Exercise 3: USB DAQ project
Power supply schematics

With this lab exercise we are beginning our work on the *USB DAQ project* that will be the focus of our lab course till the end of the term (see the figure below). Your task for the rest of the lab exercises will be to *gradually finish* the already started project. In this first exercise you will *prepare the schematic for the switched-mode power supply (SMPS)* for the USB DAQ system.

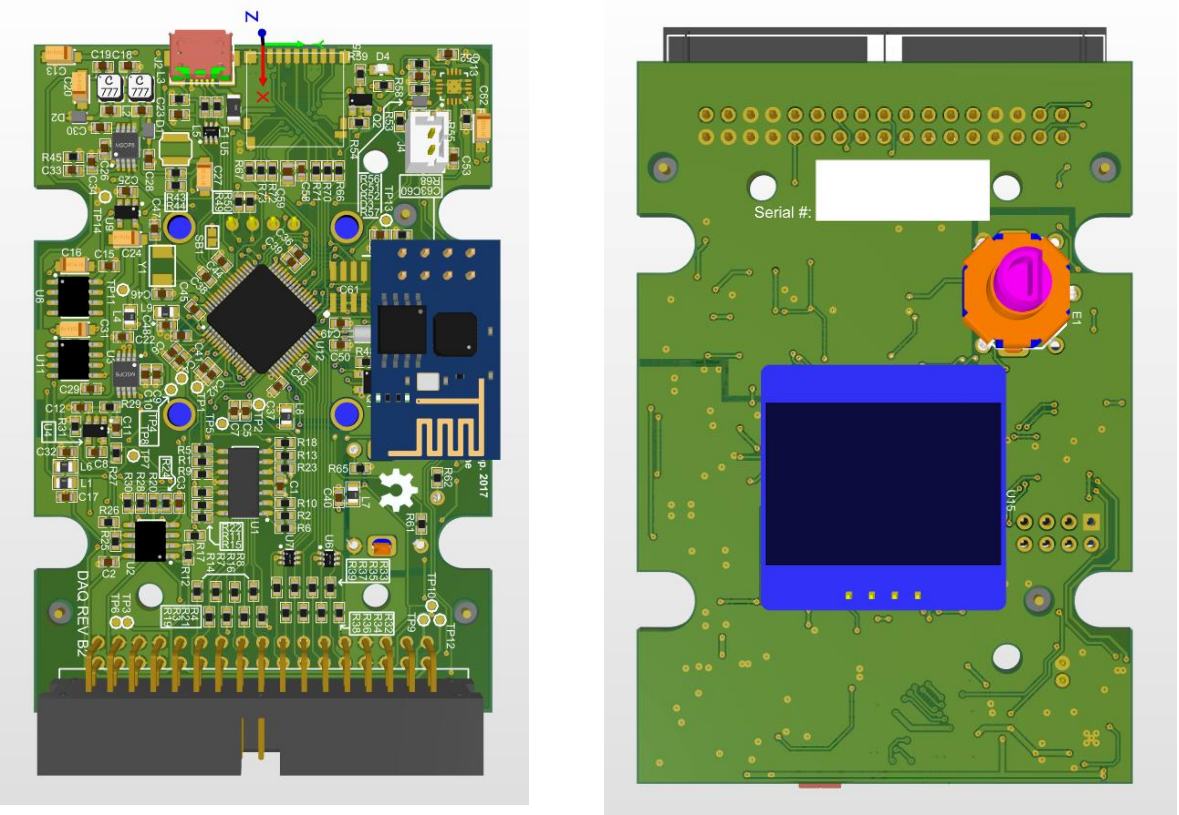

Figure 1 – an example of the top and bottom side of a finished USB DAQ card

Exercise tasks:

1. **Prepare the *project folder* for the DAQ Altium Designer project.**

   You will find the project template in the eFE attachments folder. Unpack it in your project folder.

2. **Open the project and *familiarize yourself with the modules* that the project contains.**

   Note that there is a *power module* missing.

3. **Add the "Power_supply.SchDoc" schematic to the project** (see the attachments).

   As the name already implies, this document should contain all of the circuitry that provides power supply to different parts of the USB DAQ system. Note that the so-called *split analog power supply* circuit is missing. ***Your assignment will be to design the schematic for this power supply.***

4. **Study the *application note* (slo. primer uporabe) "*AN-1106 - An Improved Topology for Creating Split Rails from a Single Input Voltage*"** for the step-up switched-mode power converter ADP1613 (see attachments).

   Give special attention to the chapter "DESCRIPTION OF TOPOLOGY" describing the *functionality of the converter*. Try to *understand how the circuit works* at least on a basic level (i.e. how the currents flow). To help you with the understanding, see the simulation provided by these two links: the SEPIC converter and the Ćuk converter.

5. **Draw the schematic for the *split analog SMPS* based on the "*Figure 14. Schematic of Test Circuit*"** found at the end of the application note. Follow the requirements below.

   5.1. The circuit schematic in the application note Figure 14 is simply bad. ***Try to draw a better schematic***, especially the part with the SEPIC and Ćuk topology parts. Imitate the circuit in Figure 1 of the application note, where both converters are drawn in *"the standard way"* (see below).

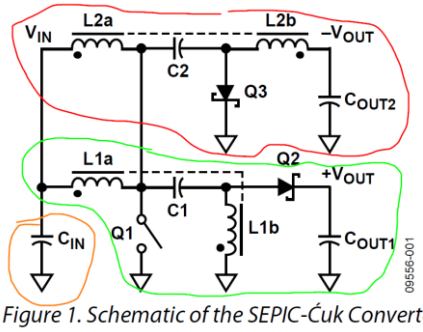

Figure 1. Schematic of the SEPIC-Ćuk Converter

   5.2. ***Where possible, use 0603 SMD components.***

   All the required components can be found in the included *project library* DAQ_REV_B.SchLib".

   5.3. ***Substitute the components from the application note schematics*** according to the following *bill-of-materials* (BOM).

Original component	Substitute component
LPD4012-153	LPD3015-153 (a coupled inductor)
D1, D2	PMEG2020
C_{IN}	2.2 µF tantalum capacitor, case A
C_{OUT}[2]	one 10 µF tantalum capacitor, case A
C_{OUT}[3]	one 10 µF tantalum capacitor, case A **and** one 1 µF generic capacitor
RF1B	113 kΩ
RF2B	10 kΩ
R_B0	do not place (omitted)
C_{SS}	47 nF generic ceramic capacitor
C_C[2]	15 pF generic ceramic capacitor
ME3220-102MLB	TYS4012100M-10 (an inductor)

6. When you finish the power supply schematics, use the complete "Power_supply.SchDoc" schematic to ***create a power supply module*** **in the *top schematic* "DAQ_REV_B.SchDoc" and connect the enable signals to the microcontroller module.**

Explanation of the exercise

With this lab exercise we are beginning our work on the *USB DAQ project* that will be the focus of our lab course till the end of the term. The DAQ stands for "Data AcQuisition", which indicates that we are dealing with a system that is built to *measure and collect measurement data* of various *physical quantities* represented in the form of electrical signals (e.g. sound, force, pressure, acceleration etc.). A DAQ system is therefore a good example of a system that *combines* both the *analog electronics* (amplifiers, signal conditioning filters) and the *digital electronics* (microcontroller, A/D converter, USB communication etc.).

Our USB DAQ system contains the following key modules:

- a USB communication interface
- a switched-mode power supply (SMPS) unit with additional linear voltage regulation
- an Atmel SAM3S microcontroller
- a WIFI module
- a user interface (OLED display, LED, rotary encoder)
- a connector interface for input and output signals
- input signal amplifiers and filters
- digital-to-analog signal conversion with output amplifiers

In the next few lab exercises you will prepare the schematics for the complete system and then we will begin with the DAQ card PCB design.

Preparation for the lab. exercise

In order to prepare for this exercise you should see the second part of the Altium Designer video tutorials, covering the schematics design. The key tutorials for this exercise are:

- Altium Schematics #01: Hierarchical schematics design
- Altium Schematics #05: Example of multilevel hierarchical design
- Altium Schematics #07: Horizontal and vertical connectivity
- Altium Schematics #08: What gets on my nerves