Construction of electronic systems

Exercise 5: USB DAQ project
PCB shape

In this exercise you will make the *initial preparations* that are necessary before you start with the actual PCB design. This preparation includes the definition of the PCB enclosure, which, in turn, defines the PCB shape. You will also prepare the mechanical layers that we will use during the PCB design.

Exercise tasks

Prepare a new template project:

1. **Prepare a *new project folder* for a *new* project template** that you will find in the eFE attachments folder.

   This project will serve as ***your new starting point for the USB DAQ PCB design.*** This is how we ensure that everybody has the same and correct schematic design.

2. **Add a new PCB document to the project and *import the schematic design into the PCB design*.**

   Be careful about the errors. There should be none.

Define the mechanical layers:

3. ***Define the mechanical layers that will use during the PCB design:***

   Single mechanical layers

   a. Mechanical 1: board shape ("Layer Type = *Board Shape*"),

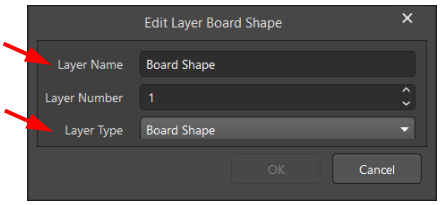

Figure 1 – mechanical layers can be defined by name only or more specifically by type.

   b. Mechanical 2: fabrication notes meant for the PCB manufacturer ("Layer Type = *Fab Notes*"),

   c. Mechanical 3: general notes ("Layer Name = *Notes*, Layer Type = NA"),

   d. Mechanical 4: guides ("Layer Name = *Guides*, Layer Type = NA"),

   Mechanical layer pairs:

   e. Mechanical 13 + 14: layer pair used for providing information about the component outlines and 3D models ("Layer Type = *Component Outline*"),

   f. Mechanical 15 + 16: layer pair used to define the "private component space", so-called component courtyard ("Layer Type = *Courtyard*").

   Note: Some of the mechanical layers may already be defined in your PcbDoc. *Make sure that layer numbers are correct.*

Define the shape of the PCB:

4. ***Import the 3D model of the bottom part of the enclosure and the 3D model of the PCB into the PCB design*** (see the eFE attachments folder). Set the "Board Side" parameter of the bottom enclosure part appropriately (see the figure below).

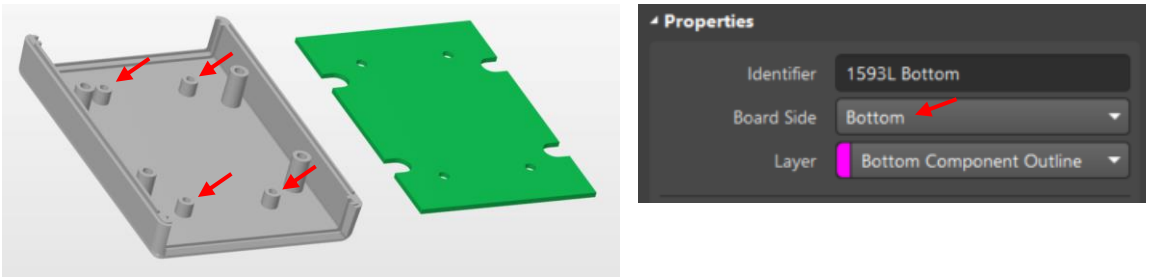

Figure 2 – the 3D model of the PCB will be used to define the shape of the PCB. We will then fit the PCB into the bottom part of the enclosure to be able to precisely place components in regards to the enclosure. Notice the standoffs (slo. nosilci, distančniki) which hold the PCB in place. Also, set the "Board Side" parameter for the bottom part of the enclosure (right figure).

6. ***Define the PCB shape from the 3D model of the PCB.***

   When the PCB shape is successfully defined you can delete the 3D model of the PCB so that it won't get into your way during the PCB design.

7. **For this PCB now define a so-called *PCB layer stack* in such a way that it is consistent with the *typical geometry of the double-sided PCBs*.**

   Hint: in the "Layer stack manager" check the "Tools" menu. Now it has a different content. Search for standard PCB layer *presets*.

   The PCB should therefore contain the following layers:

   a. silkscreen layers (a.k.a. overlay),
   b. solder mask layers,
   c. surface finish layers (for HASL etc.),
   d. copper signal layers having the "thickness" of 1 oz,
   e. dielectric layer with the relative permittivity equal to 4.3.

   This will ensure that your *PCB has the correct thickness*.

8. **Generate the board outline according to the PCB shape and place it on the Mechanical 1 layer.**

Figure 3 – the PCB shape must be traced with lines so that you can generate gerber files that you can send to the PCB shape to the PCB manufacturer

9. ***Place the PCB* into the 3D model of the enclosure** (or other way around).

   Make sure that the mounting holes are *aligned* and that the PCB really *sits on the four prepared standoffs* (see the figure above).

   Once aligned (Figure 5, right side), *lock* the enclosure 3D model location.

   Hint: add *snap points* to the enclosure that will help you align the centers of mounting holes. Make sure that the snap points are visible (View Configuration → System Colors → Custom snap point).

   Hint: in 3D view, use the "Align Face With Board" tool to precisely place the PCB on the standoffs. If the enclosure gets flipped around, make sure that he "Board Side" property of the enclosure is set to "bottom".

10. **A detail: make sure that the four PCB *mounting holes* are non-plated (i.e. not metalized).**

    If the mounting holes are plated, the metal plating may get damaged by the screw threads, leading to small metal crumbled particles which can cause problem in the electronic circuit.

    Hint: check the properties of the mounting holes for the "Plated" option.

Figure 4 - plated hole (left) vs. the un-plated hole with no copper metallization (right)

11. ***Once the PCB is aligned to the enclosure and "everything fits", do the following steps:***

    a. ***lock the location*** of the 3D model, mounting holes and the PCB shape definition on the mechanical layer 1

    b. ***hide all the unnecessary*** layers and snapping points to make the further design process more clear and un-cluttered with unnecessary information (see below)

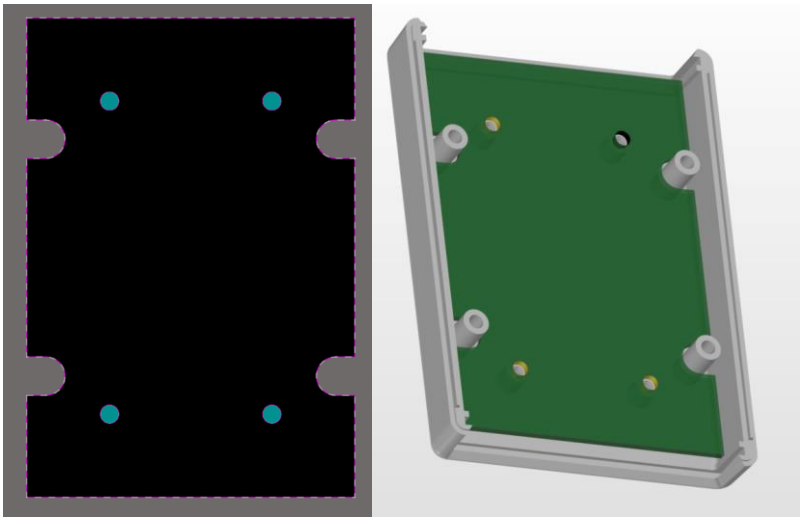

Figure 5 – left: at the end, hide all the unnecessary information to make the 2D view over the PCB design more clear. Right: 3D view of the final assembly: the PCB sits aligned in the bottom enclosure

Explanation of the exercise

Usually we have to do some "preparation work" before we can even start placing the components on the PCB and start connecting them with tracks – that is, before we actually start designing the PCB. This preparation work, among other things, usually entails the *definition of the PCB shape*. In our case, we will design the PCB shape according to the enclosure that we intend to use for our USB DAQ system.

In this exercise you will find out how to work with 3D models, use mechanical layers, learn how to define the PCB shape and specify the PCB structure (i.e. the layer stack).

At the end of the exercise, your design will finally be ready to start placing components on the PCB.

Preparation for the lab. exercise

In order to prepare for this exercise you should be familiar with the following Altium Designer video tutorials:

- Altium PCB #01: Layers
- Altium PCB #02: Defining PCB shape from a 3D model
- Altium PCB #05: Layer stack manager
- Altium PCB #06: Useful functions and shortcuts in PCB (parts of the lecture)