ENGINE

Teaching online electronics, microcontrollers and programming in Higher Education

Programing of embedded systems

7. A/D Converter

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Declaration

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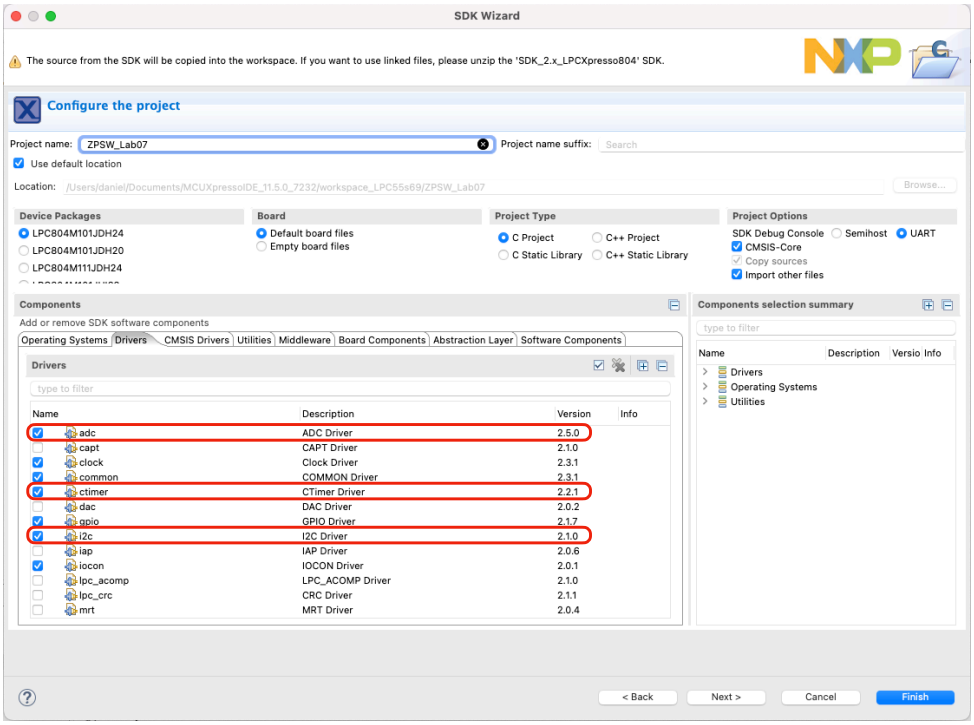
Programing of embedded systems
7. A/D Converter

I. OLED Display

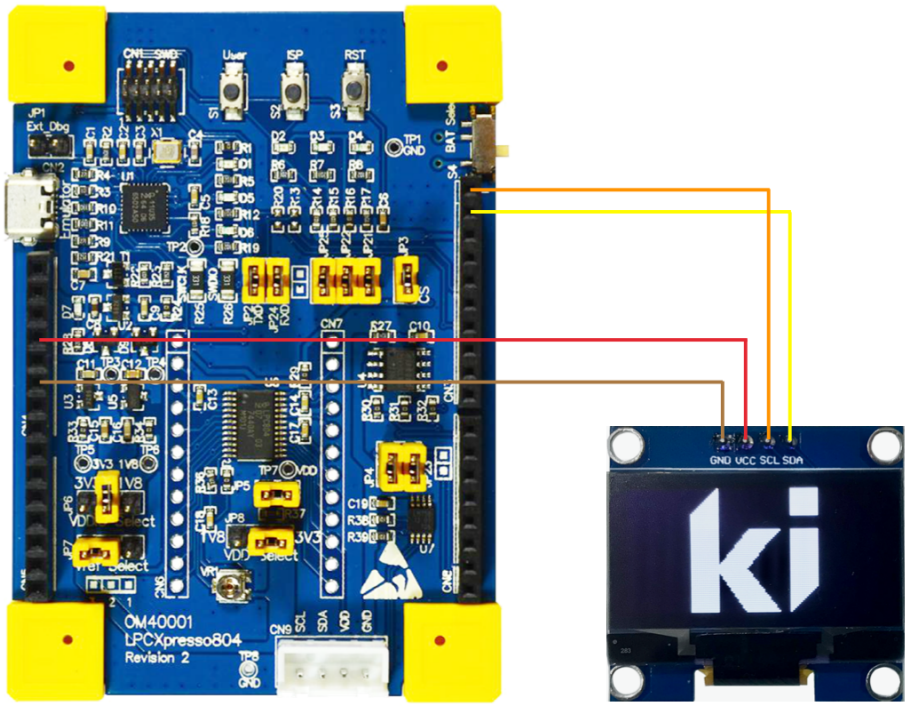
1. Create a new project for the *LPCXpresso804* board and name it eg *Lab07*.
2. Add *ADC*, *CTIMER* and *I2C* drivers:



3. Add the *OLED* library and configure the display operation as in the previous manual.
4. In *Config Tools -> Clocks*, change the frequency of the *FRO_OSC* generator to 30 MHz.
5. Go to the main project file and modify the code as below:

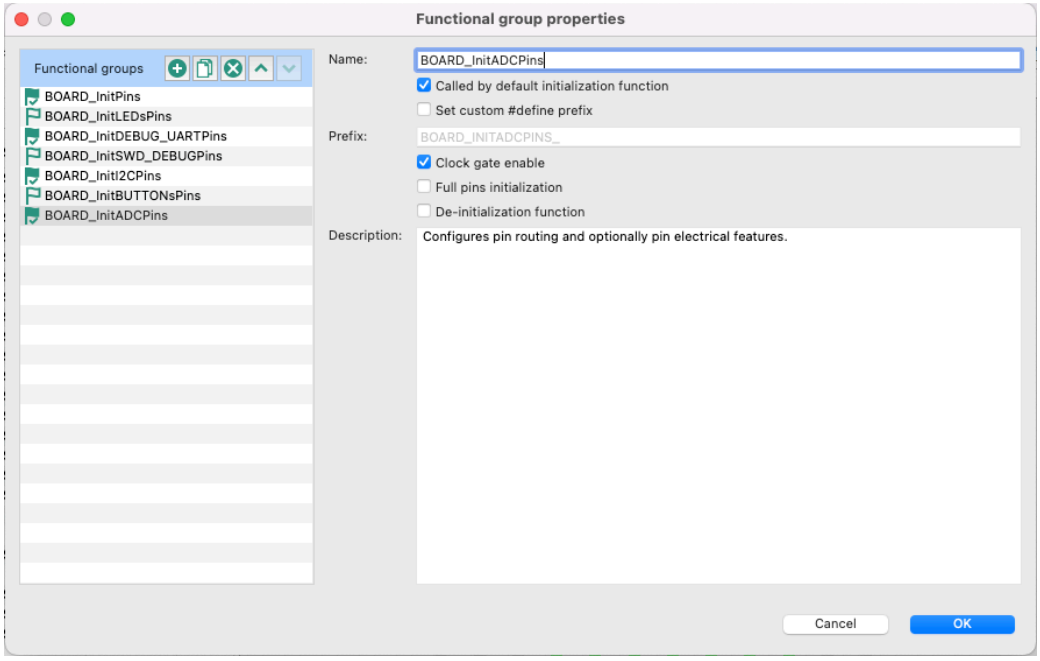
```
#include <stdio.h>
#include "board.h"
#include "peripherals.h"
#include "pin_mux.h"
#include "clock_config.h"
#include "LPC804.h"
#include "fsl_debug_console.h"
#include "oled.h"

char sbuff[32];
volatile uint16_t adcValue = 0;

/*
 * @brief   Application entry point.
 */
int main(void) {

          /* Init board hardware. */
          BOARD_InitBootPins();
          BOARD_InitBootClocks();
          BOARD_InitBootPeripherals();
#ifndef BOARD_INIT_DEBUG_CONSOLE_PERIPHERAL
          /* Init FSL debug console. */
          BOARD_InitDebugConsole();
#endif
          /* Initialize OLED */
          OLED_Init(I2C0_PERIPHERAL);

          while(1) {

                    OLED_Clear_Screen(0);
                    sprintf(sbuff, "ADC: %5d", adcValue);
                    OLED_Puts(0, 1, sbuff);
                    OLED_Refresh_Gram();
          }
          return 0 ;
}
```

6. Connect the display and check its operation.

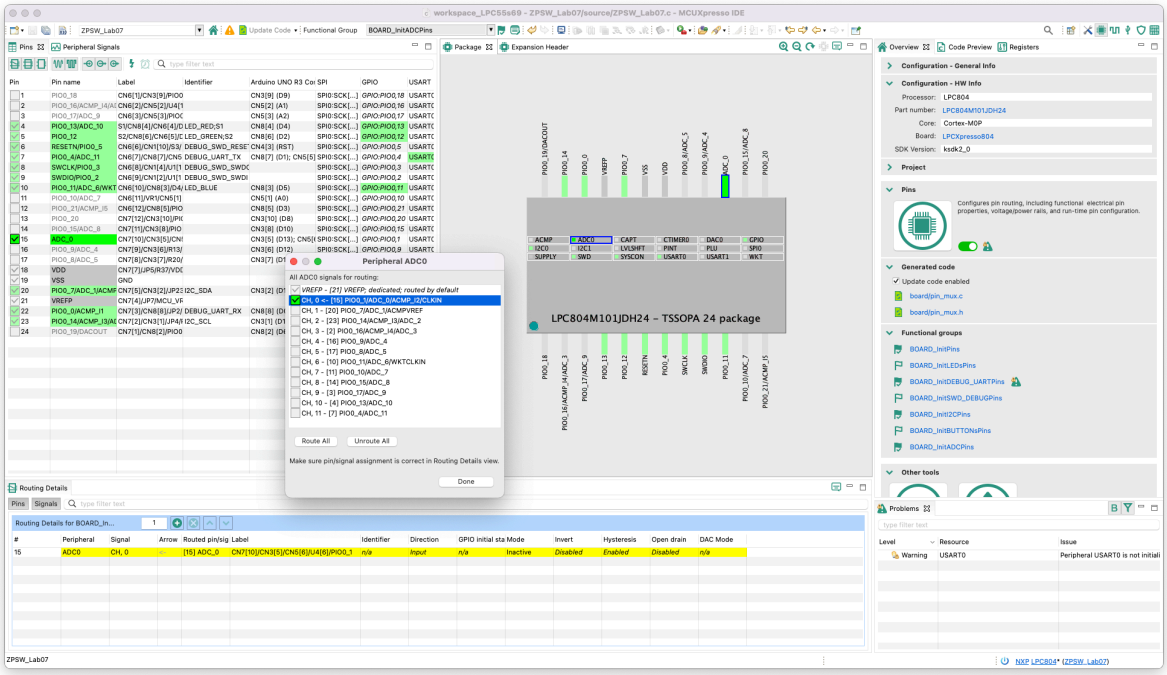


II. A/D Converter

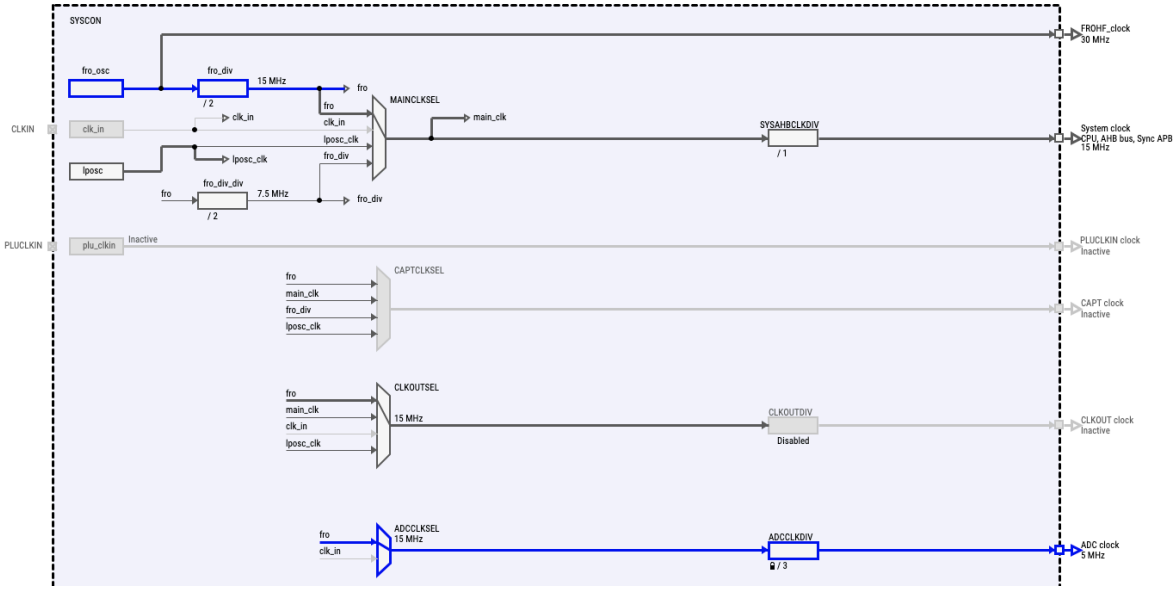
1. Go to *Config Tool -> Pins* and create a new preset called *BOARD_InitADCPins*:



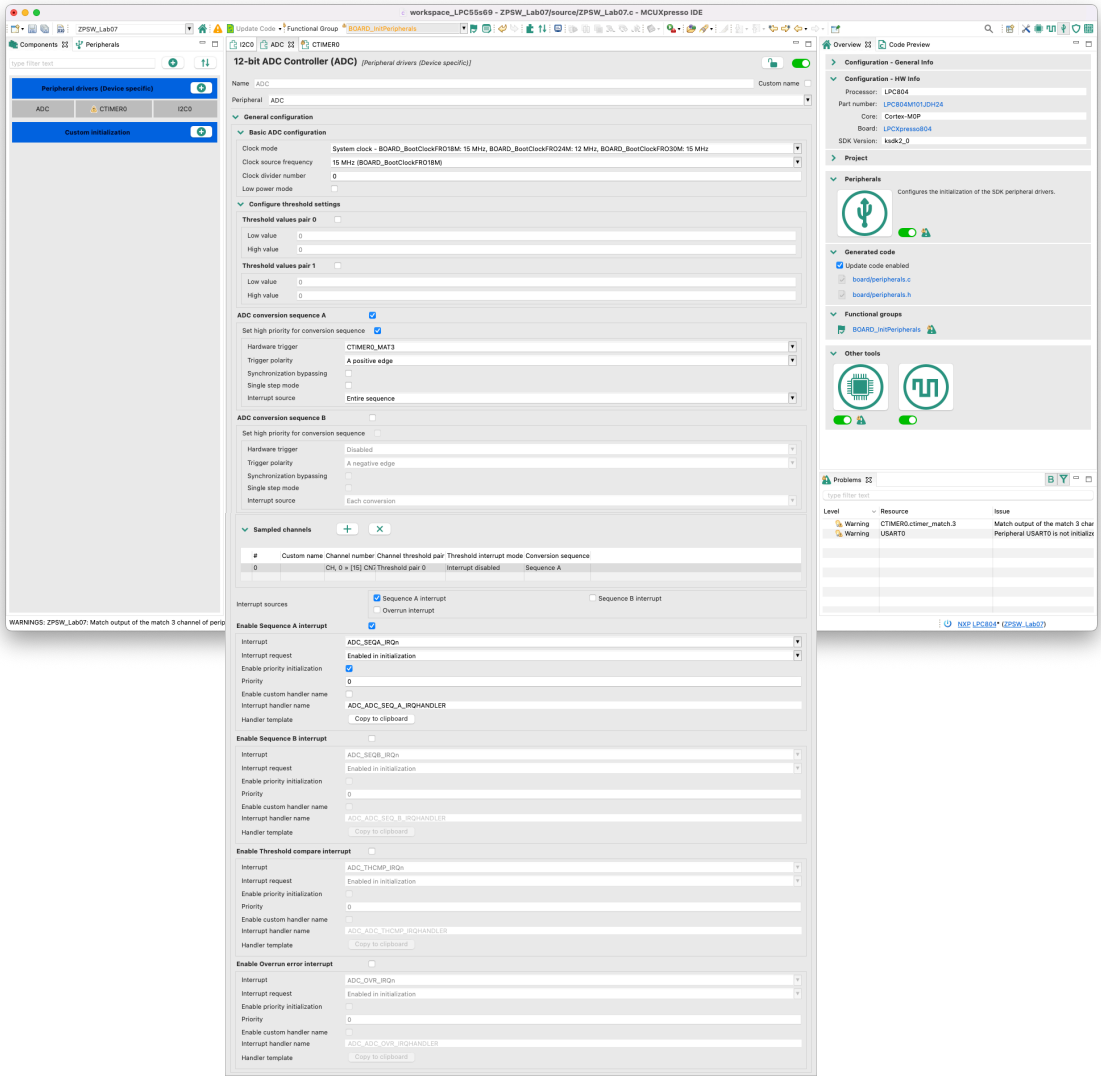
2. Click on the ADC block and connect the *ADC0* signal (*PIO0_1* pin). Disable the default *Pull-Up* by setting the *Mode* field to Inactive:



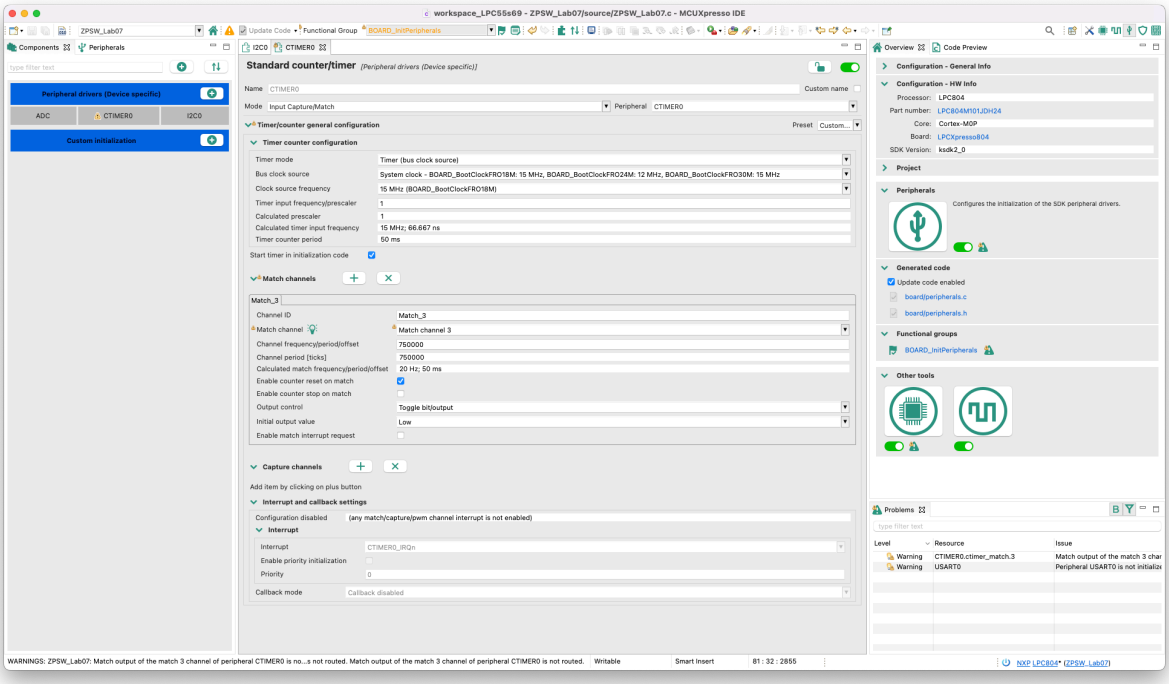
3. Go to Clocks and turn on the ADC clock 5 MHz for the A / D converter:



4. Go to ADC settings and enter the following configuration:



5. Go to Peripherals, select *CTIMER* and configure it to change the state of the output at a frequency of 20 Hz:



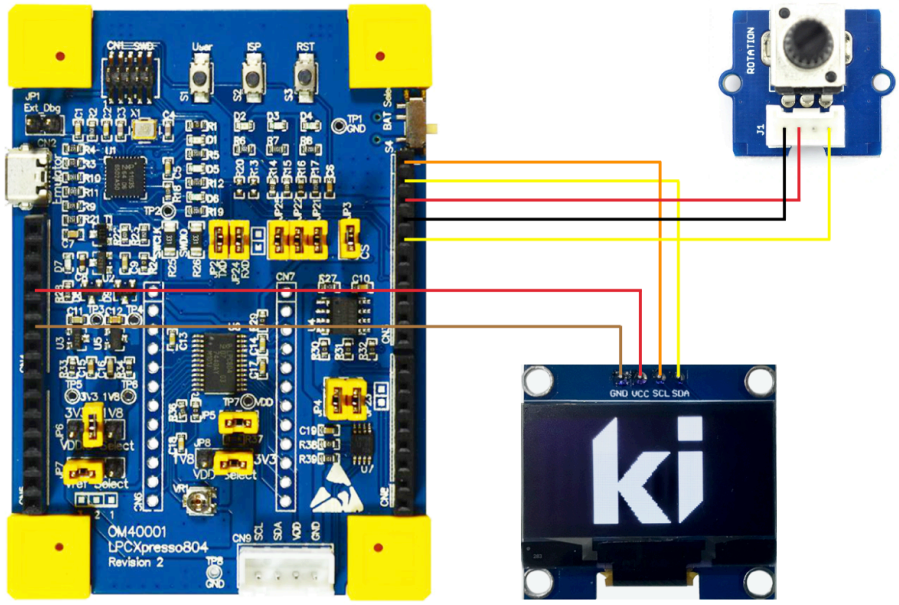
The *ADC* converter will be triggered by only one edge, therefore its sampling frequency will be twice lower - i.e. 10 Hz.

6. Go to the main project file and modify the code as below:

```
#include <stdio.h>
#include "board.h"
#include "peripherals.h"
#include "pin_mux.h"
#include "clock_config.h"
#include "LPC804.h"
#include "fsl_debug_console.h"
#include "fsl_power.h"
#include "oled.h"

static adc_result_info_t gAdcResultInfoStruct;
adc_result_info_t *volatile gAdcResultInfoPtr = &gAdcResultInfoStruct;
char sbuff[32];
volatile uint16_t adcValue = 0;


/* ADC_SEQA_IRQn interrupt handler */
void ADC_ADC_SEQ_A_IRQHANDLER(void) {
          /* Get status flags */
          if (kADC_ConvSeqAInterruptFlag == (kADC_ConvSeqAInterruptFlag & ADC_GetStatusFlags(ADC_PERIPHERAL))) {
                    /* Place your interrupt code here */
                    ADC_GetChannelConversionResult(ADC_PERIPHERAL, 0, gAdcResultInfoPtr);
                    adcValue = gAdcResultInfoStruct.result;
                    /* Clear status flags */
                    ADC_ClearStatusFlags(ADC_PERIPHERAL, kADC_ConvSeqAInterruptFlag);
          }
}

/*
 * @brief   Application entry point.
 */
int main(void) {

          /* Power on ADC. */
          POWER_DisablePD(kPDRUNCFG_PD_ADC0);
          /* Init board hardware. */
          BOARD_InitBootPins();
          BOARD_InitBootClocks();
          BOARD_InitBootPeripherals();
#ifndef BOARD_INIT_DEBUG_CONSOLE_PERIPHERAL
          /* Init FSL debug console. */
          BOARD_InitDebugConsole();
#endif
          /* Initialize OLED */
```

```
        OLED_Init(I2C0_PERIPHERAL);

        while(1) {

                OLED_Clear_Screen(0);
                sprintf(sbuff, "ADC: %5d", adcValue);
                OLED_Puts(0, 1, sbuff);
                OLED_Refresh_Gram();
        }
        return 0 ;
}
```

7. Connect the potentiometer to the board, program the microcontroller and check the example. By moving the potentiometer axis, the displayed value should change in the range of 0-4095 (12-bit resolution), which corresponds to the input voltage of 0-3.3 V.



III. GUI - a simple analog indicator

1. Modify the project code:

```
#include <stdio.h>
#include "board.h"
#include "peripherals.h"
#include "pin_mux.h"
#include "clock_config.h"
#include "LPC804.h"
#include "fsl_debug_console.h"
#include "fsl_power.h"
#include "oled.h"

static adc_result_info_t gAdcResultInfoStruct;
adc_result_info_t *volatile gAdcResultInfoPtr = &gAdcResultInfoStruct;
char sbuff[32];
volatile uint16_t adcValue = 0;
float data=0;

void Gauge(uint8_t x0, uint8_t y0, uint8_t radius, float v) {

        float k= (v*270) - 135; // degrees
        float p, q=(2*PI*k)/360.0;
        uint8_t radius0 = radius * 0.9;

        for(int i=-135; i<=135;i+=15) {

                p=(2*PI*i)/360.0;
                OLED_Draw_Line(x0 + radius0*sinf(p), y0 - radius0*cosf(p), x0 + radius*sinf(p), y0 - radius*cosf(p));
        }
        OLED_Draw_Line(x0, y0 , x0 + radius*sinf(q), y0 - radius*cosf(q));
}
```

```
/* ADC_SEQA_IRQn interrupt handler */
void ADC_ADC_SEQ_A_IRQHANDLER(void) {
          /* Get status flags */
          if (kADC_ConvSeqAInterruptFlag == (kADC_ConvSeqAInterruptFlag & ADC_GetStatusFlags(ADC_PERIPHERAL))) {
                    /* Place your interrupt code here */
                    ADC_GetChannelConversionResult(ADC_PERIPHERAL, 0, gAdcResultInfoPtr);
                    adcValue = gAdcResultInfoStruct.result;
                    /* Clear status flags */
                    ADC_ClearStatusFlags(ADC_PERIPHERAL, kADC_ConvSeqAInterruptFlag);
          }
}

/*
 * @brief   Application entry point.
 */
int main(void) {

          /* Power on ADC. */
          POWER_DisablePD(kPDRUNCFG_PD_ADC0);
          /* Init board hardware. */
          BOARD_InitBootPins();
          BOARD_InitBootClocks();
          BOARD_InitBootPeripherals();
#ifndef BOARD_INIT_DEBUG_CONSOLE_PERIPHERAL
          /* Init FSL debug console. */
          BOARD_InitDebugConsole();
#endif
          /* Initialize OLED */
          OLED_Init(I2C0_PERIPHERAL);

          while(1) {

                    OLED_Clear_Screen(0);

                    data=adcValue/4095.0;

                    Gauge(64, 32, 32, data);
                    sprintf(sbuff, "%3d%%", (uint8_t)(data*100));
                    OLED_Puts(50, 7, sbuff);

                    OLED_Refresh_Gram();
          }
          return 0 ;
}
```

2. Build the project in ***Release*** mode, program the microcontroller and check the example.

IV. Exercises

3. Modify the appearance of the analog indicator as you see fit.
4. Write a function that draws the *n-last* samples in the form of a bar graph. The graph is to move across the display screen (horizontally or vertically).