ENGINE

Teaching online electronics, microcontrollers and programming in Higher Education

Programing of embedded systems

8. Joystick analogowy

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Declaration

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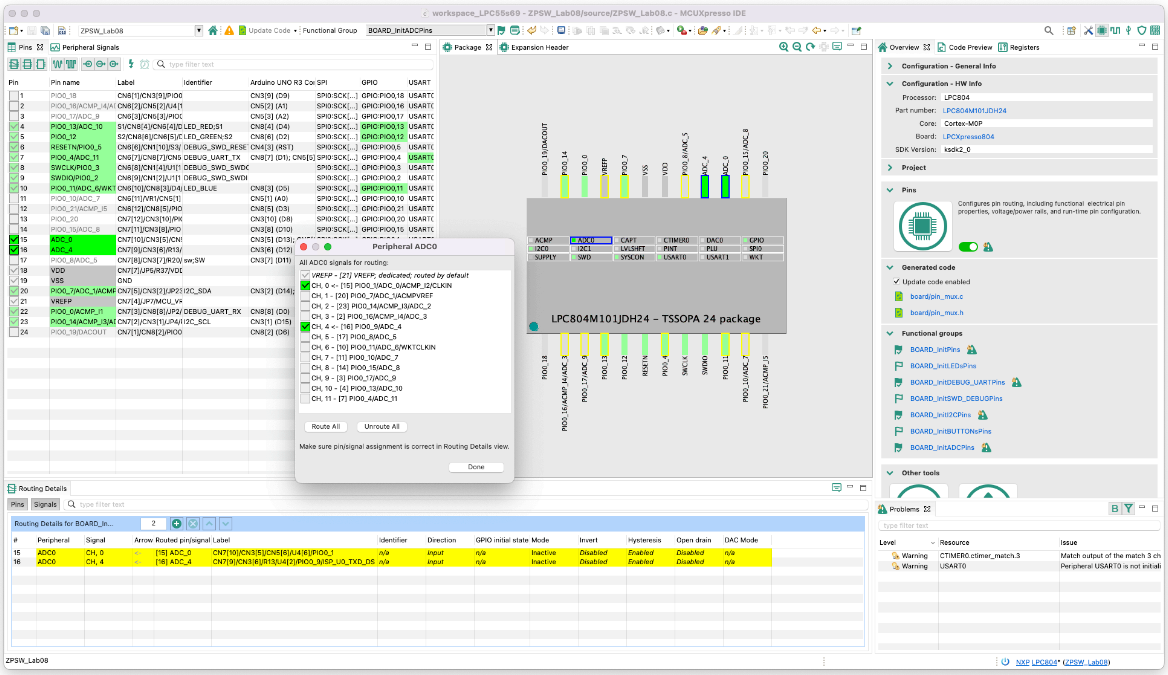
Programing of embedded systems

8. Joystick analogowy

I. Przetwornik A/C

1. Skopiuj projekt z poprzednich zajęć i nazwij go np. *ZPSW_Lab08*.
2. Przejdź do *Config Tool* -> *Pins* i otwórz preset *BOARD_InitADCPins*. Kliknij w blok *ADC* i do istniejącego sygnału *ADC0* (wyprowadzenie *PIO0_1*), analogicznie dodaj sygnał *ADC4* (wyprowadzenie *PIO0_9*):



Peripheral ADC0

All ADC0 signals for routing:

- ☑ *VREFP - [21] VREFP; dedicated; routed by default*
- ☑ CH, 0 <- [15] PIO0_1/ADC_0/ACMP_I2/CLKIN
- □ CH, 1 - [20] PIO0_7/ADC_1/ACMPVREF
- □ CH, 2 - [23] PIO0_14/ACMP_I3/ADC_2
- □ CH, 3 - [2] PIO0_16/ACMP_I4/ADC_3
- ☑ CH, 4 <- [16] PIO0_9/ADC_4
- □ CH, 5 - [17] PIO0_8/ADC_5
- □ CH, 6 - [10] PIO0_11/ADC_6/WKTCLKIN
- □ CH, 7 - [11] PIO0_10/ADC_7
- □ CH, 8 - [14] PIO0_15/ADC_8
- □ CH, 9 - [3] PIO0_17/ADC_9
- □ CH, 10 - [4] PIO0_13/ADC_10
- □ CH, 11 - [7] PIO0_4/ADC_11

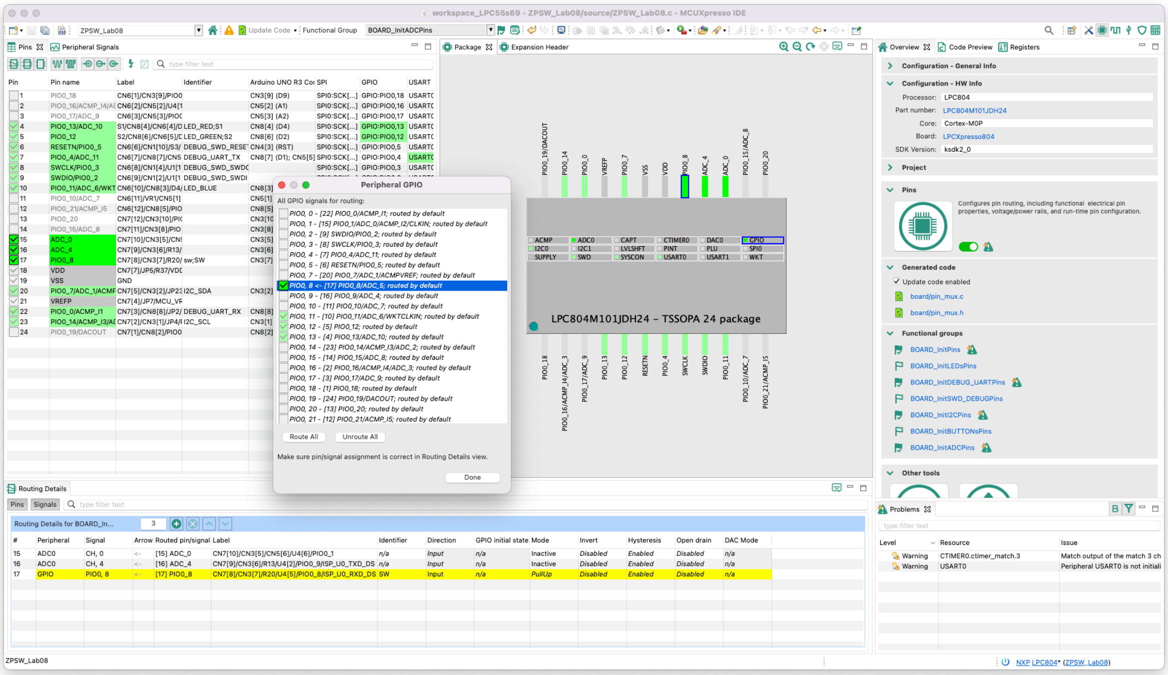
Make sure pin/signal assignment is correct in Routing Details view.

Routing Details for BOARD_In... 2

#	Peripheral	Signal	Arrow	Routed pin/signal	Label	Identifier	Direction	GPIO initial state	Mode	Invert	Hysteresis	Open drain	DAC Mode
15	ADC0	CH, 0	<-	[15] ADC_0	CN7[10]/CN3[5]/CN5[6]/U4[6]/PIO0_1	n/a	Input	n/a	Inactive	Disabled	Enabled	Disabled	n/a
16	ADC0	CH, 4	<-	[16] ADC_4	CN7[9]/CN3[6]/R13/U4[2]/PIO0_9/ISP_U0_TXD_DS	n/a	Input	n/a	Inactive	Disabled	Enabled	Disabled	n/a

workspace_LPC55s69 - ZPSW_Lab08/source/ZPSW_Lab08.c - MCUXpresso IDE
LPC804M101JDH24 – TSSOPA 24 package
Route All
Unroute All
Done

3. Dodaj wyprowadzenie *PIO0_8* jako wejściowe z *PullUp* i dodaj identyfikator SW:



Peripheral GPIO

All GPIO signals for routing:

- □ *PIO0, 0 - [22] PIO0_0/ACMP_I1; routed by default*
- □ *PIO0, 1 - [15] PIO0_1/ADC_0/ACMP_I2/CLKIN; routed by default*
- □ *PIO0, 2 - [9] SWDIO/PIO0_2; routed by default*
- □ *PIO0, 3 - [8] SWCLK/PIO0_3; routed by default*
- □ *PIO0, 4 - [7] PIO0_4/ADC_11; routed by default*
- □ *PIO0, 5 - [6] RESETN/PIO0_5; routed by default*
- □ *PIO0, 7 - [20] PIO0_7/ADC_1/ACMPVREF; routed by default*
- ☑ *PIO0, 8 <- [17] PIO0_8/ADC_5; routed by default*
- □ *PIO0, 9 - [16] PIO0_9/ADC_4; routed by default*
- □ *PIO0, 10 - [11] PIO0_10/ADC_7; routed by default*
- ☑ *PIO0, 11 - [10] PIO0_11/ADC_6/WKTCLKIN; routed by default*
- ☑ *PIO0, 12 - [5] PIO0_12; routed by default*
- ☑ *PIO0, 13 - [4] PIO0_13/ADC_10; routed by default*
- □ *PIO0, 14 - [23] PIO0_14/ACMP_I3/ADC_2; routed by default*
- □ *PIO0, 15 - [14] PIO0_15/ADC_8; routed by default*
- □ *PIO0, 16 - [2] PIO0_16/ACMP_I4/ADC_3; routed by default*
- □ *PIO0, 17 - [3] PIO0_17/ADC_9; routed by default*
- □ *PIO0, 18 - [1] PIO0_18; routed by default*
- □ *PIO0, 19 - [24] PIO0_19/DACOUT; routed by default*
- □ *PIO0, 20 - [13] PIO0_20; routed by default*
- □ *PIO0, 21 - [12] PIO0_21/ACMP_I5; routed by default*

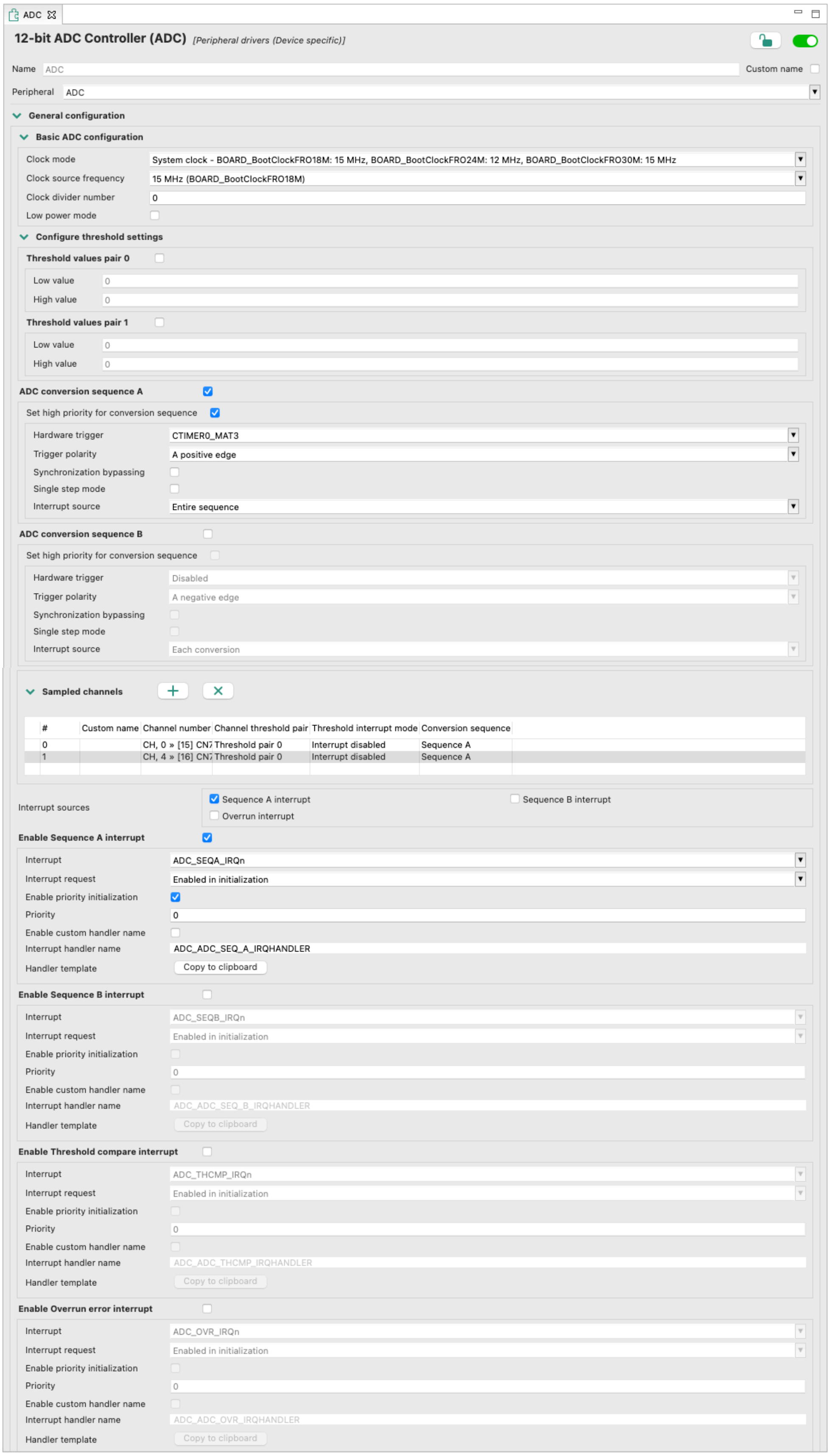
Make sure pin/signal assignment is correct in Routing Details view.

Routing Details for BOARD_In... 3

#	Peripheral	Signal	Arrow	Routed pin/signal	Label	Identifier	Direction	GPIO initial state	Mode	Invert	Hysteresis	Open drain	DAC Mode
15	ADC0	CH, 0	<-	[15] ADC_0	CN7[10]/CN3[5]/CN5[6]/U4[6]/PIO0_1	n/a	Input	n/a	Inactive	Disabled	Enabled	Disabled	n/a
16	ADC0	CH, 4	<-	[16] ADC_4	CN7[9]/CN3[6]/R13/U4[2]/PIO0_9/ISP_U0_TXD_DS	n/a	Input	n/a	Inactive	Disabled	Enabled	Disabled	n/a
17	GPIO	PIO0, 8	<-	[17] PIO0_8	CN7[8]/CN3[7]/R20/U4[5]/PIO0_8/ISP_U0_RXD_DS	SW	Input	n/a	PullUp	Disabled	Enabled	Disabled	n/a

workspace_LPC55s69 - ZPSW_Lab08/source/ZPSW_Lab08.c - MCUXpresso IDE
LPC804M101JDH24 – TSSOPA 24 package
Route All
Unroute All
Done

4. Przejdź do ustawień przetwornika *ADC* i zmień jego konfigurację przez dodanie dodatkowego kanału (*CH 4*):



ADC

12-bit ADC Controller (ADC) *[Peripheral drivers (Device specific)]*

Name	ADC	Custom name	□
Peripheral	ADC		

General configuration

Basic ADC configuration

Clock mode	System clock - BOARD_BootClockFRO18M: 15 MHz, BOARD_BootClockFRO24M: 12 MHz, BOARD_BootClockFRO30M: 15 MHz
Clock source frequency	15 MHz (BOARD_BootClockFRO18M)
Clock divider number	0
Low power mode	□

Configure threshold settings

Threshold values pair 0	□
Low value	0
High value	0
Threshold values pair 1	□
Low value	0
High value	0

ADC conversion sequence A	☑
Set high priority for conversion sequence	☑
Hardware trigger	CTIMER0_MAT3
Trigger polarity	A positive edge
Synchronization bypassing	□
Single step mode	□
Interrupt source	Entire sequence
ADC conversion sequence B	□
Set high priority for conversion sequence	□
Hardware trigger	Disabled
Trigger polarity	A negative edge
Synchronization bypassing	□
Single step mode	□
Interrupt source	Each conversion

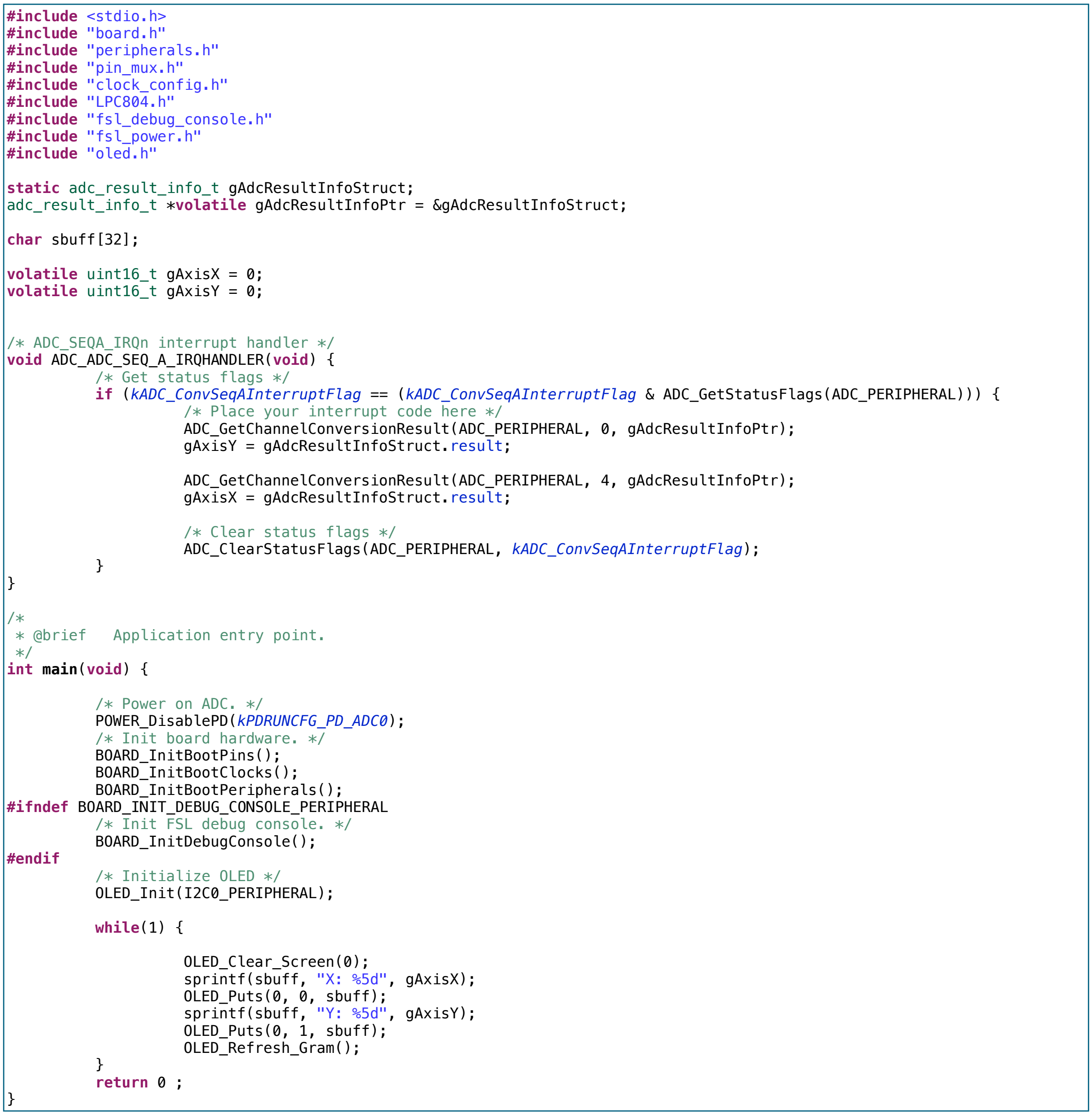
Sampled channels + ×

#	Custom name	Channel number	Channel threshold pair	Threshold interrupt mode	Conversion sequence
0		CH, 0 » [15] CN7	Threshold pair 0	Interrupt disabled	Sequence A
1		CH, 4 » [16] CN7	Threshold pair 0	Interrupt disabled	Sequence A

Interrupt sources	☑ Sequence A interrupt □ Overrun interrupt	□ Sequence B interrupt

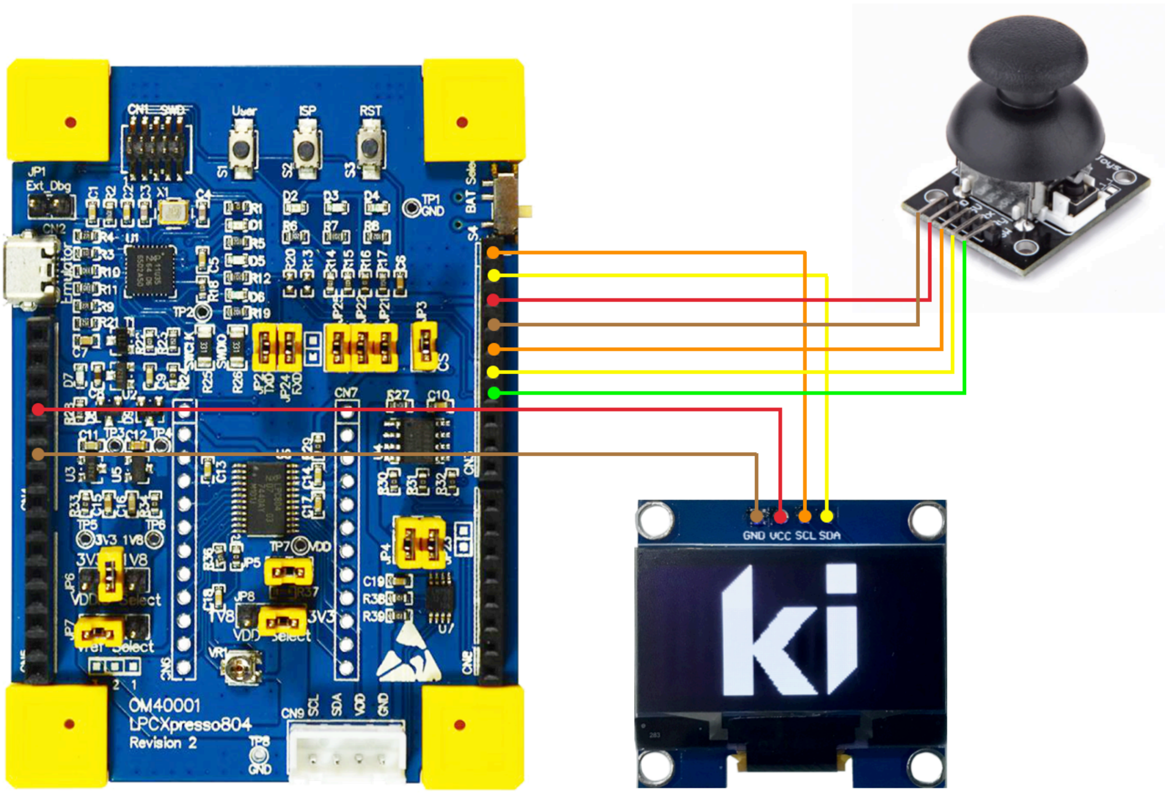
Enable Sequence A interrupt	☑
Interrupt	ADC_SEQA_IRQn
Interrupt request	Enabled in initialization
Enable priority initialization	☑
Priority	0
Enable custom handler name	□
Interrupt handler name	ADC_ADC_SEQ_A_IRQHANDLER
Handler template	Copy to clipboard
Enable Sequence B interrupt	□
Interrupt	ADC_SEQB_IRQn
Interrupt request	Enabled in initialization
Enable priority initialization	□
Priority	0
Enable custom handler name	□
Interrupt handler name	ADC_ADC_SEQ_B_IRQHANDLER
Handler template	Copy to clipboard
Enable Threshold compare interrupt	□
Interrupt	ADC_THCMP_IRQn
Interrupt request	Enabled in initialization
Enable priority initialization	□
Priority	0
Enable custom handler name	□
Interrupt handler name	ADC_ADC_THCMP_IRQHANDLER
Handler template	Copy to clipboard
Enable Overrun error interrupt	□
Interrupt	ADC_OVR_IRQn
Interrupt request	Enabled in initialization
Enable priority initialization	□
Priority	0
Enable custom handler name	□
Interrupt handler name	ADC_ADC_OVR_IRQHANDLER
Handler template	Copy to clipboard

5. Przejdź do głównego pliku projektu i zmodyfikuj kod jak poniżej:



```c
#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 gAxisX = 0;
volatile uint16_t gAxisY = 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);
                gAxisY = gAdcResultInfoStruct.result;

                ADC_GetChannelConversionResult(ADC_PERIPHERAL, 4, gAdcResultInfoPtr);
                gAxisX = 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, "X: %5d", gAxisX);
                OLED_Puts(0, 0, sbuff);
                sprintf(sbuff, "Y: %5d", gAxisY);
                OLED_Puts(0, 1, sbuff);
                OLED_Refresh_Gram();
        }
        return 0 ;
}
```

6. Podłącz wyświetlacz oraz joystick do płytki według poniższego schematu:



7. Zaprogramuj układ i sprawdź działanie przykładu.

II. Obsługa przycisku

1. Zmodyfikuj kod projektu przez dodanie obsługi przycisku w osi Z:

```c
#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 gAxisX = 0;
volatile uint16_t gAxisY = 0;
volatile bool     gAxisZ = 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);
                    gAxisY = gAdcResultInfoStruct.result;

                    ADC_GetChannelConversionResult(ADC_PERIPHERAL, 4, gAdcResultInfoPtr);
                    gAxisX = gAdcResultInfoStruct.result;

                    gAxisZ = GPIO_PinRead(BOARD_INITADCPINS_SW_GPIO,
                                        BOARD_INITADCPINS_SW_PORT,
                                        BOARD_INITADCPINS_SW_PIN);

                    /* Clear status flags */
                    ADC_ClearStatusFlags(ADC_PERIPHERAL, kADC_ConvSeqAInterruptFlag);
          }
}
```

```c
/*
 * @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, "X: %5d", gAxisX);
                    OLED_Puts(0, 0, sbuff);
                    sprintf(sbuff, "Y: %5d", gAxisY);
                    OLED_Puts(0, 1, sbuff);
                    sprintf(sbuff, "Z: %5d", gAxisZ);
                    OLED_Puts(0, 2, sbuff);
                    OLED_Refresh_Gram();
          }
          return 0 ;
}
```

2. Zbuduj projekt w trybie *Release*, zaprogramuj układ i sprawdź działanie przykładu.

III. Obsługa kursora

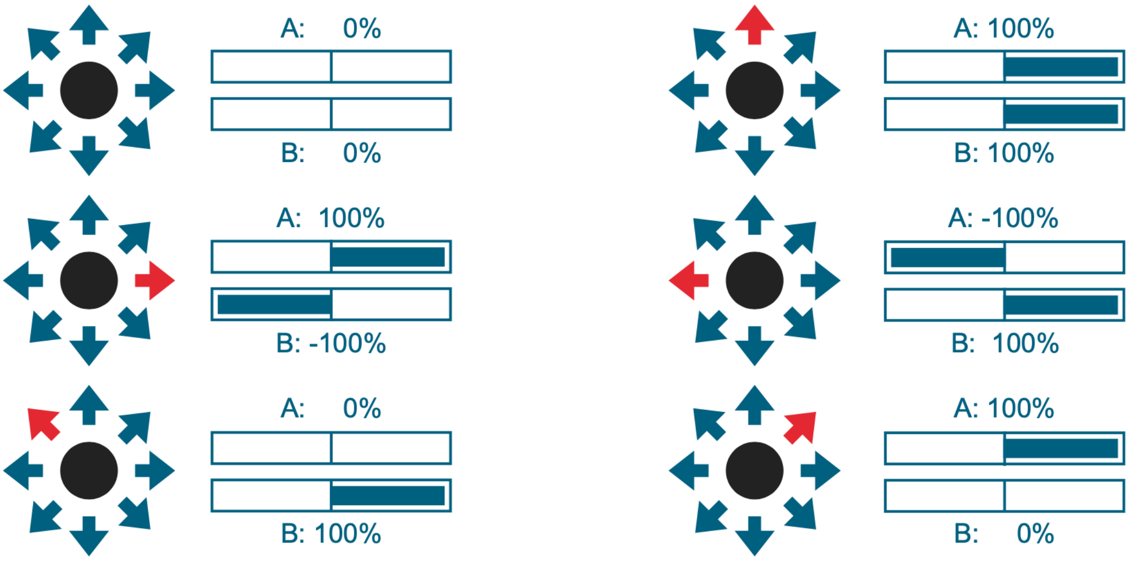
1. Zmodyfikuj kod projektu:

```c
#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 gAxisX = 0;
volatile uint16_t gAxisY = 0;
volatile bool     gAxisZ = 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);
                    gAxisY = gAdcResultInfoStruct.result;

                    ADC_GetChannelConversionResult(ADC_PERIPHERAL, 4, gAdcResultInfoPtr);
                    gAxisX = gAdcResultInfoStruct.result;

                    gAxisZ = GPIO_PinRead(BOARD_INITADCPINS_SW_GPIO,
                                        BOARD_INITADCPINS_SW_PORT,
                                        BOARD_INITADCPINS_SW_PIN);

                    /* Clear status flags */
                    ADC_ClearStatusFlags(ADC_PERIPHERAL, kADC_ConvSeqAInterruptFlag);
          }
}

void setCursor(uint8_t x, uint8_t y, uint8_t size) {

          int8_t a, b;

          a=x-size;
          b=x+size;
          if(a<0) {
                    a=0;
          }
          OLED_Draw_Line(a, y, b, y);
          a=y-size;
          b=y+size;
          if(a<0) {
                    a=0;
          }
          OLED_Draw_Line(x, a, x, b);
}

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

          uint8_t cx, cy;

          /* 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) {

                    cx = gAxisX/32;    // width: 128
                    cy = 63-gAxisY/64; // height: 64

                    OLED_Clear_Screen(0);
                    sprintf(sbuff, "X:%3d Y:%2d Z:%d", cx, cy, gAxisZ);
                    OLED_Puts(0, 0, sbuff);

                    setCursor(cx, cy, 5);
                    if(!gAxisZ) {
                              OLED_Draw_Circle(cx, cy, 8);
                    }
                    OLED_Refresh_Gram();
          }
          return 0 ;
}
```

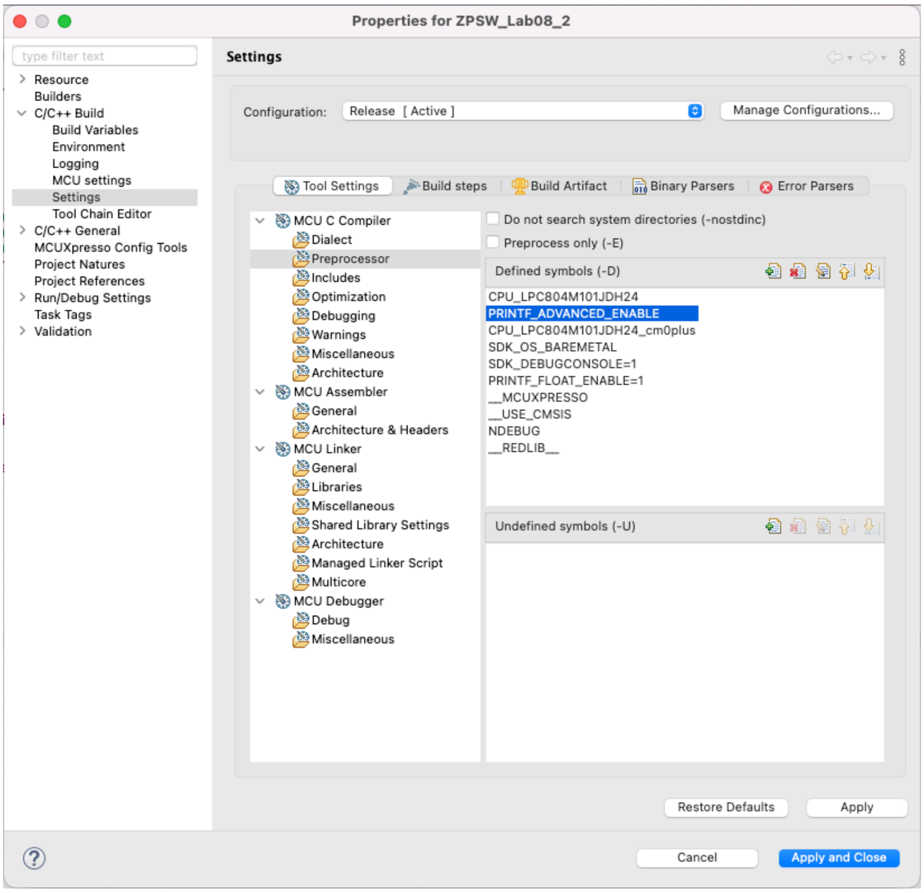
2. Zbuduj projekt w trybie *Release*, zaprogramuj układ i sprawdź działanie przykładu.

IV. Zadania

1. Napisz funkcję *PowerControl* umożliwiającą generowanie sygnałów sterujących dla 2 silników pojazdu gąsienicowego w zależności od położenia joysticka. Funkcja powinna prezentować obliczone sterowanie w postaci dwóch pasków postępu lub wskaźników wychyłowych (jak na poprzednich zajęciach) oraz wyświetlać wartości mocy w procentach. Przykładowe ustawienia joysticka:



W celu wyświetlenia ujemnych wartości, zmiennych całkowitych funkcjami *printf*, *sprint* itp. należy dodać stałą *PRINTF_ADVANCED_ENABLE* w ustawieniach preprocesora:



Properties for ZPSW_Lab08_2

Configuration: Release [Active]

□ Do not search system directories (-nostdinc)
□ Preprocess only (-E)

Defined symbols (-D)

```
CPU_LPC804M101JDH24
PRINTF_ADVANCED_ENABLE
CPU_LPC804M101JDH24_cm0plus
SDK_OS_BAREMETAL
SDK_DEBUGCONSOLE=1
PRINTF_FLOAT_ENABLE=1
__MCUXPRESSO
__USE_CMSIS
NDEBUG
__REDLIB__
```

Undefined symbols (-U)