Photodiode Transimpedance Amplifier Design Review

This document contains my notes on future improvements to my PCB-based photodiode amplifier.

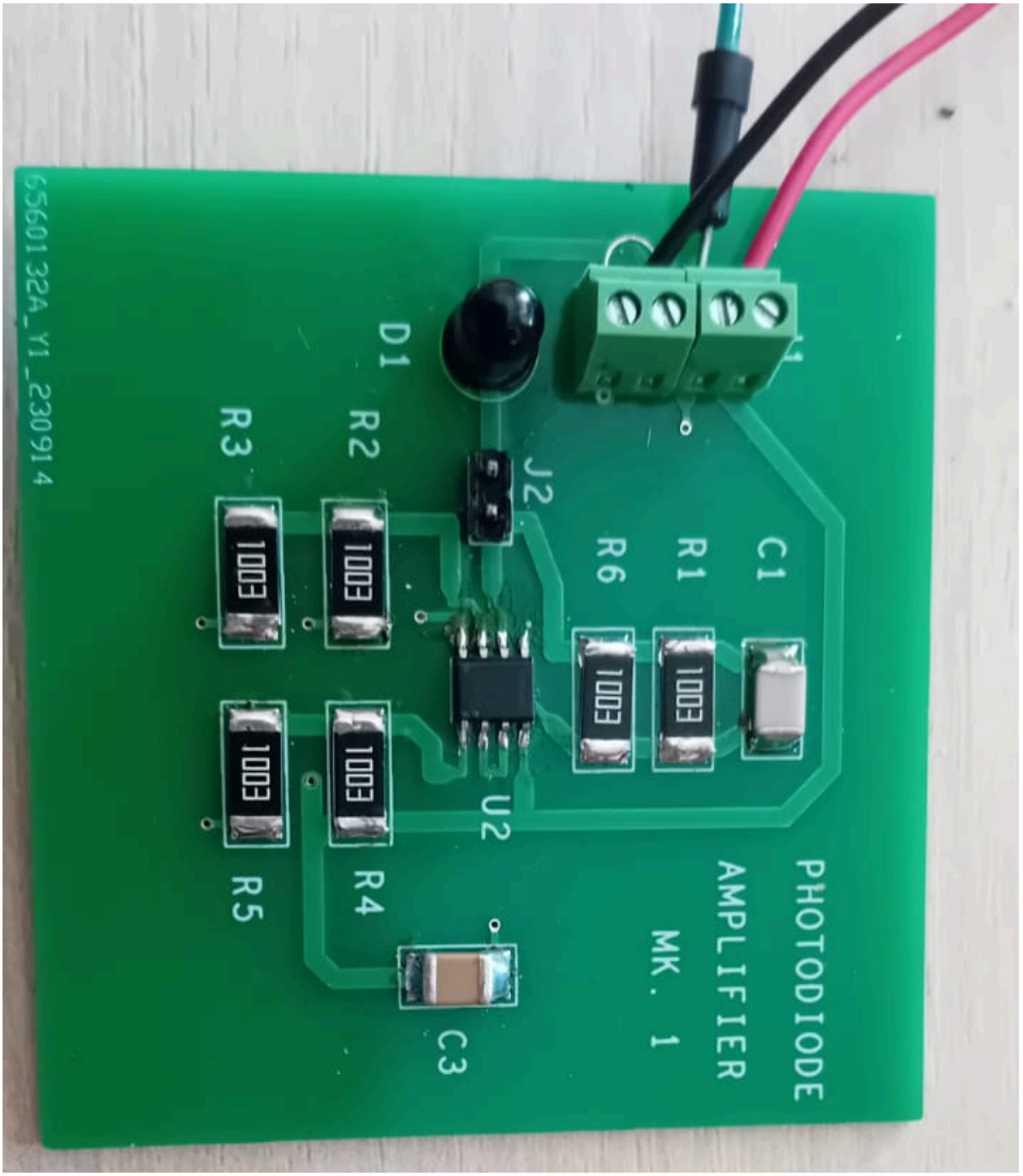
This was my first designed and fabricated PCB. I was interested more in the physical design and component procurement, than the actual circuit design. The circuit design is of course functional, but possesses a limited bandwidth of around 20kHz.

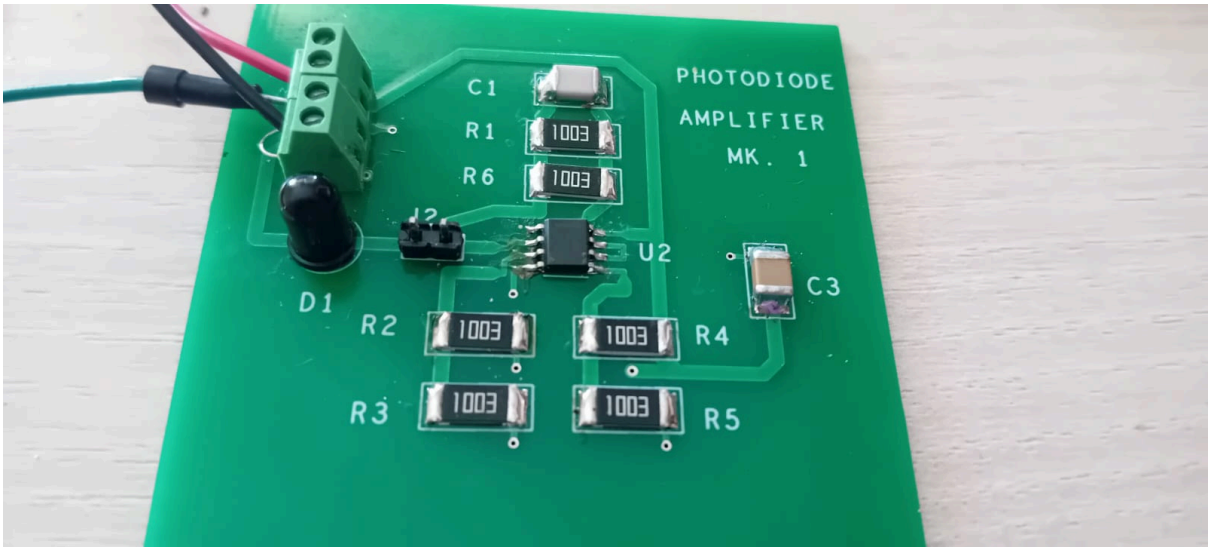
All the components were sourced from TME, the PCB was fabricated by JLC PCB. The board design and component selection is thought out such that the minimum number of different components is needed.

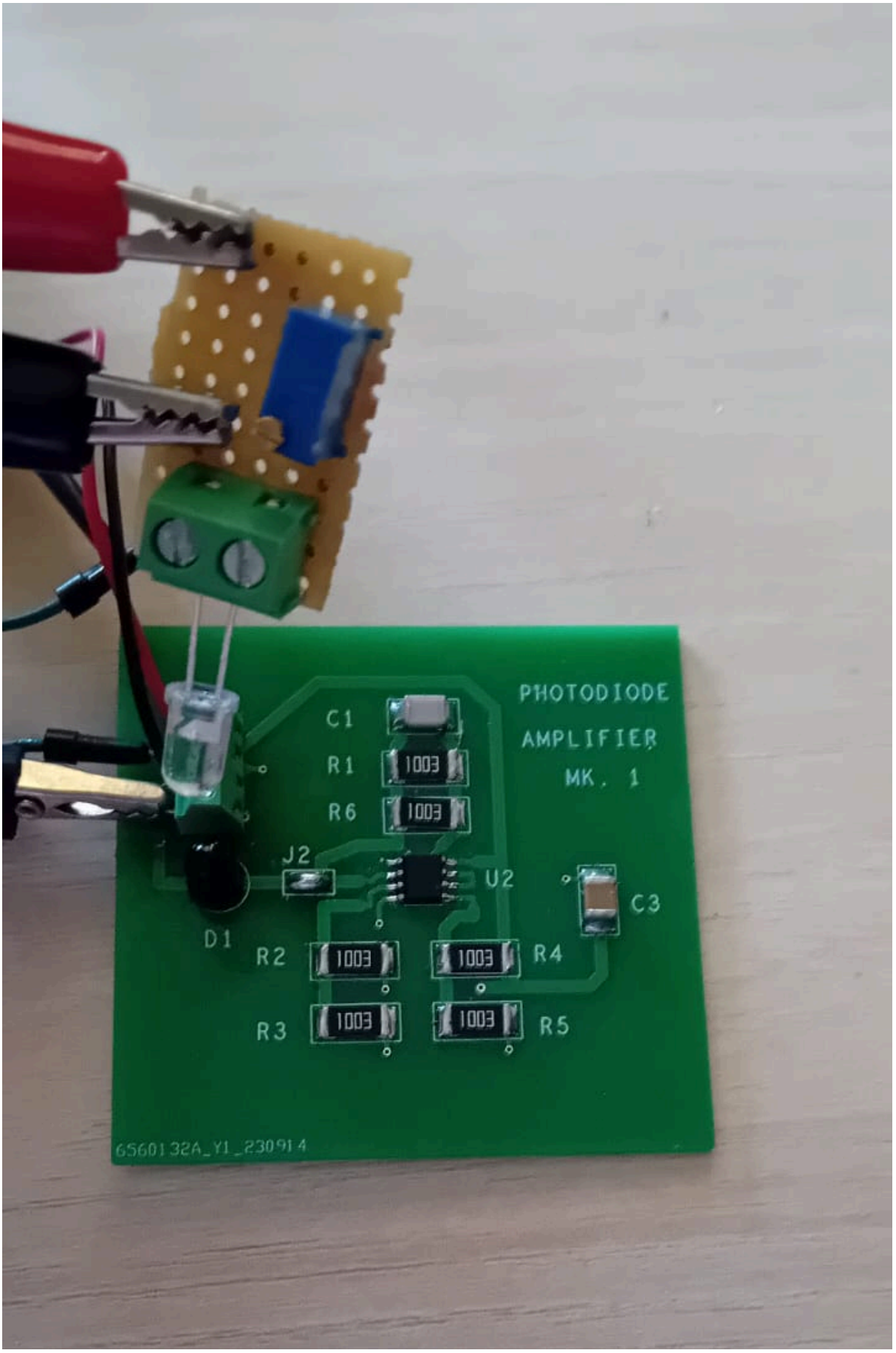
Total price for component procurement, delivery fees and PCB fabrication amounts to about 65 RON.

Note that since the completion of this project, I have improved my understanding of optoelectronic frontends significantly, more on my github page about Transimpedance Amplifier Design: https://github.com/Riggstadt/PDTIA/tree/main

Showcase of assembled PCB board




PHOTODIODE
AMPLIFIER
MK. 1
C1
R1
R6
J2
U2
C3
D1
R2
R4
R3
R5
1003


PHOTODIODE
AMPLIFIER
MK. 1
C1
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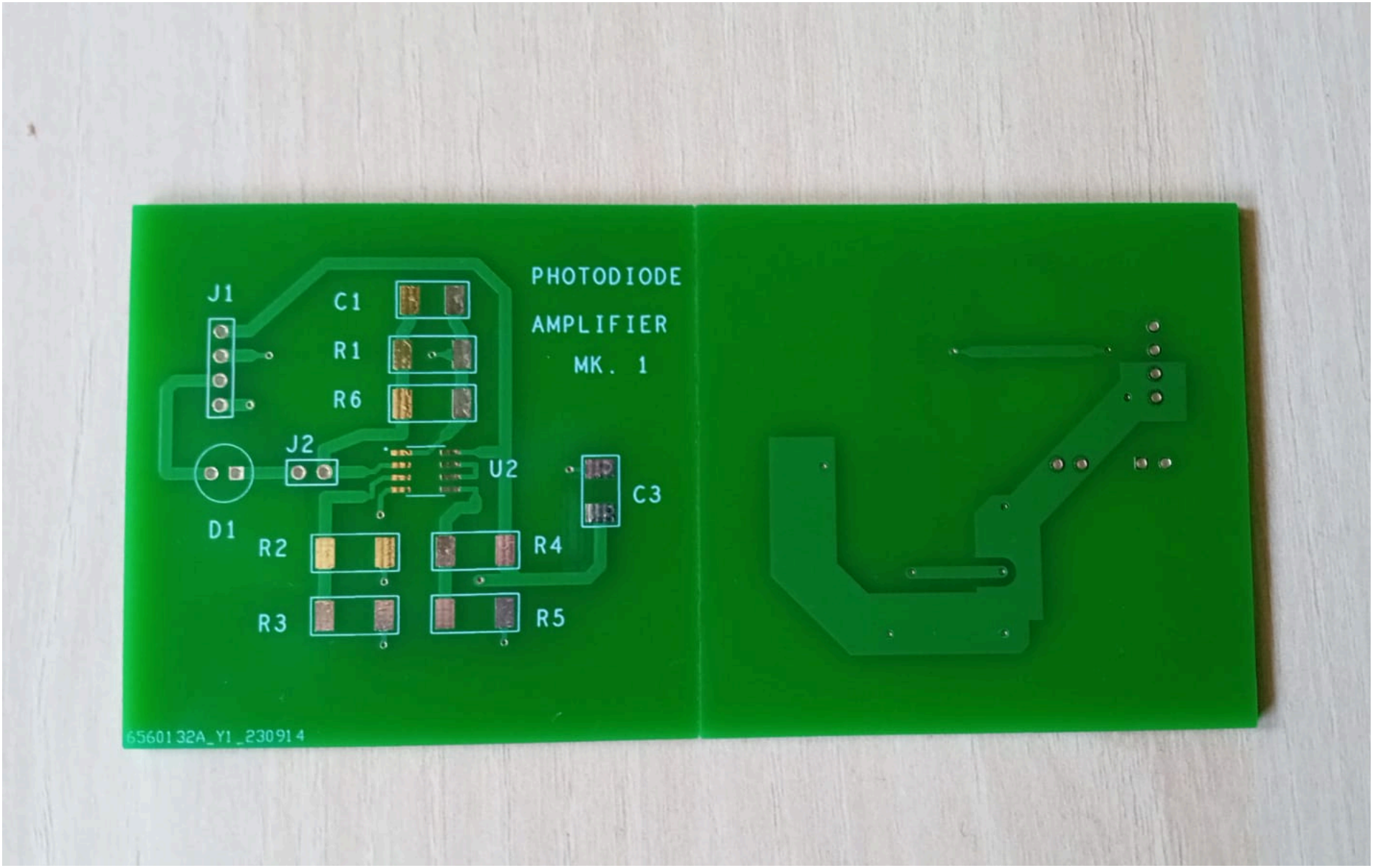
6560132A_Y1_230914


PHOTODIODE
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Issues

In this section the main issues and solutions to the amplifier board design are presented.

- Used two 2X 2.5mm screw terminals without lateral rails instead of 4x 2.5mm screw terminal => issues with spacing
- IR photodiode is too close to the terminals
- Terminals should be moved more to the side
- Better connector for ammeter connection: instead of 2.54mm header use something else, like a JST connector
- The PCB should be a rounded rectangle with M3.5 mounting holes at every corner
- The opamp should either be bigger or use passive components more appropriate in size to the SO8 footprint
- Except for the feedback resistor, the others should be 10K instead of 100K to not affect the stability of the circuit
- The PD is reversible and cand have and additional bias voltage, but needs to have another type of connector, because soldering and desoldering it won't work every time
- To have a better learning platform I should add more test points and a develop a IR emitter-based test fixture as well as a nano-Ampere current sensor for the PD current
- Unused second op amp should be used as a buffer for the DC offset of the main TIA
- Add 0.1uF and 1uF filter capacitors as close as possible to opamp
- Narrower traces could be used
- make single vcc plane or physically separate VCC from output signal

Other observations:

- Some op amps purposefully designed to be used as TIAs will have gains exceeding 1M, most jellybean op amps will have at most 100K or less
- The slew-rate (SR) [V/us] should be way bigger than for a jellybean part: i.e. the LM358 has a SR of 0.5V / us; Testing the LM358 as a precision diode, I've learned that even modest 10kHz sine waves experience distortion due to the low slew-rate
- Offset voltage should be as low as possible (tens to at most hundreds of microvolts)
- Differential capacitance and Common Mode capacitance should be specified in the d/s