LED DRIVER PROJECT

DESIGN FINDINGS

LF50CDT-TRY LDO

Finding 1: Two Parallel LDO

- Why are there two LDOs producing the same 5V output? A single LDO seems to be sufficient in terms of current capability.
  Maybe you misunderstood the multi-output supply topologies in the datasheet (Page 35)?

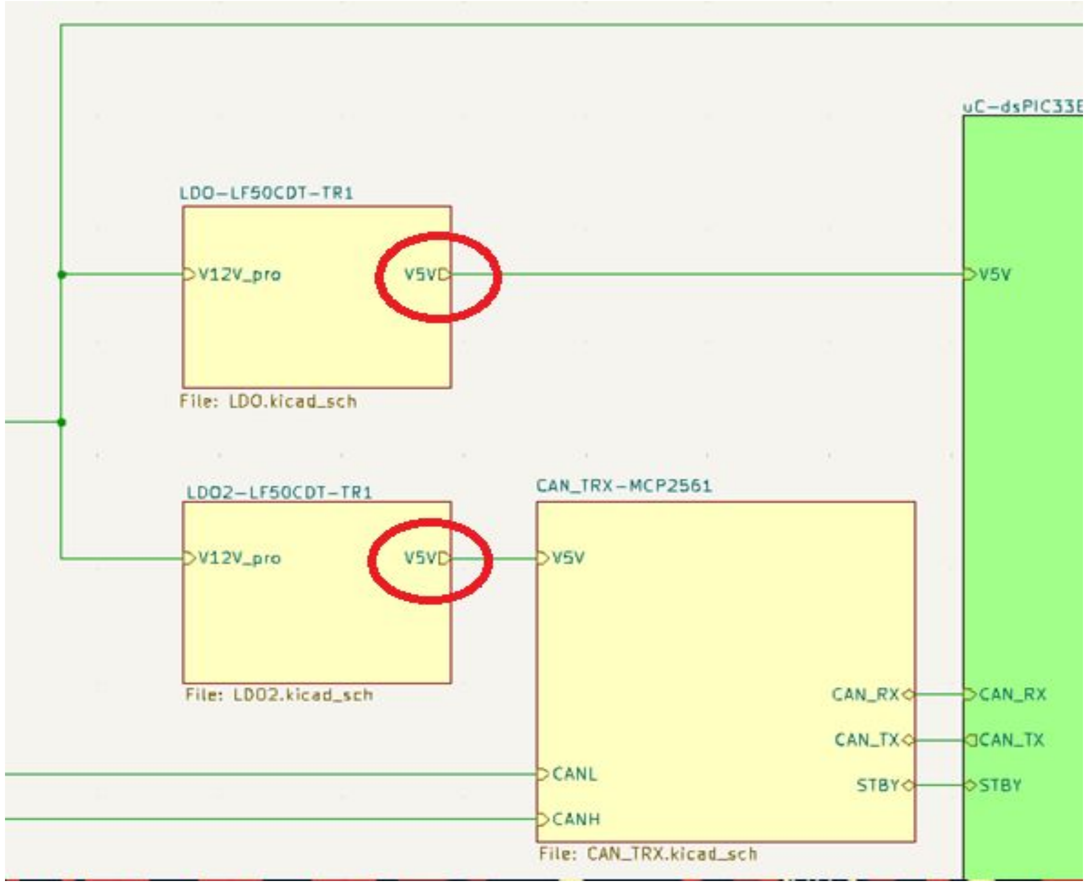


Figure 10: Logic-controlled precision 3.3/5.0 V selectable output

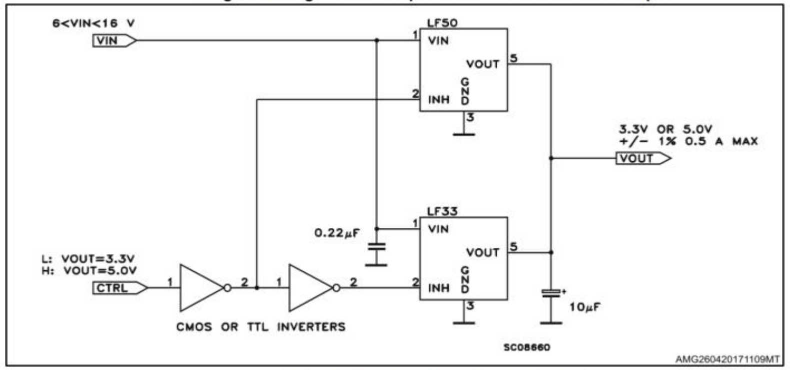
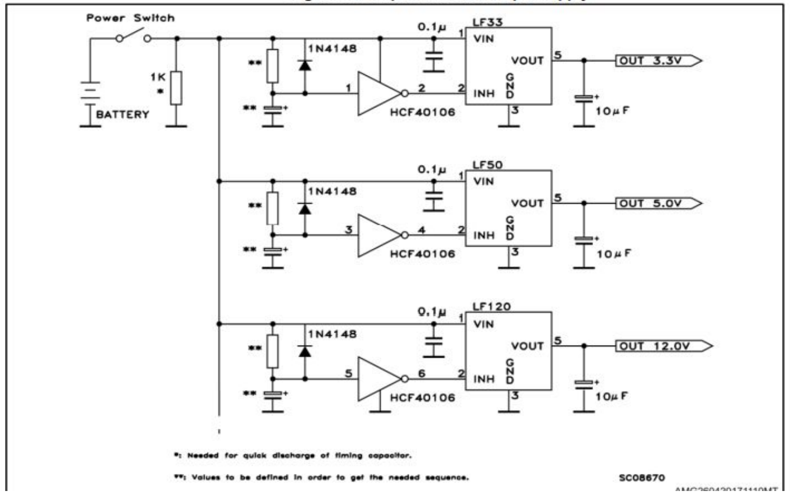
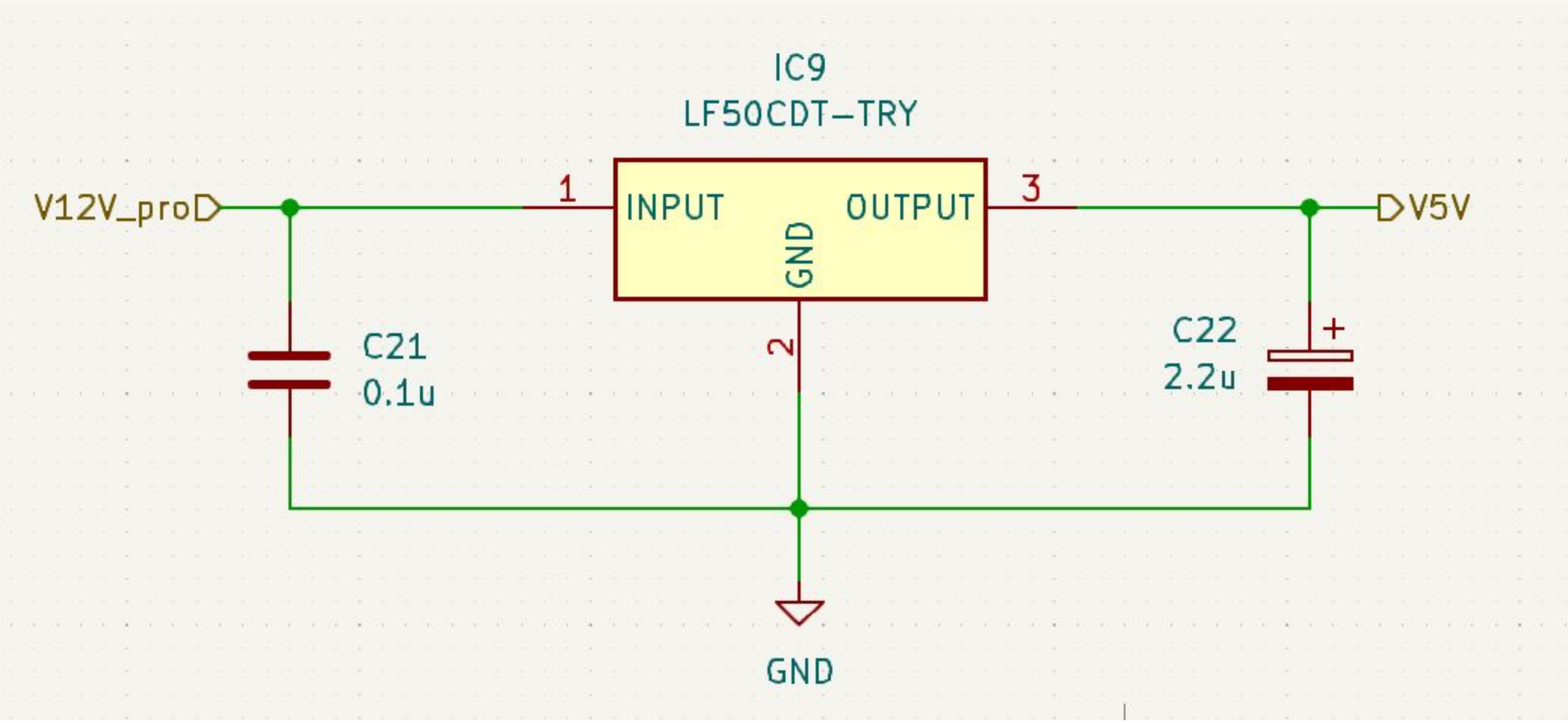


Figure 11: Sequential multi-output supply



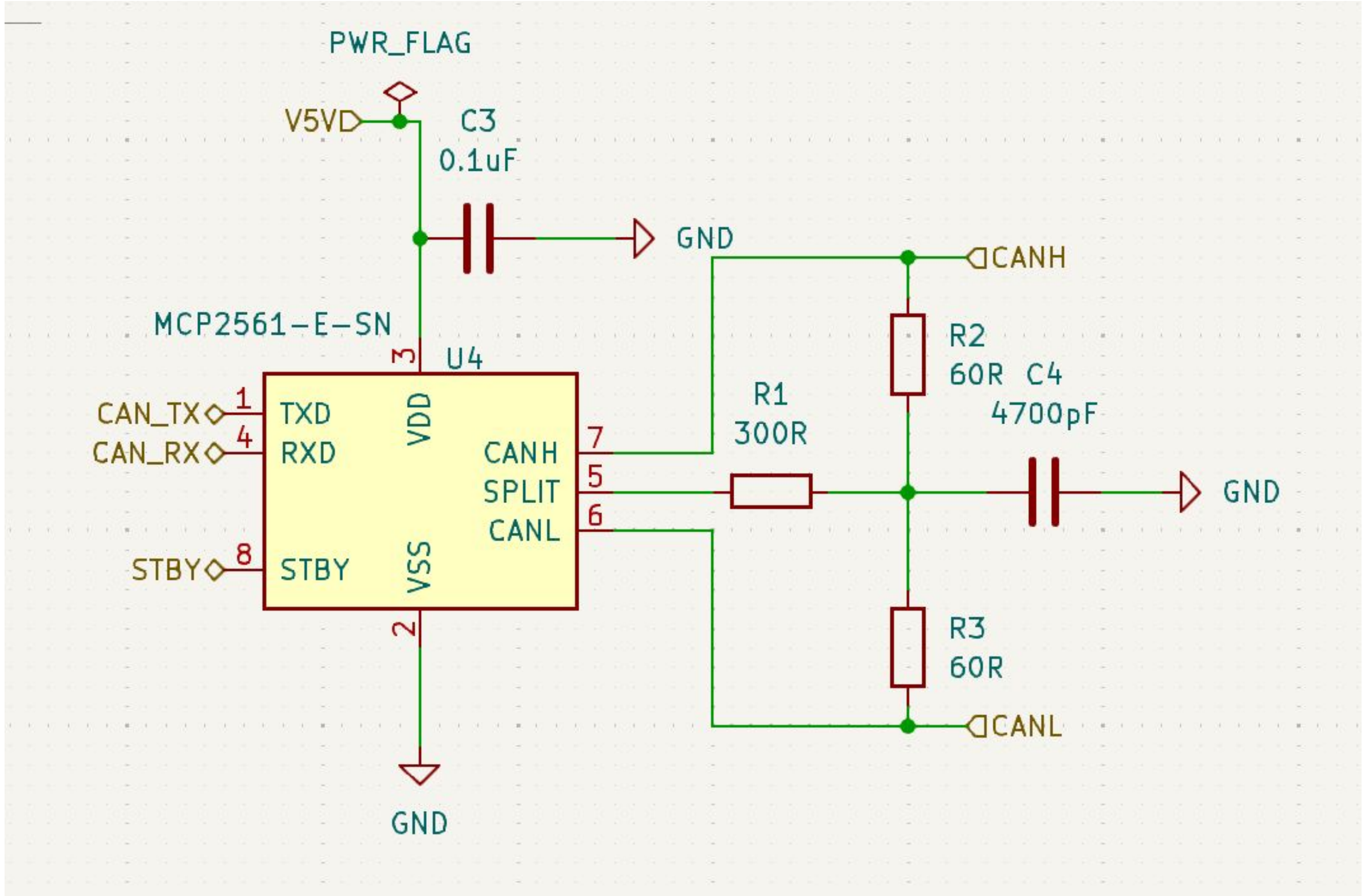
Finding 2: Thermal Issue

- An LDO with 12V input voltage and 5V output voltage was used. Issues such as power dissipation and thermal analysis should be evaluated by considering parameters such as ambient temperature and output current. I suggest you research this topic.



CAN INTERFACE

Finding 3: Use of TVS and CMC

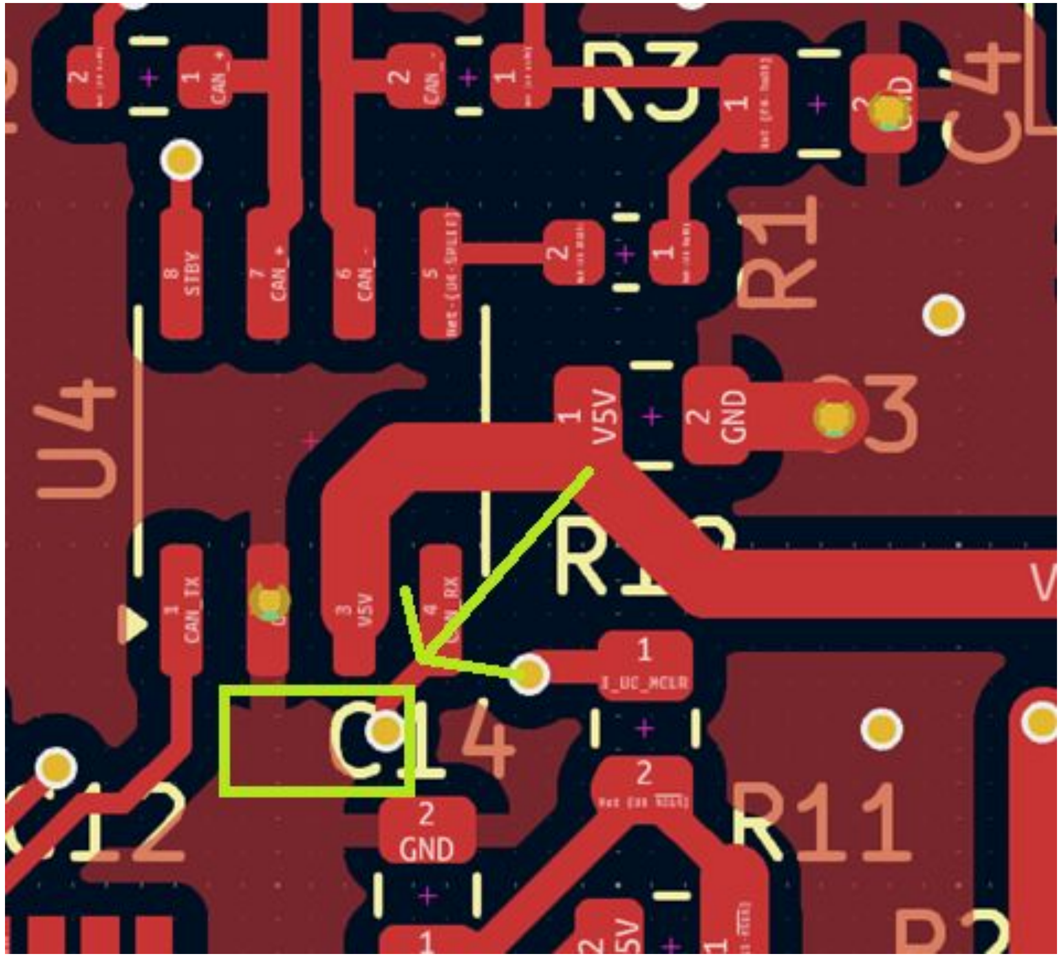


- The following documents about the use of TVS (Transient-voltage-suppression diode, CMC (Common Mode Choke) for CAN Communication interfaces should be examined. You can also get information about the layout placement of these components.

https://www.onsemi.com/pub/Collateral/AND8169-D.PDF

https://www.onsemi.com/pub/Collateral/AND8253-D.PDF

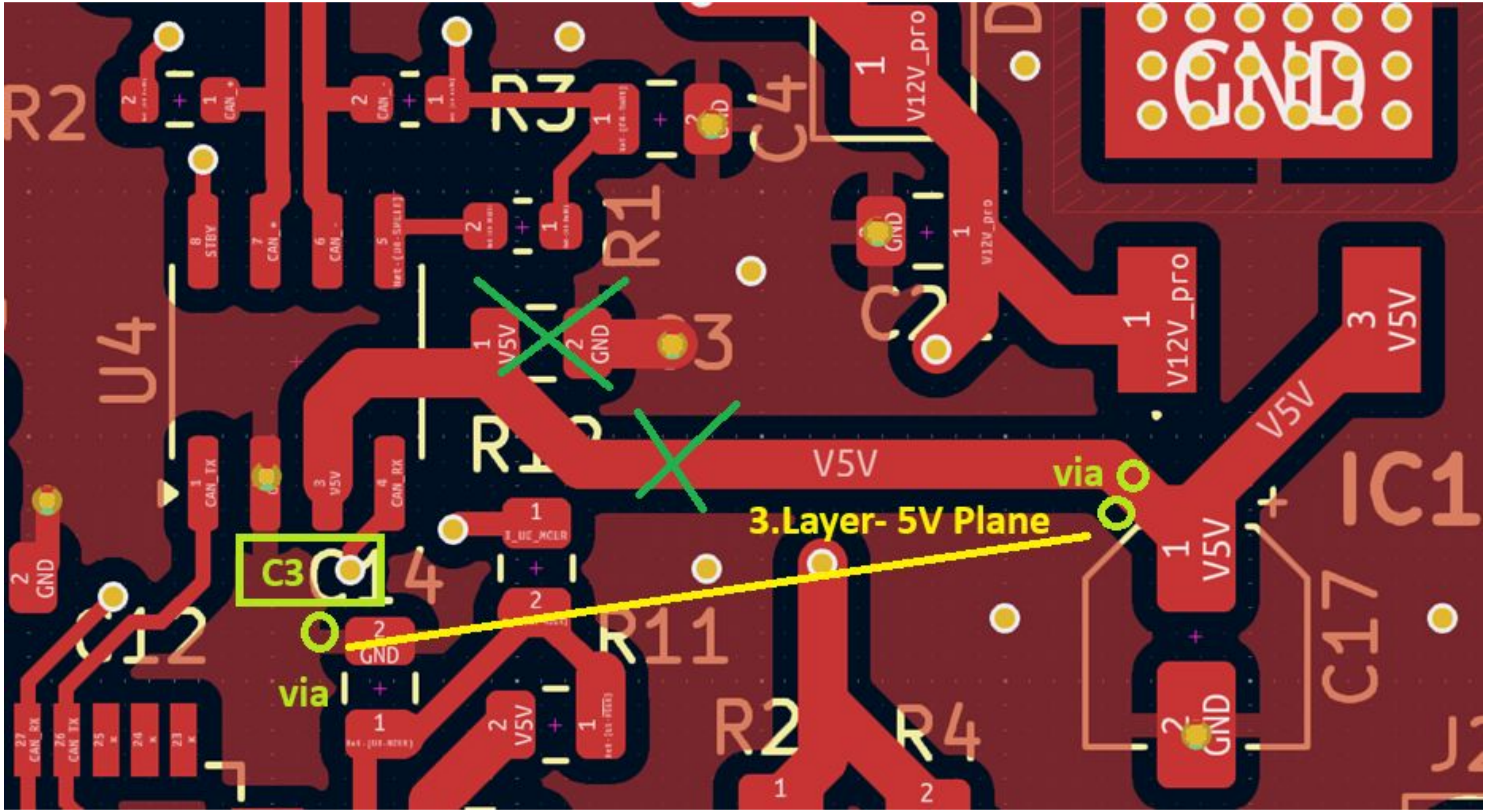
Finding 4: Capacitor Placement



- Capacitor C3 can be placed closer to the VDD pin.

Finding 5: 5V Track and PLANE

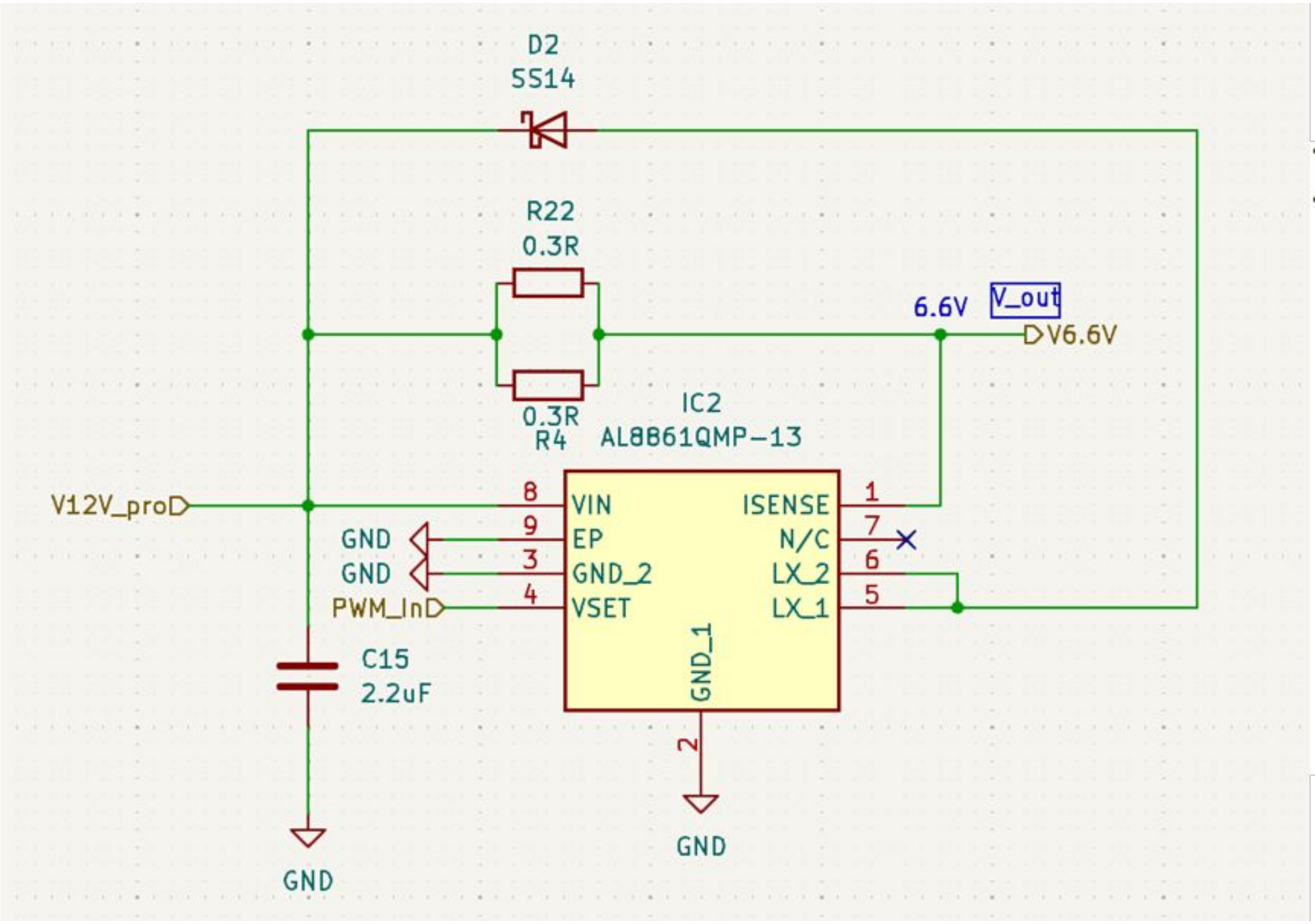
- There is already a 5V plane on the 3rd layer, so you can disconnect this 5V TRACK connection and transmit 5V through the plane on the 3rd layer with vias. In this way, you will have less problems with current capability and voltage drop.

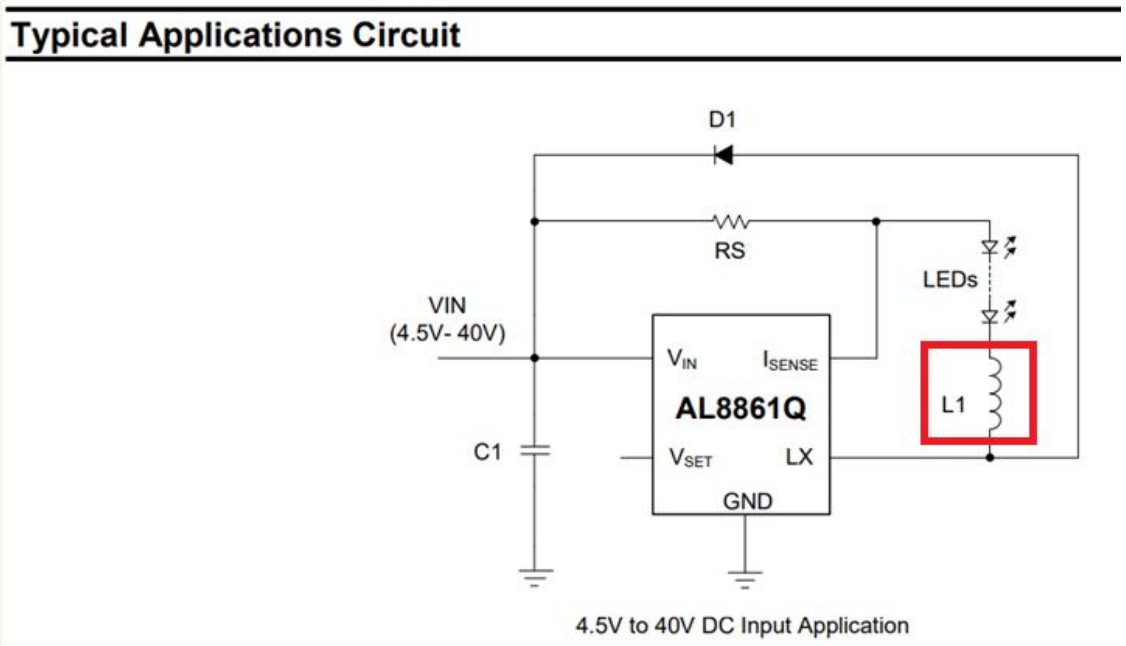


AL8861Q LED DRIVER

Finding 6: Inductor

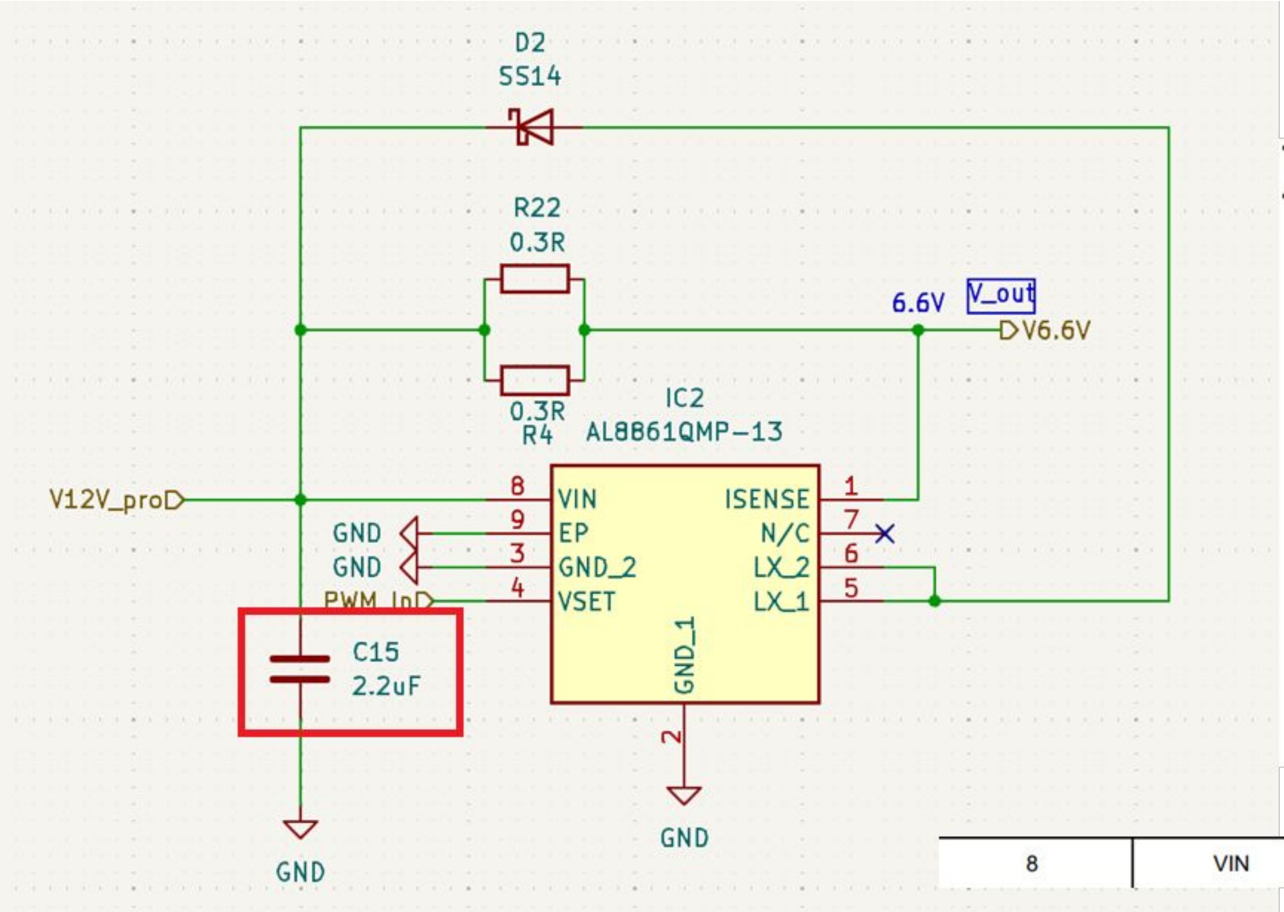
- The L1 inductor does not seem to be included in the schematic. By examining the datasheet and calculating its value, it can be added to the board in line with the suggestions in the datasheet.



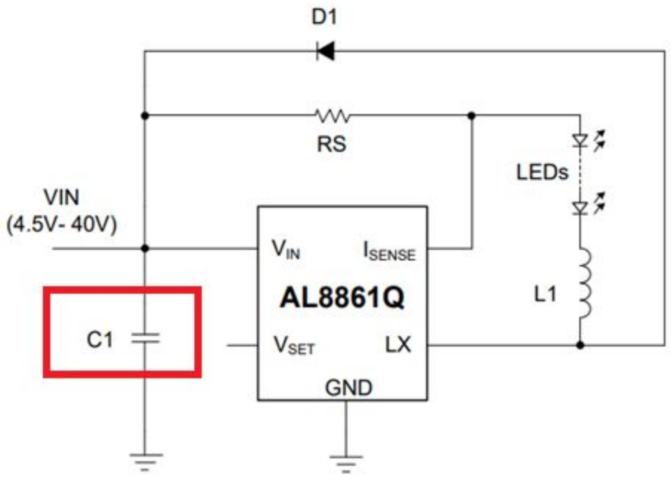


Finding 7: C15 Capacitor Value

- For the C15 capacitor, the datasheet recommends a value of 10uF or higher.



Typical Applications Circuit



4.5V to 40V DC Input Application

8	VIN	Input Voltage (4.5V to 40V). Decouple to Ground with 10μF or higher X7R ceramic capacitor close to device.

Finding 8: Datasheet Recommendation

- The recommendation section on Datasheet pages 12 and 13 should be examined and applied to the board.

EMI (Electromagnetic Interference) and Layout Considerations

The AL8861Q is a switching regulator with fast edges and measures small differential voltages; as a result, care has to be taken with decoupling and layout of the PCB. To help with these effects, the AL8861Q has been developed to minimize radiated emissions by controlling the switching speeds of the internal power MOSFET. The rise and fall times are controlled to get the right compromise between power dissipation due to switching losses and radiated EMI. The turn-on edge (falling edge) dominates the radiated EMI which is due to an interaction among the Schottky diode (D1), Switching MOSFET and PCB tracks. After the Schottky diode reverse-recovery time of around 5ns has occurred, the falling edge of the LX pin sees a resonant loop between the Schottky diode capacitance and the track inductance, L_{TRACK}. See Figure 3.

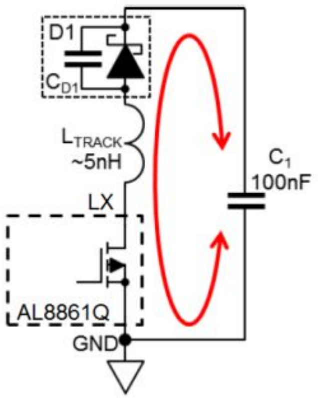


Figure 3. PCB Loop Resonance

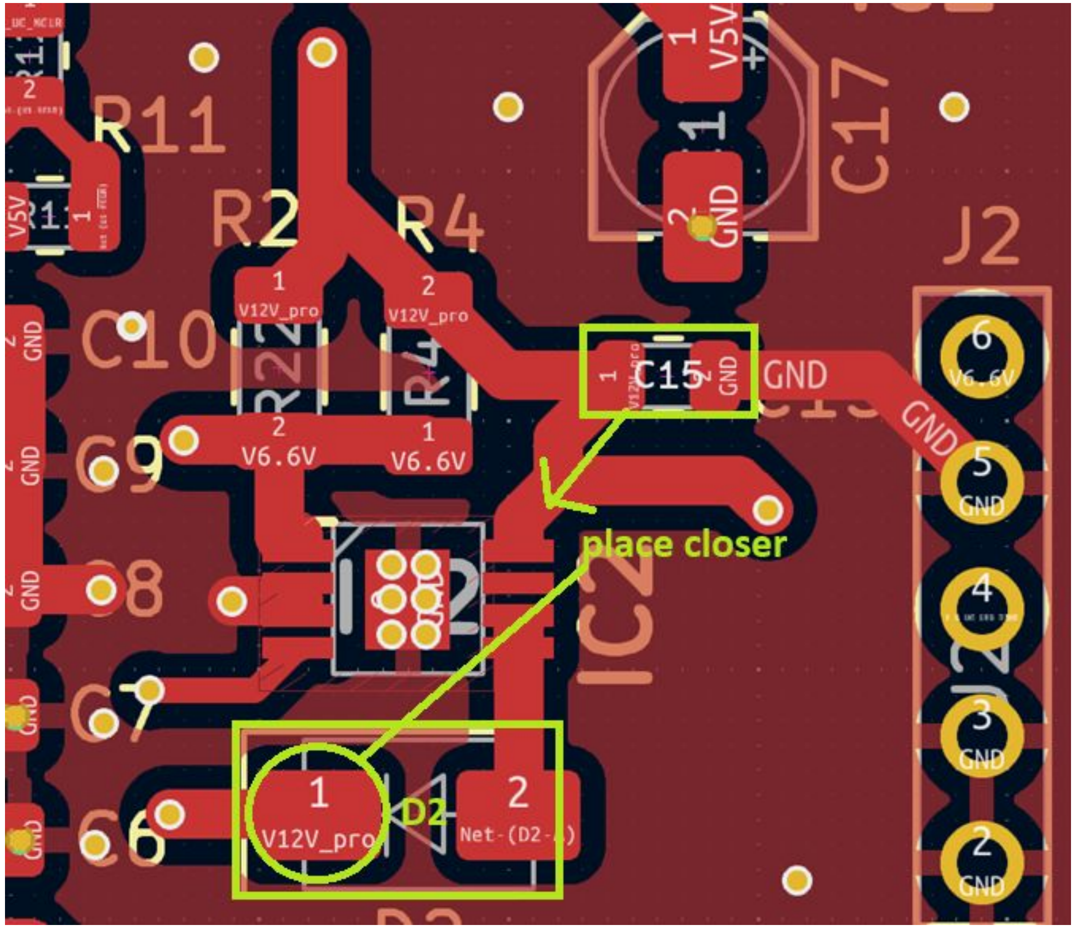
The tracks from the LX pin to the Anode of the Schottky diode, D1, and then from D1's cathode to the decoupling capacitors C1 should be as short as possible. There is an inductance internally in the AL8861Q which can be assumed to be around 1nH. For PCB tracks, a figure of 0.5nH per mm can be used to estimate the primary resonant frequency. If the track is capable of handling 1A, increasing the thickness will have a minor effect on the inductance and length will dominate the size of the inductance. The resonant frequency of any oscillation is determined by the combined inductance in the track and the effective capacitance of the Schottky diode.

Application Information (continued)

Recommendations for minimizing radiated EMI and other transients and thermal considerations are:

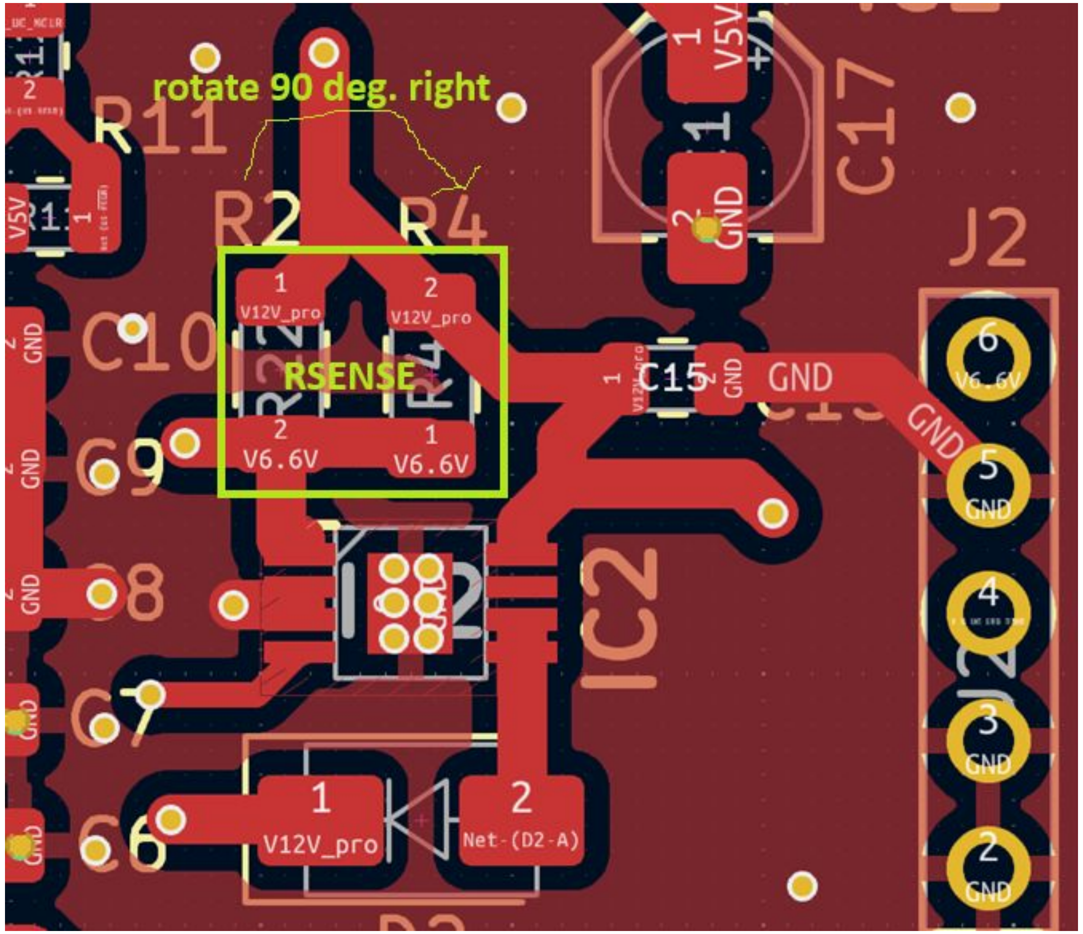
1. The decoupling capacitor (C1) has to be placed as close as possible to the VIN pin and D1 cathode.
2. The freewheeling diode's (D1) anode, the LX pin and the inductor have to be placed as close as possible to each other to avoid ringing.
3. The Ground return path from C1 must be a low impedance path with the ground plane as large as possible.
4. The LED current sense resistor (R_S) has to be placed as close as possible to the VIN and ISENSE pins.
5. The majority of the conducted heat from the AL8861Q is through the GND pin 2. A maximum earth plane with thermal vias into a second earth plane will minimize self-heating.
6. To reduce emissions via long leads on the supply input and LEDs, low RF impedance capacitors should be used at the point where the wires are joined to the PCB.

Finding 9: C15 Capacitor and D2 Diode Placement



- Capacitor C15 should be placed close to the VIN pin.
- It should also be placed close to the cathode of diode D2.

Finding 10: RSENSE Resistors



- If the RSENSE resistors are rotated 90 degrees to the right, they will be placed closer to the VIN and ISENSE pins.

Finding 11: Warning for use of VSET pin

Will the VSET pin be floating? If you are going to use PWM Dimming, I suggest you do another review about how many volts you need to drive the VSET pin here. It is currently driven by the processor with 5V. A statement in the datasheet states that it should be driven with 3.3V. However, if VSET will be left floating, then there seems to be no need for any change.

Analog Dimming

Applying a DC voltage from 0.3V to 2.5V on the VSET pin can adjust output current from 0 to 100% of I_{OUTNOM}, as shown in Figure 1. The recommended dimming range is from 5% to 100%. If the VSET pin is brought higher than 2.5V, the LED current will be clamped to 100% of I_{OUTNOM}. And the output switch will turn off if the VSET pin voltage falls below the threshold of 0.3V.

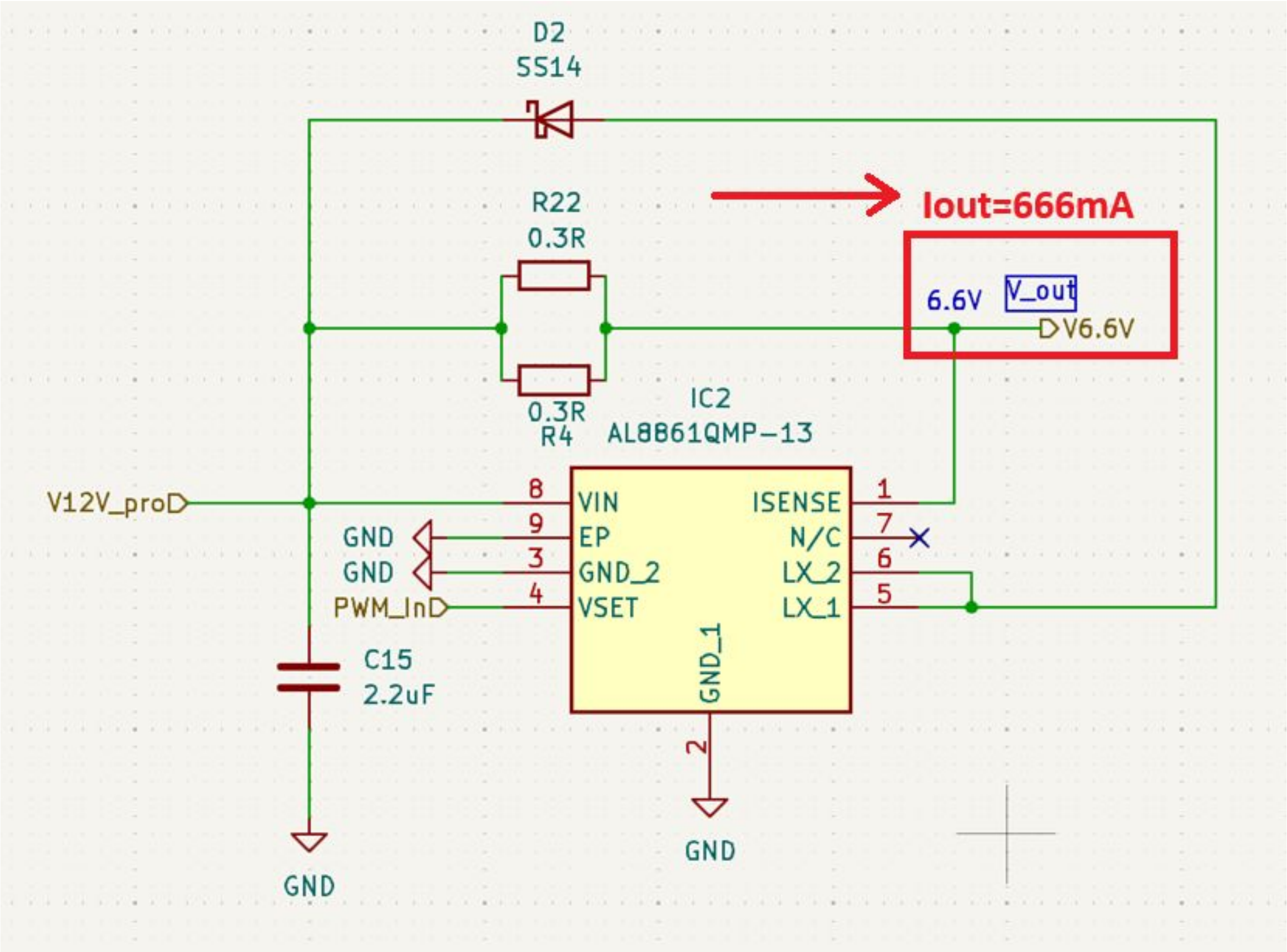
PWM Dimming

The LED current can be adjusted digitally by applying a low-frequency pulse-width-modulated (PWM) logic signal to the VSET pin to turn the device on and off. This will produce an average output current proportional to the duty cycle of the control signal. To achieve a high resolution, the PWM frequency is recommended to be lower than 500Hz. However, high dimming frequencies can be used at the expense of dimming dynamic range and accuracy. Typically, for a PWM frequency of 500Hz, the accuracy is better than 1% for PWM ranging from 1% to 100%.

The accuracy of the low duty-cycle dimming is affected by both the PWM frequency and the switching frequency of the AL8861Q. For best accuracy/resolution, the switching frequency should be increased while the PWM frequency should be reduced.

The VSET pin is designed to be driven by 3.3V logic level directly from a logic output with either an open-drain output or a push-pull output stage.

Finding 12: Question ?



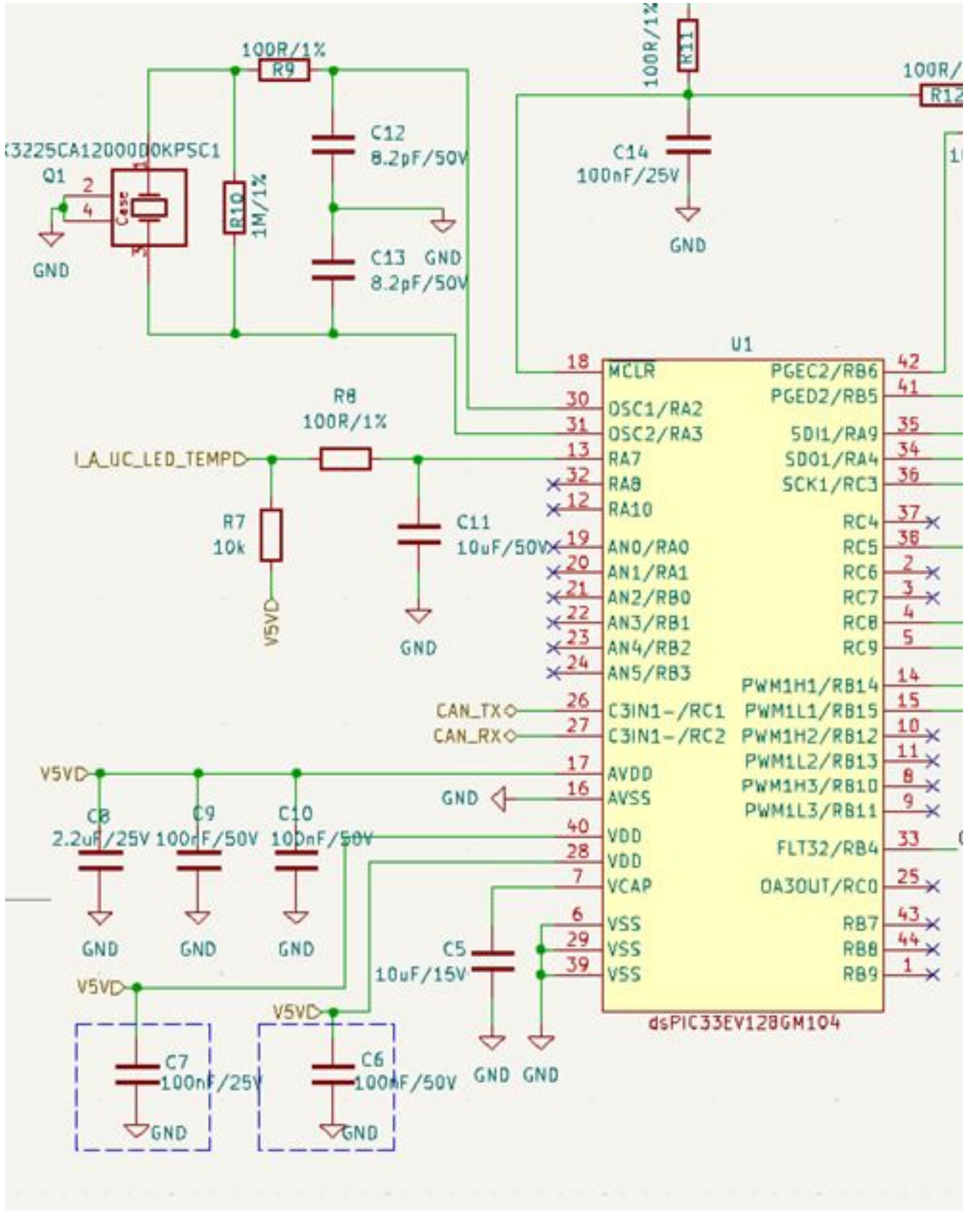
- Where does 6.6V come from? How was 667mA decided? I don't understand the relationship between 6.6V Vout and Iout 667mA, so I can't make a comment.

Rs (Ω)	Nominal Average Output Current (mA)
0.066	1500
0.1	1000
0.13	760
0.15	667
0.3	333

- Answer:

dsPIC33EV128

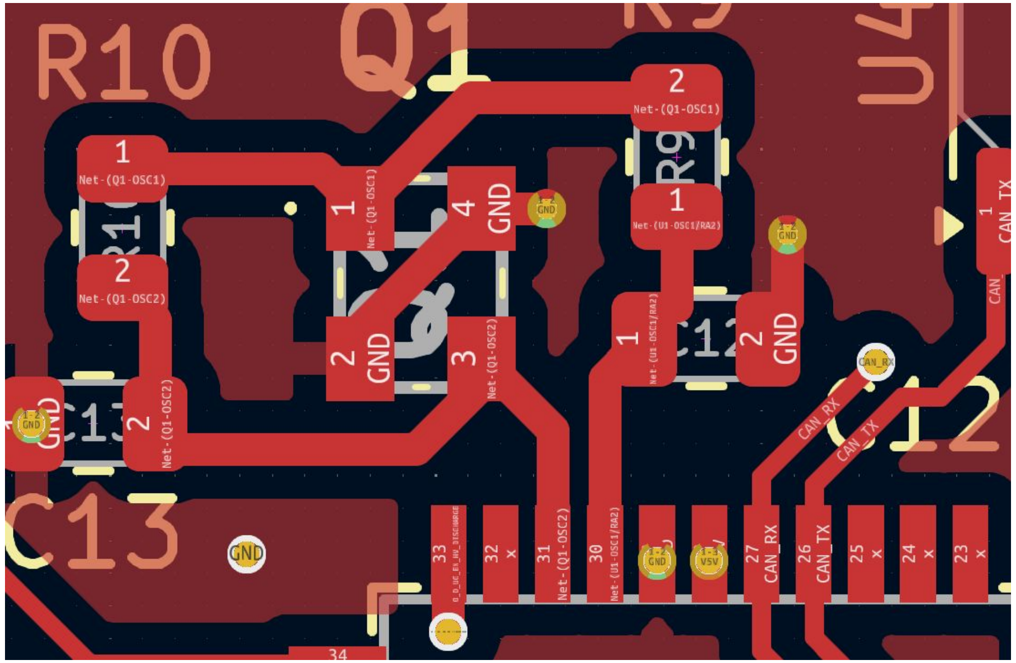
Finding 13: Oscillator



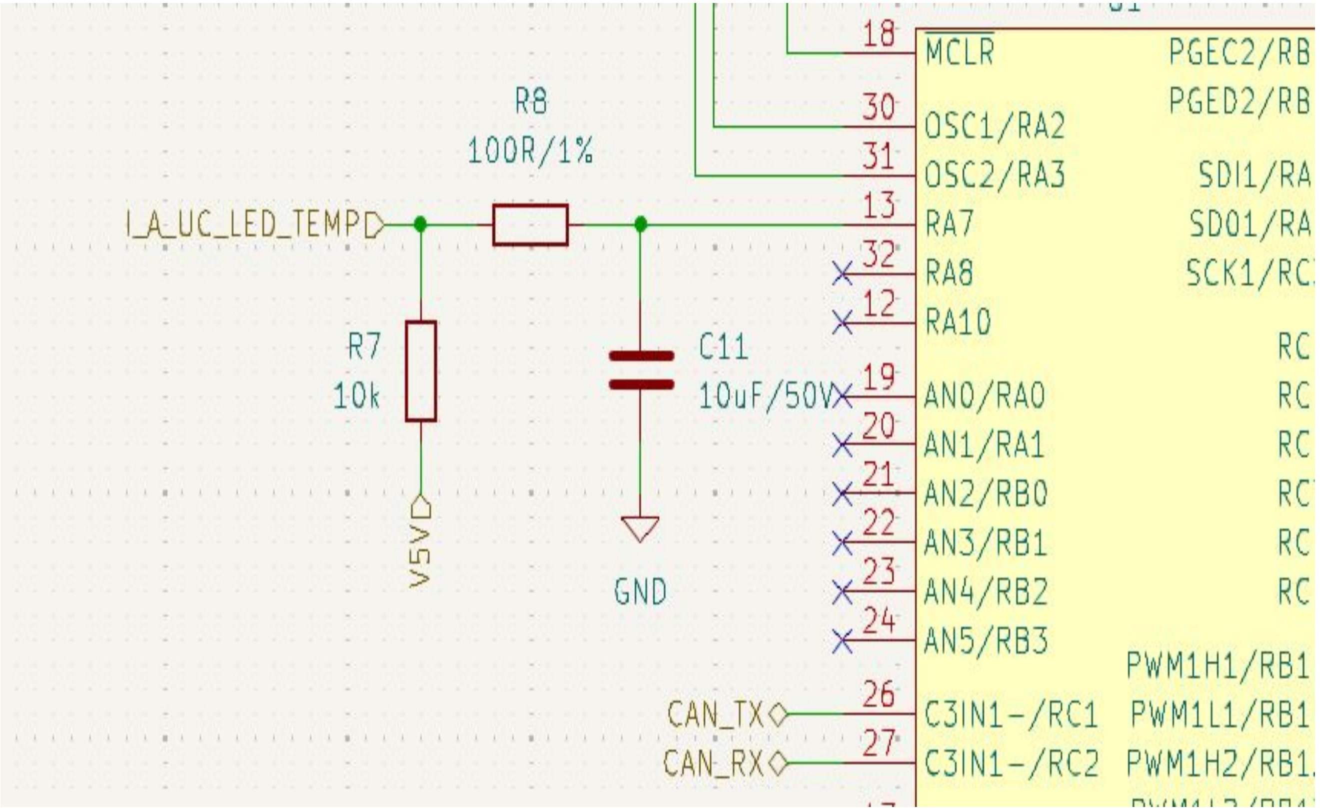
- There is no stock of the CX3225CA12000D0KPSC1 oscillator. There may be a problem if the board is produced.

- The layout of the oscillator can be done better. Try to make the oscillator signals as short as possible.

- You can review the application notes on how the oscillator layout should be (Tip: It may be more effective to rotate it 90 degrees to the right)

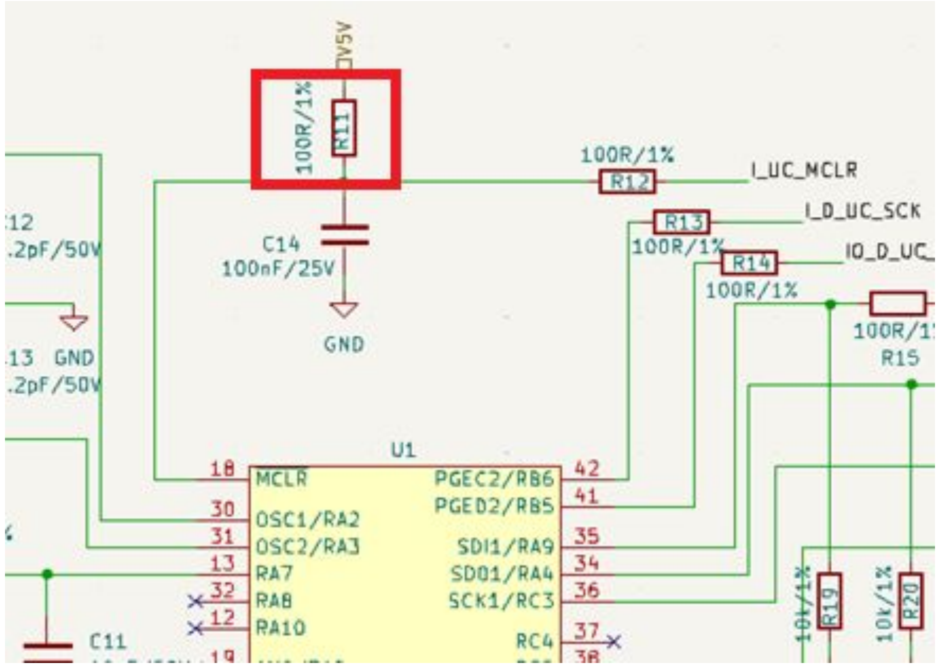


Finding 14: Low Pass Filter



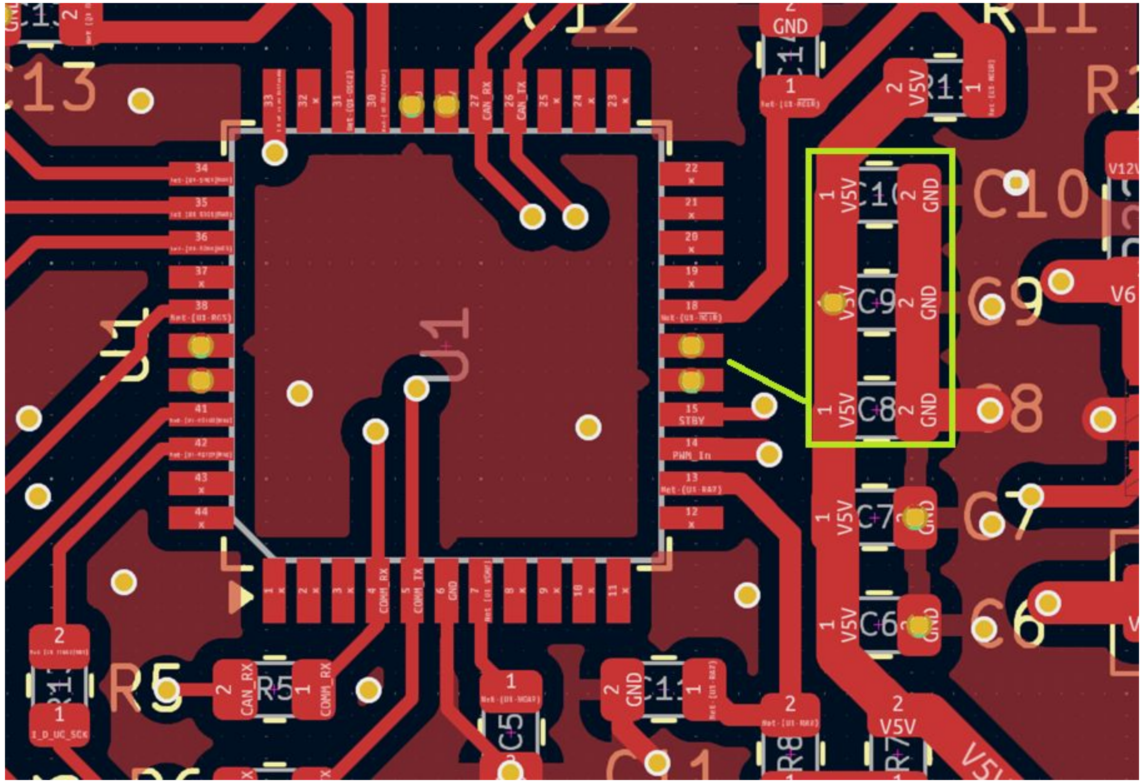
- 10uF (C11 Capacitor)is high value for an RC filter, 10nF is preferable instead of 10uF.

Finding 15: Pull-up Resistor



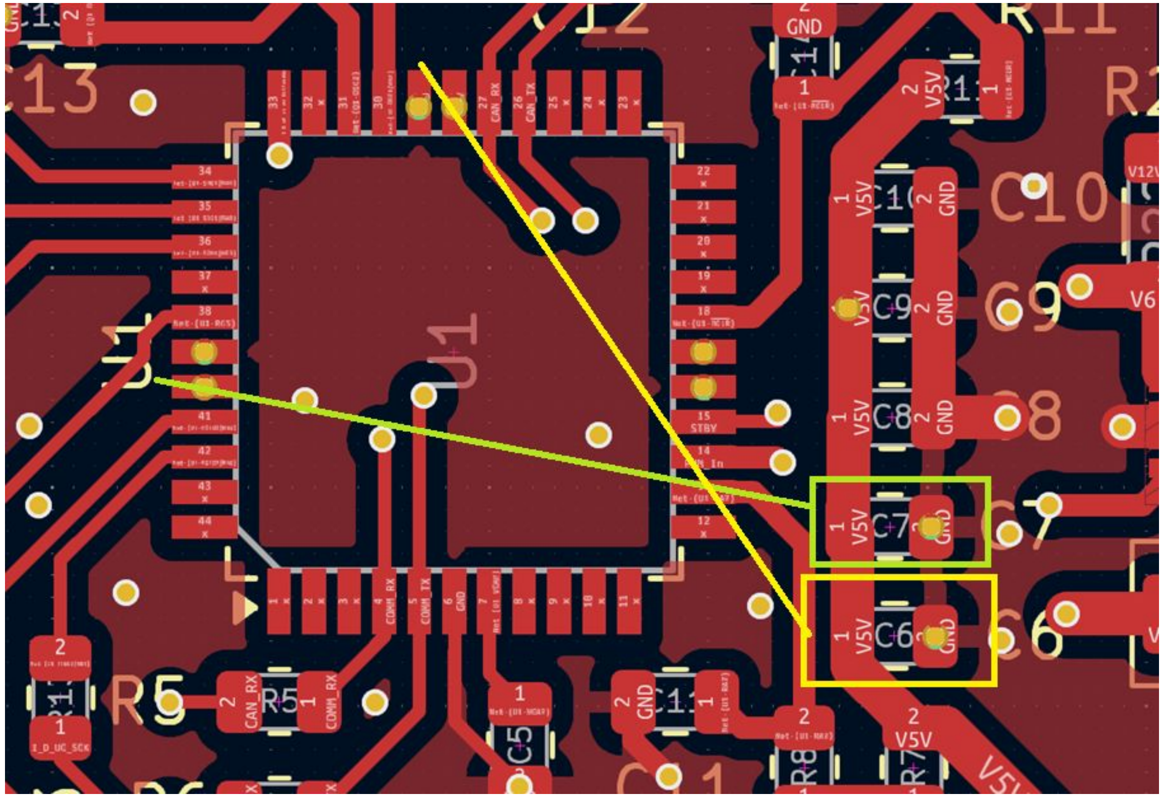
- In terms of current limitation, 10kohm resistor can be preferred instead of 100ohm R11 pull up resistor.

Finding 16: Capacitor Placement



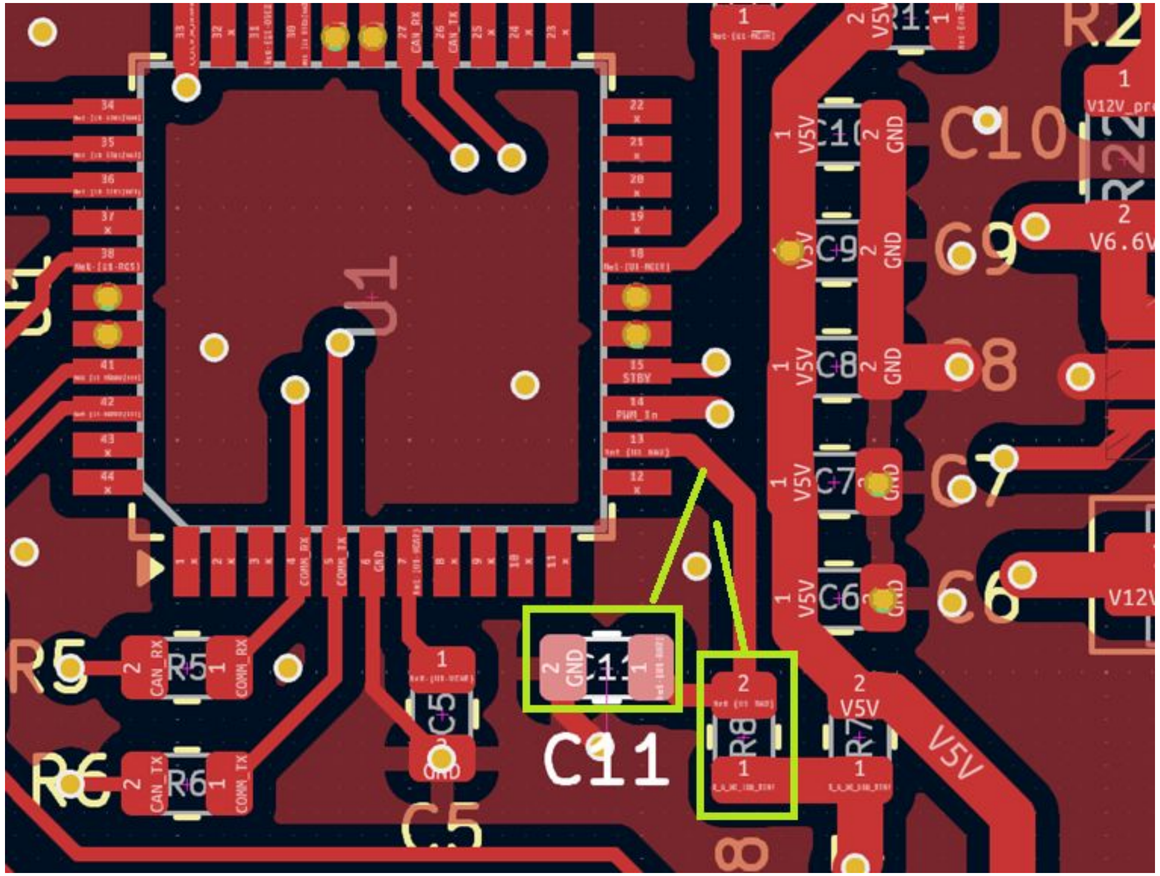
- Capacitors C8-C9-C10 should be placed as close as possible to pin 17 to reduce parasitic and lower the inductance of the path.
- Make sure that small value capacitors (100nF) are closer to the pin.

Finding 17: Capacitor Placement



- Capacitors C6-C7 must be placed close to the corresponding pins.

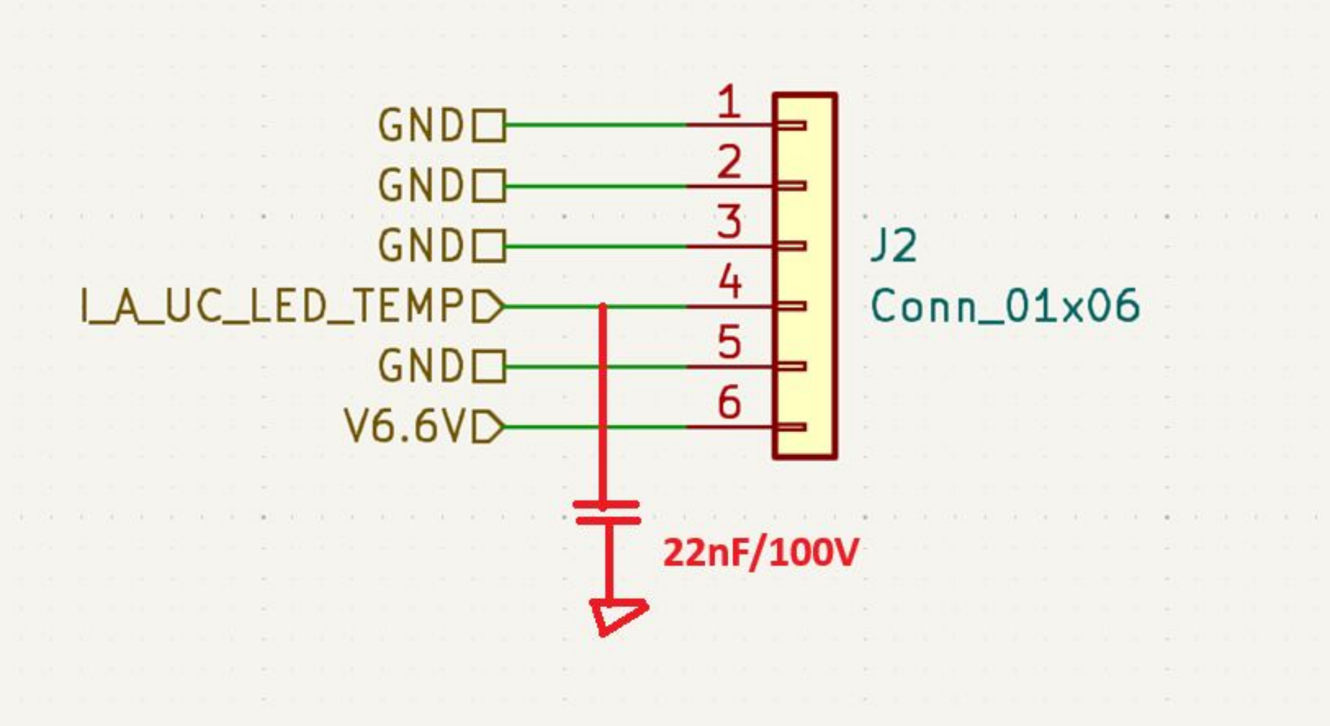
Finding 18: Low Pass Filter Placement



- R8-C11 low pass filter components should be placed as close as possible to the relevant pin. (Tip: Since C7 and C8 capacitors will be moved up, these components can be shifted to the free space).

Connector-2

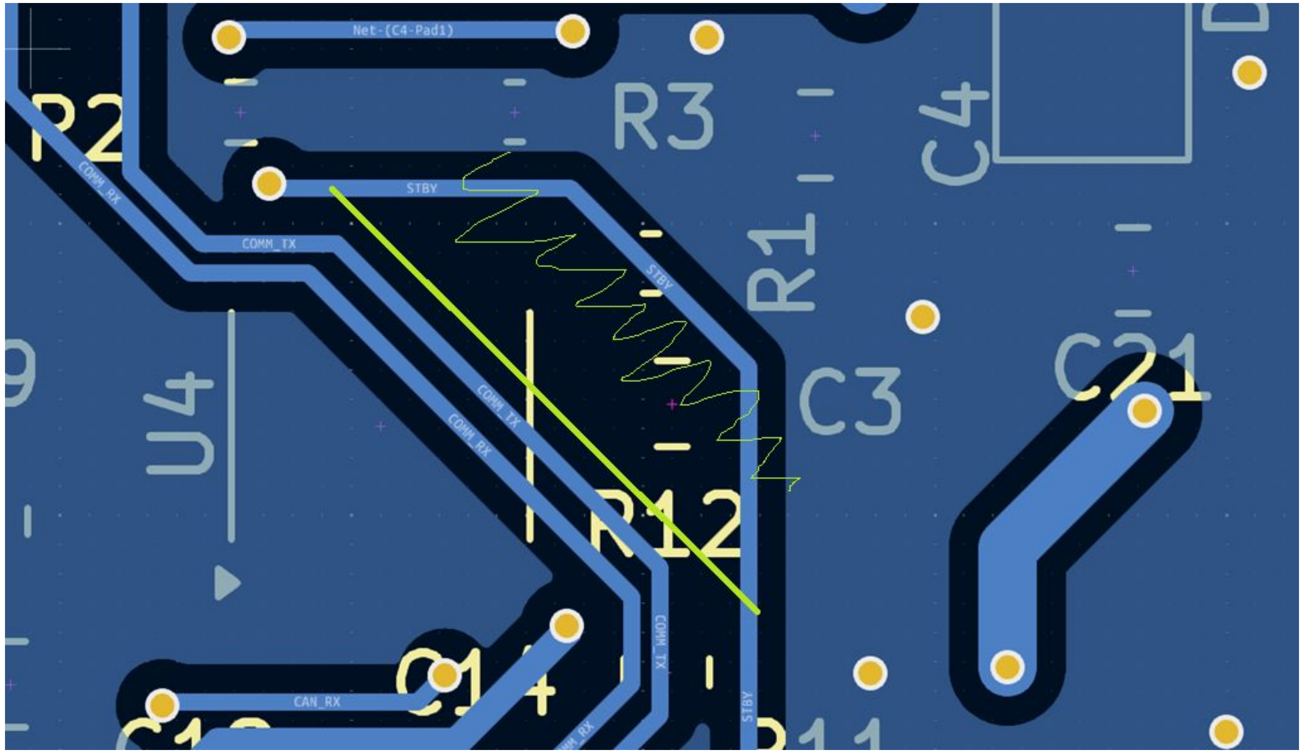
Finding 18: ESD Capacitor



- It is recommended to use 22nF/100V ESD capacitor for external signals to the board.

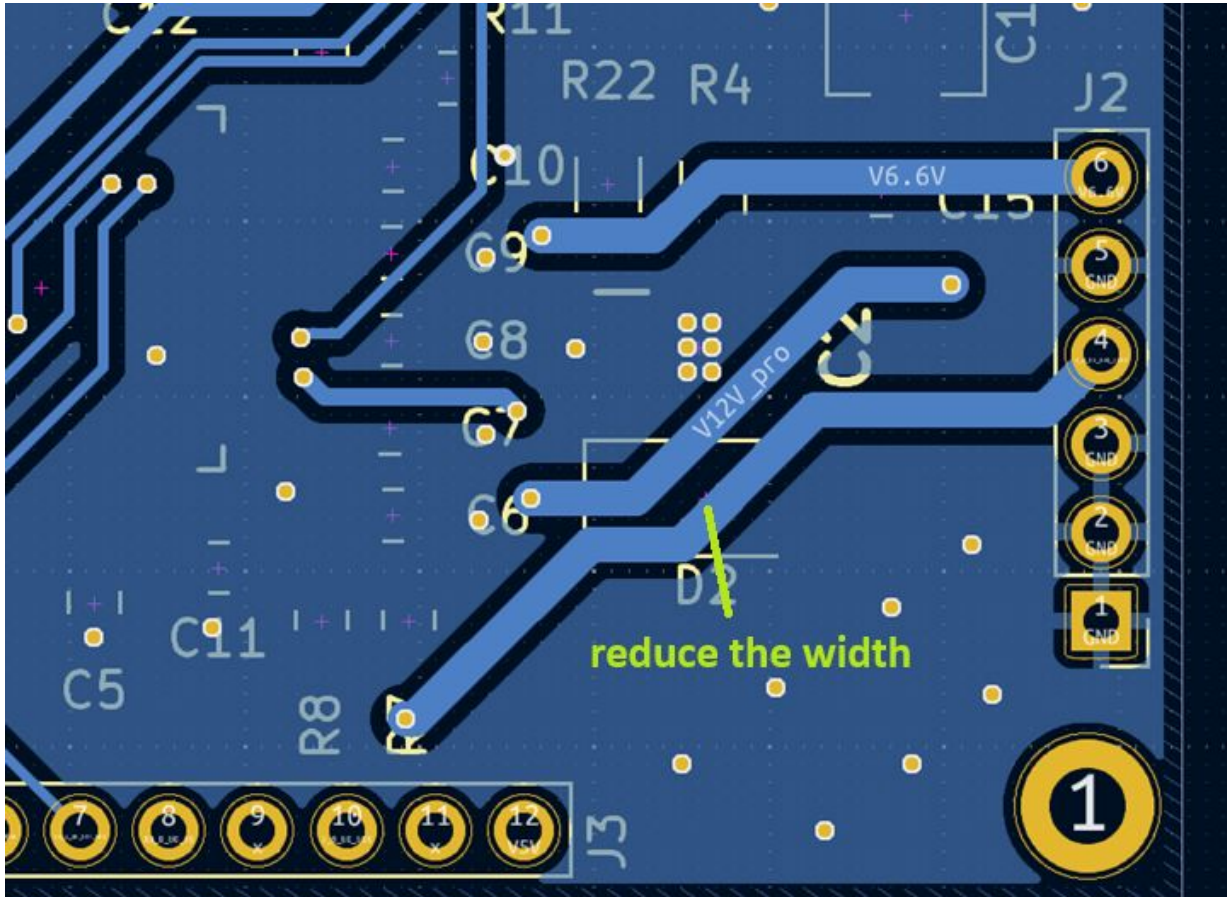
Layout Issues

Finding 19: EMC and EMI Improvement



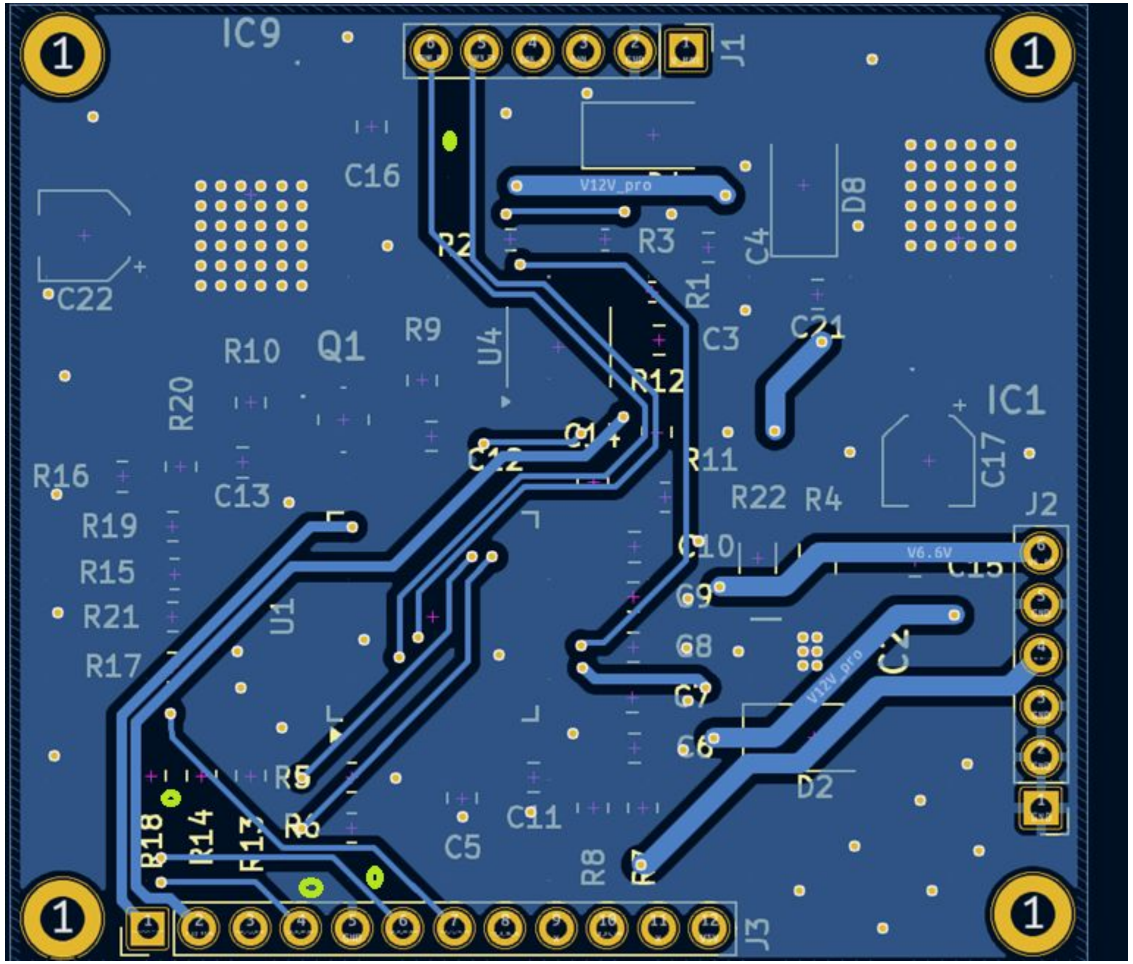
- If you shorten the STBY signal as shown in the image, the hatched area is filled with GROUND and the board is improved in terms of EMC and EMI.

Finding 20: EMC and EMI Improvement



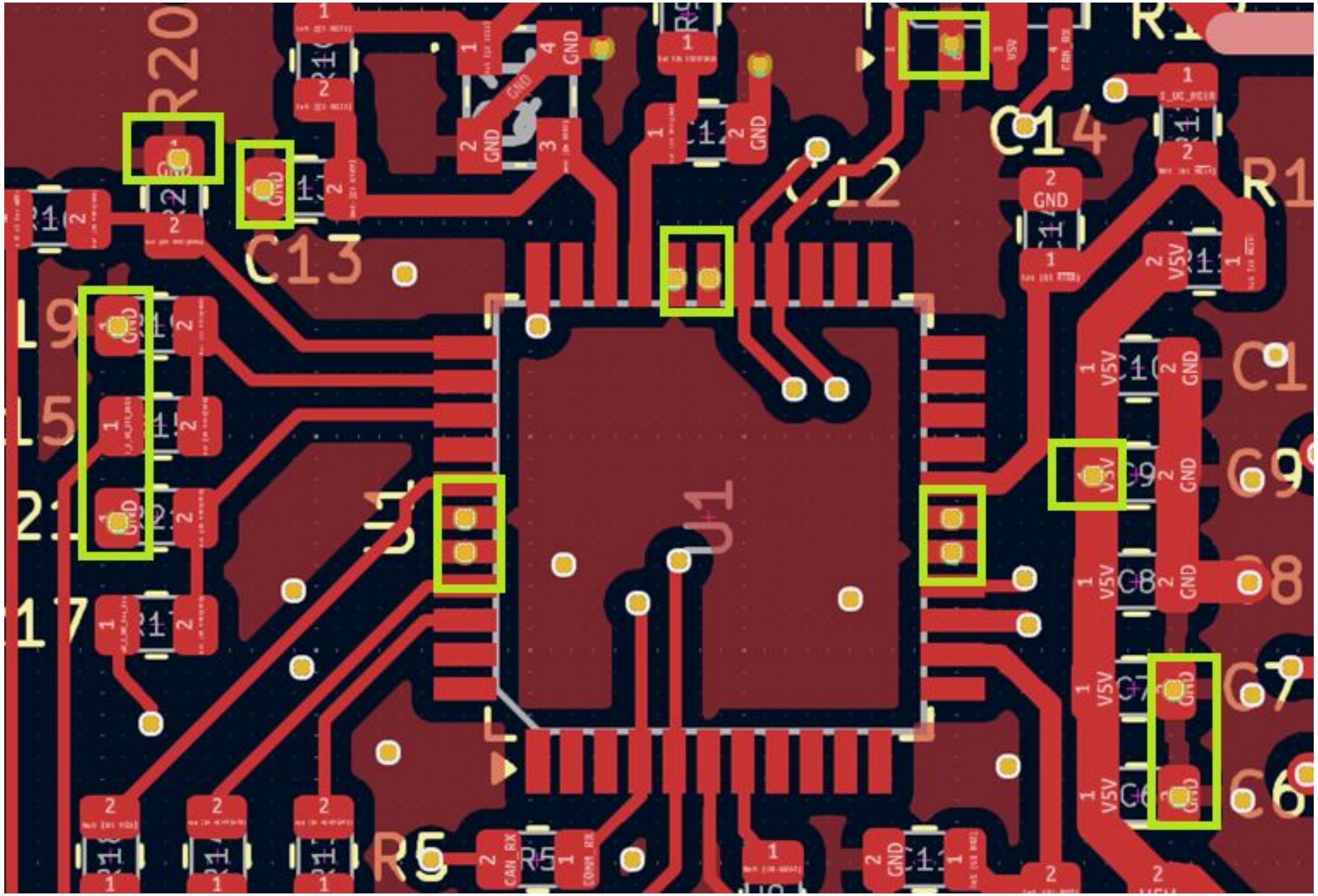
- The LED_TEMP signal will not carry a very high current, so the trace width does not need to be very wide. You can reduce the trace width so that you can fill the space between the 12V power line and this signal with GROUND copper and improve the quality of the signal.

Finding 21: EMC and EMI Improvement



- The GROUND vias can be placed as green marked and GROUND copper can be filled.

Finding 22: Via-in-Pad

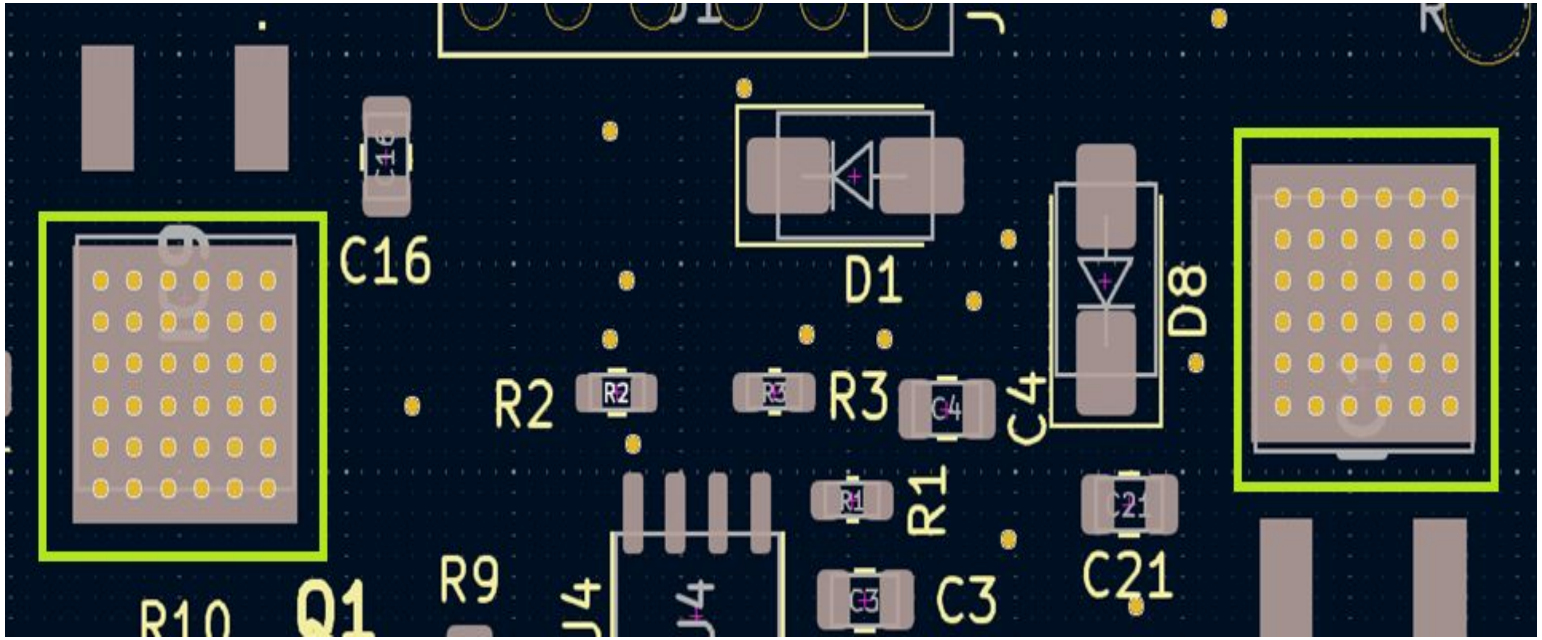


- Via-in-Pad is used on high density circuit boards. It is not required for this board (except for exposed pads). It causes extra cost.
- The vias used on the pads can be placed in empty copper areas.

Finding 23-A: Exposed Pad

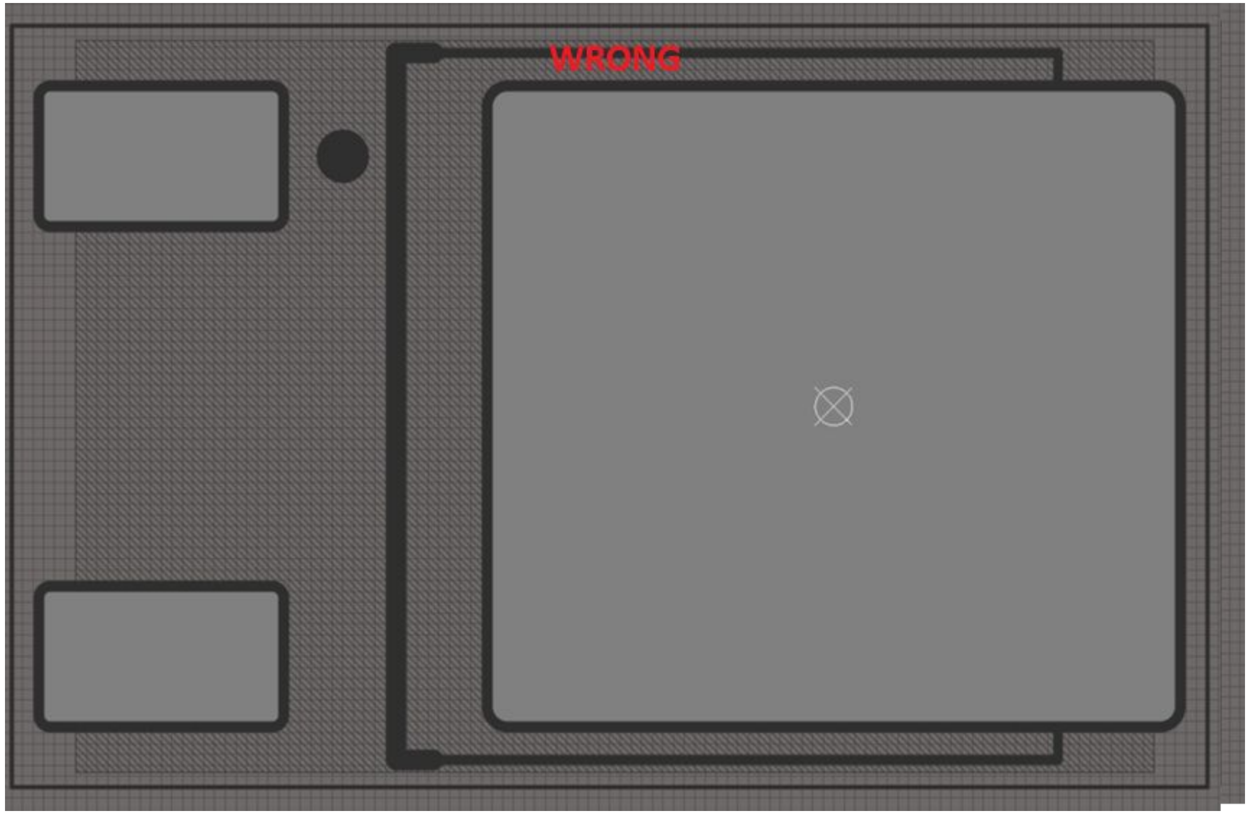
- In PCB design, in order to ensure a smoother and more reliable soldering process, the paste parts on the expose pad of components with large expose pads are usually explored and placed.

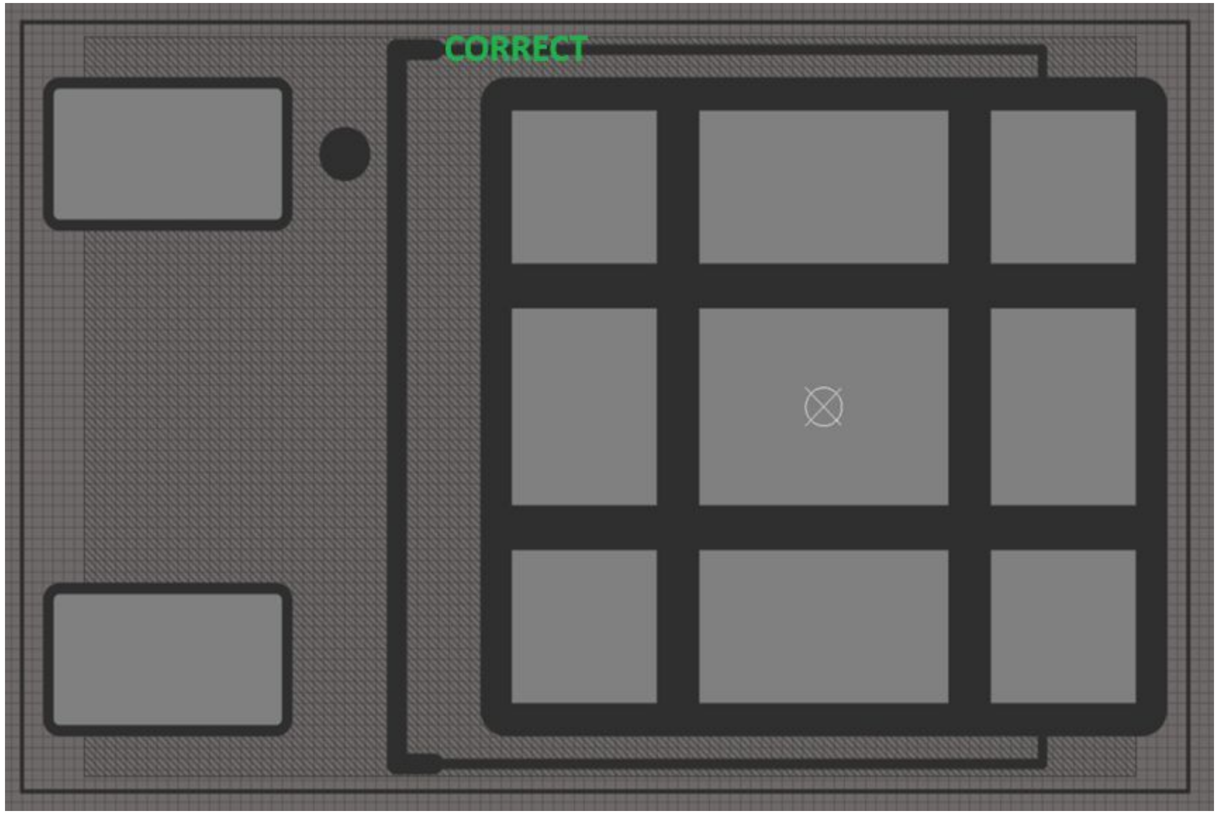
Please check the document:
https://www.infineon.com/dgdl/Infineon-AN72845_Design_Guidelines_For_Infineon_Quad_Flat_No_Lead_%28QFN%29_Packaged_Devices-ApplicationNotes-v04_00-EN.pdf?fileId=8ac78c8c7cdc391c017d0735936858e5



Please check the next page!

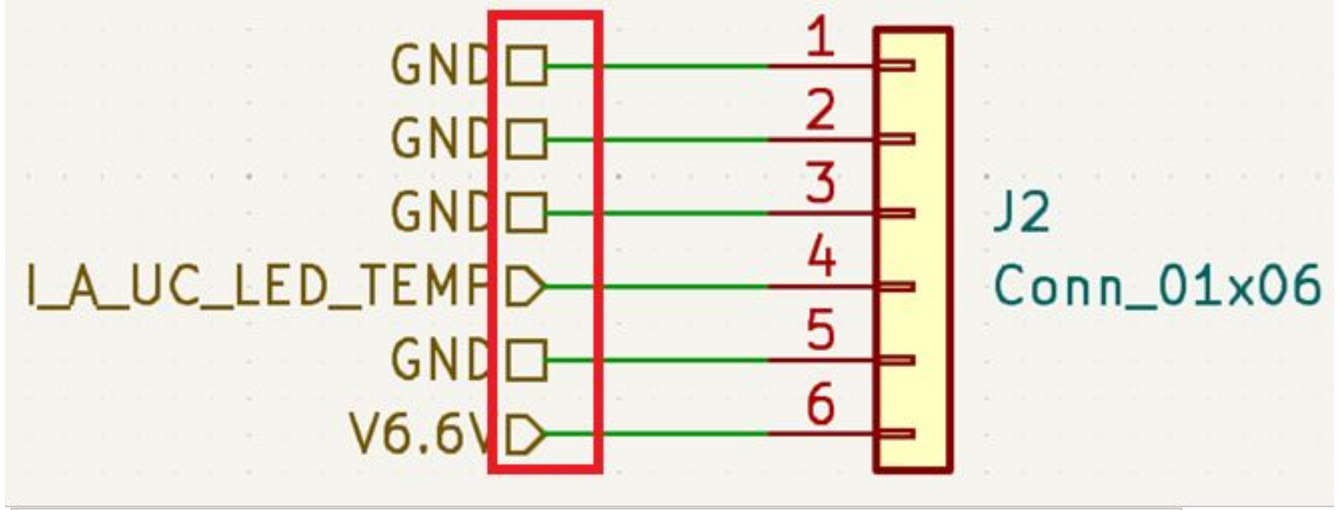
Finding 23-B: Exposed Pad

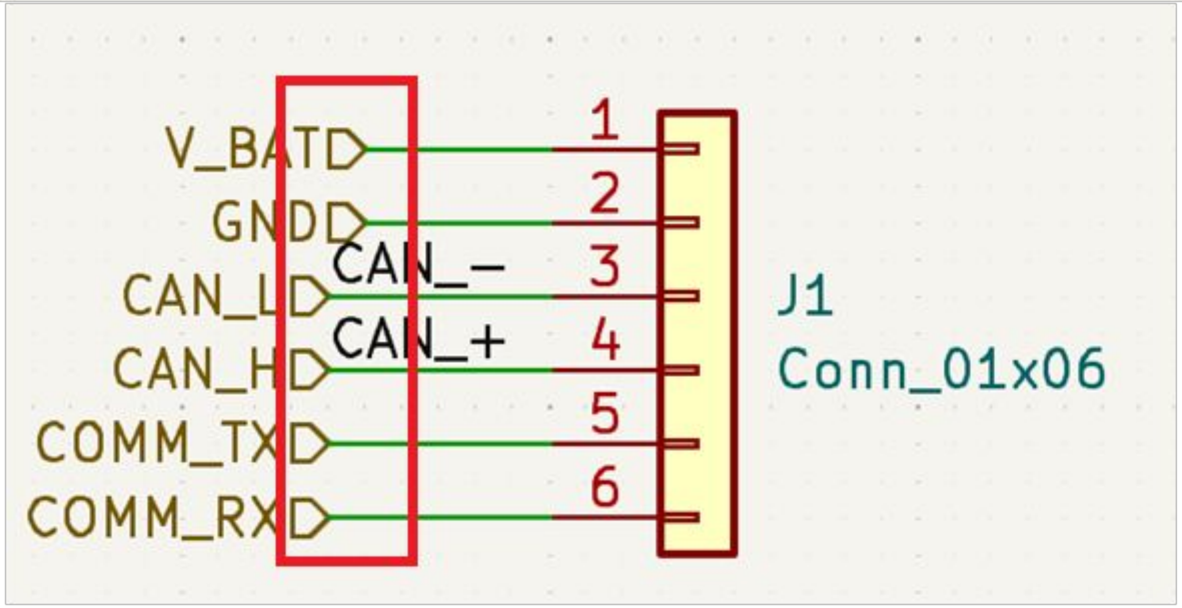




Schematic Tips

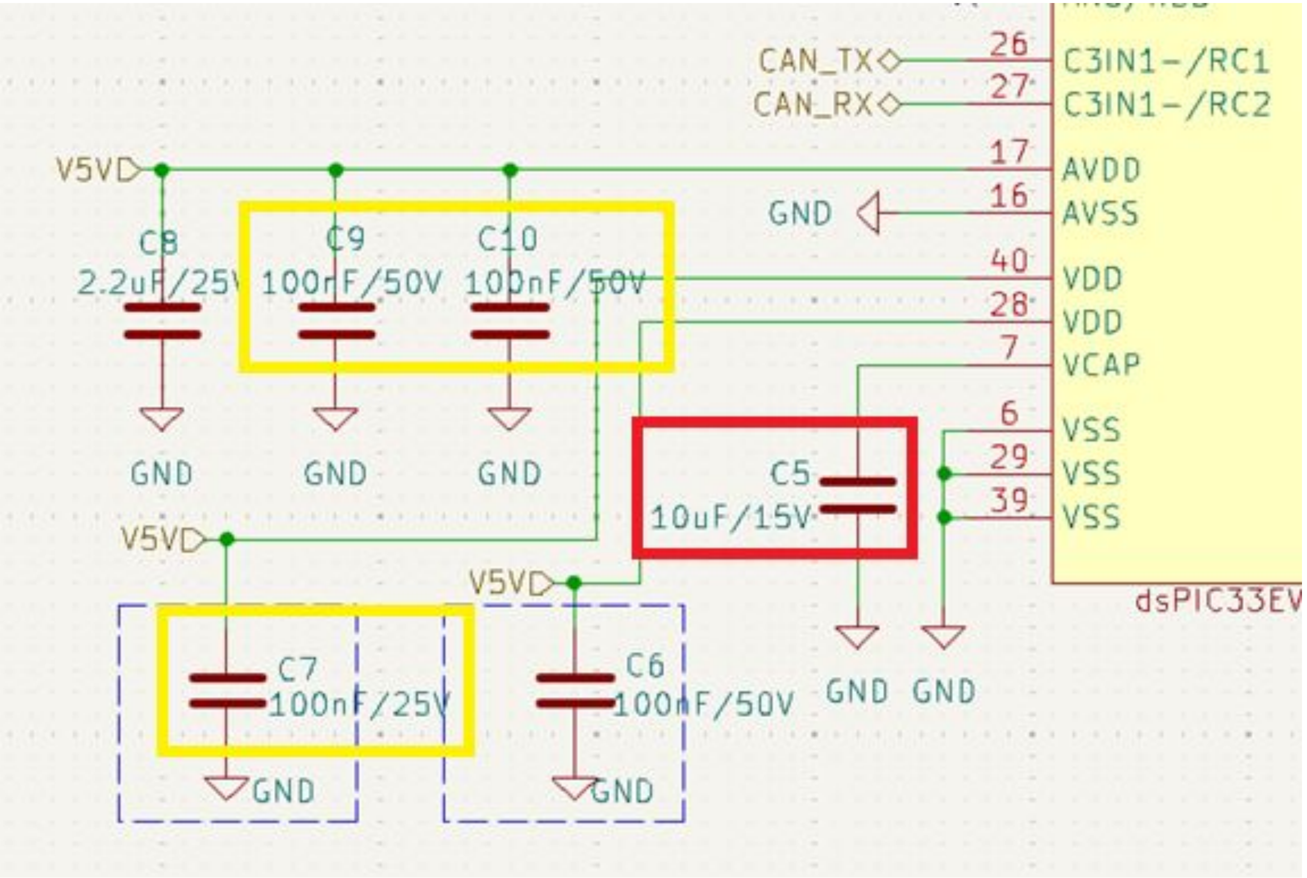
Finding 24: Signal Marks





- In general, the following markings can be noted on the schematics. For example, the signal "I_A_UC_LED_TEMP" enters the board through the connector, so it should be output, not input. Faulty signals can be examined and corrected in this way.

Finding 25: Capacitor Voltage Value and Component Partnering



- 15V voltage value is written for C5 capacitor, but you cannot find 15V capacitors in the market, you can find 16V or 25V.
- C7 capacitor is 25V, C9 and C10 capacitors are 50V, 50V capacitor can be used instead of 25V capacitor in order to save cost during production.