Construction of Electronic Systems

Exercise 8: USB DAQ project: SMPS design

By now you have made your initial component placement. Now you will design the *switched-mode power supply* (SMPS). First you will *analyze* the circuit and *identify the critical parts*. Then you will design the circuit on the PCB: you will make a *detailed component placement* and route the connections between the SMPS components, taking into account the *minimization of the electromagnetic interferences*.

Exercise tasks:

1. ***Before you start with the actual PCB design, make sure that you have the basic design rules properly set.*** Use the following settings:

   1.1. board outline clearance: 0.5 mm

   (Manufacturing → Board Outline Clearance → New rule)

   1.2. minimal electrical clearance: 8 mil (Electrical → Clearance)

   Option: use "Ignore Pad to Pad clearances within a footprint".

   1.3. routing width: (Routing → Width)

   1.3.1. minimal: 8 mil

   1.3.2. preferred: 10 mil

   1.3.3. maximal: 100 mil

   1.4. via style: (Routing → Via Style)

	ring diameter [mm]	hole diameter [mm]
minimal	0.7	0.3
maximal	1.2	0.8
preferred	0.8	0.4

   1.5 direct polygon connect to vias (Plane → Polygon Connect Style)

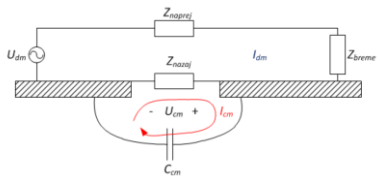
   Hint: use the advanced configuration parameters.

2. ***Analyze the switched-mode power supply circuit and identify the critical circuit parts for both SEPIC and Ćuk power converters:***

   a) where do the *critical currents* flow, which are problematic because of their *high frequency spectrum*?

   b) The *area* of which *circuit loops* must be minimized in order to minimize the *differential mode* interferences?

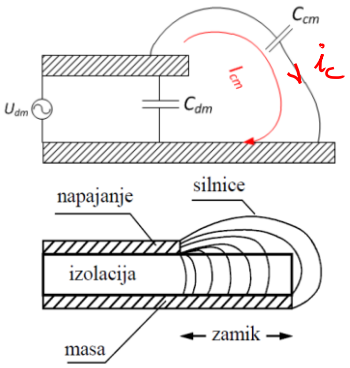
   c) Where can the *currents generate* the *common mode* interferences? What can be done to minimize these interferences?



$i_c \propto \frac{du_c}{dt}$

d) In which circuit nodes do the *critical <u>voltages</u>* appear which are problematic because of their *high frequency spectrum*?

e) Where can the *voltages generate* the *common mode* interferences? What can be done to minimize these interferences?



Advice: use the power converter *simulations* (links above) and the IC application note (see attachments eFE folder).

3. Design the switched-mode power supply, taking into account the identified critical circuit parts.

Use the knowledge and understanding of the circuit critical parts to produce a good power supply design. Start with a *<u>detailed</u> SMPS component placement*, trying to *minimize the critical circuit loops*. Also, try to place the components in such a way that the *critical ground return path impedance* is minimized.

Tip: place the critical components first and then proceed to the less critical.

Tip: First, make the component placement and only then start connecting the components.

Explanation of the exercise

Before you start with the *more detailed design of the individual circuit parts*, you should define the most fundamental design rules that dictate how the components can be *placed* (e.g. required edge clearance) and how can they be *connected* (e.g. track width limitations).

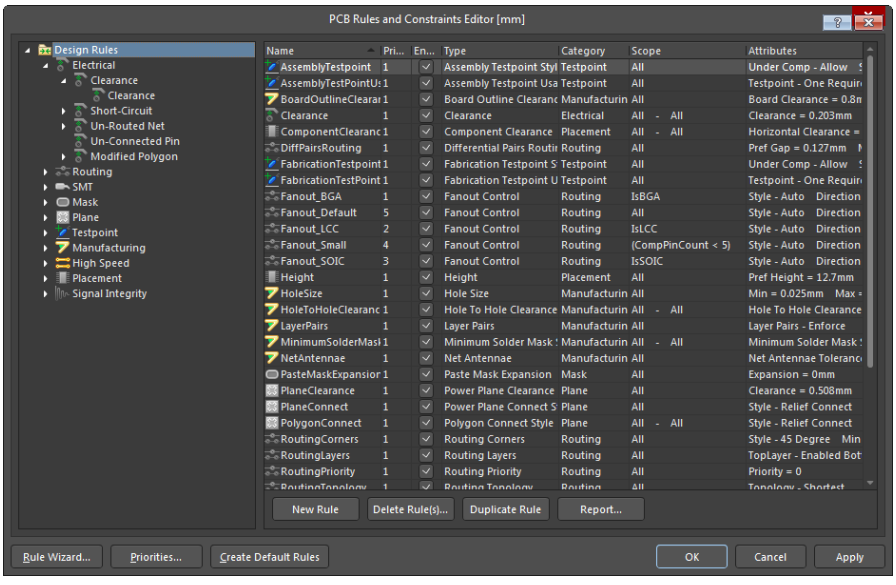


Figure 1 - setting the basic design rules before you start with a more detailed PCB design. The number of the available design rules can be a bit terrifying.

After you have made the initial component placement and prepared the basic design rules, you can start with the *detailed design of the individual electrical circuit parts*. In our case, you will start with the switched-mode power supply part. In order to make a good SMPS design, you need *to understand the way this circuit works, so that the critical parts will be easier to identify and taken care for*.

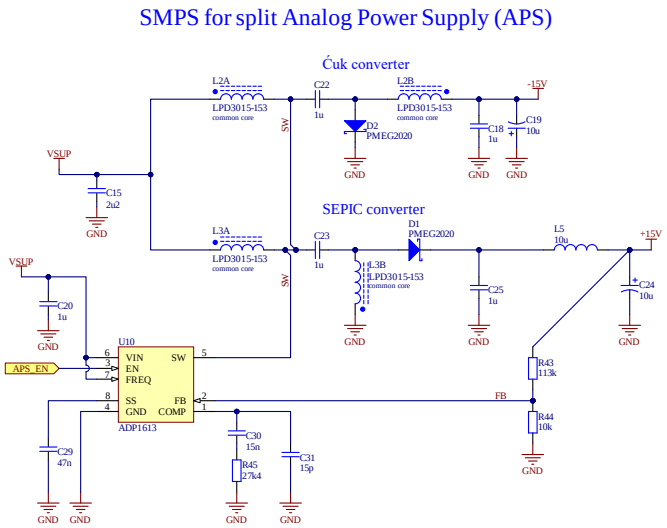


Figure 2 – you will design the switched-mode power supply for the analog circuitry

Preparation for the lab exercise

You will finally start designing the PCB so it makes sense to familiarize yourself with the useful functions and shortcuts in PCB.