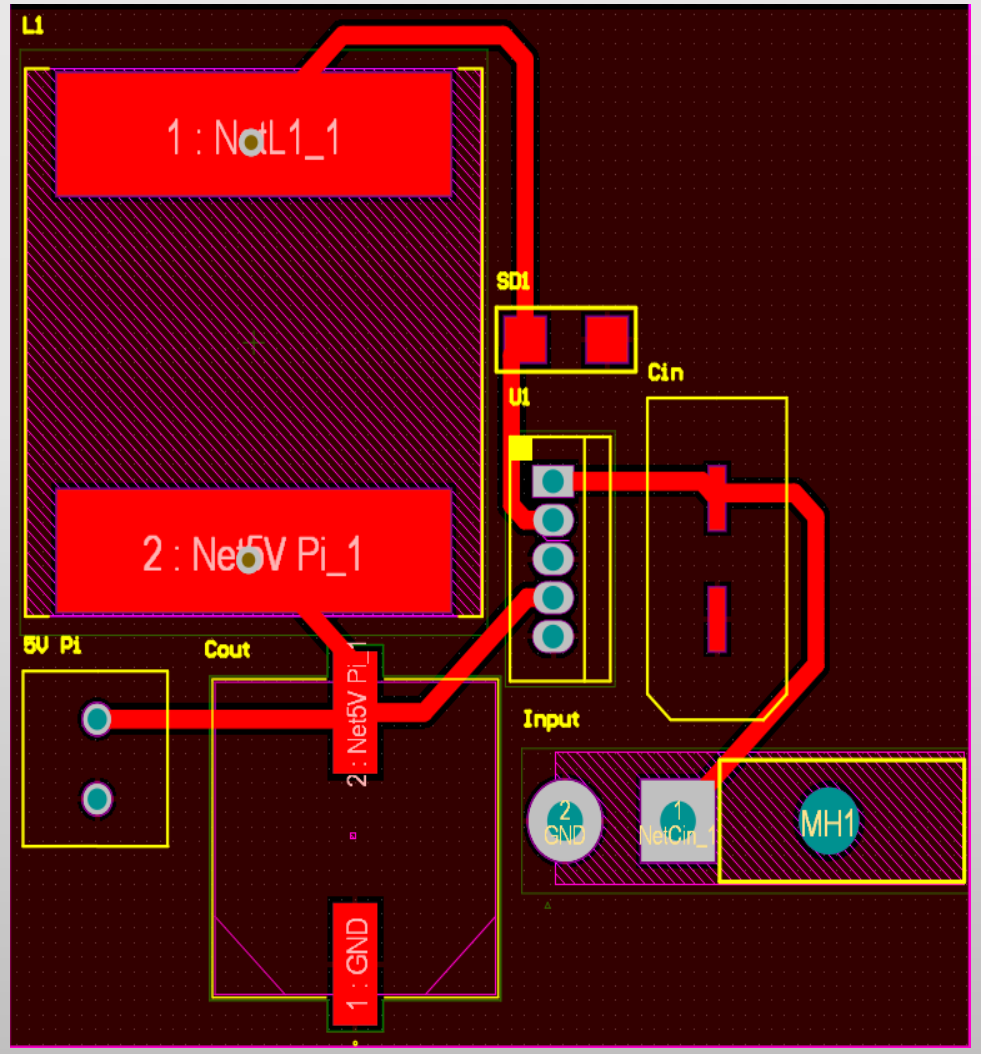
Supply to Bluetooth, Microcontroller, and Pi

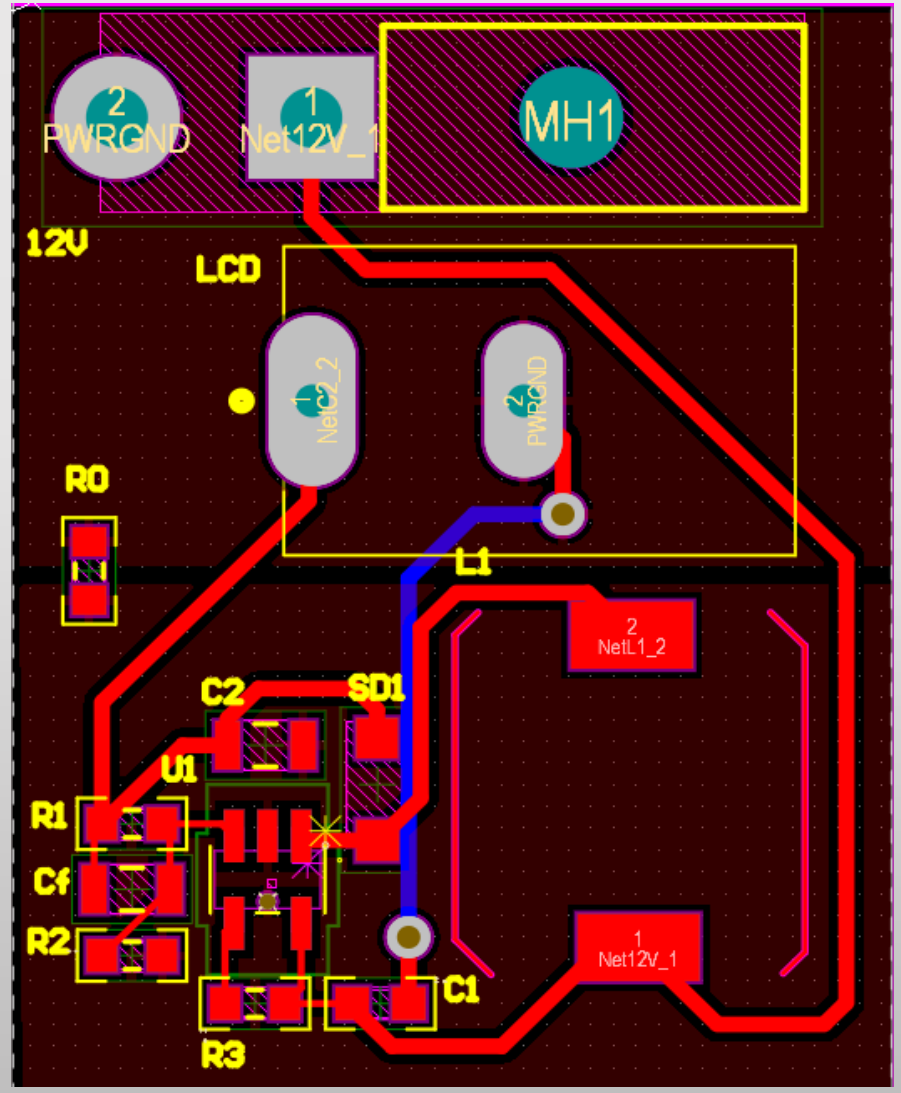




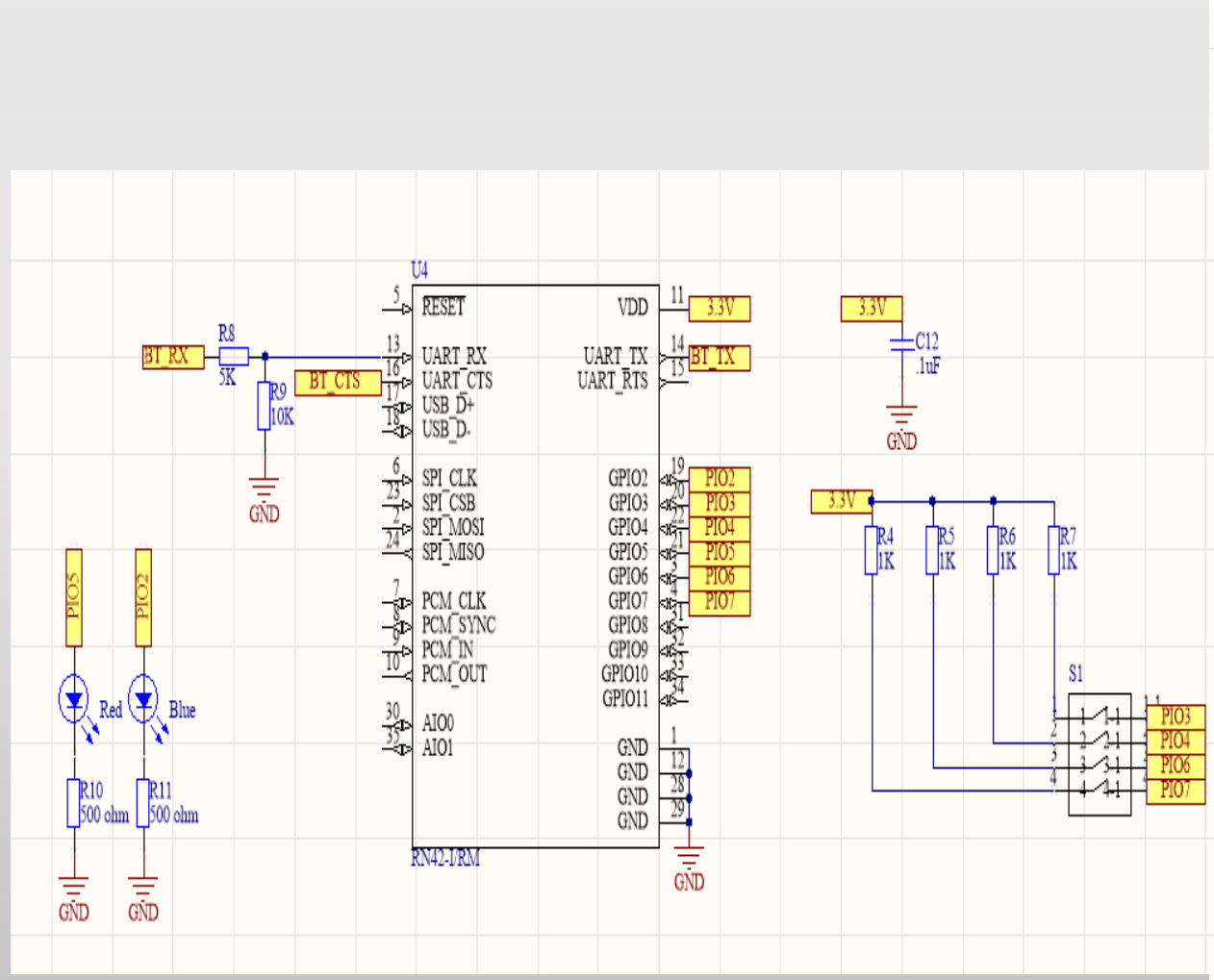


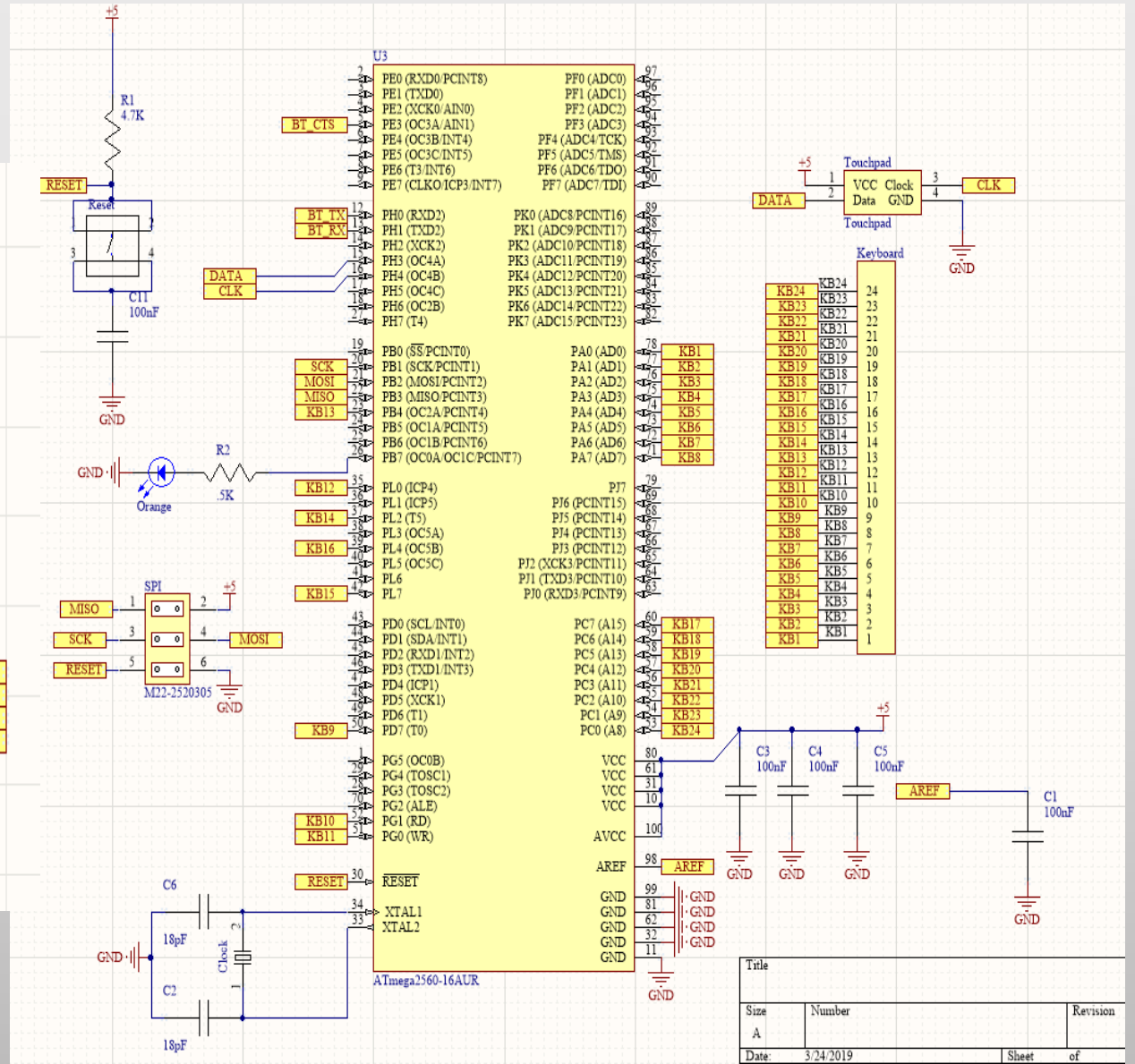
Raspberry Pi and LCD Regulator



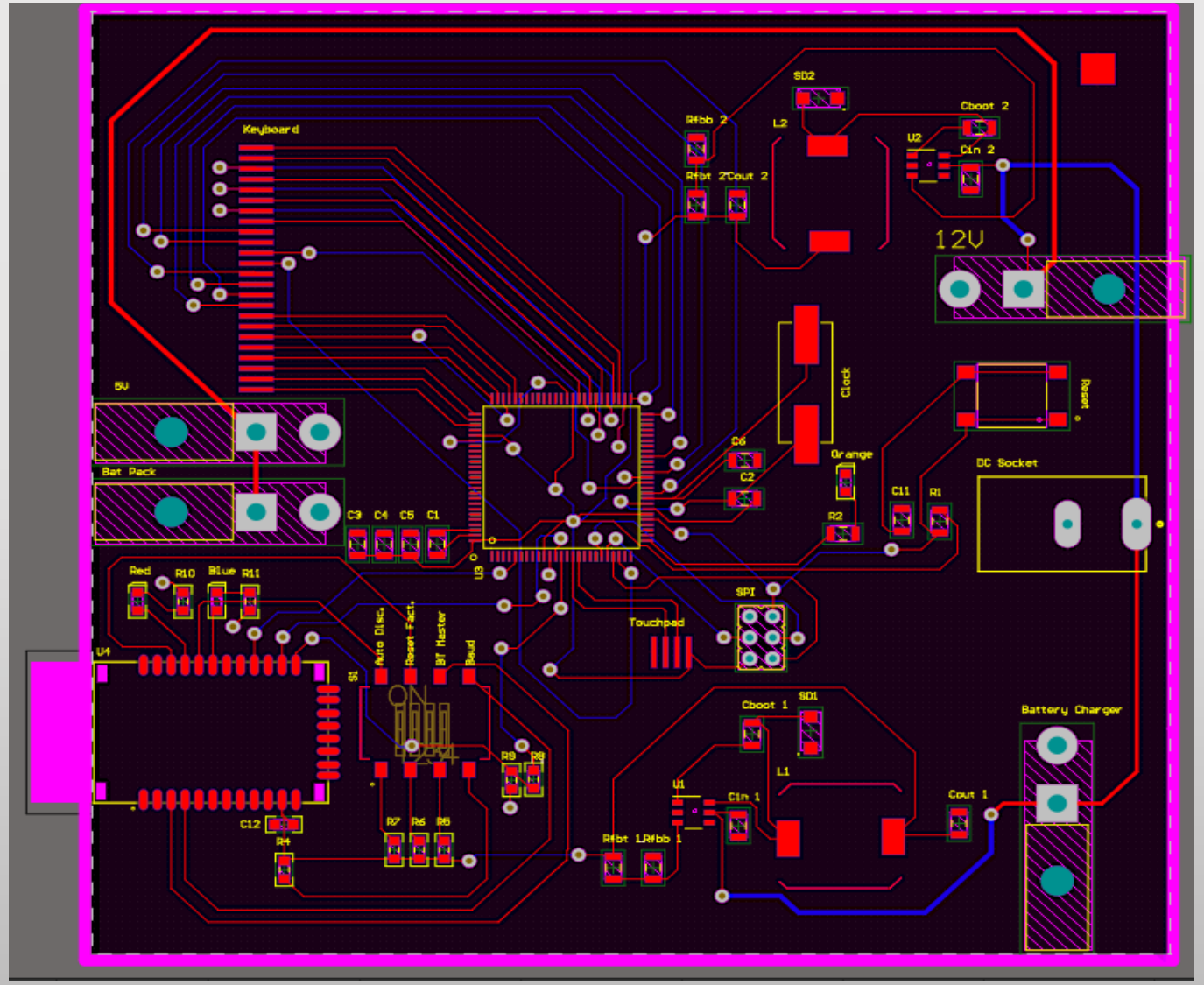


Microcontroller Schematic





Main PCB


Keyboard
SD2
Rfbb 2
L2
Cboot 2
U2
Cin 2
Rfbt 2
Cout 2
12V
5V
Bat Pack
C9 C4 C5 C1
C6
C2
Clock
Reset
Orange
R2
C11
R1
DC Socket
U3
Red
R10
Blue
R11
SPI
Touchpad
U4
S1
Auto Disc.
Reset Fact.
BT Master
Baud
R9
R8
C12
R4
R7
R6
R5
Rfbt 1
Rfbb 1
U1
Cin 1
L1
SD1
Cboot 1
Cout 1
Battery Charger

Charging Circuit: Chip Selection

Charging IC Name	Specifications/Ratings	Price
BQ24171	Input Voltage: 4.5V - 17V Output: 13.5 V/ 0.6A - 3A	$3.61 - TI
BQ24600	Input Voltage: 5V - 28V Output: 21V/ 10A	$4.15 – Arrow
BQ25883	Input Voltage: 3.9V – 6.2V Output: 9.2V/ 2.2A	$5.61 - TI

Requirements:

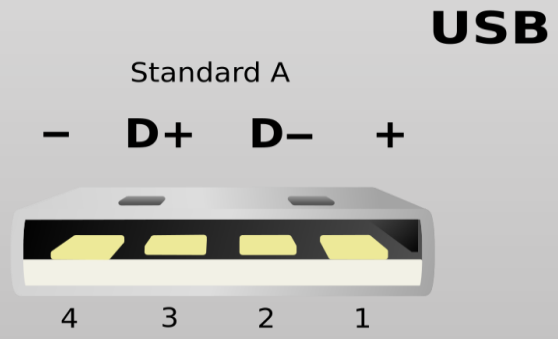
- 12V output voltage
- 3A output charging current

Reasons for selection:

- Higher charging current limit to allow for better efficiency
- Higher voltage ranges for adjustable output

USB Phone Charging

USB Type	Specifications	Price
USB 2.0 Type A Port	Output: 5V/ 2.5A	$0.40 - Arrow
USB 3.0 Type A Port	Output: 5V/ 5.4A	$2.14 - Arrow



<u>Reasons for selection:</u>

- Selected USB 2.0 due to its basic power transferring capabilities
- USB 3.0 offers higher rated current at a higher price.
- USB 3.0 offers much higher data transmission speeds, which is not needed for our application.

USB Phone Charging (cont.)

Name of Regulator	Specifications	Price
LM7805 Linear Voltage Regulator	Input: 7V – 30V Output: 5V/1.5A	$0.78 - Arrow
TLV767	Input: 2.5V – 13.6V Output: 0.8V – 13.6/ 1A	$1.05 - TI
TPS73801-SEP	Input: 2.2V – 20V Output: 1.21V – 20V/ 1A	$2.05

Requirements:

- 5V output
- >500mA charging current
  - *USB 2.0 Standard*

Reason for Selection:

- Broader input voltage range
- Rated for higher output current
- Cheaper than competitors
- Low noise
- Fewer components to set up

Battery Level LED Indication

Name of Chip	Specifications	Price
LM324	Input Supply: -0.3V to 32V	$7.34 - Arrow
LM3914	Input Supply: 1.2V to 12V Output Current: 2 mA to 30mA	$9.64 - Mouser
LM108	Input Supply: 15V to 20V	$2.24

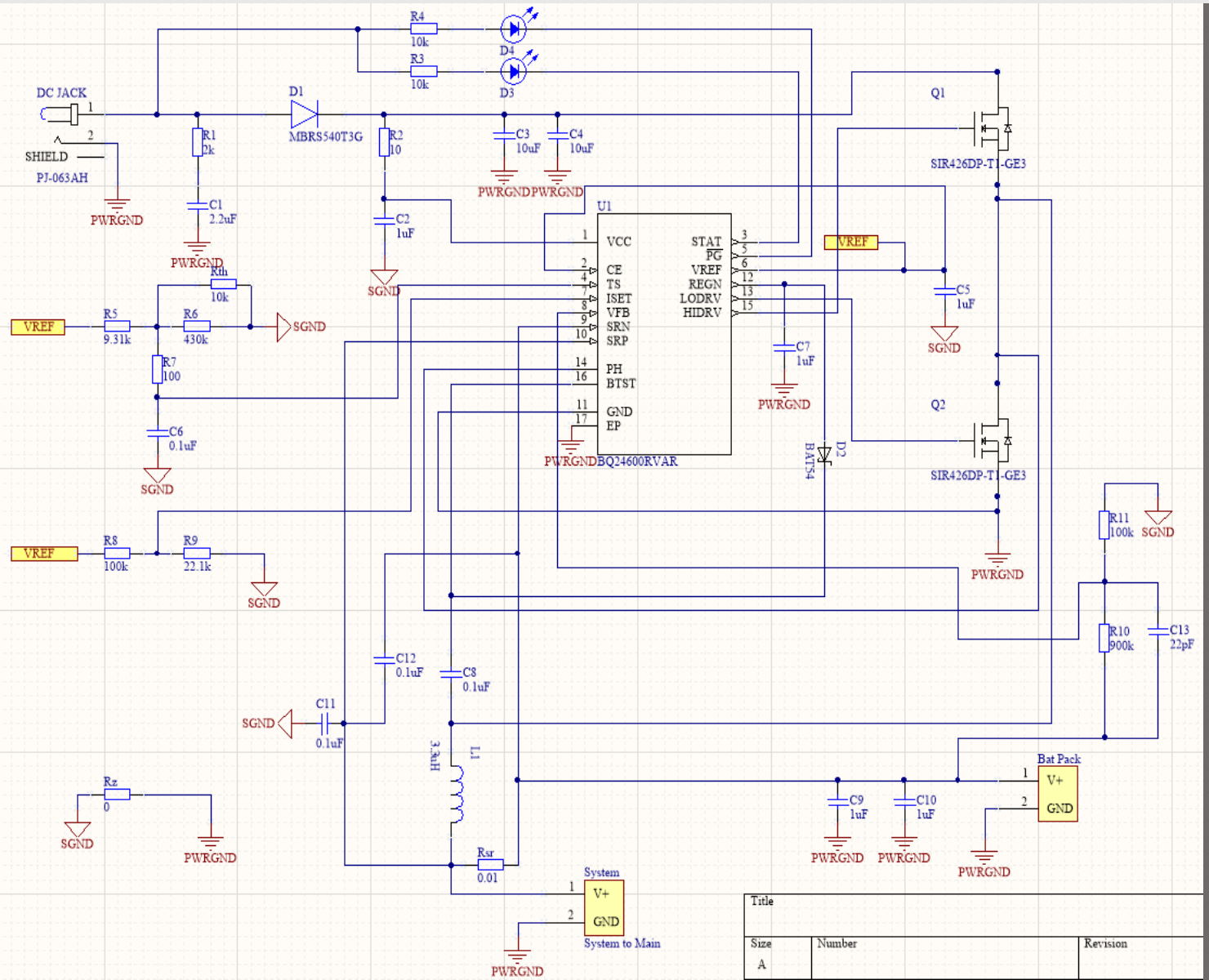
Requirements:

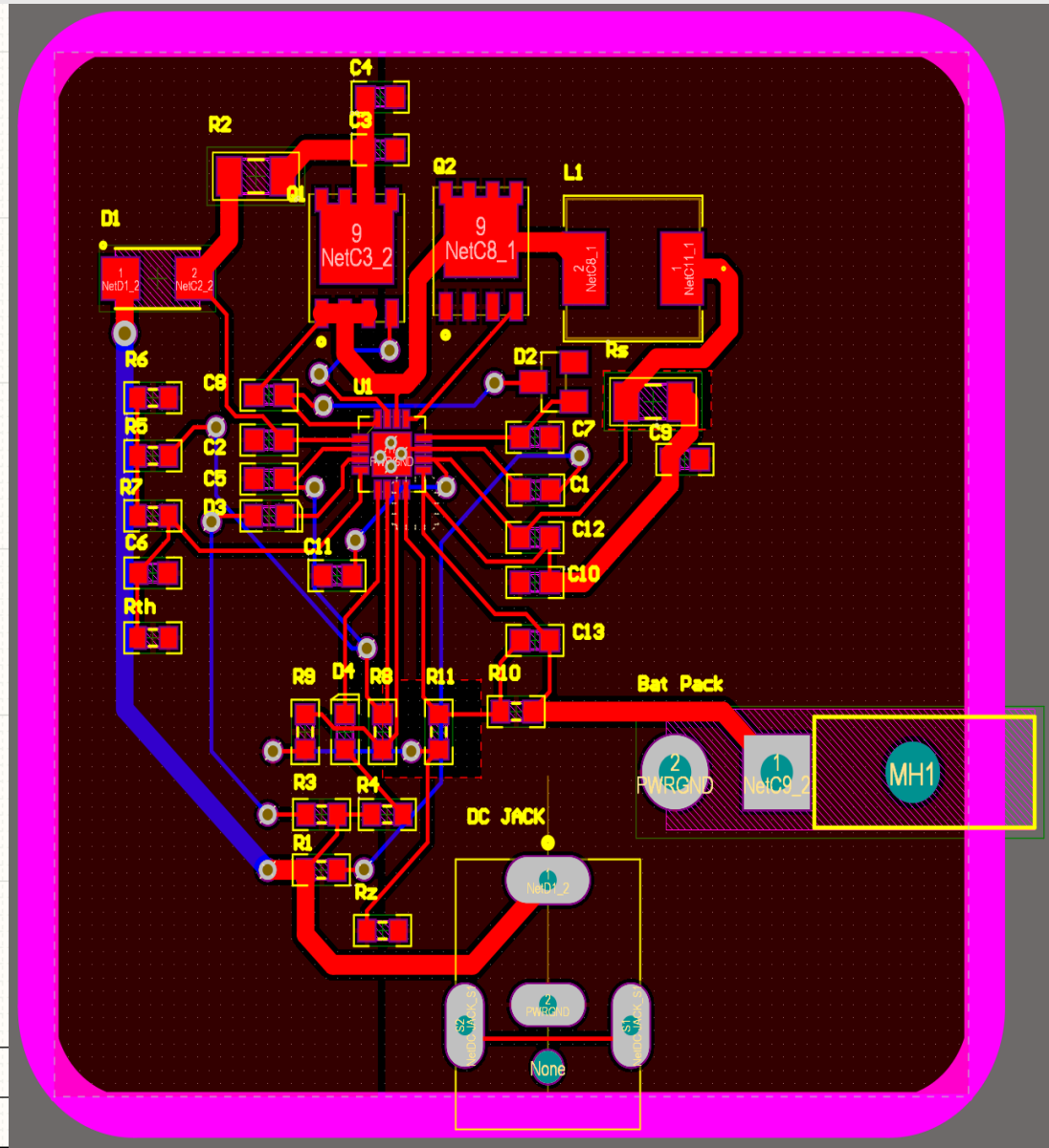
- Drive a minimum of 10 LEDs
- Measures 0V-11.1V from battery

Reasons for chip selection:

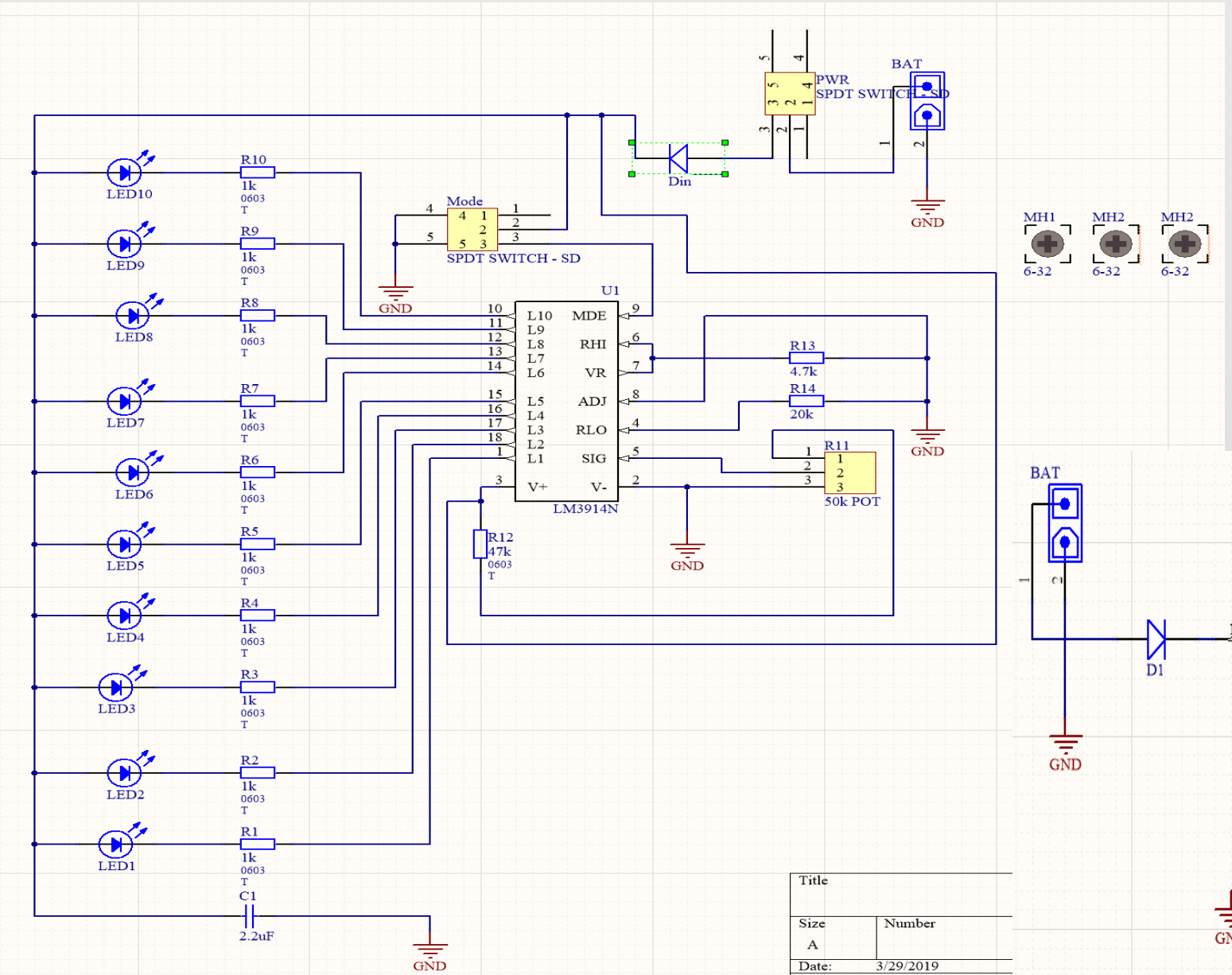
- Low programmable output current
- Can easily be configured with a potentiometer
- More expensive, but meets our exact battery capacity

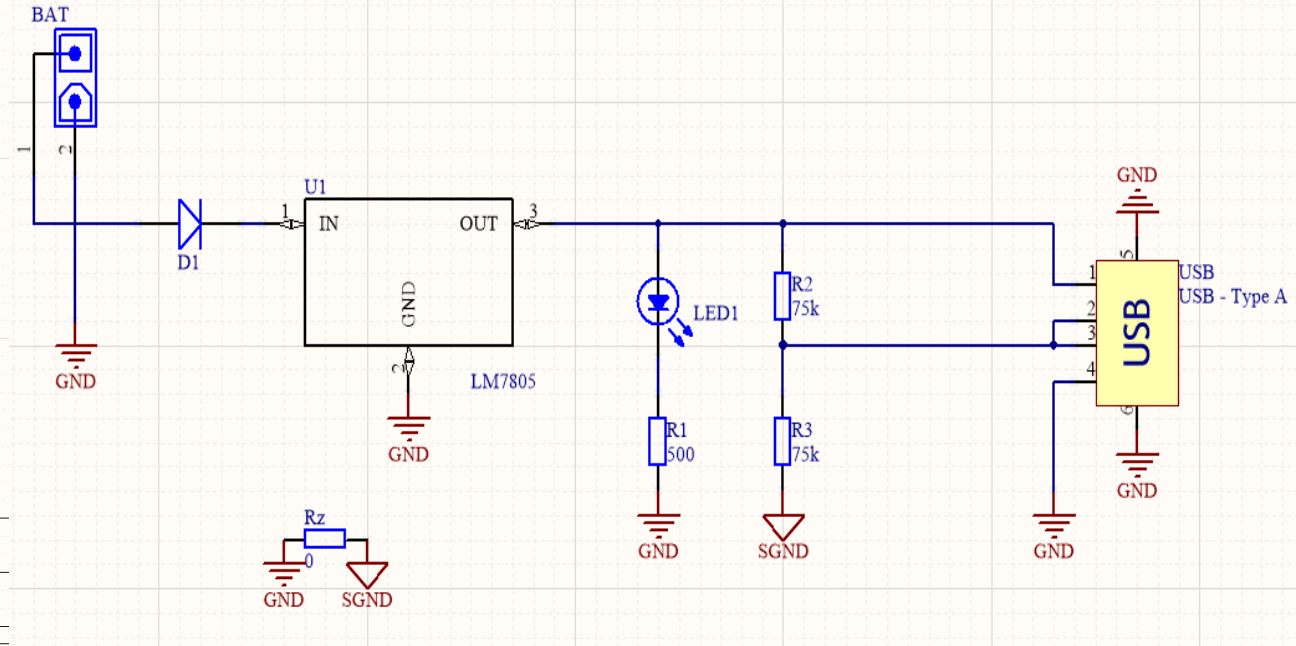
Charging Circuit Schematic & PCB Layout





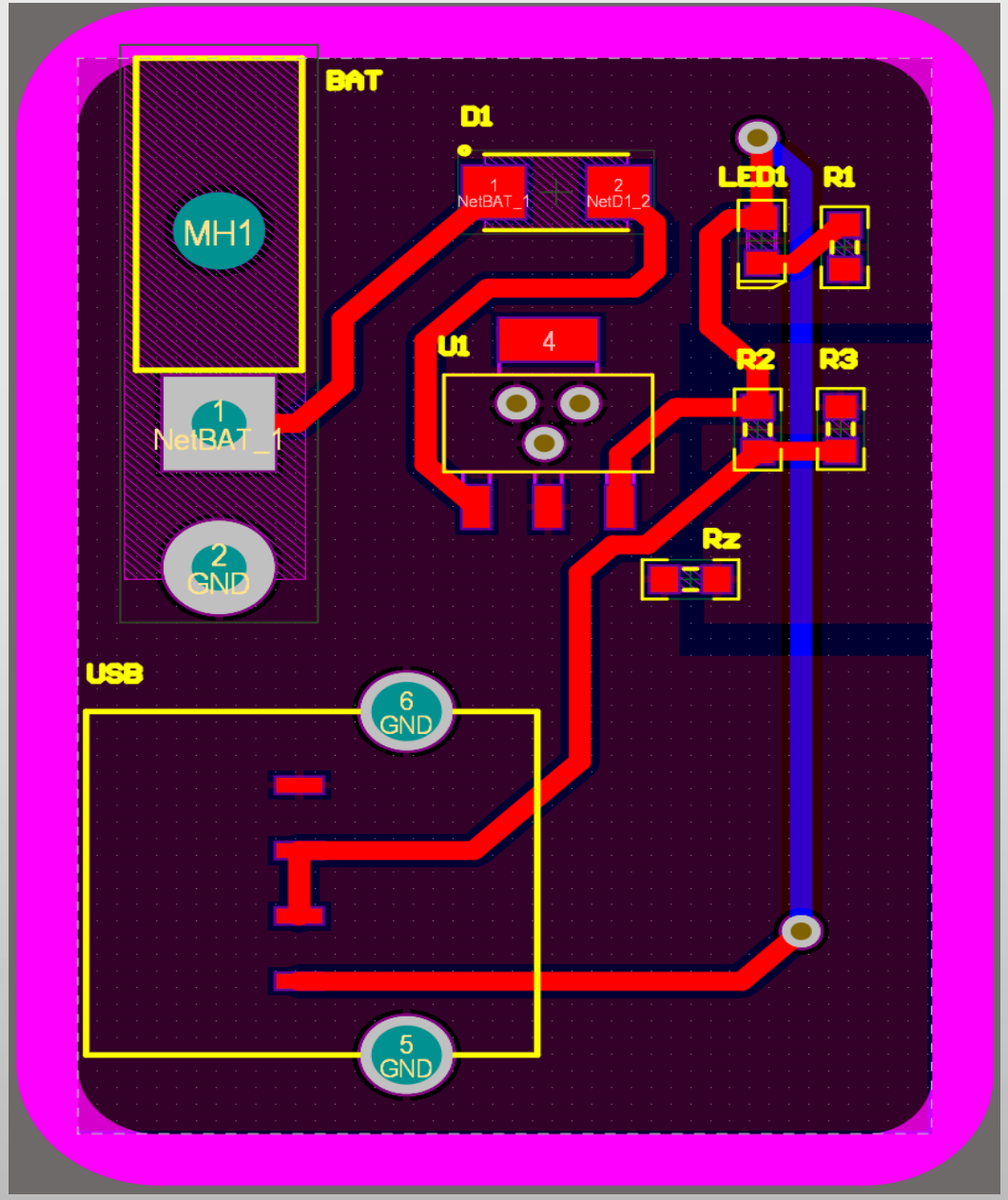
Battery LED Indicator & USB Phone Charging Schematic

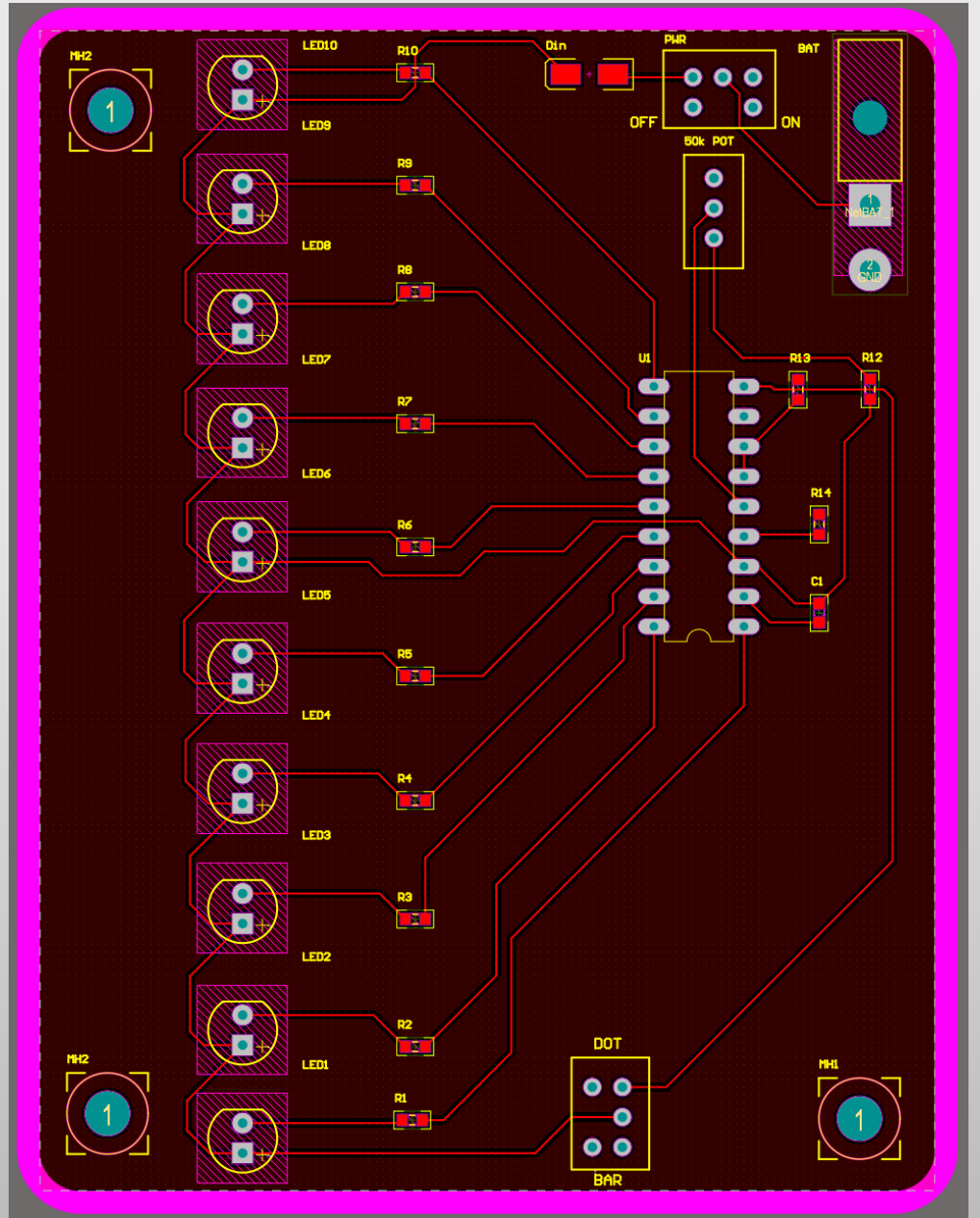




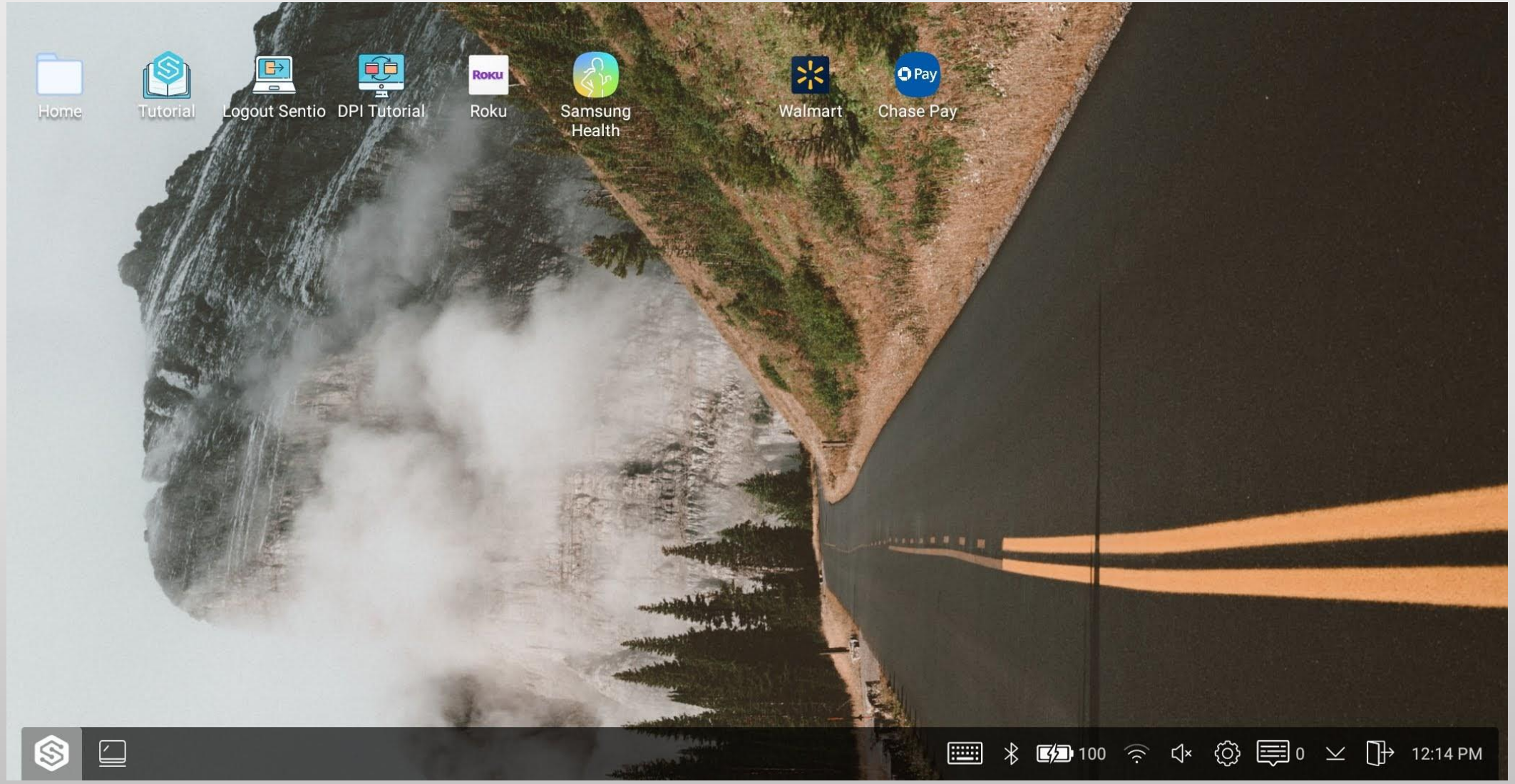
Title	
Size A	Number
Date:	3/29/2019

USB Phone Charging & Battery LED Indicator PCB



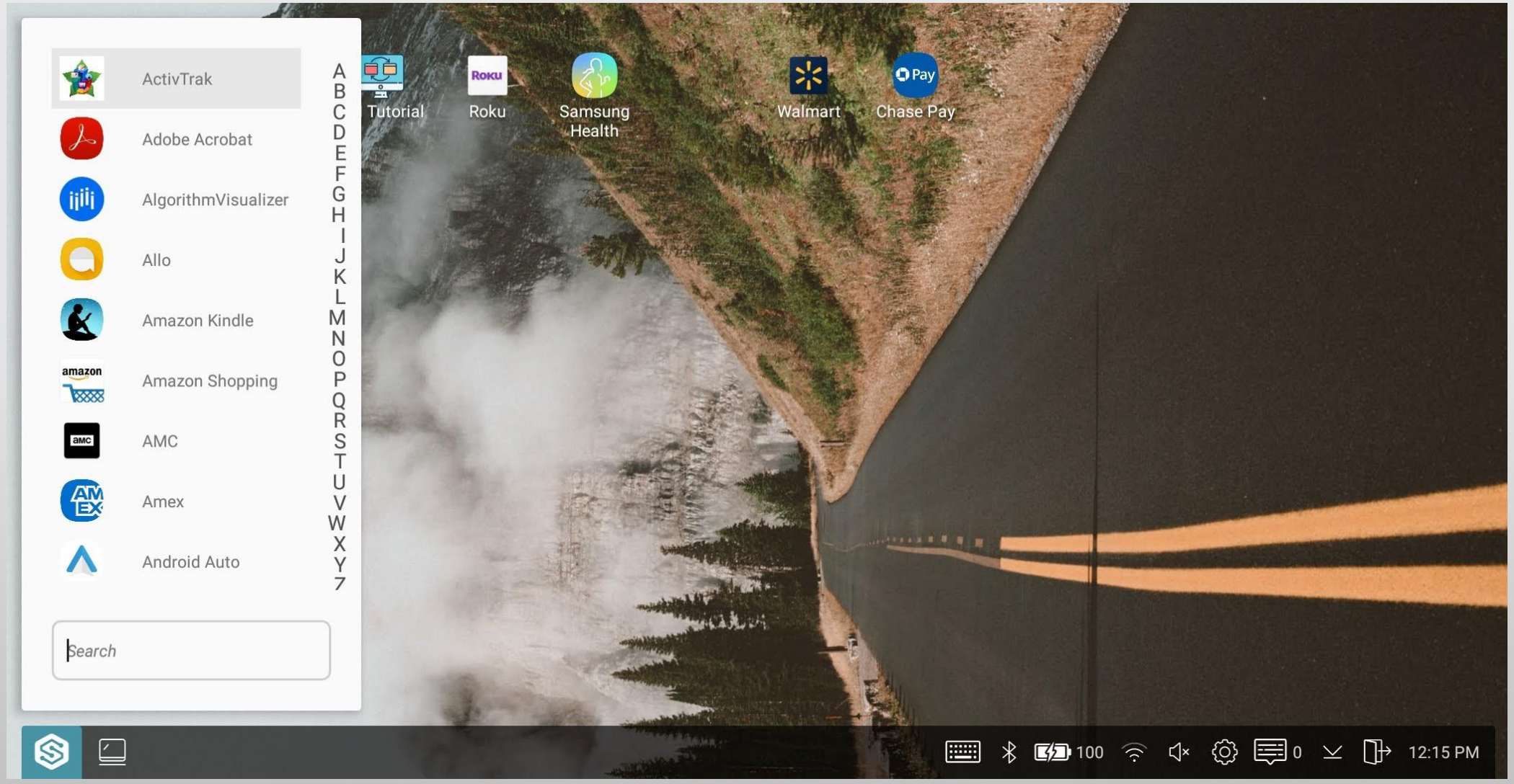


Android Application (Sentio Desktop)



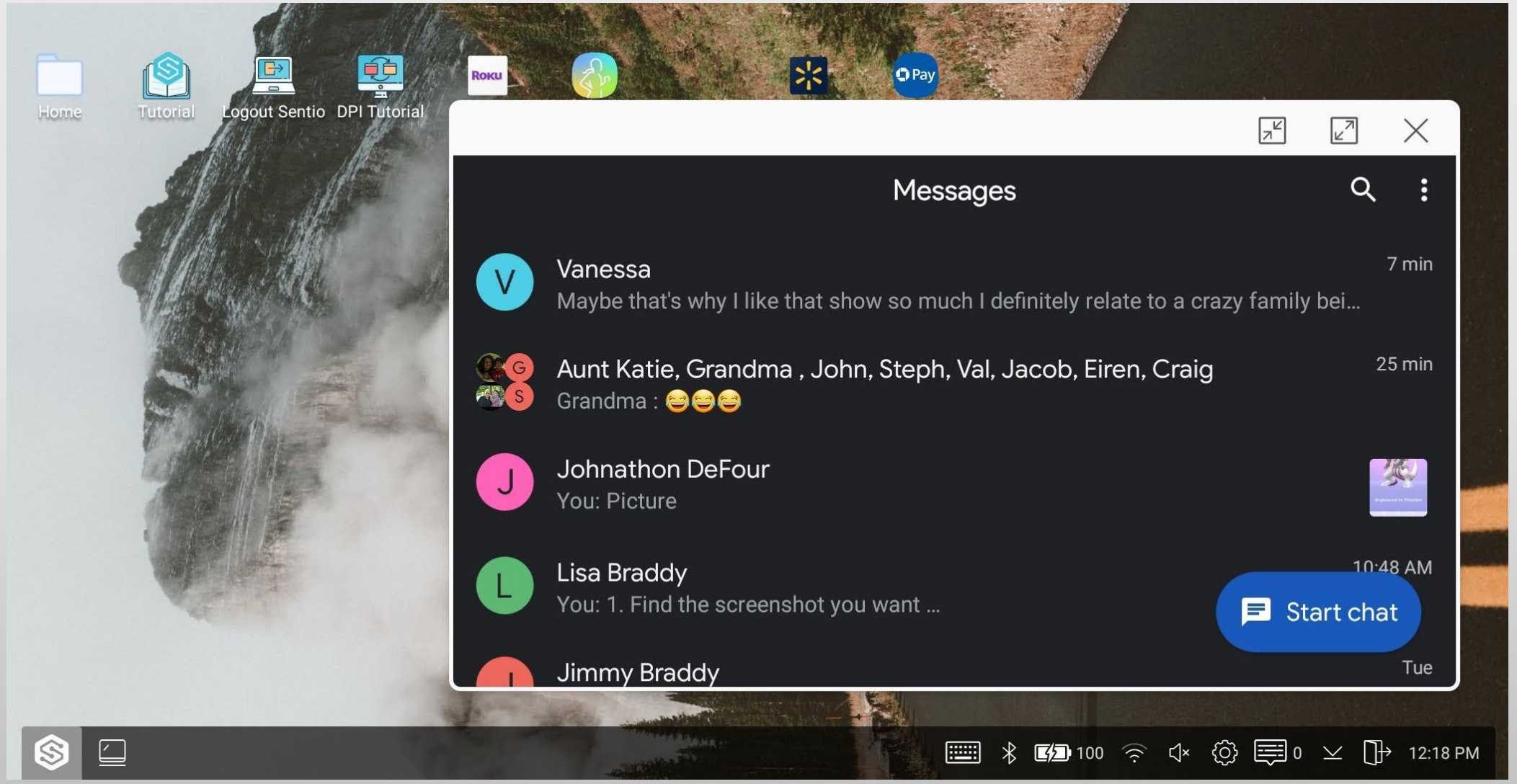
Main computer screen on android

Android Application Cont’d



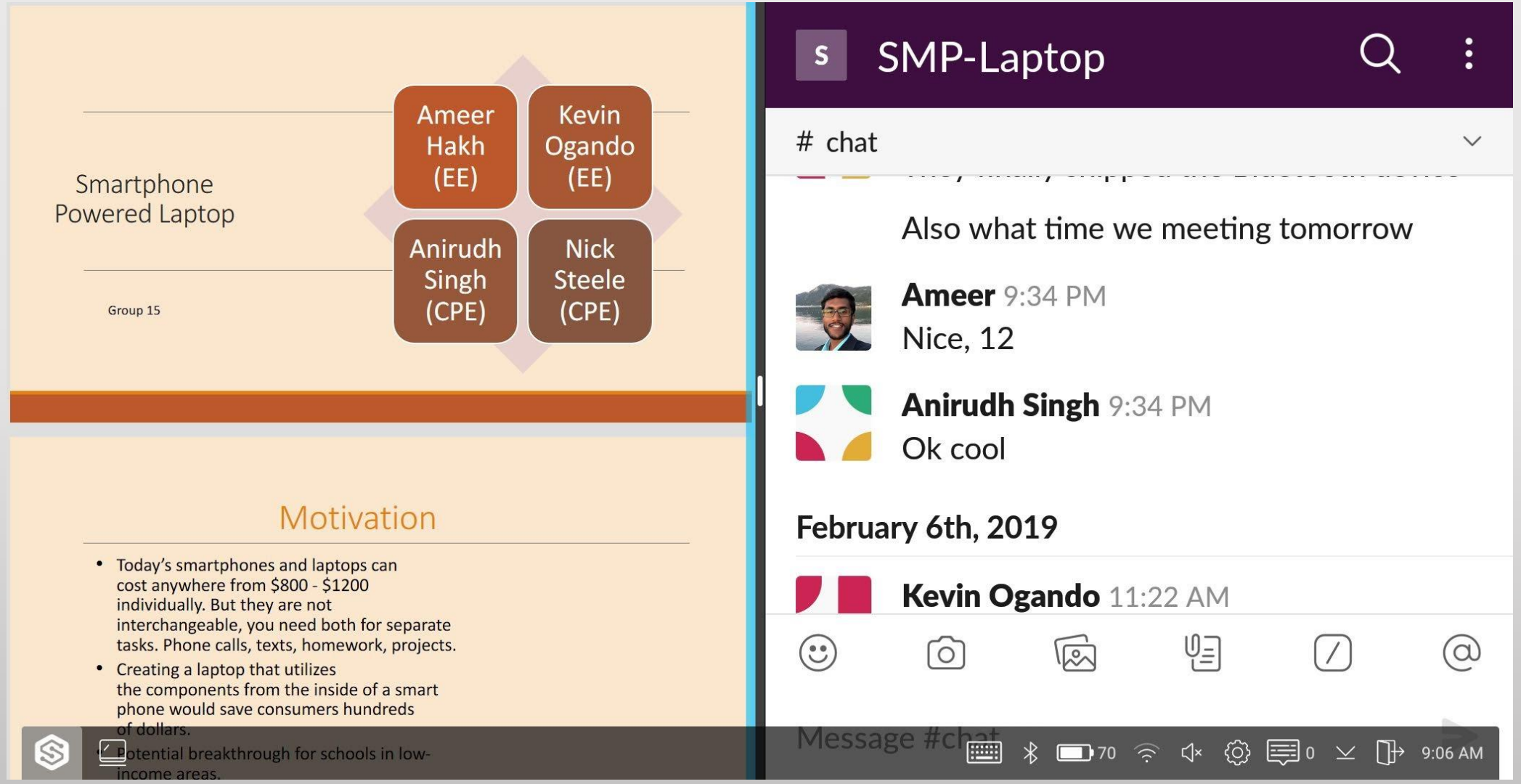
When windows button is hit

Android Application Cont’d



Stray window on screen with minimize, maximize, and close options

Android Application Cont'd



Two applications split side by side

Administrative Content

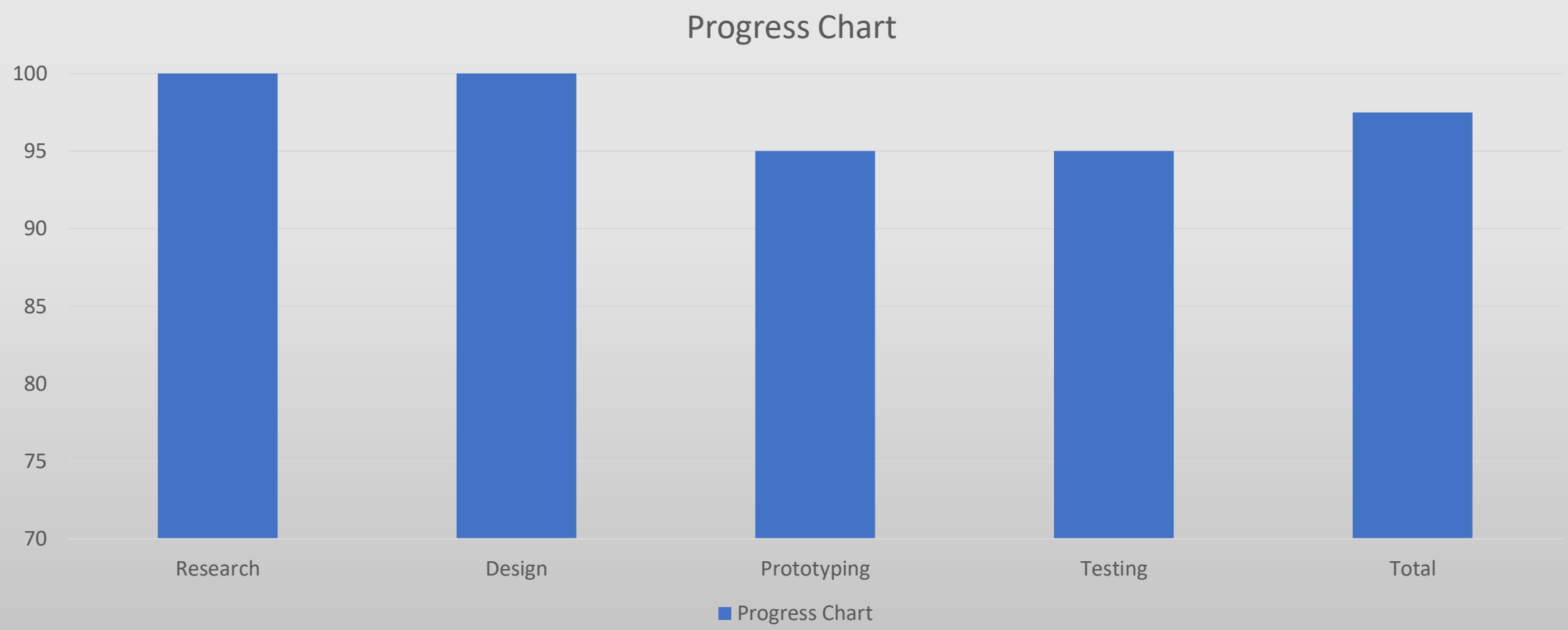
Work Distribution

	Power	PCB Design	Wi-Fi Direct	Bluetooth	Touchpad	Keyboard
Ameer	Secondary	Primary		Primary	Primary	Secondary
Kevin	Primary	Secondary			Secondary	
Anirudh			Primary	Secondary		Secondary
Nick			Secondary	Secondary		Primary

Budget and Financing

.	Part Number	Unit Cost	Quantity	Total Cost
Processor	ATmega2560	$12.21	3	$36.63
	Rasperry Pi 3	$35.00	1	$35.00
	Atmega Breakout Board	$84.95	1	$84.95
BT Module	RN-42 HID	$14.38	2	$28.76
				$0.00
Battery				$0.00
	Charging IC - BQ24600	$4.15	1	$4.15
	Battery Management System 3s	$4.99	1	$4.99
Touchpad	TM-00309-004	$10.00	1	$10.00
				$0.00
Keyboard Program Module	Teensy 3.2	$23.00	1	$23.00
Keyboard	N/A	$0.00	1	$0.00
LCD	LCD Inverter Board	$35	1	$35.00
	LCD Screen	$0	1	$0.00
Connectors	24-Pin FPC 1mm	$4.99	1	$4.99
	24-Pin FPC Breakout Board	$5.11	1	$5.11
	DC Barel Jack	$0.58	3	$1.74
	Molex RA POS	$1.44	3	$4.32
	6-Pin Female and Male Connector	$6.23	1	$6.23
Design	PCB JLCPCB - Voltage Reg. and Main PCB	$29.43	1	$29.43
	PCB JLCPCB - Battery LED and USB Charging			$0.00
	PCB JLCPCB - Battery Charging	$31.11	1	$31.11
Voltage Regulator	LMR14010A	$2.59	6	$15.54
	LM2731	$1.94	2	$3.88
	LM2576T - 5.0	$2.03	2	$4.06
				$0.00
				$0.00
Tools	Breadboard and Wires	$9.00	1	$9.00
				$377.89

Project Progress



Questions?