LAB 3-1

PROGRAMMING USING INTERUPT

OBJECTIVE:

- Understand and utilize external interrupts, timer interrupts.
- Scan 7-segment LED displays and LED matrices using timer interrupts.
- Understand how to control and measure motor speed

REFERENCES:

- Experiment guide, chapters 3, 4, 5, 7,12.
- Atmel-2505-Setup-and-Use-of-AVR-Timers_ApplicationNote_AVR130.pdf.

EXPERIMENT 1:

a) Programming to generate a 1 kHz frequency signal on pin PC0 using Timer 1 overflow interrupt. When Timer 1 overflows, the interrupt routine will toggle the PC0 pin and reset the counter register value.

b) Connect PC0 to the oscilloscope to measure the waveform.
(Note: The clock frequency for the CPU on the experimental kit is 8 MHz.)

EXPERIMENT 2:

a) Repeat exercise 1 using Timer 1 in CTC mode, utilizing the COMPARE_MATCH interrupt, to generate a pulse with a frequency of 100 Hz on pin PC0.

b) Configure the timer to generate a COMPARE_MATCH interrupt every 1 ms. Inside the interrupt, use a counter to count the number of interrupt occurrences and control pin PC0 to generate a pulse with a frequency of 100 Hz.
Instructions: Increment the counter by 1 each time the interrupt occurs. If the counter reaches 5, toggle PC0 and reset the counter to 0.

c) Compile the program and observe the oscilloscope to verify the functionality of the program.

EXPERIMENT 3:

a) Connect the necessary signals to control the 7-segment LED display module.

b) Utilize the COMPARE_MATCH interrupt of Timer 1, as in Exercise 2, to display the numbers 1-2-3-4 on four 7-segment LED displays with a scanning frequency of 50 Hz. To

measure the scanning frequency, toggle pin PC0 each time it switches to the next LED and measure this pulse on the oscilloscope.

(Refer to Chapter 4 of the experiment guide for further details.)

EXPERIMENT 4:

Requirements:

a. Write a program to control the speed of a DC motor using PWM with a frequency of 1 kHz, using Timer 0. Control the speed increase/decrease using two buttons, where each button press increases/decreases the duty cycle by 5%. Allow the motor to start/stop and control the motor direction (forward/reverse) using two switches on a dip switch.
   - Connect the motor to the kit.
   - Connect the signals from the two switches on the dip switch to two AVR ports.
   - Connect the signals from the two buttons to two AVR ports.
   - Connect the signal from pin OC0B to a test point channel for measurement.
   - Connect the signals from two port pins to control the forward/reverse direction to a single LED for status checking.

b. Compile, execute, and test the program by measuring the waveforms on an oscilloscope and observing the LED status when changing the dip switch and pressing the speed increase/decrease buttons.

c. Connect the PWM signal to MOTOR_ENABLE and the control signals for the motor direction to MOTOR_CTRL1 and MOTOR_CTRL2 on J76 of the DC_MOTOR module.

d. Test the operation of the system.

e. Measure the waveforms from the two A-B signals of the encoder and compare them in the two cases of the motor rotating forward or backward.

LAB REPORT

Class group: *Group:*
Subject:

EXPERIMENT 1:

1. Answer the questions:

   a. In Normal mode, do we need to reset the count register when entering the Overflow interrupt?

   b. Explain the values written to the timer configuration registers and prescaler.

2. Program source code with comments

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EXPERIMENT 2:

1. Trả Answer the questions:

a. In CTC mode, do we need to reset the count register when entering the COMPARE_MATCH interrupt?

b. What are the advantages of this mode compared to the configuration in Exercise 1?

c. Explain the values written to the timer configuration registers and prescaler.

2. Program source code with comments

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EXPERIMENT 3:

1. Answer the questions:

   a. To achieve a scanning frequency of 50Hz, how long will one LED remain lit?

   b. In that case, what will be the frequency of pin PC0 (toggled each time the LED switches)?

   c. How many interrupt occurrences are required to switch the LED?

2. Program source code with comments

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EXPERIMENT 4:

1. Answer the questions:

   a. Describe the connections on the kit.

b. Capture the waveform of the 2 encoder channels in both the forward and reverse rotation cases.

2. Program source code with comments

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