Lab5 Assignment

Note that all students are required to work on this lab assignment in teams of two. Teams cannot change during labs. The deadline for team member changes (email instructor) is Thursday, April 6. A change in team members will result in a loss of bonus points for consistency/teamwork (i.e., same partner for all labs and project)!

For Lab5, one report per group is sufficient. All software development for Lab5 must be done in C language.

Note that each team member must be able to explain all hardware and software components.

Objective
Gain some experience with C-based programming of AVR microcontrollers, serial interface protocols (I2C, RS232, ...), ADC, and DAC.

Mid-lab review (April 12) - show the TA your progress towards completing the lab (see below)
Deadline: April 19 (see ICON for checkoff sign up)

Lab Description

In this lab, you will build a remotely controllable analog signal measurement and generation system using the built-in A/D converter of the ATmega328P controller and the MAX518, an external two-channel D/A converter with an I2C interface. Important aspects of the utilized ADC and DAC will be covered in class (review the relevant lecture notes). The MAX518 chip and associated components are included in the kit.

The system will have an RS232 interface (9600 8N1) that will be connected to your laptop/computer. The computer user will be able to trigger analog voltage measurements and set the output voltage (sequence) for both channels of the DAC by means of commands sent through the RS232 interface.

The system will implement the following commands.

Command	Function	Arguments
G	Get single voltage measurement from ADC	no arguments The ATmega328P ADC must be used in 10-bit mode!
S,c,v	Set DAC output voltage	c … DAC channel number (integer, c ∈ {0,1}) v ... output voltage (float, format: "n.nn" V, needs to be converted into a decimal number which is sent to the DAC such that the quantization error is minimal)
W,c,f,r	Generate a sine wave on DAC output	c ... DAC channel number (integer, c ∈ {0,1}) f ... frequency of waveform (integer, f ∈ {10,20} Hz), the signal frequency must be within +/- 5% r ... number of consecutive waveform cycles to generate (integer, 1≤ r ≤ 100) A lookup table for generating the sin wave can be found on ICON (file: “sin_table.csv”)

Here is the nominal message exchange between the person typing on the terminal keyboard and analog interface system, which will send information back to the terminal screen (use the Arduino IDE Serial Monitor functionality as terminal emulator). Text shown in BOLD is typed by the user on the keyboard. Non-bold text represents responses by the analog interface system.

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G
v=0.244 V


S,1,3.45
DAC channel 1 set to 3.46 V (177d)


W,0,10,50
Generating 50 sine wave cycles with f=10 Hz on DAC channel 0
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After completing the assignment, upload your C source code and report to ICON. If you plan to see a TA on the day the lab is due, a sign up for check off is required (see ICON).

Note that you can use available libraries for I2C and RS232 communication. Do not forget to mention the utilized libraries in your report. Note that some libraries need to be configured for the specific AVR microcontroller used.

For check off, develop a test approach so that you can demonstrate to the TA that the read ADC as well as generated DAC voltages are correct.

Mid-lab review - Show a TA your progress towards completing Lab5 (use ICON for sign up). It is expected that you can demonstrate that your program can successfully demonstrate RS232-based communication and reading of ADC voltage values.