CG1112 Engineering Principles and Practices II

Week 3 Studio 1 – Soldering & Wire-Wrapping

Objectives:

1. Learn HW Prototyping Skills like Soldering and Wire-Wrapping
2. Plan the Proto-Board Layout for your own circuit
3. Develop the appropriate Arduino Code

Equipment Needed:

1. Laptop with Arduino Uno installed
2. Arduino Uno Board
3. 220 ohms Resistor x2
4. Coloured LED's (Red / Green / Yellow) (Quantity depends on your design)
5. RGB LED's x 2
6. Wire-Wrapping Tool
7. Small Breadboard
8. ProtoBoard
9. 30AWG Wires
10. Soldering Station
11. Mounting Headers (x 1 strip)
12. Male Headers for Breadboard (x 2 heads)

1. Introduction

The objective of this studio is to learn both Soldering and Wire-Wrapping.

You do not need to rush and complete your design by today. Do it patiently. If you need more time, please come back during the other days and complete it. You are free to use any number of LED's and arrange them in any way you like.

Typically, when developing a new piece of hardware, you would breadboard it first to test the circuit design, then prototype it on a board like the stripboard or protoboard, before going on to designing a custom built PCB. Due to lack of time we have skipped the bread-boarding part. Furthermore, you are all familiar with breadboards in EPP-1.

You will be working individually to develop your own LED flasher board. Refer to this video to see how it behaves:

https://youtu.be/aMvdQKIVxWY

Since you will get to keep this work-of-art, you definitely want to make something that you will be proud of. An example of the final board will look something like what you see in Figure 1. The picture on the left for Figure 1, shows the final wire-wrapped circuit. The picture on the right of Figure 1, shows the wire-wrapping and soldering.

Prepared by Ravi Suppiah (dcsravi@nus.edu.sg)

Since you are just starting to learn soldering a wire-wrapping, you don't need to develop the exact same circuit like what is shown. You can choose to design something simpler with your own layout. The minimum requirements are as such

- RGB LED (x1)
- Coloured LED's (x6)

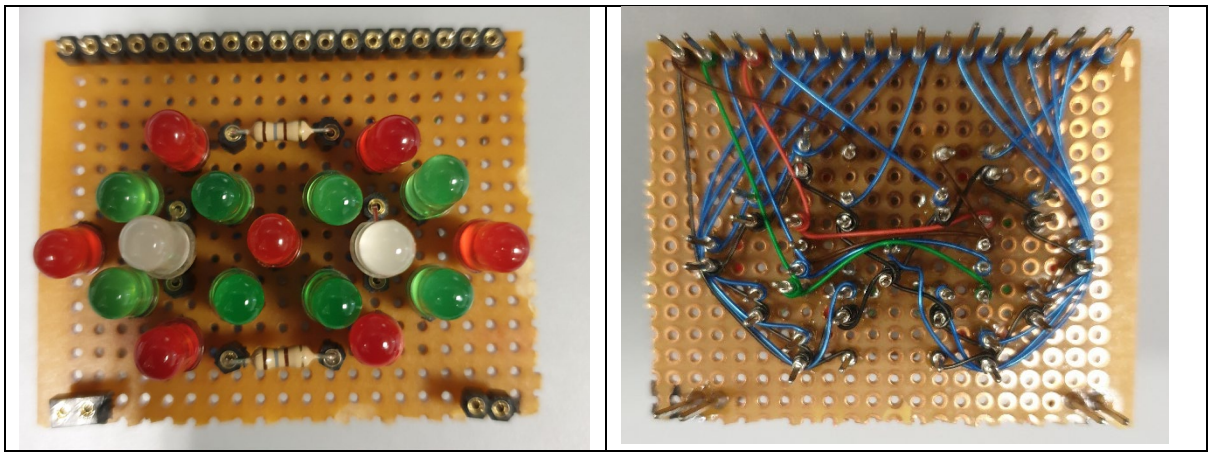

Figure 1: Completed LED Flasher ProtoBoard

2. ProtoBoard

A protoboard is shown in Figure 2. As can be seen, it contains several holes, with each hold surrounded by a conductive pad. There are no interconnections between the pads. The main advantage of using such a protoboard is that you are free to place the components whichever way you prefer. You are not constrained by any existing connections. That also means, that you now have to manually create all the connections you need for your circuit.

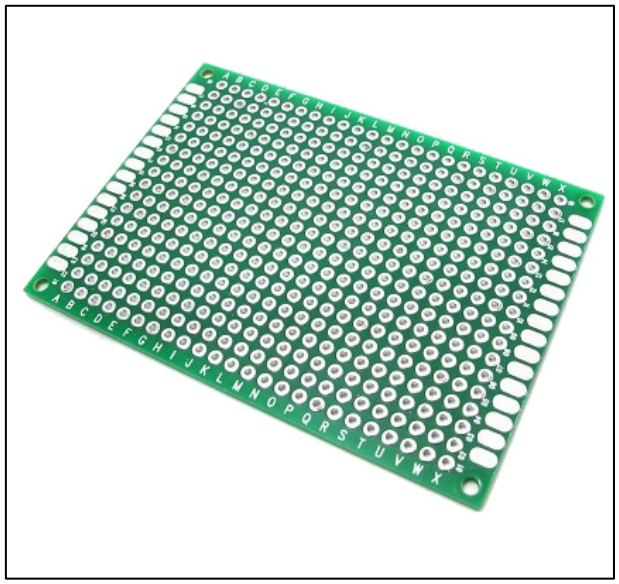

Figure 2: ProtoBoard

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3. Wire-Wrapping Headers

Wire-Wrapping headers allow us to swap components easily without having to unwrap and re-wrap whenever we need to swap-out any components.

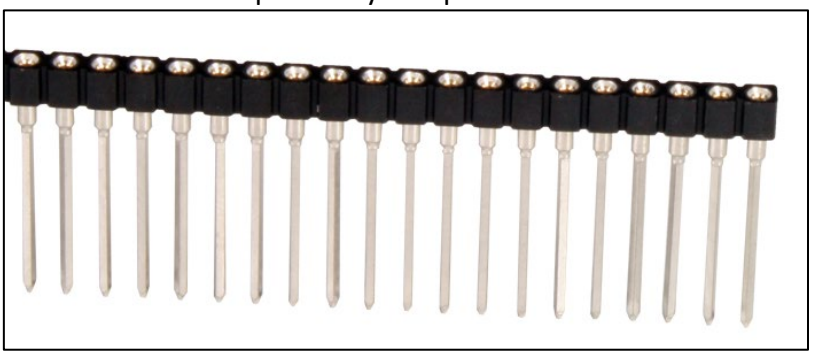


Figure 3: Wire-Wrapping Headers

As can be seen from Figure 1, we use these headers for all the LED and Resistor connections as well as for the wired connections between the protoboard and the Arduino Uno. The headers pins should be soldered onto the protoboard (Figure 4).

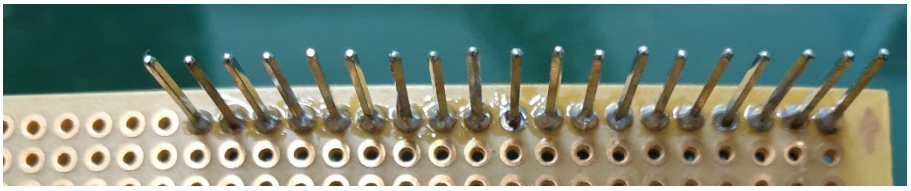


Figure 4: Soldered Header Pins

4. Other Components

The rest of the components are what you have used before in EPP1, namely the Coloured LED's as well as the RGB LED's together with resistors.

5. Plan & Implement Your Design

Now, you need to plan your design and implement the soldering and wire-wrapping on your protoboard.

Design Phase:

Draw out the connections between the Arduino and the LED's. Make a decision on how many LED's you want you want to use in your design. In your schematic, you also need to include the plan for the connections to the Single-Line Connector. Refer to Appendix A for the Design for the LED Flasher Circuit.

For the LED's you need to cut the headers to just have 2 pins. For the Resistors, you need single header pins, spaced apart. The long single strip is for all the wired connections to the Arduino Uno. Remember to also include a pin for the GROUND (GND) connection. Figure 5

shows the layout for the sample circuit. You need to use some scotch tape to hold the connectors in place when you turn over the board to do the soldering.

The Normal Coloured LED's can be connected to the Digital or Analog Pins, configured as outputs. For the RGB LED, you can connect them to the PWM pins.

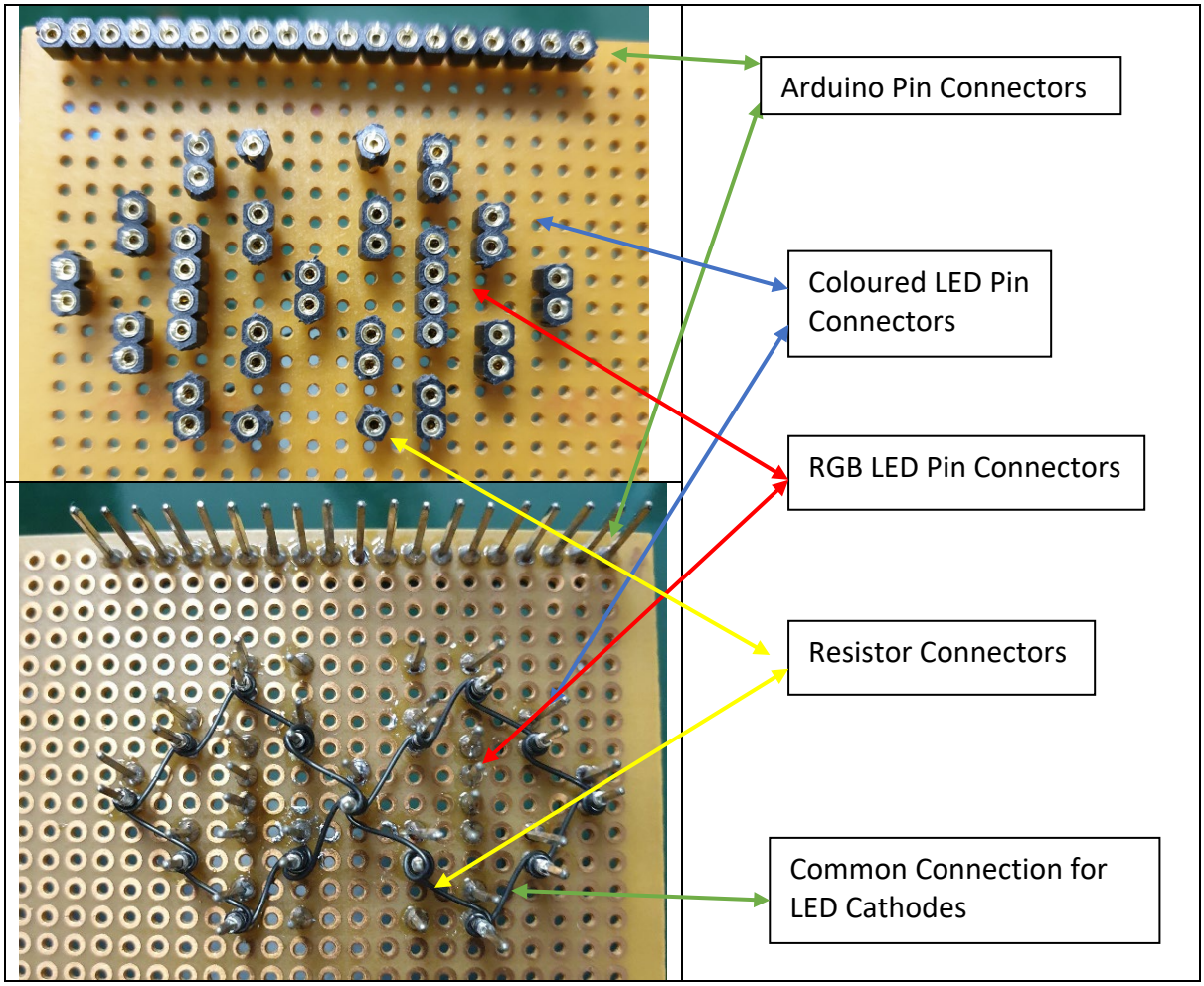


Figure 5: Connector Layout

You can connect all the Cathode's of the Coloured LED's together to create a common Ground Line. This line will connect to a single resistor being connected to GND pin on the Single-Line connector.

For the Coloured LED's each Anode pin will connect to a single pin on the Single-Line Connector as shown in Figure 6.

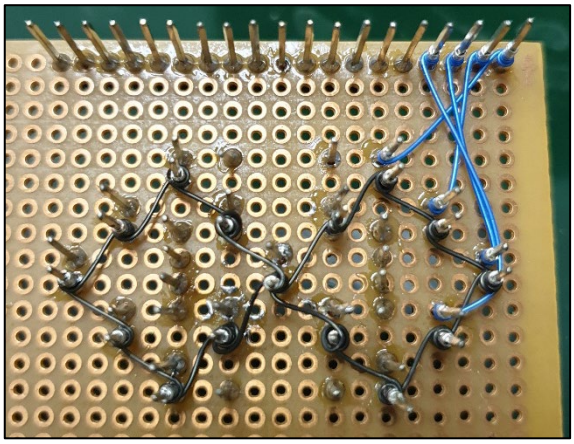


Figure 6: Anode Pin Connections for the LED's

For the RGB LED, we will connect them to the PWM Pins. This is because we will be using the analogwrite() function to vary the voltages sent to the R, G and B pins. This will enable us to continuously change the colour of the LED.

The completed wire-wrapping is shown in Figure 7.

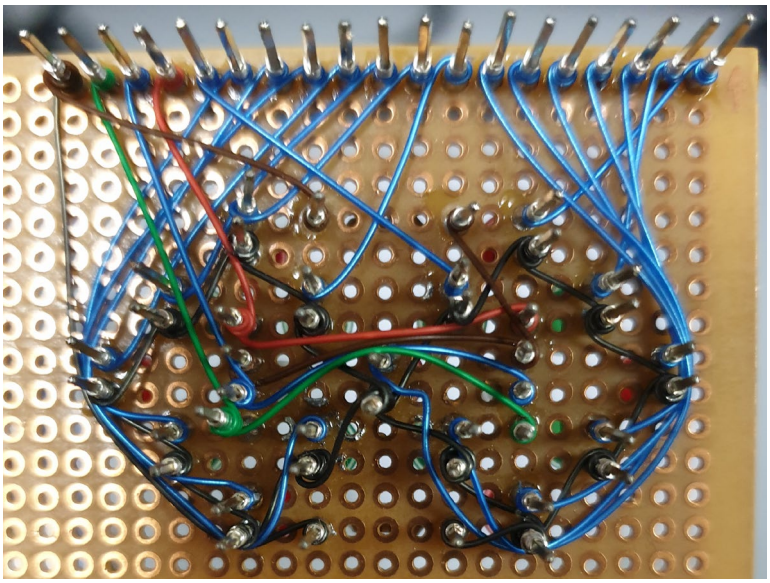


Figure 7: Completed Wire-Wrapping

Figure 8 shows all the components mounted into the wire-wrapping headers. As can be seen, we need to cut the leg of the LED's to make sure they fit securely into the headers while staying close to the protoboard. This makes the whole circuit look very neat and professional.

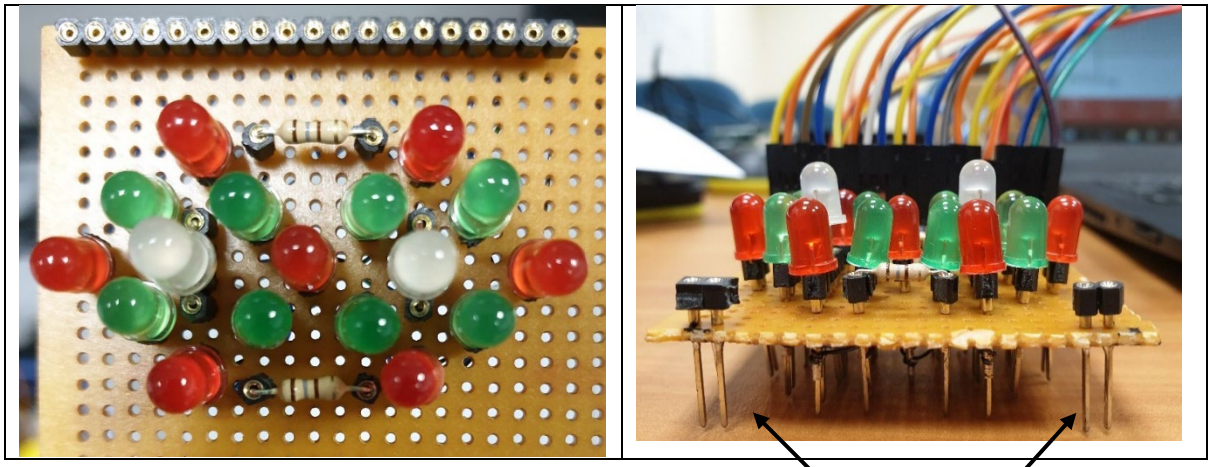


Figure 8: All Components Mounted

You will notice TWO additional 2-pin connectors without any components. These are there to help balance the board on the table.

In Figure 9, you can see the connections to the Arduino Uno. Check back on your circuit design so that you are sure that you are connecting the correct pin to the correct LED.

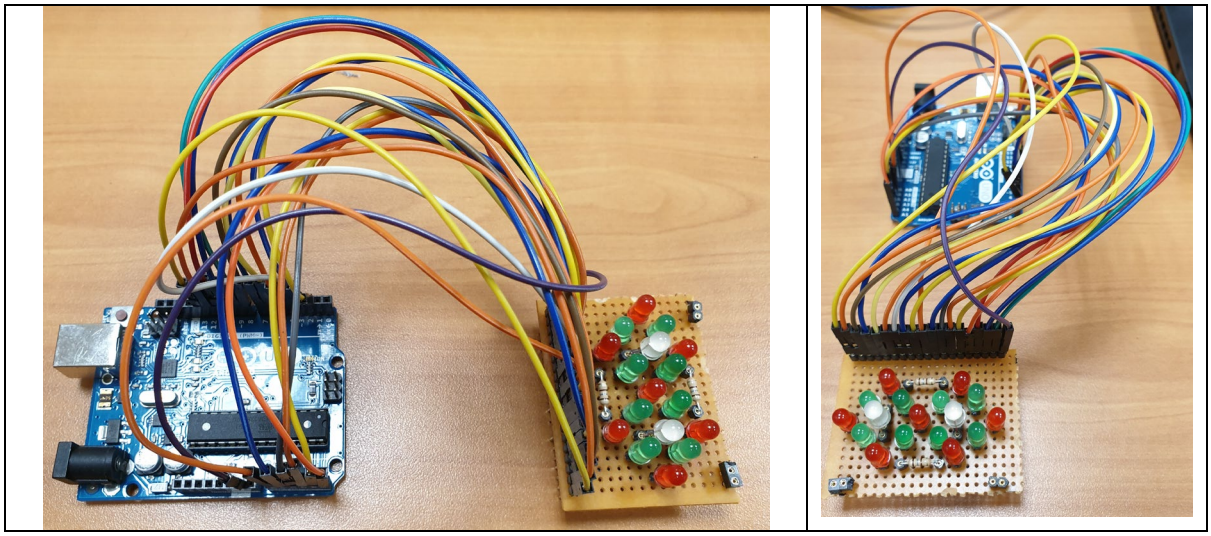


Figure 9: Connections between Arduino Uno and the ProtoBoard

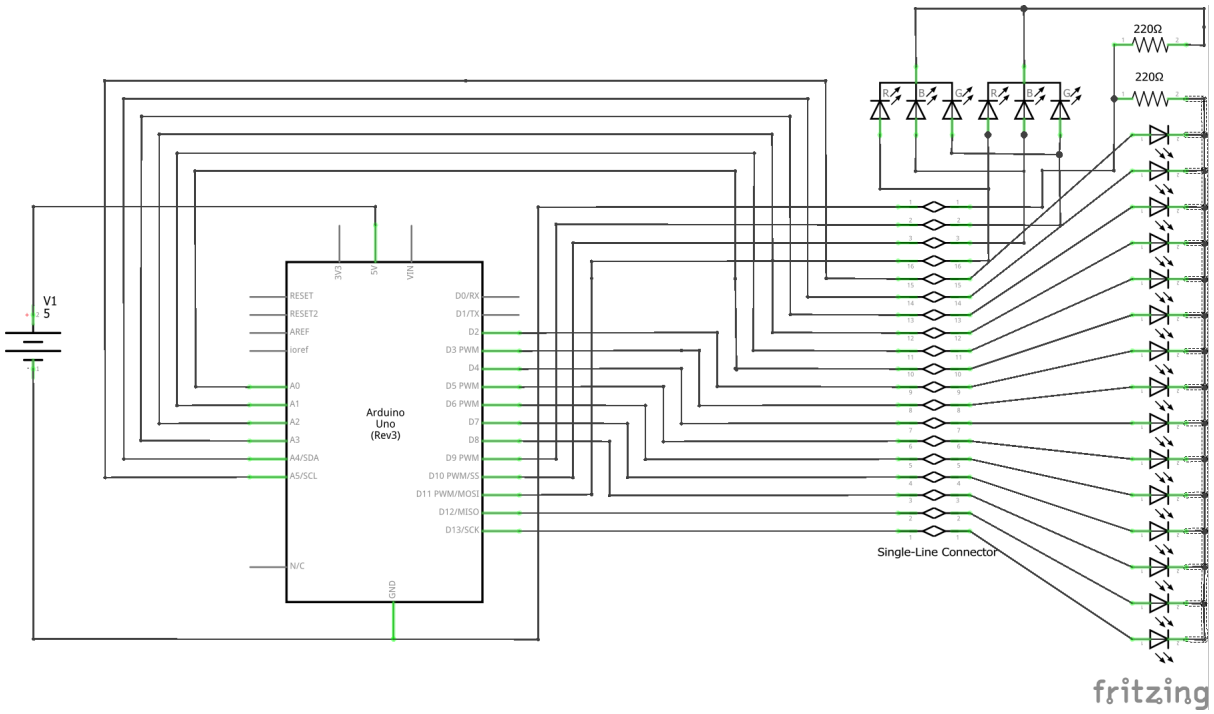
6. SW Development

Now that you are done with all your HW prototyping, you can now focus on the SW development of your design. Since the focus of this studio is on HW prototyping, you are given full flexibility to design the SW as you like. You can think of any LED patterns that you would like to showcase and develop the code for it.

7. That's It! Video Time!

With everything complete, feel free to take photos and videos of your masterpiece and share it with your family and friends! Be proud of what you have achieved today. These skills will go a long way in making you a full-fledged Computer Engineer! ☺

APPENDIX A



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