Electronic Flip Sign

Group 16

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MOTIVATION

We were commissioned by Professor Young to make an LED sign that is lightweight and portable. This is to be used in a few different occasions such as:

- Sporting events
- Professional work: Uber name signs, Tour guides, Directing traffic

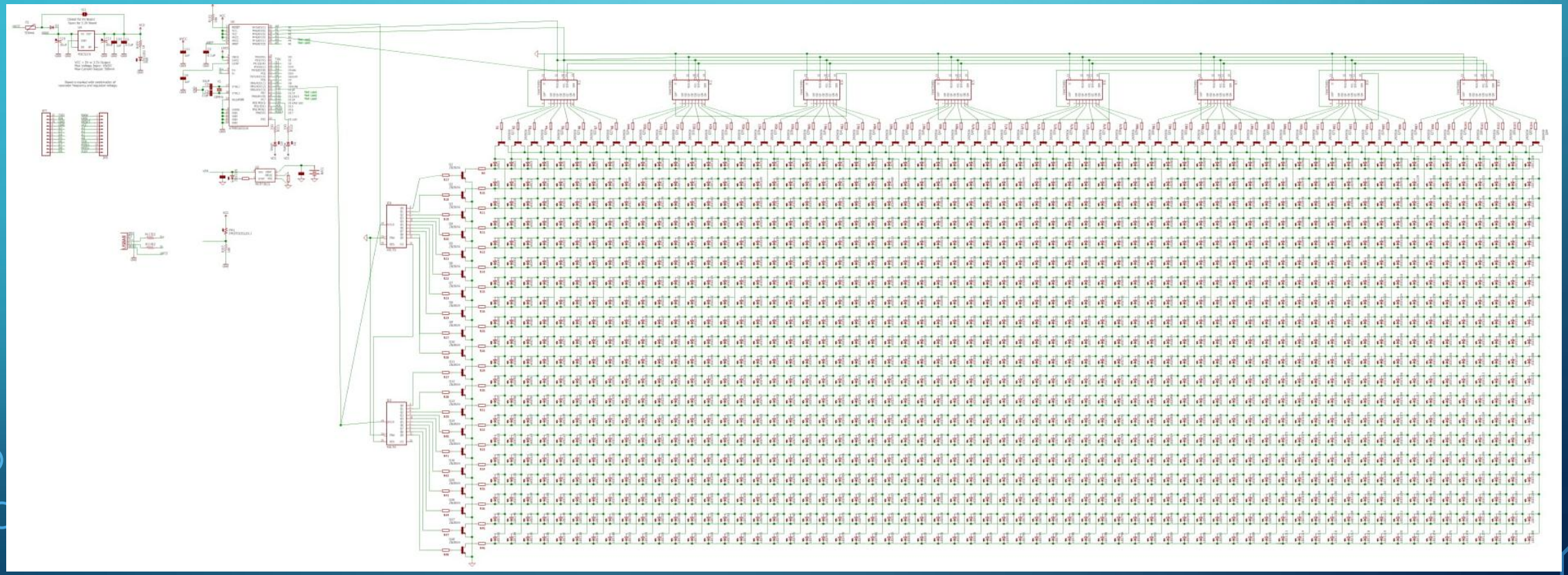
GOALS AND SPECIFICATIONS

Battery Life:	15 min on time
Weight:	Approximately 8 ounces
Connectivity:	Bluetooth and USB
Visibility:	Readable 35 ft. away
Production cost:	$40 (cost per unit at 1000 units)

Characters:	Capital letters and !, @, #, $, as well as a select few emoji's
Scrolling:	Text will scroll across device
Multilane:	Text will appear on two lines
Programmable:	Custom messages using PC or phone app

HARDWARE

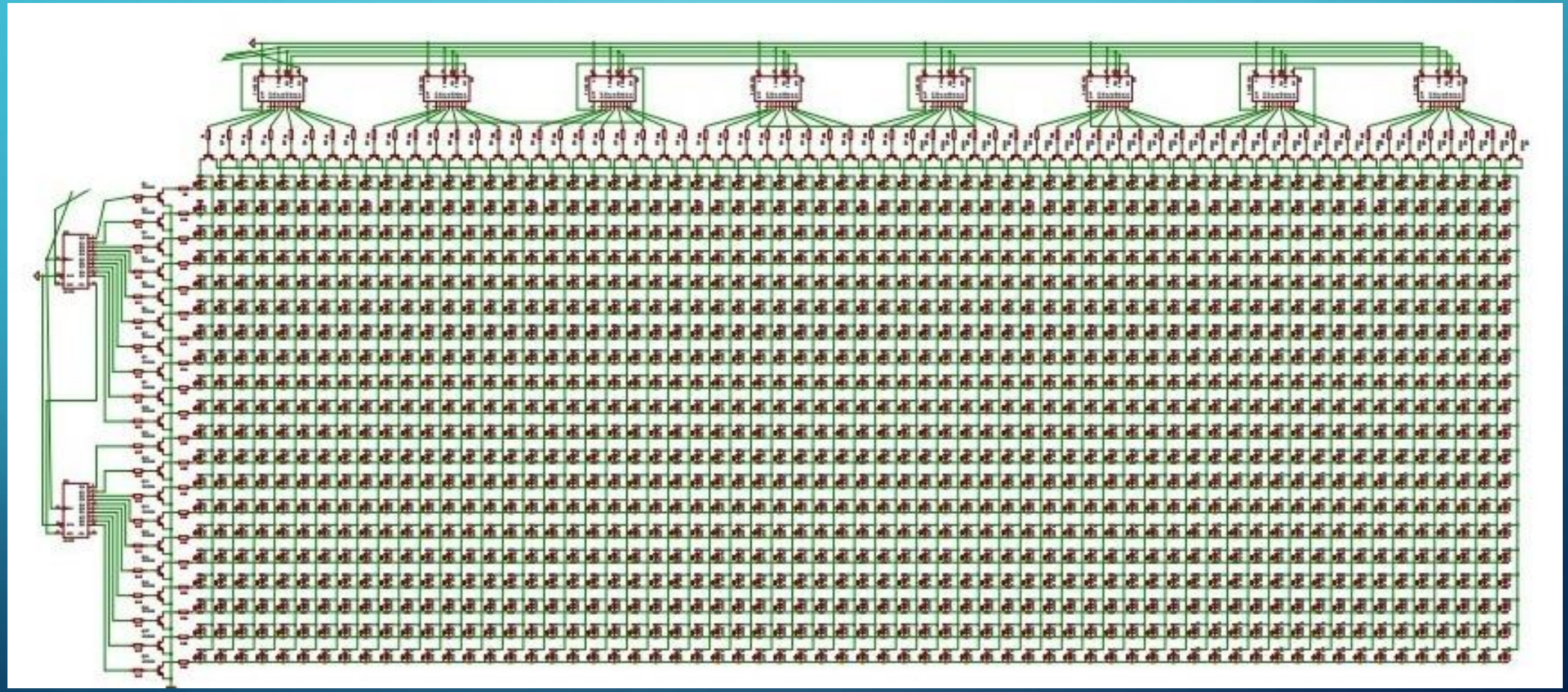
SCHEMATIC



LED DRIVERS

LED Drivers	Price	Type	Advantages	Disadvantages
Max7219	$0.50-$9.88	LED Driver	Self contained	5V and more chips
TLC5940	$2.90	Shift Register		Cost
HT1632C	$3.40	LED Driver	Controls more	5V and cost
74HC595	$0.32	Shift Register	Cheap	Needs helping circuits

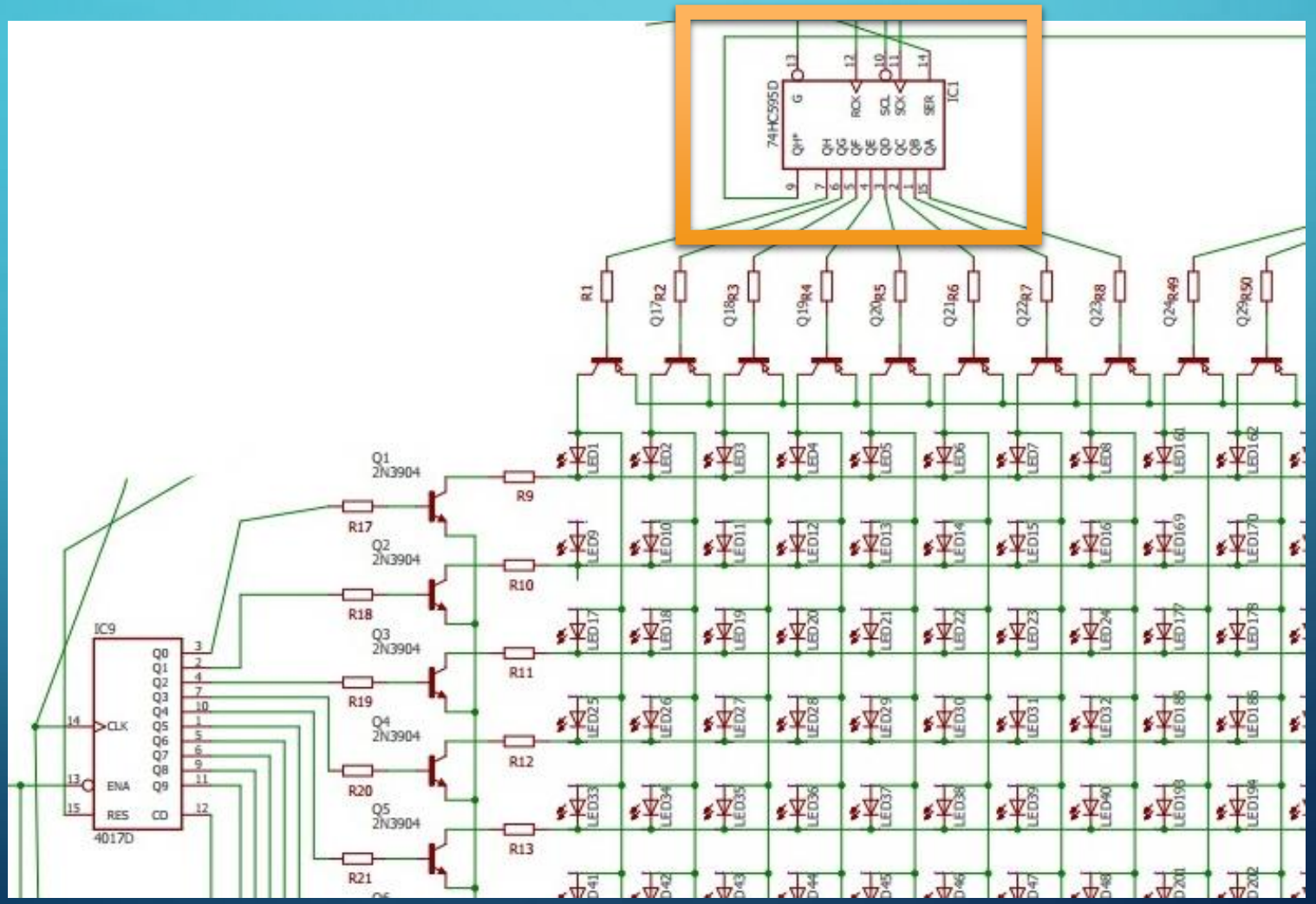
LED DISPLAY SCHEMATIC



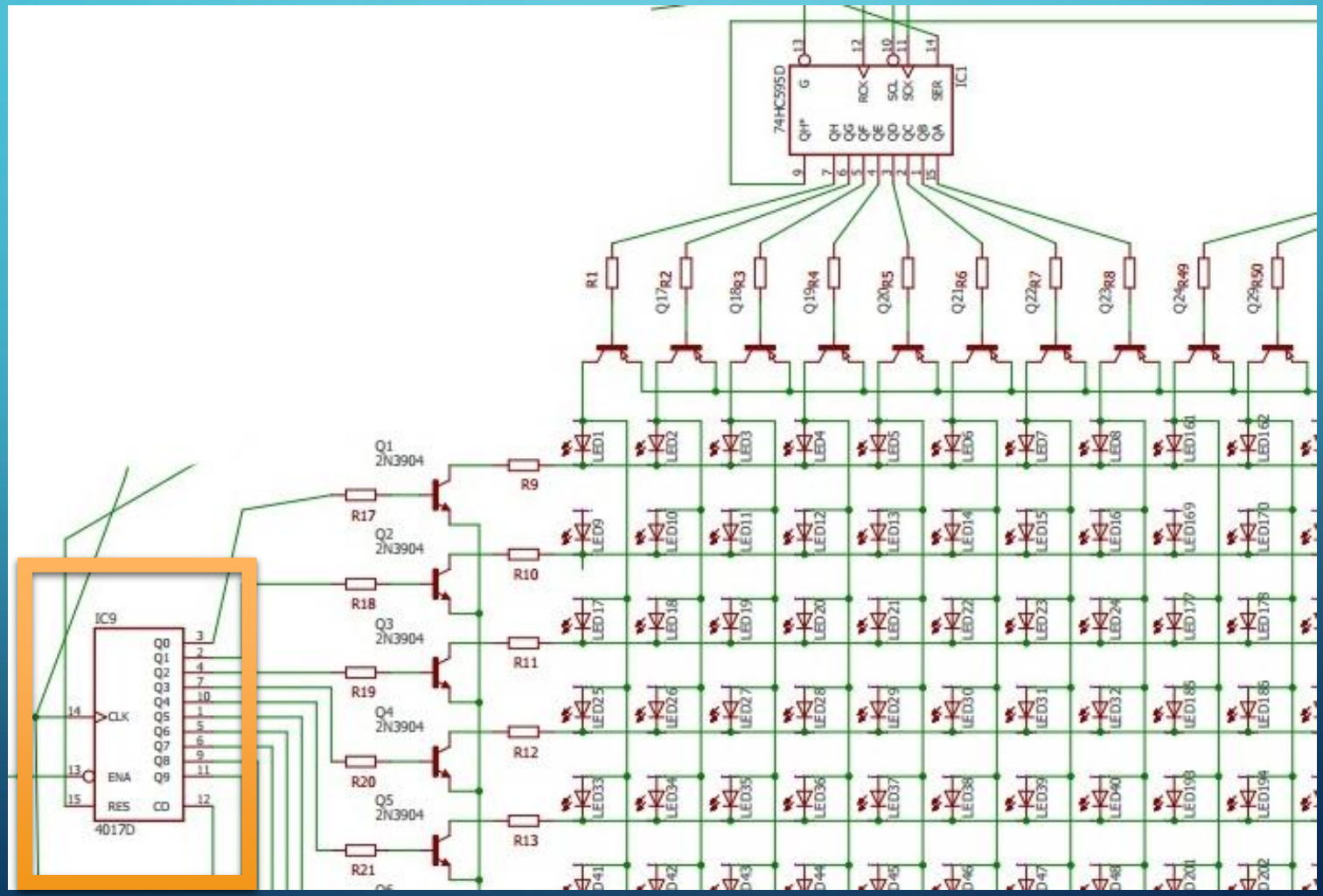
LED MATRIX

- Wired like battleship – positive on the columns and ground on the rows
- Only one row will light up at any given time
- Rows scan down fast to give the impression of a constant display
- Columns will all be on or off to light the pattern of LEDs desired for that current row

SHIFT REGISTER 74HC595



DECADE COUNTER 4017



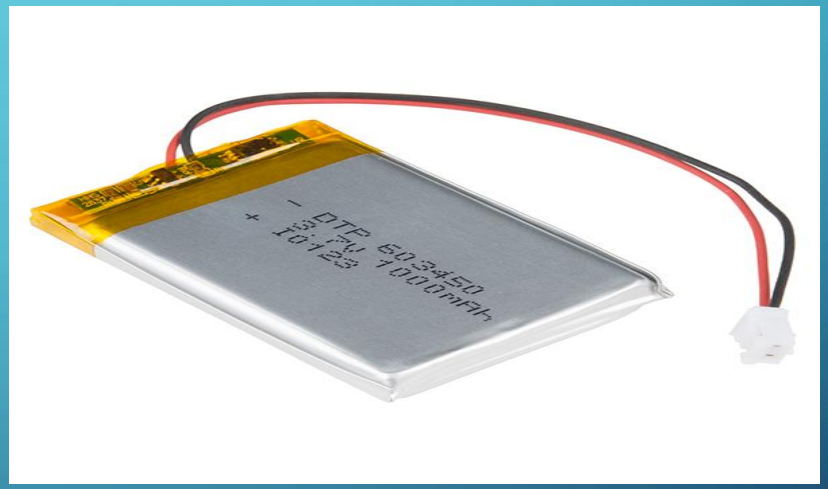
Power System

POWER SUPPLY

- Polymer Lithium Ion Battery
- Charging Circuit
- Protection Circuit

BATTERY REQUIREMENTS

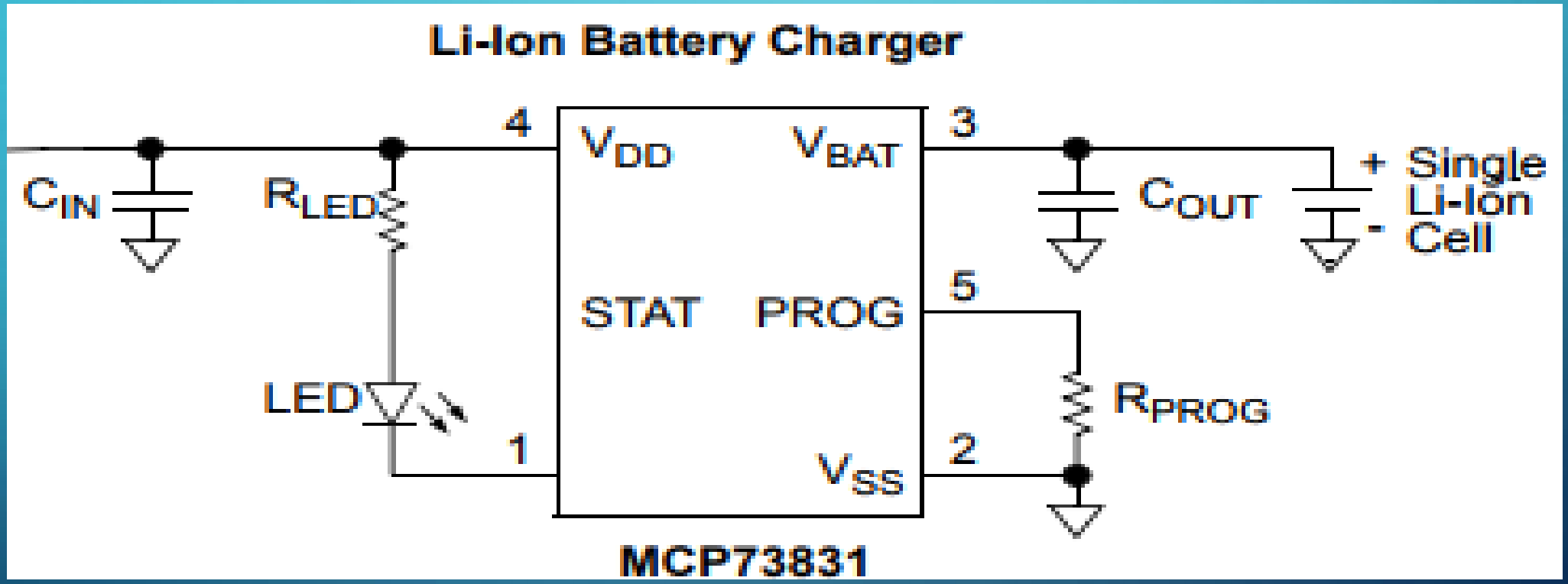
- Should be able to supply sufficient amount of current to the device
- Must be rechargeable
- Light weight
- Portable
- Display on-time for ~15 min.



POLYMER LITHIUM ION BATTERY

- lithium ion battery has high energy density
- standard voltage is at 3.7V
- cycle life is one of the longest
- Lithium ion batteries can produce currents greater than needed

LITHIUM ION CHARGER



PROTECTION CIRCUIT

- Protects from charging over maximum voltage (4.2V)
- Prevents discharge below their minimum safe voltage (3.0V) - usually taken care of by any on-cell protection circuit
- Dose not allow more current than the battery can provide
- Provides correct charging current
- Will not allow charging above or below certain temperatures (usually about 0-50 degrees C) - sometimes handled by the charger, but often not an issue as long as the charge rate is reasonable.

AMBIENT LIGHT SENSOR

AMBIENT LIGHT SENSOR

- The ambient light sensor is used to tell the system the level of brightness surrounding the device so that the program can then send that information to the LED driver and pulse wave modulator to adjust the brightness of the LED's.
- Having a sensor detecting light is the main component of the auto brightness function of the display, this will dim the display as the ambient light gets darker this is to keep a similar perceived brightness while at the same time saving power.
- There are a few different types of sensors to get a reading that can send a value for the brightness to the processor.

Ambient Light Sensors	Input/Output	**Cost**	**Advantages**	**Disadvantages**
Light Dependent Resistor	Light to voltage	$0.70	LDR is it is cheap and compact	Requires external circuit
TSL235R	Light to frequency	$3.00	This sensor requires no other circuits and is pre calibrated.	Expense
BH1750	Light to digital	$1.66	it is self contained	Expense and Size
OPT3001	Light to digital	$3.84	small in size and self contained	Expense

PHOTO CELL

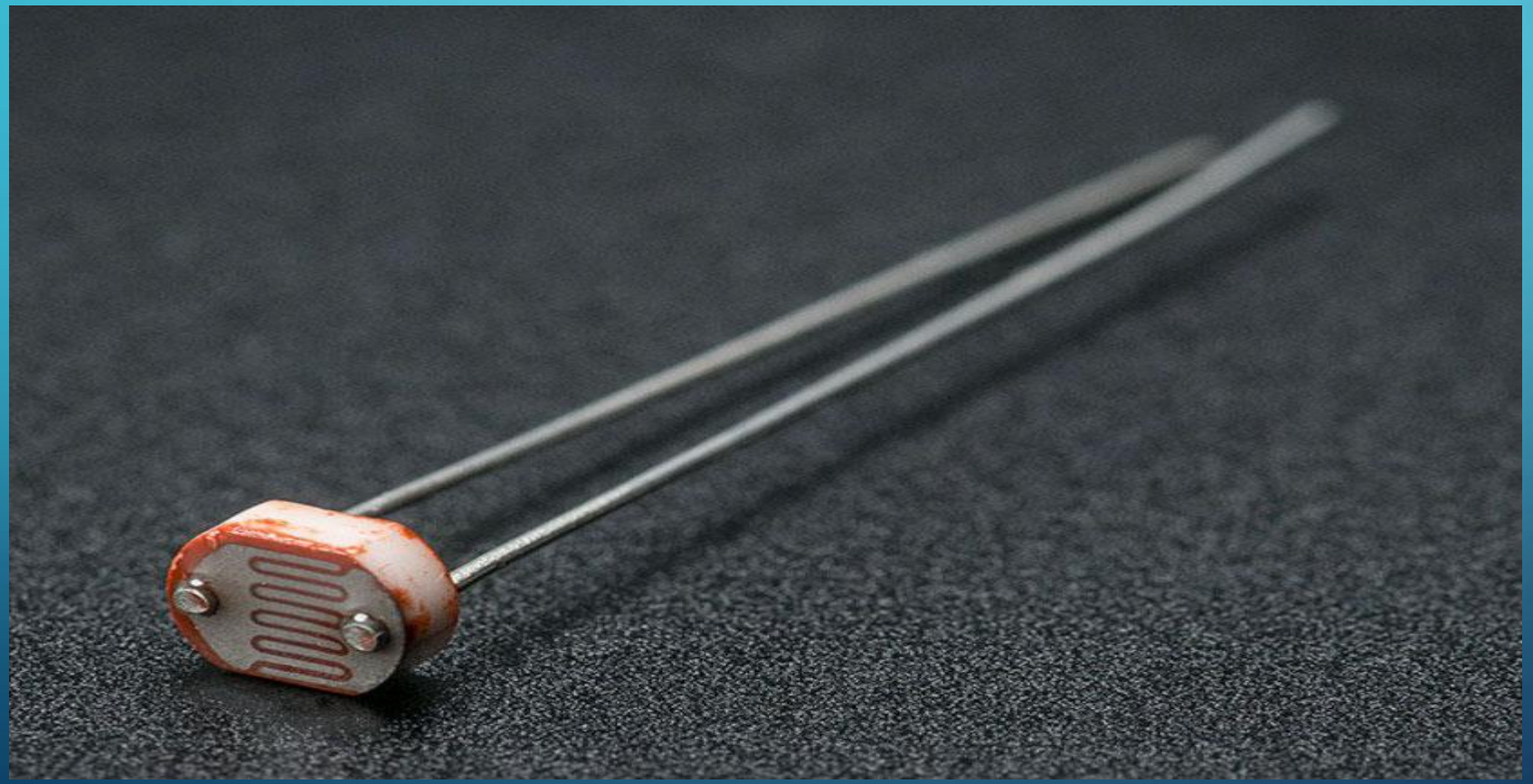


PHOTO CELL

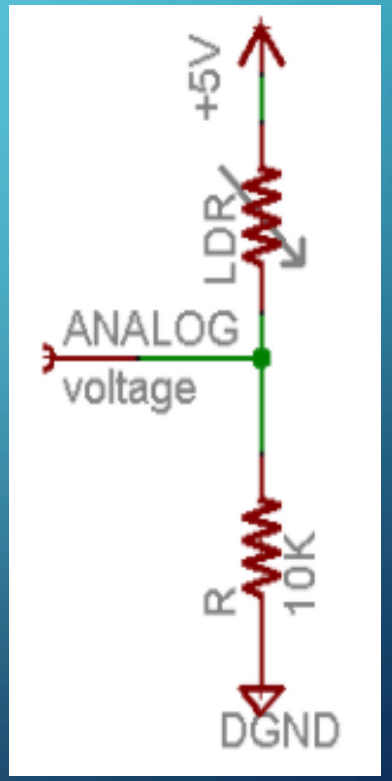
- Next sensor is a light dependent resistor (LDR) also called a photocell.
- This is as the name states a resistor that is dependent on light, the more light it gets the lower the resistance is. In order to change the brightness of the LED's the value for light must be something that can be sent to the processor. To create a value for this sensor a circuit is made using voltage division

PHOTO CELL

- Advantages
- LDR is it is cheap and small, this is a larger factor due to the fact that the sensor will have to be located on the outside of the device to read the light levels.
- This sensor does require a small circuit and a analog to digital converter in order to be usable, this makes the system as a whole larger but the other components will be on the PCB and in the processor.

PHOTO CELL

Ambient light like...	Ambient light (lux)	Photocell resistance (Ω)	LDR + R (Ω)	Current thru LDR +R	Voltage across R
Dim hallway	0.1 lux	600KΩ	610 KΩ	0.008 mA	0.1 V
Moonlit night	1 lux	70 KΩ	80 KΩ	0.07 mA	0.6 V
Dark room	10 lux	10 KΩ	20 KΩ	0.25 mA	2.5 V
Dark overcast day / Bright room	100 lux	1.5 KΩ	11.5 KΩ	0.43 mA	4.3 V
Overcast day	1000 lux	300 Ω	10.03 KΩ	0.5 mA	5V



Software

Software Overview

- Graphical User Interface (GUI)
  - Customize messages
  - Android App
  - Windows Program
  - Bluetooth
  - Data Transfer
- Microcontroller
  - LED Matrix Display
  - Button Functionality
  - Bluetooth
  - Data Transfer

MICROPROCESSOR SELECTION

Microprocessor	Price($)	Operating Voltage (V)	RAM(bytes)	Program Mem((KB)	Cpu Speed (MHz)
ATmega32u4	**3.98**	**2.7-5.5**	**2,560**	**32**	**16**
ATmega328p	2.01	1.8-5.5	2,048	32	16
MSP430G2553IPW20R	2.42	1.8-3.6	4,096	16	16
MSP430G2553IN20	2.42	1.8-3.6	4,096	16	16

MICROPROCESSOR

- Our chosen microprocessor is the ATmega32u4, because its program memory size was large enough to contain our code.
- Built in USB support.
- Programming in the Arduino 1.8.5 Environment
- Using mainly C Programming Language

"ATmega32u4 Microcontroller" - Microchip.com

PROGRAMMING Microprocessor

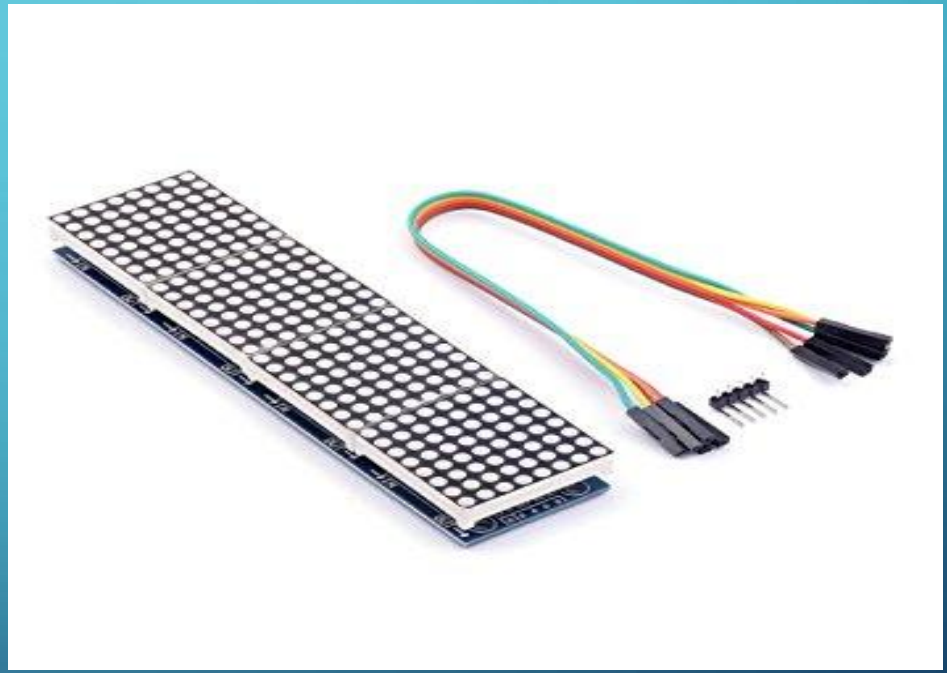
- Start up procedures
- Processes Messages for LED Matrix
- Stores messages and features for the device
- Allocates messages and characteristics to specific buttons
- Incorporates Sleep Mode
- Connectivity

PROGRAM OPERATIONS

- The device, when first booted, will flash welcome three times and then go into an low powered state with all the LEDs off and wait for input from the buttons using interrupts.
- This low power mode will reduce power consumption whenever the device is not in use, but still remains responsive.
- When plugged in using the USB cable, the device will display the battery charging icon while it is charging.

PROGRAMMING FEATURES

- The features available for the user to use to customize their messages are as follows:
  - Single/Multi-Line
  - scrolling text
  - scrolling speed
  - Display Time
  - Flashing Text
  - Flashing Speed
  - Reverse Text



"Cylewet MAX7219 Dot Matrix Module 4 in 1 Display" - Amazon

Graphical User Interface

- The GUI will provide a user friendly experience for customizing the messages stored on the Electronic Flip Sign.
- Simple selection for customization of messages includes:
  - Display Time
  - Changing between Multi-line and Single-line display
  - Enable Scrolling/Flashing Text
  - Set Scrolling/Flashing Speed
- Simple text boxes users to input messages
- Connection button that connects the computer to the device
- Will Be available on Windows and Android Devices.

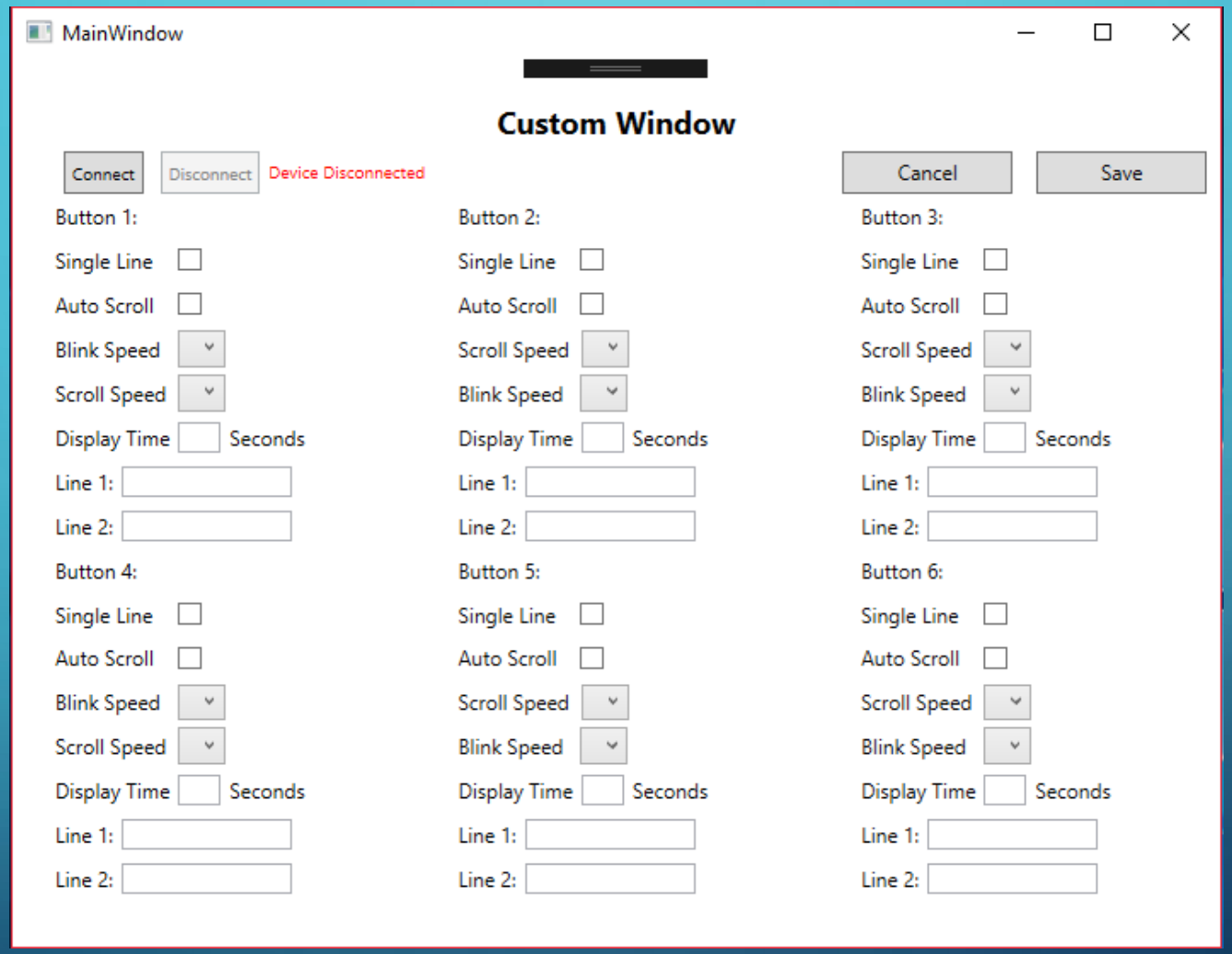
Sending Data

- Data of user input messages with the assigned display button and selected features is created using the GUI
- The custom messages are then passed from the GUI to Microprocessor using Serial or Bluetooth Communication.
  - The Serial Communication involves the use of a basic micro USB cable that interacts with the software on a Windows PC.
  - The Bluetooth Communication uses the RN4020 chip due to it supporting Bluetooth version 4.1, which allows for a more reliable connection.
- Previously stored information is also passed back to the software in order for the user to see the current configurations that are stored on the device.

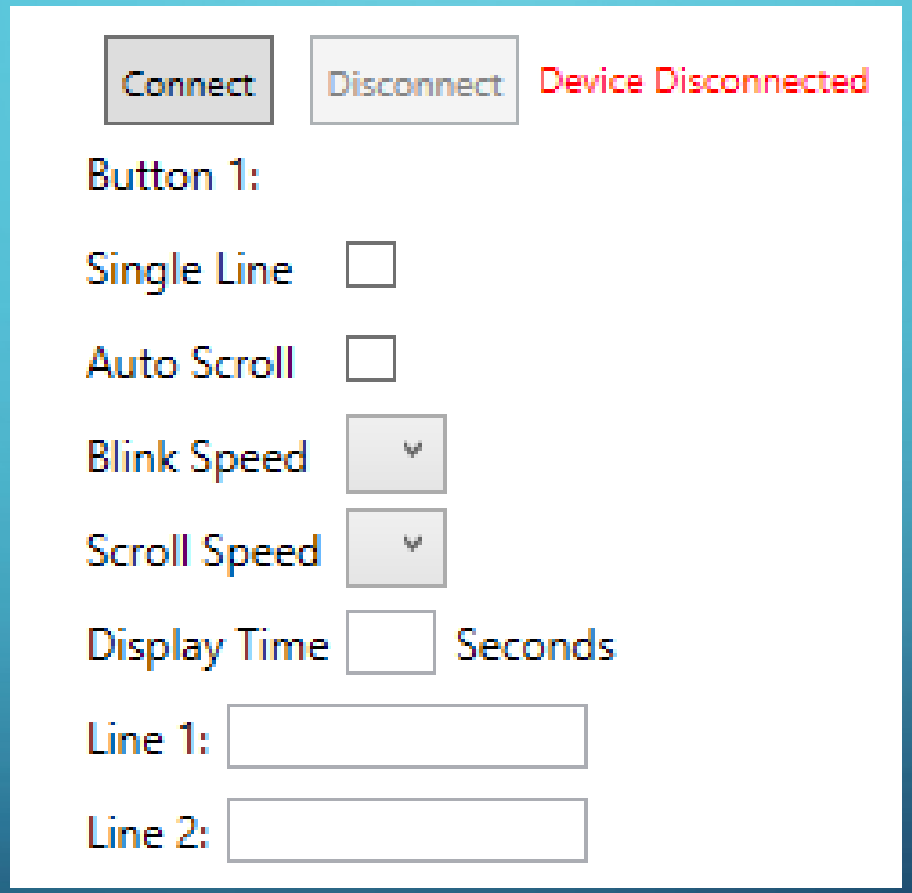
BLUETOOTH

- Bluetooth will be used to connect the device to an android device to allow a user to edit the sign's configuration on the fly.
- The bluetooth feature will be enabled through the sign using a button combination. Once this combination has been pressed, the sign will flash all the leds in a sequence 1 flash then 2 flashes every 2 seconds until an android device or computer has been paired to it.
- Once a device has successfully paired to it, the leds will stay on for 3 seconds then turn off and the user can now program using the android app.

GUI


MainWindow
Custom Window
Connect
Disconnect
Device Disconnected
Cancel
Save
Button 1:
Single Line
Auto Scroll
Blink Speed
Scroll Speed
Display Time
Seconds
Line 1:
Line 2:
Button 2:
Single Line
Auto Scroll
Scroll Speed
Blink Speed
Display Time
Seconds
Line 1:
Line 2:
Button 3:
Single Line
Auto Scroll
Scroll Speed
Blink Speed
Display Time
Seconds
Line 1:
Line 2:
Button 4:
Single Line
Auto Scroll
Blink Speed
Scroll Speed
Display Time
Seconds
Line 1:
Line 2:
Button 5:
Single Line
Auto Scroll
Scroll Speed
Blink Speed
Display Time
Seconds
Line 1:
Line 2:
Button 6:
Single Line
Auto Scroll
Scroll Speed
Blink Speed
Display Time
Seconds
Line 1:
Line 2:

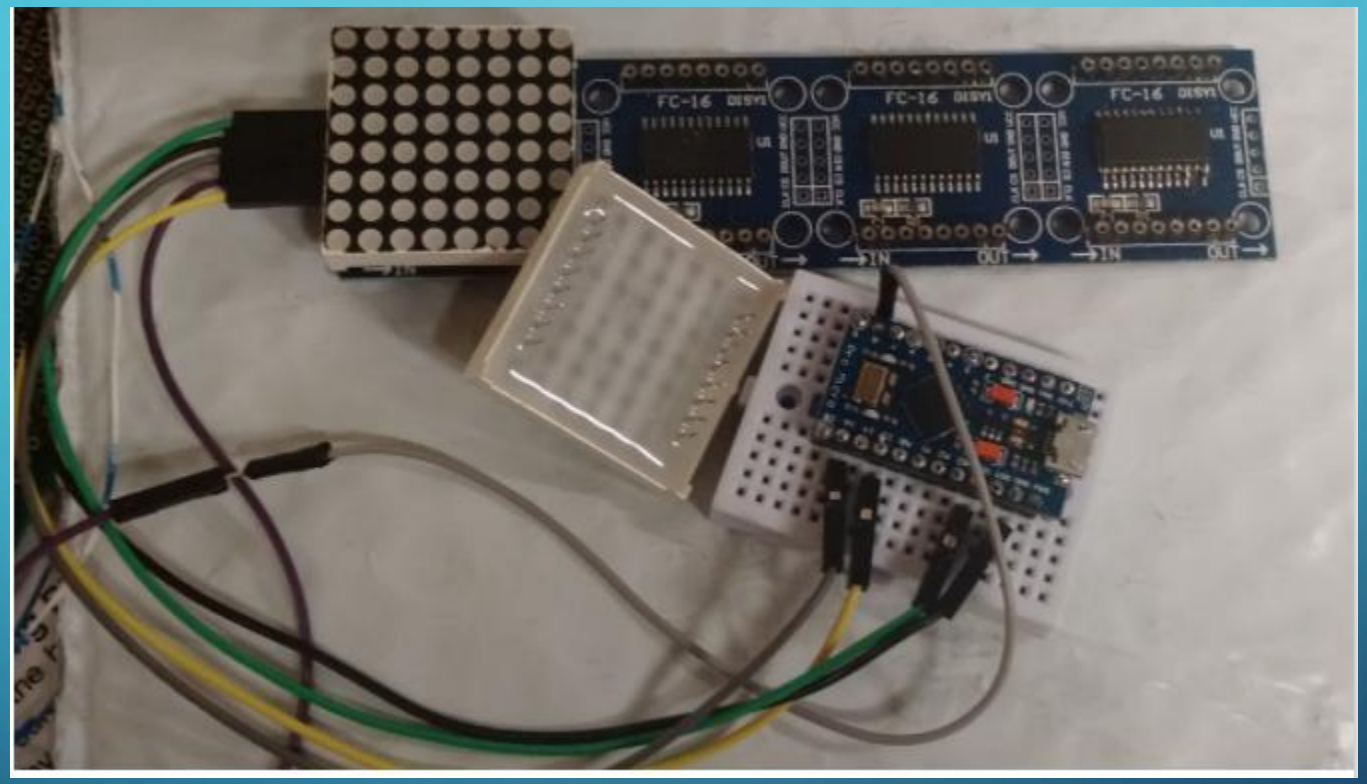
GUI BUTTON LAYOUT



COST

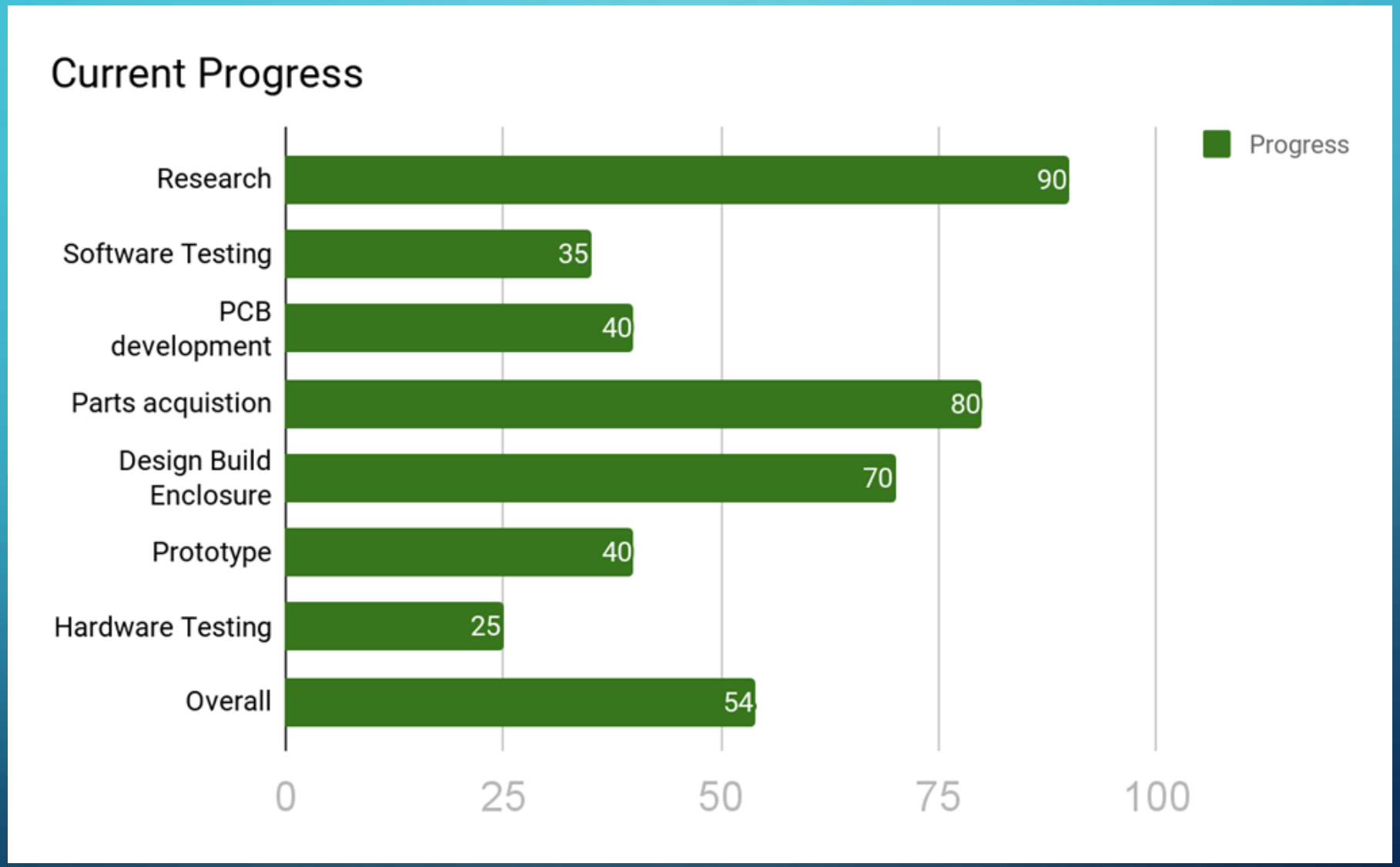
Components	Rev A	Rev B	Production Costs 1000 units
PCB	$80.00	$80.00	$3.00
Case	$10.00	$10.00	$2.00
Battery	$4.00	$4.00	$2.00
LED's	$8.00	$8.00	$6.00
LED Drivers	$20.00	$20.00	8.00
Bluetooth	$10.60	$10.60	$5.20
Photoresistor	$0.70	$0.70	$0.30
6 buttons	$0.42	$0.42	$0.20
MPU	$4.12	$4.12	$3.27
USB port	$0.70	$0.70	$0.33
Power Switch	$0.50	$0.50	$0.30
Passive components	$0.75	$0.75	$0.40
Power circuitry	$1.00	$1.00	$0.60
Total	$140.79	140.79	$31.60

PROTOTYPING



DISTRIBUTION OF WORK

	Richard	Dominick	Brennan	John
Graphical User Interface and Connectivity			Primary	Secondary
Programming Microprocessor			Secondary	Primary
LED Matrix and PCB Design	Primary	Secondary		
Charging Circuit and LED Drivers	Secondary	Primary		


Current Progress
Progress
Research
90
Software Testing
35
PCB development
40
Parts acquistion
80
Design Build Enclosure
70
Prototype
40
Hardware Testing
25
Overall
54
0
25
50
75
100

QUESTIONS?