NTNU – Trondheim
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TDT4258 Energy Efficient Computer Design
Laboratory Report

Exercise 2 - DAC

Group 29:

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Abstract

An abstract is a short (100 to 500 words), high-level summary of the entire document. For this kind of report, you would start by introducing the concept that the report talks about and the goals of the work, followed by information about how the work was done and some summary of results.

This report is a hands-on approach towards learning energy efficient programming using primarily the C language. The work is done on the EFM32GG-DK3750 microcontroller from Silicon Labs, but it is applicable for programming other types of microcontrollers as well. This report describes how to utilize the on-board DAC in order to make music and sound effects, but still maintaining a low energy consumption. It is desirable to keeping the energy consumption low for a lot of reasons. Microcontrollers are used in lot of energy-sensitive areas, often battery powered, like implantable medical devices, remote controls and toys, so you want to increase their life time by decreasing the energy usage.

NEEDS TO BE WRITTEN WHEN WE HAVE RESULTS!!!

On RUNNING

- (Tried to down-scale, but dropped due to sound quality)
- Reduced interrupt-frequency
- EM1 (gets rid of 200 interrupts per note)

On IDLE

- Turned off DAC
- Turned off Timer
- EM2 (WFI)

Generated tones beforehand, so we didn't need to do a lot of heavy divisions for each boot. Used shifting in stead of multiplication/division. Decided using integers instead of floats for the tones.

TRY Update linker script when disabling RAM-blocks 32.5.1 GPIO$_{P}x_{C}TRL-PortControlRegister$11.5.3 $HighFrequencyPeripheralClockDivisionRegister$

COULD TRY Decrease voltage

1 Introduction

Your report should start with an introduction chapter that motivates the subject in general and describes the problem you are trying to solve.

2 Background and Theory

This chapter should describe the theoretical background needed to understand and solve the problem. For instance, a description of the hardware platform or specific components involved in this assignment, definition of concepts that are important to understand the solution should be summarized here. Add citations to show sources whenever appropriate, LaTeX and bibliography managers make this easy. For instance, "I always thought something was fundamentally wrong with the universe" [1].

This chapter will provide information about hardware, software and different topics important for understanding the results.

2.1 Hardware

The hardware used in this exercise is the EFM32GG-DK3750 development board from Silicon Labs depicted in Figure **??**. It was connected to a personal computer via USB. It also includes a TFT screen which can display real-time energy consumption. The EFM32GG uses the energy efficient 32-bit ARM Cortex-M3. It's worth mentioning that the M3 uses Harvard architecture [**?**], which allows it to read input at the same as it can execute instructions.

2.1.1 DAC

The board has an integrated DAC (digital-to-analog converter), which will be used for playing music and sound effects. A DAC takes input as digital data, a stream of binary values, and outputs analog values in the form of voltage or current.

Sound is best described mathematically as sine waves. Since a DAC takes discrete values as input, you can generate an output that best resembles the sound by taking samples of the sine wave. The more samples you have per period, the higher the quality of the output.

2.1.2 Gamepad

In addition we had a gamepad with eight buttons and eight LEDs depicted in Figure **??**. This was connected to the development board's GPIO pins. The gamepad includes a jumper, that when set to the lower two pins will exclude the LEDs form the power measurement.

2.2 Static vs dynamic power consumption

The total power consumption is the sum of static- and dynamic power consumption, given by Formula 2.1:

$$P_{tot} = P_{dynamic} + P_{static} = \alpha C V^2 f + I_{static} V \tag{2.1}$$

2.3 The C language

2.4 Energy Efficiency

3 Methodology

This chapter will describe the workflow, and a detailed explanation of our implementation. At the end of this chapter we will discuss the testing of our implementation.

3.0.1 Workflow

The code was written in Emacs on Ubuntu 14.04LTS running in VirtualBox on a Windows8.1 laptop.

Bulding and flashing

Bulding the program was done using `make`.

3.1 Testing

Add content in this section that describes how you tested and verified the correctness of your implementation, with respect to the requirements of the assignment.

Figure 3.1: A JPEG image of a galaxy. Use vector graphics instead if you can.

4 Results

In this chapter, you should discuss the results you have obtained from your implementation. These can be correctness results, i.e whether the implementation behaved as expected, or numerical results that express runtime or energy measurements.

5 Conclusion

This chapter should be a look back at the entire report and summarizing the problem, the solution and the obtained results.

5.1 Evaluation of the Assignment

You can include comments about the assignment itself here. While this part is not obligatory and not graded, it is valuable feedback to the course staff that can be used to improve the exercises in the future.

Bibliography

[1] D. Adams. *The Hitchhiker's Guide to the Galaxy*. San Val, 1995.