Lab Task 1 - System Setup

Gruppe 12

- Part 1: RPi setup
  - Done (RPi is set up)

- Part 2: Preparation tasks
  1. Block Diagram drawn in draw.io.
  2.
     a. According to the serial timing chart in figure 1-1 of the datasheet (page 5, found on Blackboard), four clock cycles are needed for an ADC to take and transfer a sample back to RPi.

     b. With a 3.3V supply voltage, the resolution of the ADC [mV] is given by:

$$\frac{\text{Input range}}{2^n}$$

where n refers to amount of bits.

Bit resolution of MCP3201 is 12-bit.

Input range is 3,3 (V_{DD}) to GND (0V) = 3,3V.

Thus the resolution is:

$$\frac{3{,}3V}{2^{12}} \approx 0{,}806 \cdot 10^{-3}\ V = \underline{\underline{806 mV}}$$

c.) $V_{DD} = 3,3V$; $V_{SS} = GND = 0V$

Maximum input voltage (IN^+) given by:

$V_{REF} + IN^-$ (page 3 of datasheet)

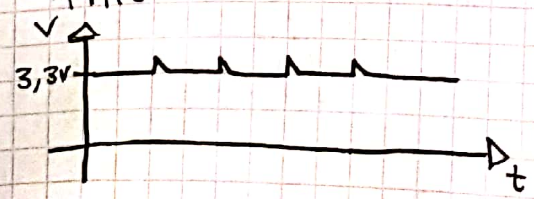
In our case; $V_{REF} = V_{DD}$ & $IN^- = GND$,

so $IN^+_{max} = 3,3V$.

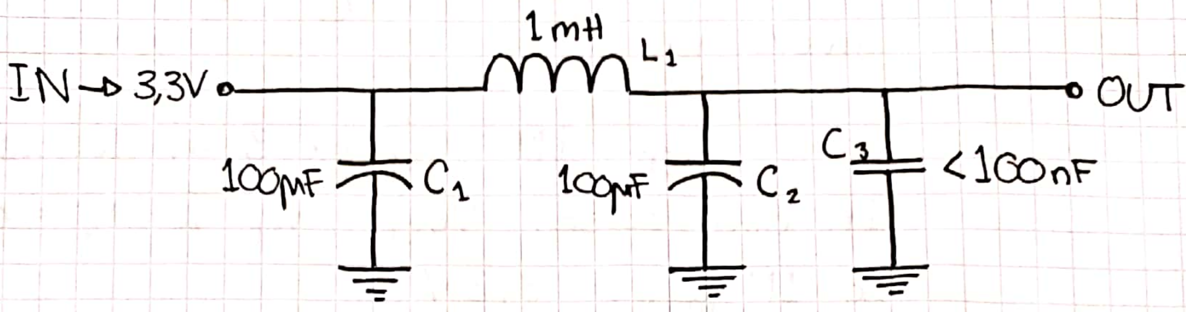
3. Linux kernel allocates time slots for all running processes by using a scheduler (asynchrons concurrency). Since we want live samples, this process may interfere with the timing while using a high sampling frequency. Direct Memory Access uses hardware modules to sample and control pins, so that the Linux OS on the CPU wont interfere. By using DMA, we wont experience unwanted disruptions from the Linux kernel scheduler.

- Part 3: Lab assignements

1. DC-currents from power supplies may have ripples that interfere with the wanted operation of the ADCs/RPi. This noise typically looks something like this



Thus, a lowpass-filter will be implemented to flatten this out. The lowpass-filter looks like this:



The inductor suppresses high frequencies, the two large capacitors stabilize the voltage, and the small capacitor works as a high frequency shunt(?). The frequency response given by voltage division:

$$V_{out} = V_{in} \frac{\frac{1}{j\omega C_2} + \frac{1}{j\omega C_3}}{\frac{1}{j\omega L_1} + j\omega C_1}$$

$$\Rightarrow H(\omega) = \frac{V_{out}}{V_{in}} = \frac{\frac{1}{C_2} + \frac{1}{C_3}}{\frac{1}{L_1} - \omega^2 C_1}$$

Plugging in values ($C_3 = 100nF$), we get:

$$H(\omega) = \frac{10010000}{1000 - \omega^2(10^{-4})}$$

$\Rightarrow$ Now, the 3dB cutoff frequency:

$$|H(\omega)| = \frac{10010000}{\sqrt{1000^2 - \omega^2(10^{-2})}} = \frac{1}{\sqrt{2}}$$

Scanned by CamScanner

$$\Rightarrow 10010000\sqrt{2} = \sqrt{1000^2 - \omega^2(10^{-2})}$$
$$\Rightarrow (10010000\sqrt{2})^2 = 1000^2 - \omega^2(10^{-2})$$
$$\Rightarrow \omega^2 = \frac{1000^2 - (10010000\sqrt{2})^2}{10^{-2}}$$

$$\Rightarrow \omega \approx 36271,6$$
$$\Rightarrow f = \frac{\omega}{2\pi} \approx \underline{5772,8\,Hz}$$

Fiks det...

(Mulig dette er helt på trynet).

2. Circuit diagram drawn using draw.io, in the same file as the block diagram.

Testing the circuit:

- We want to test ADCs in one plot, to be able to separate signals, we use voltage division. Initial DC offset is set to 2V, and will be utilised by one ADC.