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I3GFV

Experiment

A/D and D/A

Purpose

The main purpose of these experiments is to understand the principles of A/D, D/A-conversion and signal conditioning.

A scale is implemented using a load cell, an instrumentation amplifier and the PSoC.
The difference between absolute and ratiometric measurements is also examined.

The experiments should end up with a small journal and the PSoC creator projects.

Literature

- Data sheets
- PSoC Manuals.

The relevant documents can be downloaded from BlackBoard.

General guidelines

Document the experiments in a journal.

Describe the experiment objective(s), results and reflect upon the results.

Document the test setup with photos and diagrams.

Note which components you use. Which type of motor, which sensor etc.

Document the electrical wiring and create oscilloscope/logic analyzer dumps, where you find it appropriate.

Include relevant parts of datasheets or other documentation. The relevant parts are often diagrams and illustrations.

Keep a good structure in the code and document the code.

Perform the experiments in a structured manner: Think -> Do -> Document -> Reflect. And possibly iterate.

Conclude upon the results:

- What worked?
- What didn't work?
- Did anything surprise you?
- What caused the most problems?

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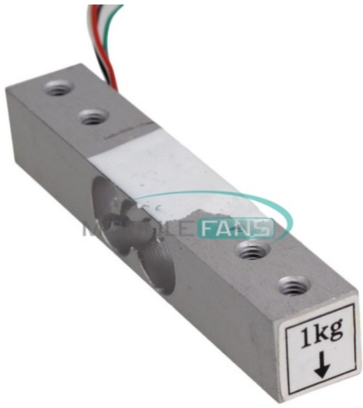
Load cell



Figur 1 Load cell

The load cell is based on a strain gauge and has a range from 0 to 1 kg.

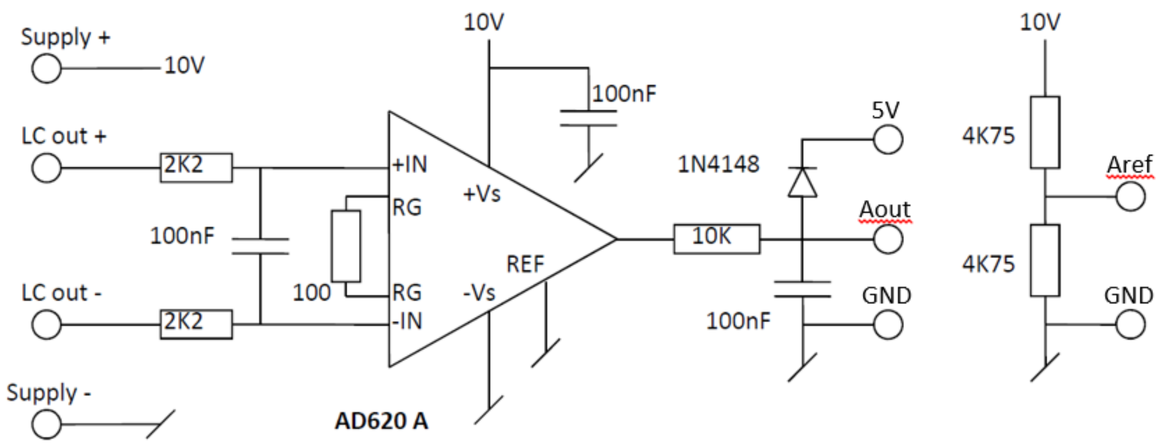
The output signal is approximately 1 mV/V.

Even without a provided load, the load cell may output a positive signal, so you will need to consider that, when you calculate the weight.

The output of the load cell may be non-linear with very small loads, so you may have to 'pre-load' it to enter its linear range.

Conversion circuit

The following circuit is used in the experiment for signal conditioning and to interface between the strain gauge and the A/D converter in the PSoC.



Figur 2 AD620 diagram

The circuit is available on a PCB.

Experiment 1: Implement a scale

Implement a scale based on the load cell, the instrumentation amplifier and the PSoC.

The PSoC contains both a Sigma-Delta ADC and a SAR ADC. The Sigma-Delta ADC can not be used with an external reference outside the range of 0.9V to 1.3V, so you shall use the SAR ADC for this experiment.

Write a program to calculate the weight at least once per second and output the measured weight to a console, connected to the UART on the PSoC.

Examine the linearity of the scale. Do you need to pre-load the load cell?

Calibrate the scale. You can use the following nuts for calibration:

- M8 ≈ 5g
- M10 ≈ 10g
- M12 ≈ 15g

What is your formula for conversion from ADC measurement to weight in gram?

Experiment with different external reference voltages for the A/D converter, while you change the supply voltage to the load cell.

If the external reference voltage is a constant voltage, e.g. 5V from the PSoC, the measurement is absolute. If the reference voltage is proportional to the load cell supply voltage, the measurement is ratiometric (connect the ADC reference to Aref shown on figure 2).

What benefits does the ratiometric measurement give? And why?

Add ‘Tara’ functionality to the program, so the scale is reset, when a command is sent to the PSoC via the UART.

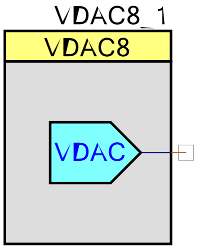
What is a reasonable resolution for the scale?

How accurate is your scale? Is there difference in the accuracy, if you use absolute or ratiometric measurements?

Can you improve the accuracy, by increasing the sampling rate?

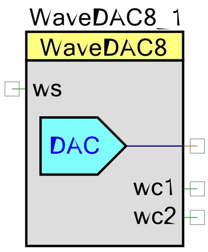
Experiment 2: DAC (optional)

Experiment with the VDAC8 and WaveDAC8 components in the PSoC.



Figur 3 VDAC8 komponent

Start by generating a steady output from the VDAC8 (e.g. max, max/2, min) and verify the output with an oscilloscope.
Add functionality to generate a variable output, e.g. based on input to the ADC.



Figur 4 WaveDAC8 komponent

Experiment with the WaveDAC8. It can be used to generate arbitrary waveforms, so basically, you can implement a function generator with the PSoC. Verify the output with an oscilloscope.