Construction of Electronic Systems

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

Guidelines for designing the fast USB connection

Below you will find a list of important *guidelines for designing fast differential communication lines* such as the "full speed" 12 Mbit/s USB:

1. keep the *overall length* of the USB connection from the connector to the microcontroller *as short as possible.*

2. Try to keep the signal traces D+ and D− *parallel and symmetrical*.

3. Make the connections for both differential signals *approximately the same length.*

   Mind: the USB 2.0 full-speed communication (12 Mbit/s) is, in a way, relatively "slow communication" and the signal *length-matching* here is not that critical (matching to approximately 1 mm is required).

4. Try *not to create **large** obstacles for the return currents* on the ground path underneath the fast signal connections (Figure 1 a).

   Mind: if there must really be an obstacle, try to make it as small as possible (Figure 1 b).

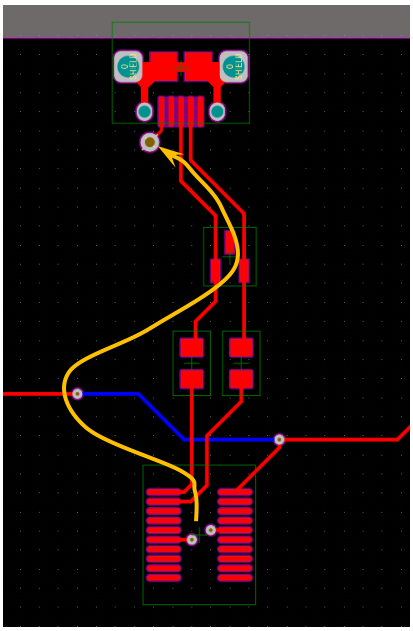
5. The fast signal connections *should not change layers* (Figure 1 c).

6. Make the *loop area between the differential signals small* (Figure 1 d).

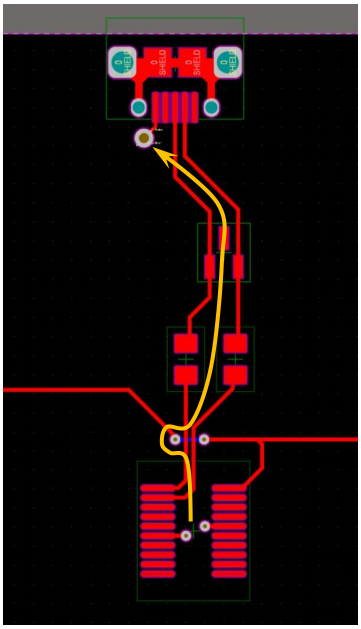
7. Provide a *low impedance return path for the ESD protection* (Figure 2).

   A hint: wide connections provided by a large area of copper offer low inductance paths.

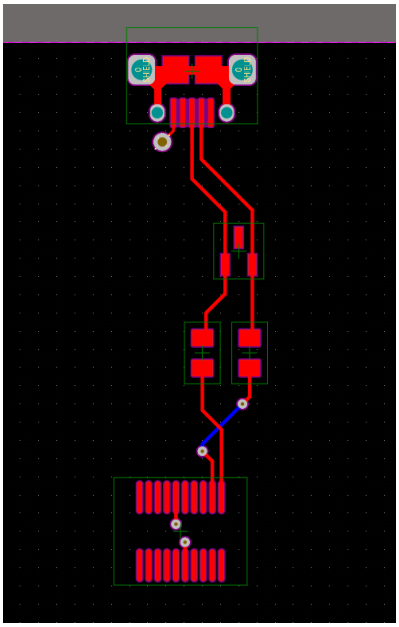
Study the design examples below.



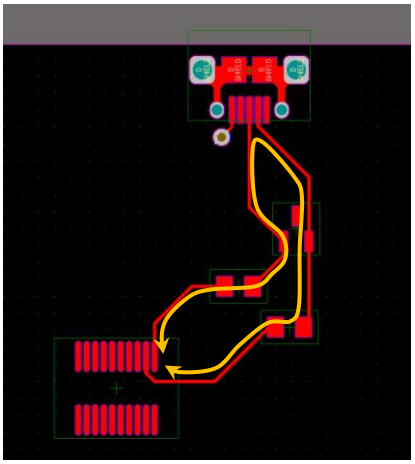
a)



b)



c)



d)

Figure 1 – a few details that you need to be careful about when designing the fast USB communication lines (see the guidelines above). In these examples a USB-to-UART FTDI chip is used instead of a microcontroller.

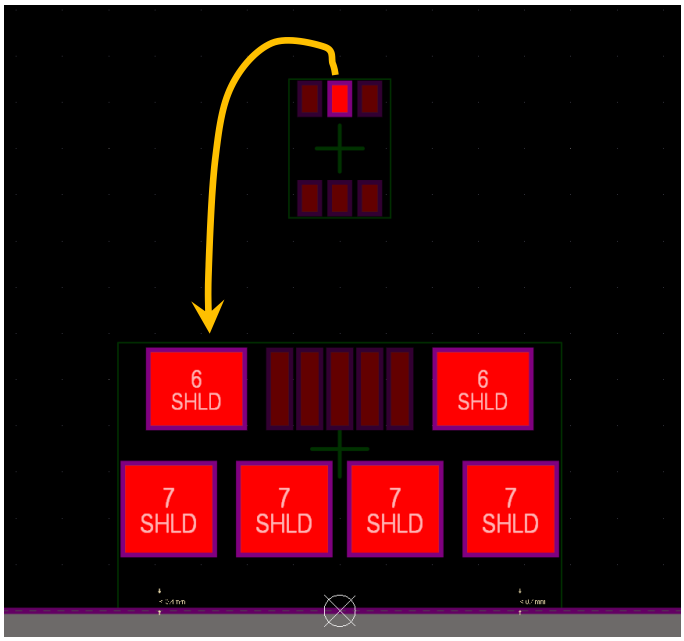


Figure 2 – you should try to make the return path for the electro-static discharge (yellow) very low impedance in order to keep the induced voltages during the fast discharge low, thus protecting your microcontroller