Construction of Electronic Systems

Exercise 10: USB DAQ project: microcontroller part & USB part design

In this exercise you will design the microcontroller part and the USB part of your PCB. As typically, you will first identify the critical circuit parts and then design these two segments.

Exercise tasks:

1. ***Analyze the microcontroller module (Figure 1) and try to identify the critical parts.***

   Also, consider how the individual circuit components can be used in the most beneficial way to make a better circuit design.

   a. Which parts of the microcontroller module *are critical*?

      Advice: go through microcontroller pins and check what kind of signals are connected to them?

      i. Which parts generate *"digital noise"*?

      ii. Are there any *sensitive pasts*?

      iii. Are there any *high-frequency signals* connected to the microcontroller?

   b. *Which components play an important role* in these critical parts of the circuit?

      i. Make sure that you know understand their role and know how to *use these components properly* to create a good circuit design. Use the theory from the lectures.

      ii. Are there any components that are critical for a good design and belong near the microcontroller on the PCB but are not in the microcontroller schematics?

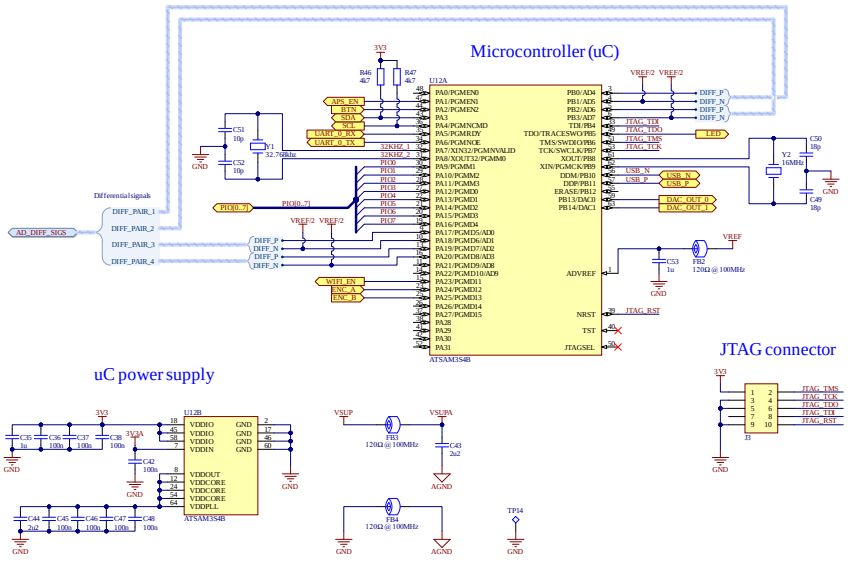

Figure 1 - the microcontroller module has important critical parts that need to be identified before the PCB design

2. ***Similarly, analyze the USB module (Figure 2):***
    a. Which part prevents noise to propagate over the bus power supply?
    b. How does the electrostatic discharge (ESD) protection circuit work?
    c. The ESD pulses are fast changing signals. How should the return path for the ESD pulse be designed – in terms of the return path impedance?
    d. What is the role of the series resistors R40 and R41?
    e. Where should you place the components that are the first components that USB signals reach coming from the USB connector?
    f. The USB communication is based on a fast differential signal pair. How should this fast differential signals be routed on the PCB in order to minimize the EMI?

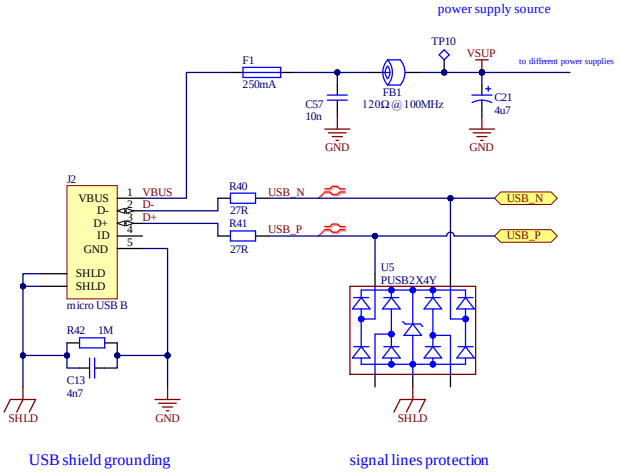

Figure 2 - you will design the USB part

3. ***Design the microcontroller module and the USB module.***

Advice: make sure that the microcontroller location and orientation are suitable (consider the location of other modules). Then, make a good detailed placement of components. Start with the most critical components and proceed to the less critical components. When you are happy with the component placement, start routing the connections. Again, from the most critical to the less critical. Do not forget to place the ground vias. Try to minimize the segmentation of the ground polygon pour beneath the microprocessor. Use the idea of "fanout routing" to achieve this (see additional materials).

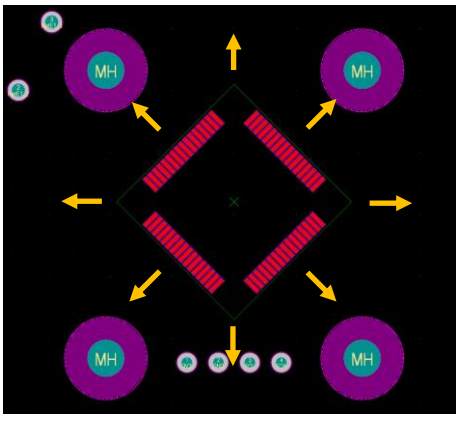

Figure 3 - deciding where exactly to place the microcontroller so that you will have enough room for all the important components that should be near the microcontroller. The issue here are the obstacles surrounding the microcontroller (i.e. the holes and locked component pins).

Explanation of the exercise

We are moving the focus of our PCB design to the center of the PCB, where you will design the microcontroller part. Microcontrollers are, of course, widely used in electronics: from very simple devices to complex systems. Therefore it is important that you are aware of the potential problems that come with the microcontroller PCB design and that you know how to deal with them.

Preparation for the lab exercise

You can refresh the knowledge about the bypass capacitors and their appropriate application.

Also, you can refresh the knowledge about the fast signals and their ground return paths.