Title page: MSP432 Lab 1
CE6302, Embedded Systems, 302 Laboratory - 83204
Lab Topic: Joystick to Seven-Segment Display
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1. Objective:

Lab 1 is to use MSP430 MCU to get input of the analog voltage value from the joystick, and convert it to digital value and output it to the LCD screen with digits from range 0 to 99. This includes understanding the use of Energia IDE, coding and flashing program to the MCU, basic knowledge of the MSP432P401R board and Educational BoosterPack MKII.

Purpose: The goal of this lab is to read the input value from one axis of the joystick, convert that value from the ADC to a range of 0 to 99, and display it on the LCD screen. This lab will help solidify our understanding of ADC, data mapping, and interfacing peripherals with a microcontroller.

Method: To get input voltage and convert it to integer, we use the function analogRead() and map() which are provided; To separate the integer to tens and unit digits with 0 to 99, we use modulo operation to get unit digits and division operation to get tens digits; To display, we use function setOnes() and setTens() which are provided.

Result: the LCD screen displayed digits from 00 to 99, corresponding to the location of joystick in its vertical axis. Moving the joystick from lowest position to highest position in vertical, the number shown on the LCD screen was continuously increasing.

Hardware used: SimpleLink MSP432P401R LaunchPad, Educational BoosterPack MKII. Software used: Energia-1.8.10

2. Introduction:

2.1 Hardware and Software Background Information:

MSP-EXP432P401R LaunchPad: The SimpleLink MSP-EXP432P401R LaunchPad development kit is an easy-to-use evaluation module for the MSP432P401R microcontroller. It contains everything needed to start developing on the MSP432 LowPower + Performance Arm 32-bit Cortex-M4F microcontroller (MCU).

Educational BoosterPack MKII: The Educational BoosterPack MKII offers a high level of integration for developers to quickly prototype complete solutions. Various analog and digital inputs/outputs are at your disposal including an analog joystick, environmental and motion sensors, RGB LED, microphone, buzzer, color LCD display, and more. The module of Color TFT LCD Display, 2-Axis Joystick with Pushbutton, is used within the experiment.

Energia: Energia is an open-source electronics prototyping platform started by Robert Wessels in January of 2012 with the goal to bring the Wiring and Arduino framework to the Texas Instruments MSP430 based LaunchPad. The Energia IDE is cross platform and supported on Mac OS, Windows, and Linux. Energia uses the mspgcc compiler by Peter Bigot and is based on the Wiring and Arduino framework. Energia includes an integrated development environment (IDE) that has its foundation in the Processing IDE (Processing→Wiring→Arduino→Energia). Energia is also a portable framework/abstraction layer that can be

used in other popular IDEs. Utilize a web browser based environment with Texas Instruments CCS Cloud at dev.ti.com or TI's powerful CCS Desktop IDE.

2.2 Purpose of the Experiment

The purpose of the experiment is to get the input value of one axis of the joystick, convert that value to the range 0 to 99 from the ADC value, and output that value on the LCD screen.

2.3 Summary of the Experiment

By adding the code within function loop() from the framework code provided, we use the ADC module of MSP430 to get 0V to 5V input voltage with 12 bit resolution, convert it to digits from 0 to 99, and communicate with the LCD screen to display the digits.

2.4 Findings of the experiment

The main objective is to read and process the input from one axis of a joystick, map the resultant ADC value within a range of 0 to 99, and send it for display on an LCD screen.

3. Explanation:

3.1 Experiment procedure

To achieve this, we modified the range to 4000 - 4050, and changed the mapping from 9 to 99.
First, divide the number by 10 to get the integer value of the tens place, and then modulo (%) by 10 to get the remainder that provides the one's place. We add a function setTens(tens). After checking and uploading the code to Energia IDE, which is further sent to LaunchPad, we were successfully able to display the numbers from 0 to 99 on the LaunchPad.

3.2 Experiment Images

Image 3.1: MSP430_Display_30

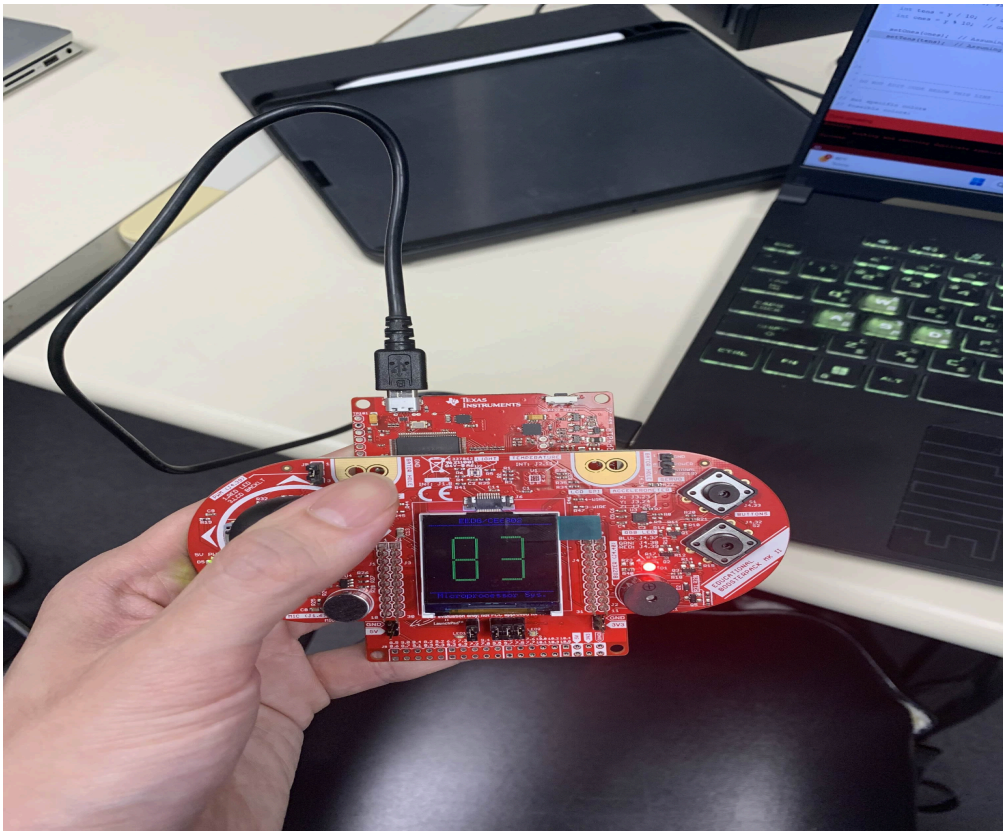

Image 3.2: MSP430_Display_83

3.3 Codes

```
// Add loop code
void loop()
{
    y = map(analogRead(joystickYPin), 0, 4050, 0, 99);
    y = constrain(y, 0, 99);

    int tens = y / 10;  // Get the tens place
    int ones = y % 10;  // Get the ones place

    setOnes(ones);  // Assuming setOnes sets the ones place
    setTens(tens);  // Assuming setTens sets the tens place
}
```

Image 3.3: Experiment Code

4. Discussions and Conclusions:

4.1 Comparison of your experimental results with the research/theory of the concept with reasoning.

The experimental results obtained from this lab are really close to theoretical considerations: the ADC, data mapping, and modular programming in embedded systems. In theory, the MSP430's ADC converts the analog input of a joystick to a digital value depending on the resolution of the ADC, such as in a 12-bit ADC, values range from 0 to 4095. That was indeed verified through the experiments where the joystick input was successfully read and mapped the ADC values in a range of 0 to 99, showing linear

scaling to be effective.

4.2 Learnings from the experiment

In this lab, we learned how to take an analog input from a joystick with the MSP430's ADC and convert the values into a range of 0 to 99 for an LCD display. This includes analog-to-digital conversion, mapping of data, and implementation of code in a modular fashion by breaking down the values into tens and ones places. Interfacing with the LCD, testing, and debugging were also learned using Energia IDE.
To sum it up, this lab added great knowledge of programming embedded systems, the workflow that needs to be done in order to connect the hardware and software components efficiently.

4.3 Video Link

https://youtu.be/Q-yDtbXjPZg

5. References:

Texas Instruments, https://www.ti.com/
Texas Instruments, Educational BoosterPack MkII Guide, https://www.ti.com/lit/ug/slau599b/slau599b.pdf
Energia, https://energia.nu/