San José State University
Department of Computer Engineering
CMPE 146-03, Real-Time Embedded System Co-Design, Fall 2019

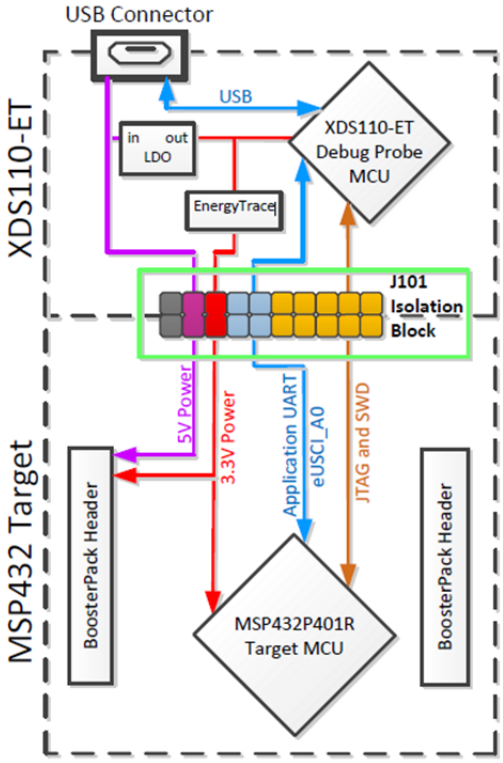
Lab Assignment 5

Due date: Friday, 11/01/2019

1. Description

In this assignment, we will be familarized with the power consumption of the MCU using TI's EnergyTrace technology. EnergyTrace is an analysis tool that measures and displays the application's energy profile and helps to optimize it for low-power consumption.

The EnertyTrace circuitry resides on the debug probe (XDS110) side of LaunchPad. It measures the current consumed by the MSP432 side in real time.



EnergyTrace wiki page: http://processors.wiki.ti.com/index.php/EnergyTrace_for_MSP432

2. Exercise 1

Unfortunately, the EnergyTrace tool is not available on CCS Cloud. Therefore, we need to install a local version of CCS. Go to http://software-dl.ti.com/ccs/esd/documents/ccs_downloads.html to download and install the software in your laptop.

It would be easier to duplicate an existing working project than creating one from scratch. After installation, use the Resource Explorer to import an example project, like the CRC-32 one that you have done in a previous lab. Make sure the project works properly.

Lab Report Submission

Describe any issue that you may have encountered during installation and setting up the project.

3. Exercise 2

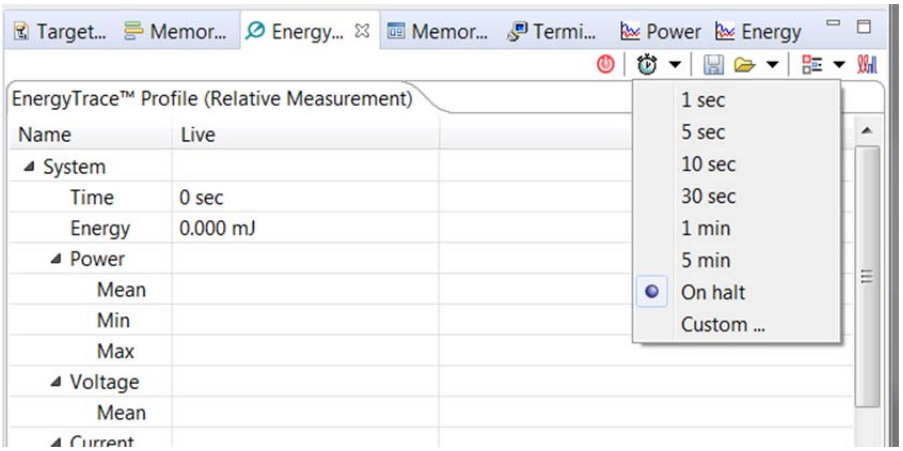
In this exercise, we are going to carrying out CRC-32 computation in different ways and measure the power consumptions. Use the source file *crc32_calculation.c* on Canvas that comes with this PDF. You can replace the contents of the main file of the project in the above exercise with with this C file. This program would compute the CRC-32 checksum for a fairly large data block (59 KB). Three methods are used: software, hardware and DMA. Run the program and make sure the checksums from all three methods agree.

Exercise 2.1

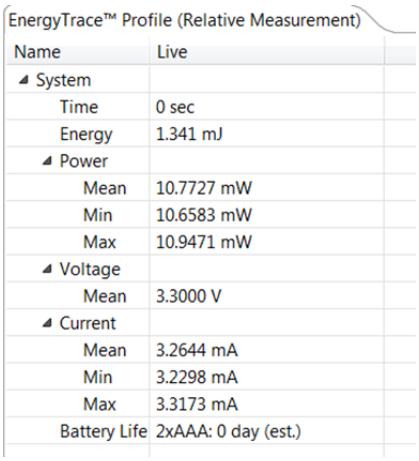
In this exercise, we are going to do measurement using the hardware method only. There are three lines of #define statements in the C file:

```
#define USE_HW_METHOD
#define USE_SW_METHOD
#define USE_DMA_METHOD
```

Comment out the USE_SW_METHOD and USE_DMA_METHOD lines. The program will only do the hardware method. Click on the debug icon to start up the program. Before pressing the green arrow icon to execute the program, we need to start up the EnergyTrace tool. On the lower=right corner, click on the Energy tab. Click on the stopwatch icon and select “On halt.” Start the energy measurement.



Press the green arrow icon to execute the program. When the program finishes, the processor will halt and EnergyTrace will stop its measurement. And you will see it shows something like this:



We are interested in the following values: Energy, mean power and mean current. Record those numbers.

Lab Report Submission

Report the numbers and show a screenshoot of the display.

Exercise 2.2

In this exercise, we are going to do the software method only. Comment out the #define statements for the other two methods and run the program as in the previous exercise.

Lab Report Submission

Report the results and show a screenshoot of the display.

Exercise 2.3

In this exercise, we are going to do the DMA method only. Comment out the #define statements for the other two methods and run the program as in the previous exercise.

Lab Report Submission

Report the results and show a screenshoot of the display.

Exercise 2.4

In this exercise, we are going to do the DMA method again but without the energy-saving LPM0 mode. Comment out the statement to call *MAP_PCM_gotoLPM0()*.

```
while (!dma_done)
{
    //MAP_PCM_gotoLPM0();
}
```

Lab Report Submission

Report the results and show a screenshoot of the display.

Exercise 2.5

At this point, you actually have four sets of results. Use Excel (or some other graphing tool) to display them in a bar graph so that we can compare the four methods easily.

Lab Report Submission

Show the screenshoot of the graph. Describe the observations that you have from the results.

4. Exercise 3

In this exercise, you are going to write a program to time how long a button is pressed down using two methods: One is polling and the other is with interrupt in low power mode.

Exercise 3.1

Use only the 32-bit timer to measure the time. You will use a loop to detect when the button is pressed. After it is pressed, use another loop to detect when the button is released. Print out time in ms and then halt the processor, like the way it is done in the previous exercise. Use EnergyTrace to measure the power consumption.

Lab Report Submission

Report the time and the three values we measured in the previous exercise with EnergyTrace.

Exercise 3.2

Similar to the previous exercise, use only the 32-bit timer to measure the time that the button is pressed down, but only use the interrupt method in low power mode. Basically, most of the time, the program execution is totally suspended, processor waiting for something to happen. Use EnergyTrace to measure the power consumption. Try different low power modes to get the lowest power consumption.

Lab Report Submission

Report the time and the three values we measured in the previous exercise with EnergyTrace. Compare the results with the polling method. Also report different low power modes that you have tried.

5. Grading

	Points
Exercise 1	1
Exercise 2.1	1
Exercise 2.2	1
Exercise 2.3	1
Exercise 2.4	1
Exercise 2.5	1
Exercise 3.1	1
Exercise 3.2	2

Report Contents	1
Total	10

Grading Policy:

The lab's grade is primarily determined by the report. We will grade the report first. Based on what we see in the demo, we may adjust the grade by either deducting or adding points.

Demo is mandatory. If you don't show up for demo, half of the points will be deducted.

If you miss the submission deadline for the report, you will get zero point. However, you can still come to the demo to show what you have done and hopefully learn something as well. And you may get a maximum of 30% of the full grade for the assignment. I will drop the lowest score of the lab assignments when I determine the final grade.

As for the report contents, do not use screenshots to show your codes. In the report body, list the relevant codes only for the exercise you are discussing. Put the entire program listing in appendix. Put the contents of one exercise in one section. Do not separate them to two different sections. This will make the grading easier.