EE Fundamentals Lab - Assignment 2

Selected resistors and the calculations

Voltage Calculations

1. First Output Voltage (VOUT1)

- Formula: VOUT1 = 2V + 0.01 × Day of the Month
- Calculation: VOUT1 = 2 + 0.01 × 5 = 2.05V

2. Second Output Voltage (VOUT2)

- Formula: VOUT2 = VOUT1 + 0.1
- Calculation: VOUT2 = 2.04 + 0.1 = 2.15V

3. Third Output Voltage (VOUT3)

- VOUT3 = VOUT2 = 2.15V

Resistor Calculations

Using R1 = 240Ω:

- Given: VOUT = 2.05V,
- R1 = 240Ω

  Using Formula VOUT = Vref(1+(R2/R1)) + (I_{adj}*2)

  0.64 = R2/240Ω

  R2 = 153.6Ω

  Closest = 160 Ω

LED Specifications

Key Information from Datasheet

1. Forward Voltage (VF):
    - Typical VF: 2.0V
    - Maximum VF: 2.5V (at IF = 20mA)
2. Recommended Forward Current (IF):
    - Typical IF: 20mA (0.02A)
    - Maximum IF: 25mA (0.025A)

Current-Limiting Resistor (R7) Calculation

- Formula: R7 = (VOUT - VF)/IF
- Given values:
    - VF = 2.0V (typical forward voltage at IF = 20mA)
    - IF = 20mA = 0.02A
- Calculation: R7 = (2.05 - 2.0)/0.02 = 2.5Ω

TPS79301 Voltage Regulator Calculations

Key Information

1. Output Voltage Formula: VOUT = VREF × (1 + R3/R4)
    - VREF = 1.224V (internal reference voltage)
    - Required VOUT = 2.15V

Resistor Calculations

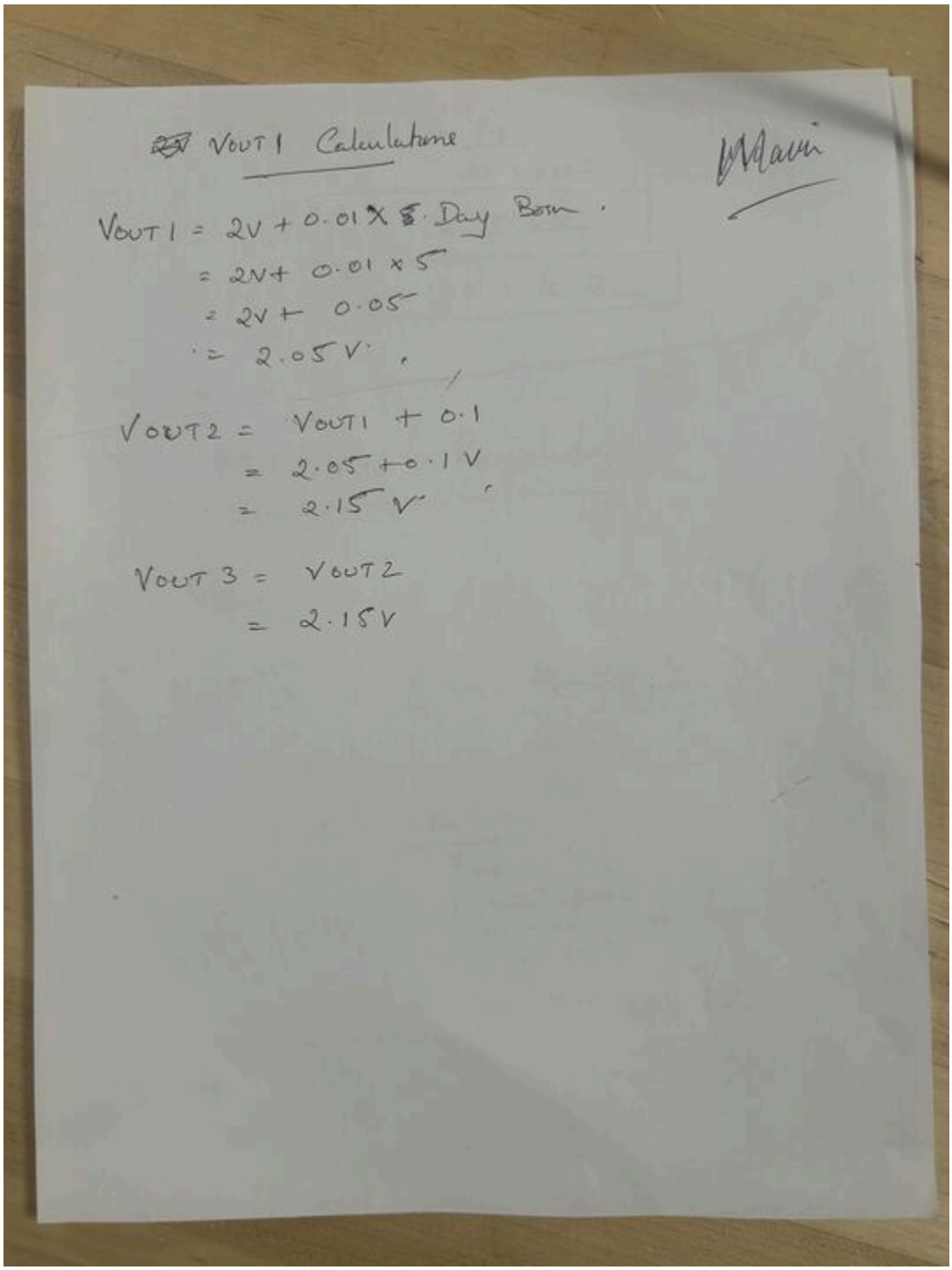
Step 1: Calculate R3 and R4

1. Formula rearranged: R3/R4 = (VOUT/VREF) - 1
2. Calculation: R3/R4 = 2.15/1.224 - 1 = 0.7558187
3. Using R4 = 30.1kΩ
    - R3 = 0.0.7558187 × 30.1 kΩ = 22.75 kΩ
    - Standard values:
        - R3 = 22kΩ
        - R4 = 30kΩ

Step 2: Calculate R8 (LED Current-Limiting Resistor)

- Formula: R8 = (VOUT - VF)/IF
- Values:
    - VOUT = 2.15V
    - VF = 2.0V
    - IF = 20mA = 0.02A

- Calculation: R8 = (2.15 - 2.0)/0.02 = 5Ω



~~V_{OUT1} =~~ LM317 Regulator

$$V_{OUT1} = V_{ref} \times \left(1 + \frac{R_2}{R_1}\right) + (I_{adj} \times R_2)$$

$$2.05 = 1.25 \times \left(1 + \frac{R_2}{R_1}\right) + (0 \times R_2)$$

$$\frac{2.05}{1.25} = 1 + \frac{R_2}{R_1}$$

$$1.64 = 1 + \frac{R_2}{R_1}$$

$$0.64 = \frac{R_2}{240}$$

$$R_2 = 153.6\ \Omega$$

$$1.64 = \frac{R_1 + 240}{R_1}$$

$$1.64 R_1 = 240$$

$$\frac{1.64 R_1}{1.64} = \frac{240}{1.64}$$

$$R_1 = 146.3\ \Omega$$

TPS 7930 Regulator

$V_{REF} = 1.2246\,V$

$R_4 = 30.1\,k\Omega$

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_1}{R_2}\right)$$

$$V_{OUT2} = V_{ref} \times \left(1 + \frac{R_3}{R_4}\right)$$

$$2.15 = 1.2246 \times \left(1 + \frac{R_3}{30.1\,k\Omega}\right)$$

$$\frac{2.15}{1.2245} = 1 + \frac{R}{30.1 \times 10^3\,\Omega}$$

$$0.755.8187 = \frac{R_3}{30.1 \times 10^3}$$

$$R_3 = 22.75\ k\Omega$$

$$R_4 = 30.1\ k\Omega$$

MIC5376 - Regulator

$$V_{OUT} = V_{REF}\left(1 + \frac{R_1}{R_2}\right) = V_{REF}\left(1 + \frac{R_5}{R_6}\right)$$

$$2.15 = 1\left(1 + \frac{150\ k\Omega}{R_6}\right)$$

$$2.15 = 1 + \frac{150\ k\Omega}{R_6}$$

$$1.15 = \frac{150\ k\Omega}{R_6}$$

$$R_6 = \frac{150 \times 1000}{1.15}$$

$$R_6 = 130.434\ k\Omega$$

LED Calculations — LSR976. (3)

Forward Voltage = 2.00V

$V = IR$

$R_7 = \frac{V_{OUT1} - V_f}{I_f = 20mA}$

$R_7 = \frac{2.05 - 2.00V}{20 \times 10^{-3}}$

$R_7 = \frac{0.05}{20 \times 10^{-3}}$

$R_7 = 2.5\,\Omega$

LED — LTST

$V_f = 2.00V$

$I_f = 30\,mV$

$R_8 = \frac{V_{OUT} - V_f}{I_f}$

$= \frac{2.15 - 2.00}{30 \times 10^{-3}}$

$= \frac{0.15}{30 \times 10^{-3}} = 5\,\Omega$

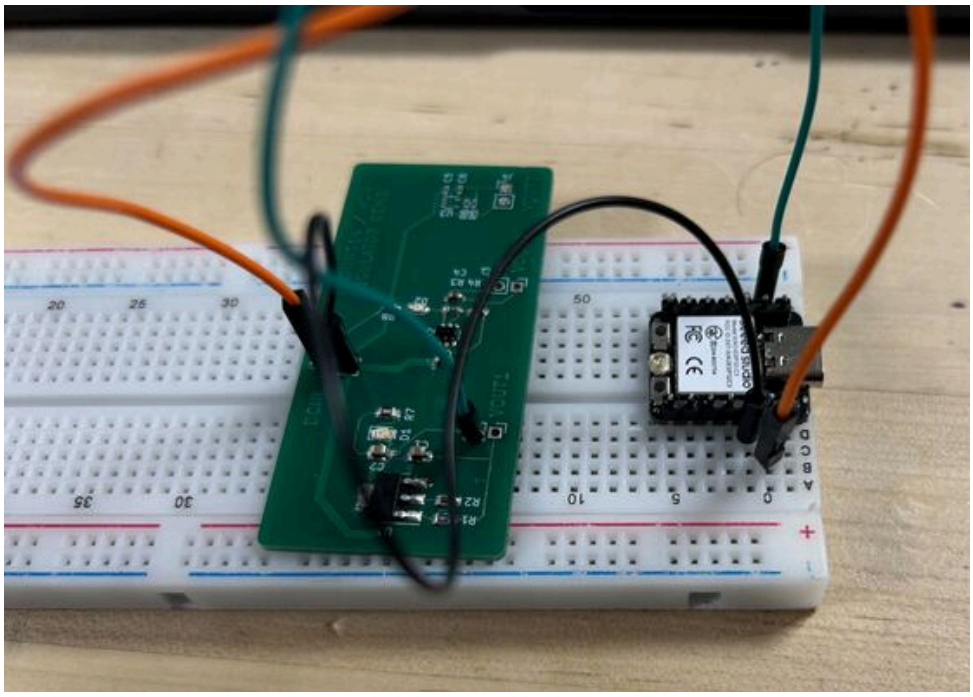
Screenshot of the exported BOM spreadsheet

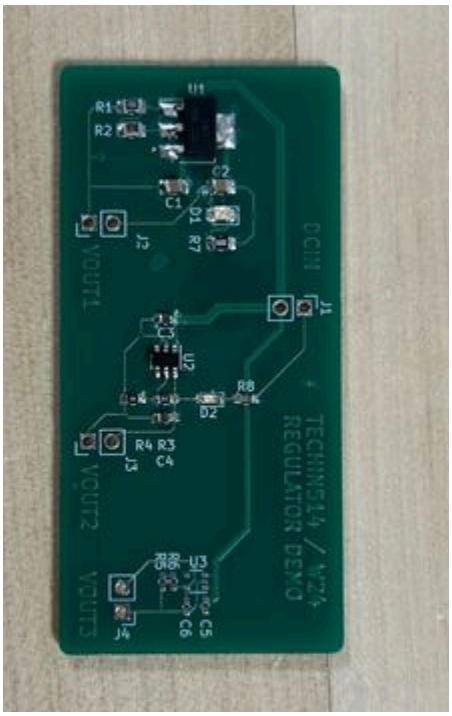
#	Reference	Qty	Value	Footprint	DNP
1	C1, C2	2	1uF	Capacitor_SMD:C_0805_2012Metric_Pad1.18x1.45mm_HandSolder	
2	C3, C4	2	1uF	Capacitor_SMD:C_0603_1608Metric_Pad1.08x0.95mm_HandSolder	
3	C5, C6	2	1uF	Capacitor_SMD:C_0402_1005Metric_Pad0.74x0.62mm_HandSolder	
4	D1	1	LED	LED_SMD:LED_0805_2012Metric_Pad1.15x1.40mm_HandSolder	
5	D2	1	LED	LED_SMD:LED_0603_1608Metric_Pad1.05x0.95mm_HandSolder	
6	J1, J2, J3, J4	4	n.m.	Connector_PinHeader_2.54mm:PinHeader_1x02_P2.54mm_Vertical	
7	R1	1	240 Ω	Resistor_SMD:R_0805_2012Metric_Pad1.20x1.40mm_HandSolder	
8	R2	1	153.6 Ω	Resistor_SMD:R_0805_2012Metric_Pad1.20x1.40mm_HandSolder	
9	R3	1	22.75 kΩ	Resistor_SMD:R_0603_1608Metric_Pad0.98x0.95mm_HandSolder	
10	R4	1	30.1 kΩ	Resistor_SMD:R_0603_1608Metric_Pad0.98x0.95mm_HandSolder	
11	R5	1	150 kΩ	Resistor_SMD:R_0402_1005Metric_Pad0.72x0.64mm_HandSolder	
12	R6	1	130.434 kΩ	Resistor_SMD:R_0402_1005Metric_Pad0.72x0.64mm_HandSolder	
13	R7	1	2.5 Ω	Resistor_SMD:R_0805_2012Metric_Pad1.20x1.40mm_HandSolder	
14	R8	1	5 Ω	Resistor_SMD:R_0603_1608Metric_Pad0.98x0.95mm_HandSolder	
15	U1	1	LM317_SOT-223	Package_TO_SOT_SMD:SOT-223-3_TabPin2	
16	U2	1	TPS79301-EP	Package_TO_SOT_SMD:SOT-23-6	
17	U3	1	MIC5377	Package_TO_SOT_SMD:SOT-353_SC-70-5	

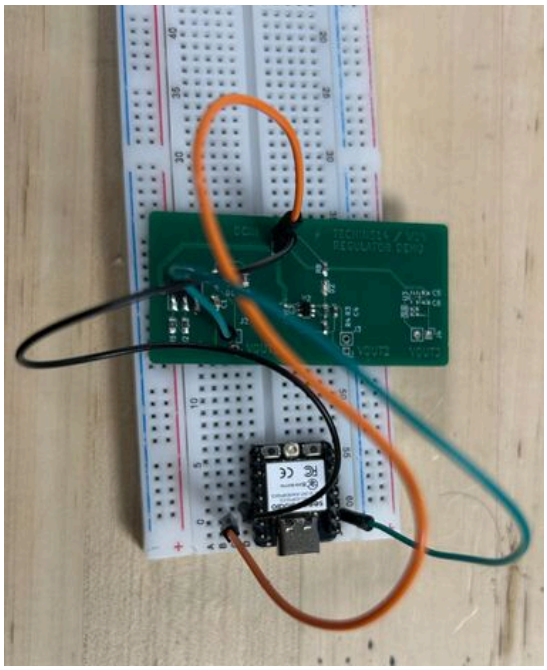
Final Adjustment Note

The output voltage (VOUT2) was adjusted from 2.15V to 2.5V to ensure the proper functioning of the LTST-C191KRKT LED. This change was necessary because the LED has a forward voltage (VF) requirement of up to 2.4V to illuminate, and the original VOUT was not sufficient to forward-bias the LED. The higher VOUT ensures stable LED operation while minimizing the effect on the rest of the circuit.

Board Images

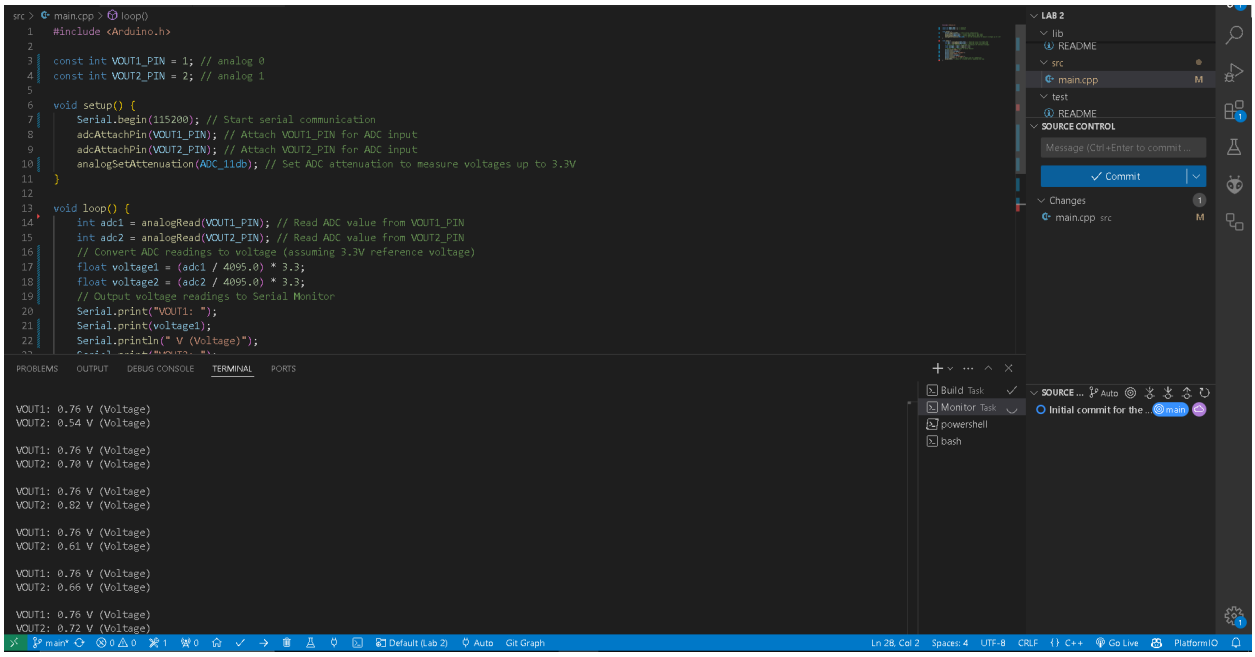






Link to github repo:
https://github.com/prunus77/TECHIN514-Hardware-Software-Lab/blob/main/PlatformIO/Projects/lab2/src/main.cpp

Screenshot of the serial output



Help Section:
Given:
Kelly helped me debug the code
And Shareef helped me while I was getting a build error

Received:
I helped Shareef with soldering