EE 308 – MICROPROCESSORS
LABORATORY MANUAL – 5 –
INTERFACING POTENTIOMETER with TIVA GPIO [1]

Objective:

The main objective of this experiment is to interface a potentiometer with EK-TM4C123G

GPIO (PE3) by configuring it as an Analog Input (AN0) and to observe its corresponding 12-bit digital value. In this experiment, we will also understand the Analog-to-Digital Conversion (ADC) and processing of the analog signals in a digital environment.

Introduction:

In this experiment, the potentiometer is interfaced to the TM4C123GH6PM processor via a GPIO (PE3) configured as analog input. The potentiometer input is read by the 12-bit ADC peripheral of the processor and the analog input voltage is converted to corresponding digital values. These 12-bit digital values are stored in a temporary register. The functional block diagram as shown in Figure 1 illustrates the working principle of the experiment.

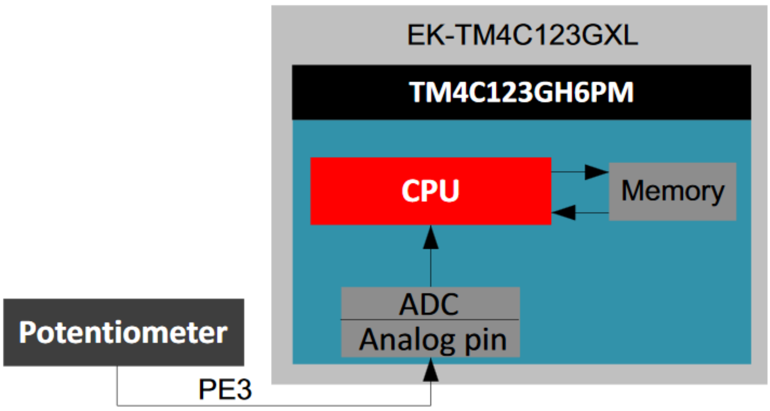

Figure 1 Functional Block Diagram

Analog to Digital Conversion Module:

TM4C123GH6PM MCUs consists of two ADC modules (ADC0 and ADC1) that can be used to convert continuous analog voltages to discrete digital values. Each ADC module has a 12-bit resolution, operates independently, can execute different sample sequences, can sample any of the shared analog input channels and generate interrupts & triggers based on the conversion process. The features of the ADC module are:

- Two 12-bit 1MSPS ADCs giving a digital range of 0 to 4095
- 12 shared analog input channels

- Single ended & differential input configurations
- On-chip temperature sensor
- Maximum sample rate of one million samples/second (1MSPS)
- Fixed references (VDDA/GNDA) due to pin-count limitations
- 4 programmable sample conversion sequencers per ADC
- Separate analog power & ground pins
- Flexible trigger control
- 2x to 64x hardware averaging
- 8 Digital comparators per ADC
- 2 Analog comparators
- Optional phase shift in sample time between ADC modules is programmable from 22.5° to337.5°

The TM4C123GH6PM ADC collects sample data by using a programmable sequence-based approach. Each sample sequence is a fully programmed series of consecutive (back-to-back) samples, allowing the ADC to collect data from multiple input sources without having to be re-con-figured or serviced by the processor. The programming of each sample in the sample sequence includes parameters such as the input source and mode (differential versus single-ended input), interrupt generation on sample completion, and the indicator for the last sample in the sequence. Each ADC module of the TM4C123GH6PM has four sample sequencers that handle the sampling control and data capture. All of the sequencers are identical in implementation except for the number of samples that can be captured and the depth of the FIFO (First In First Out)

Flowchart:

The flowchart for the program is shown in Figure 2. The software controls the GPIO and ADC peripherals of the processor to convert the potentiometer input into digital values and store the converted 12-bit digital values in an array variable. A temporary array variable 'ui32ADC0Value' is initialized in the program for storing the 12-bit digital output of the ADC. The system clock is set to 40MHz and the GPIO port E (PE3) configured and enabled as analog input to the ADC0 module which is used for A/D conversion. The ADC0 module is configured to interrupt on conversion and then enabled. The program then waits for an interrupt from the ADC0. The ADC0 module reads the analog input from the potentiometer and converts to digital output and interrupts the processor. On interrupt from the ADC0, the program enables the processor trigger event and stores the converted digital value in a temporary variable. The process continues for the next analog input from the potentiometer.

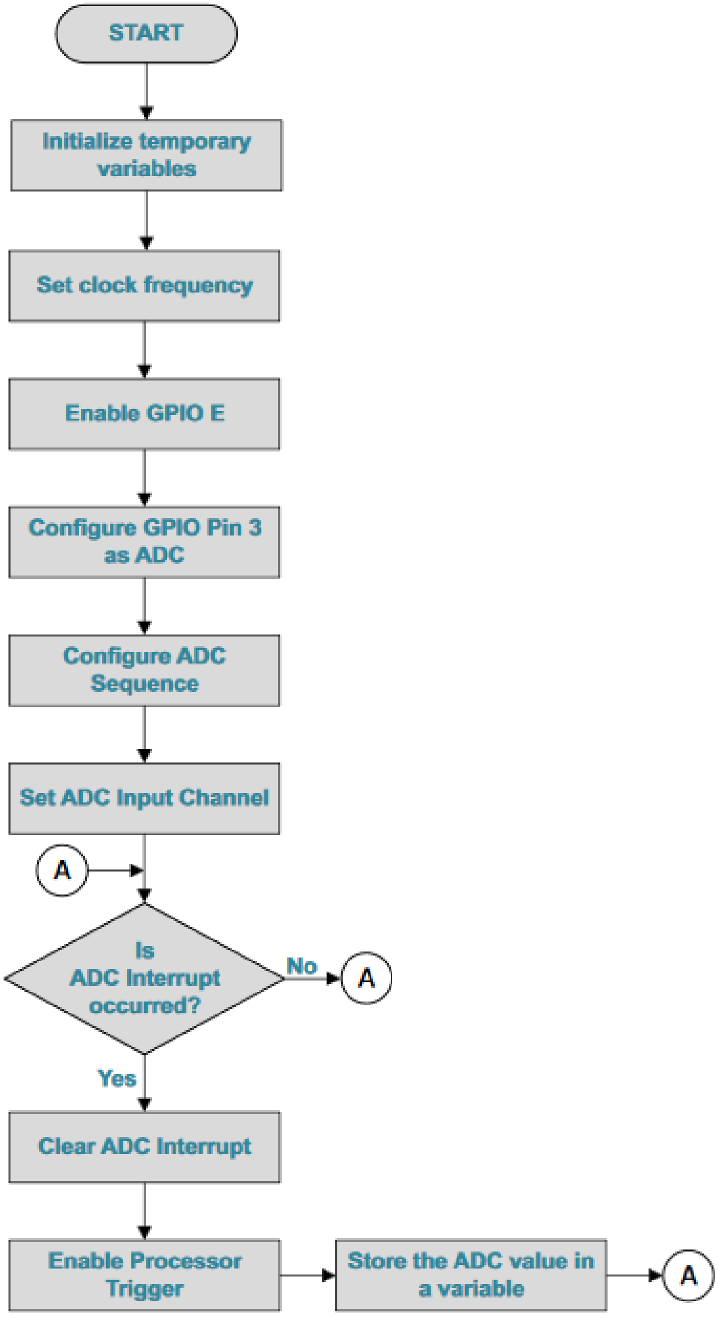

Figure 2 Flowchart for ADC Conversion of Potentiometer Input via GPIO

Hardware Setup:

Figure 3 shows the hardware connections for the potentiometer with the EK-TM4C123G.

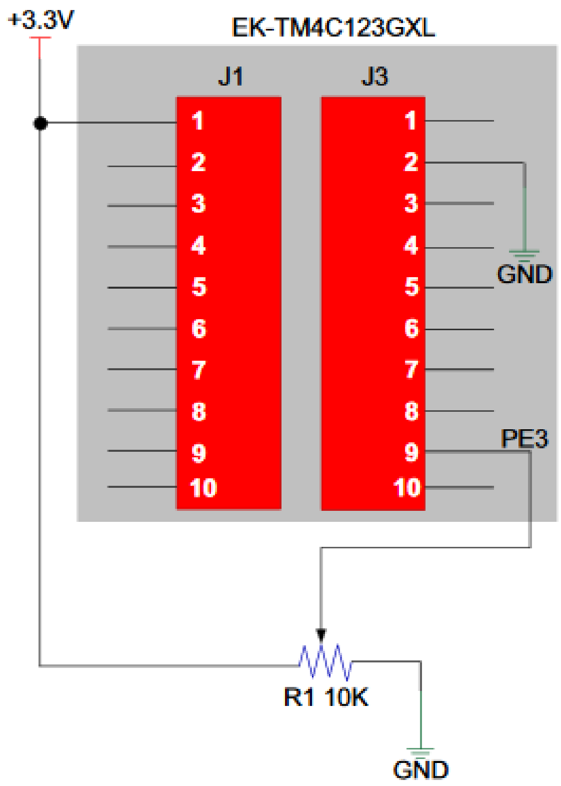

Figure 3 Connection Diagram for Potentiometer with EK-TM4C123G

The procedure to be followed for the hardware connections is:

1. Connect one lead of the potentiometer (Vcc) to +3.3V DC Supply Voltage (J1 connector Pin 1).
2. Connect the other lead of the potentiometer to the GND pin (J3 connector, Pin 2).
3. Connect the center lead of the potentiometer to pin PE3 which is the Analog Channel AN0 (J3 connector, Pin 9).
4. The Multimeter can be probed at the center lead of the potentiometer to observe the analog volt-age input.
5. This configuration varies the Analog Voltage from 0V to 3.3V depending on the wiper position on PE3 which is the AN0 or Analog Input 0 of the TM4C123GH6PM.
6. The current configuration connects the VREFP of ADC to VDDA which is 3.3V and VREFP to GND which is 0V.

After connecting the hardware, the setup appears as shown in Figure 4.

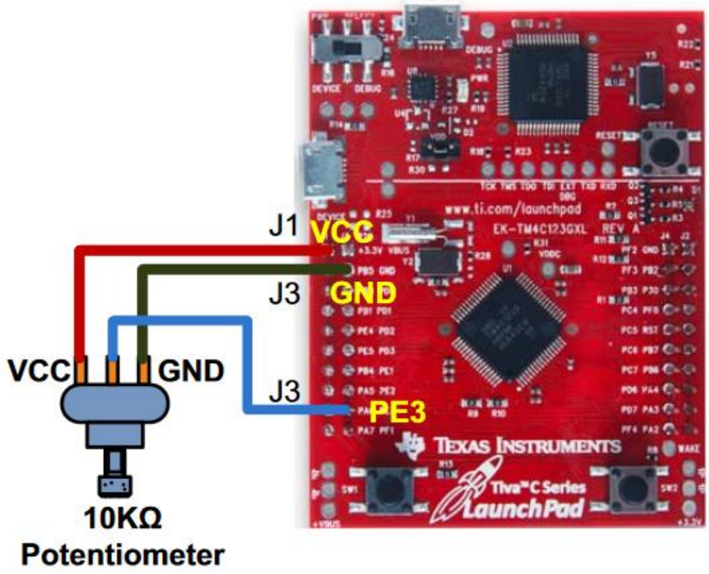

Figure 4 Hardware Setup

Summary:

In this experiment, we have successfully read the potentiometer input via GPIO and used the on chip ADC to convert the analog voltage to a digital value. We have also learnt to configure the ADC for analog to digital conversion.

References:

[1] https://www.ti.com/seclit/ml/ssqu015/ssqu015.pdf