



University of British Columbia  
Electrical and Computer Engineering  
Electrical and Biomedical Engineering Design Studio  
ELEC291/ELEC292

## Laboratory 2 – Interrupts / Alarm Clock

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### Introduction

Interrupts are very important and useful for embedded systems. An interrupt is an event that triggers the automatic execution of a predetermined piece of code. The code used to handle interrupts is often referred to as the Interrupt Service Routine (ISR). The normal or default flow of code in a microcontroller system can be interrupted by different events, for example: timers overflowing, external events, critical errors (such as division by zero or illegal op-codes), power failure, communication events, etc. In this module you will be using timer interrupts in the N76E003 microcontroller in assembly language.

### References

A51 (8051 assembler) user manual included with CrossIDE. 'A51.pdf' not only describes how to use the assembler, but also includes a detailed description of all the instructions supported by the 8051 family of microcontrollers.

N76E003 Microcontroller Datasheet. Information about timers and other hardware peripherals in the N76E003 can be found in the datasheet.

### Laboratory

1) Provided in the web page for the course is the example "ISR\_example.asm". This demonstration program carries three 'concurrent' tasks:

- Increments (when P1.6=1) or decrements (when P1.6=0) a BCD variable every half second using an ISR for timer 2;
- Generates a 2kHz square wave at pin P1.7 using an ISR for timer 0; and
- In the 'main' loop it displays the variable incremented/decremented using the ISR for timer 2 on the LCD and resets it to zero if the pushbutton connected to P1.5 is pressed.
- Toggles pin P0.4 every millisecond.

Download, compile, and load the program into the N76E003 microcontroller system and verify its correct operation using an oscilloscope or multimeter to check the 500.000Hz square wave output of pin P0.4.

2) Write/compile/run an assembly program for the N76E003 microcontroller system with LCD for an alarm clock. The alarm clock must display hours (12 hour mode with AM/PM indication), minutes, and seconds, using the LCD. The clock's current time (hours, minutes, seconds, AM/PM), must be settable using pushbuttons. The clock must also include a settable alarm. When an alarm is triggered, a speaker should produce an alarm sound. Use the mini speaker available in the microcontroller system parts kit for this purpose. Don't forget to add extra functionality and/or features for bonus marks! Demonstrate your clock to one of the lab TA during lab time. Also submit a short movie demonstration of your microcontroller system working as an alarm clock and your assembly code to Canvas.